



## Building an Exhibit to Educate Remote Communities About Recycling Practices

SCOM 5056  
December 3, 2017

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## ProtoSci Design

### Our Vision

At ProtoSci Design, we strive to build the best user-centered products by inspiring and implementing solutions for environmental concerns. Our team specializes in science communication and is determined to bring your idea to life, no matter the challenge. We are located in Sudbury, Ontario at the Living with Lakes Centre where our backyard is a daily reminder of nature's beauty and why we strive to protect it.

### Our Team

We pride ourselves on having passionate and qualified staff to assist you with your business needs. Our team is composed of:

#### **Project Coordinator:** Elizabeth Vickers-Drennan

Elizabeth, more commonly known as "Liz", is the liaison between all our teams. She is responsible for creating a schedule so each team can manage their time efficiently and respect the client's deadline. She also documents the minutes of each group meeting.

#### **Communications Specialists:** Lisa McDonald, Brigid Prouse

Lisa M. and Brigid are the front line specialists who communicate directly with our client. This includes showing the client prototypes and providing updates on the progress of the product development. They also create a roll-out plan for the exhibit, determining its use in the different locations targeted and the materials required.

#### **Evaluation Specialists:** Torben Halbe, Lisa Jones

Torben and Lisa J. are responsible for ensuring the exhibit is accurately targeting the desired users. To start, they define the users and create personas in order to help the Design Team and Construction Specialists move forward with the prototype development. In addition, they define the parameters of the communities and conduct thorough research to determine what has previously been done in this field.

**Design Team:** Torben Halbe, Elizabeth Kleisath, Jeremiah Yarmie

Torben, Elizabeth, and Jeremiah are the creative minds behind the idea for the exhibit. After consulting with the full team, they take suggestions and develop them further to bring the client's ideas to life. The trio then presents the ideas to the full team for feedback and makes adjustments to the design using the constructive criticism provided. They are responsible for creating the proposition and forming the final idea.

**Construction Specialists:** Shahana Gaur, Leah Hodgson, Meerna Homayed, Elizabeth Vickers-Drennan

Shahana, Leah, Meerna, and Liz work on building and testing prototypes that can be used to evaluate the different designs. They also make any adjustments as needed to efficiently and accurately develop a solution for the client's vision. Their last responsibility is determining the budget for the project, taking everything into consideration so there are no unexpected discrepancies.

**Managers:** Catherine Crawford-Brown, Sophie Lamoureux, Jamie Mistry

Catherine, Sophie, and Jamie are responsible for gathering all documents and materials from each group and combining them into a manuscript for the client. Transparency is a priority at ProtoSci Design, so every detail (including meeting minutes) is included. This team will present the final product and any supplementary materials to the client and ensure that they are satisfied with the solution. ProtoSci Design always guarantees client satisfaction prior to finalizing the product. In the event that the client has any last minute feedback and requests a change to be made, the team will make sure that those modifications are made in a timely manner.

## Client Request

In November 2017, we were approached by Mr. Smith, a representative from a company specializing in building travelling exhibits for the purpose of science outreach.

Mr. Smith tasked ProtoSci Design with building a mobile exhibit that could be used to educate remote communities about the hazards of incorrect waste disposal. The purpose of the exhibit would be to raise awareness and persuade users to change their behaviours and habits. The target community would not be capable of interacting with text, so it was

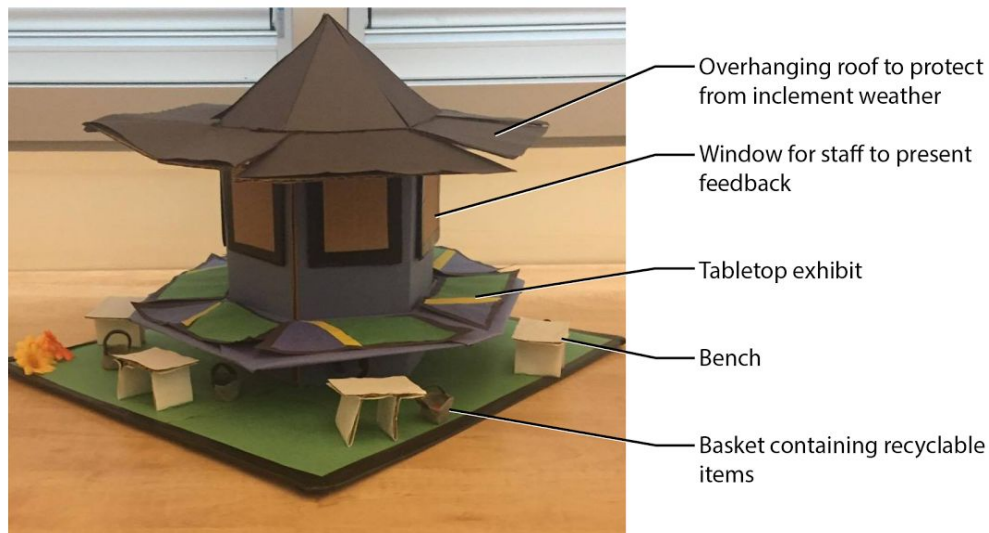
requested that the exhibit be mostly visual. Mr. Smith also requested that the users be able to interact with the exhibit in a tangible capacity that would evoke a two-way discussion between the users and the exhibit operators. He also wanted an open design such that many people could watch the user and learn from their actions and how they interact with the exhibit.

### Proposed Prototype

Using the criteria outlined by Mr. Smith, ProtoSci Design has developed a solution that would meet the needs of the identified target audience. This is a travelling exhibit that would be set up in various communities in different countries. Since there is no universal language between these communities, the exhibit cannot rely on words, spoken or written, to communicate to these groups. Therefore, the exhibit uses a combination of visual cues and tangible objects to communicate the message.

#### **Infrastructure**

The exhibit itself is designed as a hexagonal-shaped hut (Figure 1). Each of the six sides of the hut has a tabletop, a window to the inside of the hut, and a bench. Being that the exhibit has six sides, multiple individuals can interact with the exhibit at the same time, encouraging group learning. The bench provides a comfortable place for the user to sit while engaging with the exhibit and allows other members in the community to observe what they are doing as they stand behind. A roof overhangs the entirety of the hut, including the benches and beyond to allow those watching from behind the user to be protected from inclement weather such as rain or direct sunlight. Since the exhibit does not operate on electricity, we have chosen to forego the use of solar panels.



**Figure 1:** Side view of a physical prototype of the proposed exhibit

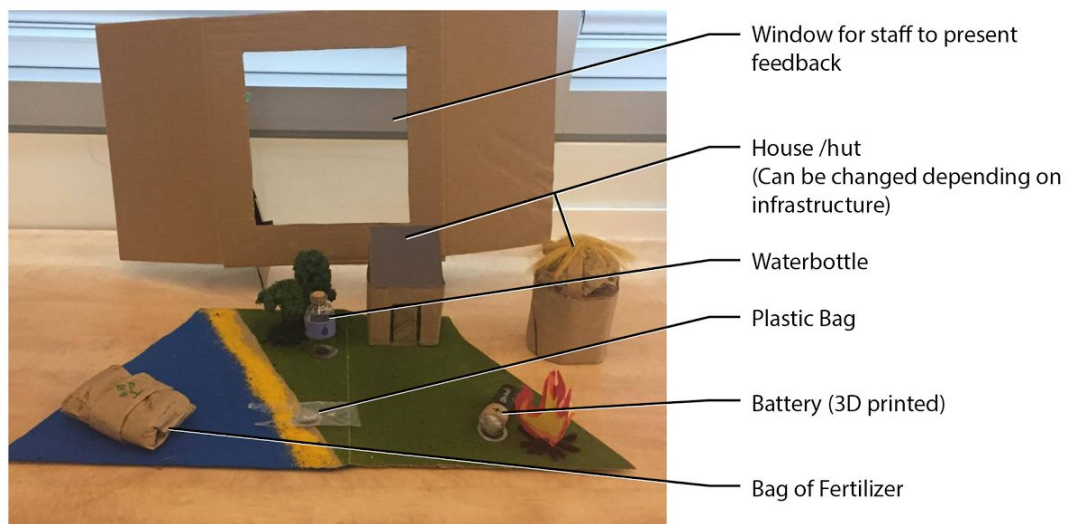
## **Interactive Design**

Each tabletop in front of the user contains a diorama of a 3-dimensional landscape including water, a shoreline and land, with a firepit present on land (Figure 2). The design team wanted to illustrate each of the different places where individuals may live or areas they may interact with regularly and where waste could be incorrectly disposed of, causing harm to the environment around the community. For example, disposing of waste in the water can result in chemical contamination of fish as well as physical dangers for fish (e.g. getting caught in plastic bags). Similar effects may be seen if items are disposed of along the shoreline. Burning the materials would likely seem like a reasonable way to dispose of them, but can release caustic chemicals that may negatively impact the health and environment of the community. Several examples of these recyclable and hazardous materials are included in the exhibit such as plastic bags, water bottles, batteries, and bags of fertilizer. We selected these items as we predicted they would be abundant in the communities and easily recognizable. In addition, we believed it would be easy to influence a change in behaviour for correctly recycling/disposing of these items.

As seen in Figure 3, each of the four landscapes has a hole in the board that corresponds to the protuberances on the individual recyclable items. Staff members who travel with the exhibit will be standing in each of the windows located on each side of the hexagon. They will observe the user as they interact with the exhibit. When the user has placed the

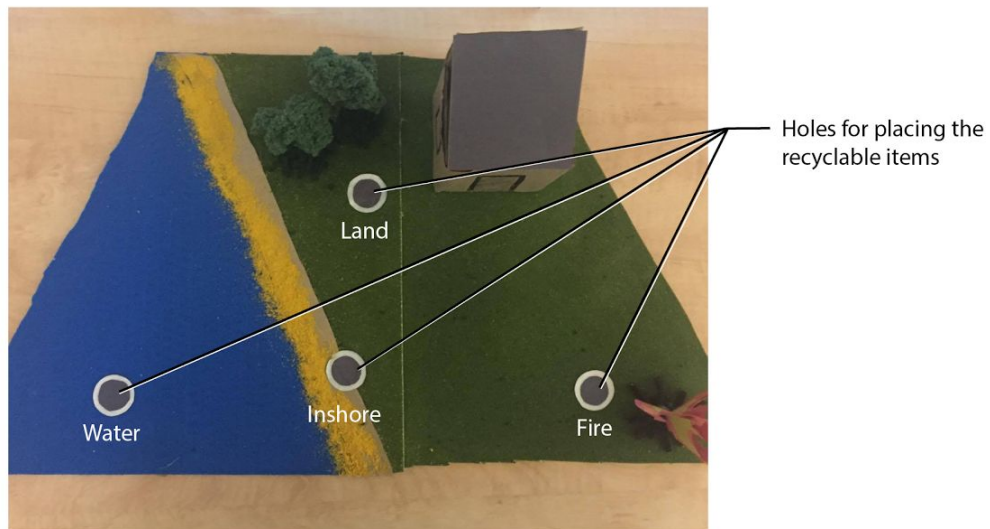
## The Recycle Hut

recyclable item in one of the holes on the board, the staff member inside the hut will hold up a sign visually depicting what would happen if the item was placed in that area. For example, if the user puts the battery in the hole associated with the fire, the staff member would hold up an image of an explosion. This would be done for each combination of recyclable items and landscapes on the board. Since there is no correct place to 'dispose' of the items on the board, the user would then be directed to take the items and put them in a representative waste bin after their interactions with the exhibit are complete. Placing the items in the waste bin would result in the user obtaining a reward from the staff members running the exhibit. These rewards would change depending on the community and may include things like seeds or other agricultural products.



**Figure 2:** Prototype of the diorama presented in front of the user including the recyclable materials

## The Recycle Hut



**Figure 3:** Overhead view of the landscapes presented on the diorama in front of the user

## Budget

As Mr. Smith provided ProtoSci Design with an unlimited budget, our design was not constrained by access to resources. However, because we did not use any technical components in this exhibit, the total cost was less than initially anticipated. Below is the detailed breakdown of the projected budget for this project, excluding the costs required for staff at each of the locations and transportation costs for the exhibit when travelling to each community (Table 1).



# The Recycle Hut

**Table 1:** Detailed budget outlining the cost to build 'The Recycle Hut'

## Report Summary

Materials	\$3,341.89
Labour	\$25,188.80
Additional Fees	\$6,000.00
<b>Total Costs</b>	<b>\$34,530.69</b>

\* Does not include transport of exhibit and staff  
 \*\*See below for breakdown of costs



### Materials

	Cost/unit	Number of units	Total cost
Lumber (Plywood)	\$32.25	12	\$387.00
Paint	\$31.00	10	\$310.00
Fastners	2.97	100	\$297.00
Transport materials	Varies	Varies	\$200.00
Dump Container	\$32.25	4	\$129.00
Table top supplies	\$50.00	6	\$300.00
Benches (2x4s)	\$8.70	18	\$156.60
Specialized baskets	\$7.47	7	\$52.29
Custom 3D Printed Items	\$20.00	28	\$560.00
<b>Construction</b>			
Contingency Costs			\$200.00
Rewards			\$400.00
Replacement parts			\$200.00
<b>Per location supplies</b>			
Wear and tear			\$150.00
<b>Cost of materials</b>			<b>\$3,341.89</b>

\* Assuming lost objects, replacement of rewards  
 \* Travel damage + on site damage

### Labour

	Number of staff	Salary/hour	Hours per person	Total hours	Total Cost
<b>Construction</b>					
Carpenters	4	\$15.00	120	480	\$7,200.00
<b>Staff Training</b>					
Operators and coordinator	7	\$11.40	80	560	\$6,384.00
Set up	6	\$11.40	5	30	\$342.00
Operation	6	\$11.40	12	72	\$820.80
<b>On Site Staff (per location)</b>					
Take down	6	\$11.40	5	30	\$342.00
Logistics Coordinator	1	\$35.00	30	30	\$1,050.00
Communications Specialists	2	\$40.00	15	30	\$1,200.00
Design Team	3	\$40.00	20	60	\$2,400.00
Construction Specialists	4	\$25.00	20	80	\$2,000.00
Evaluation Specialists	2	\$40.00	15	30	\$1,200.00
Managers	3	\$40.00	15	45	\$1,800.00
<b>ProtoSci</b>					
Coordinator	1	\$30.00	15	15	\$450.00
<b>Cost of labour</b>					<b>\$25,188.80</b>

### Additional Fees

	Total Cost
<b>ProtoSci Fees</b>	
New Client Fee	\$1,000.00
Prototype Construction fee	\$5,000.00
<b>Total additional fees</b>	<b>\$6,000.00</b>

### Costs Not Included

	Staff	Exhibit
<b>Transport (per site)</b>		
Flight		6 Cargo jet
On-land Travel		6 Transport truck

## Design Process

### Identifying the Audience

Before beginning the design process, our team had to identify the audience that would be interacting with the exhibit. We chose to target multiple communities across the globe. Since the language used would vary between each region, the modes of communication that could be used in the exhibit were limited, therefore we opted to eliminate any verbal or written mediums from this design. The design of the diorama had to reflect the communities that the travelling exhibit would visit. We included a water scene in the landscape with the intention of reaching communities that live near a body of water. Since these communities have some form of a hierarchical system, we believe it is important to have the exhibit directed towards members of higher hierarchical status who would be interacting with the displays directly. Those lower in the hierarchy would then be able to observe and learn from the interaction.

### Prototyping

In the initial phases, our Design Team identified that a change in habits is best achieved using a stimulus-response exhibit. The users would be given a negative response when they did not correctly recycle materials. However, the users would be given a reward when they correctly disposed of materials. Ideally, this reward would be something of value to the community. There should be a focus on how improper disposal of these materials can affect communities. Understanding that their current habits cause a direct threat to their resources (food, animals, water, and land) would likely make users care more. The exhibit should reflect real-life situations, informing communities about the negative environmental impacts of their current habits and promoting changes to correct these habits. Since there are cultural differences between communities, abstract symbols should be avoided and instead the use of tangible items or pictures of these items should be employed as they would be more relatable. An example of these representations could be in the form of a real car battery, a picture of a car battery, or a model replica of a car battery.

The Design Team envisioned this exhibit as having two or three steps. First, the user would have to identify recyclable materials in the area around them, either by searching a plot of soil or disassembling a car. Second, these items would be placed on a representation of the

## The Recycle Hut

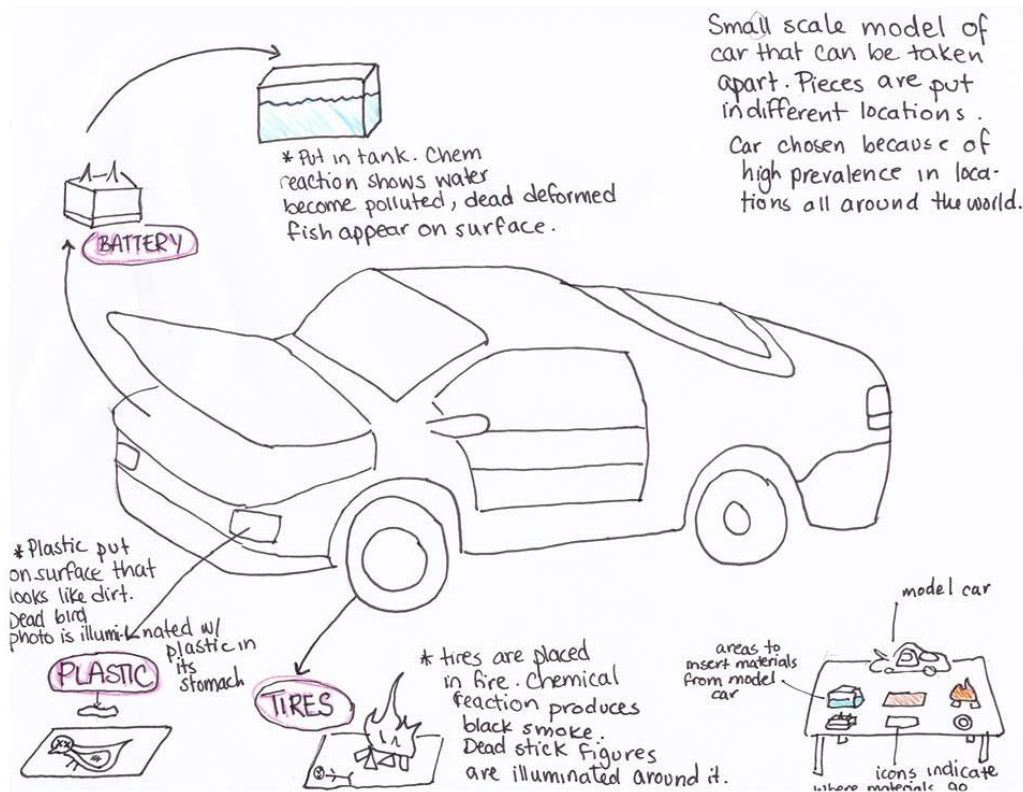
community's ecosystem and either a physical change would happen indicating a negative effect (e.g. a battery begins leaking a dark coloured liquid and the model fish die) or the exhibit would display some visual representation of a negative effect (e.g. plants dying). The latter is a screen-based approach rather than an approach using special effects. In the third step, removal of the harmful item and disposing it in the appropriate waste bin would result in some positive reward.

### User Experience Goals

We wanted to build an exhibit that would be social so that many people could interact with the exhibit at the same time as well as discussing the exhibit as they are engaging with it. We also wanted the execution to be simplistic so that it could be understood without explanation, as this cannot be provided if a language barrier exists. Helpfulness is important as we wanted the users to take away information about how their actions are affecting their environments and what they can do to correct those negative effects. Finally, we wanted it to motivate people to change their behavior in response to the negative effects they are presented, as well as the positive rewards.

### **Prototype v1.0**

In the second exhibit, a small-scale version of a car would be provided to the user (Figure 4). A car was chosen as they are widely available around the world and easily recognizable. The model car would be disassembled into its parts such as tires, battery, pieces of plastic, etc. The user would again be provided with a diorama containing different landscapes. In this scenario, chemical reactions and illuminated icons on the exhibit would be used to provide feedback instead of the screens. For example, placing the battery into the water would cause a colour change induced by a chemical reaction and dead fish would appear on the surface of the water. Tires could also be placed into a fire causing a chemical reaction that releases smoke.



**Figure 4:** Sketch of the proposed model car and locations to place the car parts

### Usability Criteria

The **effectiveness** of this exhibit is likely to be very high as the feedback (e.g. smoke from a burning tire) is much more tangible and memorable for the user than displaying an image on a screen. However, the opportunity for learning may be limited by the types of materials that can be presented from a model of a car. The exhibit may also be less relevant because disposing of a car is not an everyday task. The direct response obtained when a stimulus is applied adds to the **efficiency** of this exhibit. But time is taken away from user interactions when the chemistry has to be reset between each use. These chemical reactions are also unlikely to be **safe** in this context, especially when producing smoke. The people using it may also be fearful of the feedback. Therefore, the **utility** of this exhibit may not be as strong. Icons on the diorama showing where the user should put each piece of the car would help ensure the user **understands** the instructions. These icons should also prompt users to **remember** how to interact with the exhibit, even after they have left.

### *Design Principles*

The **visible** icons on the board showing which parts of a car can be placed in which environments should indicate to the users how to interact with the exhibit. The exhibit would also be laid out so that the smoke and colour changes are visible to the user. These types of **feedback** would occur immediately, ensuring that the user understood the action that led to the feedback. The user would be **constrained** by a set number of waste items and a set number of interactions that would cause feedback. For example, putting the tire in water would not cause anything to happen. The design has **internal consistency** as objects must be placed on the table, but also lacks this consistency as users do not know what feedback they would obtain following a stimulus. In terms of **external consistency**, the users should be able to recognize the car and parts of the car, as well as the different environments surrounding them that are represented on the board. Finally, the locations where the items must be placed would be clearly marked, providing **affordances** to the user.

### **Prototype v2.0**

In this design, a board would be placed in front of the users with representations of landscapes such as water, shoreline, and land. It would also show different objects such as trees, houses, and fire. This would be similar in structure to the *Settlers of Catan* game, but would contain 3-dimensional objects to make the landscapes more recognizable (Figure 5). Each of the landscapes would contain a divot so that the user would recognize where to place the recyclable items with which they are provided. For example, the exhibit may include bags of fertilizer, plastics, and batteries. Each divot would contain a RFID sensor and each piece of recyclable material would contain a RFID chip. Therefore, when any of the recyclable objects are placed in any of the divots, the chips would be recognized, providing feedback to a screen in front of the user. This screen would be adjustable to make the user as comfortable as possible. A specific response would be provided on the screen when a recyclable material is placed on one of the landscapes. For example, placing the battery in the water would result in images of batteries leaking and dead fish on the screen. These responses are shown below (Table 2). Because RFID chips are not especially specific, the landscapes would have to be widely spaced on the board to prevent the incorrect response from showing on the screen. Originally, the Design Team wanted one recyclable item to be dispensed at a time through a coin-slot system so that the system

would not be overwhelmed with too many algorithms. However, they determined that this would limit the exploration by the user.



**Figure 5:** Primitive schematic of the board in front of the users. The black dots indicate where the holes and RFID sensors would be placed

**Table 2:** Possible feedback from interaction between a recyclable item (columns) and a landscape (rows) on the board

	<b>Fertilizer/Pesticide</b>	<b>Plastic</b>	<b>Battery</b>
<b>Water (lake/river)</b>	<ul style="list-style-type: none"> <li>- Algae blooms</li> <li>- Unsafe to drink</li> <li>- Unsafe to swim</li> <li>- Kills animals/fish</li> </ul>	<ul style="list-style-type: none"> <li>- Kills animals who eat it (make specific animation for plastic rings around animals)</li> <li>- Plastic accumulation (island)</li> </ul>	<ul style="list-style-type: none"> <li>- Leaking causes: Contaminated drinking water</li> <li>- Killing animals</li> </ul>
<b>Shore</b>	Same effects as water effects, except that either the materials are swept into the water body or the materials are leached into the water over time. Show this animation before then leading to the water effect above		
<b>Inland ground/ garden/ yard</b>	<ul style="list-style-type: none"> <li>- Burns grass/yard and overdoses garden plants; killing plants</li> <li>- Bioaccumulates in animals through a food chain animation</li> </ul>	<ul style="list-style-type: none"> <li>- Water accumulates in plastic waste forming a breeding ground for mosquitos</li> <li>- Can interfere with garden plants, preventing them from growing/ rooting/ spreading</li> </ul>	<ul style="list-style-type: none"> <li>- Leaking into garden acidifies the soil, killing plants, grass, trees, etc.</li> </ul>

<b>Inland well</b>	Same as water animations, except it goes through the ground first and affects groundwater rather than surface/running water. Does affect animals, but still affects drinking		
<b>Fire (bonfire)</b>	- Causes fertilizer explosion and releases noxious gases	- Releases toxic fumes - Forms melted plastic that can be hard to clean once it becomes solidified	- Causes battery explosion and releases fumes, including (in Li batteries) things like Hydrogen fluoride, which is very dangerous

Initially, this prototype was envisioned as a single unit. It would stand on adjustable legs so that it could be presented even on rugged terrain. The entire exhibit would be waterproof and would be powered by solar panels. A backup generator would be included in case of solar panel failure.

### *Usability Criteria*

The **effectiveness** of this exhibit would be derived from its representation of real-life scenarios. The user should be able to recognize the recyclable items from their community and draw parallels between the landscape on the board and what is surrounding them. This also adds to the **utility** of the exhibit. The exhibit would also be **efficient** as placing a recyclable object in any of the divots would result in an immediate response. The exhibit would be **safe to use** as it does not include any harmful substances such as chemicals and would be well-balanced and stable because of the adjustable legs. Finally, because the recyclable items would fit into the divots on the board, it would be easier to **recognize** what interaction needs to be performed and **remember** for the next use.

### Design Principles

The divots on the board would be clearly **visible** so that the user is able to see them and recognize where the recyclable materials need to be placed. The waste bin where the materials need to be placed at the end should also be visible. Once the interaction has occurred, the exhibit would provide direct **feedback** in the form of an image on the screen. The interaction itself would be **constrained** as only objects that are placed in the appropriate divots on the board would elicit a response. Putting objects anywhere else on the board would not register as a stimulus. The fact that any of the objects can be placed in

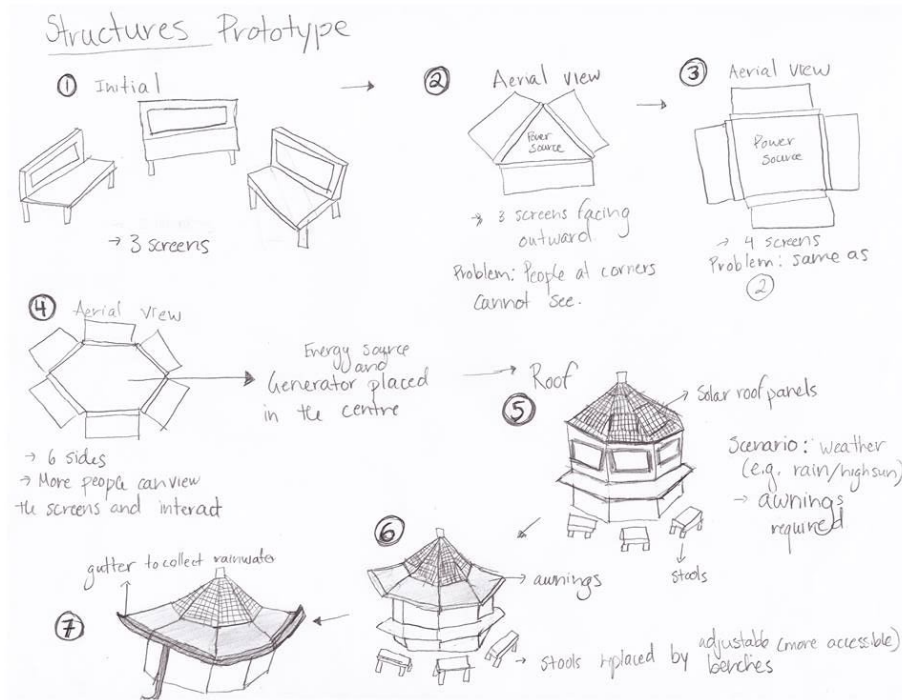
any of the divots removes any **ambiguity** from the design and provides **affordances** in this exhibit. The design would have **internal consistency** as the same feedback would be provided when an object is placed into any of the divots. It would also have **external consistency** as it would be a small-scale representation of the world around the user.

### **Prototype v2.1**

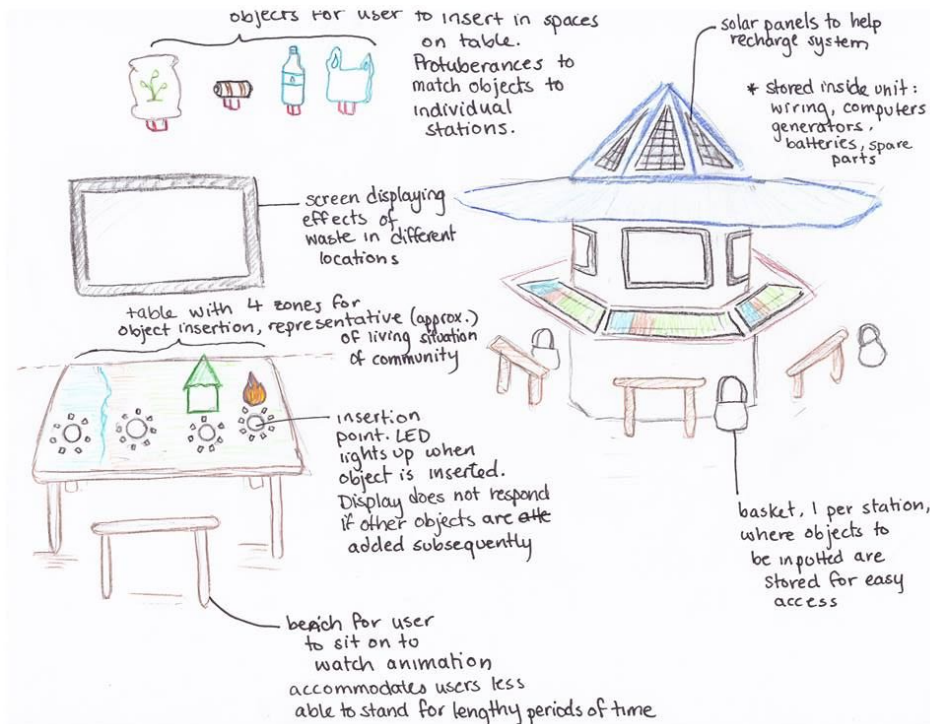
After analyzing the usability criteria and design principles of each of the prototypes, it was identified that Prototype v2.0 would be a better fit given the goal of this exhibit. As the Construction Specialists began building a physical representation of this prototype, they recognized several opportunities for improvement. For example, the exhibit could be shaped like a hexagon so that 6 users could interact with the exhibit at a given time (Figure 6). This would add to the efficiency of the exhibit. Each of these sides would have a bench for sitting at the table, leaving enough room behind it for others to watch the user engage with the exhibit. Having a hut shape with benches surrounding the walls of the hut for the users would also allow for storage of wires and screens when travelling. They also decided to add a roof that would overhang the benches so that users would be protected by inclement weather such as rain and direct sunlight. They also proposed mounting solar panels on the roof of the hut to help power the exhibit. Finally, the Construction Specialists identified bags of fertilizer, plastic (bags and bottles), and batteries as the most important recyclable materials to include (Figure 7).



# The Recycle Hut



**Figure 6:** Detailed schematic of the 6-sided structure of the exhibit



**Figure 7:** Description of exhibit elements on each side of the hexagonal hut

## Client Feedback and Adjustments

During the design process, our Communications Specialists met with Mr. Smith to provide updates on the product development. During the meeting we proposed 2 potential designs, to which he provided insightful recommendations. With the first design, Mr. Smith was impressed with our idea to demonstrate water pollution following improper waste disposal using a change in colour and the appearance of dead fish. However, we emphasized that this idea was not feasible as the demonstration would need to be repeated multiple times and the chemistry would need to be reset between each use. We therefore proposed our second idea, where the user places a hazardous item on the landscape diorama and the result of that action (such as fish dying) appears on a screen in front of them. Mr. Smith was concerned that the users would be distracted by the foreign technology of the screens, taking away from the main message of the exhibit. He therefore suggested we take a less technical approach, excluding the screens and the RFID chips. As a result, we decided to have additional staff travel with the exhibit. These individuals would survey the users as they interacted with the exhibit and provide visual feedback depending on where the user has placed the hazardous item. This would also help facilitate interactions between the users and the exhibit operators.

## Evaluation

### DECIDE Framework

#### **Determine the Goals**

The evaluation is to be conducted throughout the various stages of product development. The client has requested to be included as the potential user for testing purposes to ensure the exhibit is delivering the desired message of proper disposal methods to ultimately avoid negative impacts to the environment.

#### **Explore the Questions**

- Is it reasonable to assume that users will want to change their behaviour after interacting with the exhibit?
- What barriers may prevent changes in behavior?
- Is there somewhere that users can bring their recyclable materials after the exhibit has taught them about responsible recycling?

### **Choose the Evaluation Approach and Methods**

Before taking the exhibit on the road, usability testing will first be carried out in a laboratory setting. The evaluation will focus on whether a user interacting with the exhibit can understand what they are supposed to do without any instructions. Since the exhibit primarily relies on visual cues to direct the user through the exhibit, the testing will help determine if the user is able to make intended connections between the protuberances on the recyclable items and the holes in the diorama. Observations of the interaction and surveys answered post-exhibit interaction will be used to determine if the users understood how to interact with the exhibit and whether the main message of the exhibit was conveyed. If any of these aspects are unclear, adjustments will be made to the exhibit prior to taking it on the road.

While visiting the communities, field testing will also be conducted. This is the most important form of testing as it will reveal how the intended target audience interacts with the exhibit. The observations made while the users interact with the exhibit will provide valuable information to the designers on whether they understood the information they were supposed to take away. When possible, a translator will be present to interview users and interpret their interactions after using the exhibit. The feedback received will help ensure the exhibit's design is universally accessible and understandable by a broad group of users.

### **Identify the Practical Issues**

In conducting usability testing, several challenges will first have to be addressed. For example, it is likely that those testing the exhibit will not be from the target communities as it would be too expensive to bring the exhibit to them for testing purposes. Assuming that those carrying out the testing will be from developed communities, they will already be aware of correct recycling processes. This audience may therefore not be a good surrogate for those living in targeted remote communities.

In conducting interviews with the users during field testing, an interpreter will be required to understand what the users are saying. Unless one person is specialized in many different languages, a different interpreter will be required for each community as they will likely speak different dialects. Hiring many translators could be quite difficult and expensive.

### **Decide How to Deal with the Ethical Issues**

The most prominent issue with the ethical practices is receiving consent from the users. Since many of the individuals are unable to read, informed consent forms will not be an effective way of obtaining consent. Multiple iterations of the forms will have to be developed for each community based on their distinct dialects. Therefore, using verbal consent is more feasible by having a translator explain the study while the user is seated.

Again, since this process is complex, an adequate number of staff who speak the language will be required to speak with users about giving their consent to be studied. The participants likely will not have encountered this type of approach before and it may take time for them to understand what they are being asked. It will also be more difficult to keep track of the participants as there will be no paper trail of consent. Since there are distinct hierarchical structures in these communities, it shall be considered whether approval from the elders is sufficient to include the rest of the community.

### **Evaluate, Analyze, Interpret, and Present the Data**

This section will focus on data gathered from the field, which will reflect how the intended target audience interacts with the exhibit. This study in particular will result in high ecological validity as it is taking place in a natural setting. However, this will also make the data less reliable as the conditions around the exhibit may change. Using a structured interview style when possible will help improve the reliability of the findings, however this depends on the presence of an interpreter. Additionally, during the translation, bias may be introduced when asking and explaining the questions to the users. The study results may also be biased as interpreters may be available in certain regions, but not others. Since there are no exact measurements taken, validity in this study may also be low. However, interview questions such as “What did you learn from this exhibit?” or “What challenges did you experience when interacting with the exhibit?” may help us better understand and validate the user experience. Assuming that the evaluation is carried out across many communities, the scope would be quite large.

## Personas

The Rivera Family: Spanish speaking (Indigenous dialect) family of shoemakers headed by the stubborn maternal grandmother who runs a tight ship. They all live together under the same roof in the small village of Santa Cecilia.

The Rivera family enjoys working as shoemakers in their small Mexican village. The shop was founded by their great great-grandmother who was stubborn, but independent in succeeding on her own after her musician husband left her to raise their daughter alone. Her close-minded but hard-working and loving character has been passed onto the rest of the family. While out shopping in the Mariachi Plaza for leather goods, the three Rivera family members presented below come across ProtoSci Design's travelling exhibit surrounded by curious townspeople. They take turns interacting with the product.

Miguel is a 12-year-old boy obsessed with music, specifically playing the guitar, even though his family disapproves. He is essentially the black sheep of the family due to this curiosity towards a life beyond his family values. He is the most impressionable of the family overall.

Enrique is Miguel's father, a 38-year-old shoemaker who has married into the family. Although he identified with the hard-working culture of the Rivera history, he is more open-minded to learning new skills and accepting different viewpoints than his wife and her blood relatives.

Abuelita is the 65-year-old grandmother of Miguel and mother-in law of Enrique. She claims the highest parental figure of Miguel since her mother is mostly senile and unable to care for herself let alone her descendants. Although Abuelita is stern towards her family, this overprotectiveness stems from love. Overall, she is the least likely to adopt recycling in her daily routine and would greatly benefit from a user-friendly design to minimize her potential frustrations for learning a new task. She is extremely busy running a business and caring for a large extended family so her priorities for recycling have never entered her consciousness.

As Miguel, Enrique, and Abuelita approach the exhibit, Abuelita takes the lead, sitting at the bench in front of one of the tabletops at the hexagonal hut. Being that she is the head of

the family, it is expected that she will try the exhibit first. Enrique and Miguel stand over her and watch as she picks up one of the recyclable items provided with the exhibit and recognizes that it is a battery, similar to what she uses to power the clock in her store. She notices that there is a protuberance at the bottom of the item that would fit well into the holes that are present on the board in front of her. Hesitantly, Abuelita places the item, a battery, into one of the holes near what she sees as fire. In the window in front of her, a staff member holds up a sign showing fire everywhere. This is clearly not a good response and she should not have put the battery there. Abuelita picks up the battery and places it in the hole in the water. The staff member in front of her holds up a sign of many dead fish. This is also a bad thing. Abuelita places the battery on the shore and is again shown the image of the dead fish. Finally, Abuelita places the battery on the land, figuring that this must be a safe choice. But the staff member in front of her shows her an image of dead plants. That can't be good.

The three members of the Rivera family look around, trying to figure out where the battery should go that won't cause bad things to happen. They look around and see others taking the items from the board and putting them in a bin to the side of the exhibit. The people appear to be walking away with something after getting rid of their items. Abuelita picks up the battery and walks over to the bin. She puts the battery inside and in return, is handed a packet of seeds to grow peppers in her garden. She recognizes that this must be the correct place to put the battery. Through this interaction, Abuelita, Miguel, and Enrique have all learned that placing batteries anywhere in the environment will cause bad things to happen. But putting the battery in the bin will result in a reward. In the future, they will place their batteries in the bin and not in the water, shoreline, fire, or on land. Unfortunately, the family has to continue on with their errands, but will return later to see what happens with the other objects and to get more seeds.

## Neilson's Heuristics

### **Visibility of System Status**

Because the exhibit relies on the manipulation of tangible objects and because no technology has been included, the system status will be clear at all time as it is being controlled by the user.

### **Match Between System and Real World**

While not an exact match, the board in front of the users should resemble an environment with which they are familiar. The lack of language and substitution with visuals should also ease this recognition and ensure that the users understand the content of the exhibit.

### **User Control and Freedom**

The user is afforded complete control over the entire interaction, placing any of the recyclable materials in any of the slots on the board.

### **Consistency and Standards**

The exhibit is consistent in the aspect of stimulus-response. Placing an object on any position on the board results in the same response, but a different image is provided depending on the scenario. It should therefore be clear to the user what will happen when they place an object on the board after the first interaction.

### **Error Prevention**

The holes on the board will encourage users to put items into specific spots. However, there are no restrictions on the type of object they place on the board and where. In that case, the staff member will have to adapt and provide a response. Additionally, there are no preventative measures that determine how many objects can be placed on the board at the same time. As a result, the user may be given only one recyclable item at a time to prevent this kind of error.

### **Recognition Rather than Recall**

Based on the design, the users should be able to recognize that the protuberances on the recyclable items will fit into the holes on the board. The simplicity of the exhibit is especially important because the user should not have to remember how to interact with the exhibit.

### **Flexibility and Efficiency of Use**

Due to the simplicity of this exhibit, there is no affordance to increase the efficiency of the interaction. In addition, the speed of the interaction depends on how much attention the staff member is paying to the user's interaction with the exhibit as they must provide the corresponding response.

### **Aesthetic and Minimalist Design**

The limited number of items on the board in front of the users provides a minimalist design and makes it easier to recognize the desired interactions. Additionally, the bright colours on the board will provide a pleasing aesthetic for the user.

### **Helps Users Recognize, Diagnose, and Recover From Errors**

Since the exhibit is based on a stimulus-response model, users will be readily informed of errors. The entire exhibit is based on errors, as placing the recyclable objects in any position on the board results in a negative response from the staff member inside the hut.

### **Help and Documentation**

No help or documentation will be provided to the user as this is a purely visual exhibit to prevent a language barrier between the exhibit, staff, and users.

## Challenges

The challenges faced throughout the design and development processes were primarily due to the lack of consistency between communities. Each group that interacts with the exhibit would speak a different language or dialect and possibly have different belief systems. Our designers had to ensure that the product we were developing would accommodate any language and not be subjected to any cultural differences. Eliminating spoken and written languages was an ideal solution, however the use of pictograms and symbols was also a challenge as they could be interpreted differently between users. Our solution was to avoid the use of any symbols and instead use life-like depictions of what the user can recognize and relate to.

In addition, since the communities we're targeting are in developing countries across the globe, their infrastructure has not been developed to accommodate recycling plants or the use of modern technologies. This also provided a challenge as we were tasked to educate these communities on a foreign concept without the use of words.



# Appendix

## i) Timeline

	November										December				
Teams	Day	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
	Date	21	22	23	24	25	26	27	28	29	30	1	2	3	4
All															
Comms								Write up process for Report team						Executive report is finalized	Introduction
Ideas	Direction-Changing Conversation in Audiences	Reflection on conversation		Compile ideas	Finalize idea, Handover to prototype team			Write up process for Report team		All material to Report Writing Team					
Audiences							Evaluate Usability Criteria								
Prototype				Collect Materials			Build								
Presentation										Receive all materials from other teams		Report Writing		Presentation and report are ready	Final Presentation

## ii) Meeting Minutes

### 2017-11-16 Meeting minutes

Present: Brigid, Jeremiah, Meerna, Torben, Elizabeth, Jamie, Shahana, Catherine, Leah, Sophie, Liz

Regrets: Lisa J, Lisa M

Proposed time for next meeting (check-in): Monday, 20th at 13h00 (1:00 PM)

#### Action Items:

Who	What	By When
Everyone	Sign up to working teams. <b>See document with team descriptions and signup lists.</b>  **** You can be on more than one. The amount of members proposed are only a suggestion - we just need to balance having enough members on each team, and suiting our individual interests	End of tonight
Everyone	Contribute to brainstorm document	Sunday evening
Everyone	Confirm availability for new proposed meeting date	End of tonight
Everyone	Familiarize with resources posted by Sophie re: what other similar projects are going on	ASAP

All Teams	Define: - objectives - needs - ideas for timeline	Monday
All Teams	Create own: - slack channel - Google doc with running action items & to-do list	Monday
Ideas Team	Compile Brainstorm document contents	Monday, 13h

Sophie	Set up logo poll	Thursday night
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Everyone	Vote in logo poll	Monday
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\*\* These will always be at the top of the minutes. They will also be kept in a separate list on a document that will be available on Slack \*\*

\* Spoke about general topic, clarifying

\* need to pick a direction together, then get back to Mr.Smith

Brainstormed a bit about topic. Can be found in brainstorming document.

General teams created:

1. Ideas Team: responsible for the full development of the idea for the exhibit. this includes taking ideas, presenting them for feedback, then repeating the creation process with the feedback. Responsible for creating proposition and fleshing out final idea.
  - a. Jeremiah
  - b. Elizabeth
  - c. Torben
2. Customer Relations and Logistics Team: communications with Mr. Smith, including showing of prototypes & regular updates. Creating a roll-out plan for the exhibit for use in the different locations & the materials needed for said plan. Keeping track of expenses for project.
  - a. Lisa McDonald
  - b. Brigid
3. Audiences (anthropology) Team: responsible for defining users, for creating some personas that will help the ideas team and the building/prototyping team continue with the design process. Parameters of the communities. Making sure the exhibit is relatable. Research on what has been done before in this field
  - a. Lisa Jones
  - b. Torben

- 4. Building/Prototyping Team: responsible for going through the testing of the prototypes, and building the different models so that we can put them through the feedback process.
  - a. Liz
  - b. Meerna
  - c. Shahana
  - d. Leah
  
- 5. Final Presentation/Report Team: Responsible for getting everything together at the end and presenting the final product to client, as well as for creating a quick final write up to present to client.
  - a. Catherine
  - b. Sophie
  - c. Lisa McDonald
  - d. Jamie
  
- 6. Overall Coordinator: Somehow keeping the communication lines open.
  - a. Liz

—  
Making 3 prototypes to show him?  
Teams to be decided by tonight

## 2017-11-20 Group-wide Check-in

In attendance: Brigid, Jeremiah, Meerna, Torben, Elizabeth, Jamie, Shahana, Catherine, Leah, Sophie, Liz, Lisa J, Lisa M

Regrets: None.

**Proposed time for next meeting (check-in):** Monday, 20th at 13h00 (1:00 PM)

### Action Items:

Who	What	By When
Comms Team	Ask 3 clarifying questions to Mr. Smith <ol style="list-style-type: none"><li>1. Should the audience for this exhibit be indigenous tribes like the San people, i.e., small mobile foraging bands of hunter-gatherers who move frequently and are led by tribal elders, or should the audience be indigenous tribes like the Pueblo people, who stay relatively stationary (farming) and elect a council to lead the tribe? Or should both groups be considered possible audiences for this exhibit?</li><li>2. Is the goal to educate the groups about possible government-sponsored disposal methods in their area (like monthly trucks that drive to the local indigenous groups to collect their waste piles), or is the goal to</li></ol>	The 22nd of November

	<p>just teach them not to dispose of the waste in areas that will affect them later (e.g., water bodies)?</p> <p>3. If the exhibit we design were to incorporate a stimulus-response setup (e.g., the user must pair various kinds of waste with pictures of proper disposal sites) should an extrinsic motivation for the correct response be included? By this we mean should users be rewarded for correct responses with physical objects like food, or should correct responses be met with more intrinsic motivational factors, like a happy chirping sound?</p>	
Ideas team	Give sketches (photo or hard copy) to Prototype team	Wednesday 22nd November

\*\* These will always be at the top of the minutes. They will also be kept in a separate list on a document that will be available on Slack \*\*

Topics covered:

1. Ideas team has two alternative designs to propose:
  - a. Create a piece of waste that the user(s) will find, that has a chip inside it to identify it. If it's put on the wrong spot, then screen displays negative consequence.
  - b. Drop a battery into water (with chip on it) - leaks, shows extent of impact on system
    - For both, idea of providing \$ or tangible (seeds, fish) as a reward.
2. Confusions:
  - a. What's the objective for this project?
    - i. Mitigating the effects of improper disposal
    - ii. Proposing an adequate disposal system
  - b. Who exactly are we focusing on?
    - i. Tribally-ruled countries?
    - ii. Local tribes with little political power?
    - iii. How remote are these locations?
      - We'll be operating on the assumption that we can get to the location.
  - c. In what context is this taking place?
    - i. War torn country?
    - ii. Economic situation?
  - d. Motivation of group
    - i. Are we allowed to provide extrinsic motivation? (\$ or tangible goods)?

Prototype Team:

Will be meeting this weekend

Communications Team:

Nothing to report

Will be in contact with Mr. Smith ASAP and get back to us with answers.

## 2017-11-21 AdHoc Meeting minutes

Present: Brigid, Jeremiah, Meerna, Torben, Elizabeth, Jamie, Shahana, Catherine, Leah, Sophie, Liz, Lisa J, Lisa M

Regrets: None

Proposed time for next meeting (check-in): Wednesday 22nd November, 12H at the workshop space in Science North, post Learning Class

### Action Items:

Who	What	By When
Everyone	Reflect on group conversation had in Audiences. What shape will the project take from now on? How will we focus ourselves?	Nov 22nd, morning
Everyone	Come up with a short one-sentence expression of the direction that we now see for the project.	Nov 22nd, morning
Everyone	Meet after Learning class to discuss direction	Nov 22nd @ 12h, Science North

Meeting had due to quick discussion in Audiences class.

Significant discomfort with the audience as determined by Mr. Smith:

- 'Tribal': what is meant by this?
- Illiterate and non-english speakers?
- Too broad of a scope?
- How does this fit in with our Learning and Audiences classes? Seems fragmented and disconnected

Our consensus as a group, to define the scope of the project exclusively as:

1. Audience is non-universal (do not speak the same language)
2. Region-focused: exhibit will visit same types of locations (e.g. all areas near water)
3. Exhibit will retain feature of a few people interacting with it, while being observed by a larger group of people
4. In communities, will engage people of authority in the process of demonstrating exhibit

We will take some time to reflect and meet on Wednesday 22nd after class to reframe our approach to this project.

## 2017-11-22 Meeting minutes

Present: Brigid, Meerna, Torben, Elizabeth, Shahana, Catherine, Leah, Liz, Lisa J, Lisa M

Regrets: Sophie, Jeremiah, Jamie

Proposed time for next meeting (check-in): To be determined.

**Action Items:**

<b>Who</b>	<b>What</b>	<b>By When</b>
Ideas Team	Develop two distinct ideas Delegate one idea to the prototype team, including preliminary sketches and usability criteria	Saturday Nov 25th, morning
Prototype Team	Collect materials	Saturday Nov, 25th morning
Everyone	Contribute craft materials to prototype team's stash in SCOM room at LWL	Saturday Nov, 25th morning
Audiences Team	Create personas Create fictional community Run first round of feedback on prototype/idea	Tuesday Nov 28th, evening
Everyone	Keep detailed notes of work done in teams to make final report and presentation easier	Duration of project

1. Agreement for focus on water communities, with non-english speakers, stimulus response type of exhibit. Not considering any other details for communities. Will create our own fictional situation to best suit our needs and build our exhibit around that. Won't be building in a solution to mitigating the waste into our product.
2. Idea of testing the exhibit being delivered in a foreign-to-us language
3. **Importance of everyone keeping in their lanes** - we have a very small amount of work to do each, and shouldn't try to take care of everything. Trust each other!
4. Brainstormed to give the ideas team more variety, more material to work with.
5. Taking responsibility when it comes to checking the Slack channel.
6. Created a timeline (see separate excel sheet in GDrive)
7. Revisited the definitions of roles:

**Communications Team**

- Talking with Mr. Smith, if needed again
- Introduction for final presentation

**Ideas Team**

- Determine two viable, distinct designs
- Define usability criteria as identified in lectures (revisit these)
- Provide with preliminary sketches

**Users/Audience Team**

- Build personas to evaluate with respect to user criteria and needs
- Complete first round of evaluations using material from course, including DECIDE framework
- Provide feedback to Prototype Team
- Create fictional community

Prototype Team

- Collect materials for constructions
- Create prototype
- Modify prototype as needed

Presentation Team

- Deliver final round of evaluations using material from course, including DECIDE framework
- Prep final presentation & report (10 pages max, plus appendices)
- Jamie to make renderings of the ideas

*Still need to determine next meeting date. Will be done online.*

## 2017-11-25 Prototype Team Check-in

In attendance: Elizabeth V.D., Leah, Meerna, Shahana (Elizabeth K., Torben from Ideas Team)

Regrets: None

Proposed time for next meeting (check-in): Tuesday, November 28

**Action Items:**

<b>Who</b>	<b>What</b>	<b>By When</b>
Ideas Team	Create alternative prototype design (including sketches)	Tuesday, Nov 28, morning
Prototype Team	All collect more materials Check-in with prototype Plan next building session Start working on report for Presentation/Report team	Tuesday, Nov 28, morning

Points of discussion:

Discussion with ideas team about their vision - they originally had imagined a two part exhibit, a table + a screen, with different objects that could be placed on the board to prompt some kind of reaction on the screen.

Our concern was that it would be hard for multiple people to use it at one time, thus, we decided to go with a six-sided exhibit where multiple people could interact with and watch what happens on the screen. The actual physical exhibit would be designed with solar panels on the roof (to provide energy for the screens), an extended roof to cover the exhibit and users in case of rain/high sun, a gutter around the roof to collect rainwater. We also added benches to the design so that users could be comfortable while interacting with the exhibit.

We also adjusted the design of the items to be placed on the table - we decided to use four items total (a representation of pesticide, representation of plastics in the form of a water bottle and plastic bag, and a battery). These items will be presented to the exhibit users in a container that corresponds with each side of the exhibit. Each item will have a protuberance on the bottom that will allow it to be fit into spots on the board like a puzzle piece.

There are four areas on the board - water, inshore, inland, and fire. These all represent spots where the items could be disposed of, and thus, each area will have a designated place into which the items can be fit. Once an item is placed in one of the areas, the screen will demonstrate how the item can harm the environment. The area where the item is placed will light up with LEDs to indicate that this area is in use (which will discourage users from placing more than one item on the board, as this wouldn't work with the one-screen setup).

Although it isn't shown in our prototype, the exhibit would theoretically be made of wood and be constructed in a way that the roof and walls could be separately folded up for transport. Stored inside the interior of the unit will be all the wiring, generators and power sources. This will protect the sensitive equipment from the elements. The television screens can be easily removed for transport. Also, the exhibit is built in a manner that is quickly deconstructible for ease of transport and set-up.

Diversions from original design:

- Slot-machine dispenser to basket

While discussing the design for the prototype, we originally planned to have a slot dispenser eject one item at a time to be placed by user on the interactive table. This way, the table and video technology won't be overwhelmed by more than one object at a time, and consequently will be able to quickly and efficiently recognize the object. Once finished with each item, the user would put it into a different slot in the dispenser and a new item would emerge.

Upon building the prototype, we remarked that only dispensing one item at a time would limit the user's choice and freedoms in learning about proper waste management. Therefore, we chose not to build a dispenser mechanism for the items, rather choosing to place them all in a basket, accessible at will. The first one to touch the table (in the event that multiple items will be on the table at the same time) will initiate the corresponding video. Afterwards, the videos will play in succession of when each additional items were placed on the table. Videos of items removed will not play.

## **2017-11-27 Group-wide Check-in**

In attendance: Brigid, Jeremiah, Meerna, Torben, Elizabeth, Shahana, Catherine, Leah,  
Sophie, Liz, Lisa J, Lisa M

Regrets: Jamie

Proposed time for next meeting (check-in): None believed to be necessary. Will communicate online to confirm.



**Action Items:**

<b>Who</b>	<b>What</b>	<b>By When</b>
Presentation/ Report Team	Send out list of required items, delegated on a per-team basis	Monday Nov 27th, evening
Audiences Team	Create personas Create fictional community Run first round of feedback on prototype/idea	Tuesday Nov 28th, evening
Prototype Team	Give final details of prototype to Audiences Team	Tuesday Nov 28th, evening
Prototype Team	Build final version of prototype	Wednesday Nov 29th, evening
All Teams	Submit materials to report team	Wednesday Nov 29th, midnight

Points of discussion:

Received updated information from Ratvinder on requirements for final reports. These will be produced as follows:

- Presentation/Report team will now be responsible for submitting the final report for the project. This involves all the minutia of the development of the exhibit that has happened on our end.
- Communications Team will now take on the creation of the executive report for Mr. Smith. This will detail the product and the high-level information he needs to know.
- Every team is responsible for creating the content that will be included in the final report. Catherine will send out a list of the materials that she requires from each team, and they will produce it by Wednesday the 29th, at the end of the evening.
- Final report will be written by Friday the 2nd. Final presentations will also be prepared by that point.

Decided that it was not necessary to have a full-on check-in: moving forward, communication will be majoritarily happening online.

**2017-11-28 Prototype Team Check-in**

In attendance: Elizabeth V.D., Leah, Meerna, Shahana

Regrets: None

Proposed time for next meeting (check-in): Wednesday, November 29

**Action Items:**

<b>Who</b>	<b>What</b>	<b>By When</b>
Prototype Team	Assemble materials list Fetch said materials list Calculate theoretical budget Arrange to meet Nov 29 to continue building the prototype	Wednesday, Nov 29 afternoon

Points of discussion:

Earlier in the morning we received a pressing email from Mr. Smith, therefore we refocused our meeting to address the outstanding issues. We contacted our anthropology team to check in on their status and inquired about any updates regarding the potential audiences, environments and obstacles.

In addition, we reevaluated our design progression. This included updating the prototype sketches with intention to present them to other ProtoSci teams and our client.

This was a heavily administrative meeting, in which we coordinated and scheduled future building meetings. Half of the team focused on nailing down the design of our prototypes (including sketches), while the other half updated all clerical work for the Report/Presentation team.

## 2017-11-29 Prototype Team Check-in

In attendance: Elizabeth V.D., Leah, Meerna, Shahana

Regrets: None

Proposed time for next meeting (check-in): Wednesday, November 29

**Action Items:**

<b>Who</b>	<b>What</b>	<b>By When</b>
Prototype Team	Wait for prototype feedback from other teams Present prototypes to audiences team	Thursday, Nov 30 afternoon

Points of discussion:

The Customer Relations team met with Mr. Smith to discuss concerns about certain design elements. Our client would prefer not to have video screens, as this technology may be foreign to our users and impede learning potentials. The Prototype team met briefly with the Customer Relations team to discuss these updates and changes to the design.

## The Recycle Hut

With these recommendations, our team opted to forgo the television screens in lieu of windows showcasing a person holding three images. Instead, when the user places the item in one of the four locations on the table top (using the protuberance/hole system), the staff member in the window for that station will show the corresponding images to create a storyboard for the user. This will allow the user to receive the same message as was previously demonstrated using the television screens, but in a manner that is more comfortable and familiar to them.

Therefore, instead of housing the technology (such as the wiring and backup generators), the middle of the exhibit will be hollowed out to allow six staff members to man each booth. The solar panels were axed the exhibit no longer requires large amounts of energy.

Updates to design:

- Table tops were added to the hexagonal structure prototype.

Our team built a diorama of one of the table tops for reference. This prototype showcases the water, shore, inland and fire sections. It also includes a window to represent where the staff member will be featured.

We added circles indicating where the holes will be located for the items (with protuberances) to be placed in. Our team also built two houses, a disposal unit for waste, and examples of the items (a plastic bag, a battery, a bag of soil?, a bottle) as accessories for the diorama. These will help to explain the design ideas and concepts to our client during the presentation.

Things to consider:

- Possible rewards for completing the exhibit or to encourage proper disposal behaviour.
- Maybe seeds?
- Stimulus-response elements?