

A course collaboration between the University of Notre Dame, US and the National Institute of Design, India

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Data that sets the context of plastic consumption. It describes the magnitude of plastic consumption around the world and the proportion that is specifically used for packaging. The visual also describes the projections of its presence in the oceans over the next 30 years, and per capita consumption of plastics in the United States and India as they compare to world consumption.



Students research the time and distance fruits and vegetables travel in order to get to Ahmedabad, India. The aim was to understand the complexity of supply chains and journeys of fruits and vegetables to arrive at the wholesale markets in Ahmedabad and the needs that packaging had to fill along those journeys before arriving at the local wholesale markets.





**Figure 3**  
**FIELD RESEARCH, INTERVIEWS & PHOTO DOCUMENTATION**

Role of plastics in the understanding fruit and vegetable supply chains

Students visited the wholesale and retail markets to understand the various needs of the vendors and where plastics were replacing traditional materials. Plastics were largely used for packing in the retail purchases for consumers (Fig. 3.1). Traditional materials like jute were used for keeping vegetables cool by sprinkling water on them (Fig. 3.2 & 3.3), plastic cartons and plastic bags were used by retailers for storage, plastic cartons were used by retailers for display and stacking (Fig. 3.4), and lastly packing was required by wholesalers for transportation. It was observed that in many cases where jute had traditionally been used (Fig. 3.5), plastics were increasingly being used to replace those instances due to its durability over natural products.



3.1

3.2



3.3



3.4



3.5



**Figure 4**  
**EXPLORING MATERIALS**

**Understanding local natural materials and resources**

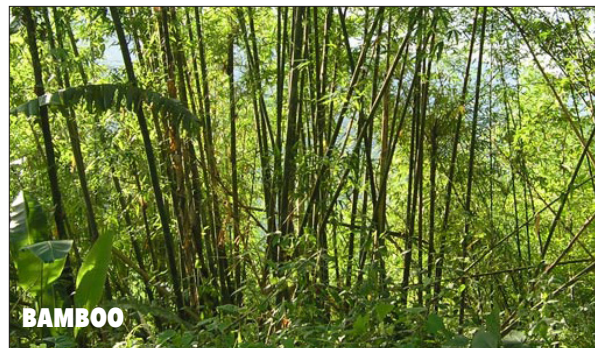
Students explored traditionally used materials like bulrush, banana, bamboo, and jute. While most are used in fruit and vegetable packaging, their use is limited by their availability in certain geographic areas. The water hyacinth on the other hand is a plant that is predominantly found across the world (except in arid areas). It has both pliability and high strength in its various stages of drying. The students decided to examine the viability of using water hyacinth for packaging as a solution for the final design intervention since it is also an invasive species that communities are looking to get rid of. It is abundantly found in tropical climates globally where the water never freezes.



4.1



4.2



4.3



4.4



4.5

<https://drive.google.com/file/d/0B8DodgzyLYoEUWZPb3hGQ1dZbVt/view?usp=sharing&resourcekey=0-mv-rOj3iLDpXBzlpjPjODg>



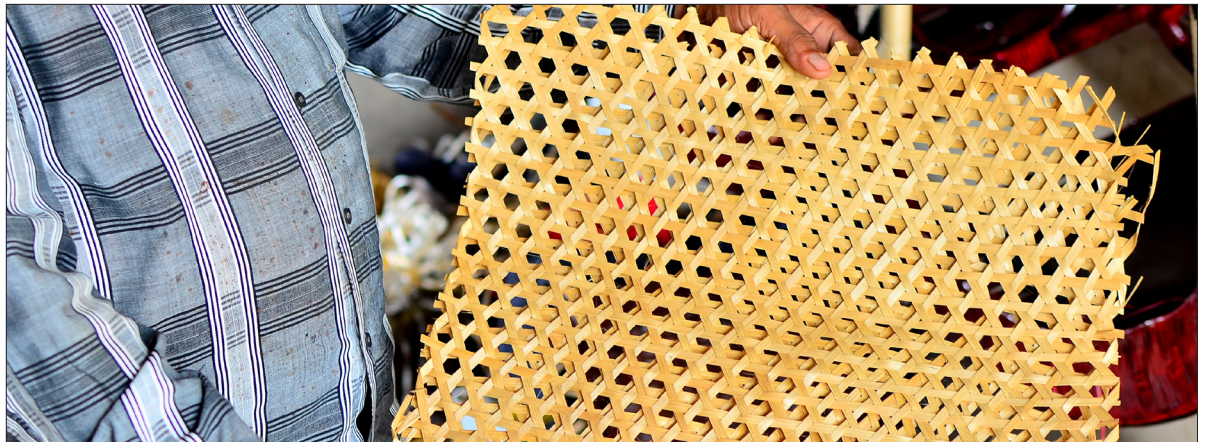
**Figure 5**  
**EXPLORING MATERIALITY**

Understanding how to use the local traditional weaving crafts to create surfaces with different tensile strengths for various uses in fruit and vegetable packaging supply chains

Students explored the pliability versus the tensile strength of the water hyacinth in its various stages of drying. (Fig 5.1) They also examined how different surfaces could be created during each stage of drying to develop surfaces from soft (for protection) to hard (for support and bearing weight) to accommodate the varying needs of wrapping fruits and vegetables in their journey from their originating sources to the wholesale markets and retail sectors. For this, students turned to the traditional crafts of weaving by working with master weavers (Fig 5.2) and consulting crafts specialists to understand the economic viability of solutions being explored.



5.1



5.2



5.3



Figure 6  
THE DESIGN INTERVENTION

Proposing a biodegradable packaging system that promotes sustainability using a cradle to cradle solution

A sustainable packaging solution using the cradle to cradle method made out of naturally biodegradable materials, specifically using water hyacinth in combination with jute and bulrush. The aim was to ensure that the packaging system was customizable, stackable, usable for display, reusable for future use, compactable, and transportable.

# NATURWEAVE

Kacey Hangeulsch | Fall 2017 | University of Notre Dame | Instructed by Professor Naeem Verma

## SUSTAINABILITY DEFINED

When one goes to India, each group was tasked with the challenge of creating a sustainable solution to a systemic issue faced both in India and in the United States. The goal was to bridge the cultural structures of both India and the United States and then come up with a common solution. However, in order to even begin to create a design solution based around sustainability we first had to understand what sustainability was.

For us, sustainability is more than just utilizing resources in ways that avoid harming the environment. It is finding solutions that actually benefit the environment, our economies, and our culture. It is through these three pillars that we determined what a successful solution was.

### The Environment

This aspect of sustainability was the most sensitive. We believed that in order to create a truly sustainable solution, the amount of harm that the environment faces must be reduced. Ideally, we hoped that our solution would not only prevent harm, but it would in fact benefit the environment in both the India and the United States.

### The Economy

In order for our solution to make some long-term, it must be financially economical. If the economics of the solution were ignored, we would likely come up with a solution that might be able to be implemented for a short period of time. Therefore, a solution that streamlined the economy by creating new jobs or sources of income was a must.

## CRADLE TO CRADLE

In typical linear production systems a product is manufactured, used once or twice, and then thrown into the garbage. These linear systems create much waste. To reduce this waste, the cradle to cradle production system was created. In this system, after a product is used in whatever way used for another purpose which avoids the waste of the product while also directly reducing the waste created by the user.

We observed that cradle to cradle is actually a cradle of jobs. Any plant can be made into fiber and that can be used over and over and finally it can be degraded and become part of the original plant. The hope is that our design solution would inspire people to apply the same system to the products created using water hyacinth so that now other they can no longer used as packaging, they become used for other purposes.

## HELPFUL USE OF A HARMFUL PLANT

Water hyacinth, although a beautiful flower grown in many gardens, is actually an invasive plant that devastates communities and water bodies left in the wild, unchecked. The plant is scientifically known as *Eichhornia crassipes* and is found in a problem plant in places all over the world. So how does one small plant cause so many problems?

The rest of the problem stems from the extreme hardness the plants have. They thrive in freshwater in tropical climates. These plants are extremely devastating to small, rural fishing villages because if a village relies on fishing as its source of income. This is because water hyacinth is considered one of the fastest growing plants with abilities to double in population size every three weeks. These plants require lots of resources in order to grow so quickly, requiring their stems and up draining the bodies of water they are in of the oxygen and oxygen supplies. Through a process known as oxygen translocation, water hyacinth also actually drains bodies of water which can turn lakes into swamps in a matter of weeks. This leaves other aquatic life, especially fish, without resources, causing them to die.

Not only do these plants destroy bodies of water, they also create habitats for mosquitoes and other waterborne diseases. This can be particularly troubling for areas lacking proper medical care.

To rid an area of this harmful plant, typically chemicals are used which also can have a negative impact on any remaining aquatic life. This creates an even longer timeline for devastated villages to get their fishing back on track. But, by creating a use for the plant through packaging, harvesting it would end up being beneficial for the communities as they work to making fishing a source of income again.

Besides just being a helpful use of a harmful plant, water hyacinth, naturally has a springy stem that, when harvested and dried correctly, becomes the perfect packaging structure. It is also very durable, easy to weave, and creates flexible structures which are ideal for fruit packaging. Water hyacinth is also very abundant which would allow for it to be used well in its second or third life cycle as a woven mat or put around plants in gardens to hold in the water.

### MASTERS

To better understand packaging materials, and production we reached out to many professionals. These people gave us expert information and helped us to streamline our direction in creating a sustainable fruit packaging solution.

#### India

While in India, we met with masters of sustainability, Shilpi Mahesh Vyas, a faculty member at the National Institute of Design, but so to water hyacinth, the material that we thought would be most beneficial for our packaging solution. Other community members in the market place such as the Dadi Dwarika, Nandini Fruit Market, and Jangir Fruit Market offered us a better understanding the needs of those who package and handle fruits.

#### United States

Then we talked with in the United States of the Department for Natural Resources allowed us to better understand the feasibility of finding water hyacinth in the United States. Members of the Midwest Backery Guild gave us insight on the best production methods and how baker packages work.

### MATERIALS

In order to create a sustainable solution that benefited the environment, we knew that the material we decided to use would be crucial. Through our research we determined that the material must first be biodegradable so that it wouldn't be a risk to animals or other aspects of the environment that we harmed by plastic. The material must also be waterproof and durable so that it could withstand being transported. Lastly, the material must be inexpensive and easy to find so that the product can be easily made, no matter where in the world it is needed.

Therefore, we chose to explore natural materials made from plants readily available in both India and the United States. We began by looking for properties of plants such as jute, banana, then bamboo, and bulrush. However, these four plants were either too hard to find in both countries, too expensive, or they didn't fit all of the properties that we knew that our material needed to be.

The exploration of these materials helped us to better understand how we might use them in our designs, even if they couldn't be the main material.

Ultimately, we ended up focusing our efforts on water hyacinth, a wild grown plant that is cost effective, readily available, and fits the properties that we need to successfully protect fruit while it is in transport or storage.

### METHODS

When looking into creating packaging, we explored different methods of manufacturing. The main idea when we use a plant based composite or to weave a basket the package finally arrived that makes weaving was the more sustainable route as it helped to increase cultural connections while also benefiting regional economies where weaving is a source of income.

The different methods for weaving depended upon the final product that we intended. We looked at how materials such as bamboo, reeds, and water hyacinth were woven differently. Methods included plaiting, weaving, and coiling which each delivered different results.

Ultimately, we concluded that using a weaving method, in which two strands are twisted around each other, to create the water hyacinth basket. We observed this method at the National Institute of Design in Ahmedabad, India.