JUBE

FUTURE IS IN THE AIR

BIO-INSPIRED SOLUTION FOR FOOD CRISIS

By BioX team, Thailand

Pat, Ratchaphak, Purichaya,Tavita, and Alfredo

Overview

The amount of population in the world is increasing, especially in low- and middle-income country. It is likely to increase from seven point two billion to nine point six billion in two thousand fifty. This cause needed of food to soar up. Edible insects are one of the answer to global food crisis due to the high protein level and rich in essential micronutrients, such as iron and zinc. They also don't need as much space as livestock, emit lower levels of greenhouse gases, and have an extremely high feed conversion rate. The team develop Jube, a bio-inspired chamber for capturing edible insects, the food of the future. The trapping mechanism is the result of the Genlisea violacea's lobster-pot trap biomimicry. In order to mimic the lobster-pot trap, the team designed the structure of hair pointing inward, which would prevent the insects that step into Jube to turn backward. The overall look of Jube is like a pitcher plant, which is the intention of the designers to mimic the fascinating shape of nature in order to make Jube more like a plant and less like a machine which can be alienated for general people. To use Jube, the user need to put some insect food into the bottom part of Jube to lure the insects. The wickerwork structure of Jube would let the wind flow by and spread the food odor to surrounding environment. Once the insects follow the odor and step into Jube, they would not be able to turn back due to the structure of hair pointing inward. The team is targeting both malnourished people and people that are not. For the person that are suffering from malnutrition, we will teach them how to build Jube by using local materials, so that they can have a device that can help them get more nutrients. After that we will gather people in the area that are interested in working with us to create Jube for selling out to the people who are not malnourished. For those general people, we are purposing them a sustainable way of dining by selling a sophisticated insects capturing device that is unique and beautifully crafted in order to promote edible insects consuming.

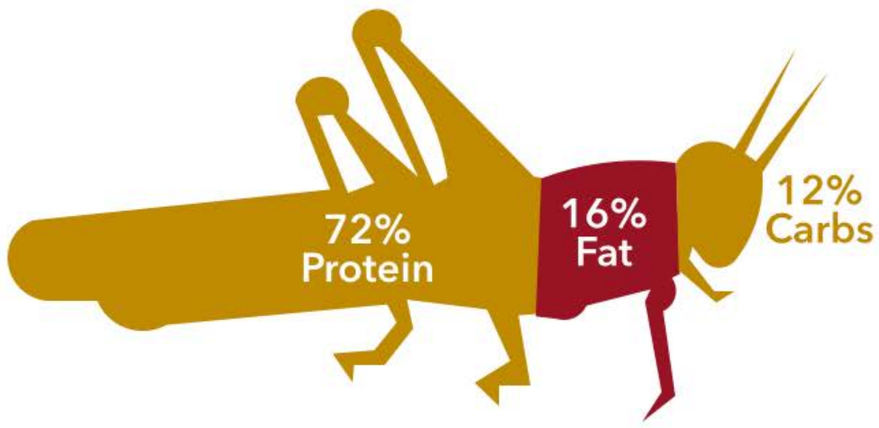
Introduction

The amount of population in the world is increasing, especially in low- and middle-income country. It is likely to increase from 7.2 billion to 9.6 billion in 2050 (UN-DESA). This cause needed of food to soar up. Low-income country, for example country in Africa, has been struggle with food crisis for a decades due to failed harvests cause by the extreme weather. Millions of people were affected by malnutrition and thousands died from starvation (Harvest Help).

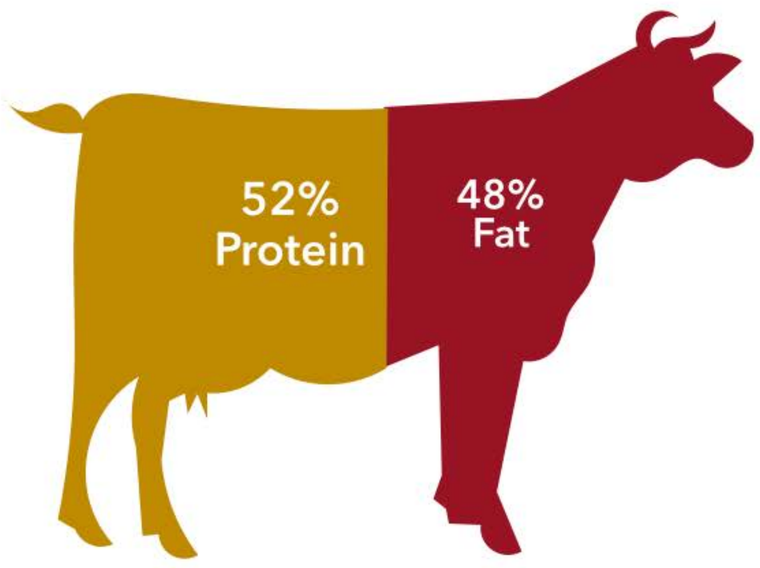
Not only in Africa, Asia also faces the food crisis. India, China, Pakistan and other large countries are under the circumstances that at least 1.5 billion people who live on the continent by 2050 will double Asia's demand for food (FAO). The fact that land for cultivation is decreasing, and the continuation of unpredictable climate and water supplies stretched to the limit. **One of the realistic options is to find a new source for food that is barely depend on those factors.**

The consumption of edible insects can be a solution for this crisis. Insects are full of protein and rich in essential micronutrients, such as iron and zinc. They don't need as much space as livestock, emit lower levels of greenhouse gases, and have an extremely high feed conversion rate. Only 1 kilogram of cricket has protein 12 times more than beef protein (Anthes). **All of these evidences clearly show that edible insects consuming are the sustainable way to feed people in the future.**

More than 1,900 species have reportedly been used as food and at least 2 billion people worldwide eat insects (FAO Edible insects 2013) for example yellow jacket wasp larvae are popular in Japan, cicadas in Malawi, weaver ants in Thailand, and termites in many African nations.

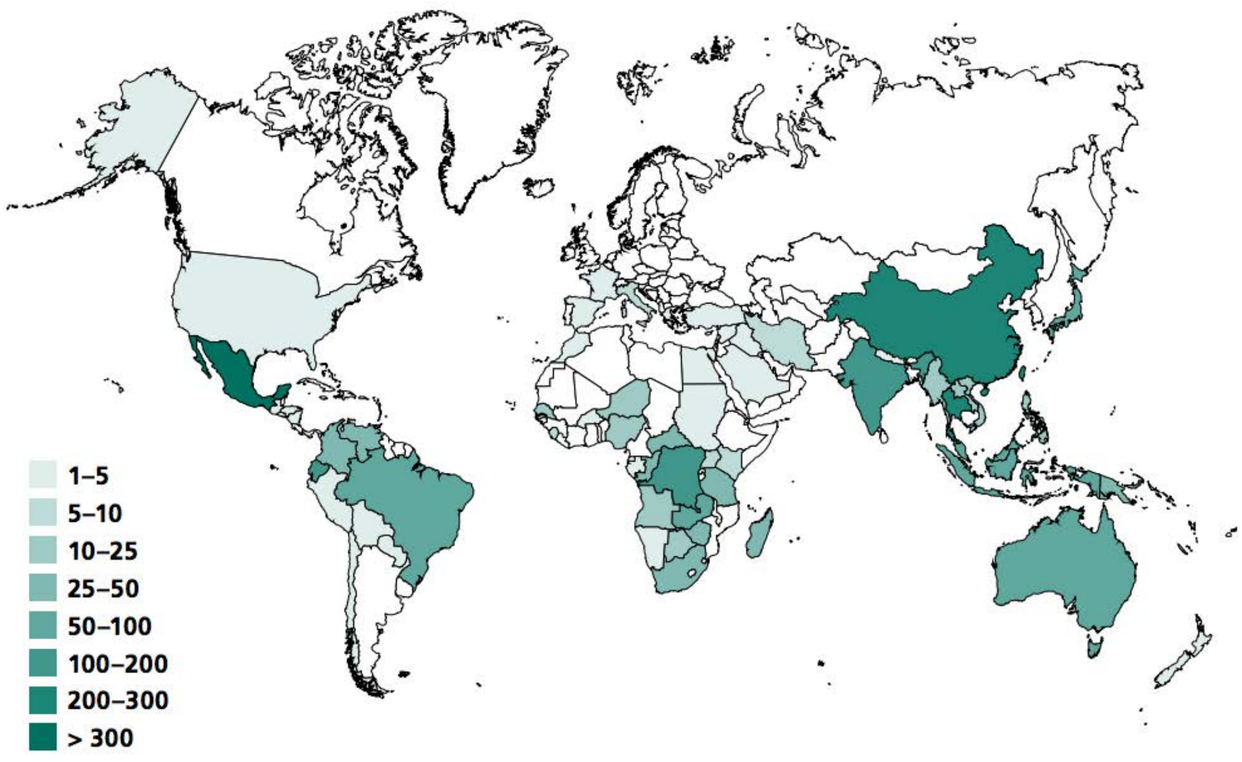


Grasshoppers



Beef mince

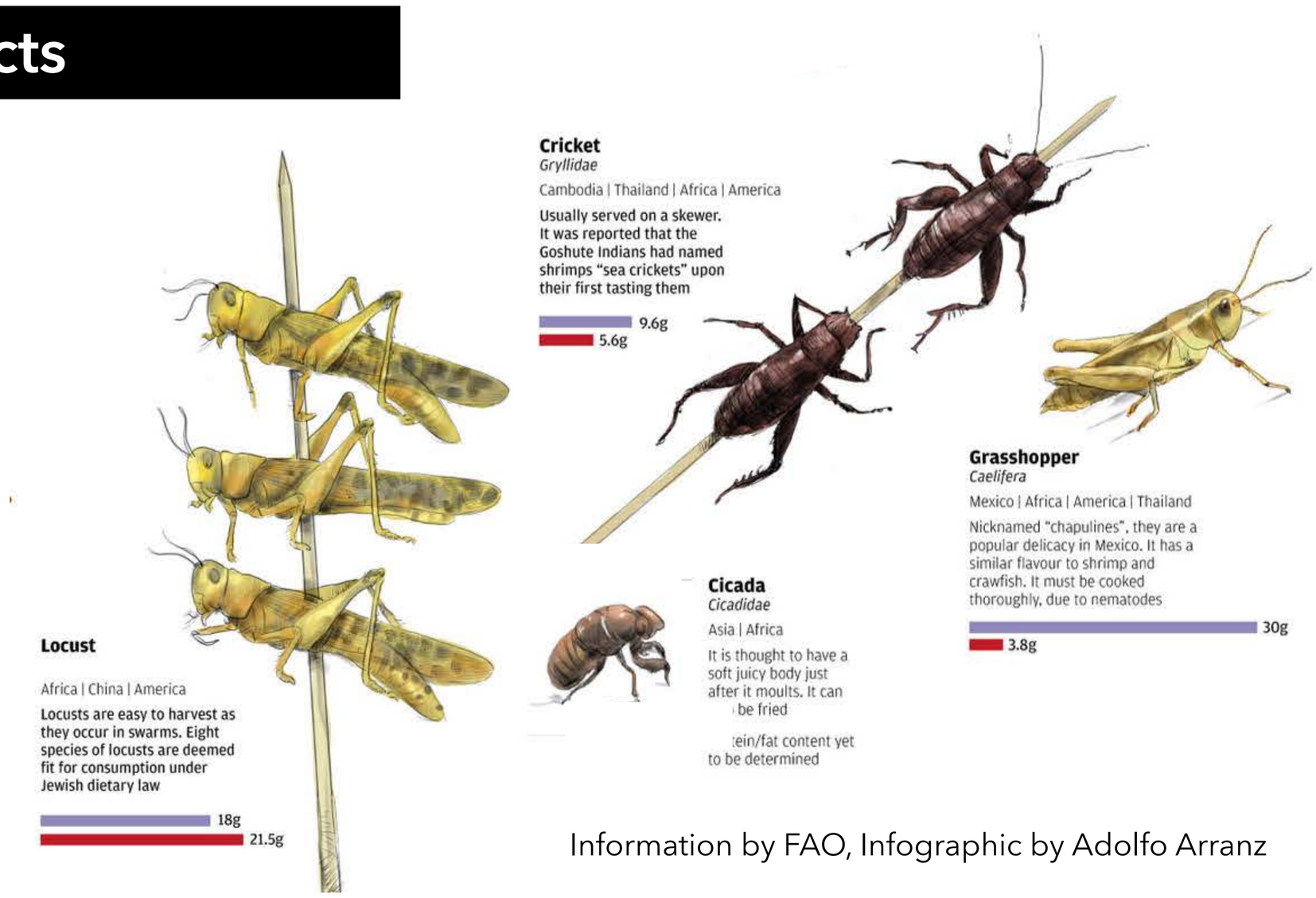
Recorded number of edible insect species, by country



Source: Centre for Geo Information, Wageningen University, based on data compiled by Jongema, 2012.

The edible insects

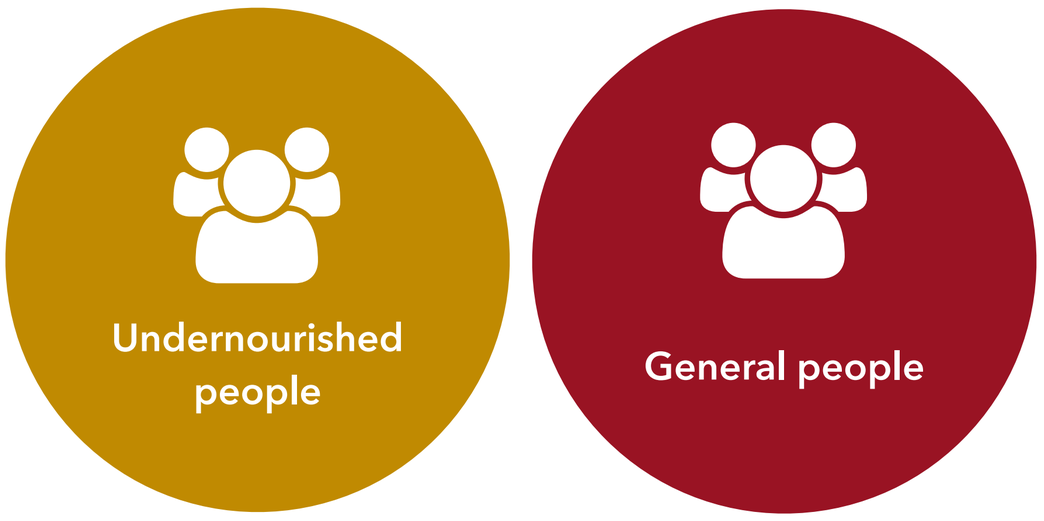
However, the edible insect practices is still infancy. In order to promote this sustainable way to acquired foods in the future, the team design Jube, a device that capture edible insects for each household. **The target insects that the team is focusing on are cricket, cicada, and locust.** Their information and nutrition ratio base on 100g weight displays on the right.



Information by FAO, Infographic by Adolfo Arranz

Scope of the project

Edible insects are one of the answer to global food crisis. However each region of the world are uniques, there are diversities in insect species, dining culture, geography, and other parameters that are specific to each area, so the team decided to use Thailand (our home) as the primary target, and provide option for further adaptation to other part of the world. For the customer, **we are not only purposing insects for people who are suffering from the malnutrition, but we are also promoting it to everyone as a solution for sustainability.**



FAO : The State of Food Insecurity in the World 2011

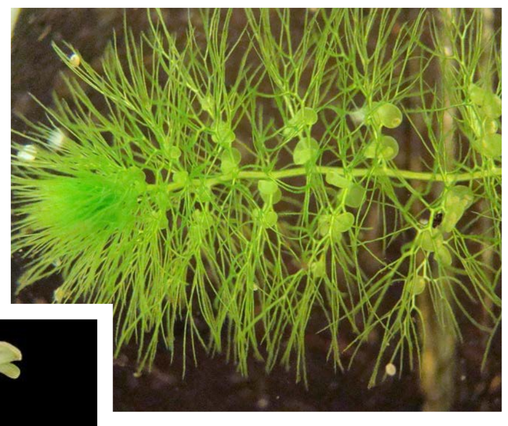
Carnivorous plants

Carnivorous plant is known for their unique ways to gather nutrients. They lure small insects to come into their trap and then digest that prey into nutrients. This kind of plants are usually found in nutrient-starved area or acidic soil. The traps can be classified into 5 main groups due to their mechanisms.

The first carnivory structure is "**Pitfall trap**" which is a pit with lubricant on top. It attracts prey through visual and chemical signals, and kill the prey through an enzymes of symbiotic bacteria in its pitfall trap. The example of this kind is *Heliamphora*.

The second kind is "**flypaper trap**". The structure is like a stick covered by sticky mucilage. This structure is found to be an extremely effective trap for small flying insects. The example of this kind is *Pinguicula gigantea*.

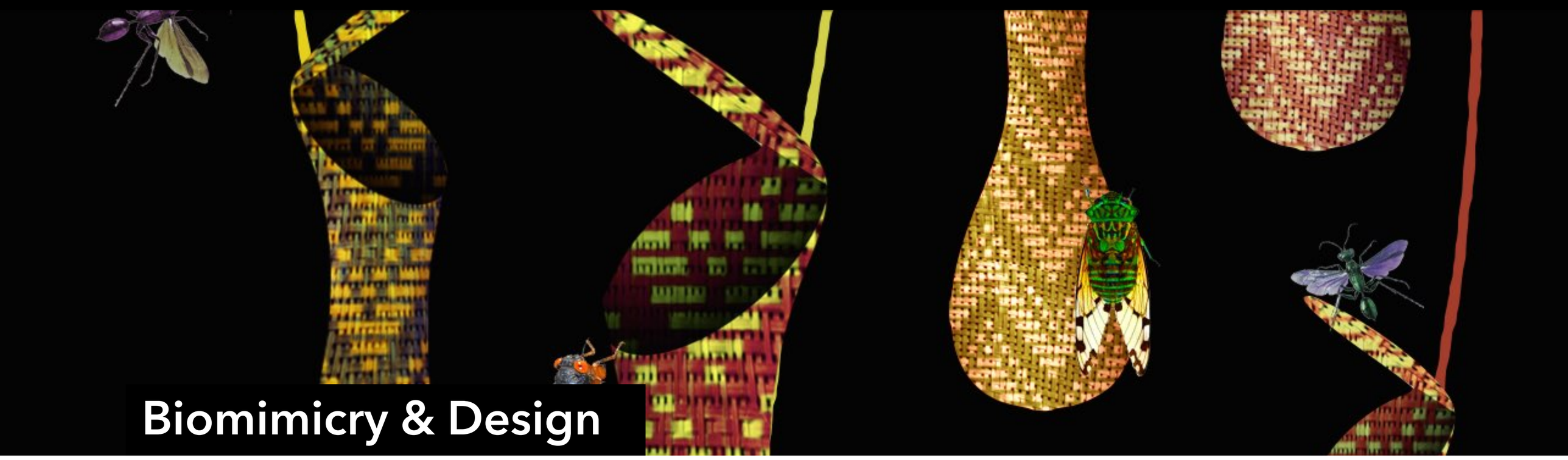
"**Snap trap**" is a jaw - liked carnivory structure which actually are leaves whose terminal section is divided into two lobes. Inside the jaw, there are needles that would let the jaw close due to the open of stretch-gated ion channels when the insect step in. The prey will slowly digested afterward. The example of this kind is Venus flytrap.



"**Bladder traps**" is a kind of trap that sucked its prey into the bladder by generating a partial vacuum inside by osmosis due to ion pumping in the interior cell. The example of this kind is *Utricularia vulgaris*.

"**lobster-pot trap**" is a Y-shaped modified leaf chamber that is easy to get in, but it is either difficult to find or obstructed by inward-pointing hair, which force the prey to move in a particular direction. The stomach of the plant is in the lower arm of the Y, where the insects are digested. The example of this kind is *Genlisea violacea*.

"**Combination traps**" combines flypaper and snap traps together. This mechanism is found in sundew *Drosera glanduligera*.

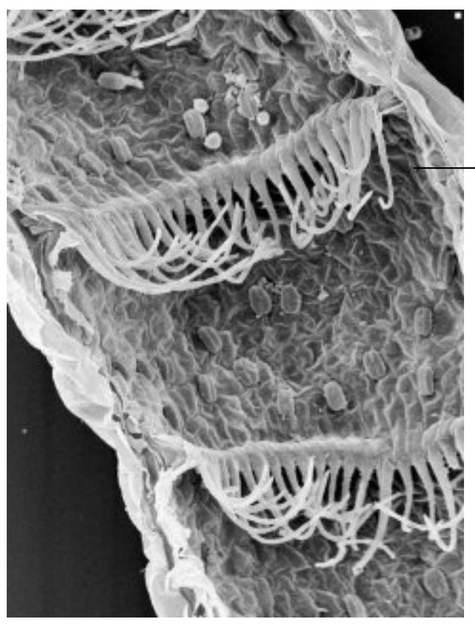


Biomimicry & Design

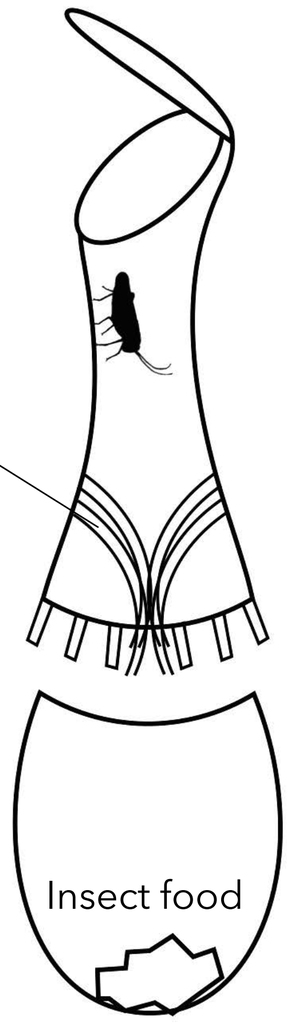
After analyzing each carnivorous plant's strategies, we are interested in mimicking **lobster-pot trap** for the trapping mechanism because this tactics is one of the two that utilized the physical structure instead of using secretion liquid to capture the insects. The other strategy that we didn't use is the **Snap trap**, found in the venus flytrap. We didn't mimic it because of the essential cellular mechanism behind the snap trap is in the micro - scale, which would not be compatible to fabricate in the area that even the food is lack.

Pitcher plant

The microscopic structure of the **lobster-pot trap**



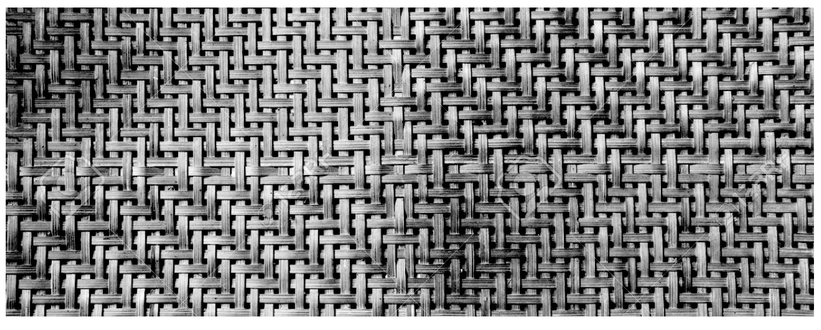
To mimic the **lobster-pot trap**, we designed the structure of hair pointing inward, which would prevent the insects that step in to turn back, by using dry rattan (a very cheap material that can be found in Thailand). In other area, the local material that is thin and flexible can be used to replace the rattan.

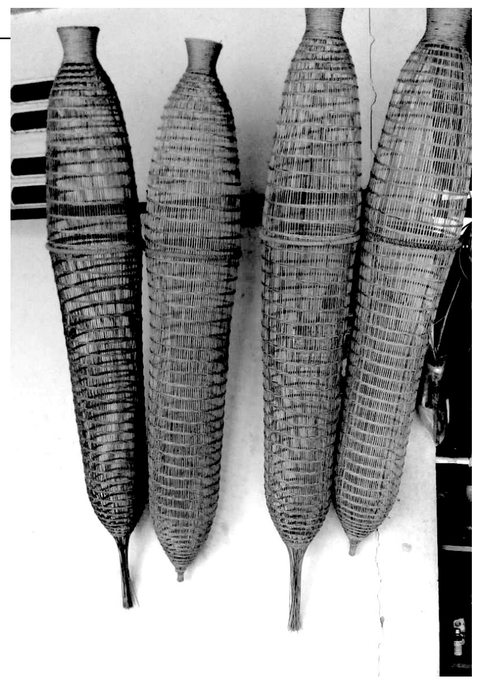


Outline

Realistic rendered

We also mimic the shape of the device from the pitcher plant due to its fascinating shape. We as a team are really concerned about creating a product that is **friendly with the user**. One of the most important feature from the plant that we can mimic is its natural shape. By doing that people would easily adopt our product because of the organic and natural liked feeling from the design.

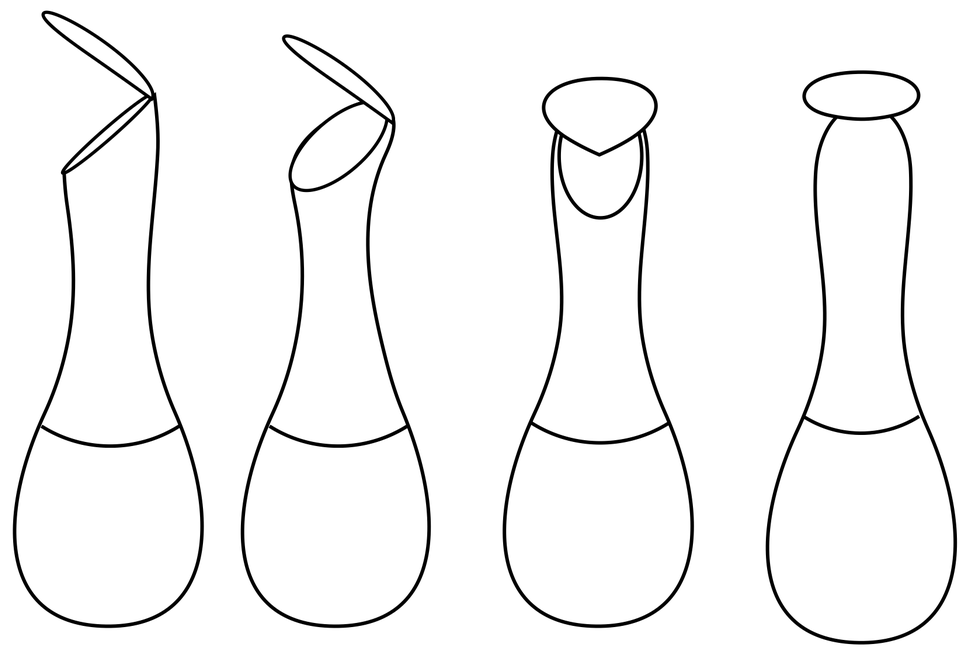


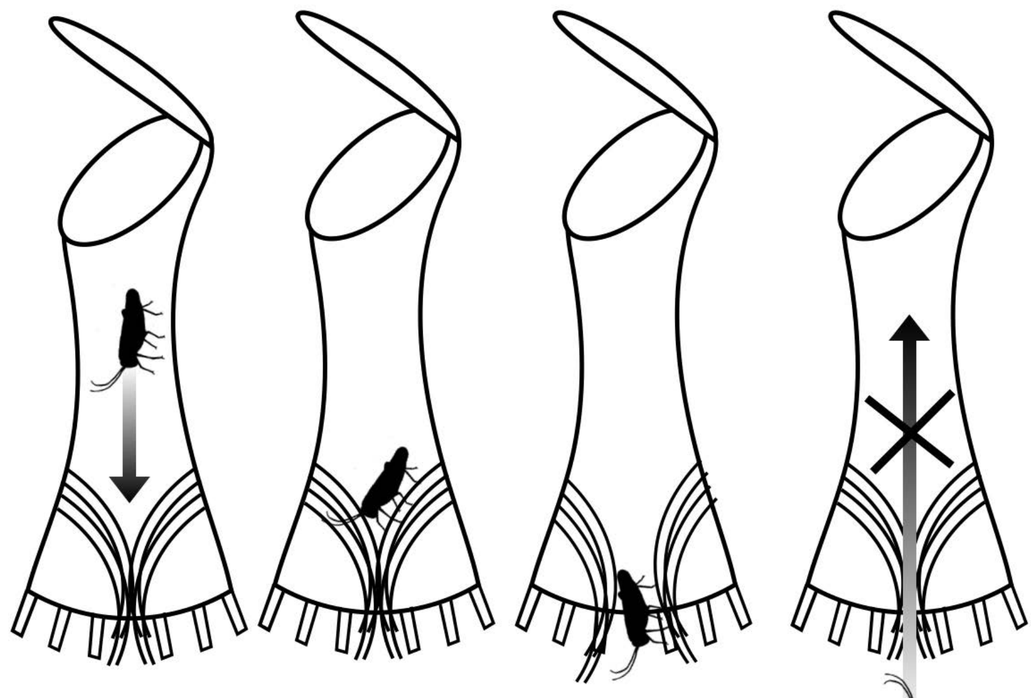


To make this product affordable, we are inspired by the traditional weaving technique of Thai people. This method were used by folk people to produce baskets and fishery tools. **The materials used for this method is dry rattan, which is very cheap, strong, and sustainable.**

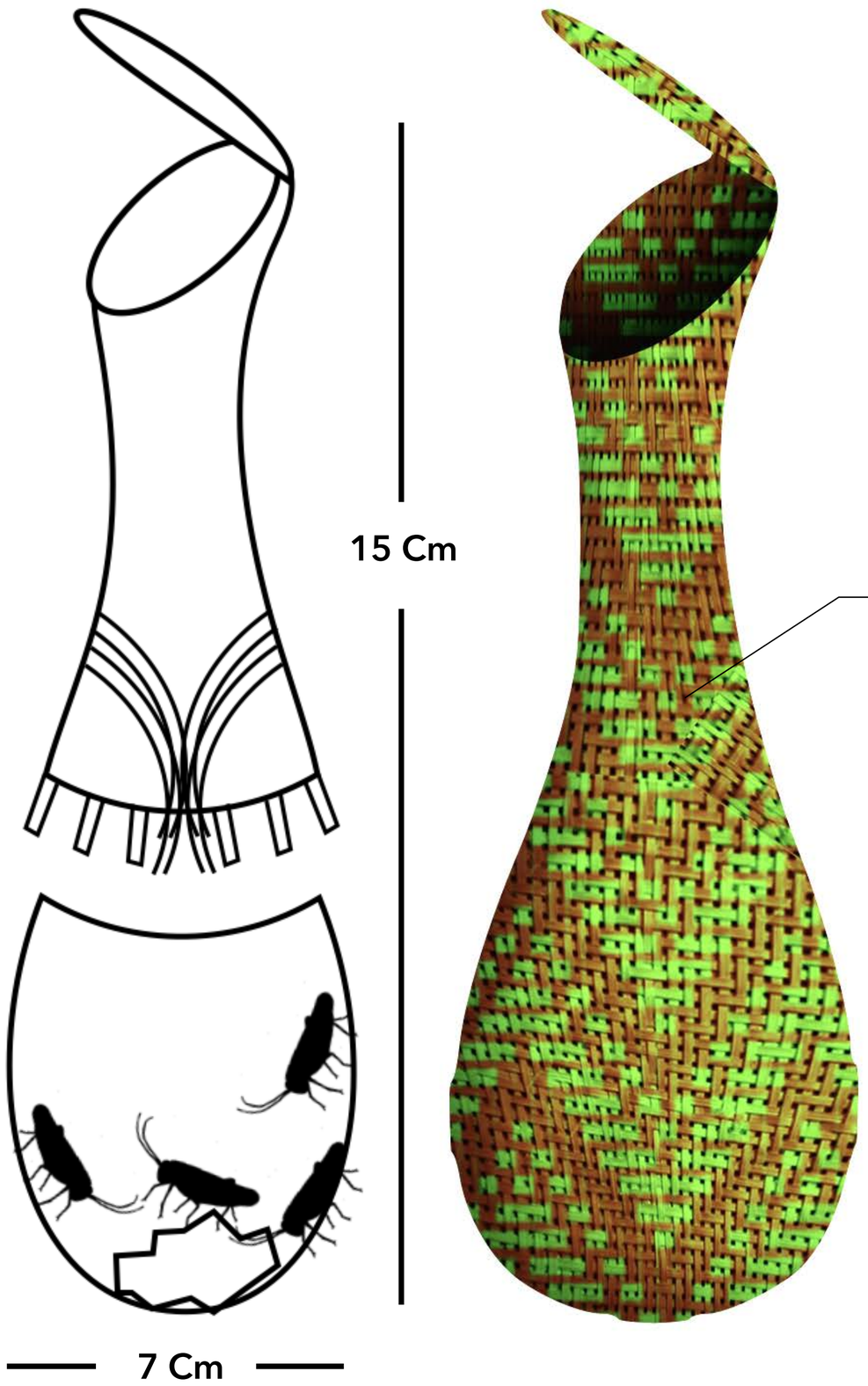
Product overview

Jube, a bio-inspired chamber for capturing edible insects, the food source of the future. The trapping mechanism is the result of the Genlisea violacea's lobster-pot trap biomimicry. In order to mimic the lobster-pot trap, the team designed the structure of hair pointing inward, which would prevent the insects that step into Jube to turn backward. The overall look of Jube is like a pitcher plant, which is the intention of the designers to mimic the fascinating shape of nature in order to make Jube more like a plant and less like a machine which can be alienated for general people. To use Jube, the user need to put some insect food into the bottom part of Jube to lure the insects. The wickerwork structure of Jube would spread the food odor to surrounding environment. Once the insects follow the odor and step into Jube, they would not be able to turn back due to the structure of hair pointing inward.

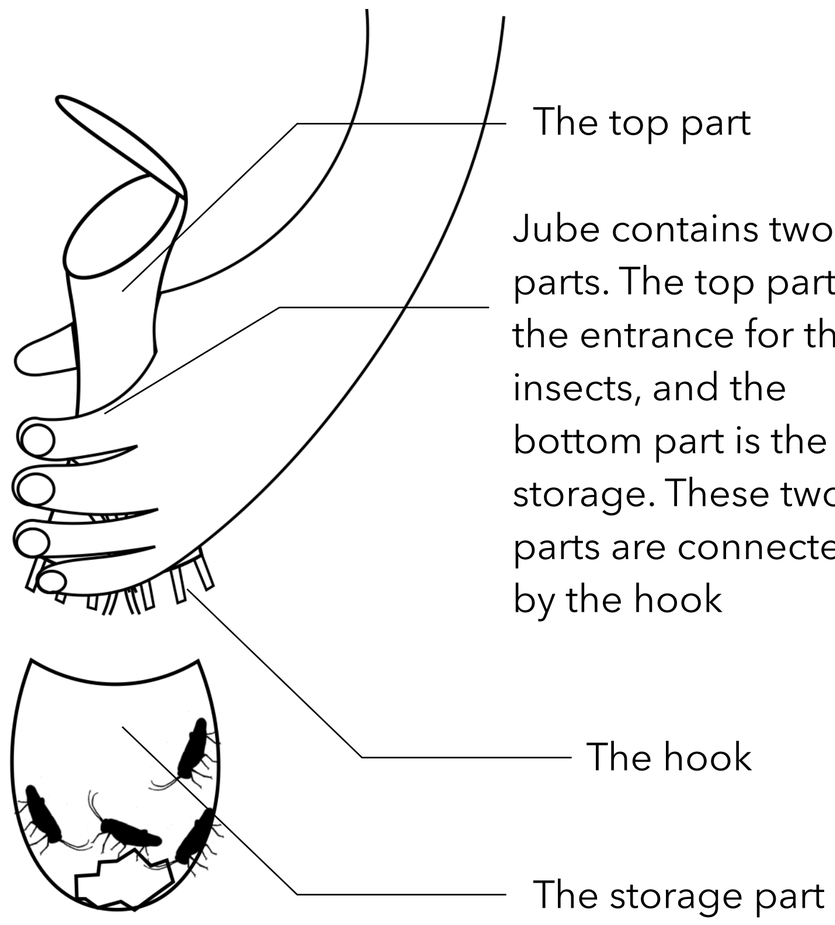




Jube's method to capture the insects is the result of *Genlisea violacea's* lobster-pot trap biomimicry.



The tiny holes in wickerwork structure of Jube would spread the food odor to surrounding environment.



Jube contains two parts. The top part is the entrance for the insects, and the bottom part is the storage. These two parts are connected by the hook

After the insects are captured, the handbook would provide options for the user to whether cook them or cultivate them. The handbook also suggests a several way to easily cook the insects into a yummy meal.

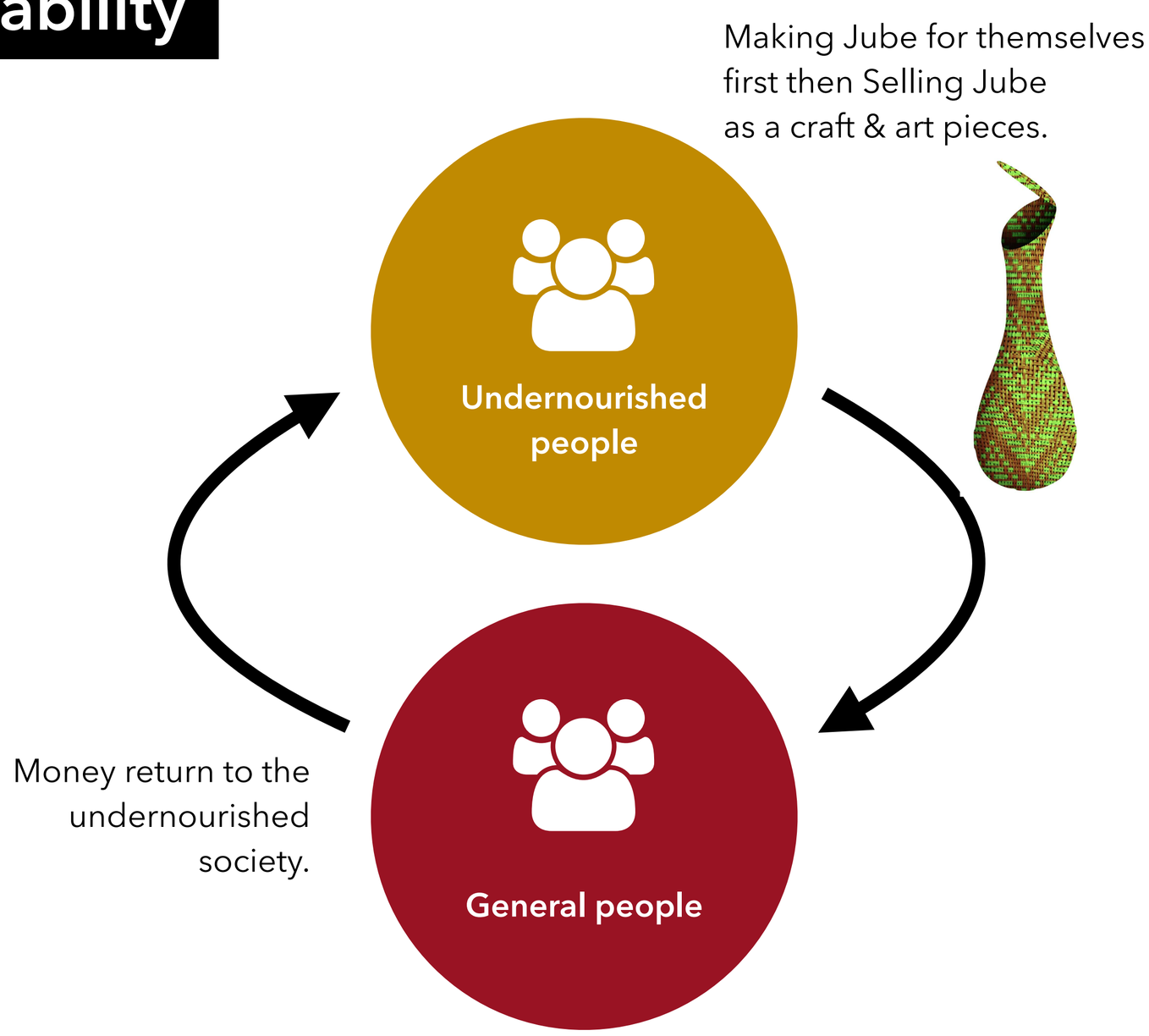
Distribution and Installation

As mentioned earlier, the team is targeting people that are suffering from malnutrition and also people that are not.
For the person that are suffering from malnutrition, we will teach them how to build Jube by using local materials, so that they can have a device that can help them get more nutrients. After that we will gather people in the area that are interested in working with us to create Jube for selling out to the people who are not malnourished. For those people, we are purposing them a sustainable way of dining by selling a sophisticated insects capturing device that is unique and beautifully crafted in order to promote edible insects consuming.

Jube is designed to be hanging out from the sealing or to be putting in the tree pot. For people who eat insects as the alternative food source or never eat insect before, the beautifully crafted design of Jube would attract their interest. June can also be a decorative item in the garden.

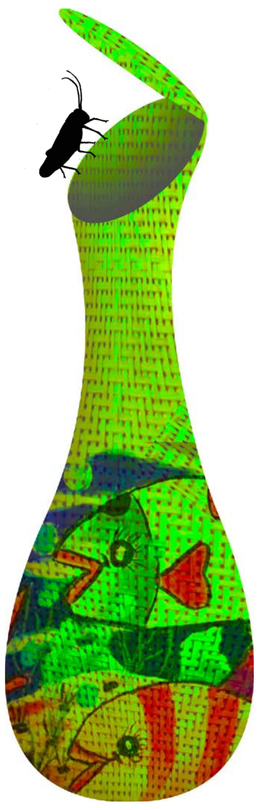
Business Model for Sustainability

All of the team members have a passion in making this world a better place, so we only care about business just to make sure that the thing that we created is sustainable. The first step in our execution plan is to teach the undernourished people to capture the insects by creating the device. After that we will encourage the those people to paint and decorate Jube in their own style. By doing that we will promote the product (Jube) from that group of undernourishment people as a piece of art and craft that can also help create a sustainable life to other people. The money from selling Jube will go back to the person that created it, so that they can use it to improve their quality of life. The team has a strong connection with NSTDA (National Science and Technology Development Agency of Thailand), and Ministry of education of Thailand, which can help promoting this project nationally and internationally.

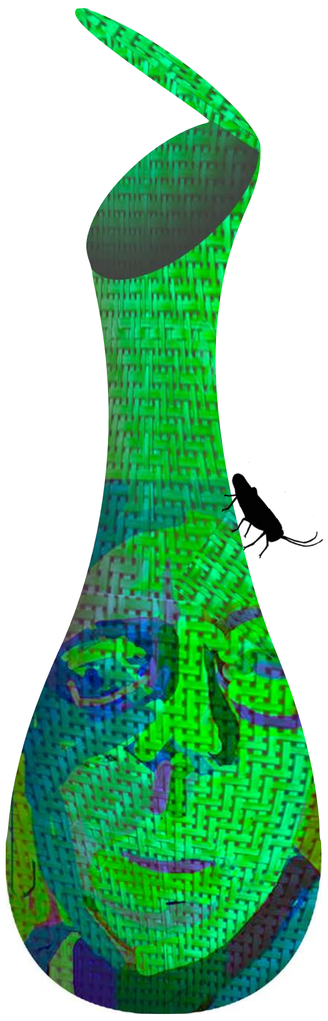


Impacts

The team believes that the developing of Jube will help solving food crisis by providing a new tool for finding a new food source, Insects. We also believe that with our strategy to teach the undernourished people to build a tool for themselves is the very sustainable way to do, and by doing that we expect the number of people who are suffering from malnutrition to be decrease.



Jube can also be used as an object for education. The educator can build a curriculum around Jube that involves science, art, sustainability life, agriculture, and society. The kids will learn how to build a stuff that can help them find food for the future, and also enjoy expressing themselves by painting Jube. This would promote a participation culture, which is the core of humanity in this century.



Since Jube is designed to be builded by using Thai traditional weaving technique. By teaching modern Thai people to weave Jube is the way in which keep the traditional knowledge alive in the modern context. If other country adopts this project to solves food crisis in their country, the people in that country should use their own weaving technique and use the local materials to build Jube instead of copying the entire method because the team created Jube by mimicking a living creature, and the most important feature of the living creature is highly adaptable.

Interdisciplinary Team

Pat Pataranutaporn
Pat is a creative biologist, artist, designer, and a freshmen at College of Liberal Arts & Sciences, Arizona State University. His work examines a range from environmental biotechnology to interactive technologies at the intersection of biology, DIY, and computation. Right now he is a research fellow at the Biodesign Insitute and School of Art, Media + Engineering at ASU, and the founder of tech startup - Arkhumanity. In launching Jube project, Pat is a project leader and creative director.

Ratchaphak Tantisanghirun
Ratchaphak is an interdisciplinary scholar. His interests are vary from materials science to biomechanical engineering. He is a recipient of Thai government's Undergrad Intelligence Scholarship, and a visiting student at CERN (European Organization for Nuclear Research).
In launching this project, Ratchaphak is in charge of analyzing bio-strategies and facilitating the conversation.

Purichaya Kuptajit
Purichaya is a Senior at chemical engineering department, Faculty of Engineering, Chulalongkorn university. Her interests is in materials science . She is a member of the most prestigious gifted young scientist society in Thailand, JSTP. She was invited to showcase her research project on the waste recycling in the international conferences throughout the world. In launching this project, Purichaya is commit to work on finding product materials and product development.

Tavita Kulsupakarn
Tavita is becoming a Freshmen at Prince of Songkla University International College. Her interests is in computer graphics, digital media, Japanese anime culture, and psychology. Her works are famously showcasing on many platforms under the name "umbrella bear". In launching this project, Tavita is working on designing the product and doing a background research.

Alfredo Raphael
Alfredo is a high school student at Saparachinee trang School. His interests are in vary from 3D fabrication to human evolution and biological simulation. He is also a member of the most prestigious gifted young scientist society in Thailand, JSTP. In launching this project, Alfredo is an expert on edible insects.

Advisory Board
In establishing the project, the team is receiving advices from the following mentors.

Prof. Werasak Surareungchai (Ph.D.) - Director of Biosensor technology, KMUTT (King Mongkut's University of Technology Thonburi)
Prof. Bank Ngamarunchot - Economics and business lecturer, KMUTT
Pondet Ananchai - Entrepreneur and CEO of Find group
Potiwat Ngamkajornwiwat (Ph.D. candidate) - Robotics researcher at FIBO (Institute of field robotics)

The team would like to acknowledge our friends who joined the discussion on this project.
Panwong Kuntanawat. Wasin Tuchinda, Tanadet Pipatpolkai, Sahutchai Gla Inwongwan, Ping Harn, Ju Chulakadabba, Tawan Thintawornkul, Cher Tonanon, Thanadol Sutantiwanichkul, Natthawoot Panitlertumpai, Ice Kanokrat, Tesla Atom, and Meng Nakpradit.

References

E. Anthes (2015). "Are Insects the Future of Food?". Discover magazine (Website).

The possible functions of the thorns of Nepenthes bicalcarata (Hook.f.) pitchers (PDF). Carnivorous Plant Newsletter 22 (1–2): 27–28.

"Harvest Help." Food Crises in Africa in the Last 30 Years. N.p., n.d. Web. 03 Aug. 2015.

Mody N. V., Henson R., Hedin P. A., Kokpol U., Miles D. H. (1976). "Edible insects

FAO. “Future prospects for food and feed security ". FAO Forestry Paper 171. Issn 0258-6150

Mody N. V., Henson R., Hedin P. A., Kokpol U., Miles D. H. (1976). "Isolation of the insect paralyzing agent coniine from Sarracenia flava". Cellular and Molecular Life Sciences 32 (7): 829–830.

Forterre Y, Skotheim JM, Dumais J, Mahadevan L (2005). "How the Venus flytrap snaps". Nature 433 (7024): 421–5

"Genlisea Lobster Pot Carnivorous Plant Trap." School of Life Sciences. University of Sussex, n.d. Web.

FAO. “The State of Food Insecurity in the World 2011”, In. Rome, Italy: FAO.

Poppinga, S., Hartmeyer, S.R.H., Seidel, R., Masselter, T., Hartmeyer, I. & Speck, T. (September 2012). "Catapulting tentacles in a sticky carnivorous plant". PLoS ONE 7 (9): e45735

Claudi-Magnussen, G. (1982). “An introduction to Genlisea". Carnivorous Plant Newsletter 11(1): 13–15