CINCINNATI ZOO CHALLENGE

PROPOSALS TO ENRICH THE EXPERIENCE IN ANIMAL ENVIRONMENTS

PD 2030 | Inquiry to Innovation | Spring 2019

UNIVERSITY OF Cincinnati

CINCINNATI ZOO & BOTANICAL GARDEN

UC Forward
The Innovation Collaborative

CINCINNATI ZOO AND BOTANICAL GARDEN

INTRODUCTION

The Cincinnati Zoo and Botanical Garden (CZBG) manages a holistic, evidence-based, and strategic approach to enhancing the experiences of animals in their care, while creating a greater awareness of animal welfare with zoo visitors. During the spring semester the CZBG collaborated with multidisciplinary teams of UC students in this class to develop enrichment practices and devices for use in animal environments at the Zoo. Zoos and aquariums are increasingly utilizing science and technology to monitor and improve care of their animals.

This collaboration is intended to bring a unique set of knowledge, skills, and fresh perspectives to enrichment proposals, particularly those related to engineering, technology, programming, and design. UC student teams were paired with animal care teams at the Zoo for a semester long process where innovative enrichment products are designed and possibly implemented for selected species. The animal care staff presented the needs of the selected animal species and worked to establish guidelines for feasibility and safety. In weekly meetings with students. CZBG staff mentored and collaborated with students to brainstorm, prototype, construct, and evaluate the final enrichment product or experience.

During the spring semester the CZBG collaborated with multidisciplinary teams of UC students in this class to develop enrichment practices and devices for use in animal environments at the Zoo.

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Source: http://cincinnatizoo.org/

ENVIRONMENTAL ENRICHMENT

Environmental enrichment is an important tool for enhancing an animal's welfare under human care. Environmental enrichment may consist of modifying the animal's surroundings and/or providing products, tools, games, or, instruments for stimulation of or use by the animals. Not only can enrichment serve to create physical and cognitive development for zoo animals, but it can also stimulate unique species-specific behaviors, provide opportunities for choice and control, and offer educational and enjoyable experiences for Zoo visitors. Some of the more common forms of enrichment are:

PHYSICAL HABITAT

This form of enrichment takes the form of the features present in an animals environment. Often times these will mimic the naturally occurring features of an animals natural habitat such as running water or leafy plants.

DIETARY

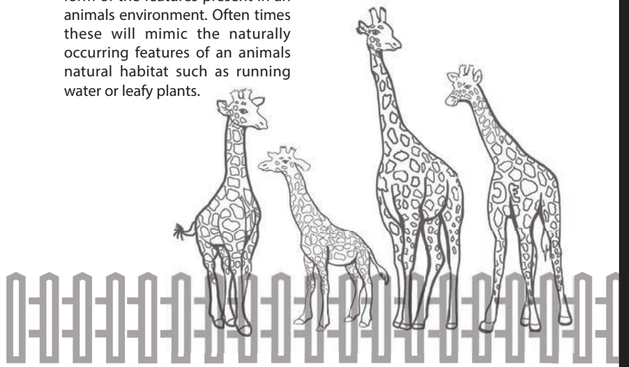
Animals are provided with a source of food different from their normal diet to provide variety and stimulus.

COGNITIVE

Enrichment design to increase curiosity and engagement. Often puzzle feeders and toys are stuffed with food to encourage foraging behaviors and delay feeding.

OLFACTORY

This kind of enrichment is used to stimulate naturalistic behavior. It includes spraying of different types of odor in a habitat to influence behavior, making the animal more active and induce exploratory behaviors.



ABOUT UC FORWARD

UC Forward is a re-imagining of what a university experience should be. It is a one-of-a-kind learning opportunity – pairing students and faculty of diverse majors in trans-disciplinary teams to collaborate with outside experts in solving today's problems and developing tomorrow's workforce in unique and relevant ways. UC Forward is an initiative that promotes opportunities for University of Cincinnati students to put what they're learning into action while they're learning it and in doing so, develop intangible skills through collaboration, team leadership and project management that you just don't get from lectures. UC Forward's Inquiry to Innovation Course is the venue for this interdisciplinary collaboration with outside partners.

THE CINCINNATI ZOO AND BOTANICAL GARDEN

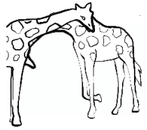
CZBG staff documents and evaluates enrichment practices to better understand animals and guide future efforts towards their care. Creativity, combined with thoughtful design and scientific evaluation, are important to continued Excellence in animal management.

MASSAI GIRAFFE

BEHAVIOR STUDY

RUMINATION

Rumination is a necessary part of digestion for giraffes occurring mostly at night when there is no stress. This is similar to cows 'chewing cud'.



NECKING

When giraffe necks collide either gently or combatively. The former happens while nurturing and the later while fighting.

NURTURING

They rub necks with other giraffes to show friendship and affection usually between mothers and offsprings

FIGHTING

Occurs between males. A giraffe will swing his head back and forth to build up speed and momentum. He will use his head as a club typically striking the opponent in the neck, body or legs

LICKING

They have prehensible tongues which can be up to 18 inches long. When feeding, they use their tongue like a hand to strip leaves and bark off of trees.

RESTING

They rest very infrequently (5-30 mins) however in zoos they may rest up to 2 hours. They may rest by sitting down, but are just as likely to rest standing up.

STRETCHING

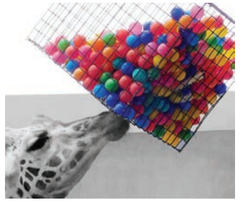
As the tallest mammal on earth, giraffes spend much of their time stretching their necks out to browse for food nearly 20 feet in the air.

CURRENT ENRICHMENTS

Cincinnati zoo has several enrichment installations based on the behavior of necking and eating. The hanging feeders are are of various shapes and sizes with holes for stuffing them with food. Textual enrichments are for rubbing against or licking. They include brush boards, latchboards, bamboo toys and fire hose. There are also plastic barrels, spoons and PVC pipes.

BEST PRACTICES

Textual Enrichment toys for giraffe include a variety of materials, objects, and surfaces for giraffes to rub against or lick. Windchimes, wooden logs, brushes and other objects can be hung up for giraffes to explore. These can add excitement and allow the giraffes to practice common necking and stretching behaviors.



Feeding Enrichment toys usually involve interesting containers and other food related obstacles. These are meant to challenge a giraffe to use its long neck and agile tongue to get food. Puzzle feeders keep giraffes eating slower and longer, which is more similar to their natural browsing tendancies.

https://www.theanimalbehaviorcenter.com/top-10-checklist-healthy-animal-behavior/puzzles-enrichment-2/
https://images.app.goo.gl/JM4ke32jDdy4BifW9
https://images.app.goo.gl/yFAP2U6Ar21kWhww8
https://images.app.goo.gl/6XfiAjaR4gykDBow5
https://honoluluzoo.org/giraffe-treat-jar-enrichment/

FACTS

The enrichment designed was to extend the feeding time of the Maasai giraffe, or the Giraffa camelopardalis tippelskirchi. The masai giraffe is native to East Africa, and is the tallest animal in the world (13-17 ft). Giraffes spend 16-20 hours per day eating and consume leaves, twigs, and bark. They use their prehensile 18 inch tongue to strip the leaves from the branches high in the trees. If water is scarce, the giraffes can extract water needed to survive from the leaves they eat. The gestation period for giraffes is 14-15 months, and when born the calf can be six feet tall. The lifespan of the Maasai giraffe is 25-30 years.

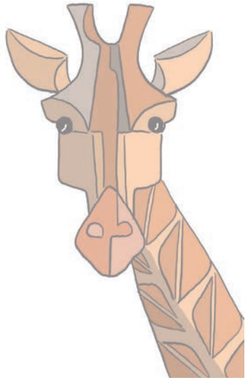
AT CINCINNATI ZOO

Cincinnati Zoo has four giraffes - 1 male (Kimba) and three females (CeCe, Tessa, and Zoey).

MASSAI GIRAFFE

THE BROWSE BOX

Adina Ballaban, Lara Koenick, Olivia Loparo, and Maddie Samson



DESIGN GOAL

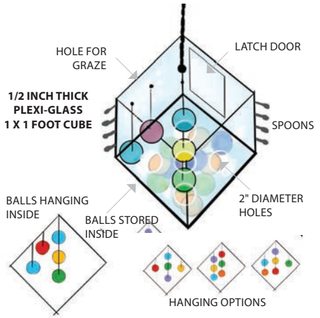
The goal of this enrichment proposal was to extend the feed time for the animal. Giraffes constantly eat, sleeping for only about 20-30 minutes at night. They require the least amount of sleep of all other land mammals. Giraffes main tool is their tongue, which can be up to 18 inches long. When feeding, a giraffe will use its tongue like a hand to strip leaves and bark off of trees. Male giraffes commonly rub their necks and heads against objects. We wanted to make sure whatever we designed was safe for this behavior.

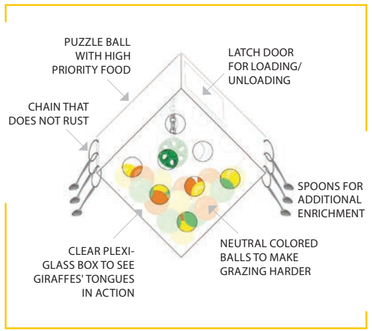
PROTOTYPE BUILDING

The prototype was fabricated in the DAAP woodshop. The drill press and hole saw was used to cut the large holes in the plexiglass that serve as the access points for the giraffes. We used the jigsaw to cut the door that allows the keepers to load and clean the box. A Dremmel was used to sand all of the holes and any part of the box which the giraffes would be interacting. We pre-drilled and countersunk all of the screws and used screws followed by DAP glue to assemble the box together. After the box was assembled we sanded to ensure that all of the edges and corners were safe for the giraffes to lick and hit with their heads.

DESIGN PRINCIPLES

EDUCATIONAL | EXTENDS FEEDING TIME | TACTILE | STIMULATING | INCLUSIVE



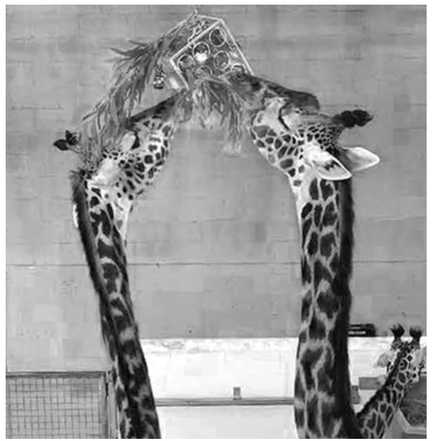


TESTING

The Browse Box was tested twice, once with Kimba and the other with Tessa, CeCe, and Zoey. This needed to be done due to the height differences between the giraffes. Both subject groups provided excellent responses to the introduction of the enrichment. Kimba responded positively by decreasing unwanted behaviors (like licking the viewing window) and increasing the time he spent standing and moving around while at the feeder. The females also responded positively by taking a longer time eating the food in the Browse Box than with normal feeders.

MOVING FORWARD

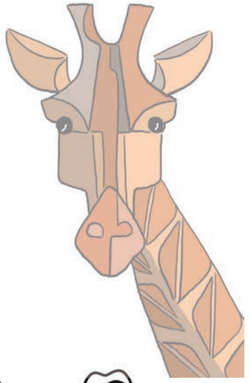
While the Browse Box successfully extended the time the giraffes ate, the time can still be improved on by making the box more difficult. This could be done by making the holes higher up or smaller. Different types of food used in the box may also play a role in determining their feeding time. The Browse Box can also be adapted for other animals, such as the okapi. One other component that may also be added to the Browse Box for the future is an "arm" that extends out from one of the outdoor posts to hold the box out so that guests can observe the giraffes using the box outside. This arm would also feature a pulley system for raising and lowering the box for keeper maintenance.



MASSAI GIRAFFE

WINDOW BOX FEEDER

Jack Buehler, Ben Merk, and Andie Ticknor

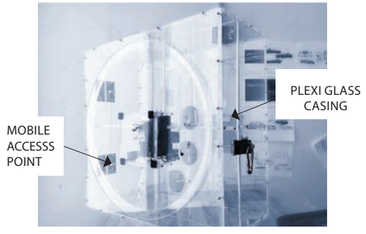


DESIGN GOAL

This enrichment can serve multiple purposes, focusing on animal exposure as well as conservation and education. The zoo keepers would like to exhibit the giraffes' eating habits to benefit the comprehension of the visitors knowledge as well as visual simulation of the giraffe's eating habits. Other considerations are the use of recycled materials and creating an easy interaction between the device and the zookeeper.

DESIGN PRINCIPLES

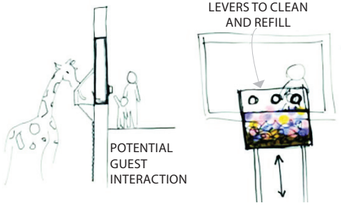
PROTOTYPE BUILDING

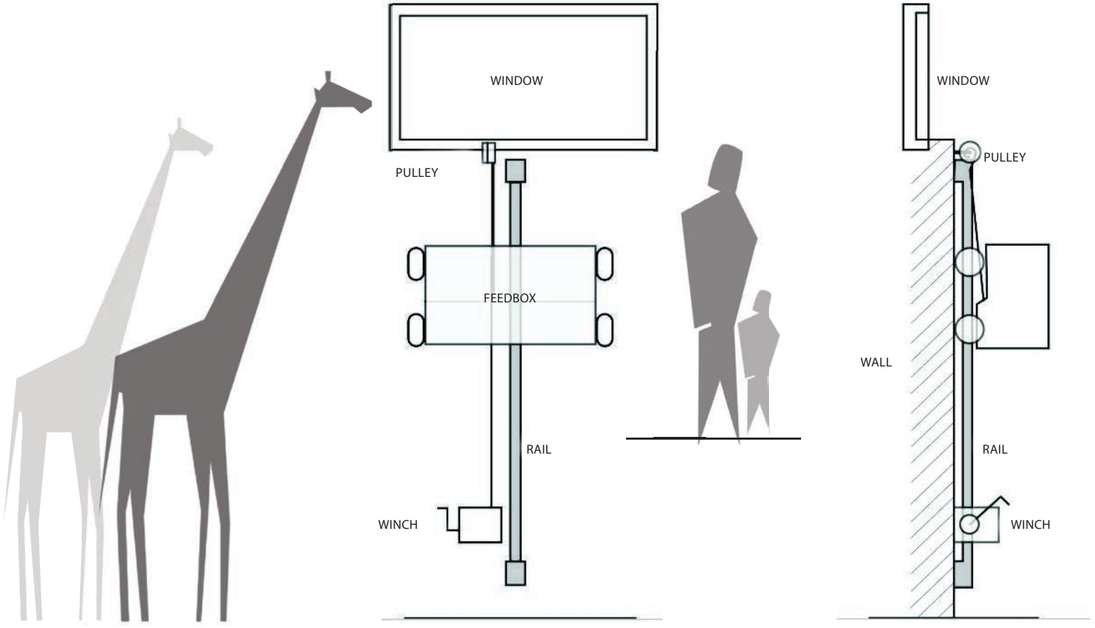


The design was taken a step further with the full-scale creation of a working prototype. The model was made entirely of Plexiglas. Secured together with glue and screws, the box feeder prototype also houses electronics that turn the front door on a timer throughout the day. There were many difficult hurdles our group had to overcome in order to create a working prototype. The largest being the plexiglass material itself with many weak points created when the material was screwed at multiple points.

IDEATION SKETCHES

'SMART FEEDER' RAISES AMD LOWERS FOOD/ GRAIN FROM BOTTOM WHEN GUEST DONATES/ TIMER GOES OFF





CONCEPTUAL SECTION SHOWING THE BOX FEEDER

TESTING

During the final stages of our prototyping, we began to notice the cracking of our Plexiglas faces inside the box. These cracks began to expand and by the next morning, the entire box was compromised and we were unable to test it at the zoo.

MOVING FORWARD

While we were at the zoo observing other students testing and presentations, we discussed with the zoo staff, keepers, and enrichment specialists about the next steps for our project. It was very clear we could not safely test it that day, but we wanted to make sure that we got an opportunity to showcase all of our hard work. We intend to stay in touch with the Cincinnati Zoo to get new materials and to rebuild the prototype in the future.

RHINOCEROS HORNBILL

BEHAVIOR STUDY

DIET

Rhinoceros Horn bills' diet largely consists of fruits (mostly figs) and infrequently, insects, small animals, and birds. They use their long beaks to pick up their food and eat by throwing their heads back and swallowing it whole.

CASQUE

Rhinoceros Hornbills have a unique, spongy appendage on the dorsal maxillary beak called a casque. Although its purpose is still debated, it is thought to enhance their vocalizations by acting as a resonating chamber and increasing the volume of their calls.

CURIOSITY

They are extremely intelligent birds, having only slightly lesser acumen than parrots. They are able to solve simple puzzles, working alone or with their partner. Group problem solving remains one of their most interesting features that may lead to unique enrichment opportunities.

CLEANLINESS

Horn bills in the wild perform many bill maintenance behaviors such as cleaning food residue from the bill and wearing down the bill tips. It is important that small forked branches are available to hornbills for bill cleaning purposes.

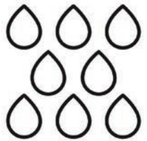
BONDING

Like many birds, Rhinoceros Hornbills bond for life. This is not exclusive to their mating partner, and may consist of another friend or family member.

BREEDING/NESTING

Hornbills generally form monogamous pairs and practice a resourceful nesting ritual. The female lays her eggs inside a hollow tree cavity, and subsequently helps the male seal the entrance with a paste made of fruit, mud, and feces. The females are trapped in this cavity for 3-5 months and are fed by their partners until the chicks leave the nest.

CURRENT ENRICHMENTS



Cincinnati zoo enrichments are provided to impact food and environment. Grapes are generally offered as a high-value food. There is currently rain system installed in one of the off-exhibit enclosures. As part of their hygiene routine, the birds are supplied with knotted ropes that they use to clean their beaks. At the center of the exhibit lies a tree, intended to mimic the arboreal environment. At the bottom of the exhibit lies a stagnant water pond intended for bathing and drinking. There is also a retractable barrier near the window that is lowered during feedings and after exhibit hours.

https://en.wikipedia.org/wiki/Ulu_Temburong_National_Park#/media/File:Buceros_rhinoceros_-Singapore_Zoo_-pair-8a.jpg
https://images.app.goo.gl/JEbBDx5xYxbYZTkN7
https://www.birdlife.org/sites/default/files/styles/1600/public/news/rhinoceros_hornbill_feeding_c_arnon_polin_more.jpg?itok=umoCYgk0
https://images.app.goo.gl/e3DiA3EknkD3qK8H8
https://unsplash.com/photos/F_iICik66Hg
https://images.app.goo.gl/jdGrnazTBmp2fQAZ7

BEST PRACTICES

Cognitive

A parrot forraging wheel that deposits food out of a small hole when it is spun

Dietary

A rhinoceros hornbill being thrown a grape by a zookeeper

Physical Habitat

A cockatoo enjoying the spray of water from a sprinkler

Food enrichment at the Nashville Zoo. Male hornbill feeding the female through the small opening.

https://www.nashvillezoo.org/our-blog/posts/involvement-in-rhinoceros-hornbill-ssp
https://images.app.goo.gl/hdWSTbLcK9xZf3ae8
https://imgur.com/gallery/PGoR6wg
https://nz.news.yahoo.com/gladys-porter-zoo-texas-announces-rare-birds-displayed-153042205.html

FACTS

The rhinoceros hornbill (Buceros rhinoceros) is a large bird that is found in the rainforests of Malaysia, Sumatra, Borneo, and other southeastern Asian countries. These birds can measure up to 50 inches tall and have a wingspan of 5 feet. They are also a long-lived species, as these birds can live to be multiple decades old when in captivity. They are distinctive from other hornbill species due to their large banana shaped casque that sits on top of their bill. These birds feed primarily on fruit, as they use their keen vision to pick out the brightly colored fruit amongst the trees. However, they have been known to occasionally eat small mammals and reptiles.

AT CINCINNATI ZOO

THE SISTERS:

The sisters are quite timid and are generally uncomfortable around the keepers. One of the sisters does not respond to their attempts to condition her with high value food and is disobedient in general. She flies on top of the "garage door" during feedings, much to the dismay of her keepers. The other aids and abets this behavior by sharing treats with the unruly sister while she's misbehaving. They enjoy playing, manipulating, and destroying objects. They were observed tossing one of their feathers around for amusement.

BRUCE AND MOM:

Bruce and Mom are more comfortable around the keepers, but can also be more aggressive. Bruce is very territtorial and enjoys destroying anything the keepers put in the enclosure. He can usually be found hitting his head against the tree while cleaning his beak. They love water and even enjoy being outside during thunderstorms.

RHINOCEROS HORNBILL

BIRD SHOWER

Frank Bolek, Jordan Perrin, and Michael Mallory

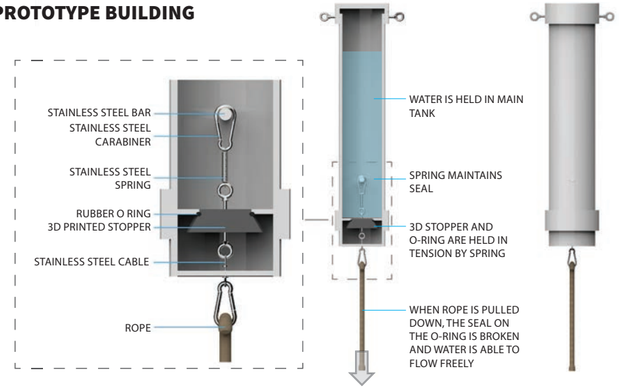
DESIGN GOAL

The shower enrichment device aims to increase the behavior of cleaning, which the horn bills rarely perform now due to the absence of moving water in their habitat. Additionally, the device aims to decrease the amount of time that the hornbills will be resting and increase their daily activity. By allowing the birds to control the output of water, they will be able to clean themselves when they desire. The rope that the hornbills pull on will also serve as another way for the birds to clean their beaks.

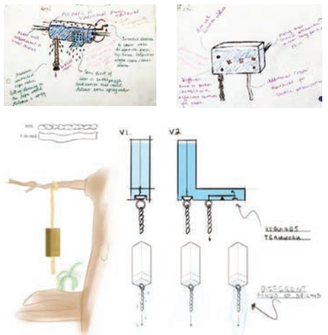
DESIGN PRINCIPLES

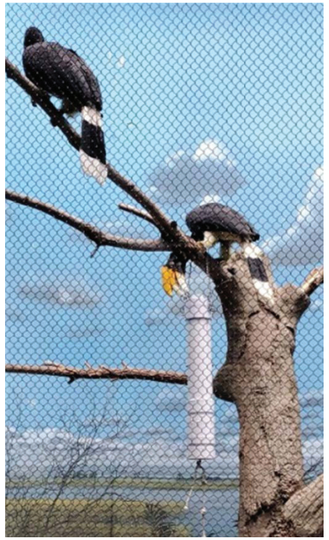
LOVE FOR WATER | HIGHLY INTELLIGENT | CONTROL OWN ENVIRONMENT | EASY TO TAKE APART

PROTOTYPE BUILDING



IDEATION SKETCHES





TESTING

The birds were curious about the device. They interacted heavily with the chains on top, smacked heads on the body of the device. We changed the attachment so chain was on the bottom in an attempt to focus attention there, but they did not use it correctly. It will take time for them to get comfortable with it.

MOVING FORWARD

Paint the device brown to match the tree trunk. Paint the bottom bright red to look like fruit and encourage birds to move towards the bottom. Change the bottom attachment. A bright, colored rope might attract the birds more. Continue to try putting the device in at different times. Putting the device in at feeding time would encourage them to move towards the bottom log and hopefully notice the dripping water.

VIRTUAL RENDERING SHOWING THE CONCEPT

RHINOCEROS HORNBILL

PUZZLE FEEDER

Hannah Salmon, Bradley Davidson, Justin Meyer, and Jamie Rinderle

DESIGN GOAL

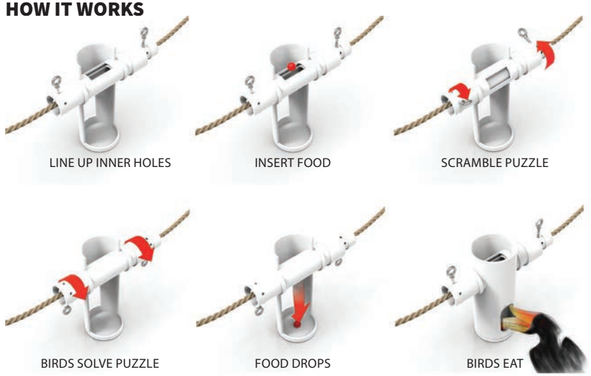
Over the course of the semester, the class was split into interdisciplinary groups to develop enrichment devices for select zoo animals. Our group used our collective knowledge and experience to create a puzzle feeder for a pair of Rhinoceros Hornbills. The device was created to engage the birds for both the mental health of the animals and the education of zoo visitors.

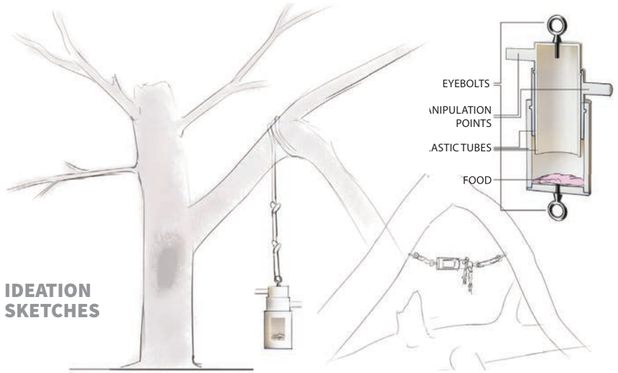
DESIGN PRINCIPLES

SELF DETERMINATION | FORAGING | TEAMWORK

PROTOTYPE BUILDING

HOW IT WORKS





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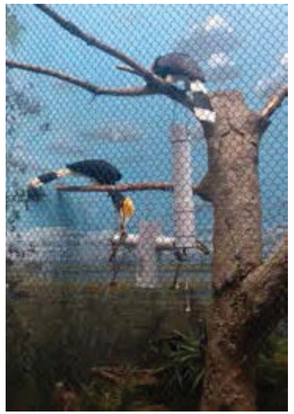


WORKING MECHANISM

The device consists of three conventional PVC pipes, modified and assembled to create a puzzle with multiple solutions. The two inner tubes each have holes centered within the largest tube and rotate freely of one another. The birds must grab ropes hanging from eyebolts on each tube to align the holes in the middle to free the food placed inside.

TESTING

During their first encounter with the feeder, the birds were extremely interested in the device, interacting with it almost immediately after it's placement in the exhibit. Keepers have noted that the birds are drastically more active when the feeder is placed in the exhibit. Although the birds haven't figured out how to use the device as intended, the keepers consider the device a success. Additionally, while they don't work together to solve the puzzle they seem to take turns interacting with the feeder. They were able to reach some of the food, depending on the location of the feeder and they consumed this food relatively quickly.

MOVING FORWARD

The Rhinoceros Hornbill Puzzle Feeder intrigued the birds; however, they are unsure how to solve the puzzle. When the feeder was initially introduced, the birds were trying to eat the food from the top, which was a different way to solve the puzzle. If it had been known that the birds prefer eating by sticking their heads down, our final design would have turned out differently.

LITTLE PENGUINS

BEHAVIOR STUDY

SWIMMING

In the wild, little penguins spend about 80% of their time in the water. They can be out swimming for as long as a month. It's no surprise that these little guys would live mostly in the water, as they are clearly built for it.

TEMPERAMENT

Noisy as Heck: They use their various vocalizations to communicate with others in their colony.

Not Very Bright: Unlike African penguins, little penguins are not capable of complex problem-solving. They often need to be trained to use enrichment.

Super Sentimental: When little penguins mate, they mate for life.

FEEDING

Hungry: Due to their active lifestyles, little penguins can eat up to 25% of their body weight in small fish and other prey.

Speed Eaters: Little penguin eat their large meals in very short amounts of time. If they are not fed quickly enough in captivity, they will walk away and sulk, even though doing so makes them starve in the process.

A Little Clueless: Little penguins presented with live fish in captivity may not know how to react without training. Due to this, many zoos with smaller colonies of little penguins tend to hand-feed or just place their food in a bowl for them.

BURROWING

In their natural beach habitat, little penguins use their feet to make burrows in the rockier parts and use the surrounding vegetation to make nests. They can suffer from bumblefoot in captivity if their environment's substrate is too rough and their feet stay in contact with it for too long.

CURRENT ENRICHMENTS

Little Penguins specifically do not tend to have the capacity to interact with different devices. The most recently given to them by the zoo has been fake kelp. However, a past enrichment device used at the Cincinnati Zoo has been a fish-filled hamster ball given to the King penguins, which floats on the water and allows the penguins to swim up and take fish out of the ball through the holes. This was very effective in enticing penguins to enter the water. There is a correlation between size and intelligence with these birds. Thus, although the enrichment may transferable between penguin species, it was important to observe the reactions of Little Penguins towards the enrichment to determine how well it may be received.

http://cincinnatizoo.org/system/assets/uploads/2011/03/little-penguin-web.jpg

BEST PRACTICES

Little Penguins are not very intelligent and hence the enrichments for them need to be simple and mostly food oriented. The only other type of enrichment for them can be environmental enrichments that allow them protection and shelter mimicing their natural habitat.

https://www.dailytelegraph.com.au/news/nsw/little-penguins-at-manly-sea-life-sanctuary-get-into-the-halloween-spirit/news-story/06e72909c670d28354cad332d7dd019b=
https://images.app.goo.gl/UeukkWqNtn8fKdUA6
Marwell Zoo, England

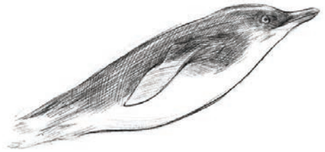
FACTS

Little penguins, also dubbed little blue penguins, little blues, or fairy penguins, are the smallest penguin species in the world. They grow up to 1.5 feet tall and live in the warmer climates of Australia and New Zealand. Like their penguin cousins, little penguins are highly colonial creatures and spend the majority of their time in the water hunting for food. On land, little penguins share nests with their mate for life* in small burrows near the water. Due to their small size, they have many predators on land, in water and even from the sky. They call to communicate their location to each other and form large groups, called rafts, when in danger.

AT CINCINNATI ZOO

The Cincinnati Zoo is home to a colony of over 30 Little Penguins, one of the largest in captivity (Cincinnati Zoo). Over the winter, 4 new chicks hatched named Toast, Pierogi, Green Eggs, and Ham -- all of the Little Penguins at the zoo are named after food aside from Bowie (named after David Bowie). In the wild, chicks go to sea for the first time between seven and eleven weeks of age. This is mirrored in the introduction of the captive chicks to their colony at the age of 6 weeks, once they are given the same diet as adult penguins.

LITTLE PENGUINS



FOOD TROUGHS

Jay Hubble, Karen Hufford, Ellora Jaggi, and Jenna Nobbe

DESIGN GOAL

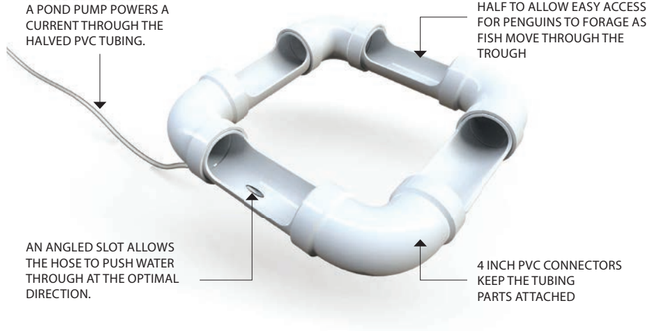
The primary goal of the design was encouraging feeding and foraging behaviors in the water. The design includes a PVC circuit carrying a stream of dead fish for feeding. The design also assists in gradual transition to feeding live fish. Our trough acts as a floating bowl for penguins to feed from. With the addition of a pond pump and a hose, the penguins can participate in eating moving fish. As the dead fish move downstream within the trough, penguins are encouraged to actively catch the fish. The fish are recycled in the PVC loop until they are eaten by the penguins.

DESIGN PRINCIPLES

NATURAL FEEDING

SWIMMING IMPETUS

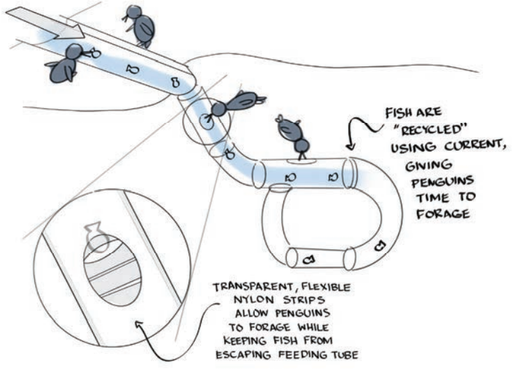
VISITOR VISIBILITY



PROTOTYPE BUILDING

The prototype was fabricated by cutting divots into PVC and sanding them to create smooth, bordered sides of a trough for fish to travel along. Pool noodles sewn into fire hose were attached to the bottom of these trough pieces as the flotation device, while an angled hole was drilled into one of the trough sections to allow tubing and a pond pump to be attached. The trough pieces were attached to PVC connectors of the same size in order to form a loop, although these were not permanently attached to promote modularity of the enrichment. Future modifications can be made in the form of using clear PVC for visibility and aesthetics or, again, manufacturing more pieces and changing the shape of the enrichment.

IDEATION SKETCHES



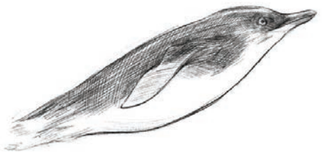
TESTING

With the Little Penguins nortoriously being so scared of new objects in their environment, the feeding trough must be slowly integrated into their habitat. The first stages are placing it in the pond without fish or a pump. Before placing the trough in the water, the penguins were sitting on one end of the shore. Shortly after the trough was installed, they moved closer to it, observing from shore. Some penguins were even curious enough to swim nearby.

MOVING FORWARD

Once the penguins are accustomed to the PVC trough, keepers can choose to put fish into a floating trough or to place it on land as a bowl. The trough may also be placed in the indoor habitat for penguins to feed out of, replacing the bowl they have used in the past. With this gradual integration, the keepers and zoo staff hope to eventually install the fully functioning trough feeder, with fish moving with the current. The trough can be expanded by enrichment teams to create different shapes or larger streams - possibly including pipe with transparent walls as well.

LITTLE PENGUINS



KELP FORESTS

Isaac Busken-Jovanovich and Madeleine Lyon,

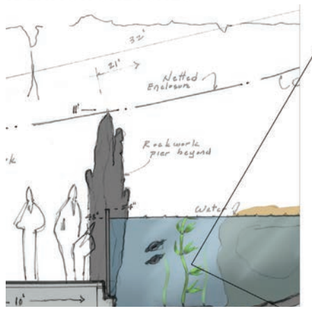
DESIGN GOAL

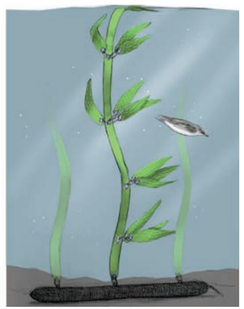
A modular kelp forest provides the Little Penguins with an aquatic stretch of varying textures and surfaces that integrates an element of the Little Penguins' natural habitat with their captive one. Due to the modular nature of the design, the forest can be arranged in a variety of patterns within the pool - at various depths of water and floor configurations. Instead of the captive Little Penguin who feels no desire to swim and fulfill its natural, species-appropriate behavior, the Little Penguins will have the option of swimming through fronds of "kelp" with a mild curiosity for the new addition to its enclosure.

DESIGN PRINCIPLES

BIOMIMCRY | SWIMMING IMPETUS | MODULAR DESIGN

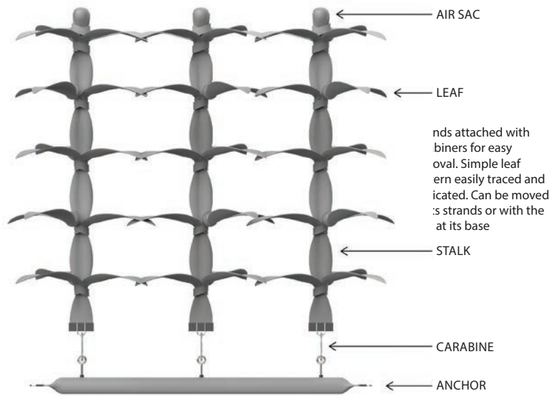
IDEATION SKETCHES

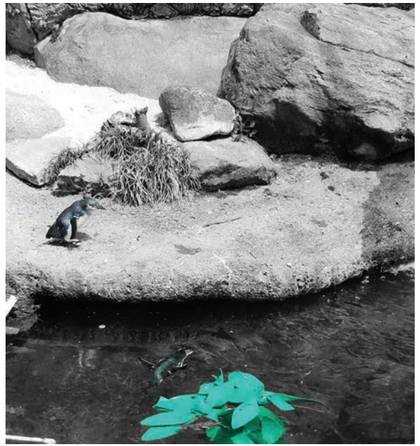


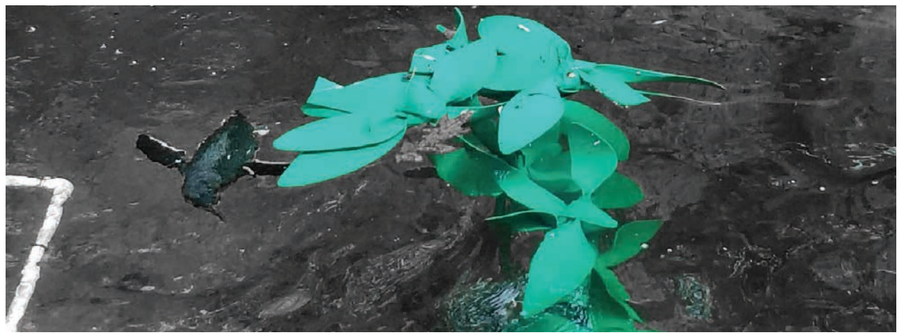


PROTOTYPE BUILDING

The artificial kelp are cut from an aquatic felt material in a mimicry pattern and attached to a central 'stipe' stalk. Ping pong balls are used to imitate the pneumatocysts (gas bladders). Each kelp frond is then clipped with a carabiner to an eye-bolt screwed into the anchor. The anchor itself is a flexible tube, made of 4" firehose, filled with sand and sealed on either side with firehose brackets. Each anchor section is 1 meter in length. A 4" diameter metal ring is carabinered to the end of the firehose bracket.







TESTING

The little penguins were more afraid of the Keepers installing the kelp than they were of the kelp itself. Once it was situated near the land bridge in section B, some curious individuals would stare at it. Those who dove into the water or were in the water already would simply swim by the it or circle around it on some occasions. A couple of adventurous penguins touched the kelp and nipped at the bottom leaves.

MOVING FORWARD

We hope that the zoo can fabricate more of these kelp units based off of our plans, as they are quick to assemble and easily scalable. As we move on, we wish that testing can continue with other penguin species such as the African penguins who may find more interest in the kelp. As the new exhibit for the Little penguins is opened, we hope that there may be several kelp units fabricated to provide a full forest for the Little penguins in their new home.

MALAYAN TIGER

BEHAVIOR STUDY

HUNTING

Malayan Tigers are nocturnal predators, and rely heavily on camouflage to ensure the success of their ambush-style of hunting.

HIDING

As tigers spend 18-20 hours of the day sleeping, they need a place to do it where they will be hidden from harm, such as other tigers. This instinctive behavior causes them to form dens in caves, trees, or dense vegetation.

SWIMMING

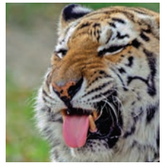
Tigers are the only one of the big cats that like to swim. They swim to cool down or travel downriver quickly. As they are strong swimmers, they often lure their prey into the water, where they can easily overpower it.

CLIMBING

Young tiger cubs are known for climbing tree and playing in high heights. As the tigers get older and larger, they mainly enjoying climbing around wild terrain and large rocks.

SMELLING

Scent marking communicates territorial boundaries and the female reproductive status. Tigers mark their scent by: urine spraying (the most common sub-behavior), scraping with gland secretions, clawing, cheek rubbing and vegetation flattening.



STEREOTYPIC PACING

BEHAVIOR IN CAPTIVITY

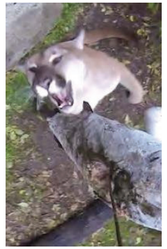
While tigers exhibit natural behaviors in captivity, they also exhibit detrimental unnatural behaviors, labeled stereotypic behaviors. Common stereotypic behaviors include pacing, or repetitive walking back and forth in the same spot that can cause damage to the tiger. A large enclosure size, significant amount of vegetation, high levels of enrichment and the availability of a pool can decrease stereotypic behaviors.

CURRENT ENRICHMENTS

Cincinnati Zoo enrichment items include boomer balls, large, durable plastic balls, and PVC logs. The keepers use scent in the form of spray-on scents and scent pipes for the tigers to investigate and play with. The keepers also make cardboard enrichment devices for the tigers to tear apart and destroy. One other popular enrichment item is creatively preparing the tigers' food, such as meat chips smushed into pinecones or meat frozen in ice during the summer.

Currently there are two public, outdoor exhibit spaces. The larger of the two exhibits have varied terrain and foliage where they can climb and hide from the public. The smaller is flatter and more sparse. Both exhibits contain pools deep enough to swim and wade. The tigers also have access to a long, heated tunnel and indoor space for inclement weather and feedings.

BEST PRACTICES



Popular enrichment for tigers in captivity focuses mostly on hunting, swimming, and eating. Scent recognition is important while hunting and can be utilized in activities involving toys and training dummies. To add excitement to feedings, keepers might animate carcasses by twitching them, smashing meat chips into pinecones, or making blood popsicles. Boomer balls and related plastic items are extremely durable and in common use. Natural enrichment items such as vegetation, pools, logs, and ice balls are also popular to add in tiger habitats.

FACTS

Malayan tigers' range is restricted to the Malay Peninsula and the southern tip of Thailand. Malayan tigers are critically endangered, and there are only an estimated 250-340 left in the wild, due to habitat loss, human conflict and poaching (WWF). While closely related to the Indochinese and Bengal subspecies of tigers, they were proven to be their own subspecies through DNA testing in 2004 (WWF). Tigers form dens in caves, trees and dense vegetation, which is important as they sleep 18-20 hours a day. In general, tigers are both nocturnal and solitary predators. They usually only come together to breed, defend territory, or rear young.

AT CINCINNATI ZOO

The Cincinnati Zoo is home to three Malayan Tigers named Batari, Chira and Izzy. They were born at the zoo on February 3rd, 2017, and had to be raised by a foster dog and keepers after their mother's maternal instincts did not kick in. These tigers are three of the 64 tigers currently part of their Species Survival Plan.

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https://www.zoochat.com/community/media/tiger-enrichment.68920/

https://blogs.smithsonianmag.com/smartnews/files/2013/11/Screen-Shot-2013-11-11-at-12.48.32-PM.jpg
https://media.npr.org/assets/img/2016/07/25/bloodsicle-10-edit_custom-be9ff1211deab-be9a69d9e74e28a78a32e62beb9-s800-c85.jpg

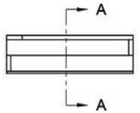
MALAYAN TIGER

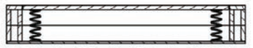
WOBBLE PLATFORM

Andrea Vale and Michael Hutchings

DESIGN GOAL

This enrichment design aims to address the decrease in physical activity for tigers in captivity. The wobble platform provides a new device for the tigers to utilize in play and when bored with their other enrichment. With this enrichment they are required to engage their muscles when interacting with this platform due to the mobility of it. While walking or jumping, a tiger needs to stabilize itself through its core and legs to prevent toppling. The hope is that this design will increase the duration of physical activity while the tigers are located in the indoor holding.





SECTION THROUGH AA

DESIGN PRINCIPLES

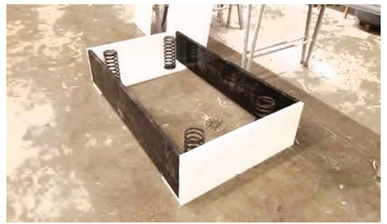
ENGAGE MUSCLES

IMPROVE BODY STABILITY

PLAY ACTIVITY

PROTOTYPE BUILDING

Platform is made from plexiglass with a protective skirt around the outside in order to avoid injury to the tigers due to pinching. The platform uses springs with a spring rate of 50 lbs. per inch. The final platform will be placed in the tiger's indoor exhibit to provide them with enrichment while they are not in the yard.



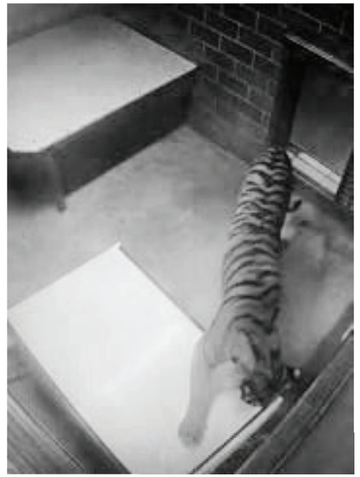
DESIGN INSPIRATIONS

CYLINDER BALANCE BOARDS

HALF-BALL BALANCE BOARD

SPRING BALANCE BOARD

https://www.amazon.com/Revolution-Balance-Board-Trainer-Blue/dp/B00AAXD 6X0?ref_=bl_dp_s_web_8510892011.
https://www.dx.com/p/Universal-Portabl e-Fitness-Yoga-Pilates-Half-Ball-Balanc e-Trainer-Board-Plate-Knee-Pads-Home-Gym-Equipment--blue-2065465#.XM9 J3y2ZM_W.
https://odditymall.com/spring-balance-board.



TESTING

During the observation for enrichment implementation, it was found that the majority of the time was spent investigating the platform via sniffing. The closest behavior observed to target behavior (on platform with all four paws) was standing on the platform with front two paws. This was also the least frequent behavior in the data sampling for the first ten hours, but increased significantly over the last five hours. This indicates that over time, the tigers more frequently exhibited behaviors similar to the target behavior. After the enrichment has been in-exhibit longer, the tigers may be more likely to stand completely on top of it.

MOVING FORWARD

Future implications for this design may include habitat transferability between indoor and outdoor exhibits or scalability for different species. This same design can be used to provide enrichment for other big cats similar in size to the Malayan tigers. It can easily be moved to one of the outdoor exhibits for the tigers so that there is more space for interaction and visitors can experience something different. The design can easily be scaled up or down by changing dimensions, acrylic thickness, and spring strength to be implemented in habitats of other species such as bears or small mammal species.

MALAYAN TIGER

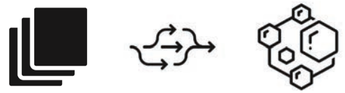
MODULAR DEVICE

Garrett Krueger, Zach Fickenworth, and Deepansha Pahwa

DESIGN GOAL

Our enrichment device is intended to elicit active hunting behaviors while also reducing detrimental stereotypic behaviors. Combining novel and multisensory stimulation will better simulate hunting conditions and prey, therefore prompting hunting behavior. Novel stimulation*, being defined as new or differing enrichment devices, has long held value among zoo keepers. Our modular device allows insert attachments for the variations in enrichment. The original concept was to fill a boomer ball with a large variety of enrichment devices for the tigers, such as wheels and activity tracking for the keepers.

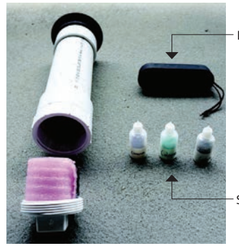
DESIGN PRINCIPLES

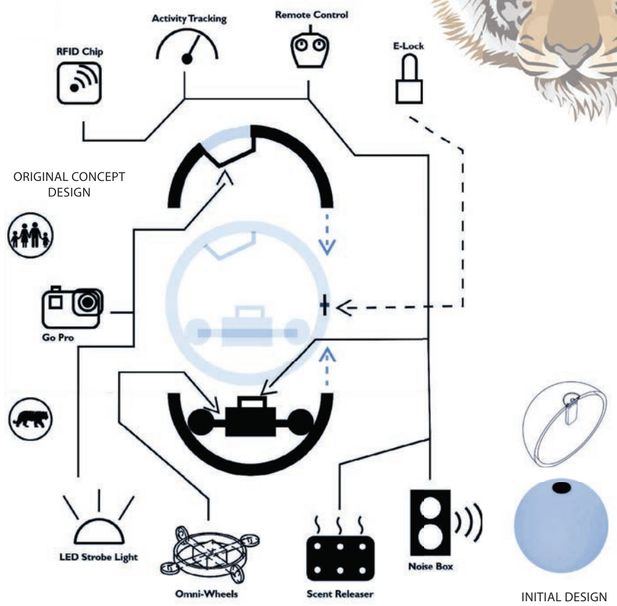


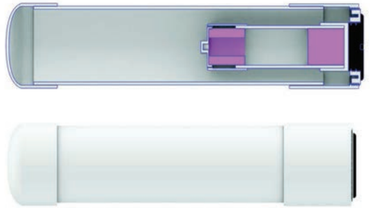
MULTISENSORY FLEXIBLE STIMULUS MODULAR DESIGN

PROTOTYPE BUILDING

For the purposes of testing enrichment devices with the tigers themselves, a new outer shell was designed out of PVC. The inner containter can be switched between a boomer ball or the new design. Our final design was realized with the fabrication of our prototype out of PVC.







***NOVEL STIMULATION:** Novel stimulation reduces habituation, which is when animals get used to the enrichment and the interactions between the animal and the device decreases over time (Mellen and Shepherdson). Novel stimulation also reduces stereotypic behaviors and increases activity levels, which are both primary goals in the care of zoo animals.*

TESTING

While there was not much observation time of the tigers with the device, the initial test was promising as the tigers interacted mildly with the device and showed interest in the various sounds played. However, their interest was typically not held for long and we did not test every component. We speculate that the ability to place a variety of objects will keep the tigers entertained longer both in the short and long run.

MOVING FORWARD

The modular nature of the device is a highlight. With sufficient engineering expertise and time, inserting more devices in the module is possible. As for the PVC design, we would recommend investing in clear PVC as it would allow for even more modular aspects. For example, any lights would be able to be placed inside, or various objects the tigers might be visually attracted to. It would also allow for a GoPro Camera insert to be utilized in the design. Still, the design is mostly optimized for creating new opportunities for the tigers, and the keepers are free to use the shell to put whatever they wish in with the tigers.

CINCINNATI ZOO CHALLENGE | SPRING 2019

MALAYAN TIGER

FEEDING ZIPLINE

Bernie Pieters and Brenna Truax

DESIGN GOAL

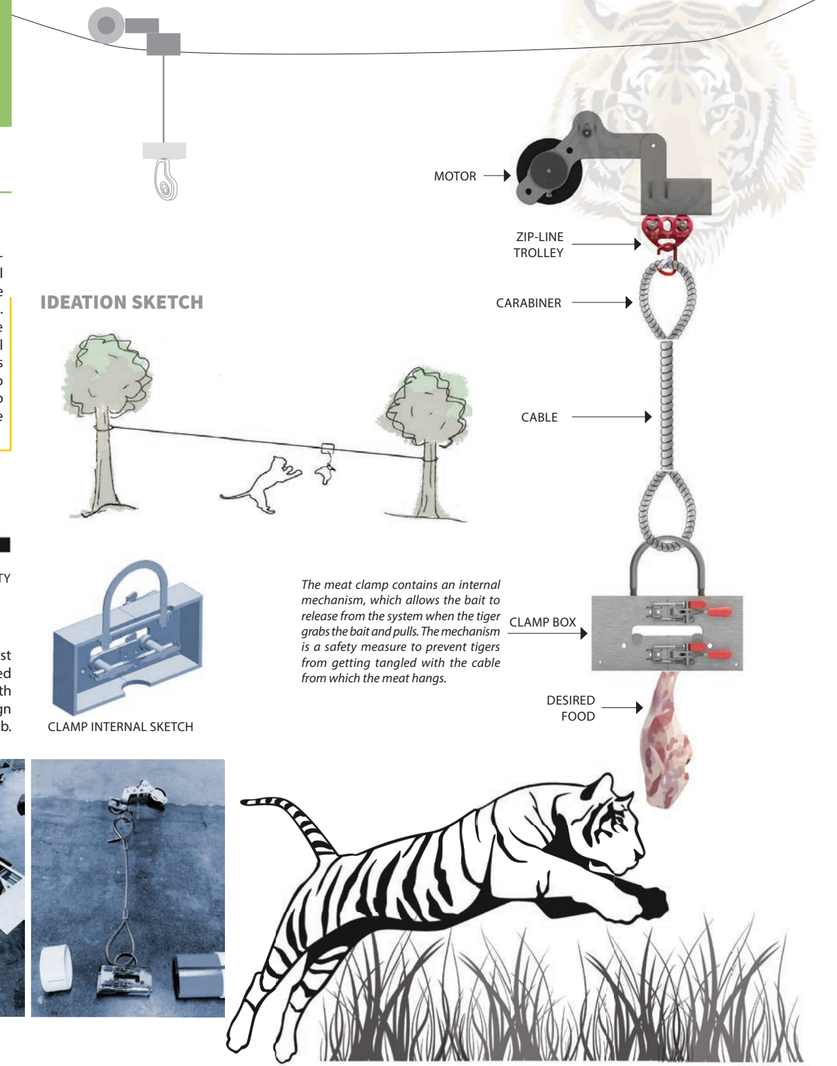
For our project, we designed and built a motorized zip-line to enrich the tigers during meal time. The zip-line will fly back and forth across the exhibit as the tigers chase it, simulating how they would chase prey in the wild. Additionally, the tigers will have to jump and attack the carcasses in order to receive their meal. This enrichment will be a great way for the tigers to use their predatory instincts and also get healthy exercise. Malayan Tigers are able to reach speed-bursts of up to 50 miles per hour. They are also able to jump more than 30 feet, which gives them a huge advantage over an animal trying to escape their attack.

DESIGN PRINCIPLES

CHASING PREY | HIGH SPEED RUNNING | JUMPING ABILITY

PROTOTYPE BUILDING

The motor box and clamp box were constructed by first water-jet cutting stainless steel, then the parts were welded together, and finally the sides were gridded down for smooth finishes. The other parts were ordered and the whole design was fabricate at Maker's Space of the UC 1819 Innovation Hub.



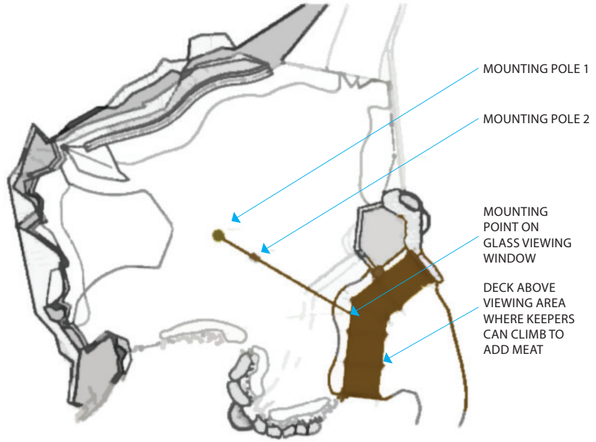
IDEATION SKETCH

CLAMP INTERNAL SKETCH

The meat clamp contains an internal mechanism, which allows the bait to release from the system when the tiger grabs the bait and pulls. The mechanism is a safety measure to prevent tigers from getting tangled with the cable from which the meat hangs.

TESTING

Unfortunately due to the large scale of our project, we were unable to conduct an evaluation on our actual design. The initial testing showed the motor, ESC, and battery combination was under-powered. The initial mounting points on the trolley shifted the center of gravity above the axis making the system inherently unstable. The meat clamp behaved as expected, and safely releases bait as a downward force is applied.



FUTURE PLAN FOR INSTALLATION

MOVING FORWARD

In the future additional attachments could be used for fixturing as that is currently the most challenging part with using the clamp. The motorized portion requires the largest amount of rework. The motor which was chosen initially couldn't provide the amount of torque necessary to move the entire system. This is in part due to the rework and strengthening of all the components adding weight to the system.

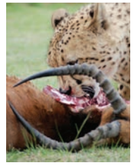
CHEETAH

BEHAVIOR STUDY

Cheetahs spend only about 12% of their time in motion, while the remaining 88% of their time is spent resting.

STALKING

Their dark spotted fur acts as a form of camouflage so they can more effectively stalk prey at close range. The distinctive black lines that curve from the inner corners of their eyes to the outer corners of their mouths prevent glare from obstructing their vision.



SOLITARY

Cheetahs are usually solitary creatures, though social groups can consist of a mother and her young or coalitions of two to three males that are typically brothers.

KILLING

Once they are in striking distance, they swipe at the legs of their prey and quickly close off their windpipe to suffocate them before consumption. The killing and eating process happens incredibly quickly for fear of kleptoparasites (i.e. lions and hyenas encroaching on their kills).

CHASING

Once they lock onto a target and have stalked close enough, they begin the chase. Sleek, flexible bodies with long legs, non-retractable claws, and a muscular tail allow them to reach high speeds (as much as 70 miles per hour) to catch their prey.

RESTING

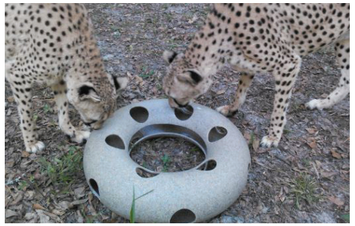
Their high metabolic activity to participate in such highspeed chases also requires immense compensation via resting – i.e. these chases can only last for short distances (about 220 to 330 feet) before overheating becomes an issue.

https://www.africa-wildlife-detective.com/cheetahs.html
https://jooinn.com/img/get

CURRENT ENRICHMENTS

The Cincinnati Zoo, like many zoos, use a mechanized lure system to provide enrichment for the cheetahs. This space is a long, grassy stretch of land including a small central pond abutted by two climbing structures, a grassy mound of earth on the left-most side, and several entrance points for the animals showcased during the encounter. This stretch of land was specifically tailored to the Cheetah Encounter, and it provides an adequate space for the cheetahs to run at elevated speeds for short periods of time both for their enrichment and that of the visitors.

BEST PRACTICES



'Cheetah Run' is the most popular Behavioral Enrichment for Cheetahs. The other enrichments include scents, hanging food, play balls and Enclosure Rotation.

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https://i.pinimg.com/564x/81/a3/40/81a340a1f552dd5f920c54c87092ced2.jpg
https://www.cheetahexperience.com/animal-enrichment

FACTS

Cheetahs (Acinonyx jubatus) are large cats that primarily reside in Northern, Southern, and Eastern Africa.Cheetahs are considered vulnerable species according to the IUCN Red List of Threatened Species. Cheetahs have many adaptations that help them run and catch prey in the wild. Having a large heart and lungs enable them to exert high energy for a short period of time. Lastly, they have blunt, nonretractable claws and ridged foot pads for quick starting and stopping. Cheetahs can only run at high speeds for about 1.5 minutes before needing to rest. They can accelerate from 0 to 60 mph in 3.4 seconds, and their stride can be up to 7.6 meters.

CHEETAH

LURE SYSTEM

Sarah Cunningham and Kathya Acharya

DESIGN GOAL

The goal of this project was two-fold: to modify existing brake installed by the Cincinnati Zoo and to design an entirely new lure system. The main differences between the old design and the new design are the motor, the controls, and the cover. The new design aimed to provide better controls over the speed of the lure system and its efficiency, while also improving the safety of the system for the trainers.

DESIGN PRINCIPLES

SPEED CONTROL

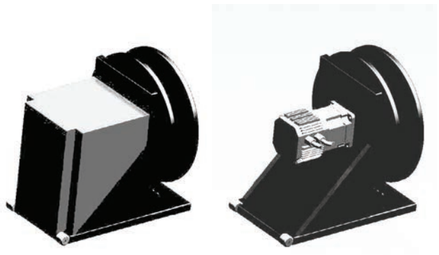
SAFETY

EFFICIENCY

CONCEPTUAL IMAGE SHOWING LURE SYSTEM

PROTOTYPE BUILDING

There is a speed control motor that adjusts power to maintain a set speed. It also has a automatic overload protection sensor, which means there is a fail safe if something goes wrong. The controls have an on/off switch, a switch to change direction, and a speed adjustment knob.



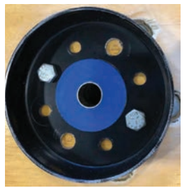
ISSUES WITH EXISTING LURE SYSTEM

Unbalanced Brake Drum

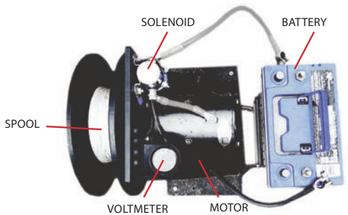
Unbalanced clearance between brake drum and brake band

Lack of clearance between brake band bolt and the spool

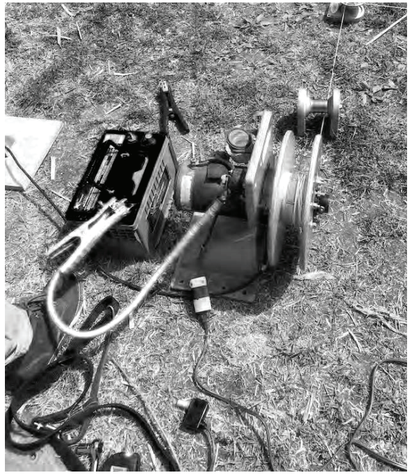
Brake band on Unbalanced surface



BRAKE DRUM, BOLTS AND SPOOL MODIFIED TO DECREASE WEARING AND INCREASE TOLERANCE



EXISTING LURE SYSTEM



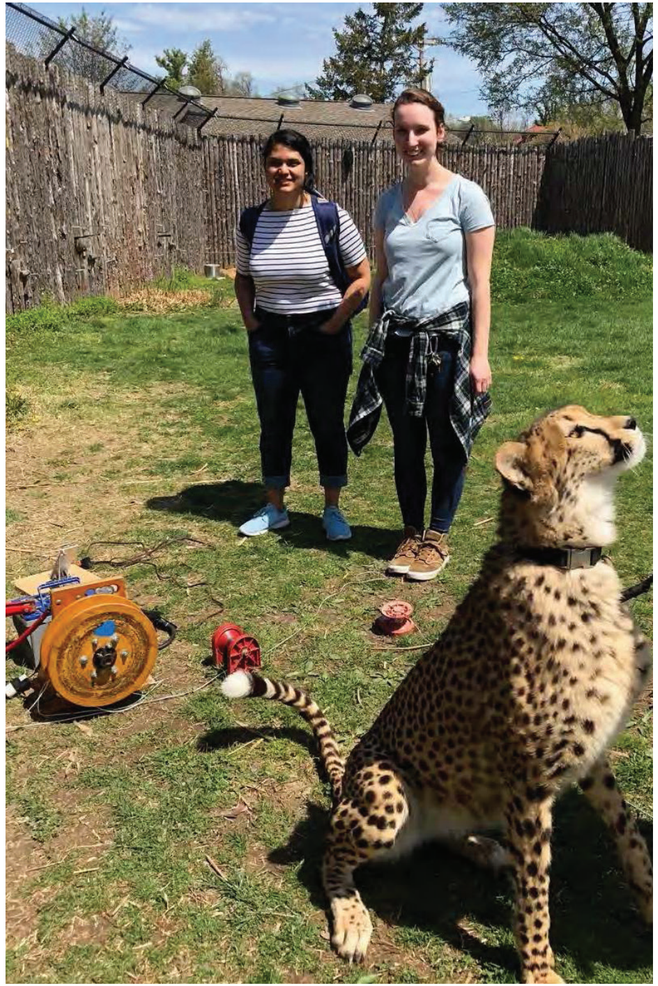
FULLY FABRICATED PROTOTYPE INSTALLED IN EXHIBIT

TESTING

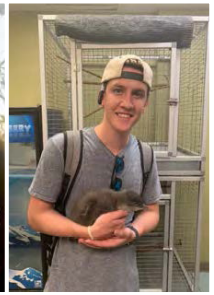
The braking mechanism was successfully modified, no longer slowing down the system due to internal friction and pulling the lure at a reasonable rate for a cheetah to chase – a 14 second run time that fell within the normal range of 8 to 17 seconds. In addition, the system reduced stopping time significantly, proving to be a safer and more efficient means of ending the run – stop time reduced from 2.6 seconds on average to 0.75 seconds.

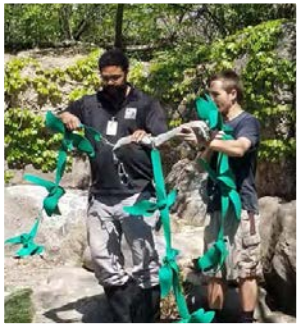
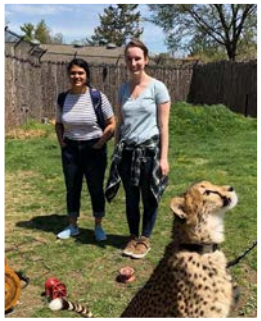
MOVING FORWARD

The current modification serves as a temporary method for the Cincinnati Zoo, which can be turned into a more permanent solution utilizing the theoretical redesign of the system. The future of this project lies in the creation of a wholly modified system, which takes advantage of continuous motor controls to preserve the motor and help prevent backlash which can cause significant delays during shows (detracting from visitors' experiences).



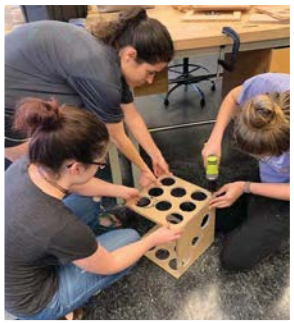








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