

# Advancing Welfare with a Push of a (Printer) Button

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Zoos and aquariums are continuously developing opportunities for animals to thrive in their environments. We often work with a wide variety of species that have very specialized behaviors and needs. This diversity poses a challenge to Behavioral Husbandry (BH) programs, as many of these needs cannot be met by products found on store shelves. We have, therefore, become accustomed to creating training and enrichment devices ourselves. At Disney's Animal Kingdom®, we believe, as technology outside of the zoo world evolves, we can look for ways to utilize

newer technologies to meet these needs and help our animals thrive.

One way we have added technology into our BH program is by utilizing a 3D printer. A wide variety of items can be produced by a 3D printer, making it possible to create training or enrichment devices targeted specifically to a species or individual. As technology develops, these printers are becoming less expensive and more user-friendly, making it possible for someone with no background in computers or engineering to successfully create novel

devices. Additionally, as 3D printing gains popularity, an ever-increasing pool of specialized 3D printing companies have opened their doors, making it much more accessible to have custom objects created. Utilizing this technology, we are able to create items that are tailored to our individual needs, rather than relying on inadequate devices off the shelf.

Offering opportunities for our animals to perform their natural behaviors is one of the cornerstones of our BH program and the 3D printer allows

3D printer with completed mushroom print, ready to be cleaned and painted



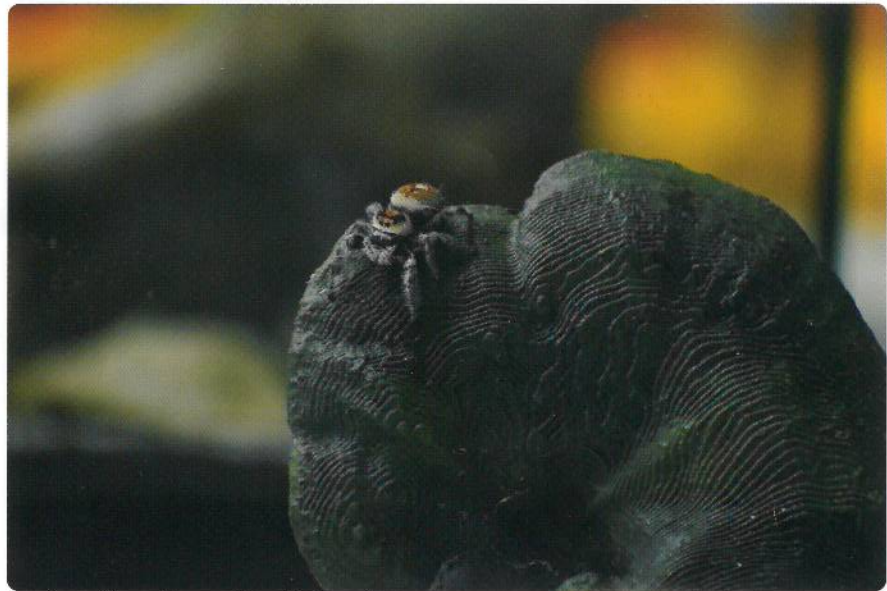
A 3D printed hippo tusk, painted to look naturalistic, is used as bio-fact by our Education Team



us to create devices that enable such opportunities. One example is a faux ribcage that was designed and printed for our three species of vulture found at Disney's Animal Kingdom Lodge. Keepers smear ground meat or spear kabobs of diet items on the ribs to encourage the vultures to use more intricate feeding behaviors, such as ripping and pulling food items off the bones, which had not been often seen with previous feeding techniques. Another use for the 3D printer has been to create dummy eggs for our waterfowl. Occasionally, for various reasons, eggs must be pulled to be incubated in managed care. Previous techniques for creating dummy eggs were very time consuming and often subject to mold or breakage. Using 3D printing technology, we are able to scan the real eggs and print duplicates that are the exact same size and weight, allowing the birds to safely carry out all of the natural behaviors associated with incubating their eggs.

We can also use the same scanning technology to create unique, natural-looking devices. Enrichment that blends into the surrounding environment is important for the stories we share. Counteractive to this objective, most animal enrichment items in stores are brightly colored, making it difficult to camouflage. The 3D printer allows us to develop items that fit the stories or blend into the animal's surrounding environment. Our 3D scanner enables us to scan real objects, such as hollowed-out coconuts or shelf-fungus found growing on the trees, and produce identical copies with a sturdier plastic. After scanning an object, we can then add attachment points or make the object smaller or larger to fit our needs.

In addition to enhancing our Behavioral Husbandry Program, the 3D printer has been used in collaboration with other departments within Disney's Animal Kingdom®. Working closely with our Education Department, we have incorporated 3D printing technology into our summer camp programs. Campers help design items for our animal teams



*Jumping spider resting on a 3D printed mushroom*



*A nest basket that is disguised to blend into the trees of our aviary*

and then assist in starting the printer to bring their designs to life. Our Education team also uses bio-facts to connect guests to our animals and they requested a 3D printed hippo tusk to use during their talks. We were able to modify a bone design found online and paint it to mimic a real hippo tusk. Similarly, a Megalodon tooth was needed for a presentation by our Endocrine team. Another free design was found online and we were able to have a life-sized bio-fact to share with guests when a real version was unavailable. Other applications have included our Animal

Behavior and Technology team as they were monitoring temperatures in our lion habitat and needed a way to protect the thermometer held in the water bowl. A device that fit snugly into the bottom of the water bowl was designed with a lid that could be twisted off by human fingers, but was flush enough to be protected from curious lions. As word spreads of our 3D printing abilities, our surrounding teams are discovering more and more uses.

The free designs we have downloaded are a small portion of the resources you can



Summer campers inspecting a nest basket they helped design for our aviaries

find online for 3D printing. There are a plethora of how-to videos on YouTube and plenty of troubleshooting forums to help novice users develop their skills. Additionally, the customer support team for the 3D printer that we use has been instrumental in troubleshooting problems that inevitably arise. If devices are too complicated or too large for our abilities, we have looked to outside companies for assistance. Our Asian small-clawed otters have a device printed by an outside vendor that was able to develop a more complex product

and replicate it much more quickly than what we could have done in-house. These companies are gaining in popularity, which has helped drive down the price of outsourcing some projects.

We are still discovering ways that 3D printing can help benefit the welfare of our animals. This technology has allowed us to print objects that are otherwise unavailable, making the possible applications virtually endless and only limited by our imaginations.

Vulture picking diet items off a 3D-printed ribcage



We can quickly reproduce items and make intricate designs to fit specific needs, and items are durable enough for many species of animals. There are an expanding number of materials used to make the 3D printing filaments, creating even more options and more opportunities for use. All that said, the 3D printer does have some drawbacks; it can take a lot of time to design, clean, and finish items with animal-safe paint or sealant. When a problem arises, troubleshooting can also be fairly time intensive. Additionally, the upfront cost of the printer and filament can be prohibitive for many facilities. However, when possible, a 3D printer can add such value to a behavioral husbandry program. From printing stations for zebras to nesting baskets for our aviaries, the 3D printer has been a multifaceted tool. After using the printer for three years, it feels like we have just scratched the surface of the possibilities and we are very excited to see where this technology takes us. 🐘

## REVIEW

This paper shows great creativity by utilizing a 3D printer to increase natural behavior while presenting a more environmentally-appropriate element to animal habitats. As 3D printers continue to grow in popularity, the cost will be more affordable for facilities but also its multi-use across departments, as presented in this paper, lends itself to sharing costs. The various applications of the 3D printer in this paper was fascinating and shows how ingenuity has increased our animal care.