Innovative Partnerships: Technology Collaborations for Enrichment Development

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What happens when a well-thought-out enrichment initiative falls short of its behavioral goal? Part of the enrichment design process is evaluation and readjustment. This can help determine what changes need to be made to better meet the desired behavioral goal. Would you consider adding some technology to meet the intended behavioral goal? What happens if that technology is outside your current skill set? Technology can provide means to solve complex problems but can be intimidating for those who don't know how to apply it. In the past, we at Disney's Animal Kingdom®(DAK) have incorporated new technologies like 3D printing to solve challenges that can arise with enrichment development, but there are lots of other technological solutions that can be applied as well. What we found is that sometimes you must take a deep dive into the world of engineering; and look for some partnerships to help you learn about technology and the skills to implement those tools to find solutions for enrichment development.

At DAK, we are always on the lookout for new ways to provide animals the opportunities to showcase natural behaviors with the goal of great animal welfare. During an enrichment brainstorming session for cheetahs, the animal care team wanted to focus on looking at new ways of encouraging extended periods of locomotion. To meet this behavioral goal the cheetah keepers initially designed a cheetah-activated delivery system that dispensed plastic balls for the cats to chase. Initially, the keepers trained the cheetah to activate the device, by pushing on a platform that would dispense the balls out of a chute. It was designed similarly to how a trash can lid opens mechanically when you use your foot. After a couple of attempts at tweaking the mechanism, the cheetahs chased after the ball. Unfortunately, they didn't quite reach their behavioral goal of prolonged locomotion for sustained periods. The cheetahs would chase the ball when it was in motion but, once the ball stopped moving the cheetahs quickly lost interest. The device was entirely dependent on gravity, and so the momentum of the ball would only last several seconds before coming to a complete stop. This was a problem that needed a unique solution. How could we devise a ball to continually move for a more substantial period?

Luckily, the answer came from a collaboration with some innovative partners we had collaborated with several years before. Our Enrichment Development Group (EDG) is a collaborative group of animal keepers and animal care leaders who have learned unique skills to design, create and implement the next level of behavior-based enrichment. One goal for this group is to learn skills so when an enrichment item needs to be adjusted or any component needs repaired, they

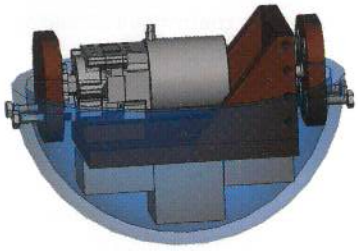
know how and what to do to adjust or fix them. The EDG had already worked alongside a group of engineers to help create unique behavior-based enrichment focusing on behaviors like foraging in species-appropriate ways for hornbills, otters, and siamangs. So, we reached out to this group to see if they could turn our idea of a self-moving ball into reality.

We brought the challenge of the initial ball delivery device and the goal of creating extended bouts of locomotion to our engineering group. The technology for a self-propelled ball already exists. There are several commercially available self-moving balls available in the pet toy market. The challenge for us was determining how to scale it up and make it cheetah proof. With our unique partnership, our animal keepers were able to provide the animal expertise and safety needs while the engineers brought their technological expertise to the design table. The engineers have different backgrounds including software for coding so the ball knew how operate on its own, and mechanical engineers designing the inside of the motor and housing so the ball could move around safely. The process of the partnership includes both groups sharing, teaching, and learning from each other. The animal care team learned how to code and assemble the ball. This way if we want to replicate this enrichment strategy for other animal species, we have the foundational skills and understanding to accomplish this. The fun for the engineers was that they found new ways to apply their skills while designing a product for animals to interact with. Their experience in designing for humans provided some overlap, especially when considering safety factors like pinch points, catches, etc.

The cheetah ball is a 10-inch hard plastic ball that can roll around on its own. The original design started with cutting the ball in half and mounting a motor and axel down the middle (Figure 1). Suspended from the motor and axel

The cheetah ball's original design started with cutting the ball in half and mounting a motor and axel down the middle

is both the electronics and ballast. This mass, which hangs below the motor and axel assembly, enables the ball to move. A computer program controls the rotation of the ballast about the center motor and axel assembly. The software, developed using Open-Source Arduino hardware and tools, works to move the ballast to a specific angle relative to the ground under the ball (Figure 2). As the ballast is offset from under the motor and axel assembly, the center of gravity shifts to one side and the ball rolls in that direction to center itself. The speed of the ball is controlled by the magnitude of the distance of the center of gravity from the center of the ball. The ball can be controlled via a remote control or a set of automatic commands. The remote control takes user input via a joystick and emergency stop button (Figure 3). This allows for immediate, controlled motion, with the ability for the keeper to stop movement at a moment's notice. The automatic operation enables the ball to have bursts of activity spread throughout the day



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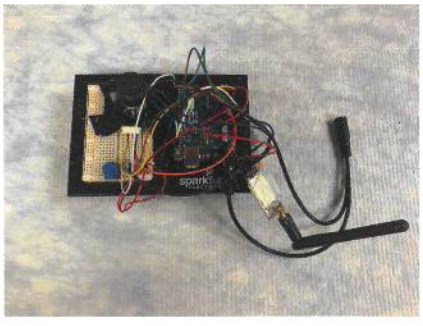

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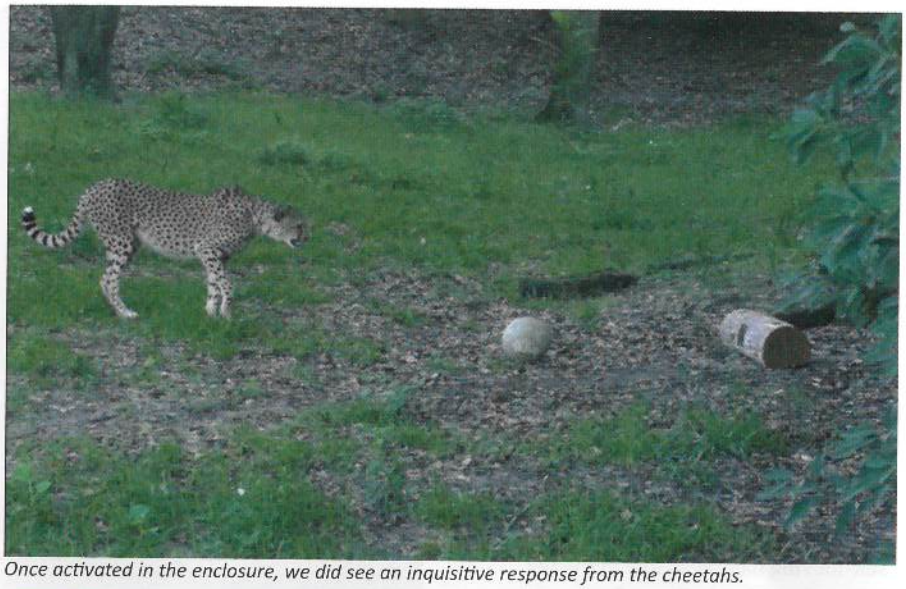
Animal-safe epoxy to create a tread-like texture



Once activated in the enclosure, we did see an inquisitive response from the cheetahs.

Cheetah interacting with the ball.

without keeper interaction. Regardless if the ball is operating remotely or automatically, movement is still achieved by shifting the ballast inside and letting the ball come back to center. This occurs over and over again in a manner of milliseconds to move the ball in a sustained, controlled manner. Sticks and rocks inside the habitat provide a randomness to the movement, allowing the ball to change direction and create an interesting device for the cheetahs.

We focused the initial testing of the ball with another species, goats, in a more controlled setting. We wanted to observe how the ball would react when an animal interacted with it. Initial tests went well, the goats were curious and did interact with the ball. What we learned was the impact from the goats didn't dislodge any key electrical components. Soon we were able to move on to test the enrichment with cheetahs and the initial test proved promising. The terrain is different in the cheetah habitat, which created a new obstacle for the cheetah ball. Since the ball was smooth and the terrain wasn't flat, the ball easily got stuck or spun in place. A quick solution was to add a small layer of animal-safe epoxy to create a tread-like texture (Figure 4). This solution worked but then created another challenge of added weight to the ball, which limited movement. Once activated in the enclosure, we did see an inquisitive response from the cheetahs. The first interaction with the cats was quite promising. They interacted with the ball by swatting at it and even chasing it (Figures 5 & 6). With the initial reaction from the cheetahs a success, we are closer to reaching our behavioral goal! Currently, we are working on version 2.0 to adjust and improve on our initial prototype. We will use the prototype to create a mold to lessen the overall ball weight and it will include an upgraded controller providing keepers the ability to control the device from a distance. As part of the enrichment development plan, evaluations will be an important step. By monitoring behavior, we will see how the cheetahs interact with the cheetah ball and assess whether we reached the initial behavior goal of sustained locomotion. The enrichment will continue to be adjusted as the cheetahs learn how to ensure the goal is still being met.

Now that our collaborative efforts from this project are almost complete, we are looking into other enrichment development projects that might benefit from the addition of technology. A couple of the future projects include looking at increasing certain behaviors

such as locomotion-responsive timed-feeders that activate when motion sensors are triggered, and foraging through the use of a vending machine enrichment device that takes tokens to encourage foraging behaviors in an under-utilized habitat. We are even looking into using non-food reinforcement to encourage certain behaviors from ectotherms. One of the projects is looking at how to use heat to encourage locomotion from snakes with timed heat sources spread throughout a habitat.

So, you may be thinking how can I do something similar at my zoo or aquarium? There are likely many community resources around you. Many zoos and aquariums are neighbors with colleges and universities, or companies that might want to partner. For universities that have engineering programs, most require a senior design project and are frequently looking for problems for their students to solve. Much of the technology inside the cheetah ball is covered in an engineering curriculum and is an excellent project to demonstrate that learning. So, you never know what interesting partners are in your community and soon you too can be designing the next level of enrichment for your animals.

Lastly, I want to thank everyone who contributed to bringing this idea into reality. First, we want to thank the East Savannah Team and Patrick Potts, for collaborating on the project and providing their animal expertise. We also want to thank all of our partners at Disney Engineering, including Kathryn Skobrak, Sylvester Kwo, Emma Lee, Michael Breen, and Cecilia Dahlinger for their technological expertise which was vital in moving this project forward. Lastly, we want to thank our Science Operation partners Andrew Alba, Angela Miller, and Mandi Schook who help create and foster these partnerships.