See like a BAT

Hear like a SNAKE

Animal**Connection**

Term Paper, Fall 2011
User-centered Research & Evaluation
Sim. Client: The Philadelphia Zoo

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I. EXECUTIVE SUMMARY

See like a bat. Hear like a snake. Experience how tigers perceive time. Animal**Connection** is our proposal for a suite of interactive, sensor-enhanced, animal role-play exhibits at the Philadelphia Zoo. We conducted interviews and contextual inquiries into reasons for visitation and use of technology at the zoo with families and individuals including the prime zoo visitor demographic of children and women 25-35 (Association of Zoos and Aquariums, 2009). Our participants expressed a strong and unmet desire for empathic zoo exhibits among the current sea of exhibits, on-site technology, and mobile apps that focus on factual learning and conservation. Smartphones, sensors, and the Arduino provide inexpensive and convenient means to creating exhibits that connect visitors to simulated animal experiences. Using Wizard of Oz, we prototyped a model exhibit simulating a day in the life of a Mexican Free-tailed Bat by outfitting blindfolded participants with echolocation devices and sending them on "bat missions." Participants favorably evaluated our exhibit during Think Aloud and retrospective interviews, suggesting it has a promising future at the Philadelphia Zoo.

Our exhibit responds to a wide variety of animal connection needs expressed by our participants, from sensory immersion to animal-human analogy. In the absence of direct competition, we instead catalogued and compared participants' needs across six related animal role-play approaches in an Animal Role-play Effectiveness Analysis (Figure 1, and see Appendix for details). The analysis reveals possible correlations between implementing a wide variety of animal connection approaches and achieving a memorable experience, and subsequently between memorable experience and overall effectiveness. The correlation between variety and memory in augmented reality exhibits is also asserted by "Technologies and Methods for Interactive Exhibit Design" (Sparacino, Larson, MacNeil, Davenport, & Pentland, 1999).

Children and adults alike were notably moved by the empathic nature of our exhibit, and both generations were similarly challenged by its narrative problem-solving format. Think Aloud participants smiled and laughed throughout the exhibit despite abbreviated training and spatial limitations, often even misinterpreting related difficulties as intentional role-play elements. These participants vindicated our combined animal role-play approach with feedback such as "That was unlike anything I've ever experienced" and "You realize that [blind] people are like the bat."

Navigating the zoo is frequently an act of on-site family negotiation, so our design carefully targets cross-generational appeal. Although our research participants applaud technology that helps them to achieve personal animal experiences, adults remain wary of technology that sharply contrasts with the natural setting, distracts them and their children from their desired experience, or is self-absorbed, e.g., a skill-based game merely superimposed with an animal theme. Our exhibit addresses adults' concerns by placing role-play center-stage and recessing technology to a supporting role in service of empathy and comprehension. Striking this balance within a loose narrative framework provides just enough structure to establish cross-generationally desirable goals without transforming the experience into an unwanted test of skill.

Our exhibit model can be extended to connect prime demographic zoo visitors with other animal abilities. Empathic animal experiences powerfully affect visitors' impressions and would fill major experiential gaps in their current zoo visits. In fact, because experience can be a more effective teacher than lecture, animal role-play exhibits

can more directly affect visitors' long-term knowledge of animal facts and concerns about conservation (Davey, 2006). Our design solution combines fun and learning in viscerally felt ways, giving zoo visitors the connection they long for while using technology unobtrusively. The contextual research underlying Animal**Connection** also better positions it to help the Philadelphia Zoo increase patronage (Morgan & Hodgkinson, 1999). We hope to iterate our design and conduct additional trials with zoo visitors pending approval by zoo administration.

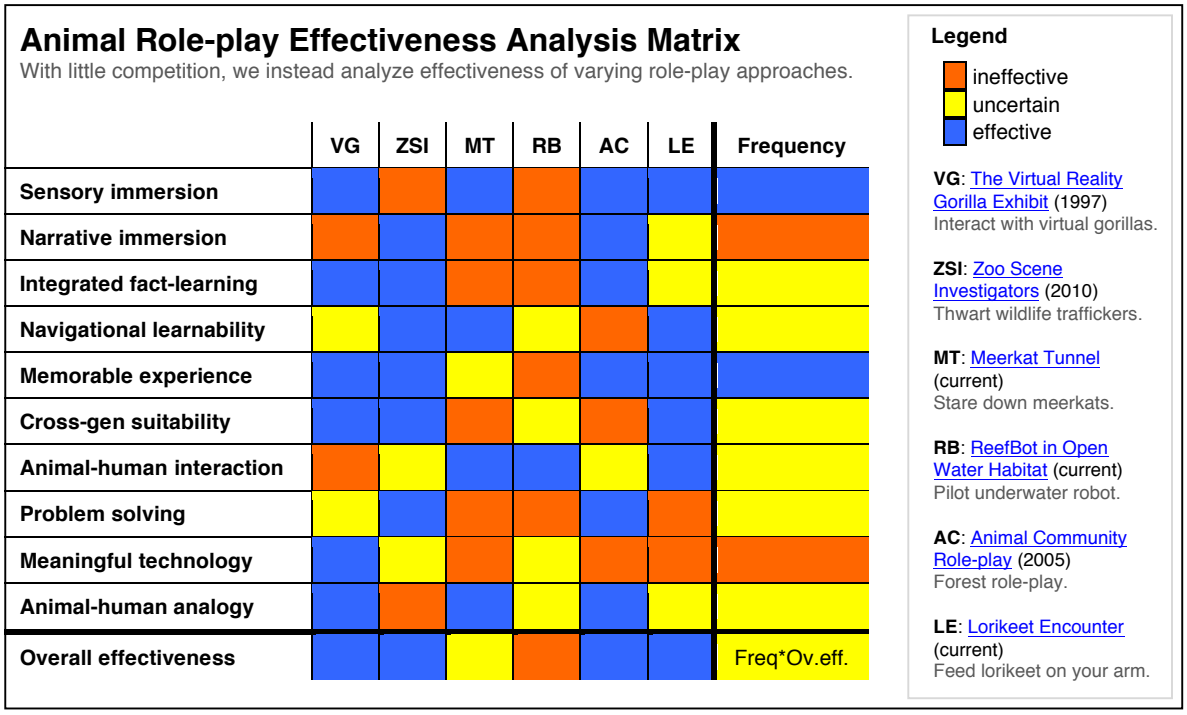

Figure 1: Matrix revealing possible correlations between a variety of approaches, memorable experience, and overall effectiveness. See Appendix for details.

II. DESIGN AND RECOMMENDATION

IIA. EXPLORATORY RESEARCH OVERVIEW

We began our exploration with the observation that the zoo's primary use of technology is as a supplement to pre-existing information resources: placards, signs, maps, traditional kiosks, and keepers. On the basis of this observation, we formed a galvanizing hypothesis that opportunities in augmented reality and mobile technology could be more effectively exploited at the zoo.

Before beginning formal research, we conducted an informal literature review to learn about prior approaches to exhibit design, visitor behavior, and technology use in zoological as well as museum settings. Our literature review lent credibility to our hypothesis, turning up many scholarly opinions but fewer concrete examples of experiential mobile technology implementation. We also found several studies *a priori* correlating time spent at an exhibit with visitor satisfaction (Bitgood, 1988; Johnston, 1998), while duration might not be the best or only explanatory variable for satisfaction.

The surprising lack of catalogued attempts to implement experiential mobile technology at the zoo, as well as the overly reductive duration-satisfaction correlation, led us to widen our scope of interest. We wondered first what constituted zoo visitors' needs, and second whether this sort of technology would effectively meet them. We thus created an interview protocol exploring reasons for visiting the zoo, mentally walking through the ups and downs of an average visit, and discussing what might constitute an ideal animal experience for adults, children, and entire families. Our stated goal was to improve the zoo visit for the prime zoo visitor demographic: children and women 25-35 (Association of Zoos and Aquariums, 2009)

To administer our protocol, on Sunday, October 16, 2011, the author of this report spent part of a Philadelphia Zoo visit with two families and one woman age 28. These participants included as many as possible members of the prime zoo visitor demographic, plus two mothers and one father in their early forties. The author gathered information in filmed contextual inquiries, formal interviews, and informal behavioral observation in the context of exhibits, on-site technology, and the Philadelphia Zoo App, a proprietary smartphone app developed by the zoo. Contextual inquiry of the Zoo App consisted of requesting a demonstration of how each visitor—family or adult—used the Zoo App during the visit. All visitors were first-time users of the app.

The following anonymous participants are referred to by pseudonym and were briefed on the confidentiality of their participation:

- *U01 (Visiting Family)—Carolyn, 43, and her daughter Josie, 11*. Carolyn is a stay-at-home mom of three girls who raises service puppies and was visiting the zoo for the first time in two years. She previously had a family membership and decided during the course of participation to purchase a new one. Carolyn does not own a smartphone, and Josie primarily used a smartphone our study provided.

- *U02 (Visiting Adult)—Dolly, 28.* Dolly is a writer who fosters kittens. She visits different zoos, mostly on the east coast, whenever possible, but does not have a membership at any. Dolly owns a smartphone without a data plan, so her use of the Zoo App was based solely on preloaded data.

- *U03 (Visiting Family)—Monica, 43, her husband Dirk, 41, her daughters Amina and Emily, 12 and 9, and her son Vincent, 10.* Monica is a part-time development consultant for small biotech companies. She has a family membership. Her family visits the zoo every six weeks. She owns a smartphone.

IIB. EXPLORATORY RESEARCH RESULTS SUMMARY

Our affinity diagram outline and consolidated cultural model (see Appendix) provide excellent summaries of our research results. On the positive side, we learned that the participants collectively envision the zoo as a place of amusement and imagination. They cherish unique opportunities to personally observe, imitate, and understand animal traits and behaviors. They deeply enjoy immersion and interaction in the animal world.

On the negative side, the reality of the zoo is fraught with family and social tensions. Participants with children must plan zoo visits around them, reducing the duration and sometimes the quality of their visits. They feel that on-site technology and

some exhibits are not adult-friendly or interactive enough, and worry that they distract their children from engaging in the zoo experience and developing an interest in animal welfare. And, participants across generations dislike crowds and complications.

For our secondary findings and recommendations, please proceed to section **IIIc**.

Our primary finding was that while our participants seek a "connection" with animals, they cannot find the kind of exhibit that provides this connection. Relatedly, they want more interactive exhibits. They perceive that the zoo must physically separate them from the animals, but wish they could somehow play a greater role in the animals' lives than as noninvasive observers and financial patrons. The most regular visitors say they are tired of being lectured about extinction and nowadays spend more time with the hot-air balloon and the swan boats than with the animals; one cannot help but see these participants as helpless bystanders shielding their eyes from a hopelessly shrinking animal world. A shining exception is the Lorikeet Encounter, where visitors interact with and feed lorikeets. Most participants cited this as a favorite, one-of-a-kind exhibit, sparking an unplanned contextual inquiry of the process (see Appendix).

The solution to the above problems needed to address both the desires of participants and the interactive dilemmas of the modern zoo. Peering through the glass in new ways, e.g., hidden cameras or smartphone guides, seemed an incomplete solution; brief physical or visual proximity is a poor substitute for emotional intimacy, as a meaningful connection is not often established in a span of seconds. And while animal-human interaction often reaps rewards for visitors—as in the case of the highly praised and widely replicated Lorikeet Encounter—it is not appropriate for many species, as visitors are well aware: "The key issue is how to entertain and educate the visitor without placing significant stress on the exhibited animals" (Fernandez, Tamborski, Pickens, & Timberlake, 2009). Finally, softening the conservation message would fail to address visitors' frustrations with the perceived lack of emotional intimacy. So, we decided to brainstorm several ideas outside the scope of most current zoo exhibits.

IIc. Solution

A two-by-two design solution grid (Figure 2) was created in the final stages of the exploratory research process. We developed design solutions to strengthen the prime zoo visitor demographic's experience in one of two ways: improve existing products and services, and create new products and services. We chose to pursue the creation of new products and services because our research models indicate significant need and opportunities in this area. We integrated several ideas for new products and services into our final solution, including haptic feedback (3), motion sensors (6), solution-oriented narrative video games (10), adult-friendly versions of interactive kids' exhibits (11), a birdcall

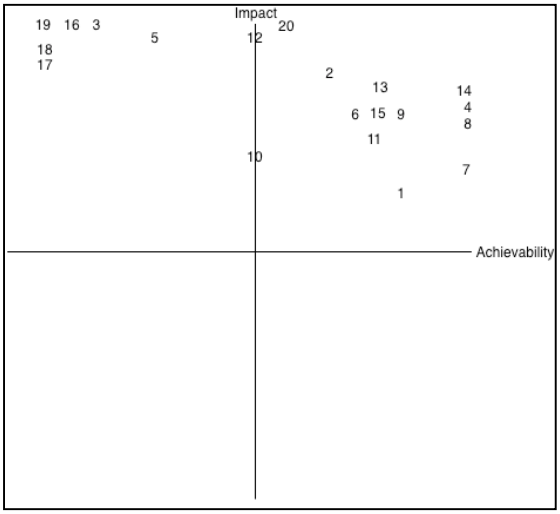

Figure 2: Two-by-two grid comparing design solutions by impact and achievability.

recognition app (15), and particularly an augmented animal perception app (20).

Our final design solution, Animal**Connection**, is a suite of interactive, sensor-enhanced, animal role-play exhibits at the Philadelphia Zoo. Animal role-play presents a unique opportunity to inject human experience with a sense of empathy, comprehension, and compassion for animals. The power of today's mobile technology allows us to augment and manipulate our experience of reality in ways that can simulate animal experience by combining mobile technology—for our purposes, smartphones or inexpensive Arduino processors—with environmental sensors that detect changes in light, sound, motion, and other physical elements. Sounds can be altered in real time, lights can be triggered, and entire systems can be set in motion by the flick of a finger or the step of a foot. With some creative exhibit design, an inconspicuous space can be transformed into a pseudo-habitat for human exploration.

Using of Oz method, we prototyped a model exhibit simulating a day in the life of a Mexican Free-tailed Bat by outfitting blindfolded participants with echolocation devices and sending them on "bat missions." Wizard of Oz method entails enactment of technological capabilities by human agents for the purpose of pretending a system is capable of more advanced actions than its current implementation permits. Our intent was to create an exhibit model for sensory augmentation and deprivation that could be easily repurposed for other animal abilities.

The structure of the exhibit model (Figure 3) follows on the next page, excluding Wizard of Oz modifications.

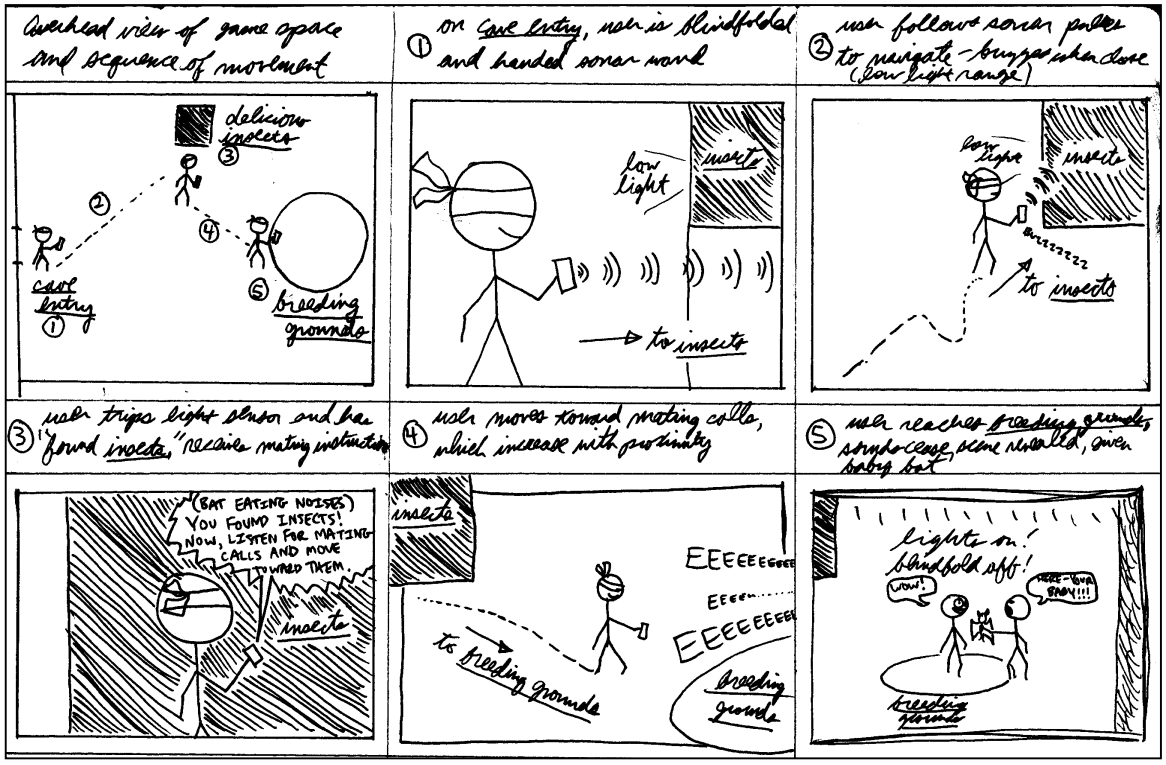

Figure 3: Vision close to formative evaluation stage. Breeding grounds were replaced with roost.

A participant enters a pitch-black space holding a sensor that transmits different

audio or haptic feedback corresponding to the participant's distance from obstacles, prey, and her cave. The participant is briefed on the details of her scenario: She is a Mexican Free-tailed Bat who has just given birth and must leave her cave in the Guadalupe Mountains to find a flying insect to eat so she can make enough milk to feed her baby upon return. The participant learns that Mexican Free-tailed bats leave their babies together in communal roosts, and each mother can find her baby by listening for its distinct cry. The participant hears her baby cry out and is instructed to remember how it sounds so she can later find her baby. Then, without the aid of vision, the participant uses her handheld sensor to navigate the space, finds an insect, and returns to her baby.

At each step, the participant triggers a sensor, prompting congratulations and additional factual information explaining her situation and how it corresponds with a real Mexican Free-tailed Bat's. At the conclusion of the exhibit, the participant is presented with a stuffed or toy version of a baby bat and instructed to "take good care of it every night." Congratulations and instructions are modeled in second-person style after the popular *Choose Your Own Adventure* series of books, e.g., "*You* are a *Mexican Free-tailed Bat!*"

IID. MEASURING SUCCESS

In the absence of direct competition, we instead catalogued and compared participants' needs across six related animal role-play approaches in an Animal Role-play Effectiveness Analysis (Figure 1, and see Appendix for details). The analysis reveals possible correlations between implementing a wide variety of animal connection approaches and achieving a memorable experience, and subsequently between memorable experience and overall effectiveness.

We chose to measure the success of our design solution by comparing its qualities against the Animal Role-play Effectiveness Analysis, and then by subjecting its performance to a series of Think Aloud evaluations. This combination would reveal both how potentially effective our exhibit model could be and how we could improve on the construction of our prototype.

III. EVALUATION

IIIA. FORMATIVE EVALUATION OVERVIEW

First, we created our Animal Role-play Effectiveness Analysis Matrix and tweaked our exhibit design to more comprehensively address the matrix's indices. Then, on Saturday, November 19, 2011, we conducted Think Aloud evaluations at Carnegie Mellon University's Masters of Human-Computer Interaction Lab. While slightly smaller than ideal for the physical nature of the interactive animal role-play exhibit, the lab space provided a controlled and safe environment for experimenting with sensory augmentation and deprivation.

We chose to conduct Think Aloud evaluations as a way to quickly determine the most critical shortcomings and successes of the exhibit in the context of the prime zoo visitor demographic for which we had designed it. In Think Aloud studies, participants use a prototype while simply thinking out loud about the use process. Although we requested additional feedback in retrospective interviews, we instructed participants not to reflect on the reasons for their actions during the Think Aloud sessions themselves; reflection changes and undermines the participant's normal decision-making flow.

Ironically, however, we recognized that the primary goal of our animal role-play exhibit was to induce self-reflection and empathy in users, so reflection of the empathic variety was present and desirable throughout the evaluations.

The following anonymous participants are referred to by user number and were briefed on the confidentiality of their participation:

- *U04 (female child age 16)*. U04 is the older sister of U05.
- *U05 (male child age 12)*. U05 is the younger brother of U04.
- *U06 (female adult age 29)*. U06 is a full-time graduate student.

We individually briefed participants and obtained signed consent forms, including parental consent for our child participants, whose father observed each child's complete evaluation. We explained the nature of a Think Aloud study and instructed participants that they were free to quit the study for any reason at any time.

Then, for each participant, we used Wizard of Oz method to evaluate the prototypical experience described in section **IIc**. Again, as defined in section **IIc**, Wizard of Oz method entails enactment of technological capabilities by human agents for the purpose of pretending a system is capable of more advanced actions than its current implementation permits. A team member paced back and forth to simulate a flying insect, two others clacked percussive instruments to approximate the sounds of Mexican Free-tailed Bat babies, and the author of this report used a handheld, stylus-operated, electric keyboard known as a Stylophone to provide participants with audio feedback corresponding to distance from obstacles, prey, and the cave. An instructional audio recording was played on a laptop. The lab space's dining area represented the cave, and an adjoining project room represented the outdoor environs of the Guadalupe Mountains.

IIIB. FORMATIVE EVALUATION RESULTS SUMMARY

Animal**Connection** achieves notable success along the indices of the Animal Role-play Effectiveness Analysis Matrix (Figure 4). Animal**Connection**'s observed weakness lies in its challenges to imparting navigational learnability, as explained in the following Think Aloud results summary. However, these challenges can be overcome by modifying and slightly lengthening the instructions, administering them prior to sensory immersion, more precisely creating the analogy of cave to exhibit space, and increasing exhibit size.

Our Think Aloud results revealed cross-generational success in infusing factual learning with a sense of mystery and role-play. Participants smiled and laughed throughout the exhibit despite abbreviated training and spatial limitations, often even misinterpreting related difficulties as intentional role-play elements. These participants vindicated our combined animal role-play approach with feedback such as "That was unlike anything I've ever experienced" and "You realize that [blind] people are like the bat." We were also told that the exhibit contained a good balance of information, instruction, and facts, and that narrative immersion added meaning to the experience. The *Choose Your Own Adventure* narrative style was also a hit with participants.

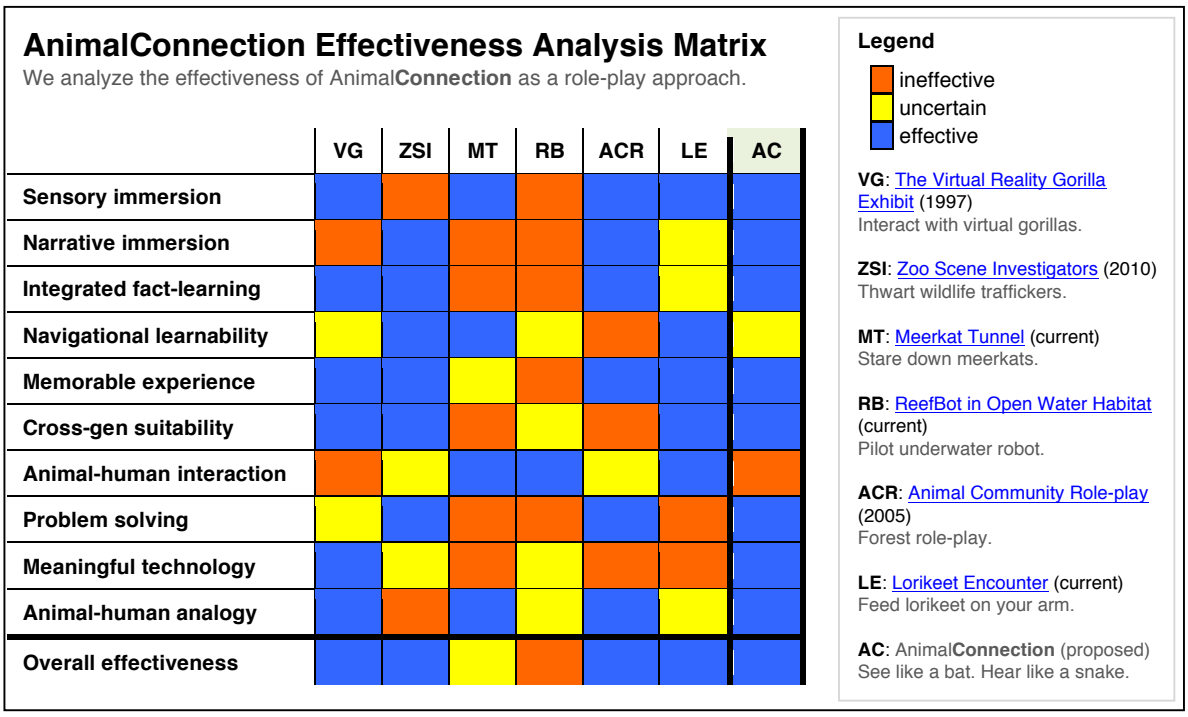

Figure 4: Matrix revealing notable success of Animal**Connection** as an animal role-play approach.

Abbreviated training and spatial limitations manifested themselves in a few key critical incidents experienced by most or all participants, although following our recommendations can easily eliminate these incidents in the future. To varying degrees, participants had difficulty finding the cave exit and differentiating between different or sustained tones. All participants found the baby bats too easy to distinguish. We primarily recommend reorganizing the exhibit space, more thoroughly training participants prior to sensory immersion, exaggerating sensory distinctions between obstacles and flying insects, and increasing the number of baby bats in the cave.

IIIc. Observations and Recommendations

Here are our observations again, this time in greater detail and accompanied by our complete recommendations and additional strategies for successful design iteration:

- Some participants had difficulty finding the cave exit at the start of the exhibit, partially because, having seen the exhibit space prior to starting, they rationally interpreted the large dining area as the outer environs and the smaller project room as the cave, whereas we had assigned these spaces the opposite roles.
    - *Severity Rating—4 Catastrophic*. We recommendation rewording instructions, preventing the ability to easily and unintentionally backtrack out of the exhibit, more precisely creating the analogy of cave to exhibit space, and staging the exhibit in a larger space.
- Participants had difficulty differentiating between different or sustained tones.
    - *Severity Rating—3 Major*. We recommend exaggerating the sensory distinctions between obstacles and flying insects, making the initial

instructional period more interactive, administering instructions prior to sensory immersion, slightly lengthening the instructions, and possibly also adding a Help button to the handheld device.

- Finally, all participants found the baby bats too easy to distinguish.
    - *Severity Rating—2 Minor.* We recommend increasing the number of babies in the cave and thus also the challenge of the exhibit's last stage.

Fixing these issues will strengthen the exhibit's navigational learnability and cement its problem-solving and cross-generational-suitability components. As our Think Aloud results reveal, the exhibit excited participants and generated strong empathy both for bats and blind people. A larger exhibit space with more obstacles and low-lighting effects could create a more dramatic experience and should be pursued. We also believe that with some alterations and possibly the advancement of smartphone technology, this exhibit model can be recreated as a standalone smartphone app, providing visitors with ways to experience animal connections outside of the zoo setting. Such an option should be explored as well, as app sales could result in a substantial windfall of funding.

In the middle stage of our exploratory research, one front-running design solution was a redesign of the Philadelphia Zoo App. Participants experienced information-structure and service-design issues using the app. Our artifact model (see Appendix) in particular reveals these issues. We believe that while our final design solution did not address the Zoo App, a redesign should be given priority status. So, lastly, here are related secondary issues we discovered in our exploratory research, followed by some possible recommendations we subsequently brainstormed:

- Staff, if they can be found, are often perceived as unhelpful and unapproachable.
    - We recommend implementing a location-aware Zoo App map that automatically offers information about exhibits, bringing back the fondly remembered Zoo Keys on the smartphone using QR codes, developing a natural language FAQ database *à la* Siri/Apple, and/or increasing the availability of zoo staff with factual knowledge of nearby animals.
- Participants experience information overload, finding the website and Zoo App confusing, ambiguously labeled, redundant, difficult to search, and more like a factual database than a resource for answering questions.
    - We recommend removing redundancies, structuring resources to supplement one another, re-labeling the Zoo App categories, and/or updating all content and functionality to match current exhibits.
- For infrequent visitors, exhibits are difficult enough to find that unexpected closures are highly disruptive.
    - We recommend creating an email list for updates and/or a "shopping list" app of currently available exhibits visitors can create upon or prior to arrival, and/or moving popular exhibits closer to the entrance.
- Smartphone users without a data plan or strong connectivity cannot use the Zoo App on-site. QR codes would also not be able to function.
    - We support the zoo's plan to install a Wi-Fi network for visitors within the next year, as described by staff via telephone on October 10, 2011.

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V. EXTRACTED DATA AND APPENDIX FOR RAW DATA*

* Video, audio, and supplementary materials will be made available upon request.