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Steering the ark toward Eden: design for animal well-being

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Whatever one thinks of capturing wild animals for pets, zoos, aquariums, or research, one may also think of their descendants as refugees of our own species' global war for dominion over nature. This paper will review the development of zoo design as we seek to improve the well-being of these zoologic refugees.

Stage 1—Physical Survival

During the era of barred cages, there were few long-term survivors. Advances in diet and veterinary care brought in the era of green-tile enclosures and, for many species, greatly increased longevity. In 1950, this success encouraged Edward Hindle, Scientific Director of the London Zoo, to say, "…the vast majority of zoo animals are far healthier…than those in the wild, and also have a longer average life."[1] Massa, the popular Philadelphia Zoo gorilla, set the species longevity record of 54 years in such an environment and was well supported by human caregivers.

Stage 2—Emotional Survival and Reproduction

While Massa had close human friends, he usually lived alone. Willie B, Zoo Atlanta's gorilla patriarch, led a similarly isolated life for his first 27 years. Then in 1988, Willie was joined by 13 gorillas from the Yerkes Regional Primate Research Center. Formed into 3 troops, they soon acclimated to their spacious naturalistic outdoor enclosures. Within this complex social and natural environment that was managed by Dr. Terry Maple,[2] the previously solitary Willie B sired 5 offspring. A total of 13 gorillas have been born at Zoo Atlanta since 1988. Similar breeding successes have been achieved by many zoos for many species when appropriate social grouping is combined with advanced veterinary care. During this same period, zoos in Lincoln Park, Illinois and Howletts, England had great success with gorillas in highly artificial, albeit enriched environments. In Europe, laws were putting building preservation above animal well-being.[a]

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Larger, lushly landscaped displays modeled on natural habitats emerged in the United States in the 1970s. My recollection of the period was that the same sentiment, which favored nature as the model in display design, favored a more hands-off policy in husbandry. Gone were chimpanzee tea parties. Gone also were mechanical mice as enrichment stimuli. Naturalistic displays were thought by some to be sufficiently stimulating that additional stimulation was unnecessary.[3] While this approach worked well, it did not always prevent problems, such as loss of occupation. Could we do more?

Green Space is Not Always Enough

As before, some behavioral problems were treated with medication, and physical and behavioral health problems were often seen as unrelated.[4] Training and behavioral enrichment activities were remedial. Hediger[5] identified problems related to boredom; lack of activity and exercise could lead to loss of physical fitness and long-term health problems. Even highly naturalistic artificial habitats may not meet all animal needs. Stoinski[6] found gorillas at Zoo Atlanta eschewed open spaces, preferring shady retreats near large solid objects. Carlstead[7] suggested some black rhinoceroes suffered chronic stress resulting in diminished longevity and reproduction when kept in small or walled enclosures, however naturalistic they appeared.

Coe and Scheffler[8] demonstrated a relationship between high levels of stress and depressed immune response. Snowdon[9] found that giving captive animals choices lowered stress levels. Larger, more naturalistic enclosures offer more choices but still fall far short of the diversity of the wild, and most important choices are made for animals by caregivers. To borrow a computer analogy, large, passive exhibit areas (hardware) also need active husbandry programs (software) to reach their full potential. Nearly 20 years ago, Fortham-Quick[10] summarized the debate between the naturalistic method[11] and the more interventionist approach of Markowitz,[12] who argued for integration of behavioral enrichment and training into the basic design of naturalistic animal displays. Yet, I have found

that until recently, training and enrichment specialists were not involved in facility design, although they are increasingly requested to solve behavioral problems later.

Stage 3—Activity-based Design and Husbandry

In attempting to create a framework for the proactive integration of design, behavioral enrichment, training, and husbandry, I proposed the following definition:

> "Activity-based design begins with the premise that the animals' long term well-being is paramount and that environments, programs and procedures which advance this goal are frequently of great interest to the visiting public. Healthy animals with stimulating behavioral choices tend to be more active. Therefore, opportunity-rich animal environments, enlightened animal care and caretaker devotion should all be made visible to the public within a setting which demonstrates the animals' innate competence."[13]

Several popular zoo exhibits of the last decade have incorporated many of these features, providing substitute occupations for animals, such as searching for and catching food (Woodland Park Zoo "Northern Trail" and Sea World Florida's "Arctic Wild"). The Wildlife Conservation Park/Bronx Zoo's "Congo" exhibit includes built-in gorilla foraging features and habitat choices within a stunningly realistic recreation of the Congo rainforest. However, this behavior-based concept may be most useful for zoo facilities lacking the space or funds for high levels of habitat verisimilitude or those choosing a more economic and flexible approach. Orangutans at National Zoological Park's "Think Tank" chose to travel overhead across the zoo to visit friends and potential mates.[14] At the Philadelphia Zoo's "PECO Primate Reserve,"[15] the indoor guest experience is more like visiting a large, complex behavioral enrichment laboratory than visiting a traditional zoo. One result has been the birth of 18 young of 6 species in the first 4 years.

Rotation Exhibits

A recent example of this activity-based approach in primate facilities is the just-opened "Gorilla Forest" at the Louisville Zoo. Troops of gorillas can choose between large naturalistic outdoor habitats or a circular arrangement of indoor day rooms surrounding a public gallery. This "gorillas in the round" concept was developed at the Apenheul Zoo in Holland and was used more recently at the Columbus Zoo.

In traditional displays, the animal spends its life in the same space. In a rotation concept, the animal may visit 4 areas each day, for example, typically accessing 4 times the space made up of 4 different settings. Behaviorally, it is a simulation of Hediger's description of a territory made up of pathways linking activity or use areas.[5] Adjacent spaces in the system are occupied by other animals, simulating overlapping territories in nature. Alternatively, some areas could be bypassed, allowing recovery from overuse or renovation to introduce novelty. This animal rotation concept should be thought of as a circuit of consecutive or serial mixed-species exhibits. Measures for controlling contagious diseases are the same as in the more common, concurrent mixed-species displays.

The gorilla exhibit complex at Zoo Atlanta was planned in 1983 with the potential to rotate 4 or more gorilla troops through 4 outdoor yards on a daily basis, simulating the movement of mountain gorillas through their home range in Rwanda.[16] While this rotation option was never used on a permanent basis, it was tested. Lukas[17] found that activity levels and exploratory behavior increased when 2 troops were gradually transitioned to daily rotation in adjacent habitats.

The most ambitious rotation exhibit in use today is the Louisville Zoo's "Island" display. Here, orangutans, siamang, tapir, babirusa, and a Sumatran tiger rotate daily among 3 naturalistic outdoor displays and a large indoor dayroom.[18] The order, sequence, duration, and timing of their movements are randomized by care staff on a daily basis to optimize novelty. A 3-year behavioral analysis by White et al[19] provided the following summary:

> "Moving animals among the exhibits affected activity levels and/or space utilization in all animals in the activity-based management system… The results support the conclusion that exposure to varying exhibits produces variation in the behavior of the animals and elicits natural behaviors that would be unlikely to occur in a traditional single exhibit. Activity-based management provides unique opportunities for the behavioral enrichment of captive animals."

Ambitious rotation exhibits are now being planned for the California Science Center, Los Angeles; Point Defiance Park Zoo and Aquarium, Tacoma, Wash; and Taronga Zoo, Sydney, Australia. Predicted benefits to animal well-being include increased stimulation and activity resulting in improved physical fitness. Staff benefits include greater responsibility and creativity in daily operations and more training. Important considerations include cost of additional staff and greater staff expertise in operant conditioning and behavioral enrichment. Construction cost is increased as well, because barriers must be designed to contain the most demanding species. Another concern is increased risk of error or mechanical failure in the operation of a greatly increased number of animal transfer gates. Louisville Zoo has developed procedural safeguards against this eventuality.[20] Do benefits in animal well-being, staff development and morale, and visitor approval outweigh concerns over increased construction and operational cost and risks of disease contamination or accident? This new approach is strongly supported by Louisville Zoo staff.[b]

Affiliative Design

Can we provide physical and social settings conducive to affiliative behavior among and between species while avoiding settings that encourage aggres-

sive behavior?[21] Critical resources, such as feeding areas, shelters, and basking locations, can be provided in widely dispersed abundance to minimize competition while ensuring opportunities for exercise and positive social interaction. The chimpanzee display at the Los Angeles Zoo was designed to eliminate previously high levels of aggression between chimpanzees and zoo visitors by reducing the amount of open-moated frontier socially defended by both species. A variety of dispersed small-scale viewing opportunities was provided. Behavioral analysis[c] showed affiliative interaction between chimpanzees and the public replaced aggressive behavior. However, aggression within the ape group also increased, perhaps because the larger area increased opportunities for group fragmentation.

Increasing Animal Physical Fitness

Cynthia Moss noted that wild elephants, which often travel many miles each day, rarely have foot problems.[d] Foot infections, sometimes life-threatening, are a common development in zoo elephants kept on hard surfaces with little exercise. A well-conceived program of vigorous exercise may be the key to elephant health and longevity.[e] New elephant facilities planned for Honolulu Zoo and Taronga Zoo in Australia will provide large pool systems where elephants can participate in low impact aquatic aerobic exercise. Sea World Florida's "Arctic Wild" encourages polar bears to dive to depths of 25 feet in attempts to catch fish. National Zoo and San Diego Zoo's Center for Research in Endangered Species have coursing areas where cheetahs enthusiastically pursue automated prey using equipment developed for coursing dogs. Fitness may also be evaluated by observing dexterity and balance. When zoo-raised golden lion tamarins were first reintroduced into their native forests of Brazil, some initially fell out of their trees. Having been raised on ridgid climbing structures, they were apparently unprepared for life in a mobile environment.[f] Today many zoo tamarin groups are housed in natural trees, and zoos in Atlanta, Los Angeles, and Denver have artificial sway branches that move realistically when primates climb on them.

Putting Animal Well-being First

Advances in diet and veterinary care from stage 1 and multi-individual, multigroup, and multispecies facilities and larger, more naturalistic exhibits from stage 2 have been integrated with advances in behavioral management. In stage 3, specialties traditionally considered separate, such as veterinary care, animal maintenance, behavioral enrichment, animal training, architecture, and landscape architecture, are collaborating to a remarkable degree in the interest of improving animal well-being. However, these examples are by no means common. Concepts such as animal rotation are met with skepticism, reminding me of the response received 25 years ago to the introduction of the highly naturalistic immersion habitats, which have become today's standard in the United States and Australia. Building on the research of White et al[19] and Lukas et al,[22] we need far more evaluation of these new activity-based zoo facilities. For example, White et al[19] found that the stimulative effect of rotation exhibits was reduced by time and habituation. Perhaps this also occurred in earlier naturalistic exhibits. No single approach is sufficient. We must continually advance to maintain high levels of animal well-being.

Stage 4—Towards Greater Self-determination for Zoo Animals

Just as each stage built on the advances of previous stages, the future will continue to build on the present and past while finding new paradigms. Stage 2 animal displays used images of animal habitats in nature and reports from field biologists as their inspiration, briefly breaking the tendency of some zoos to copy other zoos. Stage 3 advanced by including training and behavioral enrichment in daily husbandry. What new paradigm will continue this advancement?

Perhaps the most persistent feature of the relationship between a zoo's staff and its animals is the implicit assumption that captive animals must be entirely dependent on their human caregivers. Indeed, present facilities and programs depend on this condition. But what if we relaxed this assumption? What if monkeys really did run the monkey house?[23] Let us look at some of the opportunities implicit in this radical paradigm.

Over 50 years ago, Hediger[5] showed that even wild animals are not free of strict physical and behavioral limitations on their actions. Yet it may be said that the organism with the most control over its environment has the most freedom. Snowdon[9] showed captive primates can lower stress by taking control of the stressful situation. Much of the work of the behavioral enrichment movement developed to remedy behavioral anomalies resulting from lack of stimulation and choice. Operant conditioning training in zoos, while an enormously valuable tool, rarely encourages animals to take the lead in choosing the interaction. Most types of behavioral enrichment encourage free choice for animals but are usually more dependent on keeper initiative than animal initiative.

It is time to evaluate our own perceptions of animals' competence to manage their own lives. For millions of years, the antecessors of today's captive species prospered, adapted, and evolved in a world full of opportunity, risk, and intense competition. There were no humans to dice their fruit or call them in. We cannot return these refugees to earlier times, but we can respect their ability to proactively satisfy more of their own behavioral and environmental needs. In the wild, they learned from conspecifics or experience; today we can train them to use appropriately designed facilities. Perhaps they could acquire much of their own diet through active foraging, browsing, or simulated hunting, regaining an important natural occupation and increasing physical fitness. Perhaps there are ways for dolphins to manipulate the acoustic signature of their tanks or for bears or elephants to turn on a cooling shower on a hot day without human intermediaries. Motion-activated switches could turn on heaters, coolers, fans, audio-visual displays, or food dispensers, allowing individual animals, from penguins to polar bears, to customize their living facilities.[24] Animal choices need not be limited by wild precedents.

Orangutans at the National Zoo's "Think Tank," trained to use electronic intermediaries, communicate with staff using symbolic language.[14] Rather than living passively in uniform environments mandated by regulation or standard, animals in indoor environments could move through gradients of light, temperature, humidity, color, or smell to select their preferred microenvironments.

Stage 4 thinking may find its greatest opportunity in wildlife sanctuaries, including those from which animals will eventually be reintroduced into the wild. Here, the animal's adaptive competence must be honed. In 1928, Edward Beston[25] wrote:

> "For the animal shall not be measured by man. In a world older and more complete than ours they moved finished and complete, gifted with extensions of the senses we have lost or never attained, living by voices we shall never hear. They are not brethren, they are not underlings; they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendor and travail of earth."

Most of the wild animals in our zoos, aquariums, sanctuaries, and laboratories are refugees, the captive descendants of earlier generations. We cannot return them to wild habitats that no longer exist, nor can we humanely turn them loose on our streets or parks. But until the time comes, if it ever does, to recreate lost native habitat, we can take the next step by developing facilities and programs respecting the competence of even insects or crustaceans to choose among viable options, giving them greater control of their lives. In so doing, we will be rethinking our basic relationship to nature, redefining captive species not as unfortunate dependents but, as Beston suggests, "other nations" to be respected for what they are as well as what they were. It is this realization, I believe, that will lead us to stage 4, creating zoo habitats in which animals more freely engage their lives and ours.

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