Urban Interpretations of Natural Habitats

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College of Architecture and Planning
Ball State University
1985-1986
Credits

I would like to acknowledge the following persons for their support of this thesis:

Jack Wyman, Thesis Chairman
Sonny Palmer, Thesis Critic

Dwight Holland, Curator of Design,
North Carolina Zoological Park
Louis DiSabato, Director,
San Antonio Zoo

Thesis studio: John Wallis, Lee Constantine, Dino Vanonni, Carol Wakim,
Rick Ruppert

I would like to thank my mother for her support, encouragement, and appreciation for all my endeavors.
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I would like to thank my mother, Dr. Taggart Endzel, for her support, encouragement, and appreciation for my endeavors.
Abstract

This study supports the notion that natural habitats of zoo animals can be simulated through architectonic means. The purpose being to capture the essence of the environments as opposed to artificially duplicating them.

Because both animals and people are needed for a zoo to exist and the greatest concentration of people is in a city or urban environment, the zoo was designed for a prototypical urban site. This brought with it several implications in terms of zoo organization, structure, circulation, and other architectural considerations.

Most of my time was devoted to experimenting with the habitats themselves in model form. I was searching particularly for organizing systems inherent in the natural environments because I felt that the building should be based on the natural proportions, enclosure, light quality, and color which exist in the animals' habitats.

In an attempt to create a piece of architecture from this study, I looked at various ways of assembling the environments. Because of the complexity of a zoo and the time involved, I was only able to design on a most elemental level. The form and organization of the building is generated from the idea of tree structure and natural daylight. I developed a structural system which began to articulate the zoo environment I was looking for and it provided a framework for the habitats to fit into.

In conclusion the thesis is a beginning to what could evolve into a complete design with time.
I believe that architecture in an urban context can simulate the natural habitats of zoo animals. An urban zoo has various implications associated with form, building zoning and systems, natural lighting, usage, architectonic expression, and exhibition.

Most zoos are built on one plane over a large ground area. The bigger the zoo, the more land consumed. However this type of zoo is not feasible in an urban context due to economic factors. In order for a zoo to be "affordable" on this kind of site it must be vertical. This has major effects on the zoning, the different circulation systems, the structural and mechanical systems, and the means of getting daylight into the exhibit spaces.

In other zoos the visitor, service, maintenance, and staff circulation is based on a series of separate pathways that connect multiple buildings. This is similar in a vertical zoo except that they are grouped together into a core. In addition there is only one major access point rather than several scattered ones as with traditional zoos.

In a vertical zoo the structural system is of major importance. It must be adequate to support the loads and flexible in order to accommodate various sizes of exhibits, public services, animal holding areas, and offices. Because the zoo is housed in one large building rather than several separate ones, there is one probably more efficient mechanical system.

The advantage of having a zoo in an urban environment is its accessibility to large numbers of people. Not only is it a place for families to spend the day, it has the potential of being used as a lunch hour or after work activity. Because of this added use, the exhibit design must accommodate the short-term visitors as well as the all-day visitors.

Another implication of an urban zoo is that there must be a means of getting enough natural light into the exhibit spaces that are not located at the building periphery. This involves for the most part building form and orientation. It also places certain height restrictions on adjacent buildings.
Research

"In studying forms in nature we search for the understanding of the underlying principles behind them; we must always seek the connection between the form and its purpose." (Safdie)

"The ideal solution for a zoo is not to provide an exact imitation of the natural habitat, but rather to transpose the natural conditions in the wild, bearing in mind biological principles, into the artificial ones of the zoo." (Hediger)

I felt the need to understand as well as possible the natural conditions of animal behavior and habitats. H. Hediger wrote several books concerning wild animals and zoo design. He cites some specific points about mechanical equipment, ventilation, fencing, and so on which is important, but I was looking for typical animal behaviors which would perhaps provide a basis from which to design. One interesting behavior that Hediger discusses involves territorial instincts of most wild animals. They develop their territories based on a set of biological points which are connected by paths. Although an animal's domain may seem expansive, it is actually quite restricted by this territorial instinct. In the author's example the home is at the center of the area and is most important. In addition to the main home there are two emergency homes located close to feeding areas. There are points for eating, drinking, bathing, storage, and various other activities. The perimeter is defined by a series of demarcation points.

If the specific territorial instincts of zoo animals were studied, it seems that exhibit spaces could be designed according to the natural patterns made by the animals.

During my first quarter of thesis I visited several zoos, namely Lincoln Park and Brookfield zoos in Chicago, Cincinnati zoo, San Antonio zoo, and North Carolina zoo. I was looking primarily at how the exhibits were organized and designed.

Generally Lincoln Park and Brookfield zoos were designed in the Beaux Arts style inspired by the Chicago World's Columbian Exposition in 1893. This architectural vocabulary is not appropriate for zoos as they exist today. It was built with little concern for the welfare of the animals. Through research on the history of zoos I discovered that the first zoos built in the United States were designed to symbolize man's dominance over all living things. This attitude toward zoo design is outdated and thus it inspired me to look for a better form in zoo
TERRITORY MAP (H. HEDIGER)

MOATING (N.C. ZOO)

APE HOUSE STRUCTURES (LINCOLN PARK ZOO)
architecture.

There were some interesting things in the newer exhibits at the Chicago zoos. In the Ape House in Lincoln Park zoo there were metal structures that had projections at various levels. The apes used these structures like trees climbing, swinging, and playing on them. Rather than merely duplicating trees and branches, these structures had been designed to serve the same purpose as the trees in the apes' natural habitat. There is a new exhibit at Brookfield zoo in which there are three large enclosed spaces. Each are designed to simulate the natural environment in certain areas of the world. Within each of these environments one could see several examples of the native animals of that land living as they would in the wild. There were no visible barriers in the environments so that visitors are part of the environment. The animals live at certain areas in the exhibit naturally. For example some species of monkeys live mostly in the tree tops while some live in the lower branches.

The newest zoo is the North Carolina zoo near Ashboro. Prior to visiting I read a book published by the North Carolina Zoological Society. It is a proposal and statement of philosophy for a world class zoo which was to be over one thousand acres in area and located in the mountains. It is representative of the most current ideas in zoo design. Upon visiting I discovered that only small portions of the total design had been built, but they were enough to examine the success of the project. Built in the mountains, many of the outdoor exhibits incorporated natural and some artificial rock outcroppings. There was extensive use of moating as the means of separating visitors from animals and animals from animals. The African Plains exhibit made the most use of this barrier system being a flat area several acres wide. There the animals were able to behave as they would in their natural habitat. In contrast to traditional zoos in which those species are kept in small cages or pens, this exhibit was more informative in terms of their natural environment.
Design Conclusions
AFRICA

SOUTH AMERICA

exhibits

Information
central office

exhibits
The building's organization is based on the Banyan tree analogy in that all of the vertical circulation (except for fire escapes) occurs in a central core which is also the main structural support. The fire stairs are treated as tendrils which drop from the upper branches for added support. The fire stairs closest to the main core are slightly larger than the outer stairs for two reasons, one is that there are more people and therefore a greater need in that area of the building and, two, the gradual increase in the size of the elements toward the core of the building adds to the illustration of the tree structure.

Each major exhibit space is suspended from a main structural member or branch. There are three all together, Africa being at the top, which is the largest exhibit space, South America in the middle, and Asia at the bottom, the smallest exhibit space. Because the exhibits are at the south corner, the ones toward the top will get the most direct sunlight. The location of the specific exhibits within the building was determined by the amount of land each country has on the equator.

At the north corner there are zoo functions which do not require as much natural light. Public facilities such as information, food stands, zoo gift shops, and restrooms are here. Offices for zoo staff and administration are located close to the public facilities, but are somewhat secluded. These occur on the main branches which support the exhibits. The main entries to the exhibits are also on the main branch levels, so that those functions are grouped together, separate from the zoo service functions.

Between the public and administrative floors on the north side are the zoo service functions. These include animal holding pens, food preparation and
storage, and animal medical facilities. There is access to exhibit space from these service functions, but they are separate from public circulation.

The main commissary or food storage is located below ground level. Service and supply trucks enter the area via ramps off adjacent streets. Supplies and service personnel are transported by elevators specifically designated for those purposes.

Between each service and public facility is mechanical space to ventilate and act as a buffer between the zones.

Within the exhibits are pathways which direct visitors through the exhibits. As mentioned before there is one main entry to each exhibit space. There are several exits located toward the main core so that persons may tour the entire exhibit or small portions of it if for instance they were on a lunch hour or had a limited amount of time to spend. The pathways follow the structure and in the case of the African exhibit are located within the structure. They are simple in configuration so that they are easily understood by visitors. The exhibits, not the pathways are meant to provide interest and excitement.

The structure for the building is based on the idea of tree structure. There is a main vertical support of trunk, horizontal structure or branches which support the large exhibit spaces or habitats. The size and configuration of the structural members relate to the changes in size of branches and trunk of a tree. The change in size has been translated into structural density in that where a branch for instance is largest (toward the trunk), the structure is most dense. Toward the outer edges where branches become twigs and are light, the structural
members are least dense and open to admit sunlight. There is a certain dichotomy in the structure because of the fact that the longer the span, the larger and physically heavier the member. In effect however the articulation of visual weight through structural density is successful.

In order to simplify my design process, I decided to include only those animals which live in or just below trees in the respective counties. However with the vast amount of space available it would be possible and more feasible to expand the collection to include more ground dwelling animals. The initial concern was that in most zoos the plains animals which naturally live on large areas of land were being forced to live in very small areas thus depicting an inaccurate habitat. I thought that there would not be enough flat space to comfortably accommodate the plains animals in a vertical building. There is however potential for that.

The building in general is quite large in scale being roughly 800 feet tall. At the base it is smallest to meet human scale. Here visitors might feel on equal terms with the environment. As the visitors progress upward through the exhibits, they are gradually surrounded and enveloped into the environment, losing their connection to the outside world. At the top of the building where the structural modules are 90 feet, there is a perhaps more accurate relationship between man and the environment. This contributes to the educational value of this zoo in that the visitor would realize his relative scale in this context.

Originally the site was the size of one city block. Since the typical block is 200' to 300', it would be logical for the building to rest on four city blocks.
This thesis has been a study in a new form of zoo design which has some possibility in the future of being considered. As are most thesis projects it is more than one person can do in three quarters. I have however through this thesis begun to resolve the basic architectural notions of form, building systems and spacial quality. The most important part of this thesis that is missing is the actual combination of the building systems and the habitats. That second level of design detail is really the deciding factor as to the building’s success.

For future study I would recommend more research of the specific animal habitats and how the animals use them. This is very important for any zoo in order to create the best environment for the animals and the people in terms of environment and education.
Program

PUBLIC PLAZA: The plaza will consist of shaded and unshaded seating areas, planting beds for shrubs and flowers, and fountains. It is to be available to zoo visitors and the general public for recreation. Entries to the building and service ramps will be clearly marked. There will be some visual access to the exhibit spaces from the plaza. Allotted area: 325,000 sq.ft.

MAIN LOBBY: The main lobby will be located on the first floor. There will be ticket sales and admissions, an information desk, gift shops, food stands, and restroom facilities. There will be one major access point for visitors and a second entry for visitors, service, and staff. Allotted area: 14,500 sq.ft.

EXHIBITS: Animals will be seen from various pathways each of which will be devoted to a specific area within the exhibit (high, mid, low branches, and ground). There will be one main entry and multiple exits in each exhibit. Visitors will learn about the animals' habitats as well as their behavior in them. Within the exhibit space the animals will essentially be free to move about the exhibits while the visitors travel through protected walkways. Visitors will feel close to the animals and their environments and gain a better understanding of the biological systems within each exhibit. Allotted areas: Africa, 2,550,000 sq.ft., South America, 1,200,000 sq.ft., Asia, 460,000 sq.ft.

PUBLIC FACILITIES: Food stands, zoo gift shops, information desks, and restroom facilities will be located on a main circulation path. They will be visually accessible, but not directly physically accessible from the exhibits.

ADMINISTRATION: Offices will be located near the public facilities, but will retain some degree of privacy. There will be a set of elevators separate from the public elevators for the offices.

SERVICE: The service areas will not be visible to the public. They will have a separate circulation system from the others but will have access to storage areas in the public and administrative zones.

FIRE PROTECTION: There will be fire stairs and hydrants at 90 ft. intervals. There will be a sprinkler system in the structure.

It is estimated that the entire Brookfield Zoo could be placed inside this building.
Process

Because this particular building type had no real precedent, there was no model design process and therefore I had to come up with my own process. During the first and second quarters I built a series of abstract habitat models. It was an exploration into the architectonic means of simulating natural habitats. I chose to work with three major elements, rocks, water, and trees.

In the rocky environment I arranged random geometric shapes in an attempt to find the patterns and characteristics which exist in mountain and cave environments. From studying cliffs and rock formations it became apparent that there are relatively constant changes in the sizes of stones from the top of the cliff to the bottom. At the very top the stones are small and become larger toward the bottom. On the ground around the largest stones there are small stones that have fallen from the top. This progression had potential for an organizing system.

In the water model I examined the idea of using the various layers which occur naturally in water. The characteristics of light, temperature, and density change according to the relative depth. The species of plant and animal life change with these changes in environment. For example certain fish usually live near the surface of the water where it is light and warm. Others live much deeper and have adapted to the darkness, cold temperatures and water pressure. With this in mind I thought that an aquatic exhibit could be designed so that visitors walk on ramps and through tunnels to the levels where the animals naturally live.

The tree models were also based on this notion of levels in that the animals would be grouped according to the areas in which they live naturally in trees. Light quality and enclosure were explored in some models. The tree was more easily simulated architectonically than in the other two elements. Some ideas of structure and organization surfaced in the construction of the tree models which I returned to later.

Although this type of research/design could and should continue, I chose to work toward the assembly of these various environments into one building.

The tree concept consisted of a main core with horizontal structures intersecting it at various heights. Additional supports some of which contain fire stairs and mechanical equipment are located toward the perimeter of the building. The
rectilinear volumes define where the animals that live at that relative level in trees are. The large volume at the lower half of the building designates where the ground dwellers are shown. The horizontal volume at the top is where the animals that normally live in the tree tops are.

In an attempt to organize the various exhibits I developed a series of theme buildings based on natural organization systems. The major themes were water, weight, scale, tree structure, and light. While all of these had some potential, the best were tree structure and light.

Heavy exposed structure was used to define and articulate the volumes and core elements as well as giving a tree-like character to the building. The concept offered several possibilities in terms of organization because the core could be located wherever it was needed and the other elements would be able to adapt well to it. For the sake of experiment and composition I chose to place it toward one corner of the hypothetical site.

Some of the ideas from the tree concept involved light, therefore I returned to the light concept again with the idea of combining it with the tree concept. If, for example, the main core were located at the north corner of the site, the southern portions of the building would be free to develop into a form which would allow sunlight to penetrate well into the interior. The idea of organizing the animal exhibits by where the animals normally live worked well with the form generated by sunlight.

I took the sunlight idea further by experimenting with the arc the sun makes as it travels across the sky during the day. Animals that are usually most active in the morning would be located on the east side of the building and the ones most active in the evening, on the west side. The largest exhibit would be of the day animals and would be located on the south side.

Another idea evolved out of the natural light qualities that exist in the natural environments of the zoo animals. On the south side of the building the exhibit would simulate the arid zones of the environments while the north side would consist of dense jungle-like exhibits. The east and west areas would be where the interfaces between the north and south exhibits would occur.
INTERIOR TREE STRUCTURE
TRUNKS AND GRIDS
STRUCTURE AS EXHIBIT
LINEAR JUNGLE
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Appendix
I propose to design an environment for animals which satisfies their basic physiological and psychological needs via an architectural interpretation of their natural environments. I believe that the environmental qualities of a natural landscape can be interpreted through architectonic means. Characteristics that influence spacial perception such as light, shadow, texture, enclosure and color can be manipulated to emulate the environmental qualities which exist naturally in an animal's habitat.

Light can be dealt with in terms of intensity, direction and quality based on whether an animal lives in a cave, underground, underwater, in trees, under trees or in the open field. The geographic location of the animals' homeland would also determine light characteristics.

The shadows created by the interplay of light and mass can articulate spacial depth, surface texture and form. The surfaces and textures which exist in a natural landscape can be interpreted through various materials such as concrete, stone, wood, glass, steel and fabric.

Enclosure is another spacial characteristic which can be simulated architectonically. An animal's man-made environment can provide the same relative level of enclosure that exists in trees, caves or open terrain.
Since some species of animals are color-blind while others are not, different networks of dealing with color could be explored. For instance the environments of color perceptive animals could incorporate color which corresponds to the natural landscape. Colors would appear to the color blind species only as varying shades of gray. Color could be experimented with in terms of its perceived value to color-blind animals and to color perceptive humans.

I think that the best test of my thesis would be to design an urban zoo. The site would be an area within a completely man-made context. The zoos that I have seen have been located outside the urbanized areas. They have been single level developments and consequently have consumed large quantities of land. I have chosen to design a zoo on one square block within a city. In order to accommodate a sizeable collection of animals, there would have to be an extension upward, a vertical zoo.

For a zoo to exist there has to be animals and people. The greatest concentration of people is in a city. It seems logical to locate a zoo where it would be accessible to a large number of potential visitors. Another reason for putting a zoo in an urban context (perhaps surrounded by office buildings) is to revitalize the area. Not only would it be a convenient recreation spot for those who work in the area, but it would bring in additional people, which in turn might bring more business to the commercial establishments there. There would be a more continuous flow of activity during the day and on weekends.

A zoo has basically three purposes, education, recreation, and conservation of animal and plant life.

One purpose of a zoo is to educate humans about the ecosystem and their place in it.
Television, books and lectures are good sources of information, but reality cannot be duplication.

The realm of education should encompass the environment in addition to the animals themselves. The visitor should be able to sense the natural environment in which an animal lives. Sight is the one sense that most zoos utilize in exhibits, but much more could be learned about an animal's natural habitat through sound, smell and touch. For example to hear a whole herd of caribou trampling the ground, calling to one another would indicate that they are not solitary, but social animals.

The creation of the sense of territory is almost a language in itself. It marks an animal's territory, delineates social order and indicates fear. A greater understanding of the complex languages that animals use and how they interrelate could be obtained if efforts were made to interpret them into languages which humans understand.

Surface textures and level changes could be used not only to recreate the natural contours of an animal's natural environment, but to demonstrate to visitors the reasons for various characteristics that are inherent in certain animals. For example, rock formations and surface textures which exist in mountainous regions could be interpreted through rough cut stone at varying heights on the walking surface.

Another important purpose of a zoo is to provide a place for people to escape the busyness of crowded streets into an atmosphere where the normal rules of everyday life are different. It is a place to experience the exotic strangeness of wild animals. There should be elements of interest, discovery, richness and spontenaity.
One way to achieve these goals is through the technique used to design safety barriers. The barriers between wild animals and visitors should be as unobtrusive as possible. Safety could be attained by putting just enough space between the animals and the visitors so that neither could invade each other's territory. There have been studies done concerning the physical capabilities of various animals which would help determine the characteristics of the safety space. Especially in the exhibition of large animals there should be some question on the part of the visitors as to whether the animals are really confined. This would give the illusion of a natural relationship between man and animal in that there would be some sense of fear and awe for the animals.

There should be a variety of viewpoints within each exhibit. Changes in perspective and the opportunity for the visitor to move around and in the space would add interest and excitement. There should be more than one route through each exhibit so that visitors have the opportunity to choose their own viewpoints. This would also make more of the environment accessible to those who wish to explore it.

Sightlines could be used to relate different species of animals without necessarily putting them in the same physical area. This would be especially important in predator prey relationships.

Preservation is an important function of a zoo. In the natural ecological system every living species has some role which relates to another living thing. Bees for example extract nectar from flowers. In doing so they unintentionally collect and distribute pollen which in turn fertilizes the plants for reproduction. Were there no bees, the plants could not reproduce and
would become extinct. All living things are dependent on each other. Humans are dependent on animals, perhaps in ways that we do not know yet. The point is that efforts must be made to conserve what already exists.

From various books about animal psychology I have discovered that people are much more adaptive to adverse conditions than animals. For that reason when animals are put in environments which do not adequately accommodate their needs, they become sick and sometimes die. Perhaps the fact that successful animal births in captivity is relatively rare is for the same reason. Therefore I believe that the environmental qualities especially in the case of zoos are of critical importance.

I intend to create the optimum environment for zoo animals through an architectural interpretation of their natural habitats. This will be done via experiments in elements which influence spacial perception.
Interview

Dwight Holland is the curator of design for the North Carolina Zoological Park near Ashboro. I was able to speak with him about some new ideas he had about zoo design.

The first thing he mentioned was that he was trained more as an artist than an architect and that all of the exhibits were designed and built by a permanent staff of painters and sculptors. He gave me a list of what he felt to be important in zoo design. First he said that it is very important to know the behavior of every zoo animal and that spaces should be adequate for those behaviors.

Mr. Holland discussed four different types of spaces in zoos. The first type is visitor space. Visitors should be participators, not spectators. There should be a main pedestrian artery and a secondary flow for people to get out of the main flow and to stop at the exhibits. The second kind of space is the animal space. It requires room for exhibition, backup, and privacy. He said that once in a while animals need to get away from people and feel that they cannot be seen by them. It is important to have plant space to make the exhibits more interesting. This is especially important in exhibits where the animals are not very active. It gives more life to the exhibit. The fourth kind of exhibit space is called amenity space. It connects the animals and the people, but it is not specifically devoted to either.

He mentioned that people should not be able to see other people through the exhibit. This destroys the authenticity of the environment.

Exhibits are differentiated from holding pens by level changes. Usually there is a doorway hidden below the exhibits so that only the animals and the keepers know where it is. The pens and mechanical systems are located below the exhibit spaces.

We looked at some of the service, administrative, and medical facilities which were much smaller than I had anticipated. The service areas included food storage and preparation. From a main commissary the food was dispersed to the specific kitchens for further preparation.

In idea these systems were quite simple and straightforward, but in actuality they were quite complex when combined with the other zoo elements. The interview with Mr. Holland was informative in terms of realizing the extent of design involved in a single zoo.