AN ENVIRONMENTAL RESEARCH LABORATORY
FOR
BACK BAY NATIONAL WILDLIFE REFUGE

by

Michael C. Bricker

Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF ARCHITECTURE

APPROVED:

G. Hunt, Chairman

R. Barr-Kumar

August 1985
Blacksburg, Virginia
Prepared at the Washington-Alexandria Center
Acknowledgements

To my parents, whose love and support made so much possible, and to my friends, always with time to listen.

Abstract

As scientific understanding of the origin and order of coastal barrier islands continues to grow, designers are being forced to reevaluate their design strategies for the shore and near-shore areas. This project involves the design of an Environmental Research Laboratory on Back Bay, in the Back Bay National Wildlife Refuge. The problems and possibilities associated with building on the barrier islands have been analyzed, and design solutions applicable to this and other sites have been presented. In the final design, the structure has been located in the bay, shoreward of the barrier islands and elevated to permit sunlight and rainfall to pass as uninterrupted as possible to the areas below. The object of such design is to have a minimum effect on the landscape (or waterscape) below the building, while creating new green space above. All these characteristics are intended as positive results, able to transfer to other water or land sites.
The coastal barrier islands of the Atlantic coast are being developed as recreational centers from New York to Florida, with developers showing little regard for the islands' nature or the future ramifications of their actions. Coastal geologists have determined that present management practices are detrimental to the long term health of the islands (Dolan et al., 1975), yet little is being done to save the islands and the wetlands associated with them.

The barrier islands and wetlands are interrelated and must be considered a single entity if one is to propose a viable solution to construction that balances user demand with the well being of the ecosystem. It would be unrealistic to block development on the barrier islands, but current levels of growth are pushing the islands to their carrying capacity. When space for development is depleted on the islands, the next step is generally to expand construction into the protected wetlands behind the islands. This is a common occurrence in many areas, and the practice has been to dredge and fill the marshes in order to make solid land for construction. Such efforts destroy the productivity and beauty of the wetlands, while even larger developments of a similar nature planned in Bombay and Bangkok pose serious environmental risks due to reduced flood dampening and water recharge potential. (Meier, R. L., 1984) The U.S. government has noted these hazards and has drafted legislation for protection of the delicate wetland environments. The primary protection comes from the 1977 amendment of the Federal Water Pollution Control Act (FWPCA) in Section 404 of the Clean Water Act (CWA). (Office of Technology Assessment, 1982) Under Section 404, the U.S. Army Corps of Engineers is mandated to, "...restore and maintain the chemical, physical, and biological integrity of the Nation's waters." (CWA, sec. 101(a)) Also involved in wetlands management are the Environmental Protection Agency, the Fish and Wildlife Service, and the National Marine Fisheries Service. Regulatory efforts have proven effective in preserving most wetlands, generally by denial or modification of projects that are deemed harmful to the environment. Nevertheless, the question remains: can structures be produced that accept the nature of their site and are designed in a manner so that nothing is lost when they are built?
The Environmental Research Laboratory is situated in the shallow waters of Back Bay in the Back Bay National Wildlife Refuge. The Refuge, 4,600 acres of beach, marsh and open water, is in Virginia Beach, Virginia, behind 4.3 miles of continuous Atlantic Ocean coastline. It was founded in 1938 from property owned by the Princess Anne and Ragged Island hunt clubs to be a safe haven for migratory waterfowl. The shallow sheltered bay is a natural habitat for the annual migration of ducks and geese, and under strict management by the Fish and Wildlife Service the number of birds using the acreage is continuing to increase.

The building rises above the open bay several hundred yards west of the barrier island that divides the bay from the ocean. Water depth at mean low tide is only three to four feet, but a storm surge up to seventeen feet is possible in the event of the hundred year hurricane. Shallow water limits the type of transportation to the site, and to avoid environmental damage, dredging would not be considered. All construction would be from shallow draft barges until it could be moved onto the structure itself.

The wetland environment is a dynamic and fragile system, demanding an adequate understanding of its attributes before design can be initiated. The Refuge is on a barrier island, a relatively young landform that is the result of a combination of heavy sediment transfer and rising sea level. (An excellent background for this is in Hoyt, 1967 and 1968, and Komar, 1976.) The rising sea level due to postglacial submergence covered areas of low relief and began to move abundant sediment supplies shoreward. Wave action combined with the surplus sediment to form the present barrier islands, while rising sea level flooded the lowlands west of the new islands to form shallow bays. Though the barrier islands are more stable now than in the past, they are still a very dynamic environment. Height above mean sea level is seldom more than five to ten feet, and overwash of the islands during storms is a continuing developmental process. Sand is washed from the beach side to the bay side, thus filling the bay and marginally moving the island shoreward. All vegetation that is successful in this environment has adapted to salt laden ocean spray and periodic inundation, either diurnally with the tides or by the extreme storm surge. Not surprisingly, almost all structures built on the barrier islands are elevated on piers or pilings.
Basis of Design

The first structures on the barrier islands displayed a much better understanding of the dynamics of the environment than structures today. The first buildings were mobile and pulled to the ocean when used, and returned to the relative safety of the bay side of the island during the winter and foul weather. Ownership of land tracts extended from ocean to bay, and the sand was allowed to move as the storms pushed it. Today, however, with escalating land values and development pressures, permanent roads have been installed and lots have been subdivided down to suburban size plots. The most valuable oceanside lots are also the most vulnerable. Development has sparked attempts at shoreline stabilization. Though artificial dunes constructed by WPA crews in the 1930's limit the damage from waves, they also exacerbate shoreline erosion and intensify storm surge flooding. Shoreline erosion is accelerated by the dunes because unless sand is free to move inland with changing wave conditions, erosion results. (Dolan et al., 1973) Also, a significant amount of storm energy is absorbed by barrier islands that would otherwise impact more densely developed inland areas. This buffer action cannot be maintained if the beaches remain stabilized and are thus allowed to wash away. The artificial dunes, therefore, should not be reconstructed when storm action destroys them. In this regard, future development should be more sensitive to the inherently dynamic nature of the environment. This is the justification and basis for this thesis.

The structure is intended as an Environmental Research Laboratory, focused on studying the environment in which it stands: the barrier island ecosystem. As a laboratory the structure acts as an in situ domain where the environment can be studied for extended periods of time. Knowledge generated by construction of this structure and its relation to the environment is intended to influence the subsequent design of structures in similar contexts. Thus, the building itself would act as an ongoing experiment, providing opportunities for modification and prototype experimentation. This give-and-take philosophy takes on a primary role in the project, surfacing repeatedly, demanding that the building contributes more than it takes from the environment. Constructing a building requires an enormous commitment of resources, and to use these to their fullest potential, they need to be combined in configurations that will create new resources to compensate for what is used. This is accomplished in the laboratory through designs such as roof gardens where food is produced, sewage filtered, and water collected, filtered, and heated. Such concepts are neither new, nor are they widely utilized. Nancy Jack and John Todd, in collaboration with the New Alchemists, produced several concepts in their book *Bioshelters, Ocean Arks and City Farming*, that solve many problems of resource conservation and reuse. Though this thesis does not include specific design solutions for these concepts the structure is organized with them in mind, and would surely benefit from their use.

The program for the laboratory was generated as the first step in the design process, and was envisioned as an on site complex that could support extended research projects covering all aspects of the barrier island ecosystem. This encompasses projects dealing with the ecology, geology, hydrology and chemistry of the area as well as many of the consequent interdisciplinary projects that may be pursued. The laboratory was to serve as a self-supporting unit capable of housing, boarding and serving about sixty scientists and staff with the average stay between one and three months. Support facilities for the laboratories were to include living quarters, dining facilities, offices, a limited research library, and computer facilities. The structure was to impose on the natural state of the landscape as little as possible, while acting as a generator of designs for systems that offer the greatest return on the resources invested in the structure. This additional program requirement was more difficult to qualify, but existed in a conceptual form from the beginning.

During the conceptualization, two images for the building evolved, and were defined as the island and the cloud. The island describes a fixed structure that hugged the landscape and mimicked the small emergent landforms found throughout the marsh. The idea was to trap sediment, slowly building up an island around the laboratory so that new habitat would remain even after the building decayed. The antithesis of the island was the cloud, a structure that moved about the landscape like an animal, leaving only a passing shadow on the marsh. The main structure travels along a huge monorail between the ocean and the bay. This idea was even expanded into a grid of rails that allowed complex movement of several structures in the same area. This solution solved the problems of protection from storms and damage to the area under the building, but did so at the expense of a tremendous amount of material for foundations and track, and the environmental damage that so many footings would create.

The cloud and the island both contain discoveries that were important to the final design. From the island the structure took a linear shape that could act as a sediment trap, and thus slowly grow an island. From the cloud the notions of transparency and minimal contact emerged. Large areas of roof were broken up to facilitate light and rain penetration, and the distinctive winged shape resulted from the desire to minimize the imposition of the building on the marsh.
DESIGN EXPLORATION
First Floor

1. Dining
2. Greenhouse
3. Kitchen
4. Mechanical Room
5. Lecture Hall/Assembly
6. Aquarium/Display
7. Bathroom
8. Terrace
Second Floor

1. Dining Mezzanine
2. Greenhouse (open to below)
3. Computer Room
4. Mechanical Room (open to below)
5. Mens' Bathroom
6. Womens' Bathroom
7. Sleeping Quarters
8. Director's Suite
9. Terrace
Third Floor

1. Library
2. Greenhouse (open to below)
3. Sleeping Quarters
4. Women's Bathroom
5. Men's Bathroom
6. Terrace
Fourth Floor
1. Chemistry Laboratory
2. Hydrology Laboratory
3. Geology Laboratory
4. Ecology Laboratory
5. Equipment Room
6. Open to Library Below
7. Roof Terrace
Fifth Floor
1. Open to Laboratory Below
2. Nine Office Suite
3. Eight Office Suite
SECTION C-C
Details

Laboratory Floor Access Panel

Support Cable Connection
AXONOMETRIC
Conclusions

The purpose of this project was to study the problems and possibilities associated with building on the barrier islands, with primary focus on the barrier bay. There is a possibility that development will soon be considered for several similar sites along the East Coast. The design defines several factors that must be taken into account for marsh construction: foundation systems of limited size, construction methods that do not destroy the environment, and designs that allow light and rain to fall unhindered. This building does not meet the ideal objectives of non-interference with the natural environment, nevertheless, it does offer a solution that would be compatible with this fragile site and many like it. In this respect it is successful. The concepts developed are transferable and applicable to other sites. They take little away from the environment that is not returned in resources and understanding.

Bibliography


The vita has been removed from the scanned document