Delta Ranch: A Model for Resilient Housing on a Deltaic Coast

Ranch -- ety.: "country house," from American Spanish rancho "small farm, group of farm huts," from Spanish rancho, originally, "group of people who eat together," from ranchear "to lodge or station," from Old French ranger "install in position," from rang "row, line"

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Coastal communities around the world are experiencing an accelerated rate of environmental change that will continue far into the foreseeable future. The effects of this change mean that previously occupiable landscapes will become less hospitable to human inhabitation and that the plant and animal life will change dramatically. One response to these changing conditions would be to retreat. Another response would be to create a more resilient model for human inhabitation. We chose the second response and used the idea of a ranch as the paradigm for the coastal condition we explored.

The coast of Louisiana disappears at a rate equivalent to the area of one football field every 50 minutes. This is due to the combined effects of subsidence and sea level rise, which have been exacerbated by the desire to control natural deltaic processes of flooding and sedimentation along the Mississippi River, leading to a severe reduction in the capacity to grow and build land in the alluvial plain. The latest estimates show that Louisiana stands to loose more than 4000 square miles, or two times the area of the state of Delaware, by 2100.[1] The inevitability of land loss means that the over 2 million people living in southern Louisiana will need to either relocate or build differently in the coming years. Contemporary building practices have lead coastal communities to simply elevate standard prefab houses as the main form of housing. These houses are not sustainable or resilient over time. While they may be elevated above a storm surge, they are not impervious to the relatively short life cycle that these houses inherently built for. The Delta Ranch project proposed an alternative and adaptive approach to occupation that could provide a solution.

Our design for the Delta Ranch integrates the disciplines and expertise within architecture, coastal bioengineering, and coastal plant science to develop solutions for structures that can sustain themselves and the coast. Specifically, we have designed a habitable structure that utilizes (1)

1

architectural passive sustainable strategies to remediate climatic conditions for habitation, (2) bioengineered oyster reefs for harvest, coastal protection and land building (3) and coastal plants for coastal protection, land building and to develop a productive ecosystem for the structure.

The project design team, composed of two architects, a biological engineer and a plant biologist, and their respective graduate research assistants, proposed the model of a "ranch" to emulate through our design. A ranch is generally understood to be a large area of land that is used for agricultural purposes including animal and plant cultivation. The Delta Ranch is based on the concept that for humans to survive on the coast, they will have to take a more proactive approach to the environment, meaning that they will have to work with the environment more synergistically in order to survive. This idea relates back to the ranch concept in that ranchers must modestly cultivate the land in order for the animal and vegetative ecosystem to function collective to provide for each other. The same is true in Delta Ranch.

In our initial conception of the project, we sought biological components that could resist the effects of subsidence and erosion. We further sought biological components that could actively encourage land building through sediment capture and growth and well as energy dispersion during storm events. Finally, we sought biological components that could emulate or replace the structural and mechanical elements that allow human habitation. During these early discussions the biological engineer presented us with his work on "oyster rings" or biological enhanced concrete designed to optimize oyster growth and formed into shapes that serve as breakwaters. He mentioned that preliminary testing indicated that the structural capacity of the rings was greatly increased through the oyster growth. The architect's quickly extrapolated that into the idea of using the resulting artificial reef as a structural element such as a grade beam. Once the idea of a biological enhanced structure developed, we began to conceptualize the full project as a complete micro ecosystem.

To begin the project research, each discipline asked specific questions related to their discipline. For architecture, these include 1) how do the ecological systems of coastal Louisiana to provide a model for resilient architecture design; 2) how may a habitable structure leverage the dynamic ecological environment to become sustainable over time? For bioengineering, these include 1) what are the growth rates for oysters in a given area; 2) how can a bioengineered oyster reef affect the strength or stability of associated structural elements? For plant science, these include 1) what are the growth rates of specific coastal plants in a given area; 2) how

Figure 1: Projection of coastal Louisiana in 2100 from Blum and Roberts.

do plants provide land building and retention capacity; and 3) how do they affect strength/stability of habitable structures.

For our case study we selected a site in southern Louisiana on the inland side of a barrier island called Grand Isle. Because we are using oysters as our biological foundation, we needed to select a site that had characteristics of relatively high salinity, relatively low wave action, moving but shallow water, and a strong history of oyster growth. The site at Grand Isle was selected because of these conditions but also because there was also a wealth of data available to study the previous 50 year history (when we speculatively began our construction) as well as project forward 50 years based on historical data. The receding Louisiana coast is evident at this site, which was basically a marsh in 1963 and is now a vast open water bay. Our study projects both back and forward to cover a century worth of change in structure and ecosystems.

The final project reaches back 50 years in time to find applicable study data for the plants and animals, as well as 50 years into future to predict the how the structure and integrated plant and animal life work together towards resilience and longevity. The design integrates adaptive thinking and design strategies to develop a quasi-permanent core and frame, as well as provisional adaptive technologies that can respond to the various weather events and change over time. The plant and animal life are critical components of the overall design as they provided structural integrity, microclimate thermal conditioning, and nutrition. In turn, the human inhabitants must steward and care for the plant and animal life in order to assure their continued existence. As a landscape, ranches are not as controlled as a farm and imply a form of stewardship. The Delta Ranch will cultivate dynamic animal and plant habitats through human occupation and structures in a reciprocally beneficial environment.

So we begin our study in 1963. The ranchers/occupants of Delta Ranch begin their "homesteading" by installing a bed of bioengineered oyster reefs. These reefs are created using organically entrained concrete rings that attract oysters to attach and grow at an accelerated rate. The combination of shape, dispersal and materials provide an advantageous setting for oyster growth, as well as increased wave energy dissipation, which has additional ecosystem benefits.[2] At the same time, the initial structural framework is also installed. This framework is made of the same systems used to build over water highways and bridges in the area using precast piles that are driven deep into the sediment and then joined with a series of columns and plates.

Once the oyster rings have begun to propagate the oysters, their structural capacity increases and the next stage of occupation can begin. At a certain point of growth, the now conjoined oyster rings have formed a sort of mat foundation or grade-beam condition at the foot of the structure, where the building emerges from the water. This biologically enhanced foundation is more resistant to hurricane force winds and well as storm surge energy from water pushed through it during a storm.

The bioengineered oyster reef becomes a hospitable site for other types of organic life including coastal plants and animals. Coastal plants are also an important element of restorative and land building efforts on the Louisiana coast. Above ground, the plants can help resist the energy of wave action while below ground the roots help to hold and accrete soil and therefore even build land. Initially plants will need to be cultivated that are very salt tolerant

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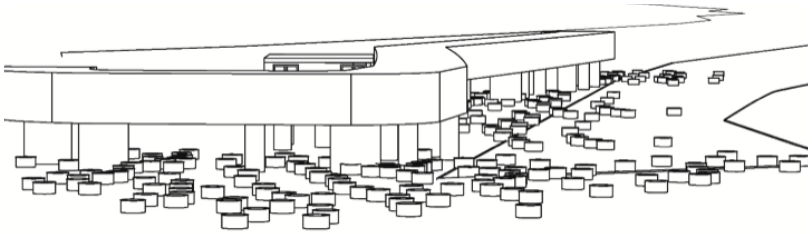
Figure 2: Bioengineered oyster rings (S. Hall and M. Byrum).

Figure 3: Coastal plants acting as both landbuilding and wave attentuating buffers (C. Knott and S. Bertrand).



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but they will be successional and moving towards relatively less salt tolerant plants as the ecosystem evolves throughout time. In addition, the Delta Ranch will provide platforms for cultivating plantings on the structure itself that will be edible, can provide shade for the inhabitants, and can be sown in the accreting land around the structure.

The concrete frame that forms part of the initial site intervention is comprised of a 10'x10' grid of columns and beams on which a series of special formed concrete "plates" can be placed. The columnar structure will extend up 10' to provide additional strength and stability through a cabled layer above. The plates are horizontal elements that have been formed to allow for various needs of the inhabitants such as inverted sections that can receive plantings or collect water and coupling ends that can be linked together. The cabling also acts as a substructure for light and temporary coverings to provide for inhabitation. Fabrics and lightweight board stock can be attached to the permanent concrete structure.

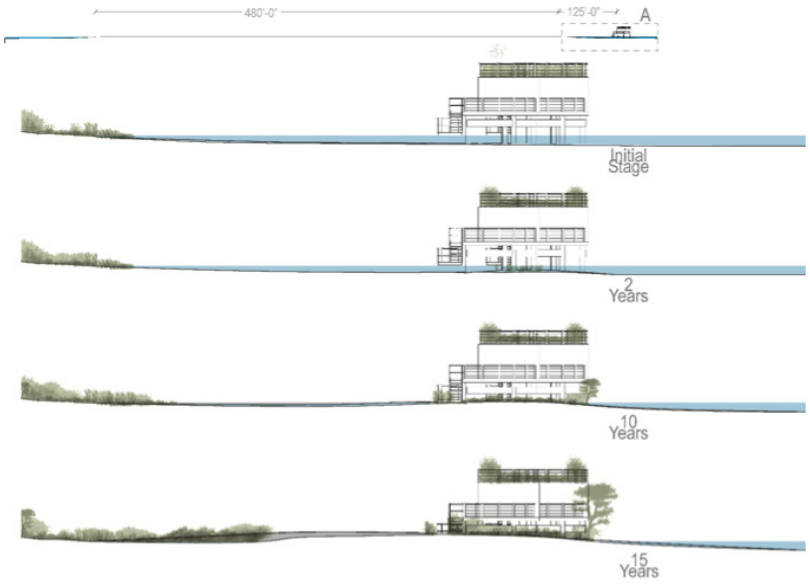
As a part of the basic architectural structure, there would also be a concrete formed core. The core serves as a central hub for a family of up to six people with capacity for storage, cooking, bathing, and sleeping. During normal operations, the core can be more or less open and serve as the central distribution point for a more casual lifestyle. In a storm event or while the Ranch is unoccupied, the core can be closed down and serve as a place of refuge for the family. Multiple cores can be inserted across a large frame to provide for a community to work together and efficiently farm the area. This would also economize on the overall cost of the framing and infrastructure.

The intention for the inhabitation is that it be as self-sufficient as possible. Utilizing a mix of low-tech and high-tech strategies will allow the ranchers to optimize their use of energy, water and resources during inhabitation. While we have implied the use of some contemporary technology, such as solar panels, we intend for the structure to be flexible and minimal enough to adapt to changing technologies as appropriate.

From time to time, hurricanes have and will continue to occur on the coast, created major changes in the land massing around the Ranch and in the immediate vicinity. Given the provisional nature of the occupation, all that may remain are the concrete frame and the core elements. When these events inevitably occur, the ranchers have an opportunity to revise and adapt, just as the animal and plant systems will evolve and adapt. Our strategy is that the lightweight and temporary elements will be replaced every 5-10 years allowing for updates in technology and new methods to be implemented.

Implementing our model is something that we have not fully studied yet but there are some implications that we are already aware of and planning to address to the further development of this project. The first is a question

Figure 4: Preliminary axonometric view of proposed structure with oyster rings.



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of economic and scale. The initial structural elements are going to be much more expensive than traditional home construction because in execution, the design more closely resembles highway infrastructure. Therefore, it will require a large investment at the scale of a community in order to construct and cultivate. Also, in order for this type of intervention to actually work at both the scale of human inhabitation as well as land building, it will have to operate at a scale that is larger than the single inhabitant.

The Delta Ranch provides a new model for occupying the Louisiana Coast and perhaps other coastal conditions. It relies on some existing cultural norms such as boating, oyster fishing, and provisional occupation. However, unlike the current housing available to coastal inhabitants, it does have a long life span because of the integration of natural and manmade systems. The projects success relies on integrating the disciplines and expertise within architecture, coastal bioengineering, and coastal plant science to develop solutions for structures that can sustain themselves and the coast. The Delta Ranch is a habitable structure that utilizes (1) architectural passive sustainable strategies to remediate climatic conditions for habitation, (2) bioengineered oyster reefs for harvest, coastal protection and land building (3) and coastal plants for coastal protection, land building and to develop a productive ecosystem for the structure.

The final project reaches back 50 years in time to find applicable study data for the plants and animals, as well as 50 years into future to predict the how the structure and integrated plant and animal life work together towards resilience and longevity. The design integrates adaptive thinking and design strategies to develop a quasi-permanent core and frame, as well as provisional adaptive technologies that can respond to the various weather events and change over time. The plant and animal life are critical components of the overall design as they provided structural integrity, microclimate thermal conditioning, and nutrition. In turn, the human inhabitants must steward and care for the plant and animal life in order to assure their continued existence. While this would be a desirable goal for all buildings, in Louisiana, it is rapidly becoming the only imaginable way that we can continue to live along our diminishing coast.

Figure 5: Section showing changes in vegetation and structure over time.

ENDNOTES

1. Blum, Michael and Harry Roberts. "Drowning of the Mississippi Delta due to insufficient sediment supply and global sea-level rise." *Nature Geoscience:* Vol 2, July 2009.

2. Byrum, Matt. "Culturing Coastal Plant and Animals for Sustainable Housing." *World Aquaculture Magazine.*