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The Regenerative Rebuilding Strategy For Sustainable Coastal Communities. An Architectural Thesis and Case Study Of Rebuilding Post-Tsunami Sri Lanka.

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Introduction

Developments are occurring at a rapid pace along coastlines all over the world. In fact a full two-thirds of the world's population, or 4 billion people, live within 250 miles of a coast[1]. In the United States architects have recognized the negative effects of existing building practices on beaches. In fact, designers have eagerly adopted methods of "sustainable design" to band-aid the problem. While seemingly an improvement upon past building practices, current movements in sustainable design focus on slowing down the degradation to the beach environment instead of encouraging healing practices. If we are to sustain the existence of both mankind and the planet then just slowing down the damage is not enough. To restore beach ecosystems a regenerative architecture must replace exploitative architecture. In order to heal our beaches architecture must integrate regenerative cyclic processes which develop over time and which are found already existing in beach ecosystems. Regenerative architecture must promote co-evolution and interdependency of both land and humankind together, sustain existing ecosystems and natural materials, and re-establish the relationship between human and water.

Our relationship with the water permeates our very existence. The ocean is the source of the entire water supply of the earth. There is life in the water, not only in literal terms because of wild animals and plants. Humans develop a very intimate relationship with water: we are 80% water at birth and even in religious sects, baptism, the process of cleansing and spiritual renewal, occur in water. The ocean and beach are interdependent with human life. This relationship is inseparable, which is why it is so difficult to see the beach and ocean raped by the structures we build.

It is an easy parallel to consider beach construction pollution on a level such as the battered Gulf Coast from Hurricane Katrina. But the issue of coastal overbuilding can be seen in many other more subtle ways. It is in the smaller developments of coastal destruction that create the greater disasters over time. For example, a former popular surfing location in Virginia Beach was overrun with the development of a condominium built within yards of a wildlife refuge. The shore itself was straightened out to allow for a four-foot concrete retaining wall to protect the precious concrete and steel structure. The condo had not only robbed the shore of its land but also removed its natural S-curve landform. As one can imagine, the condominium had no relationship to the land it was built upon, or the people who frequent the area; surfers, sailors, and families.

The "Sanctuary"

The condominium development in Virginia Beach is called "The Sanctuary at False Cape"designed by Cox Kliewer Associates Architects. "The Sanctuary" is located within 200 feet of Back Bay Wildlife Refuge (8,000 acres of unscathed wildlife habitat) and within 50 feet of the shoreline at low tide. The refuge is home to thousands of geese, wild horses, sea turtles, and undisturbed sand dunes. During the foundation and piling construction, thirty-one pilot whales beached themselves within two miles from the condominium. While information is currently inconclusive on the North Carolina/Virginia border whale stranding, it is important to question if it was simply coincidence or was there a cause-effect connection?

Besides being a danger to wildlife, "The Sanctuary" uses nine of the most common toxins in construction. According to the World Health Organization[2], 1/3 of remodeled buildings in America have some toxin in them making people chronically ill. The effect is also devastating to animals and can produce mutations and kill entire ecosystems. The "Sanctuary" is only one magnified example of the rampant beach development occurring throughout the United States and the world. Now the question becomes: what can architects do?

Regenerative Architecture: Co-Evolution, Co-Existence, and Interdependency

In order to establish a relationship between the beach ecosystems and architecture, a critique of the existing movement of "sustainable architecture" is necessary. Currently the big movement is to think "green". We build out of "sustainable" products and we create organizations such as the USGBC (US Green Building Council) and LEED who can put stamps of approval on architecture and announce the building as being 'safe' for the environment. Unfortunately there still is an extreme disconnect between the "green" which is approved and *actual* green design which relates and interacts with the land. While we have made great strides in the past twenty years, we are still experimenting with fully ecologically sustainable architecture. Existing architecture does not conform to mother-nature or benefit from the systems she has to offer. Instead architects, planners, and corporate developments reshape her existence until she barely resembles the shore she used to be.

In the case of "The Sanctuary", the shore was straightened out. In order to "save" the shoreline from erosion, the architects designed and built a concrete seawall into the sand less than 50' from the building. The seawall protects the sand from eroding up to the building; meanwhile the shore will eventually erode up to the seawall. In that case, the shore between the building and the seawall will become "private property". Clearly this is a blatant disregard for the beach, the meaning of the shoreline, and the people who inhabit that area. Not to mention, the construction of the seawall itself has destroyed an entire ecosystem in the process. The first line of defense against erosion is the sand dunes, however in order to be closer to the ocean, the sand dunes were removed and replaced with a "seawall". The effects are now devastating.

An article written by Associated Press correspondent Sue Lindsey (published in USA Today on May 14, 2005) describes the debate between tourism dollars versus the environmental health of beaches, specifically Virginia Beach: "Coastal engineers say beaches ravaged by storms naturally reshape themselves to some extent within about six months. But to maintain them as wide, sandy spaces attractive to tourists, they need an infusion of sand every few years. Whether this cycle of replenishing sand is the best use of taxpayer money — and is good for the beaches — is a matter of ongoing debate between scientists and officials in beachfront towns. And it only heats up after intense hurricane seasons." The article continues with Duke University geologist Orrin Pilkey, who said: "The problem is people build too close to the shoreline and now they come to us to save them." He continues to say that the action of pumping in sand has a dramatic effect on the ecosystems in the ocean. It's an even worse reaction on the ecosystems once the sand is dumped onto the shore. The "new" sand kills everything already existing there, especially if the sand is drastically different. In addition, the sea level is rising and if we continue our building patterns in this way we will need to pump even more sand in the coming years. How long can we keep pumping sand? What

price will we pay if we destroy the existing ecosystems?

The Ecosystems Pay the Price

There are four types of beach ecosystems[3]. The first is the *beach/dune/barrier island* ecosystem. This ecosystem is the most dynamic of all four. It contains multi-cellular organisms from insects to birds. The beach/dune/barrier island ecosystem acts as the first line of defense of the land from hurricane destruction from large, pounding surf. The second ecosystem is the *salt marsh*; home to plants and animals acclimated to high salt content. Grasses, sedge, some fish, and invertebrates are most common in this ecosystem as well as raccoon, otter, and sea turtles. The third ecosystem is *estuaries*; where freshwater and saltwater join. Oysters, mud flats, and shellfish are the most common organisms and this ecosystem is the most productive. Finally, the *mangrove* ecosystem is a series of deeply rooted plants and trees which can grow in the water. They act as natural filters of estuaries and naturally remove pollutants from the water (Back Bay Wildlife Refuge).

The ecosystems act as a barrier and filter from pollutants and natural occurrences. It is not just pumping sand and rising sea levels we should be concerned about. According to the World Health Organization, the building industry regularly uses nine deadly toxins in construction. These toxins are used in building materials found throughout beach architecture and structures everywhere. When natural disasters such as hurricanes occur, or even when water runs through the pipes in your home or when the sun beats down on a structure the toxins are released into the environment and even into your own body. These toxins cause cancer, lung disease, kidney inflammation, and behavioral issues in humans. Meanwhile in beach ecosystems it causes things such as disease in fish and birds, beaching of whales and dolphins, and the extinction of entire ecosystems. So with all the leading technology in sustainable design the question still needs to be asked: where is the ecological sustainability in *beach* architecture?

The Cycle

Architect William McDonough[4] is on the forefront of the sustainable movement. His idea has evolved from a decade ago when thinking “green” was just making things “less bad”. In fact, he termed the phrase “less bad does not equal more good”. His book Cradle to Cradle explains the rationale that to be sustainable we must reconsider the way we make things and ultimately “remake” them. We must see the beginning *and the end* of our structures as contributing to the environment. In other words, we do not recycle (“downcycle” as McDonough describes), we must learn to “upcycle”. The term “upcycling”, for example, would mean that a structure would have a “cradle-to-cradle” effect. In essence, it is the term “cycle” that instigates the validity in the regenerative argument. In theory, the structure would never “die” instead its substance would just cycle back and return to its ecosystem by natural process producing a positive effect.

Regeneration and the Environment

The Gaia Theory developed by James Lovelock, Dian Hitchcock, and other scientists described the idea of the earth being a living organism and it being dependent upon human life. In 1979, Lovelock wrote the book Gaia: A New Look at Life on Earth which stated that: "... the physical and chemical condition of the surface of the Earth, of the atmosphere, and of the oceans has been and is actively made fit and comfortable by the presence of life itself. This is in contrast to the conventional wisdom which held that life adapted to the planetary conditions as it and they evolved their separate ways." So in essence, life is needed to sustain the earth. With that being understood, then there must be a series of natural process that can explain this theory.

“One process by which carbon dioxide is removed from the atmosphere is rock weathering, where rainwater and carbon dioxide combine with rocks to form carbonates... The carbonates are washed away into the ocean, where microscopic algae use them to make tiny shells. When the algae die, their shells sink to the bottom of the ocean, forming limestone sediments. Limestone is so heavy that it gradually sinks underneath the Earth's mantle, where it melts. Eventually

some of the carbon dioxide contained in the limestone will be fed back into the atmosphere through another volcano[5]."

This is a perfect example of a natural process of materials which pass through multiple ecosystems of the beach and ocean where there is a cradle to cradle effect. Russian scientist Vernadsky said: "Life appears as a great, permanent and continuous infringer on the chemical 'dead-hardness' of our planet's surface ... Life therefore is not an external and accidental development on the terrestrial surface. Rather, it is intimately related to the constitution of the Earth's crust, forms part of its mechanism, and performs in this mechanism functions of paramount importance, without which it would not be able to exist." With the understanding that life and the earth can only exist in unison together, can a structure generate a valuable contribution to the life cycle and become part of the process?

Regeneration and Design

"Our design practices need not only to do no harm, they must initiate regenerative processes to replace the degeneration resulting from past practices" as stated by Pamela Mang[6] in her online article, Regenerative Design: Sustainable Design's Coming Revolution. In this same article, Pamela Mang describes Sym Van der Ryn's writing: "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes" is indicative of ecological design. In order to save human life and what ecosystems remain, architecture must be more than just "green" and more than "sustainable".

Theory and Design

A contradiction of architecture itself is that in order to build we must destroy. However, regenerative architecture may turn that paradigm on its head. What if our new form of beachfront architecture was created from a naturally occurring lightweight material? What if regenerative architecture was to allow for the continued growth of that material and encourage its reproduction all while filtering the ocean's tidal water and returning it to the ocean?

In his book Lightness[7], the Dutch physicist Adriaan Beukers claimed that: "if materials were lighter, less energy would be spent constructing buildings, since all materials must be transported or lifted by machinery at one time or another". Given this idea of lighter materials, Peter Testa Architects and MIT students created a theoretical Carbon Skyscraper: a skyscraper which "uses sinuous strands of resin-impregnated carbon fiber that are lighter and stronger than steel". Built out of modular construction techniques, the skyscraper would conserve energy and reduce the weight of the structure on the soil beneath it. In the case of beachfront architecture, would it be possible to utilize a new ultra-light material form to build structures? Are there other materials yet to be discovered that can be used in the same way?

Architecture embodies a spirit which is defined by a form. The spirit is simultaneously created and discovered by its inhabitants as an intangible emotional attachment that makes the structure come alive. It is this spirit which will create the regenerative architecture and allow for it to sustain in the constantly moving edge between water and shore. Through regenerative architectural forms this respect can be reclaimed in the spirits of all types of people on the shore.

The Regenerative Cycle

Understanding regeneration in terms of a cycle is the most important conceptual realization. The cycle will occur over a period of time and the actual amount of time will be paramount to the life of the structure. A cyclic process will have a positive effect on the environment throughout its life. Deriving the cycle from existing ecosystem organisms will drive the design process. As found in the Gaia Theory, the earth and humankind need each other to exist. The goal of determining a cycle in regenerative architecture is to make the beach and structure a continuous cycle which each is dependent on the other, even if the structure is only semi-permanent.

Life Creates Conditions Conducive to Life[8], a paper distributed by the Business Ecology Network at Florida A&M University in 1998. The paper condenses the meaning of an economy of ecological standards. Based on this paper, the following was determined:

-Life builds from the bottom up
-Life uses benign manufacturing

-Life fits form to function
-Life is cyclic processes and recycles resources
-Life is locally attuned and resourceful
-Life adapts and evolves
-Life coexists within a cooperative framework
Existing organisms hold these characteristics by nature's design and regenerative architecture will imitate their processes.

In David Eisenberg and William Reed's thesis entitled Regenerative Design: Toward the Re-integration of Human Systems with Nature[9] they state:
"We are more likely to achieve large improvements if we participate with nature on its own terms… Regenerative design requires that we participate with nature in a mutually beneficial relationship… instead of trying to stabilize natural systems by brute force and the creation of 'manageable uniformity' (Lyle), we must identify the key systems (living and geological) involved in a "place" and understand what permits these systems to maintain viability over time and allows them to evolve in relation to each other (a continuous birth, life, death cycle)."

Finding the System

From the same thesis, in a later statement Reed and Eisenberg state: *"Healthy ecological systems don't maintain a stasis; they have a spiraling, complex growth pattern that has continuous and changing birth/life/death cycles. Living and natural systems are not merely closed loop systems, but continually evolving open systems."*
Understanding these systems in a place-based form will generate the architectural remedy.

The Regenerative Case-Study: Sri Lanka

Sri Lanka was affected by the tsunami on eastern, southern, and south-western coastal areas. Unawatuna, on the south-western edge of Sri Lanka, is surrounded by several coral reefs and before the tsunami was a popular tourist location as well as surfing location. The people of Unawatuna have had their entire economy destroyed. Villages were obliterated and where people once sold fish right off the boat, is now desolate shoreline.

Scientists from Cornell University, Texas A&M, Georgia Tech, and the U.S. Geological Survey[10] studied the events of the tsunami. The tsunami struck Sri Lanka on the eastern shores. Scientists found that the reason the south-western areas were hit so hard was because: "By removing some of the coastal protection, a conduit was created through which the tsunami could flow freely" and inevitably allowed the tsunami to even speed up in some places and hit the south and south-western areas. As the article continues, the scientists further state: "…coral mining and human development in Sri Lanka helped December's tsunami sweep even further inland than it might have."

According to Arjan Rajasuria[11] of the National Aquatic Resource, Research, and Redevelopment Agency of Sri Lanka eighteen million people live in Sri Lanka and half of those live in coastal areas. The article further explains that "nearly all of Sri Lanka's reefs are located within 40km from the coast" (par. 4) and "since 1994 the reefs have been reduced to 13.2% coverage". The coral reefs of Sri Lanka are clearly in danger. Not because of the tsunami, the reefs remained intact after the tsunami, but from harvesting the reefs for limestone and other building products. Reduced reef coverage caused the fish to leave and also leave the shore unprotected against erosion.

The danger for Sri Lanka now lies in the rebuilding efforts of the coastal fishing villages. Vernacular buildings were constructed out of natural materials and coral-based building materials. The coral reefs cannot sustain mining any longer. Sri Lanka desperately needs to find a way to rebuild without using coral limestone. Sri Lanka can continue with disastrous building practices or they can begin a revolution and adopt an entirely positive form of architecture that will benefit the land and economy.

Research through Design: The Animal as Cycle

Research through design begins as a process from the site analysis and discovering which organism or animal to base the derivation of structure and skin. Coral is an animal who survived the tsunami and which has value to both humans and the land and reveals several

symbiotic relationships explained in a cyclical form. It is created from layers upon layers of dead coral bodies. The layers calcify and create a bony skeleton while multiple live layers build to create the skin.

Sri Lanka has 183 species of stony coral and they fall into the following groups: acroporidae, favilidae, portidae, and pocilloporidae[11]. These four groups all have properties of asexual reproduction and spawning, as well as the ability to mutate into other species. The new coral spawns and mutates to create larger barriers beneath the wave break line. The evolutionary process of spawning was built in a physical model. To summarize, this model revealed how the female and male parts of coral spawn and find each other randomly in the ocean. This process of reproduction makes it possible to "install" regenerative coral forms in the ocean for coral to grow on and eventually take over- thus the process being revealed.

Symbiosis + Regeneration

Symbiotic relationships are essential to coral life. Coral is part of a positive up-cycle of life. The cycle begins with coral spawning, which was previously explained. As the coral grows, fish find homes within the coral habitat. Fish supply the coral with bacteria and smaller bait to live on and in turn the fish live within the coral for protection. As the fish multiply, fishermen from the village come into the reef to gather a day's catch. This in turn "feeds" the economy of the village as tourists and other villagers come to buy the fresh fish. The tourists stay in the villages and see the reef as a vacation destination, in turn "feeding" the economy as well. As the economy increases, the villagers are able to reinvest this money into their village and their architecture, supplying more regenerative buildings on the land. A regenerative cycle is revealed and comes full circle. The cycle is termed as "Emergence-Evolution-Reclamation". In terms of defining regenerative architecture, this cycle becomes the most important revelation.

This cycle is part of a series of cycles that intertwine to design the complex and dynamic symbiotic relationship of regenerative architecture. Regenerative architecture is about consciousness of these cycles and influencing the environment and the people. In Sri Lanka there lies the possibility of causing a revolution for the environment.

Sri Lanka Benefits from Regeneration

The architectural program for rebuilding Sri Lanka needs to benefit not only the people, but also the economy.
The first conceptual model was a visual understanding of the reef and the way the ocean and beach respond to it. A wave begins at sea and as it approaches shore, it gets larger. When a coral reef is present below the surface, the wave will break upon the reef. The reef survives on this energy from the wave while the wave is reduced in size by up to 75%. This barrier prevents erosion of the shoreline. In this conceptual model, the structure grows up from the ocean and the coral becomes a part of the structure. The structure spawns forth onto the shoreline and anchors here. The model illustrates the symbiotic relationship between wave and reef and structure, which has become yet another cycle in this search for regenerative architecture.

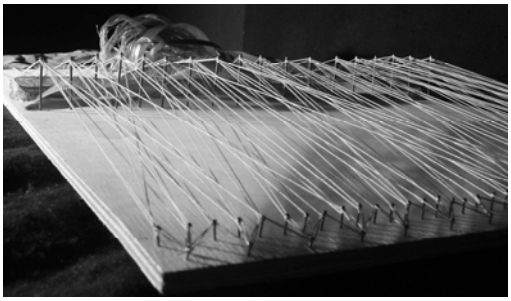

Fig. 1. Conceptual Model

The Final Synthesis of Cycle + Regeneration

Fig. 2. Market fishermen untangling nets

The project becomes a cycle of symbiotic relationships through time. As the structure emerges slowly coral grows on foundation elements in the water allows for anchoring of the structure on the shore. As the structure emerges from the water, the skin will be applied. The structure will eventually take form while the coral and animal growth continues. Eventually the structure will begin to become apart of the coral, as layers emerge, decay, and return to earth. The structure erodes while the coral growth thickens over time. Eventually the part of the structure in the ocean will decay and be "reclaimed" by the animal.

Fig. 3. Market Structure

Fig. 4. Plan

The coral forms in the water depict a complex "growing" structure. At the location of the shoreline, the polyps grow in a radial for simplifying the structure and revealing a place for human habitation. This structure is the fish market. The fish market curves around the shore and is designed using three different forms: a form for gathering/sitting, a form which creates the actual marketplace structure, and finally the form which the shading devices are attached. The convergence of these forms creates a dynamic and complex pattern which reveals the essence of the cycle and the symbiotic relationships found in coral.

Endnotes

[1] Hinrichsen, Don. "Ocean Planet in Decline." (October 12, 2004).

[2] World Health Organization

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