Strong Winds and Rising Currents: A Design Proposal for the Grand Bahama International Airport

Over the last decade, the islands of the Bahamas have been battered by a series of powerful hurricanes of increasing strength and frequency. The high winds and flooding that arrive with each storm result in significant damage to buildings and infrastructure on this low-lying island chain in the middle of "hurricane alley". The Grand Bahama International Airport, on Grand Bahama island, has been a casualty of several recent hurricanes.

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The Grand Bahama International Airport, on Grand Bahama island, has been a casualty of several recent hurricanes. A combination of wind damage, flooding and loss of electrical power have effectively shut down the airport for days or even weeks at a time, as was the case after hurricane Wilma in 2005.

The documentary film and book, An Inconvenient Truth (2006)[1], generated greater awareness about the threats of global warming among architects and society at large. Although there has been substantial research into building components that can withstand windstorm and flooding, there has been less attention paid to comprehensive building design for climate change and "rising currents".[2] In the mid-2000's the Grand Bahama Port Authority, the entity that owns and manages the airport, began exploring ideas to accommodate future growth of the airport complex, including a new passenger terminal. Although various design proposals took into account the potential for flooding by raising the terminal a few feet off the ground, most of the concepts only addressed climate change as a peripheral issue, not as a core concern. In 2012, our design team developed a concept for a new passenger terminal.

SITE ANALYSIS

The Grand Bahama International Airport (GBIA) is located in the City of Freeport approximately 90 miles east of Ft. Lauderdale, Florida (Fig. 1).

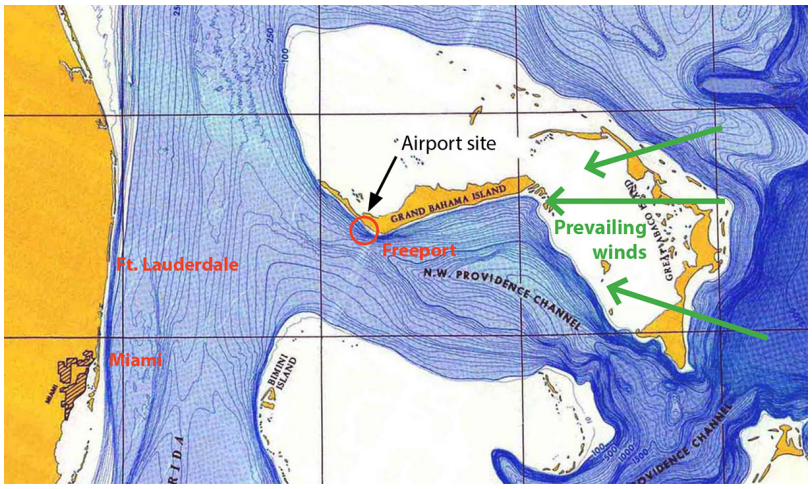

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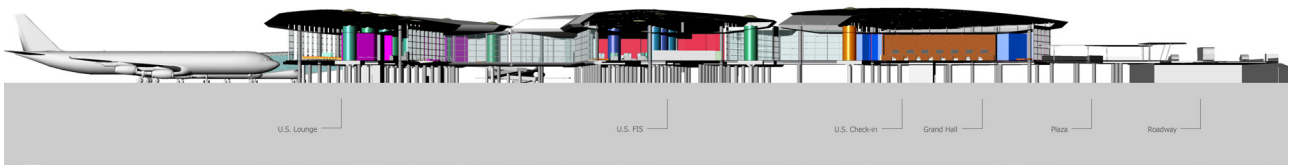
Figure 1: GBIA Site - Grand Bahama Island

With an average elevation of seven feet above sea level[3], the airport site has been prone to flooding during frequent tropical storm surges. The original Freeport airport terminal[4] was completed in 1958, designed by Alfred Browning Parker (1916-2011), Florida's premier "tropical organic" architect. Parker was keenly aware of designing for climactic conditions within the sub-tropical zone of Florida and the Caribbean. Although he incorporated natural ventilation and day lighting strategies and chose robust construction materials, his design for the terminal did not take into consideration the potential for flooding because the building was placed directly on the ground. Even with subsequent additions over the years, the level of the terminal was never raised. Architects of Parker's generation were not faced with the threats of global warming including the challenges of rising sea levels that are currently beginning to impact sub-tropical regions. In the early 1970's the runway was extended to 11,000 ft. to accommodate jumbo-jet service from Europe. Throughout the 1970's and 1980's several additions were made without a comprehensive master plan. The proposed terminal for the GBIA will be placed on an open site located to the east of the existing terminal complex. This new site is more strategically located to the primary transportation route and the original planning axis of the city. The existing terminal will eventually be transformed into a cargo handling complex.

The islands of the Bahamas were formed by the calcified build-up of marine organisms over thousands of years. Currents of wind and water have shaped them. When the sea and land formations of the Bahamas are viewed from an aircraft or from space, one can observe ocean currents and sand rills endlessly converging and diverging. An infinitely varied palette of blue and green characterizes an aqueous environment that is in constant flux. Arguably, these flows and patterns are analogous to the movements of people, cars and aircraft at an airport. Currents of water and wind sculpt the grains of the great Bahamian sand bars. The formations produced are ever changing; while seemingly endless, they are ephemeral and will be washed away by the next tide.

The climate in the northern Bahamas is classified as subtropical maritime with wet and dry seasons. The rainy season runs from June to October which coincides with a period of increased hurricane activity. Prevailing winds generally approach from the East, ranging between Northeast and



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Southeast orientations. The ocean waters are warmed by the current of the Gulfstream passing in between Grand Bahama and the Florida coast. Although the relative humidity can reach levels of seventy percent in the summer, a steady breeze makes the air feel less humid and makes it possible, even in our age of excessive climate control, to live and work in buildings without air-conditioning.

DESIGN CONCEPT

Ever since the airport was conceived as a distinctive architectural building type beginning in 1920's, airport designers have debated over what identities an airport should have. As a threshold of first impressions, the airport should not only introduce the visitor to the city of arrival but also represent the national identity of a country. Traveling is an act of discovery. Just as Christopher Columbus arrived in the Bahamas in 1492 and "discovered" the New World, tourists arriving at the Grand Bahama International Airport will be introduced to a new culture and place. Our concept of an airport terminal is one that reflects the natural and cultural environments of the islands of the Bahamas while addressing the concerns of climate change. Through architecture, this building attempts to create an engaging experience for its different users: tourists, residents, and employees. This design project draws upon primary and secondary research that included the analysis of a wide variety of airports built over the last eighty years from a functional, environmental and architectural perspective. Paralleling contextual design strategies such as those found in the Kuala Lumpur International Airport by Kisho Kurokawa (2000), our airport seeks to create a symbiosis between the climate and culture of the Bahamas.

The plan and section (Fig. 2) of the new terminal fulfills the functional program while abstracting the land and sea formations of the Bahama islands. This configuration allows for a flexible approach to expansion and addresses ever increasing airport security requirements. Interior partitions can be moved as the airport adjusts to changing functions and future growth.

Culture and identity of the Bahamian people are revealed through the use of color, material and art; these reflect the different traditions of its people through history (the indigenous Lucayan and Taino Indians, Eleutheran settlers, the African migration, the British colonists and more recent immigrants). The palette of interior colors and textures reflect the natural environment of the Bahamas; the colors of the sea, sun, plants, shells and the artifacts and art of the Junkanoo festival, the most popular expression of Bahamian culture (Fig 3). Wall murals portray images of Bahamian life and terrazzo floors incorporate abstracted images of the flora and fauna. Screened balconies give passengers an opportunity to step outside to enjoy fresh air.

Figure 2: GBIA Section Rendering

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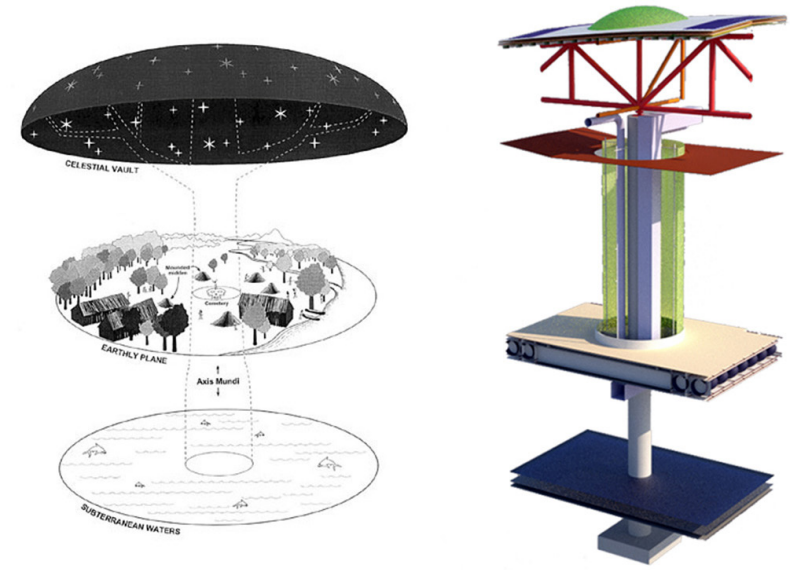

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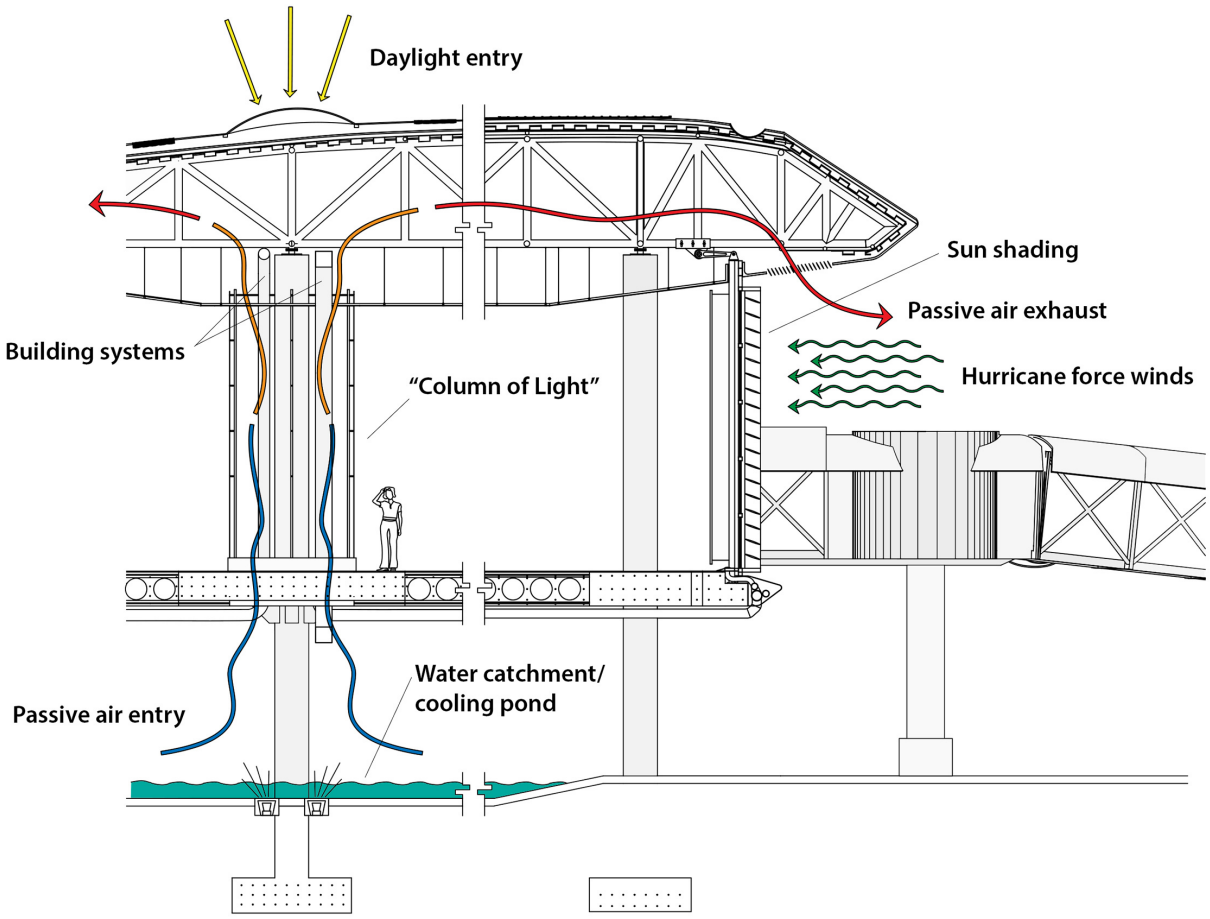
STRUCTURAL AND ENVIRONMENTAL SYSTEMS

Since an airport is a place of transition between ground and sky, the question should be asked: "How can we connect the ground to the sky?" and conceptually, what kind of structural and architectural elements can make this connection? The Japanese architect Toyo Ito has explored the idea of columns as conveyors of light and conduits for environmental systems. In his Tower of Winds (1986), the architect suggests that light and sound are conveyed vertically. Additionally, in Ito's Sendai Mediatheque (2001) lattice tube columns become giant channels for the movement of people and building systems.

The proposed terminal building utilizes a basic structural system of column and plate. Based on the tripartite axis mundi of the indigenous Taino Indians, the "column of light" acts as the main structural element and as a conduit for light and environmental systems (Fig. 4). A field of columns, a loose representation of the Grand Bahama pine forests, raises the building off the ground safely above hurricane storm surges, facilitates air circulation and

Figure 3: GBIA Interior Perspective

Figure 4: GBIA Taino Axis Mundi and Column of Light



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provides shelter for airport equipment and service vehicles. The concrete floor plate, supported by columns, hovers over water catchment pools, giving the impression that the building is floating on a shallow sea and serves as a metaphor of the Bahamian islands.

These columns elevate the building off the ground to facilitate air circulation and passive cooling thus responding to the sub-tropical climate. The inner concrete column anchors the building to the ground, while the surrounding "column of light" links it to the sky. In this way, light is captured through architecture. Each thirty-six inch diameter concrete column is surrounded by a colored and translucent Plexiglas shield. The space between the column and the shield acts as a conduit for light and mechanical systems: electrical, HVAC, plumbing, and communications. The piping and ductwork that runs through this space is partially visible when standing near the column. It gives the viewer an indication of how the building functions and "breathes". Natural daylight enters the building from within the column shield by way of rooftop skylights. At night, flood lights located in the water catchment pools project upward along the columns resulting in a shimmering effect from the movement of the water below (Fig 5).

The concrete floor plate is constructed with the Bubble deck[5] system which is a type of hollow core slab system. Large recycled PVC inflated spheres are inserted into the form work before the concrete is poured. These spheres remain in the slab permanently, reducing the slab weight.

Figure 5: GBIA Typical Section with Climate Systems

The roof structure is based on a network of steel tube trusses with corrugated metal decking and a reflective standing seam roof surface. Acting as a "climate skin", the roof confronts the forces of wind, water, and sun while providing a comfortable interior climate. Large vented roof overhangs reduce heat load and are part of a passive cooling system that employ the "columns of light" as air circulation conduits. Photovoltaic panels, supplementing the airport power supply, cover large portions of the roof surface. The large roof enclosure acts as a container for various building systems: HVAC, electrical and plumbing, communications and fire suppression.

When exterior walls are non-load bearing, as in this building, the walls can become "curtains of glass" creating opportunities for the framing and differentiation of views to the outside. Views of aircraft and landscape are composed by employing various screening strategies and by varying the transparency level of the glass. Horizontal louvers provide sun shading and protect the glass curtain wall during storm events, while maintaining views to the outside.

Performance based design strategies were used to assist in the development of the architectural design. Considerations regarding energy usage, carbon footprint, thermal load, day lighting, water usage, water catchment, informed the design process. The environmental effectiveness of the design is currently being analyzed and tested through the use of new building performance analysis software[6] and the original digital building model.

CONCLUSION

The design for the Grand Bahama International Airport passenger terminal seeks to minimize the effects of catastrophic weather events while utilizing and promoting sustainable design approaches. Local culture and sense of place are abstracted through architectural strategies based on a contextual language. By engaging with and acknowledging significant environmental and cultural characteristics, using contemporary materials and technologies, and employing performance based design analysis, this airport aims to foster an experience that is local, global and environmentally responsible.

ENDNOTES

1. Gore, Albert. 2006. An Inconvenient Truth. Emmaus, PA: Rodale Books
2. Bergdoll, Barry and Nordenson, Guy. 2011. Rising Currents: Projects for New York's Waterfront, exhibition March 24 - October 11, 2010. New York: The Museum of Modern Art.
3. GBIA site elevation data. 2005. Grand Bahama Port Authority.
4. Henning, Randolph C. 2011. The Architecture of Alfred Browning Parker: Miami's Maverick Modernist. Gainesville, FL: University Press of Florida. Pg. 121
5. BubbleDeck International, Farum, Denmark
6. DIVA for Rhino, IESVE, others