ISLAND TEAM 2013

ARCHITECTS
ANA sofíA cardona
joAnne mUniz

STRUCTURAL ENGINEERS
nanyu zhao
steven shuhui qu

MECHANICAL ENGINEER
reinier kok

CONSTRUCTION MANAGER
Kourosh salehzadeh

LIFE CYCLE FINANCIAL MANAGER
felix bolwhan
WHO ARE WE?

STRUCTURAL ENGINEERS

SITE

ARCHITECTS

CONSTRUCTION MANAGER

LIFE CYCLE FINANCIAL MANAGER

MECHANICAL ENGINEER
LOCAL HAZARDS:

HURRICANES
BETWEEN MONTHS OF AUGUST, SEPTEMBER, AND OCTOBER

EARTHQUAKES
THERE HAVE BEEN FOUR MAJOR EARTHQUAKES IN PUERTO RICO. THE LATEST OCCURRED IN 1918 AND HAD A MAGNITUDE OF 7.5 IN THE RICHTER SCALE. AS AN AFTERSHOCK, THERE WAS A 19.5 FEET [6 METER] HIGH TSUNAMI RECORDED.

TSUNAMIS

CLIMATE:

TYPE OF CLIMATE
HUMID - TROPICAL

TEMPERATURE
RANGES FROM 70 - 90 F (~ 20 - 30 C)

PRECIPITATION
RANGES FROM 2 - 6 INCHES (~ 50 - 160 mm)

RELATIVE HUMIDITY
RANGES FROM 73% [MARCH] TO 78% [JUNE]

WIND SPEED
RANGES FROM 2 - 3 BEAUFORT (~ 2 - 5 m/s)

GENERAL DESCRIPTION:

DAYLIGHT
12 HOURS [6AM - 6PM]

RAINFALL
APRIL - NOVEMBER
TEMPERATURE AND PRECIPITATION CURVE

METRIC

IMPERIAL

AIR TEMPERATURE RANGE: 70 - 90°F (~ 20 – 30 °C)
MEAN OUTDOOR AIR TEMPERATURE: 80 °F
PRECIPITATION RANGE: 2 – 6 inches (~ 50 – 160 mm)
FOR A MEAN OUTDOOR AIR TEMPERATURE OF 80°, THE 90% ACCEPTABILITY CRITERIA IS:
OPERATIVE TEMPERATURE 23.5 °C < TO < 28.5 °C
RELATIVE HUMIDITY RANGES FROM 73% IN MARCH TO 78% IN JUNE

WHEN AIR WITH HIGH ‘RH’ ENTERS THE BUILDING AND IS COOLED, THE ‘RH’ INCREASES EVEN FURTHER

WIND SPEED RANGES FROM 2 - 3 BEAUFORT (~2 – 5 m/s)

PREVAILING WIND DIRECTION: EAST
MOVABLE OFFICE SPACE
“CREATING A BUILDING THAT CAN EVOLVE INTO ANOTHER, WHICH IS NOT MEANT FOR ONE PURPOSE AND ONE ALONE. AN OFFICE DOES NOT HAVE TO FUNCTION AS A TYPICAL 2013 OFFICE MODEL.”
“WHAT ARE SEMINAR SPACES, TYPICAL ENCLOSED SPACES? OPEN SPACE?”
ARMADILLO FAÇADE
OPEN ARMADILLO FAÇADE
DESIGN CRITERIA:

INTEGRATION: INTEGRATE ARCHITECTURAL PLAN, MEP SYSTEM AND EASY TO CONSTRUCT.

COORDINATION: CREATE LARGE OPEN SPACE

SUSTAINABILITY: EARTHQUAKE PERFORMANCE LEVEL AND REPAIRABLE (FUSE)
## Design Loads

<table>
<thead>
<tr>
<th>Floor</th>
<th>Dead Load (PSF)</th>
<th>Live Load (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>75</td>
</tr>
<tr>
<td>1</td>
<td>70</td>
<td>110</td>
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</tbody>
</table>

## Function Spaces

<table>
<thead>
<tr>
<th>Function Spaces</th>
<th>Live Load (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>50</td>
</tr>
<tr>
<td>Faculty Lounge</td>
<td>80</td>
</tr>
<tr>
<td>Auditorium (average)</td>
<td>100</td>
</tr>
<tr>
<td>Classroom &amp; Seminar</td>
<td>40</td>
</tr>
<tr>
<td>Labs</td>
<td>100</td>
</tr>
<tr>
<td>Server Room</td>
<td>125</td>
</tr>
<tr>
<td>Technical Support</td>
<td>100</td>
</tr>
<tr>
<td>Storage</td>
<td>250</td>
</tr>
<tr>
<td>Mechanical Room</td>
<td>100</td>
</tr>
<tr>
<td>Stair</td>
<td>100</td>
</tr>
<tr>
<td>Corridor</td>
<td>80 or 100</td>
</tr>
<tr>
<td>Roof</td>
<td>40</td>
</tr>
</tbody>
</table>

## Wind and Seismic Conditions

<table>
<thead>
<tr>
<th>Wind Conditions</th>
<th>Seismic Conditions</th>
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<tbody>
<tr>
<td>Wind Speed 170 mph</td>
<td>Soil D</td>
</tr>
<tr>
<td>Base Shear 160 kips</td>
<td>Base Shear 500 kips</td>
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</tbody>
</table>
Mat Foundation

Shallow Foundation
Place from -8’ below grade
Thickness: 2’ thick for both concept

Soil Profile:

Bearing Capacity: 5000 PSF

Medium to Very Stiff Clayey Soil, 0’

Water Table, 17’
<table>
<thead>
<tr>
<th>Component</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column</td>
<td></td>
</tr>
<tr>
<td>Round</td>
<td>R=24”</td>
</tr>
<tr>
<td>Rectangle</td>
<td>12’x18’</td>
</tr>
<tr>
<td>Beam</td>
<td></td>
</tr>
<tr>
<td>Filler Beam</td>
<td>W12X26</td>
</tr>
<tr>
<td>Int Girder</td>
<td>W21X111</td>
</tr>
<tr>
<td>Ext Girder</td>
<td>W27X84</td>
</tr>
<tr>
<td>Gravity Wall</td>
<td></td>
</tr>
<tr>
<td>Gravity Wall</td>
<td>12”</td>
</tr>
<tr>
<td>Composite Floor System</td>
<td></td>
</tr>
<tr>
<td>LW Slab</td>
<td>4.5”</td>
</tr>
</tbody>
</table>
## Palm Tree — Steel and Concrete

**Level 2**

### Column
- **Round**
  - R = 24”
- **Rectangle**
  - 12’x18’
- **Tension**
  - Pipe 1 STD

### Beam
- **Filler Beam**
  - W12X26
- **Int Girder**
  - W21X111
- **Ext Girder**
  - W27X84

### Gravity Wall
- **Gravity Wall**
  - 12”

### Composite Floor System
- **LW Slab**
  - 4.5”
### PALM TREE — STEEL AND CONCRETE

#### Level 3

<table>
<thead>
<tr>
<th><strong>Column</strong></th>
<th><strong>Round</strong></th>
<th>R=24”</th>
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</thead>
<tbody>
<tr>
<td><strong>Rectangle</strong></td>
<td>12’x18’</td>
<td></td>
</tr>
<tr>
<td><strong>Tension</strong></td>
<td>Pipe 1 STD</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Beam</strong></th>
<th><strong>Filler Beam</strong></th>
<th>W12X26</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Int Girder</strong></td>
<td>W24X131</td>
<td></td>
</tr>
<tr>
<td><strong>Ext Girder</strong></td>
<td>W27X84</td>
<td></td>
</tr>
<tr>
<td><strong>Composite Floor System</strong></td>
<td>LW Slab</td>
<td>4.5”</td>
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</tbody>
</table>
## REDISTRIBUTION

<table>
<thead>
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<th>Component</th>
<th>Details</th>
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<tr>
<td>Column</td>
<td>Round: R=24”</td>
</tr>
<tr>
<td></td>
<td>Rectangle: 12'x18’</td>
</tr>
<tr>
<td>Tension</td>
<td>Pipe 1 STD</td>
</tr>
<tr>
<td>Beam</td>
<td>Filler Beam: W12X26</td>
</tr>
<tr>
<td></td>
<td>Int Girder: W24X131</td>
</tr>
<tr>
<td></td>
<td>Ext Girder: W27X84</td>
</tr>
<tr>
<td>Composite Floor System</td>
<td>LW Slab: 4.5”</td>
</tr>
</tbody>
</table>

@10’ @6’ skip compression column
PALM TREE — CONCRETE IDEA

REISTRIBUTION
GRAVITY LOAD PATH
Shear Wall
Shear Wall 12"

11'
22'
11'
39'
15'
• ROOF BEAMS ARE SLOPED

• COLUMNS WILL HAVE HORIZONTAL LOAD
• EASY TO CONSTRUCT

• BIG SPACE

• SUSTAINABLE

• INTEGRATE ARCHITECTURAL FACADE

• WEAK LATERAL RESISTANCE
<table>
<thead>
<tr>
<th>Component</th>
<th>Size</th>
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<tbody>
<tr>
<td>Column</td>
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<tr>
<td>Round</td>
<td>R=12”</td>
</tr>
<tr>
<td>Round</td>
<td>R=18”</td>
</tr>
<tr>
<td>PT Beam</td>
<td></td>
</tr>
<tr>
<td>Int Beam</td>
<td>24”X12”</td>
</tr>
<tr>
<td>Gravity Wall</td>
<td>12”</td>
</tr>
<tr>
<td>Floor System</td>
<td></td>
</tr>
<tr>
<td>PT Slab</td>
<td>10.5”</td>
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</table>
## Palm Tree — Concrete

### Level 2

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
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<tr>
<td>Round</td>
<td>r=12”</td>
</tr>
<tr>
<td>Round</td>
<td>r=18”</td>
</tr>
<tr>
<td>Tension</td>
<td>Pipe1std</td>
</tr>
<tr>
<td>Pt Beam</td>
<td></td>
</tr>
<tr>
<td>Int Beam</td>
<td>24”x12”</td>
</tr>
<tr>
<td>Gravity Wall</td>
<td></td>
</tr>
<tr>
<td>Gravity Wall</td>
<td>12”</td>
</tr>
<tr>
<td>Floor System</td>
<td></td>
</tr>
<tr>
<td>Pt Slab</td>
<td>10.5”</td>
</tr>
</tbody>
</table>
### Column
- Round R=12”
- Round R=18”
- Tension Pipe1STD

### Beam
- PT Beam
- Int Beam 44”X21”
- Ext Beam 24”X12”

### Wall
- Gravity Wall 12”

### Floor System
- PT Slab 10.5”
## REDISTRIBUTION

<table>
<thead>
<tr>
<th>Column</th>
<th>Tension</th>
<th>Beam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension</td>
<td>Pipe 1 STD</td>
<td></td>
</tr>
<tr>
<td>Beam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Int Beam</td>
<td>44”X21”</td>
<td></td>
</tr>
<tr>
<td>Ext Beam</td>
<td>24”X12”</td>
<td></td>
</tr>
</tbody>
</table>

- Column: Tension
- Beam: Int Beam 44”X21”
- Beam: Ext Beam 24”X12”

Diagram: Floor plan with marked columns and beams.
PALM TREE — CONCRETE IDEA

REDISTRIBUTION
Gravity Load Path
| Shear Wall | 12” |
| Columns   | R=12” |
Load Path
• ROOF BEAMS ARE SLOPED

• COLUMNS WILL HAVE HORIZONTAL LOAD

• BIG SPAN
• GOOD LATERAL RESISTANCE

• INTEGRATE ARCHITECTURAL COMPONENT

• BIG SPACE

• HEAVY MASS

• HUGE COMPONENT
### Design Goals

<table>
<thead>
<tr>
<th>THERMAL ENVIRONMENT</th>
<th>CLASS</th>
<th>SPECIFICATIONS</th>
<th>TEMPERATURE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>CLASS B</td>
<td>COOLING SEASON: 24.5 – 27.5 C</td>
<td>76 – 81.5 F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HEATING SEASON: 21.5 – 25.5 C</td>
<td>71 – 78 F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENERGY</th>
<th>NET-ZERO</th>
<th>ANNUAL PRIMARY ENERGY CONSUMPTION ≤ RENEWABLE ENERGY PRODUCTION ON SITE</th>
<th></th>
</tr>
</thead>
</table>

| INDOOR AIR QUALITY (IAQ) | GOOD | 25 < RELATIVE HUMIDITY < 60%; CO2 concentration ≤ 1000 ppm             |            |

| LIGHTING QUALITY      | GOOD | DAYLIGHT FACTOR ≥ 2.5%                                                 |            |
CONSTANT PARAMETERS

Location: San Juan, Puerto Rico
Weather Station: 1080107
Outdoor Temperature: Max: 92°F/Min: 67°F
Floor Area: 30,000 sf
Exterior Wall Area: 16,000 sf
Average Lighting Power: 1.01 W / ft²
People: 124 people
Exterior Window Ratio: 0.40
Electrical Cost: $0.09 / kWh
Fuel Cost: $0.78 / Therm
SANDWICH HEIGHT: 2’ INCLUDING BEAM HEIGHT
SANDWICH HEIGHT: 2’
WIND DRIVEN NATURAL VENTILATION
ASSISTING MECHANICAL VENTILATION
AVERAGE ILLUMINANCE: 200 LUX
WIND – DRIVEN CROSS VENTILATION IN OPEN ZONES
AIR – BASED COOLING
NIGHT VENTILATION TO ACTIVATE THE THERMAL MASS
LAMELLAE PROVIDE SHADING
BUOYANCY BASED VENTILATION IN OPEN ZONES, DRIVEN BY STACK EFFECT OR DISPLACEMENT VENTILATION WITH OUTLET FANS
NIGHT VENTILATION TO ACTIVATE THE THERMAL MASS
OPEN ZONES: CROSS VENTILATION
CLOSED ZONES: MECHANICAL IN, NATURAL OUT
UFAD
UNDER FLOOR AIR DISTRIBUTION

VAV
VARIABLE AIR VOLUME
DISPLACEMENT VENTILATION WHEN NOT WIND – DRIVEN
MECHANICAL IN, NATURAL OUT

Air supply
Sunlight
OPEN ZONES: DISPLACEMENT VENTILATION WHEN NOT WIND – DRIVEN, MECHANICAL IN, NATURAL OUT
CLOSED ZONES: MIXING VENTILATION
“CREATING A BUILDING THAT CAN EVOLVE INTO ANOTHER, WHICH IS NOT MEANT FOR ONE PURPOSE AND ONE ALONE. AN OFFICE DOES NOT HAVE TO FUNCTION AS A TYPICAL 2013 OFFICE MODEL.”
Main Stair

Fire Stair & Elevator

Roof Opening
3000 sqft & 600 sqft
### Floor Load Path

<table>
<thead>
<tr>
<th>Load</th>
<th>Dead (PSF)</th>
<th>Live (PSF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Floor</td>
<td>72</td>
<td>88</td>
</tr>
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</table>

### Wind and Seismic

<table>
<thead>
<tr>
<th></th>
<th>Wind</th>
<th>Seismic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>170 mph</td>
<td>Risk III</td>
</tr>
</tbody>
</table>

**Floor Level**

**Roof Level**
Column Size W14 X 38
Slab Thickness 6”
Mat Foundation Thickness 2 ft
Majority Member W14 X 38
W24 X 94
W33 X 221
Slab Thickness 4”

Slop Beam to Accommodate Large Classroom
Majority Member W14 X 38
W24 X 94
Cantilever Office & Auditorium
W33 X 221
W36 X 361
Slab Thickness 4”
Steel Scheme
Third Level

Majority Member W14 X 38
W24 X 94
Cantilever Office & Auditorium
W33 X 221
W36 X 361
Slab Thickness 4”

Auditorium
Auditorium Two Story High Exterior Tie Beam Only
Corridor Slab Ends Here

Here
Majority Member W14 X 38
W24 X 94
Cantilever Office & Auditorium
W33 X 221
Roof Thickness 4”

Small Cantilever Beam Support the Long Beam Around Roof Opening
Column & Brace W14 X 38
Add Tension Member to tie up the two cantilever part.
Steel & Concrete Scheme

HOVER BOX
Column Size 20” X 20”
Slab Thickness 6”
Mat Foundation Thickness 2 ft
Concrete Beam Section 18” X 12”
W24 X 94
W33 X 221
Slab Thickness 4”
Concrete Beam Section 18” X 12”
W24 X 94
Cantilever Office & Auditorium
W33 X 221
W36 X 361
Slab Thickness 4”
Concrete Beam Section 18” X 12”
W24 X 94
Cantilever Office & Auditorium
W33 X 221
W36 X 361
Slab Thickness 4”

Corridor Slab Ends Here
Auditorium Two Story High Exterior Tie Beam Only

Auditorium
Concrete Beam Section 16” X 12”
18” X 12”
Cantilever Office & Auditorium
W33 X 221
W36 X 361
Roof Thickness 4”

Small Cantilever Beam Support the Long Beam Around Roof Opening
Column 20”X 20”
Shear Wall Thickness 18”
Shear Wall resist lateral force and balance moment from cantilever part.
### Steel Scheme

<table>
<thead>
<tr>
<th>Item</th>
<th>Bulk Volume cft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Slab &amp; Roof</td>
<td>17000</td>
</tr>
<tr>
<td>Steel Beam Column Brace</td>
<td>1200</td>
</tr>
</tbody>
</table>

### Steel & Concrete Scheme

<table>
<thead>
<tr>
<th>Item</th>
<th>Bulk Volume cft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Slab &amp; Roof</td>
<td>17000</td>
</tr>
<tr>
<td>Steel Member</td>
<td>700</td>
</tr>
<tr>
<td>Concrete Beam &amp; Column</td>
<td>8000</td>
</tr>
<tr>
<td>Shear Wall</td>
<td>15000</td>
</tr>
</tbody>
</table>
Compare

**Steel Scheme**
- Light Weight
- Fast Construction
- High Recycle Rate
- Good Seismic Stability

**Steel & Concrete Scheme**
- Cheaper
- Material Availability
- Good Wind Stability
- High Rotation Stiffness
MEP Coming Through
✓ Cellular beams with multiple openings for services

Heavy Structure Member
Compacted Floor Section
✓ Shallow floor integration
ATRIUM AND OPEN SPACES REQUIRED
A COMPLEX STRUCTURAL DESIGN
COMPLEX STRUCTURAL DESIGN NOT BENEFICIAL FOR DUCTING
HEIGHT 40”
Combined height 34”

Steel beams with integrated ducting
ELECTRICITY DISTRIBUTION
WATER DISTRIBUTION
HOVERING BOX #1 – MECHANICAL BALANCED

AIR SUPPLY
AIR EXTRACT
TRAFFIC & LOGISTIC

HIGHLY TRAFFICKED

NORMAL TRAFFICKED

P – PARKING
H – HOSPITAL
R – RESIDENCE
U – UNIVERSITY
• MAIN ROADS IS AVAILABLE

• PARKING LOT TRAFFICKED PART TIME OF THE DAY

PUBLIC TRANSPORT
H - HOSPITAL
P - PARKING

LOGISTIC DIRECTION

BOOTH DIRECTION
ONE DIRECTION
LOGISTIC & SITE

- **P** - PARKING FOR WORKERS
- **ES** - ESTABLISHMENT
- **SEPARATE IN- & OUTGOING TRAFFIC**

**LOGISTIC DIRECTION**
- BOTH DIRECTION
- ONE DIRECTION
- PARTIALLY TRAFFIC
• E – ELECTRICITY GENERATOR IN NEAR AREA

• W – WATER CAN BE PROVIDED BY “AAA [ACUEDUCTOS Y ALCANTARILLADOS]”
CONSTRUCTION & SITE

LOCAL COMPANIES

1. STEEL ➢ 5mi
2. CONCRETE ➢ 6mi
3. CONSTRUCTION EQUIPMENT ➢ 3mi
4. PRECASTING CONCRETE ➢ 5mi
5. GLAZING COMPANY ➢ 1mi
6. OFF-STORAGE COMPANY ➢ 9mi
7. MEP COMPANY ➢ 2mi
• **THE VALUE OF TVDIS BASED ON**:
  
  - RS MEANS – SQUARE FOOT ESTIMATOR
  - PREVIOUS YEARS ISLAND TEAM ESTIMATIONS

• **EXPECTED INFLATION RATIO IS AN AVERAGE OF ACTUAL INFLATION RATIO OF PUERTO RICO DURING LAST 10 YEARS BASED ON WORLD BANK**
Island Team -activities

Contracts -Preconstruction
- Supplier purchase

Site Preparation
- Soil level work
- Establishing on site

Construction Preparation
- Contractor mobilize
- Water, Recycling, power conn. to site
- Excavation
- Water tank
- Ground cover

Structure Work
- Construction start
- Mat foundation
- Floor slab level 1
- Concrete structure level 1
- Floor slab level 2
- Concrete structure level 2
- Floor slab level 3
- Concrete structure level 3
- Roof
- Topping-out ceremony

ISLAND TEAM – CA 280 DAYS OF CONSTRUCTION

SCHEDULE PROCESS

TAKING INTO CONSIDERATION TWO PREVIOUS REFERENCE ISLAND PROJECTS

Roof envelope
Building envelope level 1
Building envelope level 2
Building envelope level 3
Building enclosed

Interiors part 1
- Interior walls level 1
- Doors level 1
- Interior walls level 2
- Doors level 2
- Interior walls level 3
- Doors level 3

Lab & Computer rooms (incl. Testing)
- Slab LAB
- Structure LAB
- Roof LAB
- Shell LAB
- Temporary LAB entrance
- Installation level 2 - LAB
- Surface level 2 - LAB
- LAB Cleaning & inspection

MEP/HVAC
- Installation level 1
- Installation level 2
- Installation level 3

Interiors part 2
- Surface level 1
- Surface level 2

**Project Plan**

- **Project start** (May 2015)
- **Construction start** (late Sep 2015)
- **Hurricane season**
- **Lab rooms finished** (Feb 2016)
- **End** (Jun 2016)
CONCLUSION: PALMTREE CONCRETE AND STEEL COMBINED SHOWS THE BEST RESULTS
<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Category</th>
<th>Risk name</th>
<th>Description</th>
<th>Consequences</th>
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</thead>
<tbody>
<tr>
<td>planning &amp; construction</td>
<td>price changes</td>
<td>steel price</td>
<td>change in steel price</td>
<td>higher/lower purchasing cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>concrete price</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>inflation in construction cost</td>
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<td>exceeding schedule</td>
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<tr>
<td>operation &amp; maintenance</td>
<td>price changes</td>
<td>oil price</td>
<td>price changes</td>
<td>higher/lower purchasing cost</td>
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<tr>
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<td>electricity price</td>
<td>price changes</td>
<td>higher/lower purchasing cost</td>
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<td>water price</td>
<td>price changes</td>
<td>higher/lower purchasing cost</td>
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<tr>
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<td>inflation in O&amp;M costs</td>
<td>inflation is higher/lower than expected</td>
<td>higher or lower O&amp;M cost</td>
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<tr>
<td></td>
<td>other</td>
<td>hurricane</td>
<td>category 5 hurricane during O &amp; M phase</td>
<td>repair/ rebuilt/ cleaning costs</td>
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<tr>
<td></td>
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<td>earthquake</td>
<td>maximum probable earthquake during O &amp; M phase</td>
<td>repair/ rebuilt/ cleaning costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HVAC system performance</td>
<td>HVAC system works better/worse then expected</td>
<td>higher/lower cooling cost</td>
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<td></td>
<td></td>
<td>life expectations</td>
<td>life expectations not as expected</td>
<td>higher/lower replacement costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vandalism</td>
<td>vandalism in or outside the building</td>
<td>repair/ cleaning costs</td>
</tr>
<tr>
<td>RISK NAME</td>
<td>DESCRIPTION</td>
<td>CONSEQUENCES</td>
<td>RISK MANAGEMENT</td>
<td></td>
</tr>
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<td>-------------------</td>
<td>--------------------------------------------------</td>
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<tr>
<td>HURRICANE</td>
<td>HURRICANE DURING CONSTRUCTION PHASE</td>
<td>ADDITIONAL COSTS FOR RE-BUILDING, RE-PURCHASING</td>
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<tr>
<td>VANDALISM</td>
<td>VANDALISM IN OR OUTSIDE THE BUILDING</td>
<td>REPAIR/ CLEANING COSTS</td>
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<tr>
<td>SOIL-CONDITIONS</td>
<td>PROBLEMS WITH THE EXCAVATION AND THE FOUNDATION</td>
<td>ADDITIONAL COSTS FOR DIFFERENT FOUNDATION</td>
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<tr>
<td>EXCEEDING CONSTRUCTION SCHEDULE</td>
<td>AVAILABILITY OF BUILDING CAN NOT BE GUARANTEED</td>
<td>ADDITIONAL COSTS (E.G. CONTRACT PENALTY)</td>
<td>CREATE A REALISTIC TIMEFRAME AND INCLUDE BUFFERS</td>
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</tbody>
</table>
1. INFLATION IN CONSTRUCTION COSTS
2. WATER PRICE CHANGE
3. VANDALISM IN OR OUTSIDE THE BUILDING
4. HURRICANE DURING O&M PHASE
5. REFUSED PERMISSION
6. ELECTRICITY PRICE CHANGE
7. UNEXPECTED SOIL CONDITIONS
8. HVAC SYSTEM PERFORMANCE
RISK TREATMENT

ADDRESSING THE RISK OF HURRICANES DURING O&M PHASE:

\[ \rightarrow \text{OVERHANGING “LEAVES” OF THE FAÇADE CLOSE TO PROVIDE SHELTER} \]

SAVES ABOUT: $650,000 OF REPLACEMENT COSTS AND $220,000 OF CLEANING COSTS DURING THE 25 YEARS OF PROJECT LIFETIME

SUM $870,000
### DECISION MATRIX

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Emphasis</th>
<th>Palm Tree Concept Concrete</th>
<th>Palm Tree Concept Steel and Concrete</th>
<th>Hover Box Concept Steel and Concrete</th>
<th>Hover Box Concept Steel</th>
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<tbody>
<tr>
<td></td>
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<td>Team</td>
<td>Owner</td>
<td>Team</td>
<td>Owner</td>
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<tr>
<td>Construction costs</td>
<td>5,00%</td>
<td>8,57</td>
<td>6,5</td>
<td>6,00</td>
<td>8,5</td>
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<tr>
<td>Value for money</td>
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<td>7,00</td>
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<tr>
<td>Architectural aesthetics</td>
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<td>7,5</td>
<td>9,00</td>
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<td>Addressing the required room program</td>
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<td>Innovation in design - Leapfrogging</td>
<td>14,00%</td>
<td>6,57</td>
<td>6,5</td>
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<td>Integration of nature</td>
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<td>8</td>
<td>8,5</td>
<td>8,00</td>
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<tr>
<td>Creation of an open and collaborative space</td>
<td>16,67%</td>
<td>8,29</td>
<td>8,75</td>
<td>8,43</td>
<td>8,75</td>
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<tr>
<td>Usage of natural ventilation</td>
<td>10,00%</td>
<td>8,71</td>
<td>7,5</td>
<td>8,72</td>
<td>7,5</td>
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<tr>
<td>Provided safety for the occupants</td>
<td>5,67%</td>
<td>7,86</td>
<td>7</td>
<td>8,00</td>
<td>7,5</td>
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<tr>
<td>Resistance to natural hazards, especially</td>
<td>12,33%</td>
<td>8,29</td>
<td>6,75</td>
<td>8,57</td>
<td>8,75</td>
</tr>
<tr>
<td>earthquakes &amp; hurricanes</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Sum weighted:</td>
<td></td>
<td>8,11</td>
<td>7,61</td>
<td>7,99</td>
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<tr>
<td>Result:</td>
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<td>7,86</td>
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</table>

**CHOSEN OPTION**
CENTRAL CORE LOCATION AND SPACING

PALM TREE ROOF STRUCTURE AND FUNCTIONALITY
WITHIN THE TEAM

WITH THE OWNERS

WITH OUR MENTORS

THANKS TO:

HUMBERTO CAVALIN
GITTE SORENSEN
DAVID BENDET
WAFAA SABIL
GREG LUTH
EDUARDO MIRANDA
RENATA ABMA
KYLE ADAMS
JOHN NELSON
LUIS RIVERA
ALIAA EDDNAN HUSEIN
HENRY TOORYANI
FERNANDO CASTILLO COHEN
HOSS NASSERI
BJORN WUNDSCHE
UNIVERSITY OF PUERTO RICO
SCHOOL OF ENGINEERING
RIO PIEDRAS CAMPUS

ISLAND TEAM 2013