ISLAND 2019
Team
Our Dedicated Members

Universidad de Puerto Rico
California State University Chico
Tsinghua University
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Wesley González
Anthony Ayllon
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Xiaqing Sia Wang
Hannah Brownell
Yunyi Zhang

A
SE
SE
MEP
CM
CM
Our Beloved Owners

Luke Lombardi  
Nick Zeman  
Mikki Seidenschnur  
Camila Hernández
Site
Site Analysis

To Local Community
To Other School Facilities
To Historical Main Quad
The Site
Preserved Trees @ ~ 30 ft

Student Center
@28 ft

Major City Traffic
@65 ft
@15 ft

Site dimensions:
- Trees @ ~ 30 ft
- Major City Traffic @ 65 ft
- Student Center @ 28 ft
Challenges

- Cross Ventilation vs. Operable Facade
- Transparency vs. Structural Safety
- Sustainability vs. Location Availability
- THE BIG IDEA

- Height Allowance
- Underground Excavation
- High Water Table
- Possible Hurricane
- Humidity
- Seismic

Constructability
Soil Condition

Surface Sandy Clay (1500 psf) 0'
Medium to Very Stiff Clay Soil (5000 psf) 0.6'
Water Table -17'

- Excavation
- High water table → Liquefaction

+ Foundation Strength
Seismic/Wind

Risk Category III:
Failure poses substantial risk to human life and substantial economic loss

Seismic Design Category D

<table>
<thead>
<tr>
<th>Site Spectra (g)</th>
<th>Design Spectra</th>
<th>Fundamental Period (ASCE 7, 12.8-7)</th>
</tr>
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<tbody>
<tr>
<td>(ATC, ASCE 7)</td>
<td>ASCE 7</td>
<td>11.4</td>
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<tr>
<td>$S_S$</td>
<td>0.974</td>
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<tr>
<td>$S_1$</td>
<td>0.382</td>
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<td>$S_{MS}$</td>
<td>1.169</td>
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<tr>
<td>$S_{M1}$</td>
<td>0.955</td>
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<tr>
<td>$S_{DS}$</td>
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<tr>
<td>$S_{D1}$</td>
<td>0.637</td>
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</tbody>
</table>

| $T_0$ (s) | 0.163 | 0.200 |
| $T_5$ (s) | 0.817 | 1.000 |
| $T_1$ (s) | 12 | 12 |
| $T_a$ (s) | 0.256 | |

Ultimate Wind Load Design Gust
Wind Speeds in the United States
Based on ASCE 7-10 Chapter 26, 27

Risk Category III-IV

You are in a wind-borne debris region.
Climate Condition (ASHRAE Climate Zone 1A, Hot & Humid Climate)

Temperature

Relative Humidity - 71% ~ 78%

Sun Hours - 250 hr monthly

Precipitation - 51 inch. annual
Sun Movement and Shading Analysis

Winter Solstice

Summer Solstice
Wind Analysis

- Prevailing winds come from East and Northeast direction
- Take advantage of the wind for wind-driven cross ventilation
Program
...a place to breath, connect, and foster the flow of people!
Architecture
El Corazon
Campus buildings inspiration

Outside-inside relationship
Permeability and transparency elements
Visual connections with greenery scapes
Cross ventilated spaces
Aims and Goals
3D Overview
Site Context and impact zones

Campus integration
Aerodynamic interaction
Wind exposure facades
Cross road for students to meet, learn and collaborate

User: Young creative students, faculty and community members
EL CORAZON

Campus interconnection
Pedestrian integration
Expanding views
Inside-outside integration
Central communal space
Orientation and Cross Ventilation

Perimeter offices on Level 2 are naturally ventilated during 55.7% of the occupable time.
Orientation and Cross Ventilation
Orientation and Shading Analysis

Winter Solstice Noon

Summer Solstice Noon

Roof Overhang 5’ 3”
Ground level

Interconnected outdoor areas
Leisure and Study
Flexible combined spaces

Bathroom
Instructional Lab
Internet Server
Large Classrooms
Shaft
Small Cafe
Storage
Student Offices
First Level

- Administrative
- Bathroom
- Dept. Chair’s office
- Elevator
- Faculty Lounge
- Faculty office
- Senior Adm. office
- Shaft
- Small classrooms
- Storage

Interconnected outdoor areas

Leisure and Study

Flexible combined spaces
Underground Level

58'  9'  20'  13'  16'

Auditorium

Bathroom

Elevator

Seminar Rooms

Shaft

Storage
Facades

South

West
Facades

East

North
Facade views - inside-outside relationship

Valwood (Wooden Aluminium)  Operable vertical louvers
Facade views - Interior Spaces

Faculty Lounge

Flexible study areas
... a SPOT at campus to meet, learn and innovate in all directions.
Architecture
El Spot
Site Context and impact zones

Campus geometry disruption
Aerodynamic interaction
Center point for students to meet, learn and cocreate
Courtyard to reduce building heating
Footprint Reduction

User: Young creative students, faculty and community members
EL SPOT

Interaction gradient
Vertical integrity
Inside-Outside

Radial access
Reaching entrances

720 degrees views
Always seeing
Views exchange
Aims and Goals
3D Overview
Orientation and Shading Analysis

Winter Solstice Noon  Summer Solstice Noon

Service Core  Facade
Ground Level

- Atrium interconnected spaces
- Double use large classrooms
- Connection with surroundings

100 ft x 100 ft Square footprint

50 ft Ø footprint

- Bathroom
- Cafe
- Instructional Lab
- Janitor
- Large Classrooms
- Shaft
First Level

Gathering spaces

Diverse study areas

Visual connection between public and private programs

Bathroom
Janitor
Shaft
Small classroom
Student offices

100 ft Ø footprint
10 ft cantilever
30 ft Ø atrium
Second Level

Semi-private interaction areas
Corridor reimagined
Bidirectional daylight entrance

Administrative Assistant
Bathroom
Department Chair’s Office
Faculty Lounge
Faculty Office
Janitor
Senior Administrative Office
Shaft

100 ft Ø footprint
10 ft cantilever
Underground Level

Interactive auditorium

Multi-purpose space

Dynamic educational experience
<table>
<thead>
<tr>
<th>Sections</th>
<th>Auditorium</th>
<th>Faculty Lounge</th>
<th>Faculty Office</th>
<th>Instructional Lab</th>
<th>Janitor</th>
<th>Large Classroom</th>
<th>Small Classroom</th>
<th>Technical Support</th>
</tr>
</thead>
</table>
Sections

- Administrative Assistant
- Auditorium
- Department Chair’s Office
- Faculty Lounge
- Faculty Office
- Instructional Lab
- Seminar Room
- Storage
- Student Offices

- 100 ft Ø base and underground
- 120 ft Ø cantilever levels
- 30 ft Ø atrium
Sections

- Auditorium
- Faculty Lounge
- Faculty Office
- Instructional Lab
- Internet Server
- Large Classroom
- Small Classroom
- Mechanical Room

100 ft Ø base and underground
120 ft Ø cantilever levels
30 ft Ø atrium
Atrium panorama: SPOTS to learn

Daylight
Meeting balconies
Dynamic study spaces
Parameters for facade development

Environmental conditions:
- Shading
- Daylight

User experience:
- Reflectance
- Comfort
- Learning experience

(A+MEP) (A+MEP+E+CM) (A+MEP+Owners)
Facade Impact on Sun Shading

<table>
<thead>
<tr>
<th>Area</th>
<th>Recommended Lux</th>
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<tbody>
<tr>
<td>Classroom</td>
<td>161</td>
</tr>
<tr>
<td>Hallway</td>
<td>376 - 430</td>
</tr>
<tr>
<td>Office</td>
<td>430 - 538</td>
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</tbody>
</table>

Before

After
Colors in facade: a comfortable environment

Associating colors with emotion, culture and experiences
Facades

East

North
Facades

West

South
View from Avenida Universidad
Structural

El Corazon
Lateral Loads

Wind Loads for MWFRS:

<table>
<thead>
<tr>
<th></th>
<th>height</th>
<th>Kz</th>
<th>qz</th>
<th>qh</th>
<th>(Windward) qz<em>G</em>Cp</th>
<th>(Leeward) qh<em>G</em>Cp</th>
<th>(Internal) qi<em>G</em>Cpi</th>
<th>P (psf)</th>
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</thead>
<tbody>
<tr>
<td>Floor 2</td>
<td>17</td>
<td>0.57</td>
<td>35.84</td>
<td>35.84</td>
<td>24.37</td>
<td>-15.23</td>
<td>+_20.57</td>
<td>~33</td>
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<tr>
<td>Floor 3</td>
<td>30</td>
<td>0.7</td>
<td>44.02</td>
<td>44.02</td>
<td>29.94</td>
<td>-18.7</td>
<td>+_20.57</td>
<td>~37</td>
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<tr>
<td>Em Core</td>
<td>40.5</td>
<td>0.76</td>
<td>47.79</td>
<td>47.79</td>
<td>32.49</td>
<td>-20.31</td>
<td>+_7.31</td>
<td>~34</td>
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</tbody>
</table>

ASCE 7-16 Chapter 26 Chapter 27
Possible impact protection system is required (ASTM E1996)
### Typical Loading

<table>
<thead>
<tr>
<th>Occupancy of Use</th>
<th>Live Load (psf)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom</td>
<td>40</td>
</tr>
<tr>
<td>Lobby and 1st Floor Corridor</td>
<td>100</td>
</tr>
<tr>
<td>2nd Floor Corridor</td>
<td>80</td>
</tr>
<tr>
<td>Lounge</td>
<td>80</td>
</tr>
<tr>
<td>Computer/Server Room</td>
<td>100</td>
</tr>
<tr>
<td>Storage (Light/Heavy)</td>
<td>125/250</td>
</tr>
<tr>
<td>Stairs and Exit Ways</td>
<td>100</td>
</tr>
<tr>
<td>Instructional Lab</td>
<td>150</td>
</tr>
<tr>
<td>Roof</td>
<td>20</td>
</tr>
</tbody>
</table>

*Partition load can be neglected where live load > 80 psf, else partition ~ 15 psf
**¼ storage LL included in seismic weight

Minimum Uniformly Distributed Live Loads (ASCE 7-10 Table 4-1)
### Structural System Decision Iteration

<table>
<thead>
<tr>
<th>PT Flat Plate</th>
<th>Composite Concrete Finish + Metal Deck</th>
<th>Concrete 1 Way or 2 Way Slab</th>
<th>Concrete 2 Way Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Shear Wall</td>
<td>Steel Moment Frame + Reinforced CMU</td>
<td>Hybrid Concrete PT Moment Frame</td>
<td>Moment Frame</td>
</tr>
</tbody>
</table>
Structural System Decision Matrix

- Seismic Resistance
- Constructability
- Hurricane Resistance
- Reduce Carbon
- Modualibility
- A+SE Compatibility

Legend:
- Purple: Concrete PT FP
- Blue: Steel Moment Frame + RF CMU
- Orange: Prefab Hybrid Façade Moment Frame
- Green: Concrete Moment Frame
Structural System

Concrete

Steel/CMU
Concrete
Underground Level

- 8” PT Flat Plate Slab
- 12”x12” RC Columns
- 18”x18” RC Columns
- 8” RC Shear Wall Cores
Concrete Level 1

- **8” PT Flat Plate Slab**
- **12”x12” RC Columns**
- **18”x18” RC Columns**
- **18”x24” RC Beams**
- **8” RC Shear Wall Cores**
Concrete Level 2

- 8” PT Flat Plate Slab
- 12”x12” RC Columns
- 18”x18” RC Columns
- 18”x24” RC Beams
- 8” RC Shear Wall Cores
- 2 Panel Sizes
Concrete Load Path
Load Path with Lateral Load

Seismic

Wind

V = 1131 k

V = 155.8 k
Cantilever Design Solution

20’ Precast Moment Frame

18” x 18” RC Columns

18” x 24” RC Beams

Post-Tensioned to Resist Cracking
Steel/CMU
Underground Level

4” Concrete 2” Metal Composite Deck

- **W14** Column at Perimeter
- **W10** Column Gravity
- **W18** 15’ Cantilever Beam
- **W12** 6’ Cantilever Beam
- **W18** Open Web Joist @ 30’ Span
- **24”** Deep Castellated Girder @ 50’ Span

CMU with #8 Rbar
Steel/CMU
Level 1

- **4” Concrete 2” Metal Composite Deck**
- **W14** Column at Perimeter
- **W10** Column Gravity
- **W18** 15’ Cantilever Beam
- **W12** 6’ Cantilever Beam
- **W18** Open Web Joist @ 30’ Span
- **24” Deep Castellated Girder @ 50’ Span**

CMU with #8 Rbar
Steel/CMU Level 2

- 4” Concrete 2” Metal Composite
- **W14** Column at Perimeter
- **W10** Column Gravity
- **W18** 15’ Cantilever Beam
- **W12** 6’ Cantilever Beam
- **W18** Open Web Joist @ 30’ Span
- 24” Deep Castellated Girder @ 50’ Span

CMU with #8 Rbar

![Diagram with CMU Infill]
Steel/CMU Load Path

V = 1131 k

640 k

346 k

145 k

moment arm
Steel/CMU Challenges and Features

Open Web Joists and Castellated Beams
  + MEP Implementation
  + Floor Clearance

CMU Infill Shear Wall
  + Constructability
  + Seismic Resistance
  + Reduce
Structural

El Spot
## Structural System Decision Iteration

<table>
<thead>
<tr>
<th>PT Flat Plate</th>
<th>Composite Concrete Finish + Metal Deck</th>
<th>Tension Cable + Strengthen Diaphragm</th>
<th>Concrete 2 Way Slab</th>
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</thead>
<tbody>
<tr>
<td>Concrete Shear Wall</td>
<td>Steel Bracing</td>
<td>Steel Bracing</td>
<td>Moment Frame</td>
</tr>
</tbody>
</table>
Structural System Decision Iteration

Seismic Resistance

Constructability

Hurricane Resistance

Reduce Carbon

Modualibility

A+SE Compatibility

- Concrete PT FP + Shear Wall
- Steel Frame + Bracing
- Cable System
- Concrete Moment Frame
Structural Solutions

Concrete

Steel
Concrete
Underground Level

10” PT Flat Plate Slab

- 12”x12” RC Columns
- 8” RC Shear Wall Cores
- 8 Panels
Concrete
Ground Level

- **10” PT Flat Plate Slab**
- **12”x12”** RC Columns
- **8”** RC Shear Wall Cores
- **8 Panels**
Concrete
Level 1

- **10” PT Flat Plate Slab**
- **12”x12” RC Columns**
  - **12”x24” RC Beams**
- **8” RC Shear Wall Cores**
- **8 Panels**
Concrete Level 2

- **10” PT Flat Plate Slab**
- **12” x 12” RC Columns**
- **8” RC Shear Wall Cores**
- **8 Panels**
Vertical Load Path
Lateral Load Path

Seismic

\[ V = 1328 \text{ k} \]

Wind

\[ V = 133 \text{ k} \]
Steel
Underground Level

- 4” Concrete 2” Metal Composite Deck
- **W14** Column at Perimeter
- **W12** Column Gravity
- **W14** Cantilever Beam
- **W14** Girder @ 20 ft Span
- 18” Deep Castellated Girder @ 30 ft Span
- **5** square inch BRB
- 14” Retaining Wall
Steel
Ground Level

4” Concrete 2” Metal Composite Deck

- **W14** Column at Perimeter
- **W12** Column Gravity
- **W14** Cantilever Beam
- **W14** Girder @ 20 ft Span
- **18”** Deep Castellated Girder @ 30 ft Span
- 4 square inch BRB
Steel
Level 1

4” Concrete 2” Metal Composite Deck
- **W14** Column at Perimeter
- **W12** Column Gravity
- **W14** Cantilever Beam
- **W14** Girder @ 20 ft Span
- 18” Deep Castellated Girder @ 30 ft Span
- 3 square inch BRB
Steel
Level 2

4” Concrete 2” Metal Composite Deck

- W14 Column at Perimeter
- W12 Column Gravity
- W14 Cantilever Beam
- W14 Girder @ 20 ft Span
- 18” Deep Castellated Girder @ 30 ft Span

- 3 square inch BRB
Steel Roof

4" Concrete
2" Metal Composite Deck

W14 Column at Perimeter

W12 Column Gravity

W12 Cantilever Beam

W12 Girder @ 20 ft Span

14" Deep Castellated Girder @ 30 ft Span

2 square inch BRB

Φ 1" Cable Bracing
Steel Load Path
Steel Load Path with Seismic Load

353 k
247 k
150 k
80 k

V = 830 k
Foundation Design

Isolated square foundation

- Wind Overturn
- Seismic Activities
- Liquefaction

# of Piles: 22

8’

EL CORAZON

Footing Stress: 4042 PSF

Eff Cone Shear: 177 psi

12’

EL SPOT

Footing Stress: 2878 PSF

Eff Cone Shear: 74 psi

# of Piles: 24
360 Degree Auditorium Display

- Dynamic Educational Experience
- Improved Sightlines
- Inspiration from Mercedes Benz Arena

Our Vision
M.E.P.

El Corazon
El Spot
<table>
<thead>
<tr>
<th>Primary System</th>
<th>Energy Eff.</th>
<th>Initial Cost</th>
<th>Reliability</th>
<th>Spatial</th>
<th>Water Use</th>
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<tr>
<td>Water-Cooled Chiller</td>
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<tr>
<td>Air-Cooled Chiller</td>
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<tr>
<td>Central Cooling Plant</td>
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<table>
<thead>
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<tbody>
<tr>
<td>Overhead VAV</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>FCU + DOAS</td>
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<tr>
<td>ACB + DOAS</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Raindiant + DOAS</td>
<td></td>
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</table>
## HVAC System - Secondary Systems

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Mech Ventilation</th>
<th>Natural Ventilation</th>
<th>Dehumidification</th>
<th>Duct Size</th>
</tr>
</thead>
</table>
| Option 1 Overhead VAV | ![ductwork](image1.png) | ![air terminals](image2.png) | ![humidity](image3.png) | Riser - 36” x 24”  
Main - 30” x 18”  
Branches - 21” x 12” |
| Option 2 FCU + DOAS | ![ductwork](image1.png) | ![air terminals](image2.png) | ![humidity](image3.png) | Riser - 15” x 15”  
Main - 10” x 8”  
Branches - 6” x 4” |

*For both option 1 and 2, we are using displacement ventilation for auditorium and large classrooms.*

*For both option 1 and 2, we are using displacement ventilation for auditorium and large classrooms.*
Schematic Diagram Option 1 - VAV

- Air Filter
- Desiccant Wheel
- Cooling Coil
- Air-Cooled Chiller
- CHWS - 44F
- CHWR - 54F
- Room 1
  - VAV Box
  - SA - 55F
  - Room 2
  - VAV Box
- Room 2
- SA - 55F
- RA - 75F
- RA
- OA
- EA
Schematic Diagram Option 2 - FCU + DOAS

- OA
  - Air Filter
  - Desiccant Wheel
  - Cooling Coil
- CHWS - 44F
- CHWR - 54F
- SA - 55F
- RA - 75F
- Room 1
- Room 2

Air-Cooled Chiller

EA
**EL CORAZON** Floor Sandwich - Main Floor

**Concrete + Overhead VAV**

- POST TENSION 2 WAY SLAB
  - 10"
  - SUPPLY
  - RETURN DUCT
  - 2'

- Steel Open Web Joist & Truss Girder + FCU & DOAS
  - COMPOSITE CONCRETE + METAL DECK
  - 6"
  - OA DUCT
  - EXHAUST DUCT

- 14’ Floor Height
- 11’2” Clearance

- 18” Open Web Joist
- 6” Return Duct & Diffuser

- 11’6” Clearance
EL CORAZON Floor Sandwich - Auditorium

Concrete + Displacement Ventilation

- POST TENSION 2 WAY SLAB
- CEILING
- 12' Floor Height
- 9' - 13' Clearance
- 16' Floor Height
- 18" RETURN PLENUM
- SUPPLY DUCT

Open Web Joist & Truss Girder + Displacement Ventilation

- COMPOSITE CONCRETE + METAL DECK
- CEILING
- 12' Floor Height
- 9' - 13' Clearance
- 16' Floor Height
- 18" RETURN PLENUM
- SUPPLY DUCT
- 6' Open Web Joist
EL SPOT Floor Sandwich - Main Floor

Concrete + Overhead VAV

- POST TENSION 2 WAY SLAB
  - 10”
  - 2’
  - SUPPLY
  - RETURN DUCT

- 9’2” Clearance

Composite Slab with Steel Beam + FCU & DOAS

- COMPOSITE CONCRETE + METAL DECK
  - 6”
  - W14 Beam
  - 12” DOAS + FCU
  - 6” Return Duct & Diffuser

- 12’ Floor Height

- 9’6” Clearance
EL SPOT Floor Sandwich - Auditorium

Concrete + Displacement Ventilation

- POST TENSION 2 WAY SLAB
- 18" RETURN PLENUM
- 12' Floor Height
- 9' -13' Clearance
- CEILING

Composite Slab with Steel Truss Beam + FCU & DOAS

- COMPOSITE CONCRETE + METAL DECK
- 18" RETURN PLENUM
- 12' Floor Height
- 9' -13' Clearance
- 16' Floor Height
- CEILING
- 24" Open Web Joist

SUPPLY DUCT1
Mech Room Location - Roof

Mech Room 1
240 sf (AHU 1 Only)

Mech Room 2
540 sf
(AHU 2&3 + Chiller + Pumps + Water Treatment)

Shaft 1
60 sf (Zone 1 Only)

Shaft 2
115 sf (Zone 2&3)

Shaft Arrangement

- Vertical Supply
- Vertical Return
- Rainwater Collection
- Non-Potable Water
- Potable Water
- Sewage
Distribution Tree - Underground (Applies to VAV and DOAS)

Rainwater Collection Tank
6' x 12' x 10'

Zone 1
Zone 2
Zone 3
Shaft
Distribution Tree - Level 1 (Applies to VAV and DOAS)
Distribution Tree - Level 2 (Applies to VAV and DOAS)
Mech Room Location - Underground

**Mech Room 1**
- 270 sf (AHU 1)

**Mech Room 2**
- 360 sf (AHU 2 + Pumps + Water Treatment)

**Shaft 1**
- 60 sf (Zone 1)

**Shaft 2**
- 60 sf (Zone 2)

**Rainwater Collection Tank**
- 6’ x 12’ x 10’
Distribution Tree - Underground (Applies to VAV and DOAS)
Distribution Tree - Ground Level  (Applies to VAV and DOAS)

- Zone 1
- Zone 2
- Shaft
Distribution Tree - Level 2 (Applies to VAV and DOAS)
On-site Solar Energy

14,000sf Usable Roof

215 Azimuth

18.5 deg Tilt

3’ x 6’ PV Panel
Open Rack
15% Standard Eff.

1543 kWh/yr/kWp
750 Modules
301,100 kWh/yr
100% Energy Use Coverage

11,000sf Usable Roof

180 Azimuth

1577 kWh/yr/kWp
600 Modules
241,800 kWh/yr
48.6% Energy Use Coverage
Rainwater Collection

- 52 inch/yr
- 80% Catchment Eff.

- Collection Tank (5000 gal)
- Non-potable Filtration

14,000sf Usable Roof
490,000 gal/yr
75% Non-Potable Use Coverage

11,000sf Usable Roof
380,000 gal/yr
58% Non-Potable Use Coverage

Rainwater Collection Capacity (gallon)
EL CORAZON - STV Iteration

![Graph showing iterations for carbon, energy, and water consumption across different phases: Preliminary, Natural Ventilation, Solar PV, LEED Standard Plumbing Fixture, Rainwater Collection. Each phase shows a decrease in carbon and water consumption, and an increase in energy consumption.](image-url)
EL SPOT - STV Iteration

- Carbon (Concrete + VAV)
- Energy (Concrete + VAV)
- Water (Concrete + VAV)
- Carbon (Steel + FCU)
- Energy (Steel + FCU)
- Water (Steel + FCU)
Construction Management

El Corazon
El Spot
Construction Safety

SITE SAFETY
All Visitors and Contractors MUST report to the Site Office to receive information and rules regarding this site.

- Safety helmets must be worn
- Safety footwear must be worn
- High visibility jackets must be worn
- No unauthorised persons allowed on this site

Helmet Detection

Safety Sign

Fatigue Wristband

Daqri Smart Glasses
Offsite Logistics and Route to Site

Deliveries would exit of 17 and follow the Large Vehicle Route into the campus and to the site.
Equipment Selection

MK 140 Mobile Tower Crane
Heaviest Pick: 11,300 lbs HVAC System

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Lines</td>
<td>EN 14439</td>
</tr>
<tr>
<td>Max. lifting capacity</td>
<td>17,636 lbs</td>
</tr>
<tr>
<td>Lifting capacity at max.</td>
<td>4,188 lbs</td>
</tr>
<tr>
<td>radius</td>
<td></td>
</tr>
<tr>
<td>Max. hook height</td>
<td>130.00 ft</td>
</tr>
<tr>
<td>Luffed jib position</td>
<td>70 °</td>
</tr>
</tbody>
</table>

John Deere 345G LC Excavator

345G LC Excavator

- Net Power: 186 kW (249 hp)
- Max. Digging Depth: 7.57 m (24 ft. 10 in.)
- Operating Weight: 35 700 kg (78,710 lb.)
Onsite Logistics - El Corazon and El Spot - Option 1

This option would be option 1 for both buildings, El Corazon and El Spot. Possible delivery to stay on Large Vehicle Route.

- Material Storage
- On-Site Parking
- Jobsite Trailer
- Temporary Toilets
- First Aid Stations
- Tire Wash Stations
- Rumble Pads at Entrances
- Silt Fencing
Onsite Logistics - El Corazon and El Spot - Option 2

This option would be option 2 for both buildings, El Corazon and El Spot

- **Material Storage**
- **On-Site Parking (Not included)**
- **Jobsite Trailer**
- **Temporary Toilets**
- **First Aid Stations**
- **Tire Wash Stations**
- **Rumble Pads at Entrances**
- **Silt Fencing**
Crane Locations - El Corazon

Each Crane are positions of the crane.

With each crane placement, the crane can reach all parts of the structure and can lift the heaviest pick safely.
Crane Location - El Spot

It can reach all parts of the structure and can lift the heaviest pick safely.
Construction Sequencing - El Corazon

Zone 1

Zone 2

(Level 1 Floor)
Construction Sequencing - El Spot

(Underground Level)
Schedule Timeline - El Corazon

Concrete option total: 222 Workdays

Steel option total: 196 Workdays
Schedule Timeline - El Spot

Concrete option total: 237 Workdays

Steel option total: 217 Workdays
**Budget**

- **Total Donation**: $12,000,000 (Jan 2019)
- **Budget**: $10,500,000

**Inflation**
- CPI in Puerto Rico (IMF World Economics Outlook): Inflation = 1.11% (Geometric Average 2008~2017)

**Return on Interest**
- Change in RSMeans Data (Geometric Average 2017~2019): Average inflation = 2.74%
- ROI in Puerto Rico (5-year deposit):
  - Deposit: up to 1.46%
  - Savings Accounts: up to 0.55%
  - All Loans: from 5.99%
  - Personal Loans: from 5.99%
  - Credit Cards: from 11.20%
  - Risk free rate = 1.46%
Cost Estimation Accuracy Evolution

Exemplified by concrete alternative

- RSMeans Square Foot Estimator
- Manually quantity take off
- Add rainwater collection system
- Automated quantity take off
Automated Material Take Off

Extract  Filter  Calculate  Format  Export
Cost Estimation

El Corazon
Concrete
$7.6 million

El Corazon
Steel
$7.8 million
Cost Estimation

El Spot
Concrete
$ 8.3 million

El Spot
Steel
$ 8.5 million
Decision
Decision Process

Step 1: Set up **decision matrix**

Step 2: Determine **weights** for each criterion (with **owners** input)

Step 3: **Score** each option on each criterion

Step 4: Make **decision** based on total score

Diagram:
- **Goal** → **Objectives** → **Criteria**
  - Which criteria is more important?
  - **Owners** ↔ **AECers**
  - How do each option perform on the criteria?
Step 1: Setup Decision Matrix

Choose the most desirable option

**Architectural Design**
- Aesthetics
- Environment Impact
- Community Integration
- Creativity

**Functionality**
- Space Utilization
- Accessibility
- Code Appliance
- Comfort

**Sustainability**
- Energy Consumption
- Carbon Footprint
- Air Quality
- Water Efficiency

**Construction Issues**
- Schedule
- Ease of Construction
- Material Locality

**Economics**
- Construction Cost
- Maintenance Cost
- Expected ROI

**Disaster Handling**
- Seismic Performance
- Hurricane Performance
Step 2: Determine Weight for Each Criterion

Goal:

Objective:

Criteria:

Analytic Hierarchy Process
- Subjective multi-criterion decision process
- Based on psychology & statistics

Fuzzy Synthetic Evaluation
- Objective multi-criterion decision process
- Based on fuzzy mathematics
## Step 2: Determine Weight for Each Criterion

<table>
<thead>
<tr>
<th></th>
<th>Camila</th>
<th>Luke</th>
<th>Mikki</th>
<th>Nick</th>
<th>Owner Average</th>
<th>Team Island</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Architecture design</strong></td>
<td>20.7%</td>
<td>3.5%</td>
<td>6.1%</td>
<td>7.5%</td>
<td>9.5%</td>
<td>12.2%</td>
</tr>
<tr>
<td><strong>Functionality</strong></td>
<td>13.1%</td>
<td>9.3%</td>
<td>18.5%</td>
<td>4.7%</td>
<td>11.4%</td>
<td>16.6%</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>2.3%</td>
<td>10.8%</td>
<td>2.2%</td>
<td>3.6%</td>
<td>4.7%</td>
<td>7.8%</td>
</tr>
<tr>
<td><strong>Economics</strong></td>
<td>6.7%</td>
<td>18.4%</td>
<td>11.1%</td>
<td>16.3%</td>
<td>13.1%</td>
<td>9.0%</td>
</tr>
<tr>
<td><strong>Sustainability</strong></td>
<td>27.4%</td>
<td>31.1%</td>
<td>32.2%</td>
<td>34.7%</td>
<td>31.4%</td>
<td>21.7%</td>
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<tr>
<td><strong>Disaster handling</strong></td>
<td>29.8%</td>
<td>26.9%</td>
<td>29.8%</td>
<td>33.2%</td>
<td>29.9%</td>
<td>32.6%</td>
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</table>
### Step 3: Score Each Option on Each Criterion

<table>
<thead>
<tr>
<th>Objective</th>
<th>Criterion</th>
<th>Weight</th>
<th>El Corazon - Concrete</th>
<th>El Corazon - Steel</th>
<th>El Spot - Concrete</th>
<th>El Spot - Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Architectural Design</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aesthetics</td>
<td>22%</td>
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<td>4.25</td>
<td>6.5</td>
<td>6.25</td>
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<tr>
<td></td>
<td>Environment Impact</td>
<td>21%</td>
<td>5</td>
<td>6.5</td>
<td>4.75</td>
<td>6.75</td>
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<tr>
<td></td>
<td>Community Integration</td>
<td>24%</td>
<td>7</td>
<td>5.5</td>
<td>8.5</td>
<td>8.5</td>
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<tr>
<td></td>
<td>Creativity</td>
<td>33%</td>
<td>6.25</td>
<td>4.75</td>
<td>8.5</td>
<td>9</td>
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<td><strong>Total</strong></td>
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<td>6.0</td>
<td>5.2</td>
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<td>7.8</td>
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<tr>
<td><strong>Functionality</strong></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Space Utilization</td>
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<td>5.5</td>
<td>7</td>
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<td>5.5</td>
<td>7.5</td>
<td>7.5</td>
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<tr>
<td></td>
<td>Building Code Appliance</td>
<td>26%</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>5.5</td>
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<tr>
<td></td>
<td>Comfort</td>
<td>40%</td>
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<td>7.5</td>
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<td>5.3</td>
<td>4.4</td>
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<td>6.9</td>
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<tr>
<td><strong>Construction Issues</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Schedule</td>
<td>61%</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Ease of Construction</td>
<td>39%</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>7.2</td>
<td><strong>8.0</strong></td>
<td>5.2</td>
<td>6.0</td>
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</tbody>
</table>
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<th>El Spot - Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sustainability</strong></td>
<td>Energy Consumption</td>
<td>33%</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Water Efficiency</td>
<td>15%</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
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<tr>
<td></td>
<td>Indoor Air Quality</td>
<td>37%</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Material and Resources</td>
<td>15%</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>6.1</strong></td>
<td><strong>5.7</strong></td>
<td><strong>5.9</strong></td>
<td><strong>5.5</strong></td>
</tr>
<tr>
<td><strong>Economics</strong></td>
<td>Construction Cost</td>
<td>61%</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Maintenance Cost</td>
<td>39%</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>6</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>8.6</strong></td>
<td><strong>7.2</strong></td>
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<td><strong>5.4</strong></td>
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<tr>
<td><strong>Disaster Handling</strong></td>
<td>Seismic Performance</td>
<td>52%</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>8</td>
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<tr>
<td></td>
<td>Hurricane Performance</td>
<td>48%</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>6</td>
</tr>
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<td></td>
<td><strong>Total</strong></td>
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<td><strong>7.0</strong></td>
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</tbody>
</table>
Step 3: Score Each Option on Each Criterion
### Step 4: Make Decision Based on Total Score

<table>
<thead>
<tr>
<th>Objective</th>
<th>Weight</th>
<th>El Corazon - Concrete</th>
<th>El Corazon - Steel</th>
<th>El Spot - Concrete</th>
<th>El Spot - Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural Design</td>
<td>9.5%</td>
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<td>5.2</td>
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<td>7.8</td>
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<td>4.5</td>
<td>7.4</td>
<td>6.9</td>
</tr>
<tr>
<td>Construction Issues</td>
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<td>8.0</td>
<td>5.2</td>
<td>6.0</td>
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<tr>
<td>Economics</td>
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<td>7.2</td>
<td>6.8</td>
<td>5.4</td>
</tr>
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<td>Sustainability</td>
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<td>5.7</td>
<td>5.9</td>
<td>5.5</td>
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<tr>
<td>Disaster Handling</td>
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<td>6.5</td>
<td>7.0</td>
<td>7.0</td>
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<td><strong>6.1</strong></td>
<td><strong>6.6</strong></td>
<td><strong>6.3</strong></td>
</tr>
</tbody>
</table>
Step 4: Make Decision Based on Total Score
Team Process
Team Process - Evolution of Task Tracking

**IPD Commitment List**
- Lack of Motivation
- Lack of Transparency

**Slack Callout Scheduling**
- Lack of Consistency
- Lack of Transparency

**TeamGantt**

- Actively Receiving
  - Motivation
  - Consistency
  - Transparency

---

**Wesley**: Are we meeting now?

**Yunyi**: What?

**Hannah**: No way!! I'm working!!
Team Process - Technology

ASTERISK

VR

ZOOM + SPAN

14 Iterations Alternatives

DYNAMO
Team Process - Technology - Dynamo (IT)

**Individual Work**
- Can you fill in how much steel you use?
  - Sure!
- I need the quantity of steel.
  - We already had it.
- 40 kg

**Manual Co-Work**
- Let’s work together!
- 2000 years later
- Please check the changes
- WHAT?

**Automated Work**
- Please check the changes
Team Process - Clash Detection

+ Quick detection of duplication
+ Collaboration among all disciplines in 3D

Not really helpful in conceptual phase - Category search can be disoriented -
Team Process - Rapid Design Iteration

1st Conceptual Feb 1st

Peer Review Feb 15th

Midterm Critic Feb 22nd

Start Over - March 3rd

Winter Final
VR Collaborative Team Meeting

- Walkthrough Building
- Joint Decisions & Update
- Solve Problems
- Explore Alternative
- Co>Create
- Annotate
- Document
- Troubleshoot
THANK YOU