Winter Presentation

Team: Ariel Bautista, Carl Fosholt, Catherine Boubekeur, Derek Ouyang, Frank Musiol, Katelin Crook, Rebecca Diaz, Seale Wong
Owners: Erik Kneer, Hossein Nasseri
Professor: Renate Fruchter
Date: March 11, 2011
Site Conditions

Prevailing Winds:
- NE Trade Winds

Basic Design Wind Speed:
- 145 mph

Seismic:
- Site Classification D

Average Temp:
- Max - 86° F
- Min - 66.9° F

Average Sunlight:
- 8 hours per day
- 1,466 BTU/sqft/day

Precipitation: 60-90” annual
Architecture

Hurricane Concept

Shape

Circulation
Architecture

Site Plan

Student Center

University Avenue
Architecture

North Entrance
Architecture

South West corner, Exterior Area
Architecture

Puzzle Concept

Grid & Modules

Cantilever & Open Spaces
Architecture

Site Plan

Student Center

University Avenue
Architecture

First Floor Plan

- Core
- Small Classrooms
- Instructional Labs
- Double Height
- Seminar Rooms
- Entrance Atrium
Architecture

Central Atrium View (looking south)
## Hurricane- Steel Solution- Design Loads

### Structure

#### Hurricane- Steel Solution- Design Loads

<table>
<thead>
<tr>
<th>Component</th>
<th>Dead</th>
<th>Live</th>
<th>Seismic</th>
<th>Wind</th>
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<tbody>
<tr>
<td></td>
<td>Roof</td>
<td>Roof</td>
<td>Second Story</td>
<td>Second Story</td>
</tr>
<tr>
<td>Weight (psf)</td>
<td>65</td>
<td>20</td>
<td>70</td>
<td>75</td>
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<tr>
<td></td>
<td>Green Roof</td>
<td>Green Roof</td>
<td>Roof</td>
<td>Roof</td>
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<tr>
<td>Weight (psf)</td>
<td>115</td>
<td>20</td>
<td>165</td>
<td>30</td>
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<tr>
<td></td>
<td>Floor</td>
<td>Floor</td>
<td></td>
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<tr>
<td>Weight (psf)</td>
<td>85</td>
<td>60</td>
<td></td>
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</table>

- **Basic Wind Speed**: 145 mph
- **Base Shear**: 230 kip
- **Site Class**: D
- **Ss=**: 0.852
- **S1=**: 0.279
Hurricane - Typical Member Sizes

First Story:

Fill Beam: **W18x35**

Exterior Beam/Girder: **W24x131**

Frame Beam/Girder: **W30x99**

Kickers: **W12x26**

Frame/BRB Column: **W14x68**

Interior Column: **W14x74**

Composite Floor: **2VLI18**

2” Deck with 4.25” concrete cover
Hurricane - Typical Member Sizes

Second Story/Roof:
Bean 38’ Span: \( W_{18x35} \)
Interior Girder 38’ Span: \( W_{24x131} \)
Exterior Girder 38’ Span: \( W_{24x62} \)

Corner Column: \( W_{14x48} \)
Exterior Column: \( W_{14x61} \)
Interior Column: \( W_{14x74} \)

Cantilever Beams: \( W_{30x99} \)
Cantilever Columns: \( W_{14x74} \)
Hurricane-Gravity Load Path Diagram
Hurricane- Lateral Load Path Diagram

Structure

N-S Direction
Hurricane- Cantilever Solution

**Truss Solution:**
- Truss Beams: **W30x99**
- Truss Columns: **W14x74**
- Truss Diagonals: **HSS 6x6x5/8**

**Behavior:**
- Loads to Backspan and BRBF
- Stiff Columns for Deflection
Hurricane- Lateral System

BRBFs:

Beam: **W30x99**

Column: **W14x68**

Brace: \( \frac{3}{4}'' \times 3 \ \frac{1}{4}'' \) plate

Lateral System

Pony Wall

Connection

Critical
Hurricane- Foundation Design

Spread Footings:
- Exterior Column: 9'x9'x2
- Interior Column: 9'x9'x2

Continuous Footing: 2'x2'
Grade Beams
12” Retaining Wall

Soil Profile:
Bearing Capacity: 5000 PSF

Medium to Very Stiff Clayey Soil, 0’
Water Table, 17’
Hurricane- Concrete Solution- Design Loads

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Dead</td>
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<tr>
<td>Roof</td>
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<td>Floor</td>
<td>120</td>
<td>psf</td>
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<tr>
<td>Live</td>
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<td></td>
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<tr>
<td>Roof</td>
<td>20</td>
<td>psf</td>
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<tr>
<td>Green Roof</td>
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<td>psf</td>
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<tr>
<td>Floor</td>
<td>60</td>
<td>psf</td>
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<tr>
<td>Seismic</td>
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<td></td>
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<tr>
<td>Second Story</td>
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<td>kip</td>
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<tr>
<td>Roof</td>
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<tr>
<td>Wind</td>
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<tr>
<td>Roof</td>
<td>30</td>
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</tbody>
</table>

Basic Wind Speed: 145 mph
Base Shear: 450 kip
Site Class: D
Ss: 0.852
S1: 0.279
Hurricane- Typical Member Sizes

**First Story:**

Post Tensioned Tapered:

Beam 38’ Span: **18”x24”**

Interior Girder 38’ Span: **22”x36”**

Exterior Girder 38’ Span: **18”x36”**

Exterior Column: **14”x14”**

Interior Column: **18”x18”**
Second Story/Roof:

Post Tensioned Tapered:
Beam 38’ Span: **18”x24”**
Interior Girder 38’ Span: **22”x36”**
Exterior Girder 38’ Span: **18”x36”**

Cantilever Column: **12”x12”**
Exterior Column: **14”x14”**
Interior Column: **18”x18”**
Hurricane-Gravity Load Path
Hurricane- Cantilever Solution and Lateral System

Vierendeel Truss

Beams: 18”x36”

Columns: 12”x12”
Hurricane- Lateral System

Lateral System:

8” Shear Walls

8” Pony Wall System
Hurricane- Foundation Design

**Spread Footings:**
- Exterior Column: 9’x9’x2’
- Interior Column: 11’x11’x2’

**Continuous Footing:** 2’x2’
- Grade Beams
- 12” Retaining Wall
- Slab on Grade
## Structure

### Puzzle - Steel Solution - Design Loads

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<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Dead</strong></td>
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<td></td>
</tr>
<tr>
<td>Roof</td>
<td>65</td>
<td>psf</td>
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<tr>
<td>Green Roof</td>
<td>115</td>
<td>psf</td>
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</tr>
<tr>
<td>Floor</td>
<td>85</td>
<td>psf</td>
<td></td>
</tr>
<tr>
<td><strong>Live</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Roof</td>
<td>20</td>
<td>psf</td>
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<td>Floor</td>
<td>60</td>
<td>psf</td>
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<tr>
<td><strong>Seismic</strong></td>
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<td>70</td>
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<td>Roof</td>
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<td><strong>Wind</strong></td>
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<tr>
<td>Roof</td>
<td>30</td>
<td>kip</td>
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</tr>
</tbody>
</table>

| **Basic Wind Speed** | 145 mph |
| **Base Shear**       | 230 kip |
| **Site Class**       | D       |
| **Ss**               | 0.852   |
| **S1**               | 0.279   |
Puzzle- Typical Member Sizes

First Story:

Beam 25’ Span: \textbf{W12x19}

Exterior Girder 30’ Span: \textbf{W14x30}

Auditorium Beam 50’ Span: \textbf{W24x94}

Auditorium Girder 30’ Span: \textbf{W24x94}

Corner Column: \textbf{W14x43}

Exterior Column: \textbf{W14x43}

Interior Column: \textbf{W14x61}

Cantilever Column: \textbf{W24x94}

Composite Floor: \textbf{2VLI18}

2” Deck with 4.25” concrete
Puzzle- Typical Member Sizes

Second Story:
Beam 25’ Span: **W12x19**
Exterior Girder 30’ Span: **W14x30**
Cantilever Beam 25’ Span: **W24x94**

Corner Column: **W14x43**
Exterior Column: **W14x4-3**
Interior Column: **W14x61**
Cantilever Column: **W24x94**

Composite Floor: **2VLI18**
2” Deck with 4.25” concrete

cover
Puzzle- Typical Member Sizes

**Roof:**
- Beam 25’ Span: **W12x19**
- Interior Girder 25’ Span: **W14x45**
- Exterior Girder 30’ Span: **W14x30**
- Cantilever Beam 25’ Span: **W24x94**

**Corner Column:**  **W14x43**
- Exterior Column: **W14x43**
- Interior Column: **W14x61**
- Cantilever Column: **W24x94**

**Composite Floor:** **2VLI18**
- 2” Deck with 4.25” concrete
Puzzle- Gravity Load Path Diagram
Puzzle- Lateral Load Path Diagram
Vierendeel Truss:

Beams: **W24x94**

Columns: **W24x**
Puzzle- Lateral System

BRBF Connection Typical:
- Beam: W30x90
- Column: W14x53
- Brace: ¾”x 3” Plate

Cantilever Connection: Vierendeel Truss

Lateral System:
**Spread Footings:**

- Exterior Column: $6' \times 6' \times 1.5'$
- Interior Column: $9' \times 9' \times 2'$

**Continuous Footing:** $2' \times 2'$

**Soil Profile:**

- Grade Beams
- 12" Retaining Wall
- Bearing Capacity: 5000 PSF

- Medium to Very Stiff Clayey Soil, 0'
- Water Table, 17'
Puzzle- Concrete Solution- Design Loads

**Dead**
- Roof: 70 psf
- Green Roof: 120 psf
- Floor: 120 psf

**Live**
- Roof: 20 psf
- Green Roof: 20 psf
- Floor: 60 psf

**Seismic**
- Second Story: 150 kip
- Roof: 300 kip

**Wind**
- Second Story: 75 kip
- Roof: 30 kip

**Basic Wind Speed**: 145 mph
**Base Shear**: 450 kip
**Site Class**: D
**Ss=**: 0.852
**S1=**: 0.279
First Story:

Post Tensioned Tapered:

Interior Beam: **12”x18”**

Interior Girder: **16”x30”**

Other Beam/Girder: **12”x24”**

Corner Column: **8”x8”**

Exterior Column: **12”x12”**

Interior Column: **16”x16”**
**Second Story:**

Post Tensioned Tapered:
- Interior/Cantilever Girder: **16”x30”**
- Other Beam/Girder: **12”x24”**

Corner Column: **8”x8”**

Exterior Column: **12”x12”**

Cantilever Column: **10”x10”**

Interior Column: **16”x16”**
**Second Story:**

Post Tensioned Tapered:
- Interior/Cantilever Girder: **16”x30”**
- Other Beam/Girder: **12”x24”**
- Interior Beam: **12”x18**
- Corner Column: **8”x8”**
- Exterior Column: **12”x12”**
- Cantilever Column: **10”x10”**
- Interior Column: **16”x16”**
Puzzle- Details

Shear Wall Detail:

Typical Post Tensioned Beam:
Puzzle- Lateral System and Cantilever Solution

**Cantilever Solution:**
- Vierendeel Truss Beam: 16”x30”
- Columns: 8”x8”

**Lateral System:**
- 8” Shear Walls

```
<table>
<thead>
<tr>
<th>25' - 0”</th>
<th>25' - 0”</th>
<th>25' - 0”</th>
<th>25' - 0”</th>
<th>25' - 0”</th>
<th>25' - 0”</th>
</tr>
</thead>
</table>
```

Diagram showing the structure with labeled beams and columns.
Puzzle- Gravity and Load Path Diagram
Puzzle- Lateral System
Puzzle- Foundation Design

**Spread Footings:**

- **Exterior:** 8’x8’x2’
- **Interior/Cantilever:** 10’x10’

**Continuous Footing:** 2’x2’

- **Grade Beams**
- **12” Retaining Wall**
- **Slab on Grade**
Avg. temp range
76F – 83F

Avg. relative humidity range
60%-90%
Indoor air quality goal:

75F Temperature
60% Relative Humidity
Reduce Heat Loads

- Cool and green roofs
- High efficiency façade and window materials
- Vertical/horizontal shading

Panelite
## Internal Heat Loads

<table>
<thead>
<tr>
<th>Loads</th>
<th>Method</th>
<th>Standard</th>
<th>Value</th>
<th>Type</th>
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<tbody>
<tr>
<td>Lighting Loads</td>
<td>Building Area</td>
<td>ASHRAE 90.1</td>
<td>1.2 W/s.f.</td>
<td>University</td>
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<td>Plug Loads</td>
<td>Building Area</td>
<td>ASHRAE 90.1</td>
<td>0.5 W/s.f.</td>
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<td>Occupant Loads</td>
<td>Activity/room density</td>
<td>ASHRAE Fundamentals, Ch. 18</td>
<td>330 Btu/h</td>
<td>Seated, at rest</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>400 Btu/h</td>
<td>Office work</td>
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## External Heat Loads

<table>
<thead>
<tr>
<th>Loads</th>
<th>Design Assumption</th>
<th>Data Assumption</th>
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<tbody>
<tr>
<td>Hurricane (Btu/h)</td>
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<tr>
<td>Solar radiation</td>
<td>37453</td>
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<td>Conduction (windows)</td>
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<td>Conduction (façade)</td>
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<td>8520</td>
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<td>Conduction (façade)</td>
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<td>Hurricane (Btu/h)</td>
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<td>Solar radiation</td>
<td>50367</td>
<td>43443</td>
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**Legend**
- Auditorium
- Building remainder

<table>
<thead>
<tr>
<th>Loads</th>
<th>Design Assumption</th>
<th>Data Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar radiation</td>
<td>400 s.f. windows</td>
<td>Lat 18.5N</td>
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<tr>
<td>Conduction (windows)</td>
<td>U-factor 0.71</td>
<td>Indoor temp 75F, Outdoor temp 90F, Ground temp 80F</td>
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<tr>
<td>Conduction (façade)</td>
<td>R-value 10</td>
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<tr>
<td>Main duct size</td>
<td>Hurricane (s.f.)</td>
<td>Modules (s.f.)</td>
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<tr>
<td>----------------</td>
<td>-----------------</td>
<td>----------------</td>
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<tr>
<td>Overhead</td>
<td>1.5</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>Underfloor</td>
<td>2.5</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
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</tbody>
</table>
**Legend**

- **Main duct**
- **Auditorium AHU**
- **Atrium**
- **Natural ventilation**

**Auditorium:** single-duct VAV

**Building:** single-duct VAV
Ventilation – Puzzle

Legend

- **Main supply/return duct**
- **Auditorium AHU**

Auditorium: single-duct VAV
Building: single-duct VAV
Raised Floor

Dropped Ceiling
Chilled Water Location

 MEP

Site

Chillers
Panelite

Glass material

Interior wall

Atrium
Site Logistics: Bus Stops, Train Station and Parking Lots
Site Logistics: Job Site Traffic Route
Site Logistics: Construction Site
Site Logistics: Construction Site

- Tree Protection Fence
- Recycling Area
- Equipment Storage
- Restrooms
- Trailer 1
- Material Laydown
- Excavation Material
- Non-Traffic Road
- Ave. Universidad
Site Logistics: Equipment

Mobile Crane  
Skip Loader  
Excavator

Heaviest Lift: 5.5 Kips  
Reach: 160 ft.

- Rented 6.3 miles from the site at Velázquez Hydraulic Services.
- Use of Green Equipment to reduce CO2 Emissions.
Site Logistics: Excavator Selection

Hurricane – 16’ 5”

Puzzle – 16’ 4”
Compare with existing building using **SQFT Method** and **RS Means**

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ISLAND PROJECT 2015</th>
<th>JAIME BENITEX REXAC 2009</th>
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</thead>
<tbody>
<tr>
<td>CAPACITY (SQ FT)</td>
<td>30,000</td>
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<tr>
<td>LOCATION</td>
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<td>COST</td>
<td>$8,759,017</td>
<td>$13,000,000</td>
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</table>
Cost Estimate: Comparison

Construction Cost

- **Puzzle**
  - Steel
  - Concrete

- **Hurricane**
  - Steel
  - Concrete

- Cost: $6,000,000,000, $7,000,000,000, $8,000,000,000
Cost Breakdown

**Hurricane – Concrete:** $7,450,000

**Hurricane – Steel:** $6,900,000

**Module – Concrete:** $7,280,000

**Module – Steel:** $6,800,000
Schedule

Project Start 9/30/15

Site is Limited

81 Days

102 Days
Early Move In 5/15/16

Project Complete 9/26/16

161 Days
### LEED: Sustainability Review

**LEED Review:**
Best Case Scenario: Platinum  
Worst Case Scenario: Certified

<table>
<thead>
<tr>
<th>Credit</th>
<th>Possible Points</th>
<th>Points Awarded</th>
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<tbody>
<tr>
<td>Sustainable Site</td>
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<tr>
<td>Water Efficiency</td>
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<tr>
<td>Energy and Atmosphere</td>
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<td>12</td>
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<td>Materials and Resources</td>
<td>14</td>
<td>12</td>
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<tr>
<td>Indoor Environmental Quality</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td><strong>Gold Certification</strong></td>
<td></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>
Life Cycle Costs of a building

Planning → Construction → Operation → Replacement → Demolition

- Planning & Building costs
  - Costs (Depending on idea)
  - Idea/planning 60 days

- Operation Costs
  - Maintenance Costs
  - Service Costs & Management fees
  - Operation/Replacement 25 years

- Replacement Costs for components
  - Replacement Costs for components

- Demolition Costs or reutilization
  - Demolition Costs or reutilization
  - Demolition Costs or reutilization

- Life Cycle Costs
  - Life Cycle Costs

- Completion Building, Costs: 7.10 – 7.25 Mil

- Progress of Life Cycle Costs
  - Progress of Life Cycle Costs

- Time (depending on idea)
  - Time (depending on idea)
Developement of the room program (auditorium) from Feb 4th – Mar 11th

1. Auditorium
2. Instructional Labs
3. Server Room & Tech Support
4. Bathroom, MEP, Stairs, Elevator & Storage Core
5. Coffee Shop & Store
6. Atrium

### Development of the Auditorium

<table>
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<tr>
<th>Date</th>
<th>Size</th>
<th>Achieved Presettings Owner</th>
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<tbody>
<tr>
<td>Feb 05</td>
<td>2664 sf</td>
<td>88,8%</td>
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<tr>
<td>Feb 27</td>
<td>2738 sf</td>
<td>91,3%</td>
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<tr>
<td>Mar 02</td>
<td>2818 sf</td>
<td>93,9%</td>
</tr>
<tr>
<td>Mar 06</td>
<td>3311 sf</td>
<td>110,4%</td>
</tr>
</tbody>
</table>
Final room program Mar 11

- Presettings Owner
- Hurricane
- Puzzles
Handling A-Risks:

- Insure
- Schedule to avoid bad weather during construction period
- Innovative protection:
  - Only partly maintenance
  - Base isolators against earthquakes
## Life Cycle Benchmarks

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Goal</th>
<th>Hurricane</th>
<th>Puzzles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non assignable area/ Assignable area</td>
<td>minimize</td>
<td>0.24</td>
<td>0.47</td>
</tr>
<tr>
<td>Building surface/ Building volume</td>
<td>&lt; 0.25</td>
<td>0.19</td>
<td>0.14</td>
</tr>
<tr>
<td>Net floor area/ Gross floor area NFA/GFA</td>
<td>&gt; 0.6</td>
<td>0.64</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Average for university buildings
Life Cycle

Operation & Maintenance Cost Estimate over 25 years

- Hurricane
- Puzzles
## Decision Matrix

### Life Cycle

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting</th>
<th>Hurricane</th>
<th>Puzzles</th>
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Evaluated by quantitative elements

1. **Steel**
Puzzle Steel
Weekly Interaction

We Wish: Develop this flow chart and make it more like a launchpad and less like a record.
Iteration and Reiteration

1. *Hurricane, “flying box”*
   - SE and CEM provide Immediate feedback

2. *Feasible structure & cost*
   - Full team discussion
   - Many reiterations
   - Owners and mentors provide input

3. *New solution, larger atrium*
   - Entire team continues to integrate design

4. **4 major reiterations for Hurricane design**
   *Over 1000 waves & 2000 MB files!*
Interdisciplinary, multimedia interaction with mentors
- Physical meeting
- Integrate structure & architecture
- Screen share, physical & virtual notes
- Follow-up with reiterations

Special Thanks to:
- Greg Luth (SE)
- Humberto Cavallin & David Bendet (A)
- John Nelson & Dennis Kwan (MEP)
- Dan Gonzalez, Henry Tooryani & Dustin Rothwell (CEM)
- Björn Wündsch, Hans-Wilhelm Alfen, Axel Seifert & Matthias Ehrlich (LCFM)
Architecture
Mechanical
Life Cycle
Structure
Construction
Thank You!
Spread Footing Spreadsheet
http://www.asdipsoft.com/Walls.htm
http://www.bridgeengineering.info/post_tensioned_beam.html
http://www.starseismic.net/pdf/Star_Seismic_2010.pdf