ISLAND team
Final Presentation – May 7, 2010

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U. Puerto Rico

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Stanford

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Stanford

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U. Wisconsin

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Bauhaus U.

Erik Kneer
Owner
Project Site
• Existing slope: 1:12 (aprox.)
• High traffic pedestrian corner
• Lush vegetation
• Vast green lawn
Site Conditions

- Latitude: 18°30’ N
- Prevailing Winds: North-East Trade Winds
- Basic design wind speed: 145 mph
- Seismic: Site Classification D
- Average Temp: 86°F - Max
  66.9°F - Min
- Average Sunlight: 8hrs per day
  1,466 BTU/sq.ft/per day
- Precipitation: 60-90” annual

Five Goals

**sustainability/ building performance**
- strength of concept
- use of natural resources
- interior/exterior connection
- energy efficiency
- efficient use of space on site

**enhance user experience/value**
- user experience
- circulation
- program relationships
- surrounding context

**flexibility/adaptability**
- flexibility
- modularity

**cost/construction efficiency**
- initial cost
- short schedule
- local building method
- maintenance & operation cost
- floor space efficiency
- constructability
- space requirements

**Structural performance**
- Clear load path
- Seismic performance
- Hurricane performance

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<tbody>
<tr>
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<td>8.4</td>
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Decision Matrix

CHOICE: RADIATOR CONCRETE STRUCTURE
Create an interaction hub in campus and within itself.
Floor Plans

1. Entrance
2. Large Class
3. Auditorium

First Floor

- Entrance
- Large Class
- Auditorium
Engineering Plaza
Floor plans

Second floor

1. Entrance
2. Large Class
3. Auditorium

Third floor

4. Laboratories
5. Small Class
6. Seminars
7. Server rm.
8. Faculty lounge
9. Student Offices/terrace
10. Faculty offices
11. Administration

---

Floor plans with dimensions:
- Entrance: 38’ x 12’ x 37’
- Large Class: 22.5’ x 22’ x 22’
- Auditorium: 25’ x 22.5’ x 22’
- Laboratories: 22’ x 22’ x 22’
- Small Class: 22’ x 22’ x 22’
- Seminars: 22.5’ x 22’ x 22’
- Server rm.: 22’ x 22’ x 22’
- Faculty lounge: 22.5’ x 22’ x 22’
- Student Offices/terrace: 22’ x 22’ x 22’
- Faculty offices: 22’ x 22’ x 22’
- Administration: 22’ x 22’ x 22’
Education Island
Volumetric Development

Section AA

Dimensions:
- 24'
- 44'
- 46'
- 19'
- 5.5'
- 30'
- 5.5'
- 15.5'
Small Classroom View
East-West Section
Volumetric Development
East Entrance
Volumetric Development
North West Entrance
Loadings and Combinations

- Wind Exposure B
- Hurricane seismic prone region
- Design wind speed 145mph
- Fundamental structural period 0.2sec
- Reduction factor 4 for Reinforced Shear Wall
- Load Combinations
  - 1.2D + 1.6L
  - 1.2D + 0.5L + 1.6W
  - (1.2 + 0.2 SDS)D + 0.5L + 1.0E
  - 0.9D + 1.0E

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<td>Self weight</td>
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<td>MEP</td>
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<td>20 psf</td>
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<tr>
<td>Auditorium</td>
<td>60 psf</td>
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<tr>
<td>Classroom</td>
<td>40-80psf</td>
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<table>
<thead>
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<td>Roof Edge</td>
<td>40 psf</td>
</tr>
<tr>
<td>Roof interior</td>
<td>23 psf</td>
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<tr>
<td>Windward</td>
<td>22 psf</td>
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<tr>
<td>Leeward</td>
<td>14 psf</td>
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<table>
<thead>
<tr>
<th>Lateral Earth</th>
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<tbody>
<tr>
<td>Surcharge</td>
<td>100psf</td>
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<tr>
<td>Sandy clad</td>
<td>γ=120 pcf</td>
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<table>
<thead>
<tr>
<th>Earthquake Load</th>
<th></th>
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<td>Sds (g)</td>
<td>0.676</td>
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<tr>
<td>Sd1 (g)</td>
<td>0.365</td>
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</table>
Concrete Structure Overview

- Height above surface 30ft
- Deepest excavation 18ft
- Light weight concrete, w=110pcf
- Reinforced Concrete Building (Shear wall)
  - Strong lateral system
  - Little displacement
Floor Plans

First Floor
- 114ft
- Dimensions: 24 15 15 15 6 13 13 13

Second Floor
- Dimensions: 15 9 22 22 9 12 25 22.5

Third Floor
- 55ft x 15.5ft

Roof
- Dimensions: 25ft 25ft 25ft

Materials:
- Slab
  - Post tension flat slab
    - 8-wire PT tendon @ 30 in c/c
    - #4 @ 12 in c/c rebar T&B
  - Flat slab 10"

- Typical "Island" Beam Size
  - 12 x 20
  - 18 x 24

- Typical Column Size
  - 12 x 12
  - 14 x 14

- Shear Wall thickness
  - Most shear wall at the periphery
  - 12 in
  - Two interior shear walls align with hard constraints

Notes:
- Two interior shear walls align with hard constraints
Gravity and Soil Load Path

- Gravity
- Lateral (Wind Load)
- Lateral (Soil Load)
Seismic/ Wind Load Path on the ‘Island’

- Regular beam-column grid
  - Gravity
    - Regular support at 6 ft interval for glass walkway
    - 3 central columns – direct gravity load path
  - Lateral
    - Direct load path - tension /compression of the beams

Load Direction

Load Path

Gravity Load Path

76ft

39ft

44ft

44ft

70ft

Section

Total weight ~7000kips
Total base shear 1200kips (R=4)

Roof 580kips
Third floor 410kips
Second floor 220kips
Engineering Details

- Vierendeel Truss for Cantilever
  - 12 x 24 Beam (4 no.s #9)
  - 14 x 14 Column (8 no.s #8)

- Staircases
  - Slider joint
  - Supported by half landings and floors
  - #4- 8” longitudinal rebar T&B

Moment diagram of the Cantilever

CAD drawings of the Stairs
Engineering Details

- Waffle Slab
  - 16 x 28 Beam
  - 4 no.s #9

Modeling of slab in Etabs

Moment diagram of the long span beams
Structural Model

- BIM - Revit
- Structural Analysis - Etabs
Structure subject to earthquake loads
Analysis Result

- **Strength**
  - Force (Axial Force Shear Moment)
  - Stress (Floor diaphragm and wall)

Axial force in beams under Earthquake Load
Tension (20kips) Compression (18kips)

Slab diaphragm stress under semi rigid diaphragm under earthquake load
Max shear stress 0.3 ksi
Analysis Result

- Stiffness \( (C_d = 4) \)
- Inter-story Drift \( (2.5 \times 10^{-3}) \)
- Max Roof Displacement \( (0.7 \text{ in}) \)

Drift Ratios in X&Y direction

Displacement in X & Y direction
## Foundation

<table>
<thead>
<tr>
<th>Type</th>
<th>Qty</th>
<th>Length (ft)</th>
<th>Width (ft)</th>
<th>Depth (ft)</th>
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<tbody>
<tr>
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<td>11</td>
<td>6</td>
<td>6</td>
<td>1.5</td>
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<tr>
<td>Aud Strip</td>
<td>2/2</td>
<td>76/38</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Class Strip</td>
<td>4/3</td>
<td>30/25</td>
<td>6</td>
<td>3</td>
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</table>

<table>
<thead>
<tr>
<th>Slab on Grade</th>
<th>Area (ft^2)</th>
<th>Thickness (in)</th>
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</thead>
<tbody>
<tr>
<td>Auditorium</td>
<td>76x38</td>
<td>8</td>
</tr>
<tr>
<td>Classroom</td>
<td>30x25</td>
<td>6</td>
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</table>
Typical Details

Beam Detail (18 x 24)
- Flexure rebar 3 no.s #4
- 135° Links #4 @ 6” at 1’ from the end of beam

Wall Reinforcement (12 in)
- # 5 @12”
- 8 no.s # 9 @ Boundary Zone
ISLAND story
A design & development story….

Winter Quarter: success & challenges
ISLAND story
Central Glass Area
ISLAND story
Glass/Concrete Walkway (6-Column)
ISLAND story
Life Cycle Insight

lighting cost

cleaning cost
ISLAND story
Glass/Concrete Walkway (6-Column)
Island story
Life Cycle Insight

cooling cost

lighting cost
Island story
Life Cycle Insight

cleaning cost
lighting cost
cooling cost
ISLAND Story
Structural Insight

- A→E
  - Loss of structural rigidity of the building
    - Regular beam column framing
    - Change of design assumptions and modeling assumptions
      - Increased forces in beams members → potential congestion rebar → CM
- Loss of structural rigidity of the building
  - More thorough considerations in beam/wall/slab reinforcement detail (feasible?)

- Details of glass panel supporting system
  - Seamless – same level
  - Invisible – no bolts and nuts visible to users

**Slab to Wall Detail**

**Glass Panel supporting system and details**

- Single row ¾’’ 8’’ spacing bolts embedded in the concrete beam
- 2 no.s angles (L8x6x1/4) or prefabricated section
- 2 in glass panels
- HSS 4 x 3 x 1/8
ISLAND Story
Structural Insight

- Rework the central area vertical system to reduce columns from 6 to 3 columns
- Column align with proposed seminar rooms partition
- Larger columns 14 x 14 to be used

10 ft \rightarrow 17 ft from column to the classroom partition
Winter Quarter Design
Architect Insight

- Loss of concept and spatial qualities…
• More Natural Lighting
ISLAND story
MEP Insight

• Good Lighting

• High Solar Heat Gain
ISLAND story
3-Column Glass Walkway
ISLAND story
Final Design
Construction Manger Goals and Challenges

- CM Challenges of the “Island,” as defined by the Island Story
  - Keeping on Schedule and Under budget
- Goals of CM
  - Based on design development, meeting the needs of the owner, architect, structural engineer, and integrating with life cycle financial manager
Jobsite Traffic Route
Jobsite Logistics/Placement

Staging and on-site fabrication:
- Reachable by crane
- Used for building components that require on-site fabrication
- Formwork assembly and storage
- Rebar assembly
- Storage of components too heavy for forklift operations
Estimate Breakdown

<table>
<thead>
<tr>
<th>UNIFORMAT</th>
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<tbody>
<tr>
<td>A Substructure</td>
<td>$432,600</td>
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<tr>
<td>B Shell</td>
<td>$1,652,900</td>
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<tr>
<td>C Interiors</td>
<td>$855,000</td>
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<tr>
<td>D Services</td>
<td>$1,550,100</td>
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<tr>
<td>E Equipment &amp; Fittings</td>
<td>$373,300</td>
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<tr>
<td>F Special Construction &amp; Demolition</td>
<td>$120,300</td>
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<tr>
<td>G Building Sitework</td>
<td>$148,600</td>
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<tr>
<td>Z General</td>
<td>$2,403,800</td>
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<tr>
<td>TOTAL 2009</td>
<td>$7,136,600</td>
</tr>
<tr>
<td>TOTAL 2015</td>
<td>$8,037,000</td>
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</table>

Z General
- Architectural Fees - 10%
- Contingencies - 10%
- Over Head and Profit - 15%
- Builders Risk Insurance - 0.5%
- Commissioning - 0.5%
- Bond s- 2%
- Permits - 2%
- Equipment - 5%
- Site Tools - 2% of bare labor costs
- Construction Field Testing - $3,800
- Site Temporary Power - $2,200

Unformat Breakdown

- A Substructure: 6%
- B Shell: 20%
- C Interiors: 12%
- D Services: 22%
- E Equipment & Fittings: 5%
- F Special Construction & Demolition: 2%
- G Building Sitework: 31%
- Z General: 31%

- A Substructure $432,600
- B Shell $1,652,900
- C Interiors $855,000
- D Services $1,550,100
- E Equipment & Fittings $373,300
- F Special Construction & Demolition $120,300
- G Building Sitework $148,600
- Z General $2,403,800
- TOTAL 2009 $7,136,600
- TOTAL 2015 $8,037,000
# Estimate Breakdown

## Financial Adjustments
- 2009 RS Means Data
- Inflation = 2%
- Investment Rate = 3%
- 2015 Budget @ 3% = $8,700,000

## Masterformat

<table>
<thead>
<tr>
<th>Division</th>
<th>Description</th>
<th>Budget 2009</th>
<th>Budget 2015</th>
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<td>08</td>
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<td>Finishes</td>
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<td>32</td>
<td>Exterior Improvements</td>
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**TOTAL 2009** | $7,136,600 | **TOTAL 2015** | $8,037,000
Project Cost - City Comparisons

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<th>Project Location</th>
<th>Cost Percentage</th>
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<tr>
<td>Reno, Nevada</td>
<td>98.83%</td>
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<td>Madison, Wisconsin</td>
<td>97.85%</td>
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<tr>
<td>Los Angeles, California</td>
<td>106.80%</td>
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<tr>
<td>Albuquerque, New Mexico</td>
<td>91.31%</td>
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<tr>
<td>San Fransisco, California</td>
<td>124.00%</td>
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<tr>
<td>National Average</td>
<td>100.00%</td>
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<tr>
<td>Puerto Rico</td>
<td>83.63%</td>
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Estimate Progression and Lessons Learned

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<th>Method</th>
<th>Date</th>
<th>Cost (million)</th>
<th>$/SF</th>
<th>Lessons</th>
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<td>RS Means SF Estimator</td>
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<td>$4.95</td>
<td>$138</td>
<td>Poor Quality</td>
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<td>Project SF Comparisons</td>
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<td>$160</td>
<td>High Variability</td>
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<td>Winter Quarter Estimate</td>
<td>12-Mar</td>
<td>$6.13</td>
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<td>Concrete more economically Viable in PR</td>
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<td>Spring Quarter Estimate</td>
<td>5-May</td>
<td>$7.13</td>
<td>$237</td>
<td>Construction Costs in Puerto Rico less than national average</td>
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</table>
- Start Date: August 17, 2015
- Crane On Site: October 1, 2015
- Critical Stage: Superstructure Completion
- Milestone I (topping off): December 25, 2015

Project Schedule – Phase I

Phase I

- Structural concrete, placing, continuous footing, deep, direct chute, includes vibrating, excludes material
- Compaction, structural, common fill, 8’ lifts, vibratory plate
- Backfill, bulk, 6’ to 12’ lifts, dozer backfilling
- Structural concrete, in place, gravity retaining wall, 10’ high, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, slab on grade, direct chute, up to 6’ thick, includes vibrating, excludes material
- Backfill, bulk, 6’ to 12’ lifts, dozer backfilling
- Structural concrete, in place, columns, square, max reinforcing, 12’ x 12’, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, shear wall, min reinforcing, 12’, includes forms (4 uses), reinforcing steel, and finishing

4000 Site Mobile Crane - 34 Week Rental

- Structural concrete, in place, elevated slab, waftle slab, 30” dome, 125 psf superimposed load, 20’ span, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, beam, 6 kip per L.F., 25’ span, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, elevated slab, flat plate, 125 psf superimposed load, 20’ span, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, shear wall, min reinforcing, 12’, includes forms (4 uses), reinforcing steel, and finishing

- Structural concrete, in place, columns, square, max reinforcing, 12’ x 12’, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, shear wall, min reinforcing, 12’, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, columns, square, max reinforcing, 12’ x 12’, includes forms (4 uses), reinforcing steel, and finishing

- Structural concrete, in place, beam, 6 kip per L.F., 25’ span, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, shear wall, min reinforcing, 12’, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, columns, square, max reinforcing, 12’ x 12’, includes forms (4 uses), reinforcing steel, and finishing
- Structural concrete, in place, beam, 6 kip per L.F., 25’ span, includes forms (4 uses), reinforcing steel, and finishing

Timeline

- Start Date: August 17, 2015
- Crane On Site: October 1, 2015
- Critical Stage: Superstructure Completion
- Milestone I (topping off): December 25, 2015
### Project Schedule – Phase II

<table>
<thead>
<tr>
<th>Date</th>
<th>Task Description</th>
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<tr>
<td>12/22/15</td>
<td><em>Critical Stage I: Interiors Startup After Building Top-off</em></td>
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<tr>
<td>1/23/16</td>
<td><em>Critical Path: Mechanical Systems</em></td>
</tr>
</tbody>
</table>

#### Timeline

- **Start:** Mon 8/17/15
- **Finish:** Mon 9/5/16

#### Cost Breakdown

- **$0.00** to **$8,000,000.00**

#### Key Components

- **Insulation:** Ductwork, blanket type, fiberglass, flex, firestop, vapor barrier wrap, 70 lb density, 1/2" thick
- **Mechanical:** Ductwork, fabricated rectangular, 1000 to 2000 lb, aluminum alloy 3003-M14, includes fittings, joints, supports and allowance for a flexible connection, excludes insulation
- **Electrical:** Wire, type NM-B, asbestos sheathed, 1000 volt, THHN, 1/0", copper, black jacket

#### Technical Details

- **Hydraulic Passenger Elevators:** Base unit, standard finish, 1500 lb, 300 fpm, 2 stop
- **Pipe, Copper:** Tubing, solder, 1/2" diameter, type K, includes coupling & clevis hanger assembly 18" O.C.
Critical Stage II: Electrical Fixture Installation
Critical Path: Partition Walls and Painting
Milestone II: (crane off site): May 26, 2016
# Project Schedule – Phase VI

- **Critical Stage III: Interior Component Installation**
- **Building Start-Up/Commissioning:** July 22, 016
- **Milestone III (Substantial Completion):** August 5, 2016
- **Building Closeout and Turnover:** August 10, 2016
Clash Detection – CM/MEP
MEP Section

10.5' ME

1.5' MEP

1' Structure
• Chilled Beams
• Large Classrooms
• Computer Lab
• South facing façade
  "Island"

• Raised Flooring
• Auditorium
• Natural Ventilation
• Corridors
• Lobby
• North and East Facades
Sustainable Systems

Daylight Controls
• Dim lights on the perimeter and in the center area

Multi Service Chilled Beams
• Are prefabricated and generate less labor
• Help decrease clashes between systems

Raised Flooring
• Reduced Maintenance Cost
Natural Ventilation
CA Title 24 Requirements

• All spaces are within 20 ft of operable window
• Openings are at least 5% of floor area

Mechanical Ventilation
CA Title 24 Requirements

Larger of

1. 15cfm/person

2. Minimum rate (cfm/sqft) based on building type. Typically = .15cfm/sqft
Thermal Comfort
Humidity

Standard 55-2004 Comfort Range

- 1.0 clo = winter indoor clothing
- 0.5 clo = summer indoor clothing

Operative temperature = average of air temperature and mean radiant temperature

Ranges correspond to +/-0.5 PMV

~0.5 Clo
Knee Length Skirt + short sleeve shirt
Or Shorts + short sleeve shirt
Thermal Comfort
Natural Ventilation Areas

ASHRAE Standard 55-2004
Adaptive Comfort Model for Nat Vent Spaces
(Appplies when occupants have access to operable windows)
Lighting Design


<table>
<thead>
<tr>
<th>Category</th>
<th>Activity</th>
<th>Illuminance Target (footcandles)</th>
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<tbody>
<tr>
<td>A</td>
<td>Circulation Orientation</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>Public Areas</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>Simple Tasks</td>
<td>10</td>
</tr>
<tr>
<td>D</td>
<td>Large Tasks Good Contrast</td>
<td>30</td>
</tr>
<tr>
<td>E</td>
<td>Small Tasks Good Contrast</td>
<td>50</td>
</tr>
<tr>
<td>F</td>
<td>Small Tasks Poor Contrast</td>
<td>100</td>
</tr>
</tbody>
</table>

+/− 33% variation acceptable

Use 3800 lumen lamps in the Multi Service Chilled Beams with 58W per lamp

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of Lamps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditorium</td>
<td>51</td>
</tr>
<tr>
<td>Large Classroom</td>
<td>20</td>
</tr>
<tr>
<td>Lab</td>
<td>38</td>
</tr>
<tr>
<td>Small Classroom</td>
<td>10</td>
</tr>
<tr>
<td>“Island”</td>
<td>17</td>
</tr>
<tr>
<td>Office</td>
<td>4</td>
</tr>
<tr>
<td>Corridor</td>
<td>5</td>
</tr>
<tr>
<td>Lobby</td>
<td>17</td>
</tr>
</tbody>
</table>
Lighting Power Benchmark
CA Title 24 Area Category Method

<table>
<thead>
<tr>
<th>Room</th>
<th>Allowable(W)</th>
<th>Actual(W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditorium</td>
<td>4275</td>
<td>2863</td>
</tr>
<tr>
<td>Large Classrooms</td>
<td>1296</td>
<td>1085</td>
</tr>
<tr>
<td>Small Classrooms</td>
<td>717</td>
<td>600</td>
</tr>
<tr>
<td>Lab</td>
<td>2530</td>
<td>2119</td>
</tr>
<tr>
<td>“Island”</td>
<td>1320</td>
<td>947</td>
</tr>
<tr>
<td>Offices</td>
<td>224</td>
<td>204</td>
</tr>
<tr>
<td>Corridors</td>
<td>807</td>
<td>225</td>
</tr>
<tr>
<td>Lobby</td>
<td>2574</td>
<td>957</td>
</tr>
</tbody>
</table>
### Ventilation Needed Per Room

<table>
<thead>
<tr>
<th></th>
<th>Sqft</th>
<th>People/SF</th>
<th>People</th>
<th>cfm/person</th>
<th>cfm</th>
<th>ASHRAE cfm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Floor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditorium</td>
<td>2850</td>
<td>0.143</td>
<td></td>
<td>407.55</td>
<td>15</td>
<td>6113.25</td>
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<tr>
<td>Office</td>
<td>5000</td>
<td>0.01</td>
<td></td>
<td>50</td>
<td>15</td>
<td>750</td>
</tr>
<tr>
<td>Restroom</td>
<td>286</td>
<td>0.01</td>
<td></td>
<td>2.86</td>
<td>15</td>
<td>42.9</td>
</tr>
<tr>
<td>Classroom E</td>
<td>950</td>
<td>0.05</td>
<td></td>
<td>47.5</td>
<td>15</td>
<td>712.5</td>
</tr>
<tr>
<td>Classroom N</td>
<td>943</td>
<td>0.05</td>
<td></td>
<td>47.15</td>
<td>15</td>
<td>707.25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Second Floor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab</td>
<td>2346</td>
<td>0.01</td>
<td></td>
<td>23.46</td>
<td>15</td>
<td>351.9</td>
</tr>
<tr>
<td>Restroom</td>
<td>286</td>
<td>0.01</td>
<td></td>
<td>2.86</td>
<td>15</td>
<td>42.9</td>
</tr>
<tr>
<td>Classroom</td>
<td>1350</td>
<td>0.67</td>
<td></td>
<td>904.5</td>
<td>15</td>
<td>13567.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Third Floor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Office</td>
<td>2183</td>
<td>0.01</td>
<td></td>
<td>21.83</td>
<td>15</td>
<td>327.45</td>
</tr>
<tr>
<td>Office</td>
<td>925</td>
<td>0.01</td>
<td></td>
<td>9.25</td>
<td>15</td>
<td>138.75</td>
</tr>
<tr>
<td>Restroom</td>
<td>286</td>
<td>0.01</td>
<td></td>
<td>2.86</td>
<td>15</td>
<td>42.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LEED</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                |       |           |        |            |       |            |
| **Total**      | 22797.3 | 5668.14  | 8643.4 | 29636.49  | 7368.582 | 11236.42 |
Internal Heat Gains

• **Office Equipment**
  - Laptops - 40W
  - Desktops - 80W
  - Projectors - 100W

• **Occupants**
  - Light office work - 225Btu/hr

• **Lighting**
  - 58W per Lamp

<table>
<thead>
<tr>
<th>Air Handling Unit</th>
<th>Feet of Beams</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,900L/s = 12,501cfm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Auditorium</th>
<th>Large Class</th>
<th>Small Class</th>
<th>Lab</th>
<th>Seminar</th>
<th>Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>78</td>
<td>70</td>
<td>80</td>
<td>10</td>
<td>4</td>
</tr>
</tbody>
</table>
Sustainable Materials

• EcoRock Drywall
  80% less energy to produce
  80% recycled materials
  Can be fully reutilized
  Most mold-resistant
  •

Fly Ash
  1 ton reduces 1 ton of CO2 emissions
  Stronger and more durable
  Increases Workability
  Decreases heat of hydration
  •

Bamboo Flooring
  1 ton reduces 1 ton of CO2 emissions
  Stronger and more durable
  Easier to pour
eQuest Model

Goals

• Most accurate representation of the actual building envelope.
• Accurate load inputs
• Multiple HVAC systems

Customized Features

• Glazed roof openings
• Daylight controls
• Natural Ventilation
Baseline vs Radiator

334,000kWh/yr

259,000kWh/yr
## Energy Benchmarks

### Target Energy Performance Results (estimated)

<table>
<thead>
<tr>
<th>Energy</th>
<th>Design</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Performance Rating (1-100)</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>Energy Reduction (%)</td>
<td>76</td>
<td>26</td>
</tr>
<tr>
<td>Source Energy Use Intensity (kBtu/Sq. Ft./yr)</td>
<td>99</td>
<td>311</td>
</tr>
<tr>
<td>Site Energy Use Intensity (kBtu/Sq. Ft./yr)</td>
<td>30</td>
<td>93</td>
</tr>
<tr>
<td>Total Annual Source Energy (kBtu)</td>
<td>3,054,149</td>
<td>9,567,869</td>
</tr>
<tr>
<td>Total Annual Site Energy (kBtu)</td>
<td>914,416</td>
<td>2,864,631</td>
</tr>
<tr>
<td>Total Annual Energy Cost ($)</td>
<td>$49,580</td>
<td>$155,321</td>
</tr>
</tbody>
</table>

### kWh/year Comparison to Building in SoCal

<table>
<thead>
<tr>
<th>End Use</th>
<th>kWh/year Design</th>
<th>kWh/year Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling</td>
<td>83750</td>
<td>87340</td>
</tr>
<tr>
<td>Ventilation</td>
<td>60500</td>
<td>31070</td>
</tr>
<tr>
<td>Interior Lighting</td>
<td>134750</td>
<td>56840</td>
</tr>
<tr>
<td>Office Equipment</td>
<td>24750</td>
<td>81650</td>
</tr>
<tr>
<td>Misc</td>
<td>10750</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>314,500</td>
<td>256,900</td>
</tr>
</tbody>
</table>
Monthly Utility Bill

Annual Bill: $48,163
Decision PV-Systems

- Initial cost
- O&M costs
- Energy savings
- Performance during hurricane season

Diagram showing solar panels with labels for direct sunlight, diffuse sunlight, and reflected light.
Trade-Off Analysis PV-panels

- State Rebate
- Without State Rebate
- Rent of roof
- Buyback
Project Cash-Flow

- $10,000,000.00
- $8,000,000.00
- $6,000,000.00
- $4,000,000.00
- $2,000,000.00
- $0.00

Year of operation phase

- Equity cash flow
- Cash flow of direct payments

Year of operation phase

- $20,000,000.00
- $0.00
- $-20,000,000.00
- $-4,000,000.00
- $-6,000,000.00
- $-8,000,000.00
- $-10,000,000.00
Debt Service Coverage Ratio/Loan Life Coverage Ratio

DSCR

LLCR

year of operation phase

year of operation phase
Point of Break-Even

accumulated cashflow before financing

years of operation phase
Point of Break-Even

accumulated cashflow before financing

years of operation phase
O&M Cost

- Electricity: 48%
- Cleaning Cost: 24%
- Other O&M Services: 26%
- Water: 2%
Life-Cycle Cost Present Value

**with financing cost**
- Construction cost: 61%
- Operation & maintenance cost: 22%
- Replacement cost: 5%
- Interest payments: 12%

**without financing cost**
- Construction cost: 69%
- Operation & maintenance cost: 26%
- Replacement cost: 5%
Sensitivity Analysis

- construction cost
- o&m cost
- replacement cost
- financing cost
## LEED Certification

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Site</td>
<td>15</td>
</tr>
<tr>
<td>Water Efficiency</td>
<td>6</td>
</tr>
<tr>
<td>Energy and Atmosphere</td>
<td>15</td>
</tr>
<tr>
<td>Material and Resources</td>
<td>4</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>12</td>
</tr>
<tr>
<td>Innovation in Design</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>55</strong></td>
</tr>
</tbody>
</table>

**LEED SILVER CERTIFICATION**
Sustainable Performance

- use of natural ventilation
- sensing & monitoring of lighting
- use of solar energy
- use of local materials/ by-products ➞ Fly Ash, EcoRock
- open spaces ➞ permability/ connectivity
- ability of adaption of changed specification
Winter Quarter Presentation March 5\textsuperscript{th}
Meeting After Winter Presentation to define goals for Spring Quarter
Early April Schedule Pushed back by “Island” Development
Revit “check out” and “check in” model
Façade development between architect and construction manager
Model Coordination

Me: Using model, start at: 6:25pm PST
End at: 9:55pm PST

Sandra: hey everybody! i will be available from 2Pst onwards till i don’t know maybe 4-5 PST. i will be online at skype

Marielis*: using model: 9am -11;30am PST. friday apr 23.
opened file: CM-4.22.2010_Radiator_Model_(floor attachment)v5
new file saved as: A-4.23.2010_Radiator_Model_v6

Marielis*: using model: 12:30pm -2:30PST. friday apr 23.
opened file: A-4.23.2010_Radiator_Model_v6
new file saved as: A-4.23.2010_Radiator_Model_v6

Zan: Hi Marielis, so I took the 4.17.2010 for the change in wall ...I have not uploaded yet but seems you have another model..I will change your updatest model then ..I have made small change so i dont think it it take a lot of time. So I will use A-4.23.2010_Radiator_model v6

Can I confirm A-4.23.2010_Radiator_Model_v6 is the most update one and I will finish using model: 7:20pm -9:00PST. Friday apr 23.

Zan: Hi guys...you want to add anything specific on Sunday agenda? you add edit it on googledoc...For now, I just have two items but I will add one more about the prezentation soon...free feel to add yours

Zan: opened file: A-4.23.2010_Radiator_Model_v6
new file saved as:4.23.2010_Radiator_Model_v7

Marielis*: using model: 8pm -9PST. PST. Sat apr 24
opened file: 4.23.2010_Radiator_Model_v7
new file saved as:4.24.2010_Radiator_Model_v8
Thank You!

Axel Seifert
Afann Naqvi
Prof. Renate Fruchter
David Bendet
Erik Kneer
Greg Luth
Kristen and Tim and GPLA
Prof. Helmut Krawinkler,
Prof. Humberto Cavallin
Andrea Jungbecker
Cole Roberts
Prof. Cristina Algaze
Prof. Ronnie Borja
Glenn Katz
Willem Kymmel
Prof. Renate Fruchter
Matthias Ehrlich
Henry Tooryani