Spring Presentation
May 9th 2014
### Winter Quarter Decision Matrix

<table>
<thead>
<tr>
<th>Average Weighting</th>
<th>DD PT-slab</th>
<th>DD Composite Steel</th>
<th>L PT-slab</th>
<th>L Composite Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept and Design</td>
<td>13%</td>
<td>143</td>
<td>147</td>
<td>87</td>
</tr>
<tr>
<td>Structural Design</td>
<td>11%</td>
<td>121</td>
<td>92</td>
<td>102</td>
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<tr>
<td>Constructibility</td>
<td>13%</td>
<td>116</td>
<td>158</td>
<td>89</td>
</tr>
<tr>
<td>Energy Consumption</td>
<td>12%</td>
<td>101</td>
<td>98</td>
<td>97</td>
</tr>
<tr>
<td>Sustainability</td>
<td>12%</td>
<td>100</td>
<td>104</td>
<td>84</td>
</tr>
<tr>
<td>Building Health + Challenges</td>
<td>10%</td>
<td>101</td>
<td>101</td>
<td>87</td>
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<tr>
<td>Integration of the Big Idea</td>
<td>11%</td>
<td>113</td>
<td>113</td>
<td>83</td>
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<tr>
<td>Costs</td>
<td>18%</td>
<td>193</td>
<td>139</td>
<td>198</td>
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<tr>
<td><strong>100%</strong></td>
<td><strong>129</strong></td>
<td><strong>122</strong></td>
<td><strong>110</strong></td>
<td><strong>105</strong></td>
</tr>
</tbody>
</table>
General conditions

Campus placed in concavity between arms of a Sierra Nevada mountain range, which can be seen from 2nd level in the buildings.
- **Summer**: hot days / cold nights
- **Winter**: Cold, Snowfall
- **Sunshine hours a year**: 3650
- **Very dry desert climate**
- **Santana winds - dust**

**Climate data**

- Precipitation inches x10
- Snowfall inches x10
- Record high °F
- Average high °F
- Average temp °F
- Average low °F
- Record low °F
- Slightly sloped terrain
- Water Table an Frost Line at 4’ under grade
- Heavy Earthquakes

Probabilities for the next 50 years:

> 95% Magnitude 5.0
~ 20% Magnitude 7.0
Double diamond footprint Position on the site
Inspiration came from the surrounding environment.
1. Idea of climbing the mountain.... REVERSED!
2. So the building grows up when you climb it to get nice views to the mountains
3. CRACKING THE BUILDING IN TWO SEPARATE
4. SPLIT LEVELS
That enhances visual connections in the building and allow for the bigger clearance in rooms
5. CREATING A LIGHT TUNNEL IN THE HEART
Atrium provides even more daylight
6. CONNECTING SPLIT LEVELS BY ADA RAMP SO CONTINUOUS CARPET IS CREATED WITHIN ENTIRE BUILDING
Slipping Building Concept: Split Floor Ramp System

Two halves of the building slide and connections are detailed to allow slippage during earthquake.

ASCE 7-10 Chapter 12.12.3

Building designed for 2% Story Drift
Top of building seismic expansion joint
→ requires 1’ joint minimum.

Seismic Expansion Joint
http://mmsystemscorp.com/ejp/

Stanford University - Center for Clinical Science Research
Teflon and Polished Steel Sliders

1’ gap at roof
Linear interpolation of gap sizing at different story levels

Roof and Façade Detailing
Ramp Consideration

35' RC Beam
24" x 12"

10" Slab

Seismic Gap 1'

Ridge 2014
Connection Details

Bolted Connection
Open or Closed
Swaged Socket

Gusset Plate welded to C-Channel
Temporary formwork for ramp construction

Temporary Cross Members

Temporary Eastern Side Vertical Supports 10ft OC

TERRACE

LVL 2.5

LVL 1.5

Temporary Horizontal Shoring/Formwork

Completed in 3 Sections
HEALTHY LIVING

• Reduce VOC loads
• Remove CO2, Replacing it with O2
• People perform better in environments with plants
  • Reduce Stress
  • Prevent Fatigue
Healthy Materials

Renewable

Modular floor carpet tiles

Thermafleece - Insulating wool batt

Life Cycle

Recycle

Local
INTERACTION

Total Electricity Consumption
Equivalent pounds of carbon dioxide emitted into the atmosphere today

- MLE
  - 206 occupants
  - 2,733 Lbs of CO2

- Performance Now
  - 10%

- Comparison
- History
- Unit equivalent

- Introduction
- Electricity
- Comparisons
- Competition
- Green Tips
- Green Features
- Weather
Fiber Optic Daylighting

Passive Dynamic Glazing
Site visualization with BIM

2D View

Handrails

Temporary Gravel cover

3D View

Fall protection gear

Slips, Trips & Falls
ENTRANCE LEVEL

LEGEND
- AUDITORIUM
- LARGE CLASSROOM
- MEP

RIDGE 2014
Production Strategy

Prefabricated aluminum façade

- Corrosion resistant alloy
- Surface is dirt-repellent

DirtT modular internal walls

- Sustainable technology
- 1/10 installation time
- 20% cheaper
**RIDGE 2014**

**Loads**

**Snow Load** 15 psf

**Dead Load**
- 125 psf
- 115 psf
- 115 psf
- 115 psf

**Live Load**
- 30 - 100 psf
- 30 - 100 psf
- 30 - 100 psf
- 40 - 100 psf

**Site Class B** (Rock)

**1378 k (SW-side) / 1655 k (NE-side)**

**Superimp. Dead Load** 25 psf
**Solar Panels** 10 psf

**Airhandling Unit** 1,5 kips
**Water Cistern** 10 kips
RIDGE 2014

Floorplan: Basement

12'' shear wall

12'' x 12'' columns
12'' SHEAR WALL

12'' x 12'' COLUMNS

12'' x 12'' SLANTED COLUMNS

Cantilever (4' / 8')

Cantilever (6' 6'' / 10' 6'')

PT Girders
- 20'' x 36''
- 15'' x 30''

Floorplan: 1st Floor
Tendon Layout: Non-Auditorium Side

Tendon between Gridline C and D

Distributed tendons

7'' Slab
5 ksi NW-Concrete

Banded tendons
**Tendon Layout: Auditorium Side**

### PT Slab

- **Bay size**: 18' x 21'
- **Slab Thickness**: 7"
- **Max. Sag**: 2.5"
- **Typical Strand Size**: 0.5"
- **GR270 Monostrand**
- **PT stress**: 216 ksi
- **Mild Reinforcement**: #5 at 6"

### Long Term Loss

- **13.5%**

---

**Tendon on Gridline 3**

- **Band Tendons**
- **Distributed Tendons**

**Locations**

- **Span 1**: 127.5 in
- **Span 2**: 182.5 in
- **Span 3**: 100.87 in
- **Span 4**: 208 in
- **Span 5**: 196,625 in
- **Span 6**: 212 in
- **Span 7**: 127.5 in
RIDGE 2014

SLAB DESIGN: Deflections

Class U

Terrace Level

3rd Level

Deflections

- 0.20 in
- 0.22 in
- 0.35 in
Max $P = 106$ kips

Halfen HDB Software Tool

European Technical Approval ETA 12/0454
Slab – Column Detail

#6 @ 10"

#5 @ 8"

7” SLAB

12” x 12” Column

Slab – Wall Detail

#6 @ 10"

#5 @ 8"

Additional Wall Shear Reinforcement

Punching Reinforcement not shown
**Slab – Slanted Column Detail**

Max \( P = 90 \text{ kips} \)

4 #6

Additional Reinforcement

3 #5

#6 @ 10“

#5 @ 8“

7“ Slab

12“ x 12“ Column
2 independent Models

Auditorium Side

Non-Auditorium Side

Shear Wall Layout
Non-Auditorium Side - Maximum Story Drift

**X-Direction**

- Max 0.3%

**Y-Direction**

- Max 0.9%

<table>
<thead>
<tr>
<th>Story</th>
<th>Max Story Drift</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>0.0007819</td>
</tr>
<tr>
<td>3</td>
<td>0.0020714</td>
</tr>
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</table>
Auditorium Side - Maximum Story Drift

**X-Direction**
- **Global X-Direction**
- **Color**

**Y-Direction**
- **Global Y-Direction**
- **Color**

**Maximum Story Drifts**
- **MAX 1,7%**
- **MAX 2,0%**

<table>
<thead>
<tr>
<th>Story 4</th>
<th>0.0043611</th>
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<tbody>
<tr>
<td>Story 4</td>
<td>0.0052557</td>
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</tbody>
</table>

Story Number:
- Story 4
- Story 3
- Story 2
- Story 1
- Base
Foundations: 6" Slab on grade
36" x 36" strip footing
6' by 6' Footings (1.5' deep)

12" x 12" Columns
8 #9 Bars
Maximum Force 440 kips
Background: Seismic Assessment

Assessment by Static Pushover Analysis (FEMA 273 .. ASCE 41)

Ref: R.O. Hamburger
Nonlinear PMM Hinge

Hinges are calculated from section design
Non-Auditorium

Auditorium
Non-Linear Model

Etabs – Comparison Mode shapes

0.63 s

Linear Model

0.66 s

0.41 s

0.36 s
Very little nonstructural damage for 2500 year earthquake

Safe for use immediately following the earthquake

<table>
<thead>
<tr>
<th>EQ E-W</th>
<th>Nonlinear Roof Displacement</th>
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<tr>
<td></td>
<td>Non-Auditorium</td>
</tr>
<tr>
<td>DBE</td>
<td>1.07in</td>
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<tr>
<td>MCE</td>
<td>1.79in</td>
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<table>
<thead>
<tr>
<th>EQ N-S</th>
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<tr>
<td>DBE</td>
<td>1.15in</td>
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<tr>
<td>MCE</td>
<td>2.03in</td>
<td>3.11in</td>
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### Yielded Shear Walls

<table>
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<th>EQ E-W</th>
<th>Non-Auditorium</th>
<th>Auditorium</th>
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<tbody>
<tr>
<td>DBE</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>MCE</td>
<td>5</td>
<td>11</td>
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</tbody>
</table>

### IO Shear Walls

<table>
<thead>
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<th>Non-Auditorium</th>
<th>Auditorium</th>
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<tbody>
<tr>
<td>DBE</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MCE</td>
<td>1</td>
<td>0</td>
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</table>

### LS Shear Walls

<table>
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<th>EQ E-W</th>
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<th>Auditorium</th>
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<tbody>
<tr>
<td>DBE</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MCE</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

### CP Shear Walls

<table>
<thead>
<tr>
<th>EQ E-W</th>
<th>Non-Auditorium</th>
<th>Auditorium</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBE</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MCE</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Structural Health Monitoring

Accelerometer

Back Calculation of Building Response
Wall Hung Radiators

- No impact on room height
- More responsive than radiant floor heating
- Improved thermal comfort
Radiant ceiling panels
- Low risk of draft
- Require less overhead space than chilled beams
- Higher capacity compared to radiant floor cooling
- Sized for minimum ASHRAE requirements
- Auditorium - Personalized ventilation.

AHU 1
4100 CFM

AHU 2
2750 CFM

UFAD PERSONAL VENTILATION
Floor Sandwich

- PT Slab: 7”
- Ducts: 8”

High Clearance for Occupant Comfort
- No rooftop air-handlers
- Possible with the 10ft projection

**Basement Level**

**Top Floor**
- Panels: 171
- Total capacity: 56 kW
- Annual Production: 84,200 kWh
- Annual Energy Savings: $23,370
Solar Economics

**Trade-Off Analysis: PV- Panels**

- **4% Discount Rate**
- **Breakeven point at 12 years**
Building Responsiveness - Circadian Rhythms
Estimated Energy Savings: 800 kWh

Parans Tracker
Sustainable Target Value: Water Challenge
6 Tidal Cells
- Sized above 5%
- of building area
Water Target

Method of accounting for the Living Machine

<table>
<thead>
<tr>
<th>Water Use</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilet Flow Rate:</td>
<td>0.0 gal/flush</td>
</tr>
<tr>
<td>Urinal Flow Rate:</td>
<td>0.0 gal/flush</td>
</tr>
<tr>
<td>WC Sink Flow Rate:</td>
<td>1.3 gal/min</td>
</tr>
<tr>
<td>Lab Sink Flow Rate:</td>
<td>0.0 gal/min</td>
</tr>
<tr>
<td>Kitchen Sink Flow Rate:</td>
<td>3.0 gal/min</td>
</tr>
<tr>
<td>Shower Flow Rate:</td>
<td>0.0 gal/min</td>
</tr>
<tr>
<td>Landscaping Water Use:</td>
<td>0 gal</td>
</tr>
<tr>
<td>Rainwater Collection:</td>
<td>0 gal</td>
</tr>
</tbody>
</table>
Ground Source Heat Pump
Small Cistern
- 5’ Diameter
- 7.5’ Height
- 1100 Gallons
Reverse Osmosis
- Removes Chemicals
- Purifies on-demand

- Services students after recent rainfall

Reverse Osmosis Purification
RIDGE 2014

MEP Education Room

Living Machine UV Disinfection

Energy Tracking Board
Passive Dynamic Glazing

- In place of roller shades
- Less maintenance
- Improved responsiveness

Passive Dynamic Glazing
- **February:** Initial Material Estimates
- **March:** Add Energy Consumption
- **April:** Refine Design, Add Materials
- **May:** Account for Living Machine, Adjust PVs
## Performance Relative to Life Cycle Impact Targets

<table>
<thead>
<tr>
<th></th>
<th><strong>Target</strong></th>
<th><strong>Project</strong></th>
<th><strong>%</strong></th>
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</thead>
<tbody>
<tr>
<td>Carbon (kgCO2e)</td>
<td>5,631,313</td>
<td>5,046,627</td>
<td>90%</td>
</tr>
<tr>
<td>Energy (MJ)</td>
<td>131,385,813</td>
<td>74,463,522</td>
<td>57%</td>
</tr>
<tr>
<td>Water (kgH2O)</td>
<td>110,021,918</td>
<td>303,988,344</td>
<td>276%</td>
</tr>
<tr>
<td>Ozone (kgCFC11e)</td>
<td>-</td>
<td>2.23E-01</td>
<td>-</td>
</tr>
</tbody>
</table>
EROSION & DUST CONTROL PLAN

Water truck flow throughout site in 2 hr intervals throughout dry months

Sandbag barrier around storm drains

Concrete Washout w/non-permeable base layer, soil berm, and sandbag perimeter

Pea-gravel 1/4" base

Incoming direction of rainfall/snow melt on to site

Silt Fencing lining outside of security fence

Silt Fencing lining inside of security fence

Pea-gravel 1/4" base

Spoils to be covered up w/permeable covering when not in use

Entrance/Exit w/temp cattle guard

Prevailing wind direction

Hillside

Designed for Both Building Footprints
## CONSTRUCTION EQUIPMENT

<table>
<thead>
<tr>
<th></th>
<th>TOWER CRANE</th>
<th>MOBILE CRANE</th>
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</thead>
<tbody>
<tr>
<td>Space Available</td>
<td>✔️</td>
<td>✗</td>
</tr>
<tr>
<td>Operating Efficiency</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>Price</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>Manageability</td>
<td>✗</td>
<td>✔️</td>
</tr>
<tr>
<td>Mobilization</td>
<td>✗</td>
<td>✔️</td>
</tr>
</tbody>
</table>

### FINAL DECISION:
**MOBILE HYDRAULIC ALL TERRAIN 30 TON CRANE WITH 101’ BOOM**

### OTHER EQUIPMENT
- JOHN DEERE DIESEL POWERED **EXCAVATOR**. BUCKET CAPACITY 0.79 CY
- JOHN DEERE DIESEL POWERED **DOZER**. BLADE CAPACITY 2.9 CY
- JOHN DEERE DIESEL POWERED **GRADER**. BLADE PULL 28,990 LBS
SCHEDULE

Construction Starts

- May
- June
- July
- August
- September
- October
- November
- December
- January
- February
- March

Building Close-in

HVAC

ELECTRICAL

INTERIOR FINISHES

PLUMBING

EXTERIOR FINISHES

LANDSCAPING

SUBMITTAL

PROCUREMENT

SITEWORK

FOUNDATION

EXCAVATION

FRAMING

217 WORKING DAYS
FACADE
SPLIT LEVEL
CREW DISTRIBUTION

CREW 2
LVL 1
(AREA A)

CREW 1
LVL 1.5
(AREA B)

CREW 2
LVL 2
(AREA A)
WINTER

| RS Means Bare Estimate | Assembly Cost | Historic Comparison | Unit Cost | Modify Estimate |

SPRING

- Synced BIM Models
- Weekly Quantity Extraction Using Innovaya
- Exported Innovaya Takeoffs to TVD

WHY INNOVAYA
- Easy To Use
- More Reliable Quantity Takeoffs
- Avoids Repetition
BATCH QUANTITIES EXPORTED TO TVD
### CONCRETE

<table>
<thead>
<tr>
<th>CSI Masterformat 2010</th>
<th>ESTIMATED VALUE</th>
<th>TARGET VALUE</th>
<th>VALUE DELTA</th>
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<tbody>
<tr>
<td><strong>TOTAL</strong></td>
<td>$ 9,787,424</td>
<td>$ 9,600,000</td>
<td>$(187,424)</td>
</tr>
<tr>
<td>General Requirements</td>
<td>$ 1,062,124</td>
<td>$ 1,152,000</td>
<td>$ 89,876</td>
</tr>
<tr>
<td>Concrete</td>
<td>$ 1,624,898</td>
<td>$ 1,692,000</td>
<td>$ 67,102</td>
</tr>
<tr>
<td>Metals</td>
<td>$ 1,035,600</td>
<td>$ 672,000</td>
<td>$(363,600)</td>
</tr>
<tr>
<td>Finishes</td>
<td>$ 652,378</td>
<td>$ 600,000</td>
<td>$(52,378)</td>
</tr>
<tr>
<td>Plumbing/Mechanical/Electrical</td>
<td>$ 1,911,700</td>
<td>$ 1,968,000</td>
<td>$ 56,300</td>
</tr>
<tr>
<td>Earthwork</td>
<td>$ 453,332</td>
<td>$ 468,000</td>
<td>$ 14,668</td>
</tr>
<tr>
<td>Special Construction</td>
<td>$ 3,047,391</td>
<td>$ 3,048,000</td>
<td>$ 609</td>
</tr>
</tbody>
</table>

**Final Estimated Value =** $ 9,790,000

**Pie Chart:**
- **General Requirements** 11%
- **Concrete** 17%
- **Finishes** 7%
- **Metals** 10%
- **Plumbing/Mechanical/Electrical** 20%
- **Earthwork** 5%
- **Special Construction** 30%
Team Process Improvements from Winter Quarter

- More subgroup meetings
- Enhanced and efficient communication
Clash Detection

Model integration & clash tests

Setting rules & saving viewpoints with comments

Clash detection meetings & resolutions
Graphic communication on key challenges

Façade – CM/ARCH

Ramp – SE/ARCH

Key Skills Demonstrated

- Synchronous Graphic Collaboration
- Simple sketches enhance interdisciplinary understanding
- A team is smarter than the individual member
**KEY LESSON LEARNED = TRANSPARENCY IS KEY**
Lessons Learned

“People are more lovable in person”

“Learn the most when other disciplines answer your questions”

“Talk with sensitivity and compromise”

“You never know what your cyber friends are doing if their web-cam is off”

“Patience does not solve everything”

“There is always something someone did not tell you”
OWNER ADDED VALUE

- Accurate cost estimation
- Inspire students
- Cut utility costs
- Sustain severe earthquake
- Cut Maint. cost
- Interactive student learning
Thank you owners, mentors, and Renate!

Danke!

Dziękuję bardzo!