Winter Presentation
March 15th, 2013

Ridge Team 2013
"We are the Ridge Team, which, from now on, stands for awesome."
Owners: Sinan M., Anirudh R., & Maria S.

Chico, CA
Laura M. (CM)

Stanford, CA
Stephanie C. (SE)
Ramon I. (CM)

Puerto Rico
Pablo C. (A)
Jorge S. (A)

Germany
LCFM Consultants:
Stefan E. (LCFM)
Toni G. (LCFM)

Denmark
Kleanthis C. (MEP)

Slovenia
Stefan M. (SE)
Climate Challenges

- Sunshine: 3650 hr/yr
- Precipitation: 7.30 inches/yr
- Heating degrees: 5680 hr/yr
- Cooling degrees: 508 hr/yr
- Average humidity: 55%
Available in Campus
- Natural Gas for heating and DHW
- Chilled water

Alternative sources
- Ground source heat pump for heating/cooling
- Hybrid Systems

Renewable energy potential
- Photovoltaics
- Wind turbine

Harvest Rainwater
~3,6 gal/sf/yr
Reno’s University Energy Goals

1. Reduce energy consumption & use renewable energy

2. Minimize evening building usage

3. Maximize building utilization

4. Winter space temperatures: 68F
   Summer space temperatures: 78F
Big Idea

Industrial Evolution

Technology

Transformation

Convergent

Production

Divergent

Creativity

Flexible Spaces

Rapid Prototyping Labs
Transparent Engineering Building (TEB)
1. Steel
2. Concrete
### Orientation

#### Architecture
- Structure
- MEP
- Construction

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Total EUI (kBtu/sf/yr)</th>
<th>Life Cycle Energy Cost ($)</th>
<th>Net CO₂ (tn/year)</th>
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<tr>
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<td>67</td>
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</table>
Concept
Site/ TEB Concept
Site/ TEB Concept
Level -1 (Basement)

- Rapid Prototyping Labs
- Faculty Offices
- Auditorium
- Bathroom, cores, stairs, elevator...
- Student Offices & area
- Seminar Rooms

Emergency Exit
Entrance
Level -1 (Basement)
Level 0 (Campus Entrance)
Level 0 (Campus Entrance)
Level 1
Level 2
Section bb
Section cc

Architecture
Structure
MEP
Construction
Dynamic Façade System

Campus Entrance / East Façade / Privacy Glass
Dynamic Façade System

West Façade - Roller Blinds

- Simple device
- Keeps out glare and UV rays
- Easy to operate

South Façade / Parking Entrance
Square Footage Graph

- Faculty Offices
- Department Chair’s Office
- Senior Administration Office
- Administrative Assistants
- Faculty Lounge
- Student Offices
- Auditorium
- Large Classrooms
- Small Classrooms
- Seminar Rooms
- Instructional Labs
- Server Room
- Storage Rooms
- Cafe
## Load Calculation

<table>
<thead>
<tr>
<th></th>
<th>Steel</th>
<th>Concrete</th>
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</thead>
<tbody>
<tr>
<td><strong>Roof Dead Load</strong></td>
<td>90 psf</td>
<td>180 psf</td>
</tr>
<tr>
<td><strong>Roof Live Load</strong></td>
<td>20 psf</td>
<td>--</td>
</tr>
<tr>
<td><strong>Roof Snow Load</strong></td>
<td>40 psf</td>
<td>--</td>
</tr>
<tr>
<td><strong>Other Floor Dead Loads</strong></td>
<td>74 psf</td>
<td>150 psf</td>
</tr>
<tr>
<td><strong>Other Floor Live Loads</strong></td>
<td>60-100 psf</td>
<td>--</td>
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<tr>
<td><strong>Wind Shear</strong></td>
<td>100 mph =&gt; 1.5 kips / foot</td>
<td>--</td>
</tr>
<tr>
<td><strong>Earthquake Shear</strong></td>
<td>Sa = 0.4g =&gt; 680 kips</td>
<td>870 k</td>
</tr>
<tr>
<td><strong>Retaining-soil Shear</strong></td>
<td>4.7 kips / foot</td>
<td>--</td>
</tr>
</tbody>
</table>

Per International Building Code (IBC) 2006 with amendments provided by the city of Reno, Nevada

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-- || -- means same load
## Soil Conditions

**Slope:** 7' - 14' above volcanic rock

110000 cf excavation

### Depth of Excavation vs. Soil Type

<table>
<thead>
<tr>
<th>Depth of Excavation</th>
<th>Soil Type</th>
<th>Thickness</th>
<th>Bearing Capacity</th>
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</thead>
<tbody>
<tr>
<td>0 inches (0 ft.)</td>
<td>Stony Sandy Loam and Heavy Loam</td>
<td>19 inches (1.58 ft.)</td>
<td>1,500 psf</td>
</tr>
<tr>
<td>19 inches (1.58 ft.)</td>
<td>Sandy Clay Loam</td>
<td>10 inches (0.83 ft.)</td>
<td>1,500 psf</td>
</tr>
<tr>
<td>29 inches (2.42 ft.)</td>
<td>Clay and Clay Loam</td>
<td>27 inches (2.25 ft.)</td>
<td>1,500 psf</td>
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<tr>
<td>56 inches (4.67 ft.)</td>
<td>Very Gravelly Sandy Loam and Very Gravelly Loam</td>
<td>28 inches (2.33 ft.)</td>
<td>5,000 psf</td>
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<tr>
<td>84 inches (7 ft.)</td>
<td>Volcanic Rock</td>
<td>Unknown</td>
<td>8,000 psf</td>
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</tbody>
</table>

*Figure from Ridge 2012*
Foundations

• 6" - 1' slab & 1' - 2' pad footings
• Idea: to extend horizontally outside the building perimeter for 4' to stabilize
Retaining Walls

- height: 10' - 14'
- Idea: drain the water and collect it
Steel: Level -1

**Architecture**

**Structure**

**MEP**

**CM**

---

**BLUE** - Retaining Wall
**GREEN** – W14x43 Girders
**ORANGE** – W8x31 Beams @ 4’ Spacing
**RED** – W14x61 Columns
**PURPLE** – W14x61 Slanted Columns
**NAVY** – W12x40 Columns

- Slab Openings

**Composite Slab:**
6” Concrete on Steel Deck
Steel : Level 0

Architecture
Structure
MEP
CM

GREEN —
W14x43 Girders
BLUE —
W14x74 Girders
ORANGE —
W8x31 Beams @
4’ Spacing
RED —
W14x61 Columns
PURPLE —
W14x61 Slanted
Columns
NAVY —
W12x40 Columns

- Slab Openings

Composite Slab:
6” Concrete on
Steel Deck
Auditorium Slab:
Prefab PT 2’ Slab
Steel : Level 1

GREEN –
W14x43 Girders

ORANGE –
W8x31 Beams @
4’ Spacing

BLUE –
W8x28 Beams @
6’ Spacing

RED –
W14x61 Columns

PURPLE –
W14x61 Slanted
Columns

NAVY –
W12x40 Columns

Slab Openings

Composite Slab:
6” Concrete on
Steel Deck
Steel: Level 2 (Roof)

**GREEN** –
W14x43 Girders

**ORANGE** –
W8x31 Beams @ 4' Spacing

**BLUE** –
W8x28 Beams @ 6' Spacing

**RED** –
W14x61 Columns

**PURPLE** –
W14x61 Slanted Columns

**NAVY** –
W12x40 Columns

- Slab Openings

Composite Slab:
6” Concrete on Steel Deck
Lateral Systems

Challenge: Torsion due to irregularity

Cross bracing will be exposed, so aesthetics will also play a role in selection.

**RED** - Location of cross bracing shown on Level 0 plan
Floor Sandwich: Steel

Total height: 15 inch

Distribution

<table>
<thead>
<tr>
<th>Component</th>
<th>Thickness</th>
</tr>
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<tbody>
<tr>
<td>Composite slab</td>
<td>6 inch</td>
</tr>
<tr>
<td>Steel beams</td>
<td>8 inch</td>
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<tr>
<td>Ducts &amp; instal.</td>
<td></td>
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<tr>
<td>Ceiling panels</td>
<td>1 inch</td>
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<tr>
<td>Total:</td>
<td>15 inch</td>
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<tr>
<td>Girders</td>
<td>13 inch</td>
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</table>

Overhead

- Deck
- Distribution ducts
- Suspended ceiling
- Corridor
- Room
- Main Ducts
- Supply Air
- Return Air
Load Paths
Concrete: Level -1

**BLUE** - Retaining Wall
**ORANGE** - 2’x2’ Columns
**GREEN** - 1.5’x2’ Beams
**RED** - Shear Walls & Bracing

- Slab Openings

**Floor Slab:**
10” Reinforced Concrete Slab
Concrete: Level 0

**Architecture Structure**

**MEP CM**

**ORANGE** –
2’x2’ Columns

**GREEN** –
1.5’x2’ Beams

**RED** –
Shear Walls & Bracing

- Slab Openings

Floor Slab:
10” Reinforced Concrete Slab

Auditorium Slab:
Prefab PT 2’ Slab
Concrete: Level 1

ORANGE –
2’x2’ Columns
GREEN –
1.5’x2’ Beams
RED –
Shear Walls & Bracing
- Slab Openings

Floor Slab:
10” Reinforced Concrete Slab
Concrete: Level 2 (Roof)

Orange – 2’x2’ Columns
Green – 1.5’x2’ Beams
Red – Shear Walls & Bracing
Gray – Slab Openings

Floor Slab:
10” Reinforced Concrete Slab
Floor Sandwich: Concrete

Total height: 20 inch

<table>
<thead>
<tr>
<th>Component</th>
<th>Thickness</th>
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<tr>
<td>Floor finish</td>
<td>1 inch</td>
</tr>
<tr>
<td>Plenum</td>
<td>4 inch</td>
</tr>
<tr>
<td>Reinforced concrete slab</td>
<td>10 inch</td>
</tr>
<tr>
<td>Plenum</td>
<td>4 inch</td>
</tr>
<tr>
<td>Ceiling panels</td>
<td>1 inch</td>
</tr>
<tr>
<td>Total</td>
<td>20 inch</td>
</tr>
<tr>
<td>RC beam</td>
<td>9 inch</td>
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</tbody>
</table>

Underfloor Distribution

- Deck
- Return plenum
- Suspended ceiling
- Room
- Supply plenum
- Supply Air
- Return Air
HVAC Requirements

Heating Set Points: 68 F
Outdoor temperature: 19.9 F

Cooling Set Points: 78 F
Outdoor temperature: 92.2 F

Indoor Relative Humidity: 50%
Ground Source Heat Pump
- Energy efficient with low GHG emissions
- High capital cost and low operational costs (payback ≥5 years, Commercial Buildings Tax Deduction)

System ~80 tons
- Boreholes ~300 ft
- Water-to-water system
- Seasonal heat/cold storage
- Energy recovery savings up 9%

Hybrid Systems

Dual Source:
- decrease cost & efficiency

Solar Thermal:
- Dump excess solar energy to the ground, decrease cost and groundwater well depth ~11%
Air Distribution

Mechanical Ventilation

• Overhead air distribution - VAV system
• Underfloor air distribution
• Displacement Ventilation

Natural ventilation

• Stack ventilation

Control systems (of occupancy, CO2 concentration, weather provision)
UFAD & DV

UFAD
- Improved thermal comfort
- Improved ventilation efficiency and IAQ
- Reduce energy use
- Fan energy savings
- Reduced electrical demand

UFAD/DV - System
- 4” pressurized supply & return plenum
- Passive floor mounted diffusers
- Dehumidification with portion of return air
- Passive VAV cooling and fin tube heating on perimeter
# Vasari Analysis

<table>
<thead>
<tr>
<th></th>
<th>Natural Gas*</th>
<th></th>
<th>GSHP**</th>
<th></th>
<th>UFAD***</th>
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<td>Glazing</td>
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<td>80%</td>
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<td>80%</td>
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<td>kWh/sf/yr</td>
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<td>163</td>
<td>134</td>
<td>187</td>
<td>81</td>
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*Furnace with gas heat, temperature economizer, DHW unit
**HP system, temperature economizer, DHW unit
***VAV, Gas fired HW boiler, VV HW pump, HW coil
Duct Network
• Natural stack ventilation in corridor, atriums and perimeter
• Low energy fan during winter
Site Logistics
## Cost Estimate

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<th>Concept</th>
<th>Estimate</th>
<th>Difference From Target</th>
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<tr>
<td>L - Steel</td>
<td>$8,313,600</td>
<td>$\text{\textdollar} (13,600)</td>
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<tr>
<td>L-Concrete</td>
<td>$8,296,800</td>
<td>$3,200</td>
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Cost distribution

- **D Services**
  - $2,895,000
  - 35%

- **E Equipment and Furnishing**
  - $-
  - 0%

- **F Specialty Construction**
  - $-
  - 0%

- **G Building Sitework**
  - $75,000
  - 1%

- **H General Conditions**
  - $1,385,600
  - 17%

- **A Substructure**
  - $366,000
  - 4%

- **B Shell**
  - $2,351,000
  - 28%

- **C Interiors**
  - $1,241,000
  - 15%
TVD - Concrete

![Bar graph showing TVD - TARGETS BY CLUSTER Steel](chart.png)
Double Diamond (DD)

1. Central (C)
2. X - Lattice (X)
## Orientation

![Orientation map](image)

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Site/Second Concept
Site/Second Concept
Level -1 (Basement)

- Core
- Prototyping Lab
- Auditorium
- Faculty Offices
- Collaboration Space
Level -1 (Basement)
Level 0 - (Campus Entrance)
Level 0 - (Campus Entrance)
Level 1
Level 2
Flexible Spaces
Flexible Spaces
Flexible Spaces
Section aa
Section bb

Architecture
Structure
MEP
Construction

Summer

Winter
Section cc
3d views

East Façade/
DD Central

South Façade/
DD Central
3d views

East Facade/
X Lattice

South Façade/
X Lattice
Atrium Design Evolution

**Rectangle**
- Easier to fit program
- Concern about shearing along weak axis

**Circle**
- Stronger in the weak axis
- More challenging programmatically

**Cylinder**
- Simpler form while maintaining circular shape

**Hyperboloid**
- Interaction between A + SE
- Interesting, iconic form
- Added strength in multiple directions
- More challenging/costly to design & build
- Does not fit architectural scheme well
Hyperboloidal Exploration

Architecture
Structure
MEP
Construction
Central: Level -1

**Orange** –
1.5’x1.5’ Columns

**Green** –
4’x1’ Columns

**Navy** –
1.5’ x2’ Beams

**Blue** –
Tension Ring

**Red** –
Shear Walls

Slab Openings

Floor Slab: 10” Reinforced Concrete Slab
Central: Level 0

**ORANGE** – 1.5’x1.5’ Columns

**GREEN** – 4’x1’ Columns

**NAVY** – 1.5’ x2’ Beams

**BLUE** – Tension Ring

**RED** – Shear Walls

Slab Openings

Floor Slab: 10” Reinforced Concrete Slab
Central: Level 1

**Orange** – 1.5’x1.5’ Columns
**Green** – 4’x1’ Columns
**Navy** – 1.5’ x2’ Beams
**Blue** – Tension Ring
**Red** – Shear Walls

- Slab Openings

**Floor Slab:**
10” Reinforced Concrete Slab
Central: Level 2 (Roof)

**Orange** –
- 1.5’x1.5’ Columns
- 4’x1’ Columns

**Green** –
- 1.5’ x2’ Beams

**Blue** –
- Tension Ring

**Red** –
- Shear Walls
- Slab Openings

**Floor Slab:**
- 10” Reinforced Concrete Slab
X-Lattice: Level -1

- **ORANGE** – 1.5’x1.5’ Columns
- **NAVY** – 1.5’ x2’ Beams
- **BLUE** – Tension Ring
- **RED** – X-Lattice Wall
- Slab Openings

- Floor Slab: 10” Reinforced Concrete Slab
X-Lattice: Level 0

Architecture
Structure
MEP
CM

ORANGE –
1.5’x1.5’ Columns

NAVY –
1.5’ x2’ Beams

BLUE –
Tension Ring

RED –
X-Lattice Wall

Slab Openings

Floor Slab:
10” Reinforced Concrete Slab
X-Lattice: Level 1

**Architecture**

**Structure**

**MEP**

**CM**

**ORANGE** –
1.5’x1.5’ Columns

**NAVY** –
1.5’ x2’ Beams

**BLUE** –
Tension Ring

**RED** –
X-Lattice Wall

---

Slab Openings

---

Floor Slab:
10” Reinforced Concrete Slab
X-Lattice: Level 2 (Roof)

- **ORANGE** – 1.5’x1.5’ Columns
- **NAVY** – 1.5’ x2’ Beams
- **BLUE** – Tension Ring
- **RED** – X-Lattice Wall
- **LATTICE** – Slab Openings

**Floor Slab:**
10” Reinforced Concrete Slab
X Lattice Wall

Can also help carry loads from cantilever
### Vasari Analysis

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<tbody>
<tr>
<td>570,000</td>
<td>620,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CO2 emissions</th>
<th>tons/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>109</td>
<td>132</td>
</tr>
</tbody>
</table>

*Furnace with gas heat, temperature economizer, DHW unit
**HP system, temperature economizer, DHW unit
***VAV, Gas fired HW boiler, VV HW pump, HW coil
Duct Network

DV

Return

Overhead
• Natural stack ventilation in corridor, atriums and perimeter
• Low energy fan during winter
# Preliminary Schedule

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitework</td>
<td>35 days</td>
<td>Wed 9/30/15</td>
<td>Tue 11/17/15</td>
</tr>
<tr>
<td>Substructure</td>
<td>50 days</td>
<td>Tue 10/20/15</td>
<td>Mon 12/28/15</td>
</tr>
<tr>
<td>Mat Slab</td>
<td>5 days</td>
<td>Wed 11/18/15</td>
<td>Tue 11/24/15</td>
</tr>
<tr>
<td>Pile Caps</td>
<td>5 days</td>
<td>Wed 10/21/15</td>
<td>Tue 10/27/15</td>
</tr>
<tr>
<td>Grade Beams</td>
<td>5 days</td>
<td>Wed 10/21/15</td>
<td>Tue 10/27/15</td>
</tr>
<tr>
<td>Slab</td>
<td>5 days</td>
<td>Wed 10/28/15</td>
<td>Tue 11/3/15</td>
</tr>
<tr>
<td>Level -1</td>
<td>10 days</td>
<td>Tue 11/3/15</td>
<td>Mon 11/16/15</td>
</tr>
<tr>
<td>Level 0</td>
<td>10 days</td>
<td>Mon 11/9/15</td>
<td>Fri 11/20/15</td>
</tr>
<tr>
<td>Level 1</td>
<td>10 days</td>
<td>Fri 11/20/15</td>
<td>Thu 12/3/15</td>
</tr>
<tr>
<td>Level 2</td>
<td>10 days</td>
<td>Thu 12/3/15</td>
<td>Wed 12/16/15</td>
</tr>
<tr>
<td>Shell</td>
<td>60 days</td>
<td>Thu 12/17/15</td>
<td>Wed 3/9/16</td>
</tr>
<tr>
<td>Level -1</td>
<td>15 days</td>
<td>Thu 12/17/15</td>
<td>Wed 1/6/16</td>
</tr>
<tr>
<td>Level 0</td>
<td>15 days</td>
<td>Wed 1/6/16</td>
<td>Tue 1/26/16</td>
</tr>
<tr>
<td>Level 1</td>
<td>15 days</td>
<td>Mon 1/11/16</td>
<td>Fri 1/29/16</td>
</tr>
<tr>
<td>Level 2</td>
<td>15 days</td>
<td>Tue 1/26/16</td>
<td>Mon 2/15/16</td>
</tr>
<tr>
<td>Interiors</td>
<td>50 days</td>
<td>Fri 2/12/16</td>
<td>Thu 4/21/16</td>
</tr>
<tr>
<td>Interior Construction</td>
<td>65 days</td>
<td>Fri 2/12/16</td>
<td>Thu 5/12/16</td>
</tr>
<tr>
<td>Stairs</td>
<td>20 days</td>
<td>Tue 2/16/16</td>
<td>Mon 3/14/16</td>
</tr>
<tr>
<td>Services</td>
<td>40 days</td>
<td>Fri 3/25/16</td>
<td>Thu 5/19/16</td>
</tr>
<tr>
<td>Elevator</td>
<td>5 days</td>
<td>Fri 5/13/16</td>
<td>Thu 5/19/16</td>
</tr>
<tr>
<td>Plumbing</td>
<td>40 days</td>
<td>Fri 3/25/16</td>
<td>Thu 5/19/16</td>
</tr>
<tr>
<td>HVAC</td>
<td>40 days</td>
<td>Fri 3/25/16</td>
<td>Thu 5/19/16</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>40 days</td>
<td>Fri 3/25/16</td>
<td>Thu 5/19/16</td>
</tr>
<tr>
<td>Electrical</td>
<td>40 days</td>
<td>Fri 3/25/16</td>
<td>Thu 5/19/16</td>
</tr>
<tr>
<td>Site Improvements</td>
<td>25 days</td>
<td>Mon 6/27/16</td>
<td>Fri 7/29/16</td>
</tr>
</tbody>
</table>
## Cost Estimate

<table>
<thead>
<tr>
<th>Concept</th>
<th>Estimate</th>
<th>Difference From Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-Concrete</td>
<td>$8,744,400</td>
<td>$(444,400)</td>
</tr>
<tr>
<td>D-Steel</td>
<td>$9,309,600</td>
<td>$(1,009,600)</td>
</tr>
</tbody>
</table>

Pricier than L due to larger Floor and Facade SF
Cost distribution

- **G Building Sitework**: $75,000, 1%
- **H General Conditions**: $1,551,600, 17%
- **F Specialty Construction**: $0, 0%
- **E Equipment and Furnishing**: $0, 0%
- **D Services**: $2,895,000, 31%
- **A Substructure**: $366,000, 4%
- **B Shell**: $3,181,000, 34%
- **C Interiors**: $1,241,000, 13%
TVD - Concrete

TVD - TARGETS BY CLUSTER  Steel

- TARGET VALUE
- ESTIMATED VALUE
- VALUE DELTA

- A Substructure
- B Shell
- C Interiors
- D Services
- E Equipment and Furnishing
- F Specialty Construction
- G Building Sitework
- H General Conditions

$3,500,000
$3,000,000
$2,500,000
$2,000,000
$1,500,000
$1,000,000
$500,000
$0
$-500,000
$-(500,000)
Leapfrog Sustainability & Whole Life Cost Challenges
Use of translucent concrete to allow light in restrooms while maintaining structural integrity of shear walls (L-shape Concrete option)
A nervous system for the building, with sensors detecting anomalous strains.

High initial cost --> lower OM cost, better safety, especially after EQ event.

Cost: ~$40/ft²
Smart Operation

- Room controllers with batteryless sensors
- Control of HVAC and lighting

- Thermostats
- Window contacts
- Humidity sensors
- Occupancy sensors
- CO2 sensors
Building Integrated PV
30kW

Mounted On: Roof 30°
Area: 2700 sf
Annual Energy Yield: 51,7 MWh/year
Gross Evaluation: 240,000 $

Mounted On: Atrium 30°
Area: 5400 sf
Annual Energy Yield: 51,7 MWh/year
Gross Evaluation: 290,000 $

Mounted On: Façade 30°
Area: 2700 sf
Annual Energy Yield: 51,7 MWh/year
Gross Evaluation: 260,000 $

Mounted On: BIPV
Area: 2700 sf
Annual Energy Yield: 33.4 MWh/year
Gross Evaluation: 250,000 $
Rainwater Harvesting

- 36000 gal/year rainwater
- Snow melting
- Drain groundwater

Use for:
- Toilet flushing
- Plants irrigation
- Maintenance/cleaning

Diagram showing rainwater collection and use.
Building Integrated W/T
18kW

- Operate at low wind speed ~5 mph and up to 120 mph
- Take advantage of ‘chimney effect’
- Low Noise levels

18 W/T Mounted On Roof
Energy produced: 19.4 MWh/year
Gross evaluation: 130,000 $
Electricity Produced: 17,500 $/year
Real Time Positioning

http://www.ekahau.com/products/real-time-location-system/vision.html
Sustainable Target Value

**L-Concrete**
*1.013 mtCO2e  $31,000*

**DD-Cylinder**
*1065 mtCO2e  $32,000*

**L-Steel**
*993 mtCO2e  $30,000*

**DD-X**
*934 mtCO2e  $28,000*
Sustainability Goals & LEED

Kickoff
-shoot for "net zero" energy
-don't design explicitly for the LEED checklist

Winter Quarter
- Incorporation of passive solar heating & lighting
- Decision to use rainwater harvesting and PV
- Exploration of GSHP & wind turbines

Looking Ahead to Spring Quarter
- Evaluation of design under LEED+ criteria
- Continue to design for sustainability, including Energy & Atmosphere, Indoor Environmental Quality, etc.
Decision Process
0. Decision Matrix
Framework provided by LCFM consultants

1. Team & owners add/modify criteria such as:
- cost
- sustainability
- constructability
- flexibility
- innovation
- efficiency
- concept clarity

2. Owners choose weight distribution

3. Team rates concepts

4. Scores are calculated
Decision Process

Team's Recommendation to Owners!
LCFM Consulting in Spring

Communicate and consult

Establish the context
- Criteria
- Stakeholders
- Alternatives
- Define key elements

Identify the risk
- What can happen?
- How can it happen?

Analyse the risk
- Responsibility
- Costs
- Duration

Evaluate the risk
- Assessment
- Evaluation
- Risk Map
- Time table

Treat the risk
- Management
- Identify options
- Controlling

Monitor and review
Team Process
## Modes of Communication

<table>
<thead>
<tr>
<th>Mode</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text, images, videos, links to other websites, etc.</td>
<td><img src="facebook.com" alt="Facebook" /></td>
<td><img src="gmail.com" alt="Gmail" /></td>
</tr>
<tr>
<td>Instant messaging</td>
<td><img src="facebook.com" alt="Facebook" /></td>
<td><img src="talk.com" alt="Talk" /> <img src="skype.com" alt="Skype" /></td>
</tr>
<tr>
<td>Voice</td>
<td><img src="gotomeeting.com" alt="GoToMeeting" /></td>
<td><img src="skype.com" alt="Skype" /> <img src="3diic.com" alt="3DiC" /></td>
</tr>
<tr>
<td>File Sharing</td>
<td><img src="google.com" alt="Google Drive" /></td>
<td><img src="dropbox.com" alt="Dropbox" /> <img src="box.com" alt="Box" /></td>
</tr>
</tbody>
</table>
Sketching while on Skype or Gotomeeting to share ideas or receive instant feedback.
Example of Interdisciplinary Collaboration

SE Meetings by Week

- Hours
- Weeks Starting on: 21-Jan, 28-Jan, 4-Feb, 11-Feb, 18-Feb, 25-Feb, 4-Mar, 11-Mar

- Categories:
  - w/ CM
  - w/ MEP
  - w/ A+MEP
  - w/ A
  - SE Only
  - Team
  - Class
Thank You!

Your time and feedback are greatly appreciated!