SITE OVERVIEW

San Francisco State University
San Francisco, CA
SITE & ACCESS

Maps and zooming into our site

OPEN LOW NATURE

BORDER

POSSIBLE FLOW FROM COMMUNITY AND NORTH CAMPUS

SLOPE

SITE

FLOW FROM CAMPUS

CAMPUS

MORE DENSE HIGHER GROUND

DENSE LOWER GROUND

VIEW
SITE CONDITIONS

**Seismic**
- $S_s = 2.190 \text{ g}$
- $S_1 = 1.044 \text{ g}$

**San Andreas Fault**

**Soil**
- NEHRP Site Class C
- Lateral Soil Pressure: 35 psf/ft
- Bearing Capacity: 3,500 psf
- Water table: 14' below grade
- Well-sorted fine-medium sand

**Temperature**
- **Summer Design Temperature:**
  - 79°F Dry Bulb
  - 63°F WB
- **Winter Design Temperature:**
  - 41°F Dry Bulb
- **Relative Humidity**
  - 74% (Average)

**Wind**
- Average of 10-15 mph from the west

**Wind Directions Over the Entire Year**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>6%</td>
</tr>
<tr>
<td>NE</td>
<td>5%</td>
</tr>
<tr>
<td>E</td>
<td>4%</td>
</tr>
<tr>
<td>SE</td>
<td>5%</td>
</tr>
<tr>
<td>S</td>
<td>8%</td>
</tr>
<tr>
<td>SW</td>
<td>8%</td>
</tr>
<tr>
<td>W</td>
<td>38%</td>
</tr>
<tr>
<td>NW</td>
<td>18%</td>
</tr>
</tbody>
</table>
Embrace flow

Embrace wind

Be a landmark
ITERATIONS
WIND & CAMPUS FLOW

A + MEP
EXTRUSION OF FACADE

A + MEP + SE
THE SURROUNDING AREA
FACADE SYSTEM

Inspiration

Current system
SECTION THROUGH MAIN STAIRCASE

- 11'
- 11'
- 2'
- +30'
- +17'
- 11'
- 2'
- + 4'
- - 9'

A  MEP  SE  CM
**COMFORT & DESIGN TARGETS**

**Summer Design Conditions (0.5%)**
- 79°F Dry Bulb
- 63°F WB

**Winter Design Conditions (0.2%)**
- 41°F Dry Bulb

**Relative Humidity**
- 74% (Average)

**Indoor Design Targets** (+/- 0.5 PMV, ASHRAE 55-2010)
- **Summer:**
  - 74°F Dry Bulb
  - 52 fpm (max)
  - Clo = 0.5
- **Winter:**
  - 68°F Dry Bulb
  - 76 fpm (max)
  - Clo = 1.1
- Max Relative Humidity: 90%
- Met = 1.2
Alternative I: Variable Air Volume (VAV) – Natural Ventilation Hybrid System
VAV/HYBRID – FLOOR SANDWICHES

Concrete Structural System

Steel Structural System
HYDRONIC SYSTEM

Alternative 2: Hydronic Heating with DOAS / Trickle Ventilation
### GRAVITY LOADS

<table>
<thead>
<tr>
<th>Occupancy/Use</th>
<th>Uniform psf</th>
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</thead>
<tbody>
<tr>
<td>office</td>
<td>50</td>
</tr>
<tr>
<td>classroom</td>
<td>40</td>
</tr>
<tr>
<td>large classroom</td>
<td>60</td>
</tr>
<tr>
<td>assembly area (fixed seats)</td>
<td>60</td>
</tr>
<tr>
<td>assembly areas (movable seats)</td>
<td>100</td>
</tr>
<tr>
<td>computer lab</td>
<td>100</td>
</tr>
<tr>
<td>lobby/access floor systems</td>
<td>100</td>
</tr>
<tr>
<td>corridors (1st floor)</td>
<td>100</td>
</tr>
<tr>
<td>corridors above</td>
<td>80</td>
</tr>
<tr>
<td>storage (light)</td>
<td>125</td>
</tr>
<tr>
<td>storage (heavy)</td>
<td>250</td>
</tr>
<tr>
<td>roof (garden)</td>
<td>100</td>
</tr>
<tr>
<td>roof (assembly)</td>
<td>60</td>
</tr>
<tr>
<td>roof (ordinary)</td>
<td>20</td>
</tr>
<tr>
<td>restrooms</td>
<td>50</td>
</tr>
<tr>
<td>construction</td>
<td>20</td>
</tr>
</tbody>
</table>
COMPOSITE STEEL DECK SYSTEM

- Slanted W shape columns on north/west facades
- Auditorium supported by sloped floor and curved Pratt truss (floor to ceiling)
- Long span trusses

Dimensions:
- 53’
- 116’
- 39’
Composite metal deck panels
- 2VLI20 Vulcraft deck with 2.5” LW concrete overlay, fire protected gypsum board

Filler beams
- W14x48 typ.
- Longest span 20’

Girders
- W21x62 typ.
- Longest span 34’

Columns
- W14x48 typ.
- Three 13’ floors, 41’ total (one column)
LATERAL SYSTEM

BRBF
- 3 in^2 steel core
- A36 steel

SMRF
- W30x116 largest beam
- W18x130 largest column
- RBS employed

- Dual system is both stiff and ductile
- Torsion controlled
- SMRF because slanted columns
POST-TENSIONED CONCRETE SYSTEM

- Slanted concrete columns on north/west facades
- Auditorium as a concrete shell system with stiffening ribs
- Shear walls
TYPICAL GRID & OVERLAY
Post tensioning Concrete slab
- 11” solid slab
- Longest span 33’

Columns
- 16” x 16“ section
- 13’ height over one floor

Concrete shell
Shear walls
LATERAL SYSTEM

Shear walls
- 20” concrete shear walls
- Responding to horizontal loads from auditorium
- Transferring tensile loads from slabs due to slanted columns
Isolated Concrete Foundations
• 6’ x 6’ x 18”

Strip Concrete Foundations
Walls and MRF
• 6’ x 18”
ATRIUM CANYON

A + MEP
INTEGRATING THE FLOWS
SITE PLAN
OVERVIEW
THE BUILDING

NORTH

SOUTH

EAST

WEST

A MEP SE CM
CREE modular constructional system – CREATIVE RESOURCE & ENERGY EFFICIENCY

- Tall windows
- Shows construction in facade
- Integrates construction in the indoor aesthetics
Metal siding

Plate material – Both reflective and non-reflective
ROOF EVOLUTION

1: Slice through building

1: Glazed roof allowing for light to enter the area below, while covering from rain

Potential:
1: Relation to wind and water
2: Cover for roof terrace
3: Integrate elevator
4: Integrate PV’s and/or turbines
SECTION THROUGH AUDITORIUM
VAV – FLOOR PLANS

Ground Floor

First Floor

Second Floor
VAV – FLOOR SANDWICHES

Steel Structural System

CREE Structural System

CREE Structural System – Ducts and Conduits

Bulkhead
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weight</th>
<th>VAV</th>
<th>NV + VAV (Interlock)</th>
<th>Hydronic + Trickle &amp; DOAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC System First Costs</td>
<td>20</td>
<td>10</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Architectural Impacts/Central Space Impacts</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Ceiling Space Requirements/Floor-to-Floor Impacts</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Energy Efficiency/Utility Costs</td>
<td>20</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Acoustical Impact</td>
<td>5</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Indoor Air Quality</td>
<td>10</td>
<td>8</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Comfort/Individual Control/IEQ</td>
<td>20</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Maintenance Costs &amp; Reliability</td>
<td>10</td>
<td>10</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td><strong>100</strong></td>
<td><strong>68</strong></td>
<td><strong>73</strong></td>
<td><strong>75</strong></td>
</tr>
</tbody>
</table>
SUSTAINABILITY MEASURES

Daylighting

CREE System

Rainwater Harvesting & Site Water Usage

U.S. GREEN BUILDING COUNCIL
LEED SILVER
USGBC
COMPOSITE DECK SYSTEM

Pratt truss to support cantilevered auditorium

Small cantilevers

39'
TYPICAL GRID & OVERLAY

- Very modular grid
- Perfect rectangular steel deck system layout
GRAVITY SYSTEM

Composite metal deck panels
- 2VLI20 Vulcraft deck with 2.5” LW concrete overlay, fire protected gypsum board

Filler beams
- W14x48 typ.
- Longest span 21’

Girders
- W21x62 typ.
- Longest span 38’

Columns
- W14x48 typ.
- Three 13’ floors, 41’ total (one column)
LATERAL SYSTEM

BRBF
- 3 in\(^2\) steel core
- A36 steel
Isolated Concrete Foundations
- 6’ x 6’ x 18”
- #8 @ 6” o.c.
Prefabricated CREE Glulam – Concrete Slabs

Auditorium cantilever held back by tension beams

CREE Glulam columns

Core
TYPICAL GRID & OVERLAY

CREE Hybrid slabs span between Glulam columns or prestressed concrete beams.
Hybrid Glulam – Concrete slabs
• Total depth 18”
• Max span 29’

Prestressed Concrete beams
• 12”x24”
• Longest span 32’

Columns
• Glulam columns 10“x 20“ (11’ 6”)
• Concrete columns 12”x18” (11’)

Beams for tension/compression
Shear wall and moment resisting frame with same stiffness
LATERAL SYSTEM

Moment resisting frames
- Reinforced concrete
- Prefabricated post tensioning connections

Concrete core
- Reinforced concrete shear walls 12”

- Auditorium is held back by MRF and core (same stiffness required)
- Torsion controlled
Foundations for Cree System

Isolated Concrete Foundations
- 6’ x 4’ x 18”

Strip Concrete Foundations
Walls and MRF
- 6’ x 18”

Glulam columns
- 4’ x 18”
CONSTRUCTION RISK MAPPING

1. Identify Hazards
   - Electrical
   - Excavation and Trenching
   - Falls
   - Stairway Ladder
   - Scaffolding
   - Heavy Construction Equipment

2. Risk Matrix

<table>
<thead>
<tr>
<th>Risk Identity &amp; Cause</th>
<th>Probability of Occurrence (P)</th>
<th>Impact (Cost &amp; Time)</th>
<th>Risk Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk ID</td>
<td>Category</td>
<td>Location</td>
<td>Risk Description</td>
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<tr>
<td>Current Assessment</td>
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<td></td>
<td></td>
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<tr>
<td>Mitigation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategy</td>
<td>Risk Plan</td>
<td>Action Owner</td>
<td></td>
</tr>
</tbody>
</table>

3. Risk Map

   Stanford Accident Cost Accounting System (Severity)

<table>
<thead>
<tr>
<th>Hazard Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Very Unlikely</td>
</tr>
<tr>
<td>Unlikely</td>
</tr>
<tr>
<td>Possible</td>
</tr>
<tr>
<td>Likely</td>
</tr>
<tr>
<td>Very Likely</td>
</tr>
</tbody>
</table>
Goal Map them in Revit
Elaborate Strategies to Enhance Design
SCHEDULING

Foot Print

Flow - DD

Embrace - LS

Structure Type

Steel (50 wk)  CREE (51 wk)  Steel (53 wk)  Concrete (57 wk)

Steel Erection/Concrete Pouring

10 Wk  11 Wk  13 Wk  16 Wk

12 Wk  12 Wk  14 Wk  14 Wk

Façade
SCHEDULING CONSIDERATIONS

SFSU Engineering Building

**Construction (54 Weeks)**
- **Proposed Start**: Thu 4/30/15
- **Construction Starts**: Qtr 3, 2015
- **Design (10.2 months)**
  - **Procurement (14.8 weeks)**
- **Steel Erection (13 Weeks)**
  - **Moobilize**
  - **Site Grading and Utilities (7 weeks)**
  - **Foundations (6.6 Weeks)**
- **Computer Labs**
  - **Roofing (6.4 Weeks)**
  - **Interior Works (7 Weeks)**
- **Building Finishes (9 Weeks)**
  - **Foondation (6.6 Weeks)**
  - **Concrete Structure (16 Weeks)**
  - **Foundations (6.6 Weeks)**
- **Comissioning (5 Weeks)**

**Construction (57 Weeks)**
- **Proposed Start**: Thu 4/30/15
- **Construction Starts**: Qtr 3, 2015
- **Design (10.2 months)**
  - **Procurement (14.8 weeks)**
- **Concrete Structure (16 Weeks)**
  - **Moobilize**
  - **Site Grading and Utilities (7 weeks)**
  - **Foundations (6.6 Weeks)**
- **Computer Labs**
  - **Roofing (5.4 Weeks)**
  - **Interior Works (7 Weeks)**
- **Building Finishes: Final Clean-up and Occupancy (6 weeks)**
  - **Window wall and store front closures (14 Weeks)**
- **Commissioning (5 Weeks)**

**Construction Finish**: Mon 10/3/16
Dimension Restriction
Flatbed truck
102” Wide
48’ Long

• Corridors Utility Racks
CREE SYSTEM IMPACT

- Located in San Francisco
- Highly modular
- Efficiency
- Construction period cut by half
- Materials installed hold their value from a deconstruction standpoint
### Overall Budget and Target

<table>
<thead>
<tr>
<th></th>
<th>Based on RS Means SF Estimate (College: Classrooms &amp; Administration)</th>
<th>Based on RS Means SF Estimate (College: Science, Engineering, Laboratory)</th>
<th>Based on Previous Project</th>
<th>Average of Previous 3</th>
<th>Based on Owner’s Input</th>
<th>Additional % Based on Team’s Input</th>
<th>Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Grant from Donor</td>
<td>$8,500,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A</td>
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<tr>
<td>Grant Year</td>
<td>2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Construction Year</td>
<td>2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C</td>
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<tr>
<td>Expected Inflation</td>
<td>2.00%</td>
<td></td>
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<td>D</td>
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<tr>
<td><strong>BUDGET</strong></td>
<td><strong>$8,200,000</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><strong>TARGET</strong></td>
<td><strong>$7,250,000</strong></td>
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<td></td>
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<td></td>
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</tr>
</tbody>
</table>

**TARGETS DISTRIBUTION**

- **Building Sitework**: 5%
- **Substructure**: 8%
- **Services**: 39%
- **Interiors**: 14%
- **Shell**: 34%

### Additional Notes

- $8,200,000 accounts for purchase power in 2015
- $7,250,000 target lower than budget to allow for contingency
- Targets based off of owner input, previous projects, RS means, and team input
ESTIMATE – PIE CHARTS

**EMBRACE - CONCRETE**

- **Substructure, $292,000**, 5%
- **Shell, $2,220,000**, 35%
- **Interiors, $990,000**, 15%
- **Services, $2,650,000**, 42%
- **Sitework, $200,000**, 3%

**EMBRACE - STEEL**

- **Substructure, $292,000**, 5%
- **Shell, $2,170,000**, 34%
- **Interiors, $990,000**, 16%
- **Services, $2,650,000**, 42%
- **Sitework, $200,000**, 3%

**FLOW - STEEL**

- **Substructure, $302,000**, 5%
- **Shell, $2,055,000**, 44%
- **Interiors, $1,010,000**, 32%
- **Services, $2,760,000**, 44%
- **Sitework, $200,000**, 3%

**FLOW - CREE**

- **Substructure, $292,000**, 5%
- **Shell, $2,155,000**, 34%
- **Interiors, $880,000**, 14%
- **Services, $2,820,000**, 44%
- **Sitework, $200,000**, 3%
MAIN COST CONSIDERATIONS

- Auditorium
  - Embrace > Flow
    - Irregular conical shape of Embrace
- Services
  - Flow > Embrace
    - Separation by atrium requires two major service zones
- Steel vs. Concrete vs. Cree (Glulam)
  - Steel is cheapest initial cost
    - Not including fire proofing
  - Concrete cost could be offset by amount of fireproofing necessary
  - Cree is high material cost, but low labor, so less risk
    - Glulam can serve as exterior and interior finish
### Decision Matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Subcriteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Construction Costs</td>
<td>Calculation of the construction costs by RSMeans.</td>
</tr>
<tr>
<td></td>
<td>Operation &amp; Maintenance Costs</td>
<td>Includes expenses for cleaning, energy and administration as well as those for maintenance and replacements.</td>
</tr>
<tr>
<td></td>
<td>Space efficiency</td>
<td>The ratio of net external area to gross external area to determine the space efficiency.</td>
</tr>
<tr>
<td></td>
<td>Construction Time</td>
<td>Required construction time according to the work schedules of the different alternatives.</td>
</tr>
<tr>
<td></td>
<td>Income</td>
<td>Additional income</td>
</tr>
<tr>
<td></td>
<td>Constructability</td>
<td>How the building will be built and what techniques will be used (complexity associated with the production of the property).</td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO2-Emission</td>
<td>CO2-Emission in tons per year.</td>
</tr>
<tr>
<td></td>
<td>Renewable Energy</td>
<td>Usage of renewable energy (e.g. PV, wind turbine, earth heat).</td>
</tr>
<tr>
<td></td>
<td>Life Cycle of Material</td>
<td>Life span of used materials.</td>
</tr>
<tr>
<td></td>
<td>Recycled Material</td>
<td>Usage of recycled materials.</td>
</tr>
<tr>
<td></td>
<td>Structural Performance</td>
<td>Performance of the building in seismic activity.</td>
</tr>
<tr>
<td></td>
<td>Ventilation</td>
<td>The possibility to integrate a natural ventilation system in a building.</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comfort</td>
<td>Comfort of the users and employees (mostly depending on the lighting conditions and the indoor climate).</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
<td>Flexibility describes how spaces can be customized to different requirements.</td>
</tr>
<tr>
<td></td>
<td>Student/Faculty Collaboration</td>
<td>Interaction and collaboration between students and faculty members to enable a fruitful work environment.</td>
</tr>
<tr>
<td></td>
<td>Design/Iconicity</td>
<td>Attractiveness and iconicity of the design/building.</td>
</tr>
<tr>
<td></td>
<td>Innovation</td>
<td>In which extend innovations are included in the construction project.</td>
</tr>
</tbody>
</table>

- Weighted based on team and owner input
- Alternatives multiplied by respective subcriteria factor
- Final results based on 50% team input and 50% owner input
## Final Decision Making Process:

- **Flow Steel vs. Flow CREE**
- **CREE system offers:**
  - Unique challenges
  - High sustainability, modularity, and iconicity
- **Steel system offers:**
  - Simplicity
  - Lower cost
- **New challenges = New opportunities**

### Decision Table

<table>
<thead>
<tr>
<th></th>
<th>Embrace Steel</th>
<th>Embrace Concrete</th>
<th>Flow Steel</th>
<th>Flow CREE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Team 50%</strong></td>
<td>388</td>
<td>330</td>
<td>422</td>
<td>425</td>
</tr>
<tr>
<td>Karolina 50%</td>
<td>386</td>
<td>325</td>
<td>410</td>
<td>411</td>
</tr>
<tr>
<td>Michael 50%</td>
<td>386</td>
<td>327</td>
<td>409</td>
<td>412</td>
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<tr>
<td>Lauren 50%</td>
<td>397</td>
<td>337</td>
<td>418</td>
<td>422</td>
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<tr>
<td><strong>Total Score</strong></td>
<td><strong>778</strong></td>
<td><strong>660</strong></td>
<td><strong>834</strong></td>
<td><strong>840</strong></td>
</tr>
</tbody>
</table>
TEAM PROCESS AND DYNAMIC

- Continue weekly meetings in 3D ICC

- Further develop Agile IPD format and protocol for effective asynchronous collaboration over break

- Revit linking has and will continue to facilitate accurate coordination of discipline designs

- Facebook and Skype for relaxed communication
ACKNOWLEDGMENTS

Pacific Team would like to acknowledge the help and guidance of the following individuals:

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Andreas Leps
Eduardo Miranda
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Karolina Ostrowska
Lauren Scammell
Michael Seaman

Bauhaus-Universität Weimar

Aalborg Universitet