Project Goals

Total Value to the Owner
- Effectiveness
- Aesthetics
- Learning Conduciveness

Building Health
- Air Quality
- Thermal Comfort
- Lighting and Views

Respect for Natural World
- Site Relations
- Lifecycle Sustainability
Site

- View to the Lake
- Severe Weather
- Narrow Access Road
- Shading from Library and Hill
- View of Muir Woods
- Building Into Hill
Jakob

Architecture
1st Concept

Heart Building
A center of innovation this building will send out bright young minds to change the world while also educating the next generation in a multi disciplinary way; heart of the world and heart of the community.

- Team Atlantic
1st Concept

[Diagram showing blood flow through the heart with labels for Body, Right Atrium, Right Ventricle, Left Ventricle, and Lungs.]
1st Concept
Siteplan

North Park St.

- Lake Mendota
- Muir Woods
- Observatory Drive
- Option for public transport
- School of Library and Information Studies

14.03.14
4th Floor

Room Legend
- Adm. Ass. Office
- Dep. Chair Office
- E-Exit
- Elevator
- Exhibiton Space
- Faculty Collaborative Space
- Faculty Lounge/Conference Room
- Faculty Office
- Lobby/Hall
- MEP Room
- Restrooms
- Sen. Adm. Office
- Storage
Roof

Fitness Area

View Point

“Green Walls” (Espalier) to divide the spaces

Chill Zone

Multifunctional Ball Court

14.03.14
Sections
Sections
Building in Context
3D Model
2\textsuperscript{nd} Concept

EMBRACE
As a haven for learning, the embrace concept will welcome students and faculty to an environment where they are open and safe to express new ideas. At the same time, this building will encourage these innovators to take that next step outside of their comfort zones and explore the outside world

- Team Atlantic
2nd Concept
2nd Concept
Siteplan

Lake Mendota

Muir Woods

Observatory Drive

School of Library and Information Studies

North Park St.
1st Floor

Room Legend
- Elevator
- Exhibition Space
- Lobby/Hall
- MEP Room
- Restroom
- Server Room
- Shower
- Storage
- Student Fitness
- Technical Support
- Wardrobe
2nd Floor

Room Legend
- Elevator
- Large Classroom
- MEP Room
- Restroom
- Small Classroom
- Storage
- Student Collaborative Space
- Student Office

Legend:
- Elevator
- Large Classroom
- MEP Room
- Restroom
- Small Classroom
- Storage
- Student Collaborative Space
- Student Office
4th Floor

Room Legend
- Elevator
- Faculty Fitness
- Faculty Lounge/Conference Room
- Faculty Office
- Lobby/Hall
- MEP Room
- Restroom

14.03.14
Sections

27' - 0"
50' - 7"
54' - 1"
20' - 0"

151' - 8"

35' - 5"
100' - 0"
Sections

![Diagram of building sections with dimensions labeled: 145' - 1", 53' - 7", and 38' - 4". Dimensions for various levels are also marked, such as 52' - 0" and 10' - 0".]
View: Entrance
Dynamic Facade
In Context
Structural

Jingxuan Yue
# Loads

**Dead Load**

**Self-weight**
- Steel
  - Deck + Concrete: ~46 psf
  - Structural member: ~62 psf
- Concrete
  - Concrete: ~80 psf
Fixed equipment: 30 psf

**Live Load**

- Assembly area: 100 psf
- Auditorium: 60 psf
- Classroom: 40 psf
- Corridor: 100/80 psf
- Office: 50 psf
- Roof: 20 psf
- *Partition: 15 psf

<table>
<thead>
<tr>
<th>Wind Load (kip)</th>
<th>Seismic (kip)</th>
<th>Snow (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Floors</strong></td>
<td><strong>Roof</strong></td>
<td><strong>Base</strong></td>
</tr>
<tr>
<td>Heart</td>
<td>47</td>
<td>23.5</td>
</tr>
<tr>
<td>Embrace</td>
<td>50</td>
<td>25</td>
</tr>
</tbody>
</table>

Auditorium: 0
<table>
<thead>
<tr>
<th></th>
<th><strong>Steel Frame</strong></th>
<th><strong>Concrete Frame</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity system</td>
<td>Composite slab &amp; steel beams and columns</td>
<td>Two-way PT slab (typ. 8”) with PT beams Reinforced concrete columns</td>
</tr>
<tr>
<td>Lateral system</td>
<td>Steel Moment frame (Moment connection on the perimeter)</td>
<td>Shear wall</td>
</tr>
<tr>
<td>Cantilever solution</td>
<td>Diagonal Steel Braces</td>
<td>Steel rod</td>
</tr>
</tbody>
</table>
Heart-Steel Frame

- Column: W14x61 (1-2nd floor)  
  W14x53 (3rd floor)  
  (With same “T”)

- Girder: W21x62 (29’-40’ span)

- Beam: W18x35 (29’-33’ span)

- Brace: W16x26

- Composite Slab: 2” deck + 4” concrete cover  
  (10’ span)
Heart-Steel Frame

2\textsuperscript{nd} floor plan

Cantilever Solution:
Using Diagonal braces

4\textsuperscript{th} floor plan

Large classroom
Small classroom
Faculty Offices

(unit: ft)

Large classroom

14.03.14
Heart-Steel Frame

- Load Path
Heart-Steel Frame

- Load Path
Heart-Steel Frame

Braces: Contribute to gravity & lateral system

- Location of braces

2^{nd}, 3^{rd} floor

4^{th} floor
# Heart

<table>
<thead>
<tr>
<th>Steel Frame</th>
<th>Concrete Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gravity system</strong></td>
<td>Composite slab &amp; steel beams and columns</td>
</tr>
<tr>
<td><strong>Lateral system</strong></td>
<td>Steel moment frame (Moment connection on the perimeter)</td>
</tr>
<tr>
<td><strong>Cantilever solution</strong></td>
<td>Diagonal steel braces</td>
</tr>
</tbody>
</table>
Heart-Concrete Frame

First floor:
Typical span: 29’ ~ 33’
Columns: 18” diameter
Slab: 8’
Heart-Concrete Frame

Upper floors:
Typical span: 29’ ~ 33’
Auditorium span: 29’ x 40’
One-way cantilever: 21’ 6”
Two-way cantilever: 15’ x 7’

Beams:
12”x24”
16”x32” for beams above auditorium

Direction of banded tendon: North-South
Direction of equal spacing tendon: East-West
Heart-Concrete Frame

Solution to Cantilevers: ~2” steel rod
Heart-Concrete Frame

Solution to Cantilevers: Arch-shape beam

14.03.14
<table>
<thead>
<tr>
<th></th>
<th>Steel</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Why</strong></td>
<td>- Faster construction</td>
<td>- More overhead space</td>
</tr>
<tr>
<td></td>
<td>- Light weight</td>
<td>- Less expensive</td>
</tr>
<tr>
<td></td>
<td>- Good for long cantilever</td>
<td>- Higher thermal mass</td>
</tr>
<tr>
<td></td>
<td>- Recyclable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Aesthetically pleasing</td>
<td></td>
</tr>
<tr>
<td><strong>Why not</strong></td>
<td>- Relatively expensive</td>
<td>- Construction may be impacted by weather</td>
</tr>
<tr>
<td></td>
<td>- Deeper members</td>
<td>- High embodied energy</td>
</tr>
<tr>
<td></td>
<td>- Fire safety concern</td>
<td></td>
</tr>
</tbody>
</table>
# Embrace

<table>
<thead>
<tr>
<th></th>
<th>Checkerboard</th>
<th>Polar</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Tree Logo]</td>
<td>![Checkerboard Diagram]</td>
<td>![Polar Diagram]</td>
</tr>
<tr>
<td>Gridline layout</td>
<td>Orthogonal</td>
<td>Polar</td>
</tr>
<tr>
<td>Gravity system</td>
<td>Composite slab &amp; Steel beams and columns</td>
<td>Steel Moment Frame</td>
</tr>
<tr>
<td>Lateral system</td>
<td>Steel Moment Frame</td>
<td></td>
</tr>
<tr>
<td>Auditorium</td>
<td>Diagrid</td>
<td>Diagrid</td>
</tr>
<tr>
<td></td>
<td>Steel tension cable</td>
<td>Steel ring &amp; rod</td>
</tr>
<tr>
<td>Front cantilever</td>
<td>Steel truss</td>
<td></td>
</tr>
<tr>
<td>Perimeter cantilever</td>
<td>Diagonal braces</td>
<td></td>
</tr>
</tbody>
</table>
Embrace

3rd floor plan

- Column: W14x132
- Girder: W18x65 (Curved)
- Beam: W18x35 (Curved)
- Brace: W18x35
- Composite Slab: 2” deck + 4” concrete cover
Embrace-Auditorium-Checkerboard

- 5 ft diagrid
- A series of parallel 2” cables

Balance the cantilever
Inspiration and Ideas for the auditorium

As hangs the flexible line, so but inverted will stand the rigid arch.  
---Robert Hooke
Embrace-Auditorium-Checkerboard

Inspiration and Ideas for the auditorium

La Sagrada Familia --- Antoni Gaudi
Embrace-Auditorium-Checkerboard

Inspiration and Ideas for the auditorium

Inverted method to find the shape of the auditorium

Graphical statics
Embrace-Auditorium-Polar

- Use *ring* to connect upper and lower half of the auditorium
- Use *steel rod* to connect ring to the *columns*
Embrace-Auditorium-Polar

- Use **ring** to connect upper and lower half of the auditorium
- Use **steel rod** to connect ring to the **columns**
Embrace-Auditorium-Polar

Upper Half: parabolic/hyperbolic
Lower-Half: truss with parabolic
Embrace-Front Cantilever

Front and Back Cantilever
Challenge: long cantilever with little back span space

Suggestion to architect:
Reduce the length of the front cantilever
Embrace-Perimeter Cantilever

Cantilever solution by balancing with the auditorium and diagonal braces
Embrace

<table>
<thead>
<tr>
<th>Checkerboard</th>
<th>Polar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why</td>
<td>Why not</td>
</tr>
<tr>
<td>- Simpler load path for auditorium</td>
<td>- High requirement for pre-tension cables</td>
</tr>
<tr>
<td>- Beam align with walls</td>
<td>- Ring shape more effective if circular auditorium</td>
</tr>
</tbody>
</table>
Retaining wall

Option 1

Option 2

$\Phi = 35^\circ$
Foundation

Shallow foundation:
Keep the foundation above water table.

- Save the money of dewatering
- Prevent from frozen effect in winter

Bearing Capacity: 4 ksf
Foundation

Soil thickness: t = 16 in
Footing Thickness h = 21 in
Footing Width and Length: 6ft x 10ft

\[ t+h=3.08\text{ft}<6.5\text{ ft} \]

Do not touch water table

-Do not touch water table
-Excavation is larger

\[ t=\sim2.5\text{ft} \]
Mechanical
Environmental Site Conditions

Site Location

West Campus Co-Gen Plant + Walnut Street Heating Plant

Charter Street Heating Plant
General System Context

Secondary Systems: Air Handler Unit, Fans, Ducts

Primary System: Chilled Water, Steam

Terminal Systems: VAV Underfloor, VAV Overhead, Active Chilled Beams
## Heart HVAC Systems

<table>
<thead>
<tr>
<th>Steel Frame</th>
<th>Concrete Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ventilation</strong></td>
<td>VAV Underfloor</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>VAV Underfloor</td>
</tr>
<tr>
<td><strong>Heating</strong></td>
<td>Fin Tube Radiator</td>
</tr>
</tbody>
</table>
VAV Underfloor Air w/ Fin Tube Radiators

Sketch not to scale
Active Chilled Beams w/ Fin Tube Radiators

Sketch not to scale
Integration with SE

Heart Floor Sandwich

Steel and Underfloor

Concrete and Chilled Beams

Return Plenum 1'

Girder W21x62

Concrete 4'' w/ Metal Deck 2''

7' - 2''

10' - 0''

12' - 0''

Duct 14'' x 18''

Concrete 6'' w/ Metal Deck 2''
Integration with SE

Heart Floor Sandwich

Steel and Chilled Beams

Concrete and Underfloor

Duct 14" x 18"

Girder W21x62

Concrete 4" w/ Metal Deck 2"

8' - 5"

Raised Floor 18"

Concrete 6" w/ Metal Deck 2"

8' - 10"

Return Plenum 1'
# Embrace HVAC Systems

<table>
<thead>
<tr>
<th></th>
<th>Steel- Polar</th>
<th>Steel - Checkerboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilation</td>
<td>VAV Overhead</td>
<td>Active Chilled Beams</td>
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<tr>
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<td>Active Chilled Beams</td>
</tr>
<tr>
<td>Heating</td>
<td>Fin Tube Radiator</td>
<td>Fin Tube Radiator</td>
</tr>
</tbody>
</table>

14.03.14
VAV Overhead Air w/ Fin Tube Radiators
Integration with SE
Embrace Floor Sandwich

Steel and VAV

Steel and Chilled Beams

Duct 16" x 44"

Duct 14" x 18"

12' - 0"

Girder W21x62

Concrete 4" w/ Metal Deck 2"

Concrete 4" w/ Metal Deck 2"

Girder W21x62

8' - 3"

8' - 5"
Solar and Shade Studies

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>SR</th>
<th>SS</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-Jan</td>
<td>6:00</td>
<td>7:24</td>
<td>16:52</td>
</tr>
<tr>
<td>21-Feb</td>
<td>6:48</td>
<td></td>
<td>17:34</td>
</tr>
<tr>
<td>21-Mar</td>
<td>6:48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-Apr</td>
<td>6:19</td>
<td>17:56</td>
<td></td>
</tr>
<tr>
<td>21-May</td>
<td>6:59</td>
<td></td>
<td>17:05</td>
</tr>
<tr>
<td>21-Jun</td>
<td>7:27</td>
<td></td>
<td>16:27</td>
</tr>
<tr>
<td>21-Jul</td>
<td></td>
<td></td>
<td>16:23</td>
</tr>
<tr>
<td>21-Aug</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-Sep</td>
<td>6:19</td>
<td>17:56</td>
<td></td>
</tr>
<tr>
<td>21-Oct</td>
<td>6:59</td>
<td></td>
<td>17:05</td>
</tr>
<tr>
<td>21-Nov</td>
<td>7:27</td>
<td></td>
<td>16:27</td>
</tr>
<tr>
<td>21-Dec</td>
<td></td>
<td></td>
<td>16:23</td>
</tr>
</tbody>
</table>

SR = sun rise; SS = sun set

Library & hill create large shade

<table>
<thead>
<tr>
<th>Shade Percentage</th>
<th>Area Counts</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;80% shade on facade or roof</td>
<td></td>
</tr>
<tr>
<td>50-80% shade on facade or roof</td>
<td></td>
</tr>
<tr>
<td>20-50% shade on facade or roof</td>
<td></td>
</tr>
<tr>
<td>&lt;20% shade on facade or roof</td>
<td></td>
</tr>
</tbody>
</table>
### Shade and Solar Studies

**SR** = sun rise; **SS** = sun set

**21-Jan**
- 7:24 SR
- 16:52 SS

**21-Feb**
- 6:48 SR
- 17:34 SS

**21-Mar**
- 6:19 SR

**21-Apr**
- 6:59 SR

**21-May**
- 7:27 SR

**21-Jun**
- 6:29 SR

**21-Jul**
- 6:29 SR

**21-Aug**
- 6:29 SR

**21-Sep**
- 6:29 SR

**21-Oct**
- 6:29 SR

**21-Nov**
- 6:29 SR

**21-Dec**
- 6:29 SR

---

**Conclusion:** No Solar PV!

---

**Madison:** Low solar radiation

### Shade Classifications:

<table>
<thead>
<tr>
<th>Shade Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;80%</td>
<td>&gt;80% shade on facade or roof</td>
</tr>
<tr>
<td>50-80%</td>
<td>50-80% shade on facade or roof</td>
</tr>
<tr>
<td>20-50%</td>
<td>20-50% shade on facade or roof</td>
</tr>
<tr>
<td>&lt;20%</td>
<td>&lt;20% shade on facade or roof</td>
</tr>
</tbody>
</table>

### Radiation in Whr/sq in per day:

- 1,000 to 1,500
- 1,500 to 2,000
- 2,000 to 2,500
- 2,500 to 3,000
- 3,000 to 3,500
- 3,500 to 4,000
- 4,000 to 4,500
- 4,500 to 5,000
- 5,000 to 5,500
- 5,500 to 6,000
- 6,000 to 6,500
- 6,500 to 7,000
- 7,000 to 7,500
Climate

Average High Low Dew Points

Shoulder seasons are comfortable!
Auditorium Natural Ventilation

Cross ventilation
Wind-driven

Stack ventilation
Temperature-driven

Library

Hill & Woods
Site

Woods

Prevailing breeze
# Sustainable Target Values

<table>
<thead>
<tr>
<th>% of Target Values</th>
<th>Heart Steel + UFAD</th>
<th>Heart Concrete + ACB</th>
<th>Embrace Steel + VAV</th>
<th>Embrace Steel + ACB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>204%</td>
<td>186%</td>
<td>246%</td>
<td>205%</td>
</tr>
<tr>
<td>Energy</td>
<td>158%</td>
<td>143%</td>
<td>203%</td>
<td>167%</td>
</tr>
<tr>
<td>Water</td>
<td>57%</td>
<td>57%</td>
<td>57%</td>
<td>57%</td>
</tr>
</tbody>
</table>
## Impacts on CM, LCFM

<table>
<thead>
<tr>
<th></th>
<th>Heart Steel + UFAD</th>
<th>Heart Concrete + ACB</th>
<th>Embrace Steel + VAV</th>
<th>Embrace Steel + ACB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction Cost</td>
<td>Higher</td>
<td>Highest</td>
<td>Lowest</td>
<td>Highest</td>
</tr>
<tr>
<td>Life Cycle Energy Cost</td>
<td>No utility cost</td>
<td>No utility cost</td>
<td>No utility cost</td>
<td>No utility cost</td>
</tr>
<tr>
<td>Maintenance Difficulty</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
Construction Management
Construction Site Constraints

- Constricted/Narrow Site
- Sloped Site
- High water table
- Bad soil conditions
- Cold weather
- Snow/rain
Site Access

Slope – 55’
Suppliers – Concrete and Steel

Steel Suppliers

Concrete Suppliers

Endres – 12.1 Mi
Lycon – 6.2 Mi
Gerdau – 8.3 Mi
Weidenbeck – 4.8 Mi
Wingra – 6.4 Mi
Project Site

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Suppliers - Specialty

- Window and Wall Systems Supplier
- Bent Steel Fabricator
- Precast Manufacturer

- Wasau Windows – 150 mi
- Max Weiss – 85 mi
- Spancrete – 75 mi
Prefab Opportunities

Max Truck Height = 13’6”
Max Truck Length = 48’
Max Truck Width = 8’6”
Max Weight: 80,000lb

Size Limits

All Vehicles

Single Unit Trucks

Tractor-Trailer Combinations

Tractors w/ Double Bottoms

*Length from kingpin to axle must be < 43’
Prefab Opportunities

Integrated Chilled Beam

Structure+MEP - Integrated Precast Hollowcore Slabs
Heart Site Layout – Mobile Crane

Staging Area – 50’x75’
Laydown Area – 50’x50’

2 Truck Bump Outs
Heart Site Layout—Tower crane

Swing Radius - Potential Problem

Cannot Place West of Building
Embrace Site Layout – Mobile Crane

Staging Area – 50’x75’
Laydown Area – 50’x50’

2 Truck Bump Outs
Embrace Site Layout – Tower Crane

Staging Area – 25’x75’

Laydown Area – 25’x50’

1 Truck Bump Out
Excavation and Retaining Wall

Heart – 10,000 CY
Embrace – 13,000 CY

Solution: Soil Nailing, Shotcrete, CIP wall
Environmental Plan

- Inlet protection
- Stone construction entrance – dirt off tires
- Silt fence
- Porous paving
- Drain tile to vegetation
- Rain gardens
Equipment - General
# Equipment - Crane

<table>
<thead>
<tr>
<th>Category</th>
<th>Tower Crane</th>
<th>Rough Terrain Crane</th>
<th>All Terrain Crane</th>
<th>Crawler Crane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobilization</td>
<td>Yes ($60,000)</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Stability</td>
<td>Good</td>
<td>Good – Hydraulic outriggers</td>
<td>Good – Hydraulic outriggers</td>
<td>Needs level platform</td>
</tr>
<tr>
<td>Price</td>
<td>High (10-15k)</td>
<td>Low</td>
<td>Medium (6-10k)</td>
<td>High</td>
</tr>
<tr>
<td>Reach/Mobility</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>High-Tracks</td>
</tr>
<tr>
<td>Space Needed</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>
## Schedule Key Milestones

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Heart - Concrete</th>
<th>Heart – Steel</th>
<th>Embrace – Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site work/Substructure Complete</td>
<td>8/12/2019</td>
<td>8/12/2019</td>
<td>8/12/2019</td>
</tr>
<tr>
<td>Exterior skin complete</td>
<td>1/29/2020</td>
<td>1/3/2020</td>
<td>2/14/2020</td>
</tr>
<tr>
<td>Interiors complete</td>
<td>3/26/2020</td>
<td>3/2/2020</td>
<td>4/20/2020</td>
</tr>
<tr>
<td>Substantial Completion</td>
<td>4/24/2020</td>
<td>3/31/2020</td>
<td>5/19/2020</td>
</tr>
</tbody>
</table>

Concrete - Longer structure duration

Embrace – Larger building = longer duration for exterior skin, interiors
Schedule Duration

Total Work Days from Project Start to Substantial Completion

- Embrace - Steel: 252 work days
- Heart - Concrete: 235 work days
- Heart - Steel: 217 work days
TVD - Heart

Heart Construction Cost

- ACB: $7,850,000
- Underfloor: $7,690,000

Total Construction Cost

- $7,200,000
- $7,600,000
- $8,000,000
- $8,400,000

HVAC System

- Concrete
- Steel
TVD - Embrace

Embrace Construction Cost

<table>
<thead>
<tr>
<th>HVAC System</th>
<th>Concrete</th>
<th>Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACB</td>
<td>$9,480,000</td>
<td>$9,650,000</td>
</tr>
<tr>
<td>Underfloor</td>
<td>$9,220,000</td>
<td>$9,390,000</td>
</tr>
<tr>
<td>VAV Overhead</td>
<td>$9,070,000</td>
<td>$9,240,000</td>
</tr>
</tbody>
</table>

Total Construction Cost

$8.500.000 $9.000.000 $9.500.000 $10.000.000
Heart vs. Embrace

SF Construction Cost

- ACB
  - Concrete (Embrace): $180
  - Concrete (Heart): $185
  - Steel (Embrace): $190
  - Steel (Heart): $187

- Underfloor
  - Concrete (Embrace): $184
  - Concrete (Heart): $183
  - Steel (Embrace): $188
  - Steel (Heart): $186

- VAV Overhead
  - Concrete (Embrace): $181
  - Concrete (Heart): $185
  - Steel (Embrace): $185
  - Steel (Heart): $188
# Heart vs. Embrace Tradeoff

<table>
<thead>
<tr>
<th></th>
<th>Heart- Concrete</th>
<th>Heart-Steel</th>
<th>Embrace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructrability</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Schedule</td>
<td>Medium</td>
<td>Fast</td>
<td>Slow</td>
</tr>
</tbody>
</table>

*Costs and schedule will be reduced in future by removing spaces in Embrace*
Life Cycle Financial Management
Life Cycle Costs

- Discounted Budget
- Construction Costs
- O/M Costs
- Decommissioning

Time (years):
0 1 2 3 4 5 25 80

14.03.14
Life Cycle Costs

O+M Costs

| Cost/Year  | $340,000 |
| Cost/SF    | $11      |
| Cost/25 Years | $8,160,000 |
| Cost/25 Years | $10,080,000 |

Maintenance 26%
Security 21%
Cleaning 11%
Electricity 13%
Heating; Cooling 2%
Water 1%
Management 4%
Janitor 15%
Public duties 6%
Others 0%
Insurance 1%

14.03.14
Risk
Risk

Scenario

Identify Risk

- Natural, winter, snow, temperature

Define Scenarios

- Long winter period with low temperature
- Frozen soil, problems on resource delivery

Address Influences

- CM - delay in completion (schedule)

Find Solutions/Treatments

- Speeding up construction (more human resources)
# LEED

## Overview

<table>
<thead>
<tr>
<th>Category</th>
<th>Achievable</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location and Transportation</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Sustainable Sites</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>Water Efficiency</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Energy and Atmosphere</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>Materials and Resources</td>
<td>13</td>
<td>8</td>
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<tr>
<td>Indoor Environmental Quality</td>
<td>16</td>
<td>16</td>
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<tr>
<td>Innovation</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>Regional Priority</td>
<td>4</td>
<td>2</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>110</strong></td>
<td><strong>64</strong></td>
</tr>
</tbody>
</table>
LEED

Credits

40-49 Credits  50-59 Credits  60-79 Credits  80+ Credits
Certified      Silver        Gold        Platinum
Decision Matrix

Team Profile

- Big Idea
- Value
- Building Efficiency
- Sustainability
- Site Relations
- Health

Team
Decision Matrix

Owner Profile

- Site Relations
- Schedule
- Performance
- Aesthetics
- Lighting and Views
- Learning Conduciveness
- Effectiveness
- Campus Meeting
- Value for Cost
- Comfort and Environmental Impact
## Decision Matrix

<table>
<thead>
<tr>
<th>Concrete +UFAD</th>
<th>Steel +ACB</th>
<th>Project Goals</th>
<th>Steel +VAV</th>
<th>Steel +ACB</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td>Lighting and Views</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Site Relations</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Effectiveness</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Learning Conduciveness</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>Comfort</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Environmental Impact</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Aesthetics</td>
<td>4</td>
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</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Campus Meeting</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Value</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>Schedule</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total:**

- **Concrete +UFAD:** 28
- **Steel +ACB:** 30
- **Steel +VAV:** 30
- **Steel +ACB:** 31
# Decision Matrix

<table>
<thead>
<tr>
<th>Concrete + UFAD</th>
<th>Steel + ACB</th>
<th>Total Points</th>
<th>Steel + VAV</th>
<th>Steel + ACB</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>30</td>
<td></td>
<td>30</td>
<td>31</td>
</tr>
<tr>
<td>$6.9</td>
<td>$6.7</td>
<td>Value for cost*</td>
<td>$6.4</td>
<td>$6.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First cost*</td>
<td>$181</td>
<td>$193</td>
</tr>
<tr>
<td>$183</td>
<td>$191</td>
<td>O+M cost*</td>
<td>$12</td>
<td>$12</td>
</tr>
</tbody>
</table>

*in $/SF
# Decision Matrix

<table>
<thead>
<tr>
<th>Why?</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier for every profession</td>
<td></td>
</tr>
<tr>
<td>Favorable to sustainable design</td>
<td></td>
</tr>
<tr>
<td>Awesome learning experience</td>
<td></td>
</tr>
<tr>
<td>Challenging design</td>
<td></td>
</tr>
<tr>
<td>Iconic concept</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Why Not?</th>
<th>Why Not?</th>
</tr>
</thead>
<tbody>
<tr>
<td>More “conventional” building shape</td>
<td></td>
</tr>
<tr>
<td>Too many spaces created</td>
<td></td>
</tr>
<tr>
<td>Very difficult for MEP systems</td>
<td></td>
</tr>
<tr>
<td>Way too many spaces created</td>
<td></td>
</tr>
<tr>
<td>Challenge to justify costs/value</td>
<td></td>
</tr>
</tbody>
</table>
Our Choice
<table>
<thead>
<tr>
<th>I wish we had more subgroup meetings</th>
<th>MEP</th>
<th>CM</th>
<th>LCFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>I wish there was a difference between updates and topic discussion during team meetings (otherwise too long)</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>I wish the process was more productive</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>I wish team members are more responsive</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>I like the friendly and polite interactions</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>I like everyone shows up in every meeting</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>I like that everyone finishes his/her work in a timely fashion</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>Next term we will figure out a more efficient meeting time</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>Next term we will turn on our cameras</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
<tr>
<td>Next term we will discuss more before doing on our own discipline to avoid iteration</td>
<td>☺</td>
<td>☺</td>
<td>☺</td>
</tr>
</tbody>
</table>
Team Process

Team Contract

rule #1: Always be polite and bring cookies and beer!
rule #2: Be transparent - say how you feel
rule #3: Give every idea a chance and acknowledge each other’s efforts
rule #4: “Yes, and”
rule #5: “Why?/Why not?”
rule #6: Big decisions should be made as a team
rule #7: Be respectful of everyone’s time
  (be prepared, on time, give warning of upcoming travel/ plans, let people sleep just a little)
rule #8: Be supportive of each other - we’re a TEAM
rule #9: and here to learn from each other :)

Team Meetings

- Weekly rotation on moderation and documentation (spreadsheet) 😊
- Weekly task list (spreadsheet) 😞
Team Process

<table>
<thead>
<tr>
<th>Planned</th>
<th>Reality</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coordination</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A Special Thanks to:

Course Director
Renate Fruchter

Owners
Fernando Castillo
Ronnie Haagensen
Andrej Kurent

Mentors
Greg Luth
Kyle Adams
John Nelson
Luis Rivera
Sarah Russell-Smith
Björn Wündsch
Forrest Peterson
Nolan Milord
Fernando Castillo

Mentors
Eduardo Miranda
Glenn Katz
William Kymmell
David Bendet
Eric Kneer

... and everyone who has helped us along the journey with great advice, opinions, and feedback. Get ready for a bazillion more questions :D
Cheers to this quarter! Please look forward to Atlantic Team’s Spring Presentation!