Atlantic Team 2009
P5bLAB - Stanford University
School of Engineering: University of Wisconsin at Madison

The Architect
Maria Julia Escalona: University of Puerto Rico

The Structural Engineers
Markus Reuter: Bauhaus
Anirudh Rao: Stanford University
Robert Bingel: Bauhaus

The Construction Managers
Michael Spittler: UW-Madison
Hoss Nasseri: Stanford University

The Owners
Holger Keitel
Josh Odelson

Director:
Renate Fruchter
Madison, Wisconsin

- Capital of US state: Wisconsin
- Called the City of Four Lakes
- Home to the University of Wisconsin, one of the largest public university in US
- Citizens aware of quality of life
- Low unemployment rate
Lake Mendota

- northernmost and largest of the four lake near in Madison
- Buildings face the Lake area
- University borders the Lake
- Shore of Lake is lined with expensive homes and condos
- Banks of Lake contain government protected natural areas and parks
- Winter: iceboating, ice-skating ice hokey
- Summer: windsurfing, kayaking, canoeing, fishing
Site Location and Description

- Borders south coast of Lake Mendota
- Two climates: extreme winter/summers
- Benefits from outdoor activities
- Adjacent to Lakeshore Natural Preserve and Muir Woods
- Surrounded by campus buildings: Helen C. White and Limnology Laboratory
- Important topography on south and west
- Impressive view at the lake and activities
Climate

- Temperate climate or humid continental
- Variable weather patterns
- Large seasonal temperature variance
- Winter: below 0°F
- Summers: between 80-90°F
- High levels of humidity
- Large amounts of snowfall

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tbody>
<tr>
<td>Record high °F (°C)</td>
<td>56 (13.3)</td>
<td>64 (17.7)</td>
<td>82 (27.7)</td>
<td>94 (34.4)</td>
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<td>101 (38.3)</td>
<td>104 (40)</td>
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<td>3.6 (9.1)</td>
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Two Floor Plans:

Double Diamond

Square
Winter Quarter Decision Matrix

Concept I: Double Diamond

Concept II: Square
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architecture  engineering  construction management

Site Photos
Program Relationship Diagram

- FACULTY OFFICES
- DEPARTMENTS CHAIRS
- SENIOR ADM. OFFICE
- ADM. ASSISTANTS
- FACULTY LOUNGE
- STUDENT OFFICES
- AUDITORIUM
- LARGE CLASSROOMS
- SMALL CLASSROOMS
- SEMINAR ROOMS
- INSTRUCTIONAL LABS
- SERVER ROOM
- TECH SUPPORT
- STORAGE ROOMS
- CAFE/BISTRO
- SERVICE CORE

Legend:
- strong affinity
- neutral
- weak affinity
Concept Development

- Building directly responds to:
  1. Site
  2. Landscape
  3. Climate
  4. Social environment

- Integration and Transition

- Importance to public spaces
Design Process: Study Models
# Program Distribution

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<th></th>
<th>Ground Floor</th>
<th>First Floor</th>
<th>Second Floor</th>
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<td>Student Offices</td>
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<td>Elevator</td>
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<td><strong>TOTAL:</strong></td>
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<td>34,860 sq ft2</td>
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Program Key Map
1. Main Entrance
2. Seminar Room
3. Student Offices
4. Mechanical Room
5. Shaft
6. Electrical Room
7. Storage
8. Auditorium
9. Vertical circulation
10. Study Hall
11. Coffee Shop
12. Small Classroom
13. Instructional Lab
14. Lockers
15. Balcony
16. Large Classrooms
17. Faculty Office
18. Server Room + Tech Sup
19. Administration
20. Faculty Lounge
21. Recycling Trashcans
Ground Floor Program

- auditorium
- public + circulation
- seminar room
- service core
- mechanical services
- student offices
Program Key Map
1. Main Entrance
2. Seminar Room
3. Student Offices
4. Mechanical Room
5. Shaft
6. Electrical Room
7. Storage
8. Auditorium
9. Vertical circulation
10. Study Hall
11. Coffee Shop
12. Small Classroom
13. Instructional Lab
14. Lockers
15. Balcony
16. Large Classrooms
17. Faculty Office
18. Server Room + Tech Support
19. Administration
20. Faculty Lounge
Program Key Map
1. Main Entrance
2. Seminar Room
3. Student Offices
4. Mechanical Room
5. Shaft
6. Electrical Room
7. Storage
8. Auditorium
9. Vertical circulation
10. Study Hall
11. Coffee Shop
12. Small Classroom
13. Instructional Lab
14. Lockers
15. Balcony
16. Large Classrooms
17. Faculty Office
18. Server Room + Tech Support
19. Administration
20. Faculty Lounge
Second Floor Program

- public + circulation
- faculty offices
- faculty offices
- faculty lounge
- large classrooms
- faculty offices
- seminar room
- mechanical services
- service core
- faculty offices
- administration
- administration

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School of Engineering: University of Wisconsin at Madison
Technology Thinking 2015:
Sharing Walls with technological capacity

Interactive Multi-Touch Media Wall

Small classrooms

Seminar rooms

Instructional labs

Architecture

Engineering

Construction management

School of Engineering: University of Wisconsin at Madison

Atlantic Team 2009
P5bLAB - Stanford University

CIFE Stanford University
Program Key Map
1. Main Entrance
2. Public Area/Hangout
3. Green Roof
4. AHU
5. Skylight
Means of Egress Diagram
UBC-1997

1. exterior exit
2. emergency exit
Section AA

Section Key Map
1. Seminar Room
2. Main Lobby
3. Auditorium
4. Instructional Lab
5. Faculty Lounge
6. Faculty Office
7. Large Classroom
8. Public Roof Access
Section Key Map
8. Public Roof Access
9. Mechanical Room
10. Student Offices
11. Small Classroom
12. Administration
13. Server Room
14. Shaft
Section CC

Section Key Map
1. Seminar Room
3. Auditorium
6. Faculty Offices
7. Large Classroom
8. Roof Public Access
15. Study Hall
16. Coffee Shop
17. Exterior Staircase
North Elevation
East Elevation
West Elevation
Building Components
Exterior Renders: View from Lake Mendota - NW
Exterior Renders: View from Lake Mendota - NE
Exterior Renders: View from Lake Mendota - NE
Exterior Renders: View from Muir Woods
Exterior Renders: View from Lake Mendota - NW
Interior Renders: View from Student Offices
Interior Renders: View from the Faculty Lounge
Night Renders: View from Lake Mendota - N
Night Renders: View from Lake Mendota - NE
Night Renders: View from the Bike Path
 Loads Considered

- **Dead Loads**
  - 50 psf on cantilevered portions
  - 100 psf elsewhere

- **Live Loads**
  - Wind Load: 30 psf
  - Snow Load: 18.5 psf
  - Lightweight Green Roof: 17 psf
Lateral System

HSS 6x6x1/4 braces

30 psf

25 psf
Gravity System

Regular 19’x19’ grid
- W10x22 beams
- W12x30 girders
- W10x33 ext. columns
- W12x40 int. columns
Gravity System

Challenges

- 38’x47.5’ auditorium
- 19’ cantilevers on W
- 37’ cantilever on N
- 19’x37’ portion on NW
Auditorium

- W21x44 girders
- W12x53 columns
- HSS6x6x1/4 braces

1st Floor
- 19' x 19' x 19' x 19'

2nd, 3rd Floors
- 19' x 19' x 19' x 19'

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Overhang on West (19’)

- Reduce live loads from 100 psf to 50 psf
- No green roof
- W21x73 cantilevered girders limit $\Delta_{DL} + \Delta_{LL}$ to L/240
- Girder axial forces transferred to lateral system
Overhang on North (37.5’)

➢ Sloped columns reduce actual cantilevered length to 11’
19’ x 26’ double overhang
Check for deflections

Max deflection ratio under service loads = $L/245$
Construction Details
Foundation: Grid System

- 3' strip footing – 6x3ft.
- 6' strip footing – 7x3ft.

N

- retaining Wall
- strip footing – 6x3ft.
- strip footing – 7x3ft.
axial loads from the columns 130-550 kips

moments from sloped columns: 60-100 kip-ft
Foundation: Soil Pressure

min. 613 psf
max. 3640 psf
Foundation: Displacement

min. 0.25 inch
max. 1.45 inch
Retaining Wall: Diaphragm Wall System
Water pressure: 1462 psf
Passive earth pressure: 4258 psf
Active earth pressure: 3018 psf

Water pressure: 940 psf
Passive earth pressure: 4490 psf
Active earth pressure: 1895 psf
Retaining Wall: Method Of Slices

Max. Utilization: 0.73
Retaining Wall: Method Of Slices

Max. Utilization: 0.63
Retaining Wall: Construction

1. Construction of Guide Wall
2. Excavation of Panel
3. Installation of Rebar Cage
4. Concreting of Panel
5. Repetition of Process
West Wall Section

I. ROOF:
1. Live Roof (R) Lite Green Roof System
2. 1 1/2" cellular steel deck + 4 1/2" concrete slab
3. 4' space for mechanical systems
4. 3/4" thick gypsum ceiling

II. CURTAIN WALL SYSTEM
5. double glazed insulated wall
6. structural braces
7. glazed vision panel sealed unit
8. galvanized steel covering

III. STANDARD WALL SYSTEMS
9. 5" gypsum wall

IV. FLOOR SYSTEM
10. 1 1/2" cellular steel deck + 3 1/4" thick concrete slab
11. polished concrete floor
12. insulating and draining paver of porous concrete with waterproof membrane

V. FOUNDATION
13. Strip Foundation
I. ROOF:
1. Live Roof (R) Lite Green Roof System
2. 1 1/2" cellular steel deck + 4 1/2" concrete slab
3. 4' space for mechanical systems
4. 3/4" thick gypsum ceiling

II. CURTAIN WALL SYSTEM
5. Double glazed insulated wall
6. Glazed vision panel sealed unit
7. Galvanized steel covering

III. STANDARD WALL SYSTEMS
8. 5" gypsum wall

IV. FLOOR SYSTEM
9. 1 1/2" cellular steel deck + 3 1/4" thick concrete slab
10. Polished concrete floor
11. Insulating and draining paver of porous concrete with waterproof membrane

V. FOUNDATION
12. Strip Foundation

VI. STRUCTURE
13. Welded Moment Connection
14. Frame Shear Connection
Energy, Heating and Cooling

- UW-Madison Central Heating and Cooling System
- Charter Street Heating Plant
- West Campus Cogeneration Facility
Ground Floor

Key:
- Supply Air
- Return Air
- Exhaust Air
- Outside Air
MEP Vertical Distribution

Ground Floor

First Floor

Second Floor

Architecture

Engineering

Construction Management
MEP Building System
Storm Water Reclaim System

- 10,000 gallon Reclaim
- Connection to city water main
- Pump
- Reserve pressure
- Filtering
- Flow/chlorine meter
- Chlorine Injection
- To toilets
- Water from gutters
- City water main
- Automated on/off valve
- Backflow preventer
- Valve
Project Site
Steel Fabrication
Ready Mix Concrete
Tentative Storage Area

1 mile
N
Construction Site Plan
Just In Time Delivery

- A,E,C,MEP have weekly coordination meetings
Just In Time Delivery

- A, E, C, MEP have weekly coordination meetings

Last planner system

Six and Three weeks look ahead

Peer Pressure!!!!!!!!
Engineers – CM Collaboration

- Pre welded connections to reduce on site labor
- Maximize use of bolted connections, minimize welding
A/E/C Collaboration

- Large pre-fabricated pieces
- Reverse loading
A/E/C Collaboration

- Detailed design of north façade
- Hangers to set the pre fabricated sections
- Total Station to accurately set the sections in place
## Life Cycle Cost Analysis

### Initial Expenses

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<th>Years</th>
<th>Per Year Occupating</th>
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### Future Expenses

Estimated total per square foot for UW-Madison Campus = $50 K/sf.

### Operations & Maintenance Costs (est. annual)

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<th>Years</th>
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### Revenue

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### Replacement Costs (schedules)

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<td>Interior Wall Finishes</td>
<td>10,000.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Hard Finishes</td>
<td>10,000.00</td>
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<td></td>
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<tr>
<td>Interior Specialty Finishes</td>
<td>10,000.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roofing Systems (Term - 10 years)</td>
<td>12,000.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Total Life Cycle Cost

- **Total Life Cycle Cost:** $29,383,370.09 including initial cost
- **Estimated Annual Cost:** $488,827.46 not including initial cost
Life Cycle Cost Summary

Total Life Cycle Cost = $21,900,000
Estimated Annual Cost = $468,000

Projected LCC time frame: 100 years

- Initial Investment Costs: $7.6 M (34%)
- Operations Costs: $8.3 M (37%)
- Maintenance and Repair Costs: $4.5 M (20%)
- Replacement Costs: $2.0 M (9%)

*Residual Value = $445,000
Sustainability: LEED Certification

**LEED Categories**

<table>
<thead>
<tr>
<th>Category</th>
<th>LEED Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Sites</td>
<td>8 pts</td>
</tr>
<tr>
<td>Water Efficiency</td>
<td>3 pts</td>
</tr>
<tr>
<td>Energy and Atmosphere</td>
<td>10 pts</td>
</tr>
<tr>
<td>Materials and Resources</td>
<td>10 pts</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>12 pts</td>
</tr>
<tr>
<td>Innovation and Design Process</td>
<td>3 pts</td>
</tr>
</tbody>
</table>

**LEED Gold Certification**

44 pts
Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang.
A/E/C Collaboration + Owner Input

- Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang
A/E/C Collaboration + Owner Input

- Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang
Collaborative decision making and continuous zero waste intentions led to excluding the roof overhang
## Uniformat Cost Estimate

### Structure

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Excavation</td>
<td>7,000</td>
<td>$8.62</td>
<td>$56,340</td>
</tr>
</tbody>
</table>

### Exterior Finish

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Masonry</td>
<td>$8.67</td>
<td>$56,340</td>
</tr>
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</table>

### Foundation

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Strip footing</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### Retaining Wall

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Sloped 35</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### Superstructure

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Shearwall</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### Electrical

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Conduit</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### Exterior Closure

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Conduit</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### Concrete

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Concrete</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### SPECIAL CONSTRUCTION

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Special construction</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### SITE IMPROVEMENT

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Site preparation</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>

### IMPACT COST

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1088 - Impact</td>
<td>0.48</td>
<td>$55,040</td>
</tr>
</tbody>
</table>
All of this for $7.5M !!!

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 2 Cost</th>
<th>Percent</th>
<th>Level 1 Cost</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substructure</td>
<td>EXCAVATION</td>
<td>125000</td>
<td>2.0</td>
<td>443000</td>
<td>7%</td>
</tr>
<tr>
<td>Shell</td>
<td>SUPERSTRUCTURE</td>
<td>757500</td>
<td>12.3</td>
<td>2192200</td>
<td>36%</td>
</tr>
<tr>
<td>Interiors</td>
<td>INTERIOR CONSTRUCTION</td>
<td>499000</td>
<td>8.1</td>
<td>768100</td>
<td>12%</td>
</tr>
<tr>
<td>Services</td>
<td>CONVEYING SYSTEM</td>
<td>221600</td>
<td>3.6</td>
<td>2130300</td>
<td>35%</td>
</tr>
<tr>
<td>(MEP) Equipment &amp;</td>
<td>EQUIPMENT</td>
<td>23050</td>
<td>0.4</td>
<td>309000</td>
<td>5%</td>
</tr>
<tr>
<td>Furnishing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site Prep</td>
<td>SITEWORK</td>
<td>320000</td>
<td>5.2</td>
<td>320000</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Sub Total** 6162620

**INDIRECT COST** 1352300

**Total Cost** 7515000
Cost Summary

- Substructure: 36%
- Shell: 12%
- Interiors: 5%
- Services (MEP): 5%
- Equipment & Furnishing: 7%
- Site Prep: 35%
SimVision Setup
SimVision Analysis

7.5 days

Cantilever section
Foundation Design
Schedule
 MEP & HVAC

Engineer
CM

Architect
SimVision Analysis

- Roof Overhang Design
- HVAC Design
- MEP system
- Cost Estimate
- 4D model

Decision Wait
Coordination
Rework
Direct work
SimVision Analysis

Two Formal Meetings / week

More Formal Conversations on TT

One Supervisor in charge
Result of our Interventions

Acceptable Backlog - 2 days

Maximum Backlog - 1.5 days!
Result of our Interventions

- Roof Overhang Design
- HVAC Design
- MEP system
- Cost Estimate
- 4D model

- Decision Wait
- Coordination
- Rework
- Direct work
Zero Waste Summary:

- Minimize square footage
- Create efficient circulation areas
- Material selection
- Efficient slope of auditorium floor
- Elimination of roof overhang
- Maximizing use of daylight
Zero Waste Summary:

- Optimal structural design
- Lightweight structure eliminates need for piles
- Replacing of MRFs by braced frames
- Use of sloped columns reduces member sizes
Zero Waste Summary: C

- Last Planner System
- Just in Time Delivery
- Blue Jeans Insulation
- 2 Air Handling Units
- Glass and fly-ash in concrete aggregates
- Storm water reclaim system
Lessons Learned

- Adapt to different time zones
- Effective information organization
- Learning to work with the different disciplines
- Presenting a lot of information in a short time frame effectively
- Just because you say you understand, does not mean you understand (Pacific 2006)
- Sometimes, all you have to do is ask
Special Thanks

Dr. Renate Fruchter

Our Owners: Josh Odelson and Holger Keitel

Architects:
- Professor Humberto Cavallin
- David Bendet

Engineering
- Professor Luis Daza Duarte
- Professor Helmut Krawinkler
- Nick Arenson
- Dr. Greg Luth

MEP
- Professor John Nelson

Construction Managers
- Dan Gonzales
- Igor Starkov
- Henry Tooryani