Site Location
Madison, Wisconsin

Muir Woods
Existing Building
Lakeshore Path
Site Conditions
Madison, Wisconsin
# Weather & Climate

<table>
<thead>
<tr>
<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>
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## Record High

<table>
<thead>
<tr>
<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>
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<th>Nov</th>
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## Average High

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<th>Jan</th>
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<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
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## Record Low

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<th>Jan</th>
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<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
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<td>4</td>
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## Average Low

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
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<th>Aug</th>
<th>Sep</th>
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## Record Low

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<th>May</th>
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</table>

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*Atlantic team*
Weather & Climate

Heavy Rain: June – August
Average High Temps: 84° F
Average Low Temps: 58° F
## Decision Matrix

### Where We Left Off

<table>
<thead>
<tr>
<th>Metrics</th>
<th>The Staircase</th>
<th>Contrast</th>
<th>Weight</th>
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<td>Schedule</td>
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<td>Constructability</td>
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<tr>
<td>Owner Preference</td>
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**TOTAL** | 10 | 13 | 12 | 15
Contrast Shapes
Contrast
Footprint
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Contrast
Shapes + Footprint
Contrast
Shapes + Cantilivers
Contrast
Shapes + Cantilivers
Change In Shape
Influence of Other Disciplines
Change In Shape

Influence of Other Disciplines

Engineers Say Too Difficult
Change In Shape

Influence of Other Disciplines

Owners Say No!
Change In Shape
Influence of Other Disciplines

Owners Say YES!
Contrast

Site
Contrast

Site
Contrast

MEP Integration/Going native

MEP

INTENSIVE
discussions

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Contrast

1st floor

- Auditorium
- Seminar Room
- Small Classroom
- Large Classroom
- Mechanical/Technical Room
- Storage
Contrast

1st floor

- Auditorium
- Seminar Room
- Small Classroom
- Large Classroom
- Mechanical/Technical Room Storage
- MEP Showroom
Contrast

3rd floor

- Instructional Lab
- Server Room
- Faculty Offices
- Administrative Assistants
- Senior Administration Offices
- Faculty Lounge
- Department Chair's Office
- Mechanical/Technical Room Storage
- MEP Showroom
Contrast

Section North-South I - Atrium

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Contrast

Section North-South III Staircases
Contrast
Section
Contrast
Entrance 1st floor
Soil Considerations

Soil Profile

- Bearing Capacity 4 KSF
- High Water Table
- Excavation Needed

Fill

- $\phi = 35^\circ$
- $\gamma = 125$ PCF

Silty Clay

- $\phi = 41^\circ$
- $\gamma = 130$ PCF

0'
6.5'
10'
30'
Loading Considerations

Lateral Load Path

- Wind Load
- Rigid Diaphragm
- Shear Wall

76’
Loading Considerations

Gravity Load Path
Loading Considerations

Gravity Load Path

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Loading Considerations

Roof Loads

Uniform Loads
Dead Load=Self Weight
Snow Load=20 psf
Roof Live=20 psf

AHU 20 psf
Green Roof 50 psf
Snow Drift 40 psf

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Loading Considerations

2nd Floor

- Auditorium: 60 psf
- Offices: 50 psf
- Classrooms: 40 psf
- Corridors: 80 psf
- MEP: 100 psf
- Bathroom: 50 psf

R = 47’

76’
Loading Considerations

3rd Floor

- Storage 100 psf
- Offices 50 psf
- Classrooms 40 psf
- Corridors 80 psf
- MEP 100 psf
- Bathroom 50 psf
- Server Room 100 psf

R = 56'

76'
Structural System

1st Floor

- 8” Concrete Shear
- 16”x16” Columns
- 12”x12” Slanted Columns
- 20” x 20” Columns

R = 38’
Structural System

2nd Floor

- 8” Concrete Shear
- 16”x16” Columns
- 12”x12” Slanted Columns
- 20” x 20” Columns
Structural System

3rd Floor

- 8” Concrete Shear
- 16”x16” Columns
- 12”x12” Slanted Columns
- 20” x 20” Columns

R = 56’
Details
Column Sizes

Slanted Columns
12 No. 9 Bars
No. 3 ties at 12"

Typical Columns
12 No. 9 Bars
No. 3 ties at 16"

Auditorium Columns
12 No. 9 Bars
No. 3 ties at 18"
24"

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Walkway Details

- R = 47'
- 8 No. 9s
- 16”
- 76'
- 76’

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**Flat Slab System**

- **8” Slab system**
  - **Columns**
  - **Typical Slab System**
    - Positive 1 No. 4 / ft
  - **Column Strip System**
    - Positive 2 No. 4/ ft
    - Negative 3 No. 4/ ft (8 ft cutoff)
Connections
Slab to Column

8” 2-way slab
8” drop panel
10’ drop panel
Details
Shear Wall

28 No. 6 Longitudinal Bars

No. 4 Stirrups at 24”

Modular Design
Details

Soldier Pile Retaining Wall

6’

Tie Back Anchor

8” Shotcrete Lagging Smoothed Over

A

B

Trench Drain

Wire Mesh

Section B
Details

Soldier Pile Retaining Wall

- Wire Mesh
- 8" Shotcrete Lagging Smoothed Over
- Tie Back Anchor
- Mirror Drain
- Trench Drain
- Pressure Grouted Anchor
- Anchor Detail
- Drainage Fabric
- Wire Mesh

Section A

Section B
Details
Auditorium

No. 4 Stirrups at 4”

8 No. 7 Bars (14’ cutoff)

16 No. 7 Bars

16.5”

4.5”

24”

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Details
Auditorium

No. 4 Bars at 14"
No. 3 Stirrups at 16"
Cut off at 9'
2 No. 6 Bars
Modeling ETABS

Mode shape showing lateral interaction

Max deflection = 1.25”
Allowable deflection = 1.33”
MEP biotope

Blossom
MEP structure

HVAC

Diffusers + Ducts

Ducts in shafts

Chilled beams + Ducts + Pipes

Source: RE Tykle, Venteuse du bois
Floor sandwich

3 ½ ” of MEP space
MEP Floor plans
First floor

- Classrooms
- Auditorium
- Atrium
- Restrooms
- Mechanical rooms
- Corridors
MEP Floor plans
Second floor

- Classrooms
- Auditorium
- Offices
- Atrium
- Restrooms
- Mechanical rooms
- Corridors
MEP Floor plans
Third floor
<table>
<thead>
<tr>
<th>Area</th>
<th>Area %</th>
<th>Max Occupancy</th>
<th>CFM/pers</th>
<th>Max CFM Zone</th>
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</thead>
<tbody>
<tr>
<td>Classrooms</td>
<td>10.8</td>
<td>75</td>
<td>15</td>
<td>1125</td>
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<tr>
<td>Offices</td>
<td>17.5</td>
<td>200</td>
<td>20</td>
<td>4000</td>
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<tr>
<td>Corridor</td>
<td>11.9</td>
<td>20</td>
<td>15</td>
<td>300</td>
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<tr>
<td>Auditorium</td>
<td>19.1</td>
<td>470</td>
<td>15</td>
<td>4700</td>
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<td>Atrium</td>
<td>27.4</td>
<td>500</td>
<td>10</td>
<td>5000</td>
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<tr>
<td>Restrooms</td>
<td>4</td>
<td>20</td>
<td>50</td>
<td>1000</td>
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<tr>
<td>Labs</td>
<td>7.2</td>
<td>100</td>
<td>20</td>
<td>2000</td>
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<td>Server room</td>
<td>2</td>
<td>25</td>
<td>15</td>
<td>375</td>
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TOTAL CFM: 18500
# Lighting

and additional heat loads

<table>
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<tr>
<th>Area</th>
<th>Area %</th>
<th>Lighting (W/sqft)</th>
<th>Additional Load (W/sqft)</th>
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<tbody>
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<td>Classrooms</td>
<td>10.8</td>
<td>1.45</td>
<td>20</td>
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<td>11.9</td>
<td>0.57</td>
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<tr>
<td>Auditorium</td>
<td>19.1</td>
<td>1.62</td>
<td>5</td>
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<tr>
<td>Atrium</td>
<td>27.4</td>
<td>1.77</td>
<td></td>
</tr>
<tr>
<td>Restrooms</td>
<td>4</td>
<td>0.77</td>
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<tr>
<td>Labs</td>
<td>7.2</td>
<td>1.24</td>
<td>40</td>
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<tr>
<td>Server room</td>
<td>2</td>
<td>1.45</td>
<td>50</td>
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</table>
Roof area
Water catchment

Air Handling Unit
10,000 CFM

Water catchment

Green roof
Additionnal R-11
Geothermal roots

Ground source heat pump
**Ground source heat pump**

**Sizing**

Six 150 ft- deep boreholes and heat pump 11 EER sized with Equest:

MEP ↔ C: First delay estimated 2 months, finally only one week and first cost in the budget!
Baseline Energy Consumption
without ground source heat pump

Electric Consumption (kWh)

Gas Consumption (Btu)

- Area Lighting
- Task Lighting
- Misc. Equipment
- Exterior Usage
- Pumps & Aux.
- Ventilation Fans
- Water Heating
- Ht Pump Supp.
- Space Heating
- Refrigeration
- Heat Rejection
- Space Cooling
Energy Consumption with ground source heat pump

Electric Consumption (kWh)

Area Lighting
Task Lighting
Misc. Equipment
Water Heating
Ht Pump Supp.
Space Heating

 Exterior Usage
 Pumps & Aux.
 Ventilation Fans
 Refrigeration
 Heat Rejection
 Space Cooling
NPV for ground source heat pump
10 years payback

Net present value of energy system for space heating/cooling

Positive in 2025

- Annual cost of steam: 16 554 $ (2011)
- Annual cost of electricity to power the Heat Pump: 5600$ (2011)
Energy And Atmosphere

Ground Source Heat Pump

REFRIGERANT
Annual Electricity End Use

Baseline Design

499,000 kWh
26,000 Therms

Optimized Alternative

464,000 kWh
7,000 Therms

$54,260

$23,030 SAVINGS!

Electricity, kWh (x000)

Baseline Design

Optimized Alternative

Misc Equip  Space Cooling  Lights  Pumps & Aux
Fans  Space Heating  Exterior Loads  Heat Rejection
Water Efficiency

- Green Roof
- Low-Flow Urinals
- Hands Free
- Waterless Urinals
- Low-Flow
- Storage
- Native Vegetation
- Drinking Water
- Sewage
Water Indoor Usage

Baseline Design: 1,134 Gallons

Improvements: $1817 Savings

$6840 Total Savings
Sustainable Site

ENTRANCE

BUS STOP

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Materials and Resources

On-Site Sorting > 75% of Debris

Local Aggregate

Fly Ash
Materials and Resources

Local Materials  500 mile radius

40 mile radius

5 mile

35 mile

8 mile
Indoor Environmental Quality
LEED Certification

SUSTAINABLE SITE 20
WATER EFFICIENCY 9
ENERGY & ATMOSPHERE 22
MATERIALS & RESOURCES 5
INDOOR ENVIRONMENTAL QUALITY 13
TOTAL 70

LEED Gold
Site Plan for Construction

- **LIMITED ACCESS SPACE (45 feet)**
- **RECYCLING AREA**
- **POSITION OF THE BUILDING**
- **TEMPORARY FACILITIES**
- **SITE FENCE**
- **MULTIPURPOSE AREA**
  - Mobile crane
  - Bus
  - Unloading area
- **PEDESTRIAN BYPASS**
Site Access
Delivery Path

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Schedule
4D Animation
Critical Construction Zone I

Sub Structure

Retaining Wall and Foundation

Limited Construction Site
Critical Construction Zone I

Equipment

- 1x PILING RIG
- 1 EXCAVATOR
- 1x SHOTCRETE
- 4x CONCRETE MIXER
- 1x CONCRETE PUMP
- 1x TRUCK MOUNTED RIG
Mobile Crane
Haviest Lift

45’ Long Crane
Heaviest Lift is 6 klbs
Critical Construction Zone 1
Foundation – Construction Sequence

- Piles
- Heat-pump Boreholes
- Retaining Wall
- Spread Footings
- Slab on Grade
Critical Construction Zone II
Labs

LABS

OWNERS  ARCHITECT
CM  MEP
Target Value Design
1st Estimate, 2/2/2011

<table>
<thead>
<tr>
<th>Substructure</th>
<th>Shell</th>
<th>Interiors</th>
<th>Services</th>
<th>Special Construction</th>
<th>Building Sitework</th>
<th>Soft Costs</th>
<th>Totals</th>
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</thead>
<tbody>
<tr>
<td>USD (thousands)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

- Substructure: $0
- Shell: $2,000
- Interiors: $1,000
- Services: $3,000
- Special Construction: $5,000
- Building Sitework: $7,000
- Soft Costs: $8,000
- Totals: $8,287,000

1st Iteration
Target Value: $8,287,000
Target Value Design

2nd Estimate, 3/6/2011

USD (thousands)

- Substructure: $500
- Shell: $2,000
- Interiors: $1,500
- Services: $2,500 (2nd Iteration: $1,000)
- Special Construction: $1,000
- Building Sitework: $200
- Soft Costs: $500
- Totals: $8,004,000

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Target Value Design
3rd Estimate, 4/25/2011

USD (thousands)

Substructure: $0
Shell: $1,000
Interiors: $2,000
Services: $3,000
Special Construction: $4,000
Building Sitework: $5,000
Soft Costs: $6,000
Totals: $7,930,000

3rd Iteration
Target Value
Target Value Design

### Cost Based on:
- Labor
- Material
- Equipment

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<tr>
<th>Code</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Total Price</th>
<th>TargetCost</th>
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<td>14,139.28</td>
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<td>Forms in Place, 1-Way Joint Pans, 4 Use</td>
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<td>2.86</td>
<td>8,098.46</td>
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<td>Reinforcing Slab (#4 to #7)</td>
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<td>4 Rods, C-25 Crew</td>
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<td>61.23</td>
<td>1,195.57</td>
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<td>Reinforcing in Place, Slab</td>
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<td>727.31</td>
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<td>Concrete in Place, 4000 psi Normal Weight</td>
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<td>cy</td>
<td>105.00</td>
<td>2,737.34</td>
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<td>Finishing Concrete, Broom Finish</td>
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<td>57.23</td>
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# Target Value Design

## AMC atlantic team

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### AMC atlantic team
# Target Value Design

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**Final Cost, 5/5/2011**

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Target Value Design
Final Cost, 5/5/2011

$7,360,000
BIM Modeling
Coordinating Multiple Model Iterations

- Revit Server
- Navisworks
- Vico

Clash Detection
Conflicting ORIGINS
Compatibility Issues
atlantic team
# BIM Modeling

## Coordinating Multiple Model Iterations

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AVG 6 min per version x 14 versions = 84 total min

AVG 6 min per version x 11 versions = 66 total min
Project Evolution
Multiple Iterations

Architectural Models

Structural Models
BIM Modeling
Multiple Iterations

Architectural Models

Structural Models

Final Design
Project Evolution
Multiple Iterations

Architectural Models

Over 30 Architectural Models
And 20 Structural Models

Structural Models

Final Design
## IPD Process Evolution

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IPD Process Evolution
Workflow Diagram

Team Atlantic Workflow Diagram

Architect
- Floor Plans
- Exterior Material/How much is Glass??
- Input on LEED
- Finalize Labs

Engineer
- Finalize Ret Wall Design
- Shear Wall Design
- Start Auditorium Structure Design
- Exterior Beams Design
- Start SAP Model

MEP
- Routing of Pipes
- Continue Modeling

CM
- Meet about Geothermal Presentation to owners
- Cost Feedback on Façade (VICO Linking)
- Start Linking MEP Model Quantities to Cost
- Update schedule based on quantities designed
- Schedule Coordination (Labs complete early)
Changes From Winter Quarter
Progression of Momentum With Time

Momentum

Kick-Off  Crit  Cyber Presentation  Fishbowl  Final Presentation

Loss of Momentum

Time
Collaboration

Complete Chaos
Collaboration

Complete Chaos

Some Order
Collaboration

Where are the Most Recent Floor Plans?

Complete Chaos

Some Order

atlantic team
Collaboration

Complete Chaos

What?

Some Order

Where Shall We Place the Building on the Site?

We Need to Consider Excavation.

And Drainage...

And Site Access.

What About the Neighboring Buildings...

What?

That Costs Too Much.

I Just Made a Small Change...

Where are the Most Recent Floor Plans?
Collaboration

Complete Chaos

Some Order

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Some Order

- I Just Made a Small Change...
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- What?
- That Costs Too Much.

- We Need to Consider Excavation.
- And Drainage...
- And Site Access.
- What About the Neighboring Buildings...
Collaboration

We Need to Consider Excavation.

Complete Chaos  Some Order
Collaboration

Complete Chaos

And Drainage...

Some Order
Collaboration

Complete Chaos

And Site Access.

Some Order
Collaboration

What About the Neighboring Buildings...

Complete Chaos  Some Order
Collaboration

Complete Chaos — Some Order

Confusion About Other Disciplines — Appreciation and Understanding of Other Disciplines
Collaboration

Complete Chaos  Some Order

Communication

Confusion About Other Disciplines  Appreciation and Understanding of Other Disciplines
Communication

Most Effective Communication Software For Us

Google wave labs
skype
GoToMeeting
Teleplace

No Email Policy
Communication

Most Effective Communication Occurred When Co-Located
Communication

What am I supposed to do?...Let's meet.
Communication

What am I supposed to do?...Let’s meet.

And now we will talk...and talk...
Communication

What am I supposed to do?...Let’s meet.

And now we will talk...and talk...

Understanding. Educated Questions and Communication
Lessons Learned

- A global team is only as fast as its slowest network speed
- Nobody’s done until everybody’s done
- Even if you are still learning don’t forget to educate your team
- An enemy isn’t really an enemy

“I choose my friends for their good looks, my acquaintances for their good characters, and my enemies for their good intellects. A man cannot be too careful in the choice of his enemies. I have not got one who is a fool. They are all men of some intellectual power, and consequently they all appreciate me.”

-Henry Wotton, The Picture of Dorian Gray
Thank You!

All the Mentors

Glenn Katz

Martin Dembski

Josh Odelson

Renate

Tine Logonder

Willem Kymmel

Ivo Zagar

Prof. Miranda

David Bendet

Lauren Scammell

Eric Borchers

Marko Balant

Prof. Krawinkler

Prof. Borja

Michael Pearson

Prof. Miranda

Prof. Krawinkler

Prof. Nelson

Prof. Nelson

Greg Luth