Stanford University, CA, USA

MIKE
Construction Manager

YAO
Structural Engineer

NICK
Structural Engineer
University of Wisconsin, WI, USA

Tom
Structural Engineer
Aalborg University, Aalborg, DK

Nicholas Architect
Owners for Bauhaus University
LOCATION

RIVER
team
Site – Weimar Germany
Site Conditions
Site Conditions
RIVER

LOCATION

team
### Site Conditions

**CLIMATE**

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Site Conditions

Flooding

Average Flood – 0.7m
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HELIOtropism
HELIOtropism

STRENGTH:
- Response to surrounding
- Sustainable Design
- Challenging our skills
- Adapts to surroundings

OPPORTUNITIES:
- Outdoor design/ Landscaping
- Attracting public
- Educational integration
Biomimicry – SunFlower
Biomimicry – Moss
Biomimicry – Tree
Biomimicry – ParkAdaption
Biomimicry – CityAdaption
Structural Model
A. E. C. MEP. LCFM.
1st Floor
A. E. C. MEP. LCFM.

ZONE 1
Outer Radius=85’

ZONE 2
Outer Radius=152’

ZONE 3
Outer Radius=318’
All Columns are 8.5” x 8.5”

- Girder 10.75” x 15”
- Beam 10.75” x 15”
- Girder 12.25” x 19.5”
- Beam 5” x 6.75”
- ¾” Plywood Lateral System
- Concrete Retaining Wall
- 2.75” Diameter Tension Truss

• Floor Joist System are comprised of 89mm x 300mm I-Joist system on 400mm Center

• Allowable Stress Design

• Loading from German codes:
  Wind: 13.4 psf
  Snow: 17.0 psf
2\textsuperscript{nd} Floor Z – 3
A. E. C. MEP. LCFM.
3rd Floor
A. E. C. MEP. LCFM.

19.8 m

Girder 10.75” x 15”
Beam 10.75” x 15”
Girder 12.25” x 19.5”
Beam 5” x 6.75”
½” Plywood Lateral System
Concrete Retaining Wall
Heat Recovery Ventilator and Air Handling Unit Located on 3rd floor

Interior air circulated through bio-wall and mixed with fresh air
Schematic HVAC

A. E. C. MEP. LCFM.

Heat Return Loop

Vertical Ground Loop

GSHP

Vertical Ground Loop
Roof Area: 694 m²

- Average Rainfall in Weimar = 520 mm
- 361 m² (95,000 gal) total water collected
- 19% Reduction in water use

30 m² water storage
Outdoor Theater – Cost

100,000€
OPEN CANVAS
Temporary design by students

OPEN ART
Installations by students
Furniture and equipment by students

Art by students
Café – Advantage
A. E. C. MEP. LCFM.

- 6.6%
Roof Function

VENTILATION
- cool air
- summer: air goes in
- winter: air goes out

Moss & sedum
- summer: sun goes in
- winter: sun goes out

REEN ROOF

DAYLIGHTING

PV
Schedule shortened by 4 weeks
Solar Cogeneration

A. E. C. MEP. LCFM.

Solar Radiation: 3.32 kWh/m²/day
Area of Footprint: 930 m²
Efficiency: 18%
Solar Potential: 203,000 kWh/yr.

Target Consumption: 23,000 Btu/sf/yr.
Array size: 101 kW

Photovoltaics

- PV 18%
- Lost 25%
- Waste Heat Recovery 60%
- Lost 82%

Single Axis Tracking

Concentrator

Heat Collectors

Photovoltaics

Final rent without PV: 18 €
Final rent with PV: 17 €

- 1.8%
PV – Advantage on rent

A. E. C. MEP. LCFM.

final rent: 17,485,000 €
without PV: 17,805,000 €

- 1.8%
Highlight the disciplines which had a part in the slides content.
Tree Column
A. E. C. MEP. LCFM.

Columns
6.75” x 6.75”

Beam
6.75” x 8.5”

Knife Plate

Wood Structural Members
Roof Truss
A. E. C. MEP. LCFM.

23 m (76 ft)
Top Wood Cords: 6.75” x 6.75”

Diagonal Tension Bar: 1.5” diameter

Bottom Tension Bar: 1.5” diameter

Vertical Compression Member: HSS 4x4x0.25
Roof Structure
A. E. C. MEP. LCFM.
Rental Auditorium

A. E. C. MEP. LCFM.

Final rent: €17,485,000

Without rental Auditorium: €17,925,000

- 2.5%
Erection sequence

Full-height columns
Reinforcing

Erection sequence
A. E. C. MEP. LCFM.
Cut columns

Erection sequence

A. E. C. MEP. LCFM.
Highlight the disciplines which had a part in the slides content.
Atrium before Alteration

Claustrophobia
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<th>Number</th>
<th>Date</th>
<th>Fixed Date</th>
<th>Assigned</th>
<th>Location</th>
<th>Clash</th>
<th>Solution</th>
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<td>5/2/2012</td>
<td>Architecture</td>
<td>North Stanwell</td>
<td>Stairs hit columns and beams</td>
<td>Reduce size of stairs - 0.15m south and 0.15m west</td>
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<td>Architecture</td>
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<td>Interior walls hit floors above</td>
<td>Make interior walls ~3” shorter</td>
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<td>3</td>
<td>4/10/2012</td>
<td>6/4/2012</td>
<td>Structural</td>
<td>Elevator</td>
<td>Elevators run into slab</td>
<td>Make holes in slab for elevators</td>
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<td>4</td>
<td>4/30/2012</td>
<td></td>
<td>Architecture</td>
<td>River Side</td>
<td>Angled columns hit curtainwall</td>
<td>Move curtainwall out 0.15m towards river</td>
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<td>5</td>
<td>4/30/2012</td>
<td>5/3/2012</td>
<td>Structural</td>
<td>All columns</td>
<td>Columns hit roof</td>
<td>Make columns ~3” shorter</td>
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</tbody>
</table>
Biowall

A. E. C. MEP. LCFM.

Conduction through building envelope 35%
Outside Air 65%

Air Flow

Exhaust

Supply fan

ERV

Return fan

AHU

Auditorium

Other Programming

Biowall

Air

Flow

OA

Supply

fan

Auditorium

Other Programming

Biowall

Conduction

through

building

envelope

35%

Outside

Air

65%
Biowall – Advantage

A. E. C. MEP. LCFM.

- 0.4%

17,485,000 €

17,550,000 €

Final rent vs. without Biowall
Tree Moving Equipment

A. E. C. MEP. LCFM.
Tree Moving
A. E. C. MEP. LCFM.
Temporary Levee

A. E. C. MEP. LCFM.

FLOODING RISK

Storable

small modular components

Cost 253.000 €

risk cost 360.000 €
Temporary Levee – Advantage

- 0.8%

17,620,000 €

17,485,000 €

final rent

without Levee
4D Model – Floor Module
A. E. C. MEP. LCFM.
<table>
<thead>
<tr>
<th>Task Name</th>
<th>2014</th>
<th>2015</th>
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<tr>
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<td><strong>Substructure</strong></td>
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<td>Construct Levee System</td>
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<td>Slab on Grade</td>
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<td>Curtain Wall - Entrance</td>
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<td>SIPs - Exterior Wall</td>
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<td>Interior Floor</td>
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<tr>
<td>Finishes</td>
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</tbody>
</table>

Schedule

A. E. C. CM. MEP. LCFM.
• Design for simplicity, strength and moisture protection

- 8” by 8” column
- Bucket with knife plate
- Four 1” diameter through-bolts for uplift resistance
Finn Joist Detail
A. E. C. MEP. LCFM.

Dimensions & Details
Floor Module Detail
A. E. C. MEP. LCFM.

Pre-fabricated Panel Section Detail

Floor Sandwich Side View
MINIMIZING THE RENT

not by saving on quality
but

BY ADDING QUALITY
Please rate each category as to the importance of spending money on that item. Note that some categories fall under several different areas.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Category</th>
<th>Owner 1</th>
<th>Owner 2</th>
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<td>Student Offices</td>
<td>Thermal Comfort</td>
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</tbody>
</table>

Costs:
- **Baseline**: $0 to $500,000
- **Value Added**: $500,000 to $1,000,000
- **Baseline + Value Added**: $1,000,000 to $1,500,000
- **Baseline + Value Added + Baseline**: $1,500,000 to $2,000,000
- **Baseline + Value Added + Baseline + Value Added**: $2,000,000 to $2,500,000
- **Baseline + Value Added + Baseline + Value Added + Baseline**: $2,500,000 to $3,000,000
- **Baseline + Value Added + Baseline + Value Added + Baseline + Value Added**: $3,000,000 to $3,500,000
- **Baseline + Value Added + Baseline + Value Added + Baseline + Value Added + Baseline**: $3,500,000 to $4,000,000
- **Baseline + Value Added + Baseline + Value Added + Baseline + Value Added + Baseline + Value Added**: $4,000,000 to $4,500,000
Minimizing expenses

- construction cost
  - modular elements
- operation & maintenance
  - net zero
  - bio-wall
- financing
  - financial engineering

Maximizing income

- Café
  - size, location
  - rent Auditorium
  - accessibility

MINIMIZING THE RENT by >15%
TVD for LC – Minimizing Rent

A. E. C. MEP. LCFM.

- 2.2%
- 9%
- 0.6%
- 0.3%
- 2.2%
- 6.4%
- 1.8%

Total Rent in Million €

- 22.1 €
- 21.6 €
- 19.7 €
- 19.5 €
- 19.5 €
- 19.0 €
- 17.8 €
- 17.5 €
TVD for LC – Minimizing Rent

A. E. C. MEP. LCFM.

<table>
<thead>
<tr>
<th>Without TVD</th>
<th>With TVD</th>
</tr>
</thead>
<tbody>
<tr>
<td>22,100,000 €</td>
<td>17,500,000 €</td>
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</tbody>
</table>

- 20%
Life Cycle Costs

14,530,000€

Construction Costs: 46%
Operation & Maintenance: 26%
Replace-ments: 3%
Risk Charge: 4%
Interest Payments: 21%

Lifetime Costs:
- 4,130,000€
- 660,000€
- 2,820,000€
- 730,000€
- 6,190,000€

A. E. C. MEP. LCFM.
Sensitivity Analysis

A. E. C. MEP. LCFM.

LCC EFFECT
Change in Interest Rates and Construction Costs
= Biggest Effect on LCC

13,800,000 €
14,000,000 €
14,200,000 €
14,400,000 €
14,600,000 €
14,800,000 €
15,000,000 €
15,200,000 €
15,400,000 €

10% 5% 0% -5% -10%
Cumulated Cash Flow

Break Even Year 20
A. E. C. MEP. LCFM.

Rent

LC 17.490.000€
Risk Management
A. E. C. MEP. LCFM.

Life Cycle Cost estimate

Standard value

Calculations of risk surcharge

adjusted costs

Value for owner
higher financial security

Assumption on possible damage rationalized by statistical calculation

Construction Cost estimate

Value for owner
higher financial security

@RISK 5.5
Risk Management
A. E. C. MEP. LCFM.

Monte-Carlo-Simulation on extend of risk expenses.

640,000€
Surcharge

Most likely value
Loan Structure

Replacement Loan

Total Loan in Million €

DSCR

Junior Loan 20
Junior Loan 15
PV loan
Senior Loan
Private Equity

DSCR needed

0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
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11.0
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13.0
14.0
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16.0
17.0
18.0
19.0
20.0
21.0
22.0
23.0
24.0
25.0

0.60
0.80
1.00
1.20
1.40
1.60
1.80

0.0
0.5
1.0
1.5
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0.60
0.80
1.00
1.20
1.40
1.60
1.80

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DSCR
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<th>Final Rent</th>
<th>Without Financial Engineering</th>
<th>LC Advantage</th>
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<tr>
<td>€17,500,000</td>
<td>18,000,000 €</td>
<td>20,000,000 €</td>
</tr>
</tbody>
</table>

LC advantage represents a 10% reduction in the final rent when Financial Engineering is applied.
Certification
A. E. C. MEP. LCFM.

LEED Platinum
Innovation points:
net-zero
design of biowall
95% construction waste
diversion

DGNB Gold
85%
Quality of integrated
planning
Socio-cultural quality
P O P

RIVER

team
Team Work–Organization

Flat Hierarchy

equals among equals

best integration of individual skills and ideas
### Team Work – Flat Organization

<table>
<thead>
<tr>
<th>Meeting Date</th>
<th>Facilitator</th>
<th>Recorder</th>
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<tbody>
<tr>
<td>1/22/2012</td>
<td>Mike</td>
<td>Nick</td>
</tr>
<tr>
<td>1/29/2012</td>
<td>Maria</td>
<td>Yao</td>
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<tr>
<td>2/5/2012</td>
<td>Nick</td>
<td>Tom</td>
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<tr>
<td>2/12/2012</td>
<td>Yao</td>
<td>Nicholas</td>
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<td>2/19/2012</td>
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<td>2/26/2012</td>
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<td>3/4/2012</td>
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<tr>
<td>3/11/2012</td>
<td>Maria</td>
<td>Yao</td>
</tr>
</tbody>
</table>

Weekly role rotation enforces flat hierarchy.
Team Work–Process Coordination

Did it, have a look it

Got it

Wait, I show you …

Hey, can’t understand what you mean

Got it
Team Work–Process Improvement

What needed to be improved:
- Tracking of task list
- more interaction
- faster response mode

Improvement:
- daily stand–up meeting: for task tracking
  more interaction
  quick responses
### Team Work–Process Improvement

#### Meetings

<table>
<thead>
<tr>
<th>Time</th>
<th>Meeting Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>08:00–09:00</td>
<td>Daily stand-up meeting</td>
<td>Team members update progress and plan for the day</td>
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<tr>
<td>09:00–09:30</td>
<td>Weekly team meeting</td>
<td>Team discusses progress and plans for the week</td>
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<tr>
<td>14:00–15:00</td>
<td>Weekly sub-meeting</td>
<td>Special purpose sub-meeting</td>
</tr>
<tr>
<td>16:00–17:00</td>
<td>Weekly sub-meeting</td>
<td>Special purpose sub-meeting</td>
</tr>
</tbody>
</table>

#### Daily Stand-Up Meeting

- Participants: Team members
- Purpose: Update progress and plan for the day

#### Weekly Team Meeting

- Participants: Team members
- Purpose: Discuss progress and plans for the week

#### Weekly Sub-Meeting

- Type: Special purpose sub-meeting
- Purpose: Address specific tasks or projects

#### Weekly Sub-Meeting

- Type: Special purpose sub-meeting
- Purpose: Address specific tasks or projects
Team Work–Process Organization

**Week 1**
- ARUP
  - Practice Clash
  - Model to CM

**Week 2**
- Fish Bowl
  - Final Construction Costs
  - Final Clash

**Week 3**
- Dark horse
  - Revit Model Zone 1(4/16)
  - Revit Model Zone 2(4/19)

**Week 4**
- No-class
  - Revit Model Zone 3(4/27)
  - AEL - Powerpoint Presentation

**Week 5**
- Dry-Runs
  - 4D Model
  - Smart Board Planning

**Week 6**
- Final Presentation
  - Finish Other Work!

**Mentor Meetings 4/13/12**
- Finalize Concept
- Risk Analysis

**Other Notes**
- Nick/Nick is here!
- Marla is here!
Team Work–Process Iteration
Team Work–Colaboration
RIVER

team
“Design is not only about creating ideas but more about turning ideas into reality.”

“Clashing ideas of different perspectives can lead to ideas neither party would ever think of alone.”

“Do not assume, but ask and ask again.”

“Don’t be afraid to explore the most extravagant ideas, you will never know what they will turn into.”

“If You go in with an open mind, You’re likely to have a good time.”
THANK YOU…

Greg. P. Luth
David Bendet
Humberto Cavallin
Hans Verheij
Wafaa Sabil
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