River Team 2009

The Engineering School of Riverbank University

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E: XIAOYU LIU – Stanford, CA
JEFF BRUNTON – Wisconsin Madison
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C: JIANG BIAN – Stanford, CA
MATT WATLEY – Chico State, CA
LCFM: NADIN DITTMANN – Bauhaus-Universität Weimar
PPP-Project

- Project: April 2015 – March 2016
- PPP – Contract:
  - 25 years
  - design, plan, build, operate, maintain, finance

Riverbank-University Weimar

Consortium River Team

- rental fee

Operator e.g. cafeteria

Contractor

Sub Contractors

- Bank
- Investors
- Insurance Company

Students/Faculty

Public
Private

contracts
Site – Weimar, Germany
Soil Conditions

- High Water Table
- High Frost Line
- Old Plants Adjacent
- 385 kPa Bearing Capacity
## WQ - DESIGN OPTIONS

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1st Concrete</th>
<th>1st Steel</th>
<th>2nd Concrete</th>
<th>2nd Steel</th>
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<td>Strength of Concept</td>
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<td>3</td>
<td>2</td>
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<td>Owner's Preferences</td>
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<td>Constructability</td>
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<td>Functionality</td>
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<td>Sustainability</td>
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<td>3</td>
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<td>Least Cost</td>
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<td>3</td>
<td>-3</td>
<td>1</td>
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<td>Short Schedule</td>
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<td>1</td>
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<td>3</td>
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<td>Local Building Method</td>
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<td>-3</td>
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<td>-3</td>
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<td><strong>Total</strong></td>
<td><strong>5</strong></td>
<td><strong>4</strong></td>
<td><strong>14</strong></td>
<td><strong>13</strong></td>
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</table>
Based on Mentor Feedback the DESIGN WAS CHANGED
Site Plan
2nd Floor

Server
Instructional Lab
Student Office
Technical Support
Small Classroom
Seminar Room
Lounge
Mechanical Room
Restrooms
Storage
Evacuation Plan

Mobile Dykes
Evacuation Plan

- Pile Foundation
- Small Footprint with elevated electrical sys. / equip.
- Entrance barrier; water protection system
- White tank

River 2009
Site Protection - Sheet Piles

PAL 3030 - Cold formed

- Width: 660 mm
- Height: 89 mm
- Diameter: 3 mm
- Sectional area: 37.5 cm²/m
- Weight:
  - Single pile: 19.4 kg/m
  - Wall: 29.4 kg/m²
- Moment of inertia: 500 cm⁴/m
- Surface of resistance: 112 cm³/m
- Paint surface:
  - Double-sized: 0.8 m²/m²

Producer: Halteren Infra bv

Connection
Sections

Section A

Section B
Materials - Exterior

Glass

Concrete
Materials - Interior

- Travertine
- Wood
Atrium
Lounge
Atrium
Evacuation Plan
Engineering - Loads (ASCE 7)

Live Load

• Storage – 125 psf / 6 kN/m²
• Corridors, server, lobbies – 100 psf / 4.79 kN/m²
• Assembly, stairs – 100 psf / 4.79 kN/m²
• Classrooms – 40 psf / 1.92 kN/m²
• Office – 50 psf / 2.4 kN/m²

Dead Load

• Collateral – 25 psf / 1.2 kN/m²
Dimensions – First Floor

- Allowable Footprint
- Cantilever
Dimensions – Second Floor

- Allowable Footprint
- Cantilever

Similar to 3rd floor
Major Design Topics for Engineers

- Large Cantilevers
- Poor soils
- Flooding
- Limited Floor to Ceiling Height
- Irregular Geometry

20 m
Ceiling Height and Irregular Geometry Solution

\( \frac{1}{2} \)" diameter
270 ksi
7 wire strands
at 16" o.c.

\( \frac{1}{2} \)" diameter
60 ksi
rebar at 5" o.c.

\( \frac{1}{2} \)" diameter
60 ksi
rebar at 12" o.c.

12’ (3.7 m) 8’-6” (2.6 m) 3’-6” (1.1 m) 7’ (2.1 m)

16’-8” (5.1 m) 14’-4” (4.4 m)

Post tensioned floor slabs
- No geometric constraints
- similar to precast (span to depth ratio)

Idea from Greg!
Typical Slab Detailing

- Strands ½” diameter
  - 16” c/c

- 1/2” diameter (Typically 12” c/c)
Vertical System

**Walls**

Reinforcement: 
#5 80mm c/c

**Columns**

Transverse Rebar: 
#3 100mm c/c

Reinforcement:
#5 barsX4
Tie: 
#3 200 c/c

River 2009
Pile Foundation

- Inclined Slab
- Underground auditorium

11m

End Bearing Friction
Load Path

Large Cantilever

Structural Walls

LL + DL = 790 Kips
DL = 790 Kips
Construction Challenges

- Zero waste
- Irregular geometry
- Curved walls
- 15 deg slope
- Flooding
Construction Solutions

Shotcrete

Customized forms

Laser positioning

BuildExact

River 2009
MEP Distribution

- Department Chair’s Office
- Senior Admin. Assistance
- Administrative Assistance
- Faculty Office
- Meeting Room
- Lounge
- Mechanical Room
- Restrooms
- Storage
Infrared Heating

Ceiling/Wall mounted panels
Thermostat
Controller
Power-entry panel
# Cost Estimate

<table>
<thead>
<tr>
<th>Code</th>
<th>Specification</th>
<th>Quantity</th>
<th>Unit</th>
<th>USD/Unit</th>
<th>USD</th>
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<td>Z2010.5000</td>
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<td>$1,933,131.40</td>
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<td>B1030.1300</td>
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<td>Third Floor</td>
<td>11,967.20</td>
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<td>$139.54</td>
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<td>Second Floor</td>
<td>11,967.20</td>
<td>sf</td>
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<td></td>
<td>First Floor</td>
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<td>A1030.01_1</td>
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<td>A1030.01_2</td>
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<td>B1010.2110</td>
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<td>C1020.0100</td>
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<td>Subgrade</td>
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<td>$71.84</td>
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<td>sf</td>
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<td>$61,157.77</td>
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<td>A2020.0100</td>
<td>Subgrade / Basement Foundtn Wall</td>
<td>174.72</td>
<td>ft</td>
<td>$288.85</td>
<td>$50,468.45</td>
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</table>

**In total** $7,833,802.04
**Cost Estimate**

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
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<tbody>
<tr>
<td>General</td>
<td>$1,933,131</td>
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<tr>
<td>Substructure</td>
<td>$174,876</td>
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<tr>
<td>Shell</td>
<td>$2,417,796</td>
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<tr>
<td>Interior</td>
<td>$410,350</td>
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<tr>
<td>Services</td>
<td>$2,658,742</td>
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<tr>
<td>Green Features</td>
<td>$238,907</td>
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<td><strong>Total Budget 2009</strong></td>
<td><strong>$7,800,000</strong></td>
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<tr>
<td><strong>Future Cost 2015</strong></td>
<td><strong>$9,300,000</strong></td>
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</table>

The total budget for 2009 is $7,800,000. The future cost for 2015 is $9,300,000.

The pie chart illustrates the distribution of costs:
- General: 25%
- Shell: 31%
- Interior: 5%
- Services: 34%
- Substructure: 2%
- Green Features: 3%
Cost Estimate
Line of Balance

Start Date: 5/1/2015
Finish Date: 1/31/2016

*Dewatering: 3/31/2016
Line of Balance
Line of Balance

West Zone

East Zone

North Zone
4D Model

- **Recipe**
  - A2020.0100: Basement Foundry Wall (2,770.25)

- **Methods**
  - 1002: Basement Wall (2,061.98)
  - 1009: Foundation Damp Proofing (113.55)
  - 1012: Strip Footing (594.62)

- **Task Progress**
  - 471136: Pour
  - 471137: Waterproofing
  - 471138: Pile forms

  Completed: 0
  In progress: Not defined
  Not started: Not defined
Risk Management – ABC-Analysis

RISKS:

- Flood (10)
- Exceeding Schedule (14)
- Change in interest rate (8)
- Operation Costs (30)
- political risks (1-3)
- legal risks (4-5)
- contamination (15)
Financing

Planning/ Construction
5,890.00 €

Maintenance
46,900 €

Risks
642,600 €

Service
46,900 €

Operation
-12,200 €
Sensitivity Analysis
Total Costs

5.890.000 €

$7,834,000

46.900 €

-12.200 €
PPP-Project

Riverbank-University Weimar

Consortium River Team

Contractor

Sub Contractors

Bank

Investors

Insurance Company

Monthly Rental Fee

40,280€

rental fee

contracts
Sustainability - LEED

- **Sustainable Site:** 11/14
- **Water Efficiency:** 5/5
- **Energy / Atmosphere:** 11/17
- **Material Resources:** 7/13
- **Indoor Environmental Quality:** 13/15
- **LEED Innovation:** 3/5

**Project:**

- **River 2009**

**LEED Gold 2009**

**Points:**

- **33-38 points**
- **50 / 69 points**
Sustainability

High Requirements:

- green company policy
- supply of using recycled material
- Local materials
- Local companies

150km/93 miles
Sustainability


Renewable Energy Law
Sustainability – Trade-off-Analysis

**Photovoltaics**

- Area/Effective area: 800 m²/600 m²
- Line entry Consumption: 58,000 kWh
- CO2 – Avoiding total: 5760 kWh
- CO2 – Avoiding: 300 m²/240 m²
- Consumption: 58,000 kWh
- CO2 – Avoiding total: 79,100 kWh
- CO2 – Avoiding: 79,100 kWh
- Consumption: 79,100 kWh

**Solar Panels**

- Area/Effective area: 300 m²/240 m²
- Line entry Consumption: 58,000 kWh
- CO2 – Avoiding total: 5760 kWh
- CO2 – Avoiding: 39.600 kg/year
- Consumption: 39.600 kg/year
- CO2 – Avoiding total: 39.600 kg/year
- CO2 – Avoiding: 19,488 kg/year
- Consumption: 19,488 kg/year
Sustainability – Trade-off-Analysis

Photovoltaics

Solar Panels

Investment Costs without Subsidies
- 600,000 €
- 700,000 €
- 800,000 €
- 900,000 €

Investment Costs with Subsidies
- 300,000 €
- 400,000 €
- 500,000 €
- 600,000 €

Area/Effective area
- 800 m²/600 m²
- 300 m²/240 m²

Consumption
- 58,000 kWh

CO2 – Avoiding
- 6,830 kWh
- 232 g/kWh
- 19,488 kg/year
Sustainability – Trade-off-Analysis

Photovoltaics

Benefit for 25 years

Area/Effective area

300 m²/240 m²

300,000 €

400,000 €

5760 kWh

39.600 kg/year

Benefit

800 m²/600 m²

58.000 kWh

683 g/kWh

Consumption

CO2 – Avoiding

79100 kWh

232 g/kWh

19.488 kg/year

Costs Revenues

0 €

100,000 €

200,000 €

300,000 €

400,000 €

500,000 €

600,000 €

River 2009
Zero Waste
Save Space & Materials...

- Cantilever
- Reduced footprint
- Slab depth
- Skylight area on the roof
- Reduced Site

River 2009
Save Water

Rainwater Collection

Urine Separation & waterless toilet

Irritation
Urine and Brownwater Reuse System

Service Water (ground water and rain)

Drinking Water

Sanitary Sinks

Urine Separation Toilets

Urinal

Precipitation

Urine Storage

Process water

Sludge Reactor

Excess sludge

Treated Effluent

Greywater

Sewage plant

River 2009
Increased Air Quality ... / Reduced CO₂ ...
Save Energy .../ Save Heat ...

- Infrared Heating
- Energy Efficient Lamps
- Triple Glazing
Save Indoor Quality…/ Save Time…/ Save Ways …

Public and Private Spaces

Faculty offices on one floor
Software

• Revit
• ArchiCad
• Tekla
• AutoCad
• Exel
• Google Docs
• Think Tank
• Oslo
• Brainstorm
• Gmail
• Skype
Team Process

- Engineer
- Architect
- Construction Manager
- Life Cycle Manager

Key Points:
- Communication
- Trust
- Deadline
- Idea
- Talk
- Share
- Appreciation
- Owner
- Mentors
Learning

- Nadin: Not only interdisciplinary, but also inter-team collaboration.
- Jeff: Interoperability is essential in global team work.
- Jiang: Construction Manager needs to enter as early as possible.
- Brenda: Paraphrasing words does help to understand better.
- Josefine: Programs need to be interoperable
- Matt: The way to get all the work done is not to wait until the last minute
Ideas will not be realized without you!

We would like to thank:

! Renate Fruchter, Stanford University!

Our owner: David Borowicz, University of Wisconsin, Madison

Mentors:

A: Hans Verheij, Netherland
Jörg Braunes, Bauhaus University, Germany
Christian Tonn, Bauhaus University, Germany

E: Helmut Krawinkler, Stanford University
Ronnie Borja, Stanford University
Greg Luth, GPLA of California

Michael Oliva, University of Wisconsin, Madison
Larry Bank, University of Wisconsin, Madison
Nick Arenson,

C: Martin Fischer, Stanford University
Eduardo Miranda, Stanford University
Henry Tooriany, Microestimating Inc.

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Axel Seifert