River Team 2014 – Winter Cyber Presentation
Weimar, Germany
Team River and owners

- Randi Schieber (CM)
- Gitte Sørensen (owner)
- Anna Heebøll (MEP)
- Pawel Wolejsza (A)
- Felix Bollwahn (owner)
- Norayr Badasyan (LCFM)
- Milos Todorovic (owner)
- René Gallegos (SE)
- Qi Wu (SE)
- Ben Laboy (MEP apprentice)
## Climate information

<table>
<thead>
<tr>
<th></th>
<th>Dec 21</th>
<th>Mar 21</th>
<th>June 21</th>
<th>Sept 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime Hrs</td>
<td>7.5</td>
<td>12</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>Highest Altitude Angle</td>
<td>15°</td>
<td>40°</td>
<td>63°</td>
<td>40°</td>
</tr>
<tr>
<td>Avg Solar Radiation</td>
<td>734</td>
<td>2590</td>
<td>5440</td>
<td>3060</td>
</tr>
<tr>
<td>Avg High Temp (°C)</td>
<td>3</td>
<td>8</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>Avg Low Temp (°C)</td>
<td>-2</td>
<td>-1</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Avg Precip. (mm)</td>
<td>30</td>
<td>28</td>
<td>67</td>
<td>46</td>
</tr>
<tr>
<td>Heating Degree-days</td>
<td>572</td>
<td>378</td>
<td>44</td>
<td>164</td>
</tr>
</tbody>
</table>
Local Architecture & Surroundings

• Neighboring Castle
• Near River: Flood Hazard
• Site Trees
• Heavy Pedestrian Traffic
• Limited Vehicle Access
## The design proposals

<table>
<thead>
<tr>
<th>Footprint Metaphor</th>
<th>Square</th>
<th>L-shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metaphor</td>
<td>Bridge</td>
<td>Island</td>
</tr>
<tr>
<td>Facade material (primary)</td>
<td>Brickwork</td>
<td>Wood</td>
</tr>
<tr>
<td>SE Loadbearing structure</td>
<td>Steel truss</td>
<td>Bubble deck</td>
</tr>
<tr>
<td>MEP Ventilation, 1st floor</td>
<td>Overhead</td>
<td>Overhead</td>
</tr>
<tr>
<td>MEP Ventilation, 2nd+3rd floor</td>
<td>Overhead</td>
<td>Overhead</td>
</tr>
<tr>
<td>MEP Ventilation, no. of AHU’s</td>
<td>1 (roof)</td>
<td>2 (roof + 1st floor)</td>
</tr>
</tbody>
</table>
Used materials
Square - Bridge concept
Bridge - sketches
To bridge:
-the city with the park
-students with knowledge
-nature with the urbanized area
Bridge - tectonic of the mass
Bridge - sketches
Bridge - renderings
Bridge - renderings

View from the river side
Bridge - renderings

Atrium views
Bridge - floorplans

BRIDGE CONCEPT
11 FEB 2014
**Bridge - 1st floor**

- Auditorium
- Department Chair’s Office
- Senior Administration Office
- Administrative Assistants
- Faculty Lounge
- Student Offices
- Faculty Offices
- Small Classrooms
- Large Classrooms
- Instructional Labs
- Seminar rooms
- Restrooms
- Technical Support
- Storage rooms
- Mechanical room
- Locker room
- Showers
- Cafe

![Floor Plan Diagram](image-url)
Bridge - 2nd floor

- Auditorium
- Department Chair's Office
- Senior Administration Office
- Administrative Assistants
- Faculty Lounge
- Student Offices
- Faculty Offices
- Small Classrooms
- Large Classrooms
- Instructional Labs
- Seminar rooms
- Restrooms
- Technical Support
- Storage rooms
- Mechanical room
- Locker room
- Showers
- Cafe
**Bridge - 3rd floor**

- Auditorium
- Department Chair’s Office
- Senior Administration Office
- Administrative Assistant
- Faculty Lounge
- Student Offices
- Faculty Offices
- Small Classrooms
- Large Classrooms
- Instructional Labs
- Seminar rooms
- Restrooms
- Technical Support
- Storage rooms
- Mechanical room
- Locker room
- Showers
- Cafe
Bridge - roof
Bridge - sections

Cross section A-A

Southern Elevation

Longitudinal section B-B
L shape - Island concept
**Island - „big idea”**

**BEAVER LODGES = UNSINKABLE ISLAND**

**THE ISLAND OF KNOWLEDGE**

**BREATHING BUILDING; NATURAL MATERIALS**
**Island** - sketches and development of the design

Mound creates an "ISLAND"

Facade should be modeled on like beaver lodges.
Agenda

1. Concept
   Most important
   The big idea is

Direction:
Inside - Outside
City - Park - River

Central Staircase

Island

Disappearing Transgression

Jim River

Vertical
Island - tectonic of the mass

To divide the building on smaller spaces
Island - renderings
Island - renderings
Island - renderings

Southern elevation

Eastern elevation
Island - renderings

Main entrance
Island - floorplans
Island - 1st floor

- Auditorium
- Department Chair’s Office
- Senior Administration Office
- Administrative Assistants
- Faculty Lounge
- Student Offices
- Faculty Offices
- Small Classrooms
- Large Classrooms
- Instructional Labs
- Seminar rooms
- Restrooms
- Technical Support
- Storage rooms
- Mechanical room
- Locker room
- Showers
- Cafe
Island - 2nd floor
Island - 3rd floor

Auditorium
Department Chair’s Office
Senior Administration Office
Administrative Assistant
Faculty Lounge
Student Offices
Faculty Offices
Small Classrooms
Large Classrooms
Instructional Labs
Seminar rooms
Restrooms
Technical Support
Storage rooms
Mechanical room
Locker room
Showers
Cafe
Island - Roof
Island - Sections

Cross section A-A

Option 3 (Bubble Deck) + UFAD

Cross section B-B
# Design Loads (Gravity Loads)

## Dead Loads

<table>
<thead>
<tr>
<th>Description</th>
<th>psf</th>
<th>$kN/m^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEP</td>
<td>5</td>
<td>0.24</td>
</tr>
<tr>
<td>Cladding</td>
<td>20</td>
<td>0.96</td>
</tr>
<tr>
<td>Self-Weight</td>
<td>60-100</td>
<td>2.88-4.79</td>
</tr>
</tbody>
</table>

## Live Loads

<table>
<thead>
<tr>
<th>Description</th>
<th>psf</th>
<th>$kN/m^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditorium</td>
<td>60</td>
<td>2.88</td>
</tr>
<tr>
<td>Classroom</td>
<td>40</td>
<td>1.92</td>
</tr>
<tr>
<td>Corridor</td>
<td>100</td>
<td>4.79</td>
</tr>
<tr>
<td>Laboratory</td>
<td>100</td>
<td>4.79</td>
</tr>
<tr>
<td>Office</td>
<td>50</td>
<td>2.40</td>
</tr>
<tr>
<td>Partition</td>
<td>20</td>
<td>0.96</td>
</tr>
<tr>
<td>Roof</td>
<td>20</td>
<td>0.96</td>
</tr>
<tr>
<td>Snow</td>
<td>20</td>
<td>0.96</td>
</tr>
<tr>
<td>Storage</td>
<td>125</td>
<td>6.00</td>
</tr>
<tr>
<td>Stores</td>
<td>100</td>
<td>4.79</td>
</tr>
</tbody>
</table>
Design Loads (Lateral Loads)

Average Wind Load 12 mph 5.4 m/s

Design Wind Load 60 mph 26.8 m/s

Seismic Load is not a big concern
High Water Table
Limestone Beneath

Avoid Too Much Excavation
Use Piles to Anchor the Building
Concrete Bridge

- **Concrete Column**: 200mm
- **Concrete Shear Wall**: 450mm x 450mm
- **Post Tension Bubble Deck**: 340mm

**Foundation:**
- Pin Piles (8’ Dia.)

Dimensions:
- 450mm x 450mm Concrete Column
- 200mm Concrete Shear Wall
- Post Tension Bubble Deck: 340mm

Measurements:
- 5m (16ft)
- 3.6m (12ft)
- 7.2m (24ft)
- 9.3m (31ft)
- 9m (30ft)
- 40m (130ft)
- 6.7m (22ft)
- 2.5m (8ft)
- 34m (112ft)
- 10.2m (33.5ft)
Tendons Distribution & Load Path

Auditorium

Intro | Site context | A | SE | MEP | CM | LCFM | Flooding protection | Decision matrix | Team process

Tendons

Distributed & Load Path

6.7m 22ft

9m 30ft

9.3m 31ft

7.2m 24ft

3.6m 12ft

5m 16ft

2.5m 8ft

12m 40ft

5.4m 18ft

12m 40ft

2.5m 8ft
Steel Bridge

Lateral System

HSS 6x6 Steel Column

Composite Steel Floor System

Foundation: Pin Piles (8’ Dia.)

Intro | Site context | A | SE | MEP | CM | LCFM | Flooding protection | Decision matrix | Team process
Load Path

- 40m (130ft)
- 3.6m (12ft)
- 7.2m (24ft)
- 9.3m (31ft)
- 9m (30ft)
- 6.7m (22ft)
- 5m (16ft)
- 2.5m (8ft)
- 6.6m (22ft)
- 5.4m (18ft)
- 5.4m (18ft)
- 6.8m (22ft)
- 2.5m (8ft)
- 34m (112ft)
Challenges
Foundation – Pinned Piles

Gravity Load Path

Uplift Load Path
<table>
<thead>
<tr>
<th></th>
<th>Option 1: Concrete</th>
<th>Option 2: Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Floor System</strong></td>
<td>PT Bubble Deck</td>
<td>Composite Truss + Steel Deck</td>
</tr>
<tr>
<td><strong>Column</strong></td>
<td>Concrete In place</td>
<td>Steel Tubes</td>
</tr>
<tr>
<td><strong>Lateral System</strong></td>
<td>Shear Wall</td>
<td>Moment Frame</td>
</tr>
<tr>
<td><strong>Auditorium</strong></td>
<td>Mega Truss + Steel Beam</td>
<td></td>
</tr>
<tr>
<td><strong>Foundation</strong></td>
<td></td>
<td>Pin Piles</td>
</tr>
<tr>
<td><strong>Advantages</strong></td>
<td>Cheap Thermal Mass</td>
<td>Faster to Build Lighter</td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>Constructability Scheduling</td>
<td>Expensive</td>
</tr>
</tbody>
</table>
Concrete Island

- **Concrete Column**: 450mm x 450mm
- **Concrete Shear Wall**: 200mm

**Foundation:**
- Pin Piles (8’ Dia.)

**Dimensions:**
- 11.4m (37ft)
- 6.3m (21ft)
- 9.6m (31.5ft)
- 8.1m (26.5ft)
- 6.3m (21ft)
- 4.1m (13ft)
- 7.2m (31.5ft)
- 3.6m 7.2m (31.5ft)
- 6.7m (22ft)

**Other Details:**
- **Bubble Deck**: 280mm
- **Intro**, **Site context**, **A**, **SE**, **MEP**, **CM**, **LCFM**, **Flooding protection**, **Decision matrix**, **Team process**
Floor Plan & Load Path
Steel Island

Composite Steel Floor System

HSS 6x6 Steel Column

Lateral System

Foundation:
Pin Piles (8’ Dia.)
Load Path

- 11.4m (37ft)
- 6.3m (21ft)
- 9.6m (31.5ft)
- 4.1m (13ft)
- 7.2m (31.5ft)
- 3.6m (12ft)
- 7.2m (31.5ft)

- 36m (118ft)
- 35m (114ft)
- 6.7m (22ft)
Foundation – Pinned Piles

Gravity Load Path

Uplift Load Path

Intro | Site context | A | SE | MEP | CM | LCFM | Flooding protection | Decision matrix | Team process

Foundations – Pinned Piles

- Pinned Piles

Dimensions:
- 4.1m (13ft)
- 6.3m (21ft)
- 7.4m (24ft)
- 6.3m (21ft)
- 11.4m (37ft)
- 9.6m (31.5ft)
- 8.1m (26.5ft)
- 7.2m (23.6ft)
- 10.8m (35.4ft)

Levels:
- 1st Floor

Structural Elements:
- SE
- MEP
- CM
- LCFM
- Flooding protection
- Decision matrix
- Team process
### Option 1: Concrete

<table>
<thead>
<tr>
<th>Floor System</th>
<th>Bubble Deck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column</td>
<td>Concrete In place</td>
</tr>
<tr>
<td>Lateral System</td>
<td>Shear Wall</td>
</tr>
<tr>
<td>Foundation</td>
<td>Pin Piles</td>
</tr>
<tr>
<td>Advantages</td>
<td>Cheap Thermal Mass</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Constructability</td>
</tr>
</tbody>
</table>

### Option 2: Steel

<table>
<thead>
<tr>
<th>Floor System</th>
<th>Composite Truss + Steel Deck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column</td>
<td>Steel Tubes</td>
</tr>
<tr>
<td>Lateral System</td>
<td>Shear Wall</td>
</tr>
<tr>
<td>Foundation</td>
<td></td>
</tr>
<tr>
<td>Advantages</td>
<td>Lighter</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Expensive</td>
</tr>
</tbody>
</table>
Energy consumption & indoor climate

German Regulations (EnEv 2018):

- **Primary energy consumption** < 120 kWh/m²/yr
- **Energy consumption for heating** < 15 kWh/m²/yr

  Primary energy consumption = Space heating, cooling, ventilation, lighting and hot water.

European Standard (EN15251 Class II):

- **Thermal environment**: 20-26°C (68-79°F)
- **IAQ**: 0.7 l/s/m² + 7 l/s/person (1.5 cfm/m² + 15 cfm/person)
- Lighting level of min. 200 lux at 0.85 m above floor
- Requirements of RH, CO2-level and acoustics will be investigated later
Estimation of performance

Island

Bridge

Daylight factor (%)

Bridge Island

Small Classroom
Café
Computer Lab
Student Office
Senior Assist.Office
Faculty Club
THE CHALLENGE: The comfort level should be further increased, which most likely will increase the energy consumption.
System considerations - Resources on site

Solar Energy

Average Irradiation (kWh/m²)

Rain Water

Average precipitation (mm)

Heating pump in cooling mode connected w. PV/T?

Part of year with cooling demand

Toilet flush
Sustainable Target Value (STV)

**Bridge** - Steel truss - Overhead

**Island** - Steel truss - Overhead

**Bridge** - Bubble deck - UFAD

**Island** - Bubble deck - UFAD

The PV/T is not included in the STV’s models
Ventilation System

**ATD Examples**

**Overhead supply**

**Return grill**

**Passive return grill**

**UFAD supply**

**Displacement supply**

(in overhead version)
Ventilation Ducting

Steel truss - Overhead

Bubble deck - UFAD
**Bridge overhead – 1st floor**

- **Vertical piping, water circuit**
- **Vertical piping, heating circuit**
- **Vertical ducting, supply, dia. 0.4m**
- **Vertical ducting, return, dia. 0.4m**
- **Vertical ducting, exhaust**
- **Wetrooms/kitchen hood, dia. 0.3m**
- **Displacement supply ATD**
- **Supply overhead ATD**
- **Return overhead ATD**
- **Return grill**
- **Return grill, passive**
- **Exhaust wetrooms/kitchen hood**
Bridge overhead - 2nd floor

- Vertical piping, water circuit
- Vertical piping, heating circuit
- Vertical ducting, supply, dia. 0.4m
- Vertical ducting, return, dia. 0.4m
- Vertical ducting, exhaust
- Wetrooms/kitchen hood, dia. 0.3m
- Displacement supply ATD
- Supply overhead ATD
- Return overhead ATD
- Return grill
- Return grill, passive
- Exhaust wetrooms/kitchen hood
**Bridge overhead - 3rd floor**

- **Vertical piping, water circuit**
- **Vertical piping, heating circuit**
- **Vertical ducting, supply, dia. 0.4m**
- **Vertical ducting, return, dia. 0.4m**
- **Vertical ducting, exhaust**
- **Wetrooms/kitchen hood, dia. 0.3m**
- **Displacement supply ATD**
- **Supply overhead ATD**
- **Return overhead ATD**
- **Return grill**
- **Return grill, passive**
- **Exhaust wetrooms/kitchen hood**
Bridge UFAD - 2\textsuperscript{nd} floor

- **Vertical piping, water circuit**
- **Vertical piping, heating circuit**
- **Vertical ducting, supply, dia. 0.4m**
- **Vertical ducting, return, dia. 0.4m**
- ** Vertical ducting, exhaust**
  - **wetrooms/kitchen hood, dia. 0.3m**

- **UFAD plenum outline**
- **UFAD supply duct**
- **Return overhead ATD**
- **Return grill**
- **Return grill, passive**
- **Exhaust wetrooms/kitchen hood**
Bridge UFAD - 3rd floor

- Vertical piping, water circuit
- Vertical piping, heating circuit
- Vertical ducting, supply, dia. 0.4m
- Vertical ducting, return, dia. 0.4m
- Vertical ducting, exhaust
- Wetrooms/kitchen hood, dia. 0.3m

UFAD plenum outline
UFAD supply duct
Return overhead ATD
Return grill
Return grill, passive
Exhaust wetrooms/kitchen hood
**Bridge – Roof**

- **Vertical ducting, supply, dia. 0.4m**
- **Vertical ducting, return, dia. 0.4m**
- **Vertical ducting, exhaust**
- **Wetrooms/kitchen hood, dia. 0.3m**
Island overhead – 1st floor

- Vertical piping, water circuit
- Vertical piping, heating circuit
- Vertical ducting, supply, dia. 0.4m
- Vertical ducting, return, dia. 0.4m
- Vertical ducting, exhaust
  - wetrooms/kitchen hood, dia. 0.3m
- Displacement supply ATD
- Supply overhead ATD
- Return overhead ATD
- Return grill
- Return grill, passive
- Exhaust wetrooms/kitchen hood
Island overhead - 2nd floor

- Vertical piping, water circuit
- Vertical piping, heating circuit
- Vertical ducting, supply, dia. 0.4m
- Vertical ducting, return, dia. 0.4m
- Vertical ducting, exhaust
  - Wetrooms/kitchen hood, dia. 0.3m
- Displacement supply ATD
- Supply overhead ATD
- Return overhead ATD
- Return grill
- Return grill, passive
- Exhaust wetrooms/kitchen hood
Island overhead - 3rd floor

- Vertical piping, water circuit
- Vertical piping, heating circuit
- Vertical ducting, supply, dia. 0.4m
- Vertical ducting, return, dia. 0.4m
- Vertical ducting, exhaust
- Wetrooms/kitchen hood, dia. 0.3m
- Displacement supply ATD
- Supply overhead ATD
- Return overhead ATD
- Return grill
- Return grill, passive
- Exhaust wetrooms/kitchen hood
Island UFAD - 2nd floor

- Vertical piping, water circuit
- Vertical piping, heating circuit
- Vertical ducting, supply, dia. 0.4m
- Vertical ducting, return, dia. 0.4m
- Vertical ducting, exhaust
  wetrooms/kitchen hood, dia. 0.3m

UFAD plenum outline
UFAD supply duct
Return overhead ATD
Return grill
Return grill, passive
Exhaust wetrooms/kitchen hood
Island UFAD - 3rd floor

- Vertical piping, water circuit
- Vertical piping, heating circuit
- Vertical ducting, supply, dia. 0.4m
- Vertical ducting, return, dia. 0.4m
- Vertical ducting, exhaust
  - wetrooms/kitchen hood, dia. 0.3m
- UFAD plenum outline
- UFAD supply duct
- Return overhead ATD
- Return grill
- Return grill, passive
- Exhaust wetrooms/kitchen hood
**Island - Roof**

- **Vertical ducting, supply, dia. 0.4m**
- **Vertical ducting, return, dia. 0.4m**
- **Vertical ducting, exhaust**
  - wetrooms/kitchen hood, dia. 0.3m
Ventilation System

Pressure drop
- To decrease the fan pressure (and energy consumption), we have to decrease the amount of ducting, bendings, branches etc.
- UFAD has less ducting than the conventional overhead supply system.
- Bridge has more bendings than Island.
- Island has more branches than Bridge (especially in overhead version).
- **Island with UFAD** is possibly the version with lowest pressure drop and therefore the lowest fan pressure.
UFAD stratification tool

- Goal: Temperature Gradient $\leq 5^\circ$F (~2.7°C) in mixing zone
- Used diffuser manufacturer data
- Swirl diffusers in interior zone, linear bar grill in perimeter zone
- Findings: **7 foot spacing** of swirl diffusers would be optimal

Figure 1: Swirl diffuser diagram
Figure 2: Example a zone’s stratification profiles
### Materials

<table>
<thead>
<tr>
<th>NAME</th>
<th>DISCIPLINE</th>
<th>DISTANCE FROM SITE (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas-Gruppe</td>
<td>Concrete</td>
<td>2.6</td>
</tr>
<tr>
<td>G&amp;G Kran und Transport GmbH &amp; C.</td>
<td>Crane</td>
<td>1.9</td>
</tr>
<tr>
<td>WeGO Systems</td>
<td>Interiors and Fire Protection</td>
<td>8.8</td>
</tr>
<tr>
<td>Baumaschinen Reudiger</td>
<td>Equipment (not crane)</td>
<td>10.1</td>
</tr>
<tr>
<td>Stahlwerk Thuringen</td>
<td>Steel</td>
<td>57.3</td>
</tr>
<tr>
<td>RSP</td>
<td>Construction Waste and Water management</td>
<td>51.5</td>
</tr>
</tbody>
</table>
Equipment

- Crane - G&R Crane and Transport
  - LTM 1100-4.2 Mobile Crane 58 m, 100 metric Ton
- Other Equip. - Rudiger Schwarz
  - Excavator
  - Compactor
  - Skid Steer Loader
  - Pump
  - Roller
Flooding Contingency

- Hydrobaffle Mobile Flood Protection
- Available 280 km away
- Up to 1.83 m flood
  - 1.80 m shown in picture
- 2-6 hours set-up
Schedule Constraints

- **Average Ground Freeze - October 22**
  - Complete any necessary excavation and foundation prior to this date
- **Average Ground Thaw - April 20**
  - Eliminate use of very heavy machinery as much as possible 14 days prior to this date

- **Excavation - Required for Island, not Bridge**
- **Computer Lab and Office Access - May 1**
  - Run this area as separate entity of great schedule
  - Prioritize electrical and mechanical installation of this area
    - Difference between 1 AHU and 2 AHU Designs
Bridge - UFAD MEP
Bridge - Overhead MEP
Island - UFAD MEP
Island - Overhead MEP
Target Value Design – Target $6,900,000 ($7,500,000 2014 USD)

### BRIDGE - BUBBLE DECK
$7,910,000

- **F Specialty Construction** $200,000 3%
- **G Building Sitework** $24,300 0%
- **H General Conditions** $600,000 8%
- **A Substructure** $123,700 2%
- **E Equipment and Furnishing** $72,200 1%
- **C Interiors** $832,800 10%
- **D Services** $4,419,100 56%
- **B Shell** $1,635,300 21%

### BRIDGE - STEEL
$8,170,000

- **F Specialty Construction** $200,000 3%
- **G Building Sitework** $24,300 0%
- **H General Conditions** $600,000 7%
- **A Substructure** $123,700 2%
- **B Shell** $1,892,500 23%
- **D Services** $4,419,100 54%
- **C Interiors** $832,800 10%
- **E Equipment and Furnishing** $72,200 1%

### ISLAND - BUBBLE DECK
$7,590,000

- **F Specialty Construction** $200,000 3%
- **G Building Sitework** $221,900 3%
- **H General Conditions** $600,000 8%
- **A Substructure** $130,000 2%
- **E Equipment and Furnishing** $72,200 1%
- **C Interiors** $794,200 10%
- **D Services** $4,174,300 55%
- **B Shell** $1,390,000 18%

### ISLAND - STEEL
$7,680,000

- **F Specialty Construction** $200,000 3%
- **G Building Sitework** $229,600 3%
- **H General Conditions** $600,000 8%
- **A Substructure** $181,200 2%
- **E Equipment and Furnishing** $72,200 1%
- **B Shell** $1,450,700 19%
- **D Services** $4,174,300 54%
- **C Interiors** $771,900 10%
Bridge Construction Site Layout
Island Site Layout

- Intro
- Site context
- A
- SE
- MEP
- CM
- LCFM
- Flooding protection
- Decision matrix
- Team process
Runoff Protection - Silt Fence
Why we need LCC?

- Explore “Secret Life” of the buildings
- Consider first cost, all costs and benefits during LC
- Maximize savings and financial return
- Reduce investment risk
LCC Calculation

LCC = C + Repl - Res + E + W + M

LCC-Life Cycle Costs
C - Construction Costs
Repl - Replacement Costs
Res - Residual Value
E - Energy Costs
W - Water Costs
O - other Operation Costs
M - Maintenance Costs

Intro | Site context | A | SE | MEP | CM | LCFM | Flooding protection | Decision matrix | Team process

4 different alternatives
## Our LCC Results

<table>
<thead>
<tr>
<th></th>
<th>Bridge Steel</th>
<th>Bridge Bubble deck</th>
<th>Island Steel/Wood</th>
<th>Island Bubble deck</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Cost</strong></td>
<td>$8 164 600,00</td>
<td>$7 907 400,00</td>
<td>$7 511 300,00</td>
<td>$7 305 400,00</td>
</tr>
<tr>
<td><strong>Operation Cost</strong></td>
<td>$6 398 945,52</td>
<td>$6 398 945,52</td>
<td>$6 093 539,98</td>
<td>$6 093 539,98</td>
</tr>
<tr>
<td><strong>Maintenance Cost</strong></td>
<td>$1 700 447,30</td>
<td>$1 683 796,90</td>
<td>$1 657 914,06</td>
<td>$1 642 114,22</td>
</tr>
<tr>
<td><strong>LCC</strong></td>
<td>$15 280 292</td>
<td>$15 135 042</td>
<td>$14 348 104</td>
<td>$14 229 354</td>
</tr>
</tbody>
</table>
Risks-Team Assessment

- Team Member's scores for each criteria
- Graphical introduction of the results
- Total score for each criteria
Risk Influences

<table>
<thead>
<tr>
<th>Risk Influence</th>
<th>Description</th>
<th>Score</th>
<th>Rank/Severity</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influence on Health-1</td>
<td>Damage inhabitants health or cause death</td>
<td>20</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Major Building Damage-2</td>
<td>Damage buildings particular parts which are expensive, important for every day activity or crash the building</td>
<td>15</td>
<td>2</td>
<td>18.8</td>
</tr>
<tr>
<td>Major additional costs-3</td>
<td>Reconstruct, repair major parts of the building and etc.</td>
<td>15</td>
<td>2</td>
<td>18.8</td>
</tr>
<tr>
<td>Postpone construction or O&amp;M particular phase-4</td>
<td>Defective material, contract problem or getting right problems</td>
<td>10</td>
<td>3</td>
<td>12.5</td>
</tr>
</tbody>
</table>

**Risk Scores in %**

- Flood: 16%
- Wind, Rain, Hail: 5%
- Design deficiency: 5%
- Responsibiliti es definition: 4%
- Health and Safety: 10%
- Defective materials: 9%
- Unforeseen costs: 6%
- Inflation: 3%
- Supplier risk: 6%
- Environmental risk: 10%
- Construction cost overrun: 3%
- Repair add costs: 4%
- Energy supply: 3%
- Energy cost: 6%
- Owners needs change: 6%
- Building overoccupation: 4%
## ABC Matrix

<table>
<thead>
<tr>
<th>Risk Type (e.g. Flood)</th>
<th>Probability (e.g. 0,9)</th>
<th>Severity</th>
<th>Risk Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>location risks</td>
<td>0,9</td>
<td>0,9</td>
<td>0,81</td>
</tr>
<tr>
<td>inflation risks</td>
<td>0,7</td>
<td>0,9</td>
<td>0,63</td>
</tr>
<tr>
<td>building stock risks</td>
<td>0,7</td>
<td>0,7</td>
<td>0,49</td>
</tr>
<tr>
<td>Maintenance and preservation risks</td>
<td>0,7</td>
<td>0,7</td>
<td>0,49</td>
</tr>
<tr>
<td>operating risks</td>
<td>0,5</td>
<td>0,7</td>
<td>0,35</td>
</tr>
<tr>
<td>management Risks</td>
<td>0,5</td>
<td>0,7</td>
<td>0,35</td>
</tr>
<tr>
<td>Risk of function changings</td>
<td>0,5</td>
<td>0,7</td>
<td>0,35</td>
</tr>
<tr>
<td>Financial risk (including interest rate changes)</td>
<td>0,5</td>
<td>0,7</td>
<td>0,25</td>
</tr>
<tr>
<td>Technical execution risks</td>
<td>0,3</td>
<td>0,7</td>
<td>0,21</td>
</tr>
<tr>
<td>planning risks</td>
<td>0,3</td>
<td>0,7</td>
<td>0,15</td>
</tr>
<tr>
<td>Vandalism and sabotage risks</td>
<td>0,1</td>
<td>0,9</td>
<td>0,09</td>
</tr>
<tr>
<td>input risks</td>
<td>0,3</td>
<td>0,3</td>
<td>0,09</td>
</tr>
<tr>
<td>technology risks</td>
<td>0,3</td>
<td>0,3</td>
<td>0,09</td>
</tr>
</tbody>
</table>

### Risk Type

- **Very high (0,9)**
  - Probability: 0,09
  - Severity: 0,27
  - Risk Calculation: 0,45
  - Final Risk: 0,63
  - Overall Risk: 0,81

- **High (0,7)**
  - Probability: 0,07
  - Severity: 0,21
  - Risk Calculation: 0,35
  - Final Risk: 0,49
  - Overall Risk: 0,63

- **Medium (0,5)**
  - Probability: 0,05
  - Severity: 0,15
  - Risk Calculation: 0,25
  - Final Risk: 0,35
  - Overall Risk: 0,45

- **Low (0,3)**
  - Probability: 0,03
  - Severity: 0,09
  - Risk Calculation: 0,15
  - Final Risk: 0,21
  - Overall Risk: 0,27

- **Very low (0,1)**
  - Probability: 0,01
  - Severity: 0,03
  - Risk Calculation: 0,05
  - Final Risk: 0,07
  - Overall Risk: 0,09
Risk Scenarios

- Risk Types
- Different Risk Scenarios
- Treatment for each Scenario
- Cost of each Scenario
Unique risks

Flood

Oak Trees

Graffiti
Flooding Design – Big Idea
Justification

**Initial Cost (Rebar)**

- S-BD
- S-St
- L-BD
- L-St

- Extreme (2.3m)
- 100yr (2m)
- 33 yr (1.7m)

**Initial Cost Normalized (Rebar)**

- S-BD
- S-St
- L-BD
- L-St

- Extreme (2.3m)
- 100yr (2m)
- 33 yr (1.7m)

**Conceptual Expected Costs of Design Options**

- Construction Cost
- O & M Cost
- Total Cost

**Height of Flooding Design**

- 1
- 1.5
- 2
- 2.5

**Normalized Cost**

- 0,00
- 0,20
- 0,40
- 0,60
- 0,80
- 1,00
- 1,20
- 1,40

**Intro | Site context | A | SE | MEP | CM | LCFM | Flooding protection | Decision matrix | Team process**
Flooding Solution Concept
Flooding Solution Concept
Flooding Solution Concept
Bridge

2m (100yr) - Flood

2.3m - Flood
Island

2m (100yr) - Flood

2.3m - Flood
Interdisciplinary Approach

- **A**: Design of spaces
- **E**: Structural integrity
- **MEP**: Isolate equipment and electricity from water
- **C**: Water proofing and drainage system
- **LCFM**: Financial justification and mitigation of risks
Decision Matrix-Idea

Healthy Building with Efficient Services and High Aesthetic Quality

Building with High Quality, Lower Costs and Functional Quality

Model-VALUE for MONEY
Methodology

**CRITERIA:**

- Level of Indoor Climate
- Level of Building Impact on Environment
- Construction Cost
- Level of Risk Surcharge
- Life Cycle Costs
- Heating Energy Consumption <15kWh
- Primary Energy Consumption Level
- Daylight Factor
- Building and Surrounding Architecture
- Damage Level During Flood
- High Space Efficiency

How to Weight each Criteria?
How to Score each Criteria?

I know how important it is!
I know how well it is done!
Team’s Results

**Bridge steel**

```
<table>
<thead>
<tr>
<th>Indoor Climate</th>
<th>Building impact</th>
<th>Constr. cost</th>
<th>Level of risk</th>
<th>Life Cycle Costs</th>
<th>primary energy</th>
<th>heating energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flood Damage</td>
<td>Building and surrounding</td>
<td>Daylight factor</td>
<td>primary energy</td>
<td>heating energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Efficiency</td>
<td>Constr. cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

**Bridge Bubble Deck**

```
<table>
<thead>
<tr>
<th>Indoor Climate</th>
<th>Building impact</th>
<th>Constr. cost</th>
<th>Level of risk</th>
<th>Life Cycle Costs</th>
<th>primary energy</th>
<th>heating energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flood Damage</td>
<td>Building and surrounding</td>
<td>Daylight factor</td>
<td>primary energy</td>
<td>heating energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Efficiency</td>
<td>Constr. cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

**Island Steel**

```
<table>
<thead>
<tr>
<th>Indoor Climate</th>
<th>Building impact</th>
<th>Constr. cost</th>
<th>Level of risk</th>
<th>Life Cycle Costs</th>
<th>primary energy</th>
<th>heating energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flood Damage</td>
<td>Building and surrounding</td>
<td>Daylight factor</td>
<td>primary energy</td>
<td>heating energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space Efficiency</td>
<td>Constr. cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

**Island Bubble Deck**

```
<table>
<thead>
<tr>
<th>Indoor Climate</th>
<th>Building impact</th>
<th>Constr. cost</th>
<th>Level of risk</th>
<th>Life Cycle Costs</th>
<th>primary energy</th>
<th>heating energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Flood Damage</td>
<td>Building and sur.</td>
<td>Daylight factor</td>
<td>primary energy</td>
<td>heating energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space efficiency</td>
<td>Constr. cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

---

Intro | Site context | A | SE | MEP | CM | LCFM | Flooding protection | Decision matrix | Team process
Owner’s Results

**Bridge Steel**

**Bridge Bubble Deck**

**Island Steel**

**Island Bubble Deck**
Weighted Final Results

<table>
<thead>
<tr>
<th>Intro</th>
<th>Site context</th>
<th>A</th>
<th>SE</th>
<th>MEP</th>
<th>CM</th>
<th>LCFM</th>
<th>Flooding protection</th>
<th>Decision matrix</th>
<th>Team process</th>
</tr>
</thead>
</table>

**Weighted Final Results**

- **Bridge Steel/Brick**: 16.5
- **Bridge Bubble deck/Brick**: 17.5
- **Island steel/Wood**: 16.5
- **Island Bubble deck/wood**: 17.0

**Graph**

- **Indoor Climate**
- **Flood Damage**
- **Space Efficiency**
- **Building and surrounding**
- **Primary energy**
- **Heating energy**
- **Life Cycle Costs**
- **Level of risk**
- **Constr. Cost**
- **Building impact**

**Images**

- **Bridge Bubble deck/brick**
- **Island Bubble deck/wood**
Communication, collaboration and cooperation

- Active listening!
- Respond!
- Argue for your ideas!
- Be consequence-conscious!
- Say “and” not “but”!
- Have fun!

Communication
- GoToMeeting
- Facebook

Project Management
- Gannter!

File organization
- Box
- Dropbox
Team Coordination / Project Management
The Ganttter

Tasklist and project calendar in one!

<table>
<thead>
<tr>
<th>Name</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer Review Session</td>
<td>3d</td>
</tr>
<tr>
<td>Project update after peer review</td>
<td>23d</td>
</tr>
<tr>
<td>Critique Session at Feb 21st</td>
<td>4d</td>
</tr>
<tr>
<td>Winter presentation at March 14th</td>
<td>25d?</td>
</tr>
<tr>
<td>Architect</td>
<td>15d</td>
</tr>
<tr>
<td>S-Shape</td>
<td>16d</td>
</tr>
<tr>
<td>L-Shape</td>
<td>16d</td>
</tr>
<tr>
<td>MEP (4 proposals, 2 for each A proposal)</td>
<td>25d?</td>
</tr>
<tr>
<td>Final ventilation concept</td>
<td>19d?</td>
</tr>
<tr>
<td>Final water concept</td>
<td>16d?</td>
</tr>
<tr>
<td>Final heating and cooling concept</td>
<td>19d?</td>
</tr>
<tr>
<td>3D-model of HVAC</td>
<td>11d?</td>
</tr>
<tr>
<td>Floor sandwich sections showing space for MEP system</td>
<td>15d?</td>
</tr>
<tr>
<td>Analysis of environmental site conditions</td>
<td>6d?</td>
</tr>
<tr>
<td>Compare the building performance for different concepts</td>
<td>11d?</td>
</tr>
<tr>
<td>STV to assess impact on costs and overall sustainability</td>
<td>20d?</td>
</tr>
<tr>
<td>LCFM</td>
<td>11d?</td>
</tr>
<tr>
<td>Decision Matrix</td>
<td>5d?</td>
</tr>
<tr>
<td>Cash Flow Model</td>
<td>11d?</td>
</tr>
<tr>
<td>Structural</td>
<td>7d?</td>
</tr>
<tr>
<td>CM</td>
<td>6d?</td>
</tr>
<tr>
<td>TVD Estimates</td>
<td>5d?</td>
</tr>
<tr>
<td>Schedule</td>
<td>1d</td>
</tr>
<tr>
<td>Site Layout</td>
<td>6d</td>
</tr>
<tr>
<td>Structural</td>
<td>5d?</td>
</tr>
<tr>
<td>Flooding</td>
<td>5d?</td>
</tr>
<tr>
<td>S-Shape Design</td>
<td>2d</td>
</tr>
<tr>
<td>L-Shape</td>
<td>5d?</td>
</tr>
</tbody>
</table>
Team-members dependencies and Task Assignments
Thank you for your attention,

Thank you owners, mentors and Renate!