INTRODUCTION
Team

A
Rok
University of Ljubljana
Slovenia

SE
Ying
Stanford University
USA

CM

CM

SE
Aleshia
Stanford University
USA

MEP
Ewa
Danish Technical University
Denmark

Samer
Loughborough University
UK

Elisa
University of Wisconsin-Madison
USA

LCFM
Frank
Bauhaus University Weimar
Germany
Owners

Anja Jutraž
Architect
University of Ljubljana
Slovenia

Norayr Badasyan
Research Associate
Bauhaus University
Weimar
Germany

Micheal Seaman
Project Engineer
Walt Disney Imagineering
USA

Nick Zeman
Project Engineer
The Boldt Company
USA
Ljubljana

Capital city of Slovenia
300,000 inhabitants
50,000 students
Green capital of Europe 2016
People-friendly city
Walking distances
A Climate Graph for Ljubljana, Slovenia

Temperature

Copyright © 2015, www.travelslovenia.org
Precipitation

Precipitation, Snowfall and Snow Cover for Ljubljana, Slovenia

Copyright © 2015, www.travelslovenia.org
Location

Map of Ljubljana

Express

Rožnik Hill 3,0 km / 1.86 mi

City Center

Ljubljana Castle
Site Analysis

Aerial View on the Parcel

Main Vehicle Access

Pedestrian Pathway

People Circulation

Winter 2017
Express
10

Aerial View on the Parcel
Building Placement

- Connection with the existing faculties
- Alignment with existing footprints
- Forming an entrance square
- Closing the SW corner
**Challenges**

**Challenge**
High risk of a flood
High water level: -1,5 m

**Risk Mitigation**
Raise critical program above ground

**Challenge**
Earthquake zone

**Risk Mitigation**
Design strong, but ductile lateral system
ECONDUSTRY
ARCHITECTURE
ECOLOGY

- Fluid forms - WATER
- Ecological use of materials
- Design for disassembly and re-use
- Organic circulation
- Transparent facade

INDUSTRY

- Visible structure
- Economical use of space
- Flexibility
- Orthogonality
- Efficiency
Program Distribution

Sections

±0.0 m
-3.0 m
+9.0 m

STAFF
CLASSROOM

LOBBY

STUDENT
AUDITORIUM
3D View
Site Plan
Isolated Spaces
Isolated Spaces
Moving Walls
Suspended Ceiling

Grid: 80 x 80 cm

32 m

48 m
Longitudinal Section
Student Space
Entrance/ East Facade
Entrance Square
STRUCTURE
Site Conditions

Soil Strength

- Non-bearing: 0.5 m, 2000 psf
- Water Table: 1 m
- 3 m
- 6000 psf: 8 m

Seismic Zone

Max. Magnitude: 6.1 (1895)
PGA: 0.225g
**Site Conditions**

**Snow Loads**

Ground Snow Loads: 40 psf

**Flood Zone**

Man-made creek reduces flood risk

- Moderate Flood Risk
- Low Flood Risk
- Not in Flood Zone
Load Overview

Live Load:
- 40 psf – Seminar Rooms, Small Classrooms
- 50 psf – Offices, Lounges, Labs
- 60 psf – Auditorium, Large Classrooms
- 100 psf – Lobby, Corridors, MEP & Storage Rooms
- 20 psf – Roof

Snow Load:
- 30 psf

Seismic:
- Base Shear = 0.073W
Structural Alternatives

Steel Composite Floor Systems

Post-Tensioned Concrete Floor
Cantilever Evolution

Previous Design

16 m

16 m

16 m
Cantilever Evolution

New Design

1.

3.

2.

4.

Structural Challenges
Torsional Resistance

Connection to floor and roof slabs create a torsional-resistant shape.

Post-tensioned roof slabs composite with top of trusses reduce deflections.
Truss Analysis

WITH VERTICALS

Max. Deflection: 2.1"

Largest Axial Force in Diagonal: 503 k

WITHOUT VERTICALS

Max. Deflection: 1.6"

Largest Axial Force in Diagonal: 570 k
Basement

Grid Span 4m

Retaining Wall (10”)
Shear Wall (10”)
Column W14X76

32 m
48 m
Ground Floor

- Beam W24X76 (RC 12"X24")
- Column W14X76
- Shear Wall (10")

Grid Span 4m

32 m

48 m
First Floor

Beam W24X76
OR RC 12"X24"

Shear Wall (10")

Truss
Chord HSS 20X12X5/8
Web HSS 12x12x5/8

Column W14X76

Grid Span 4m
Steel

Basement

1st Floor

Ground Floor

Roof
Concrete

Basement

1st Floor

Ground Floor

Roof
Lateral Load Path

Compression  Tension
Key Coordination

Zero Waste: Find use for columns after construction to prevent waste
Zero building strategies

Building envelope

<table>
<thead>
<tr>
<th>HEAT TRANSFER COEFFICIENT</th>
<th>[W/m2K]</th>
</tr>
</thead>
<tbody>
<tr>
<td>External wall</td>
<td>0,1</td>
</tr>
<tr>
<td>Slab on ground</td>
<td>0,4</td>
</tr>
<tr>
<td>Roof</td>
<td>0,1</td>
</tr>
<tr>
<td>Glazing</td>
<td>0,8</td>
</tr>
</tbody>
</table>

Other requirements

<table>
<thead>
<tr>
<th>Daylight factor [%]</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration [m3/m2h]</td>
<td>1,8</td>
</tr>
<tr>
<td>Ventilation rate [L/sm2]</td>
<td>0,3</td>
</tr>
</tbody>
</table>

Solar heat gain coefficient

| Glazing [ ]             | 0,5     |

• Renewable energy sources
• Well insulated and tight
• Highest efficiency of appliances

2020
**Options**

<table>
<thead>
<tr>
<th>Option</th>
<th>Primary</th>
<th>User comfort</th>
<th>Electricity use</th>
<th>Initial cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AHU with Economizer</td>
<td>• High</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>2</td>
<td>Water-air heat pump</td>
<td>• Fast adjustable</td>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

- **User comfort**: • High
- • Fast adjustable
- • Easy to control

**Underfloor air distribution**

- Swirl diffuser
- Fan
- Supply duct

**Dimensions**

- 5m
- 1.5m
- 3m
- 0.8m
- Return duct

**1st floor view**
Distribution

Under floor air distribution

Open space:
• Ducted return

Offices and laboratories:
• Plenum return

*MEP room on the roof

Supply diffusers

Return terminal
Distribution

Auditoriums:
• Plenum return system

Classrooms:
• UFAD
• Displacement return
Distribution

Auditorium:
• UFAD

Lobby:
• Displacement return
CONSTRUCTION MANAGEMENT
Site Plan Overview

Legend
- Entrance (Temp Road)
- Egress (Temp Road)
- Dewatering System
- Fenced Site Area
- Building Footprint

Site Dimensions
95m x 110m
Total Cost Comparison

Target Value: €9.7 M

ESTIMATED VALUE

VALUE DELTA

ECO-Steel

Target Value: €9.7 M

€8.7 M

€8.6 M

ECO-Concrete

Target Value: €9.7 M

€8.7 M

€8.6 M

+ €1.0 M

+ €1.1 M

€10,000,000

€8,000,000

€6,000,000

€4,000,000

€2,000,000

€ -
Cost Breakdown Comparison

**ECO-Steel**
- **A Substructure**: €240,000 (3%)
- **B Shell**: €320,000 (4%)
- **C Interiors**: €270,000 (3%)
- **D Services**: €350,000 (4%)
- **E Equipment and Furnishing**: €320,000 (4%)
- **F Specialty Construction**: €540,000 (6%)
- **G Building Sitework**: €670,000 (8%)
- **H General Conditions**: €3,100,000 (35%)

**ECO-Concrete**
- **A Substructure**: €240,000 (3%)
- **B Shell**: €320,000 (4%)
- **C Interiors**: €270,000 (3%)
- **D Services**: €350,000 (4%)
- **E Equipment and Furnishing**: €320,000 (4%)
- **F Specialty Construction**: €560,000 (6%)
- **G Building Sitework**: €670,000 (8%)
- **H General Conditions**: €2,900,000 (34%)
Construction Schedule

<table>
<thead>
<tr>
<th>Line</th>
<th>Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Programme</td>
<td>5.3 weeks</td>
<td>03 Sep 19</td>
<td>25 Sep 20</td>
</tr>
<tr>
<td>2</td>
<td>Construction</td>
<td>48 w 1 d</td>
<td>03 Sep 19</td>
<td>25 Sep 20</td>
</tr>
<tr>
<td>3</td>
<td>Preliminary Site Activities</td>
<td>2 w</td>
<td>03 Sep 19</td>
<td>11 Oct 19</td>
</tr>
<tr>
<td>4</td>
<td>Project Start</td>
<td>2 w</td>
<td>03 Sep 19</td>
<td>30 Sep 19</td>
</tr>
<tr>
<td>5</td>
<td>Mobilization (Site offices, Temporary Utilities, Fencing)</td>
<td>1 w</td>
<td>03 Sep 19</td>
<td>09 Oct 19</td>
</tr>
<tr>
<td>6</td>
<td>Site Survey, Grading and Levelling</td>
<td>2 w</td>
<td>03 Sep 19</td>
<td>01 Nov 19</td>
</tr>
<tr>
<td>7</td>
<td>Substructure</td>
<td>10 w</td>
<td>14 Oct 19</td>
<td>14 Feb 20</td>
</tr>
<tr>
<td>8</td>
<td>Dewatering</td>
<td>1 w</td>
<td>14 Oct 19</td>
<td>31 Oct 19</td>
</tr>
<tr>
<td>9</td>
<td>Excavation</td>
<td>2 w</td>
<td>15 Oct 19</td>
<td>31 Oct 19</td>
</tr>
<tr>
<td>10</td>
<td>Pile Foundations + Pile Tests</td>
<td>3 w</td>
<td>01 Nov 19</td>
<td>31 Nov 19</td>
</tr>
<tr>
<td>11</td>
<td>Blinding Concrete</td>
<td>3 w</td>
<td>22 Nov 19</td>
<td>30 Nov 19</td>
</tr>
<tr>
<td>12</td>
<td>Waterproofing (2 layers, protective membrane)</td>
<td>4 w</td>
<td>27 Nov 19</td>
<td>16 Dec 19</td>
</tr>
<tr>
<td>13</td>
<td>Finishing Walls + Basement Core Walls</td>
<td>2 w</td>
<td>03 Dec 19</td>
<td>16 Jan 20</td>
</tr>
<tr>
<td>14</td>
<td>Superstructure</td>
<td>13 w</td>
<td>07 Jan 20</td>
<td>06 Apr 20</td>
</tr>
<tr>
<td>15</td>
<td>Ground Floor (Steel Columns, Steel Beams, Core Walls)</td>
<td>2 w</td>
<td>07 Jan 20</td>
<td>27 Jan 20</td>
</tr>
<tr>
<td>16</td>
<td>First Floor (Core Walls + Steel Structure)</td>
<td>2 w</td>
<td>28 Jan 20</td>
<td>17 Feb 20</td>
</tr>
<tr>
<td>17</td>
<td>Steel Truss Installation</td>
<td>1 w</td>
<td>18 Feb 20</td>
<td>26 Mar 20</td>
</tr>
<tr>
<td>18</td>
<td>Slab (Composite Metal Deck, Grade and First Floor Slab)</td>
<td>2 w</td>
<td>10 Mar 20</td>
<td>10 Mar 20</td>
</tr>
<tr>
<td>19</td>
<td>Roof (Core Walls)</td>
<td>1 w</td>
<td>31 Mar 20</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Shell</td>
<td>4 w</td>
<td>07 Apr 20</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Flooring</td>
<td>2 w</td>
<td>07 Apr 20</td>
<td>26 Apr 20</td>
</tr>
<tr>
<td>22</td>
<td>Curtain Wall</td>
<td>2 w</td>
<td>07 Apr 20</td>
<td>26 Apr 20</td>
</tr>
<tr>
<td>23</td>
<td>Sarking</td>
<td>2 w</td>
<td>20 Apr 20</td>
<td>19 May 20</td>
</tr>
<tr>
<td>24</td>
<td>Interior Finishes</td>
<td>9 w</td>
<td>14 May 20</td>
<td>18 Jul 20</td>
</tr>
<tr>
<td>25</td>
<td>Partitioning (Plasterboard, Movable Walls)</td>
<td>1 w</td>
<td>14 May 20</td>
<td>20 May 20</td>
</tr>
<tr>
<td>26</td>
<td>Painting</td>
<td>1 w</td>
<td>21 May 20</td>
<td>20 May 20</td>
</tr>
<tr>
<td>27</td>
<td>Roof Finishes</td>
<td>1 w</td>
<td>29 May 20</td>
<td>04 Jun 20</td>
</tr>
<tr>
<td>28</td>
<td>Glazing</td>
<td>2 w</td>
<td>08 Jun 20</td>
<td>18 Jun 20</td>
</tr>
<tr>
<td>29</td>
<td>Door Installation</td>
<td>1 w</td>
<td>10 Jun 20</td>
<td>04 Jun 20</td>
</tr>
<tr>
<td>30</td>
<td>Furniture and Equipment</td>
<td>2 w</td>
<td>26 Jun 20</td>
<td>04 Jul 20</td>
</tr>
<tr>
<td>31</td>
<td>MEP 3rd fit</td>
<td>1 w</td>
<td>10 Jul 20</td>
<td>19 Jul 20</td>
</tr>
<tr>
<td>32</td>
<td>Landscaping</td>
<td>2 w</td>
<td>17 Jul 20</td>
<td>30 Jul 20</td>
</tr>
<tr>
<td>33</td>
<td>External Works/ Roads/ Signage</td>
<td>1 w</td>
<td>17 Jul 20</td>
<td>30 Jul 20</td>
</tr>
<tr>
<td>34</td>
<td>Landscaping</td>
<td>1 w</td>
<td>17 Jul 20</td>
<td>30 Jul 20</td>
</tr>
<tr>
<td>35</td>
<td>Final Stages</td>
<td>8 w</td>
<td>01 Jul 20</td>
<td>26 Sep 20</td>
</tr>
<tr>
<td>36</td>
<td>Testing and Commissioning</td>
<td>2 w</td>
<td>31 Jul 20</td>
<td>03 Sep 20</td>
</tr>
<tr>
<td>37</td>
<td>Project Finish</td>
<td>2 w</td>
<td>26 Sep 20</td>
<td>30 Sep 20</td>
</tr>
</tbody>
</table>
**Milestones**

1. Seal Basement
   [6-Jan-20/6-Jan-20]

2. Place Support Columns/Shear Walls
   [27-Jan-20/27-Jan-20]

3. Erect Truss Systems
   [9-Mar-20/19-Feb-20]

4. Pour Floor Slabs & Roof
   [31-Mar-20/5-Mar-20]

5. Seal Envelope
   [28Apr-20/31-Mar-20]
DAY N NIGHT
ARCHITECTURE
**Day N Night**

**Day** – 1st Floor
- Light
- Transparent
- Naturally lighted

Terrace above the ground floor volume

**Night** – Ground Floor
- Heavy
- Enclosed
- Dark

Transparent space under 1st floor volume
Program Distribution

- LAB
- STAFF
- SMALL CLASSROOM
- LOBBY CAFE
- LOUNGE
- STUDENT
- AUDITORIUM
- LOUNGE
- CLASSROOM
- STUDENT

±0,0 m
+9,0 m
-3,0 m
Ground Floor

Mix Use
- Auditorium
- L Classrooms
- S Classrooms
- Lobby
- Cafe
- Reception

Services
- Restroom
- MEP Shaft
- Storage

Grid: 2.9 x 2.9 m

Dimensions:
- 34.8 m
- 17.4 m
- 34.8 m

Winter 2017 Express A Floor Plan

N 70
Lobby & Cafe
1st Floor

Mix Use
Labs

Faculty
Seminar
Office
Lounge

Services
Restroom
MEP Shaft
Storage

Grid: 2.9 x 2.9 m
Entrance / East Facade
STRUCTURE
Structural Alternatives

Concrete

Timber
Timber Design

Cantilevers

Long Spans

5.8 m

23.2 m

Slanted columns cut cantilever in half

BauBuche Lattice Girders

Lightweight roof
Basement - Concrete

- Grid Span 2.9m
- Retaining Wall (10’’)
- Shear Wall (10’’)
- Column 14’’ x 14’’

Structural Floor Plan
Ground Floor - Concrete

- Beam 12” x 20”
- Column 14” x 14”
- Shear Wall (10”)

Grid Span 2.9m
First Floor - Concrete

- Beam 12” x 20”
- Shear Wall (10”)
- Column 14” x 14”

Grid Span 2.9m
Roof - Concrete

- Beam 12" x 20"
- Shear Wall (10"
- Column 14" x 14"
- Grid Span 2.9m

Structural Floor Plan

Winter 2017 Express SE Structural Floor Plan 83
Concrete

Basement

1st Floor

Ground Floor

Roof
Winter 2017

Express

SE

Structural Floor Plan

Basement - Timber

Retaining Wall (10")

Shear Wall (10")

Column 280 mm x 280 mm

Grid Span 2.9m

Grid Span 34.8 m

Grid Span 17.4 m
Ground Floor - Timber

Grid Span
2.9m

Shear Wall (10")
Beam 360mm x 240mm
Beam 480mm x 240mm
Column 280 mm x 280 mm

17.4 m
34.8 m
34.8 m
First Floor - Timber

Shear Wall (10”)
Lattice Girders 0.7 m
Beam 360mm x 240mm
Beam 480mm x 240mm
Column 280 mm x 280 mm
Slanted Column 280 mm x 280 mm

Grid Span 2.9m
Roof - Timber

Beam 360mm x 240mm
Beam 480mm x 240mm
Column 280 mm x 280 mm
Shear Wall (10”)

Grid Span 2.9m

17.4 m

46.4 m
Gravity Load Path
Lateral Load Path
Key Coordination

ARCHITECTURAL – STRUCTURAL

Keep the appearance of two separate boxes, one atop the other.

0.5 m difference in elevation
Foundation Evolution

Original Design: Mat Foundations

Considerations:
- Timber design would “float” from large buoyancy forces
- Weak soils on top layers in nearby projects
- Neighboring university buildings on concrete piles

Mentor Meeting: Mentor familiar with site relayed actual site conditions from nearby projects

Updated Design:
- **Econdustry:**
  - 26 Rein. Concrete Piles
  - 400 mm x 400 mm
  - 12 m long
- **Day N’ Night:**
  - 38 Rein. Concrete Piles
  - 235 mm x 235 mm
  - 9 m long
MEP
Options

Option 1

Concrete structure

Mixing ventilation

3.5m

4.5m

Floor heating system

supply duct

Option 2

Timber structure

Natural ventilation

3.5m

4.5m

Floor heating system

Water system

High efficiency

Slow response

User control
Distribution

Offices and classrooms:

- Radiant floor heating
- Mixing ventilation
Entrance area:
• Floor heating

Auditoriums:
• Radiant wall panels
• Plenum return air

Laboratories:
• Floor heating
• Mixing ventilation
Distribution

Auditorium:
• Radiant wall panels

Laboratories:
• Floor heating
• Displacement ventilation

Open space:
• Floor heating
• Displacement ventilation
Sun path and shadows

1974 h of sunshine  No shadows  PV potential

Sunrise  Noon  Sunset

Econdustry

Day n’ Night
## On-site renewable...

<table>
<thead>
<tr>
<th></th>
<th><strong>Econdustry</strong></th>
<th><strong>Day n’ Night</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>PV facade</td>
<td>[m²] 1103</td>
<td>[m²] 756</td>
</tr>
<tr>
<td>PV roof (Tesla)</td>
<td>[m²] 1498</td>
<td>[m²] 1281</td>
</tr>
<tr>
<td>Pavegen floor tiles</td>
<td>Number of tiles independent of shape</td>
<td></td>
</tr>
<tr>
<td>Water collection potential [m³/y]</td>
<td>2087</td>
<td>1784</td>
</tr>
</tbody>
</table>
CONSTRUCTION MANAGEMENT
Total Cost Comparison

Target Value: €9.7 M

<table>
<thead>
<tr>
<th>Estimated Value</th>
<th>Value Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>€8.2 M</td>
<td>+€1.5 M</td>
</tr>
<tr>
<td>€8.0 M</td>
<td>+€1.7 M</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Budget and TVD</th>
</tr>
</thead>
<tbody>
<tr>
<td>€2,000,000</td>
</tr>
<tr>
<td>€4,000,000</td>
</tr>
<tr>
<td>€6,000,000</td>
</tr>
<tr>
<td>€8,000,000</td>
</tr>
</tbody>
</table>

DnN-Concrete
DnN-Timber
### Cost Breakdown Comparison

#### Day N Night - Concrete

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substructure</td>
<td>€ 350,000</td>
<td>4%</td>
</tr>
<tr>
<td>Shell</td>
<td>€ 670,000</td>
<td>8%</td>
</tr>
<tr>
<td>Interiors</td>
<td>€ 370,000</td>
<td>5%</td>
</tr>
<tr>
<td>Services</td>
<td>€ 2,800,000</td>
<td>35%</td>
</tr>
<tr>
<td>Equipment and Furnishing</td>
<td>€ 270,000</td>
<td>3%</td>
</tr>
<tr>
<td>Specialty Construction</td>
<td>€ 240,000</td>
<td>3%</td>
</tr>
<tr>
<td>Building Sitework</td>
<td>€ 270,000</td>
<td>3%</td>
</tr>
<tr>
<td>General Conditions</td>
<td>€ 350,000</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>€ 3,000,000</td>
<td>34%</td>
</tr>
</tbody>
</table>

#### Day N Night - Timber

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substructure</td>
<td>€ 350,000</td>
<td>4%</td>
</tr>
<tr>
<td>Shell</td>
<td>€ 670,000</td>
<td>8%</td>
</tr>
<tr>
<td>Interiors</td>
<td>€ 370,000</td>
<td>5%</td>
</tr>
<tr>
<td>Services</td>
<td>€ 2,800,000</td>
<td>35%</td>
</tr>
<tr>
<td>Equipment and Furnishing</td>
<td>€ 270,000</td>
<td>3%</td>
</tr>
<tr>
<td>Specialty Construction</td>
<td>€ 240,000</td>
<td>3%</td>
</tr>
<tr>
<td>Building Sitework</td>
<td>€ 270,000</td>
<td>3%</td>
</tr>
<tr>
<td>General Conditions</td>
<td>€ 350,000</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>€ 2,800,000</td>
<td>34%</td>
</tr>
</tbody>
</table>
Concrete

Construction Schedule

<table>
<thead>
<tr>
<th>Line</th>
<th>Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Programme</td>
<td>436w2,386d</td>
<td>30 Sep 19</td>
<td>09 Sep 20</td>
</tr>
<tr>
<td>2</td>
<td>Construction</td>
<td>45w4d</td>
<td>30 Sep 19</td>
<td>09 Sep 20</td>
</tr>
<tr>
<td>3</td>
<td>Preliminary Site Activities</td>
<td>1w</td>
<td>30 Sep 19</td>
<td>04 Oct 19</td>
</tr>
<tr>
<td>4</td>
<td>Project Start</td>
<td></td>
<td>30 Sep 19</td>
<td>30 Sep 19</td>
</tr>
<tr>
<td>5</td>
<td>Mobilization (Site offices, Temporary Utilities, Fencing)</td>
<td></td>
<td>50 Sep 19</td>
<td>04 Oct 19</td>
</tr>
<tr>
<td>6</td>
<td>Site Survey, Grading and Levelling</td>
<td></td>
<td>50 Sep 19</td>
<td>04 Oct 19</td>
</tr>
<tr>
<td>7</td>
<td>Substructure</td>
<td>16w</td>
<td>07 Oct 19</td>
<td>07 Feb 20</td>
</tr>
<tr>
<td>8</td>
<td>Dewatering</td>
<td>1w</td>
<td>07 Oct 19</td>
<td>07 Feb 20</td>
</tr>
<tr>
<td>9</td>
<td>Excavation</td>
<td>3w</td>
<td>11 Oct 19</td>
<td>24 Nov 19</td>
</tr>
<tr>
<td>10</td>
<td>Pile Foundations + Pile Tests</td>
<td>3w</td>
<td>15 Oct 19</td>
<td>24 Nov 19</td>
</tr>
<tr>
<td>11</td>
<td>Blinding Concrete</td>
<td>1w</td>
<td>15 Nov 19</td>
<td>15 Nov 19</td>
</tr>
<tr>
<td>12</td>
<td>Waterproofing (2 layers, protective membrane)</td>
<td>4w</td>
<td>18 Nov 19</td>
<td>11 Dec 19</td>
</tr>
<tr>
<td>13</td>
<td>Retaining Walls + Basement Core Walls</td>
<td>3w</td>
<td>22 Nov 19</td>
<td>15 Dec 19</td>
</tr>
<tr>
<td>14</td>
<td>Superstructure</td>
<td>9w</td>
<td>13 Dec 19</td>
<td>20 Feb 20</td>
</tr>
<tr>
<td>15</td>
<td>Ground Floor (Beams + Post Tensioned Slab)</td>
<td>2w</td>
<td>13 Dec 19</td>
<td>09 Jan 20</td>
</tr>
<tr>
<td>16</td>
<td>Ground Floor Core Walls</td>
<td>1w</td>
<td>10 Jan 20</td>
<td>16 Jan 25</td>
</tr>
<tr>
<td>17</td>
<td>First Floor (Beams + Post Tensioned Slab)</td>
<td>2w</td>
<td>17 Jan 20</td>
<td>26 Jan 20</td>
</tr>
<tr>
<td>18</td>
<td>First Floor Core Walls</td>
<td>1w</td>
<td>31 Jan 20</td>
<td>26 Jan 25</td>
</tr>
<tr>
<td>19</td>
<td>Roof (Post Tension Slab)</td>
<td>4w</td>
<td>07 Feb 20</td>
<td>07 Feb 20</td>
</tr>
<tr>
<td>20</td>
<td>Shell</td>
<td>3w</td>
<td>21 Feb 20</td>
<td>21 Feb 20</td>
</tr>
<tr>
<td>21</td>
<td>Roofing</td>
<td>2w</td>
<td>21 Feb 20</td>
<td>21 Feb 20</td>
</tr>
<tr>
<td>22</td>
<td>Curtain wall</td>
<td>2w</td>
<td>21 Feb 20</td>
<td>21 Feb 20</td>
</tr>
<tr>
<td>23</td>
<td>Shading</td>
<td>3w</td>
<td>06 Mar 20</td>
<td>19 Mar 20</td>
</tr>
<tr>
<td>24</td>
<td>Interior Finishes</td>
<td>11w</td>
<td>20 Mar 20</td>
<td>16 Jun 22</td>
</tr>
<tr>
<td>25</td>
<td>Partitioning (Plasterboard, Moveable Walls)</td>
<td>2w</td>
<td>20 Mar 20</td>
<td>02 Apr 20</td>
</tr>
<tr>
<td>26</td>
<td>Painting</td>
<td>2w</td>
<td>03 Apr 20</td>
<td>24 Apr 20</td>
</tr>
<tr>
<td>27</td>
<td>Floor Finishes</td>
<td>2w</td>
<td>27 Apr 20</td>
<td>11 May 20</td>
</tr>
<tr>
<td>28</td>
<td>Cladding Works</td>
<td>2w</td>
<td>05 May 20</td>
<td>18 May 20</td>
</tr>
<tr>
<td>29</td>
<td>Door Installation</td>
<td>3w</td>
<td>10 May 20</td>
<td>18 May 20</td>
</tr>
<tr>
<td>30</td>
<td>Furniture and Equipment</td>
<td>2w</td>
<td>27 May 20</td>
<td>09 Jun 20</td>
</tr>
<tr>
<td>31</td>
<td>MEP 3rd fix</td>
<td>1w</td>
<td>10 Jun 20</td>
<td>16 Jun 20</td>
</tr>
<tr>
<td>32</td>
<td>Landscaping</td>
<td>2w</td>
<td>17 Jun 20</td>
<td>30 Jun 20</td>
</tr>
<tr>
<td>33</td>
<td>External Works/ Roads/ Signage</td>
<td>2w</td>
<td>17 Jun 20</td>
<td>06 Jul 20</td>
</tr>
<tr>
<td>34</td>
<td>Landscaping</td>
<td>2w</td>
<td>17 Jun 20</td>
<td>30 Jul 20</td>
</tr>
<tr>
<td>35</td>
<td>Final Stages</td>
<td>12w</td>
<td>17 Jun 20</td>
<td>09 Sep 20</td>
</tr>
<tr>
<td>36</td>
<td>Testing and Commissioning</td>
<td>12w</td>
<td>17 Jun 20</td>
<td>09 Sep 20</td>
</tr>
<tr>
<td>37</td>
<td>Project Finish</td>
<td>2w</td>
<td>09 Sep 20</td>
<td>09 Sep 20</td>
</tr>
</tbody>
</table>

Legend:
- **Begin Excavation**
- **Begin Concrete Pour**
- **Building is sealed**
- **Turn over complete**
- **Lab Handover**
## Construction Schedule

<table>
<thead>
<tr>
<th>Line</th>
<th>Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preliminary Site Activities</td>
<td>2w</td>
<td>30 Sep 19</td>
<td>11 Oct 19</td>
</tr>
<tr>
<td>2</td>
<td>Project Start</td>
<td>1w</td>
<td>30 Sep 19</td>
<td>30 Sep 19</td>
</tr>
<tr>
<td>3</td>
<td>Mobilization (Site offices, Temporary Utilities, Fence)</td>
<td>1w</td>
<td>30 Sep 19</td>
<td>04 Oct 19</td>
</tr>
<tr>
<td>4</td>
<td>Site Survey, Grading and Levelling</td>
<td>2w</td>
<td>30 Sep 19</td>
<td>11 Oct 19</td>
</tr>
<tr>
<td>5</td>
<td>Substructure</td>
<td>16w</td>
<td>14 Oct 19</td>
<td>14 Feb 20</td>
</tr>
<tr>
<td>6</td>
<td>Devatting</td>
<td>16w</td>
<td>14 Oct 19</td>
<td>14 Feb 20</td>
</tr>
<tr>
<td>7</td>
<td>Excavation</td>
<td>2w</td>
<td>15 Oct 19</td>
<td>31 Oct 19</td>
</tr>
<tr>
<td>8</td>
<td>Pile Foundations + Pile Tests</td>
<td>3w</td>
<td>01 Nov 19</td>
<td>21 Nov 19</td>
</tr>
<tr>
<td>9</td>
<td>Blinding Concrete</td>
<td>3w</td>
<td>22 Nov 19</td>
<td>28 Nov 19</td>
</tr>
<tr>
<td>10</td>
<td>Waterproofing (2 layers, protective membrane)</td>
<td>4d</td>
<td>27 Nov 19</td>
<td>02 Dec 19</td>
</tr>
<tr>
<td>11</td>
<td>Retaining Walls + Basement Core Walls</td>
<td>2w</td>
<td>02 Dec 19</td>
<td>03 Jan 20</td>
</tr>
<tr>
<td>12</td>
<td>BauBuche Columns + Beams</td>
<td>4d</td>
<td>07 Jan 20</td>
<td>10 Jan 20</td>
</tr>
<tr>
<td>13</td>
<td>Superstructure</td>
<td>9w 2.5d</td>
<td>07 Jan 20</td>
<td>12 Mar 20</td>
</tr>
<tr>
<td>14</td>
<td>GfF Slab</td>
<td>1w</td>
<td>07 Jan 20</td>
<td>13 Jan 20</td>
</tr>
<tr>
<td>15</td>
<td>Shear Walls + Core Walls</td>
<td>2w</td>
<td>14 Jan 20</td>
<td>27 Jan 20</td>
</tr>
<tr>
<td>16</td>
<td>Columns + Slanted Columns</td>
<td>1w</td>
<td>28 Jan 20</td>
<td>28 Jan 20</td>
</tr>
<tr>
<td>17</td>
<td>Orders + Beams + Lattice Orders</td>
<td>2w 2.5d</td>
<td>04 Feb 20</td>
<td>04 Feb 20</td>
</tr>
<tr>
<td>18</td>
<td>First Floor Slab</td>
<td>1w</td>
<td>20 Feb 20</td>
<td>20 Feb 20</td>
</tr>
<tr>
<td>19</td>
<td>First Floor (Core Walls + BauBuche Frame)</td>
<td>2w</td>
<td>27 Feb 20</td>
<td>27 Feb 20</td>
</tr>
<tr>
<td>20</td>
<td>Shell</td>
<td>4w</td>
<td>12 Mar 20</td>
<td>09 Apr 20</td>
</tr>
<tr>
<td>21</td>
<td>Roofing (Metal Decking)</td>
<td>3w</td>
<td>12 Mar 20</td>
<td>02 Apr 20</td>
</tr>
<tr>
<td>22</td>
<td>Curtain wall</td>
<td>2w</td>
<td>12 Mar 20</td>
<td>26 Mar 20</td>
</tr>
<tr>
<td>23</td>
<td>Shading</td>
<td>2w</td>
<td>26 Mar 20</td>
<td>09 Apr 20</td>
</tr>
<tr>
<td>24</td>
<td>Interior Finishes</td>
<td>5w 2.5d</td>
<td>06 Apr 20</td>
<td>23 Jun 20</td>
</tr>
<tr>
<td>25</td>
<td>Partitioning (Plasterboard, Moveable Walls)</td>
<td>1w</td>
<td>06 Apr 20</td>
<td>26 Apr 20</td>
</tr>
<tr>
<td>26</td>
<td>Painting</td>
<td>1w</td>
<td>24 Apr 20</td>
<td>01 May 20</td>
</tr>
<tr>
<td>27</td>
<td>Floor Finishes</td>
<td>1w</td>
<td>01 May 20</td>
<td>11 May 20</td>
</tr>
<tr>
<td>28</td>
<td>Glazing Works</td>
<td>2w</td>
<td>11 May 20</td>
<td>26 May 20</td>
</tr>
<tr>
<td>29</td>
<td>Door Installation</td>
<td>1w</td>
<td>20 May 20</td>
<td>02 Jun 20</td>
</tr>
<tr>
<td>30</td>
<td>Furniture and Equipment</td>
<td>2w</td>
<td>02 Jun 20</td>
<td>16 Jun 20</td>
</tr>
<tr>
<td>31</td>
<td>MEP 3rd fix</td>
<td>1w</td>
<td>10 Jun 20</td>
<td>23 Jun 20</td>
</tr>
<tr>
<td>32</td>
<td>Landscaping</td>
<td>2w</td>
<td>23 Jun 20</td>
<td>07 Jul 20</td>
</tr>
<tr>
<td>33</td>
<td>External Works/ Roads/ Signage</td>
<td>2w</td>
<td>23 Jun 20</td>
<td>07 Jul 20</td>
</tr>
<tr>
<td>34</td>
<td>Landscaping</td>
<td>2w</td>
<td>23 Jun 20</td>
<td>07 Jul 20</td>
</tr>
<tr>
<td>35</td>
<td>Final Stages</td>
<td>8w</td>
<td>17 Jul 20</td>
<td>11 Sep 20</td>
</tr>
<tr>
<td>36</td>
<td>Testing and Commissioning</td>
<td>5w 2.5d</td>
<td>17 Jul 20</td>
<td>11 Sep 20</td>
</tr>
<tr>
<td>37</td>
<td>Project Finish</td>
<td>5w</td>
<td>11 Sep 20</td>
<td>11 Sep 20</td>
</tr>
</tbody>
</table>

### Notes:
- **Begin Excavation**
- **Timber Construction Begins**
- **Building is sealed**
- **Lab Handover**
- **Turn over complete**
Milestones

1. Seal Basement  
[12-Dec-19/6-Jan-20]

2. Place Support Columns/Shear Walls  
[16-Jan-20/3-Feb-20]

3. Erect Framing Systems  
[6-Feb-20/20-Feb-20]

4. Pour Floor Slabs & Roof  
[20-Feb-20/12-Mar-20]

5. Seal Envelope  
[5-Mar-20/26-Mar-20]

Milestone Date  
[xxx] – Concrete  
[xxx] – Timber
Equipment

Wheel Loader

Maximum Engine Power 56 kW
Operating Weight 5820 kg
Standard Bucket Capacity 1.2 m³
Equipment

Excavator
- Maximum Bucket Capacity 1.19 m³
- Maximum Engine Power 128 kW
- Operating Weight 21675 kg

Forklift
- Maximum Engine Power 55 kW
- Maximum Lift Capacity 4000 kg
- Maximum Lift Height 6.7 m

Grader
- Maximum Engine Power 98 kW
- Operating Weight 12000 kg
- Blade Width 3.05 m

• Scissor Lifts
• Compactor
Equipment

Crane Requirement

- Minimum Range:
  - L-Shape: 40m-45m
  - Double Diamond: 50m-60m
- Minimum Height: 15m-18m
- Minimum Load Capacity: 12.5-25 Ton? Air Handling Unit

Mobile Crane

Concrete Pump

Range: 20m-42m
Challenges for Spring Quarter

- **Develop**
  - Dewatering system

- **Explore**
  - Pre-fabrication
  - Just-in-time delivery

- **Reduce**
  - Construction site footprint

- **Refine**
  - Construction sequence plan

- **Incorporate**
  - Slovenian labor/material prices
LIFE-CYCLE FINANCIAL MANAGEMENT
**Integrated Risk Analysis**

**IDENTIFICATION**
What could happen, under which circumstances, to what/whom?

**INFLUENCERS**
Who can have impact on these risks and which one are priority risks?

**DEFINE & PREVENT**
What consequences could follow in best, average and worst case? How could WE prevent it?

**RISK MITIGATION**
Less risk, less cost!
## Risk Management

<table>
<thead>
<tr>
<th>Risk</th>
<th>Description</th>
<th>Consequences</th>
<th>Risk Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction period</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction delay</td>
<td>Miscalculation of schedule, Changes in planning</td>
<td>Delay for operation period, loss of rental income</td>
<td>Precise calculations including contingency buffer, Reliable subcontractors</td>
</tr>
<tr>
<td>Earthquake</td>
<td>Damaged building</td>
<td>Availability, O&amp;M and replacement cost</td>
<td>Safe structural solution which can withstand an earthquake</td>
</tr>
<tr>
<td>Flooding</td>
<td>Damaged building</td>
<td>Availability, O&amp;M and replacement cost</td>
<td>Flooding prevention system, avoiding technical equipment in flooding zones</td>
</tr>
<tr>
<td>Energy costs</td>
<td>Energy cost is higher than expected</td>
<td>O&amp;M Cost</td>
<td>Include inflation and contingency buffer, Energy production</td>
</tr>
</tbody>
</table>

Winter 2017  | Express  | LCFM  | Examples | 113
Risk Management Impact of Risk Strategy

RISK MANAGEMENT IMPACT

- Construction delay
- Earthquake
- Flooding
- Energy costs

- Risk Cost with strategy
- Risk Cost Impact
“Costs below the horizon”

Life-Cycle-Cost

CONSTRUCTION & REPLACEMENT

CM

TVD

OPERATION & MAINTENANCE

MEP

Consumption & Production

A

Area & Design

SE

Safe Structural System

RISK

Construction

Maintenance

Risks

Replacement

Interest

Operation
**LCC-Links**

**TVD - SUMMARY**

- Target Value: 9.70 Mio. €
- Estimated Value: 8.70 Mio. €
- Value Delta: 1.00 Mio. €

**STV - SUMMARY**

- Carbon (kgCO2e)
- Water (kgH2O)
- Energy (MJ)

**O&M + REPLACEMENT**

- Caretaker, 6%
- Management, 8%
- Repair, 3%
- Waste Disposal, 1%
- Electricity all, 8%
- Heating & Cooling, 5%
- Cleaning, 27%

**STV - SUMMARY**

- Financial cost, 3.60 Mio. €, 17%
- Risk surcharge, 1.40 Mio. €, 7%
- Replacement, 1.70 Mio. €, 8%
- O & M, 5.00 Mio. €, 25%

- Construction, 8.70 Mio. €, 43%

**LIFE-CYCLE-COST**

- Targets
- Project

**Winter 2017**
LCC-Rent-Relation

Life-Cycle-Cost

<table>
<thead>
<tr>
<th>LCC over 25 years</th>
<th>Life-Cycle-Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,30</td>
<td>20,10</td>
</tr>
<tr>
<td>18,80</td>
<td>18,90</td>
</tr>
</tbody>
</table>

Rent

<table>
<thead>
<tr>
<th>Estimated rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>930.000€</td>
</tr>
<tr>
<td>925.000€</td>
</tr>
<tr>
<td>900.000€</td>
</tr>
<tr>
<td>900.000€</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>930.000€</td>
</tr>
<tr>
<td>925.000€</td>
</tr>
<tr>
<td>900.000€</td>
</tr>
<tr>
<td>900.000€</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>930.000€</td>
</tr>
<tr>
<td>925.000€</td>
</tr>
<tr>
<td>900.000€</td>
</tr>
<tr>
<td>900.000€</td>
</tr>
</tbody>
</table>

Legend:
- ECONDUSTRY - STEEL
- ECONDUSTRY - CONCRETE
- DAY ’N NIGHT - CONCRETE
- DAY ’N NIGHT - TIMBER
EFFICIENT DESIGN
Collaboration within all disciplines through all steps to create an efficient building related to space, cost, risk and future operations.

ADDITIONAL PROGRAM
Integrate program related solutions for additional income into the concept by showing benefits and value to owners.

FINANCIAL STRUCTURE
Optimizing the financial structure to reduce interest payments.
Space Efficiency

GROSS FLOOR AREA DISTRIBUTION

Assignable area 69%
Non assignable area 25%
Structural area 6%

DISTRIBUTION OF ASSIGNABLE AREA

Requirement vs Currently

Faculty Office
Department Chair's Office
Administrative Assistants
Faculty Lounge
Student Office
Auditorium
Large Classroom
Small Classroom
Seminar Room
Instructional Lab
Server Rooms
Technical Support
Storage
Lobby/Reception
Student Lounge
Changing Room/Shower
Kitchen
Isolated Space
Virtual Reality Room
Cafe
GROSS FLOOR AREA DISTRIBUTION

- Assignable area 70%
- Non assignable area 24%
- Structural area 6%

DISTRIBUTION OF ASSIGNABLE AREA

- Faculty Office
- Department Chair’s Office
- Administrative Assistant
- Faculty Lounge
- Student Office
- Auditorium
- Large Classroom
- Small Classroom
- Seminar Room
- Instructional Lab
- Server Rooms
- Technical Support
- Storage
- Lobby/Reception
- Student Lounge
- Changing Room/Shower
- Virtual Reality Room
- Cafe

Requirement vs. Currently
Increasing efficiency and flexibility by outsourcing:

- Data access from all around the globe is necessary in today's and future society

- Cloud services getting more and more reliable

- University learning concept is changing

- Online education is a developing sector

Cloud services:

- Azure

Hybrid solution:

- PROTONET®
## LCFM - Summary

<table>
<thead>
<tr>
<th></th>
<th>ECONDUSTRY – STEEL</th>
<th>ECONDUSTRY – CONCRETE</th>
<th>DAY 'N NIGHT – CONCRETE</th>
<th>DAY 'N NIGHT – TIMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction cost</strong></td>
<td>8,70 Mio. €</td>
<td>8,60 Mio. €</td>
<td>8,20 Mio. €</td>
<td>8,00 Mio. €</td>
</tr>
<tr>
<td><strong>O &amp; M</strong></td>
<td>5,00 Mio. €</td>
<td>5,00 Mio. €</td>
<td>4,60 Mio. €</td>
<td>4,70 Mio. €</td>
</tr>
<tr>
<td><strong>Replacement</strong></td>
<td>1,70 Mio. €</td>
<td>1,70 Mio. €</td>
<td>1,50 Mio. €</td>
<td>1,60 Mio. €</td>
</tr>
<tr>
<td><strong>Risk surcharge</strong></td>
<td>1,40 Mio. €</td>
<td>1,30 Mio. €</td>
<td>1,10 Mio. €</td>
<td>1,30 Mio. €</td>
</tr>
<tr>
<td><strong>Financial cost</strong></td>
<td>3,60 Mio. €</td>
<td>3,60 Mio. €</td>
<td>3,40 Mio. €</td>
<td>3,40 Mio. €</td>
</tr>
<tr>
<td><strong>LCC</strong></td>
<td>20,30 Mio. €</td>
<td>20,10 Mio. €</td>
<td>18,80 Mio. €</td>
<td>18,90 Mio. €</td>
</tr>
<tr>
<td><strong>LCC p.a.</strong></td>
<td>814.000 €</td>
<td>806.000 €</td>
<td>750.000 €</td>
<td>755.000 €</td>
</tr>
<tr>
<td><strong>LCC p.a. / m² GFA</strong></td>
<td>271 €</td>
<td><strong>269 €</strong></td>
<td>275 €</td>
<td>276 €</td>
</tr>
<tr>
<td><strong>GFA in m²</strong></td>
<td>3000</td>
<td>3000</td>
<td>2730</td>
<td>2730</td>
</tr>
<tr>
<td><strong>Rent</strong></td>
<td>930.000 €</td>
<td>925.000 €</td>
<td>900.000 €</td>
<td>900.000 €</td>
</tr>
<tr>
<td><strong>Rent per m²/GFA</strong></td>
<td>310 €</td>
<td><strong>308 €</strong></td>
<td>330 €</td>
<td>330 €</td>
</tr>
</tbody>
</table>
**CRITERIA DEFINITION**

Brainstorming of different criteria, which are related to green building, the challenges and specific point of views.

**OVERALL WEIGHT**

This step relates to the decision of the overall score weighting between the PPP organization and how to integrate the user.

**INDIVIDUAL SCORING**

Every team member and owner could decide about the individual weight of each criteria and how well each concept assesses to it.

**COMPARATIVE RESULT**

The final step was a comparative analyses of the individual scoring to determine the favorite concept.
## Decision Matrix

### TEAM EXPRESS – DECISION MATRIX

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>CRITERIA</th>
<th>WEIGHT</th>
<th>STEEL</th>
<th>CONCRETE</th>
<th>CONCRETE</th>
<th>TIMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL</td>
<td>Robustness of BIG Idea</td>
<td>5.0%</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>Life-Cycle-Cost</td>
<td>5.0%</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>Construction Cost</td>
<td>5.0%</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>Annual rent</td>
<td>5.0%</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>Level of EQ Risk Impact</td>
<td>5.0%</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>Level of Flood Risk Impact</td>
<td>5.0%</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>Space efficiency</td>
<td>5.0%</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>ECONOMIC</td>
<td>Prefabrication</td>
<td>5.0%</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>ECOLOGIC</td>
<td>User comfort</td>
<td>7.0%</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>ECOLOGIC</td>
<td>Water consumption</td>
<td>3.0%</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>ECOLOGIC</td>
<td>Energy demand</td>
<td>7.0%</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>ECOLOGIC</td>
<td>Energy production</td>
<td>5.0%</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>ECOLOGIC</td>
<td>Carbon Footprint</td>
<td>7.0%</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>ECOLOGIC</td>
<td>Source of material</td>
<td>5.0%</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>ECOLOGIC</td>
<td>Design2disassembly</td>
<td>2.0%</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>SOCIAL</td>
<td>Architectural Integration</td>
<td>2.0%</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>SOCIAL</td>
<td>Daylight</td>
<td>5.0%</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>SOCIAL</td>
<td>Appeal</td>
<td>3.0%</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>SOCIAL</td>
<td>Space &amp; Circulation</td>
<td>7.0%</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>SOCIAL</td>
<td>Stress Reduction</td>
<td>7.0%</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**INDIVIDUAL WEIGHTED SCORE**

- STEEL: 3.51
- CONCRETE: 3.56
- CONCRETE: 3.43
- TIMBER: 3.35
### ECONDUSTRY - STEEL

<table>
<thead>
<tr>
<th>Category</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness of BIG...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Life-Cycle-Cost Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Annual rent</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of EQ Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of Flood Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space efficiency</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Prefabrication</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>User comfort</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Water consumption</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy demand</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy production</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Carbon Footprint</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Design2disassembly</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Architectural...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Appeal</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Daylight</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space &amp; Circulation</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### DAY 'N NIGHT - CONCRETE

<table>
<thead>
<tr>
<th>Category</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness of BIG...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Life-Cycle-Cost Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Annual rent</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of EQ Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of Flood Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space efficiency</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Prefabrication</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>User comfort</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Water consumption</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy demand</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy production</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Carbon Footprint</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Design2disassembly</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Architectural...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Appeal</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Daylight</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space &amp; Circulation</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### ECONDUSTRY - CONCRETE

<table>
<thead>
<tr>
<th>Category</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness of BIG...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Life-Cycle-Cost Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Annual rent</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of EQ Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of Flood Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space efficiency</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Prefabrication</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>User comfort</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Water consumption</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy demand</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy production</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Carbon Footprint</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Design2disassembly</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Architectural...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Appeal</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Daylight</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space &amp; Circulation</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### DAY 'N NIGHT - TIMBER

<table>
<thead>
<tr>
<th>Category</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness of BIG...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Life-Cycle-Cost Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Annual rent</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of EQ Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Level of Flood Risk...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space efficiency</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Prefabrication</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>User comfort</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Water consumption</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy demand</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Energy production</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Carbon Footprint</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Design2disassembly</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Architectural...</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Appeal</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Daylight</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Space &amp; Circulation</td>
<td>1.00</td>
<td>0.50</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
The Winner

Final Concept: Econdustry - Concrete
Team Process
Communicate - Collaborate - Coordinate

INSTANT COMMUNICATION
Keep everyone in the loop

TERF Conference Room
Collaborate - Collaborate - Coordinate

Google Drive

INSTANT COLLABORATION
Share ideas easily
Collaborate - Collaborate - Coordinate

Example: ARCH v. SE

Column clash with Partition Wall

LFCM
ARCH
CM
SE
MEP

AUTODESK® 360
AUTODESK® BIM 360™
AUTODESK® REVIT®