RIVER
FLUSS
河
नदी
River Owner Team

Renate Fruchter
USA

Luke Lombardi
USA

Ewa Kunkel
Denmark

Hussain Parsianfar
Denmark

Andrej Kurent
Slovenia
Location Germany, Weimar
Collaboration

talking...
what?
confusion
“what are we doing?”
collaboration
action!
coordination
Collaboration Tools

Coordination

Communication

Collaboration
transparency
noun | trans·par·en·cy | \ tran(t)s-ˈper-ən(t)-sē \ 

The ability to **effectively communicate** the working process and **foster trust** at three different levels: **Self**, **Team**, and **Owners**
**DPR Challenge Team Diary**

### Member Name

<table>
<thead>
<tr>
<th>Member Name</th>
<th>3/3/2018</th>
<th>3/4/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4</td>
<td>UPDATE PULL PLAN</td>
<td>Meeting with Sylvia and Bella for Ripple height and shaft location. Revising the load calculations and energy consumption estimates for Ripple.</td>
</tr>
<tr>
<td>#5</td>
<td>UPDATE PULL PLAN</td>
<td>Scheduled a mentor meeting with Noray at Bauhaus; Researched and calculated the impact of the green auditorium walls on our LCC;</td>
</tr>
</tbody>
</table>

### Member Activity

<table>
<thead>
<tr>
<th>Member Name</th>
<th>4/14/2018</th>
<th>4/15/2018</th>
<th>4/16/2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4</td>
<td>UPDATE PULL PLAN</td>
<td>UPDATE PULL PLAN</td>
<td>UPDATE PULL PLAN</td>
</tr>
<tr>
<td>#5</td>
<td>UPDATE PULL PLAN</td>
<td>UPDATE PULL PLAN</td>
<td>UPDATE PULL PLAN</td>
</tr>
</tbody>
</table>

#### Score

- **+1 (On time)**
- **+0 (< 24 hours Late)**
- **-1 (> 24 hours Late)**

#### Team Average

- **Member #1**

---

**Days From Kickoff**

---

**Score**

---

14
DPR Challenge Team Tracking

**SCORING**

- Filled on time: +1
- Filled < 24 hours: 0
- Filled > 24 hours: -1

Target Team Score

- Winter Cumulative Total
- Spring Cumulative Total
Simplification of Knowledge

TOO MUCH TEXT

DPR Challenge Owners

Landscaping

<table>
<thead>
<tr>
<th>Option</th>
<th>Pros</th>
<th>Cons</th>
<th>Suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Future landscaping development</td>
<td>Stabilizing the grounds</td>
<td>Upfront cost</td>
<td>Getting funding from the city</td>
</tr>
<tr>
<td></td>
<td>Integration with park visitors</td>
<td>Maintenance cost to keep the site around</td>
<td>Propose the design for future opportunities—show how our building can be</td>
</tr>
<tr>
<td></td>
<td>Classes outside</td>
<td>the building in order to keep the site</td>
<td>connected to the site (as a guideline)</td>
</tr>
<tr>
<td></td>
<td>Extending space for users in the summer</td>
<td>Getting permission from the city-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More directly engaging with the site and</td>
<td>boundary of our development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>river</td>
<td>Need to be careful with alternating</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>natural environment of park with runoff</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>or non-native plant species</td>
<td></td>
</tr>
</tbody>
</table>

- Feasibility of using CLT with flooding and climate?
- Idea of having exposed structural elements and concrete
DPR Challenge Integration
DPR Challenge Values

Transparency

Self

Team

Owner

Self Awareness

Accountability

Performance

Trust

Decision Making

Project Updates
Site Context

- Castle
- Main Square
- Bauhaus University
- Park an der Ilm
- Ilm River

- Flooding from the Ilm River (350cm)
- Restricted site access
Weather Analysis

Temperature

- Summer peak: 23 C
- Winter peak: -4 C

Humidity

- Average humidity: 78%
- Peak humidity: 86%

Rainfall

- Annual rainfall: 560 mm
- Max rainfall: 68 mm

Snowfall

- Average snowfall: 16 cm
- Max days: 21 in January
Wind Analysis
PPP Context

- Design
- Finance
- Construction
- Operation & Maintenance

25 years
Profit
Combining Alternatives

Modern factory - Bauhaus idea
“School of building”
### Winter Presentation Alternatives

<table>
<thead>
<tr>
<th>Material</th>
<th>SCORING</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIPPLE Steel</td>
<td>26.89</td>
</tr>
<tr>
<td>RIPPLE Timber</td>
<td>26.95</td>
</tr>
<tr>
<td>LINK Steel</td>
<td>26.16</td>
</tr>
<tr>
<td>LINK Masonry</td>
<td>25.83</td>
</tr>
</tbody>
</table>
Sustainability Integration

Social

Environmental

Economic
Integration Level 1

Benefits from nature

Building

Nature
Water
Plants
Air

People

World

University
Riverbank

Nature
Park

City
Weimar
Integration Level 2

Knowledge about **sustainable design** rippling out of the building
Integration Level 3

Building as one piece of bigger development in Weimar
Integration Level 4

Worldwide impact
Sustainability Legend

1. Nature
   Park

2. University
   Riverbank

3. City
   Weimar

4. World
RIPPLE
1

Minimal immediate impact and positive long term effect
Building adapting to changing surroundings
Giving back the green taken away from the park
Knowledge rippling out of the building
Flood Risk

Today:
data from the past

Forecast

2080

- 30 cm
Flood Damage Mitigation

- Raising electrical system components
- Concrete structure in the first meter of our building
Grid Radical Proposals

Room Legend
- Auditorium
- Large Classroom
- Restroom
- Small Classroom
- Storage

A-SE-MEP
Grid Finalized Dimensions

All units in meters.
Design Process
Design Process
Design Process
Design Process
Biophilia Green Wall

Panel system

- Inorganic medium
- Drip Emitters
- Waterproof membrane

CO₂

O₂
Section

Public spaces of the building

4,3  18,7  11,3  4,3  2,5

9 m  5,5 m  2 m  0 m  -2 m

A-MEP
### Soil Profile and Water Table

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Top Depth (m)</th>
<th>Bottom Depth (m)</th>
<th>Bearing Capacity (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Mould Topsoil</em></td>
<td>0</td>
<td>0.508</td>
<td>-</td>
</tr>
<tr>
<td><em>Younger Rimstone</em></td>
<td>0.508</td>
<td>1.143</td>
<td>-</td>
</tr>
<tr>
<td><em>Keuper</em></td>
<td>1.143</td>
<td>1.524</td>
<td>-</td>
</tr>
<tr>
<td><em>Medium Shell Limestone</em></td>
<td>1.524</td>
<td>2.1336</td>
<td>239.4</td>
</tr>
<tr>
<td><em>Medium Shell Limestone</em></td>
<td>2.1336</td>
<td>-</td>
<td>383.04</td>
</tr>
</tbody>
</table>

**Water Table 1.2192 m below grade**

**Site Conditions**
Foundations Micropiles
## Loads

<table>
<thead>
<tr>
<th>Use</th>
<th>Uniform Load (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student &amp; Faculty Offices</td>
<td>3.0</td>
</tr>
<tr>
<td>Small Classrooms</td>
<td>3.0</td>
</tr>
<tr>
<td>Large Classrooms</td>
<td>4.0</td>
</tr>
<tr>
<td>Corridors</td>
<td>5.0</td>
</tr>
<tr>
<td>Stairs</td>
<td>5.0</td>
</tr>
<tr>
<td>Auditorium</td>
<td>5.0</td>
</tr>
<tr>
<td>Assembly Spaces (Atrium and Roof)</td>
<td>5.0</td>
</tr>
</tbody>
</table>

### Use

<table>
<thead>
<tr>
<th>Use</th>
<th>Uniform Load (kN/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roof</td>
<td>0.75</td>
</tr>
<tr>
<td>Green Roof</td>
<td>2.0 (saturated)</td>
</tr>
<tr>
<td>PV Roof Panels</td>
<td>0.2</td>
</tr>
<tr>
<td>Snow Load</td>
<td>0.85</td>
</tr>
<tr>
<td>Wind Load</td>
<td>0.5 (sustained)</td>
</tr>
<tr>
<td>Earthquake Load</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>0.1 (gust)</td>
</tr>
</tbody>
</table>

*Values from Eurocodes Table 6.2, EN 1991-1-3, EN 1991-1-4, and EN 1998-1*
3D Section Cuts
HVAC System

Radiant heating and cooling

Desiccant based ventilation system

Indoor temperature : 24°C
Indoor temperature : 22°C
Indoor relative humidity : 55±10%
Noise level : 45 db
Energy Saving Methodology

- Occupancy transfer
- Occupancy schedule

Equipment selection

- R-50 insulation
- Heat mirror glass

Adaptable Facade

Cantilever

A-SE-MEP-CM-LCFM
Shaft Detail

- Supply duct
- CH.W.R pipe
- CH.W.S pipe
- Cold water
- Storm water
- Cable tray
- Black water pipe
- Hot water
- Return duct
Ground Floor 3D Coordination
Ground Floor Structural

CLT 191V Wall Panels
Concrete Retaining Walls
Glulam 305x305
Compression Ring
Tension Ring
Glulam 171x305
Glulam 222x381
Glulam 222x533
First Floor 3D Coordination

A-SE-MEP
First Floor Architecture

Lab
Small classroom
Seminar Room
Makerspace
Lounge
Student niches
Storage
Restroom
First Floor Structural
8 Loop manifold

19 Loop manifold
PUT ON 6th SCREEN one rendering of key space per floor!
Second Floor 3D Coordination
Second Floor Architecture

- Faculty office
- Collaborative space
- Conference Room
- Faculty Lounge
- Industry Office
- Student Office
- Kitchenette
- Storage
- Restroom
Second Floor Structural

- CLT 191V Wall Panels
- Concrete Retaining Walls
  - Glulam 305x305
  - Compression Ring
  - Tension Ring
  - Glulam 171x305
  - Glulam 222x381
  - Glulam 222x533
Second Floor MEP

- 8 Loop manifold
- 19 Loop manifold
PUT ON 6th SCREEN one rendering of key space per floor!
Roof 3D Coordination
Roof Architecture

- Green roof
- PV
- Mechanical Room
Roof Structural
Roof MEP - Mechanical Room

- Electric Boiler
- Accumulator tank
- Chiller
- CH.W pump
- H.W pump
- Ventilation unit
**Floor Load Combo:**
1.35 DL + 1.05 LL + 0.75 W

**Roof Load Combo:**
1.35 DL + 1.05 LR + 0.75 S

**Allowable Deflection:**
15.5 mm < L/500 = 17 mm

**Max Deflection Stress Range:**
-3 to 6 MPa

Source: Eurocode 5 (IS EN 1995-1-1)
Floor Load Combo:
1.0 DL + 1.0 LL + 0.6 W

Allowable Deflection:
15.5 mm < L/500 = 17 mm

Max/Min Stress Range:
-2 to 4 MPa

Max Deflection = 11.2 mm

Source: Eurocode 5 (IS EN 1995-1-1)
Max Shear = 19.55 kN

Max Moment = 30.25 kN-m
Connections Typical Details

Ricon® S Timber Connection by Knapp
(shear up to 100 kN)

Glulam to CLT Wall

Glulam to Glulam

Source: https://www.knapp-verbinder.com/en/
Connections Enabling Details

Auditorium Ring

Angled Foundation

Angled Columns

Concrete to Timber
Connections Design Process

Brainstorming
Sketching
Sequencing
Modeling

Mentors
SE team
CMs
Revit (Glenn)
Connections 6-Member Detail

X 17

A-SE-CM
Energy Analysis

### HVAC Systems

- **Floor Heating/Cooling**: 17.8 KWH/M2/YEAR
  - Lighting: 5.2
  - Equipment: 5.2
  - Heating: 8
  - Cooling: 8

- **Cooling Panel**: 25.9 KWH/M2/YEAR
  - Lighting: 5.2
  - Equipment: 5.2
  - Heating: 8
  - Cooling: 8

- **AHU Cooling**: 21 KWH/M2/YEAR
  - Lighting: 5.2
  - Equipment: 5.2
  - Heating: 8
  - Cooling: 8

- **Water Cooled VRF**: 19.1 KWH/M2/YEAR
  - Lighting: 5.2
  - Equipment: 5.2
  - Heating: 8
  - Cooling: 8

### Key Components
- **Lighting**: Light source utilisation
- **Equipment**: Operational loads
- **Heating**: Thermal comfort
- **Cooling**: Temperature control
Energy Simulation - Parameters

Light schedule

Occupancy schedule

Chiller/boiler schedule

Chilled water temperature - 14,0°C - 19,0°C

Boiler temperature - 35,0°C - 55,0°C

Chiller operation - 10 April to 30 Oct

Boiler operation - 31 October to 09 April
Operative temperature

Undercooled hours - 36.9 Hours

Under Heated hours - 19.7 Hours
Condensation

Lowest surface temperature - 17.8 °C

3-way motorized mixing valve

Always active ventilation system

<table>
<thead>
<tr>
<th>Room temp °C</th>
<th>Relative humidity</th>
<th>Dew point temp °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>84</td>
<td>15</td>
</tr>
</tbody>
</table>
Equipment Selection

3 number, 116 kW scroll chiller

4 number, Circulation pump

1 number, 713 kW Electric hot water generator

1 number, Dry cooler
Indoor Climate - CO₂ Concentration
Indoor climate - Daylight analysis

First floor
Indoor climate - Daylight analysis

Second floor

Daylight Factor
- 8.00
- 7.00
- 6.00
- 5.00
- 4.00
- 3.00
- 2.00
- 1.00
Site Access  Material Suppliers

- CLT Supplier
- Steel Supplier
- Equipment Rent
- Partition Supplier
- Concrete Supplier
- Curtain Wall/Skylight Supplier
- HVAC Supplier
Site Access Material Delivery

Maximum permitted trailer width:
- Length 14 m
- Minimum road width: 3.5 m

- Orange circle: Offsite Warehouse
- Black circle: Site

Possible routes and preferred routes are indicated on the map.
Site Plan Area Reduction

Without Offsite Warehouse

With Offsite Warehouse

AREA 14%
Site Logistics Phase 1

- Entrance/Exit
- Site Fence
- Runoff Avoidance Fence
- Truck Wash
- Material Storage
- Temp Road

- Rebar
- Building Footprint
- ILM RIVER
- Truck Wash
- Material Storage
Equipment Selection Crane

Grove GMK5135

Mobile Crane

Crit. Loads:
1) 2.7 tons at 43.5m
2) 3.4 tons at 41m
Equipment Selection

General

- Putzmeister 38Z Truck-Mounted Concrete Pump
- Hydraulic Drilling Rigs
- 311F L RR Excavator
- RS8-42 Mark74 Telescopic Handler
Prefabrication Interior Panels

- 150 cm width: x 136 panels
- 190 cm width: x 23 panels
- 190 cm width (+door): x 23 panels
- 150 cm width (glass): x 14 panels
Prefabrication Interior Panels

A-CM
Prefabrication Exterior Panels

- 145 cm width × 88 panels
- 175 cm width × 42 panels
- 130 cm width × 48 panels
- 145 cm width × 56 panels (adaptive facade)
Prefabrication Exterior Panels

A-CM
Prefabrication Floor 1 CLT Slab

Collaboration Result:

7 Different CLT Panel Types
Prefabrication Floor 1 CLT Slab

Type 1 x 60
Type 2 x 58
Type 3 x 13
Type 4 x 27
Type 5 x 20
Type 6 x 27
Type 7 x 18
Prefabrication Floor 2 CLT Slab
Prefabrication Roof CLT Slab
**Schedule**

<table>
<thead>
<tr>
<th>Pre-Construction</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEP</td>
<td>OCT</td>
</tr>
</tbody>
</table>

- **EARLY PRECUREMENT**
- **PRECONSTRUCTION**
- **SUBSTRUCTURE**
- **SHELL**
- **INTERIORS CONST.**
- **SERVICES**
- **FURNISHING**
- **BUILDING SITEWORKS**
- **TESTING-COMMISSIONING**

**CM**

- Enclosure 2nd Feb
- Project completion 17th June
Negative Impact Reduction

Schedule

Prefab Rebar Reinforcement: - 0.5 Weeks
Prefabricate Panels Interior & Exterior: - 4.5 Weeks
Prefabricate CLT Slab: - 2 Weeks

Total Schedule Reduction: 7 Weeks
Schedule 4D Construction
Construction Cost Estimation

TVD - TARGETS BY CLUSTER

- **TARGET VALUE**
- **ESTIMATED VALUE**
- **VALUE DELTA**

**€7 Million**
New Structure
CLT → CLT + Concrete

TARGET

Decrease of Curtain Wall area
Decrease of Green wall area

RSMeans

Initial Estimate

€ 7,100,000
Schedule Expedited

Pre-Construction

Construction

SEP  OCT  NOV  DEC  JAN  FEB  MAR  APR  MAY  JUN

EARLY PRECUREMENT

PRECONSTRUCTION

SUBSTRUCTURE

SHELL

INTERIORS CONST.

SERVICES

FURNISHING

BUILDING SITEWORKS

TESTING-COMMISSIONING

Enclosure 17th December

Project completion 6th April
LIFE CYCLE COST ANALYSIS

MEP - Vikash
MEP Consumption

ARCHITECT - Sylwia
Floorplans

Construction Costs
CM - Eithan & Austin

Risk Probabilities
SE - Belle & Vivian

LCFM - Michael
Risk Management

RISK-IDENTIFICATION
What risks may occur?

RISK-EVALUATION
Probability & Severity

RISK-STRATEGIES
Avoid/Mitigate/Accept/Transfer

RISK-COSTS

A-SE-MEP-CM-LCFM

1,3 Mio. €
Life-Cycle Risk Surcharges

774K €
Life-Cycle Risk Surcharges
Life-Cycle-Cost Development

Life-Cycle-Costs

Construction
Financing Costs
O & M
Risk Surcharges
Replacement
LCC

A-SE-MEP-CM-LCFM
Life-Cycle-Cost Distribution

Total Life-Cycle-Costs: 15,6 Mio. €
TVD - STV - LCC Development

Kick-Off Target, First concept, Circular ripple, Green wall, New structure, Spring Presentation

- Target
- STV
- TVD
- LCC

MEP-CM-LCFM
Rent Reduction Strategies

- Base Rent: 856,700 €
- Cloud Server: 841,800 €
- Purification Robots: 870,700 €

Rent Development

Economic Ecologic
Purification Robots vs. Staff

- **Drainage Construction**: -5,000 €
- **Replacement**: -75,000 €
- **M&O Costs**: +1,000 € p. a.
- **Annual Rent Reduction**: 28,900 €
Rent Reduction Strategies
Income Auditorium

14,400 € Annual Rent Reduction

M&O Costs + 15,000 € p. a.
Rent Reduction Strategies

Base Rent: 870.700 €
Cloud Server: 856.700 €
Purification Robots: 841.800 €
Rental Auditorium: 827.400 €
Café: €795.800

A-LCFM
Additional Income Café

137,300 € Inflow p.a.
- 97,400 € Outflow p.a.

39,900 €
- 5,900 € 15% Corporate Tax
- 2,400 € Commercial Tax

31,600 € Profit p.a.
Adaptive Facade
Adaptive Facade
## Adaptive Facade Prefabrication

<table>
<thead>
<tr>
<th></th>
<th>Option 1 18x18 cm</th>
<th>Option 2 22x22 cm</th>
<th>Option 3 28x28 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>User Experience</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Initial Cost (€)</strong></td>
<td>76,500</td>
<td>123,250</td>
<td>199,750</td>
</tr>
<tr>
<td><strong>Energy Production (kWh)</strong></td>
<td>9,652</td>
<td>15,075</td>
<td>22,493</td>
</tr>
<tr>
<td><strong>CO2 Savings (kg)</strong></td>
<td>5,177</td>
<td>8,086</td>
<td>12,066</td>
</tr>
</tbody>
</table>
Rent Reduction Strategies

- Base Rent
- Cloud Server
- Purification Robots
- Rental Auditorium
- Café
- Photovoltaic

Rent Development:
- 870,700 €
- 856,700 €
- 841,800 €
- 827,400 €
- €795,800
- €785,000

Rent Development Graph
Roof/Facade Photovoltaic

Power consumed - 108,377
Power produced - 112,358
Roof/Facade: Photovoltaic vs. Grid Energy

- Construction: -97,200 €
- Replacement: 97,200 €
- Annual Rent Reduction: 10,800 €
- M&O Costs: +1,500 € p. a.
Collaborative Space

Survey - 150 responses

**Connection to the Outside**
- Strong connection: 60.5%
- No connection: 39.5%

**Formal vs. Less Formal**
- Formal: 66.7%
- Less formal: 39.5%

**Assigned Space vs. Free to Choose**
- Designated space: 66.7%
- No designated space: 48.5%

**Open Space Rating**

**Semi-Enclosed Space Rating**
Collaborative Space
PPP Contract Leverage

Construction - initial cost

| PUBLIC | 100% |

Maintenance and operation cost

| PUBLIC 70% | PRIVATE 30% (4,700 € p. a.) |
Site plan

A-SE-MEP-CM-LCFM
Landscape
Ripple Makerspace

Floor 2

Floor 1

Groundfloor

A-SE-MEP-CM-LCFM
Rent Reduction Strategies

- Base Rent: €870.700
- Cloud Server: €856.700
- Purification Robots: €841.800
- Rental Auditorium: €827.400
- Café: €795.800
- Photovoltaic Makerspace: €774.000

A-SE-CM-MEP-LCFM
Owners Final Rent

870,700 € p.a.

- 12,5%

774,000 € p.a.
Sustainability Integration Summary

**Level 1**
Park & Nature
- Adaptive Facade
- Construction Site & Schedule Reduction

**Level 2**
Riverbank University
- Collaboration Space
- Student Designed Cafe

**Level 3**
Weimar City
- Makerspace
- Micropile Foundations

**Level 4**
World
- PPP Contract Leverage
- Saving Global Resources with Cleaning Robots
Thank You...Dziekuje...Grazie...Vielen Dank...
谢谢...धन्यवाद...

Teaching Staff
Renate Fruchter
Flavia Grey
Glenn Katz

Owners
Ewa Kunkel
Andrej Kurent
Luke Lombardi
Hussain Parsianfar

Mentors
David Bendet
Willem Kymmel
Anja Jutraz
Humberto Cavallin
Adhamina Rodriguez
Henry Tooryani
Charles Quaglia
Norayr Badasyan
John Nelson
Tyler Zastrow

Mentors
DPR Team
Greg Luth
Eric Borchers
Eduardo Miranda
Jason Hsai
Nick Areson
Justin Schwaiger
Erik Kneer
Afaan Naqvi
Briana White

Special thanks to the PBL community & all the 25th Anniversary AEC teams
Chill + Doors = Success

Do NOT touch the gridlines!

According to Greg Luth...

Guys I need the risk probabilities !!!

Everything can be solved with Excel...

I am just a simple man who runs ducts.

greenwalls Greenwalls GREENWALLS
“Even with the literal blood, sweat, and tears...I wouldn’t change a thing!”  - Belle

“Cross disciplinary collaboration is the key to success in any team”  - Eithan

“There is no such thing as small changes”  - Sylwia

“Anything is possible with some BS...BrainStorming”  - Renate

“Teams that build the best buildings are the best built teams”  - Austin

“Never do duplicate work”  - Vivian

“Yeah, that’s possible with some brainmerge”  - Vikash

“The higher the pressure the better the efficiency”  - Michael