Team Map

USA
- Aleshia – SE
  Stanford University
- Ying – SE
  Stanford University
- Elisa – CM
  University of Wisconsin-Madison

UNITED KINGDOM
- Sam – CM
  Loughborough University

DENMARK
- Ewa – MEP
  Danish Technical University

GERMANY
- Frank – LCFM
  Bauhaus University Weimar

SLOVENIA
- Rok – Arch
  University of Ljubljana
Team

A
Rok
University of Ljubljana
Slovenia

SE
Ying
Stanford University
USA

CM
Samer
Loughborough University
UK

SE
Aleshia
Stanford University
USA

CM
Elisa
University of Wisconsin-Madison
USA

MEP
Ewa
Danish Technical University
Denmark

LCFM
Frank
Bauhaus University Weimar
Germany
Owners

Anja Jutraž
Architect
University of Ljubljana
Slovenia

Norayr Badasyan
Research Associate
Bauhaus University Weimar
Germany

Michael Seaman
Project Engineer
Walt Disney Imagineering
USA

Nick Zeman
Project Engineer
The Boldt Company
USA
Owner Map

USA

- Nick Zeman - Project Engineer
  The Boldt Company
- Michael Seaman - Project Engineer
  Walt Disney Imagineering

GERMANY

Norayr Badasyan - LCFM
Bauhaus University Weimar

SLOVENIA

Anja Jutraž – Architect
University of Ljubljana
Ljubljana

Capital city of Slovenia
300,000 inhabitants
50,000 students
Green capital of Europe 2016
People-friendly city
Walking distances
Site Analysis

Aerial View on the Parcel

Main Vehicle Access

Pedestrian Pathway

People Circulation

North (N)
Site Plan Overview

Site Dimensions
95m x 95m

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

Spring 2017
Team Express
Site Logistics
16
Building Placement

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

Footprint Positioning on Site
Temperature

A Climate Graph for Ljubljana, Slovenia

Copyright © 2015, www.travelslovenia.org
Precipitation

Precipitation, Snowfall and Snow Cover for Ljubljana, Slovenia

Copyright © 2015, www.travelslovenia.org

Average Monthly Snowfall (in cm)
Average Monthly Number Of Days With Snow Cover
Average Monthly Number Of Days With Precipitation (1 mm or more)
Average Monthly Number Of Days With Precipitation (10 mm or more)
Sun Path and Shadows

1974 h of Sunshine  No shadows  PV Potential

Sunrise  Noon  Sunset
High Water Table

Challenge
High water level: -1.5 m
Flood Zone

Risk Mitigation
Raise critical program above ground

- Moderate Flood Risk
- Low Flood Risk
- Not in Flood Zone
Earthquakes

Challenge
Seismic zone

Risk Mitigation
Design strong, but ductile lateral system
Ecosphere

c·o·sphere

/ˈɛkəˌsfər/
noun

The biosphere of the earth, or another planet, especially when the interaction between the living and non-living components is emphasized.
NDUSTRY
Industry

in·dus·try /ˈɪndəstri/ noun

Systematic labor, especially for some useful purpose or the creation of something of value
“Rethink space and let the transformation begin!”
Adhamina C. Rodriguez, Sustainability Challenge 2017

Common Definition:
The smallest possible amount of space needed for the building program to function.

Space efficiency = Program area / Gross floor area
Team Definition:
Team Express defines a space efficient building as one which offers the flexibility to adapt to and interact with changing user requirements in a digital society on a day-to-day, as well as long-term, basis.
### Decision Matrix

#### CATEGORY | CRITERIA
--- | ---
GENERAL | Robustness of BIG Idea
ECONOMIC | Life-Cycle-Cost
ECONOMIC | Construction Cost
ECONOMIC | Annual rent
ECONOMIC | Level of EQ Risk Impact
ECONOMIC | Level of Flood Risk Impact
ECONOMIC | Space efficiency
ECONOMIC | Prefabrication
ECOLOGIC | User comfort
ECOLOGIC | Water consumption
ECOLOGIC | Energy demand
ECOLOGIC | Energy production
ECOLOGIC | Carbon Footprint
ECOLOGIC | Source of material
ECOLOGIC | Design2disassembly
SOCIAL | Architectural Integration
SOCIAL | Daylight
SOCIAL | Appeal
SOCIAL | Space & Circulation
SOCIAL | Stress Reduction

**INDIVIDUAL WEIGHTED SCORE**

<table>
<thead>
<tr>
<th></th>
<th>ECONDUSTRY</th>
<th>ECONDUSTRY</th>
<th>DAY 'N NIGHT</th>
<th>DAY 'N NIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STEEL</td>
<td>CONCRETE</td>
<td>CONCRETE</td>
<td>TIMBER</td>
</tr>
<tr>
<td>21.6</td>
<td>21.7</td>
<td>20.9</td>
<td>21.2</td>
<td></td>
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*Spring 2017*  |  *Team Express*  |  *Decision Matrix*  |  *38*
## Options Comparison

<table>
<thead>
<tr>
<th></th>
<th><strong>Econdustry 1</strong></th>
<th><strong>Econdustry 2</strong></th>
<th><strong>Day n’ Night 1</strong></th>
<th><strong>Day n’ Night 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure</strong></td>
<td>Steel &amp; concrete</td>
<td>Concrete</td>
<td>Concrete</td>
<td>Timber</td>
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<tr>
<td><strong>MEP System</strong></td>
<td>Air-Air Heat Pump</td>
<td>Water-Air Heat Pump</td>
<td>Mechanical Ventilation</td>
<td>Natural Ventilation</td>
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<tr>
<td><strong>Energy Demand</strong></td>
<td>[kWh/m(^2)]</td>
<td>39</td>
<td>39</td>
<td>40</td>
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<tr>
<td><strong>Heating Load</strong></td>
<td>[kWh/m(^2)]</td>
<td>4.66</td>
<td>4.80</td>
<td>4.95</td>
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<tr>
<td><strong>Cooling Load</strong></td>
<td>[kWh/m(^2)]</td>
<td>6.64</td>
<td>5.52</td>
<td>4.87</td>
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<td><strong>STV</strong></td>
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<tr>
<td>(\text{CO}_2) [%]</td>
<td>96</td>
<td>91</td>
<td>68</td>
<td>65</td>
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<tr>
<td>Energy [%]</td>
<td>63</td>
<td>60</td>
<td>48</td>
<td>47</td>
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<tr>
<td><strong>Energy</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PV Facade [m(^2)]</td>
<td></td>
<td>1103</td>
<td></td>
<td>756</td>
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<tr>
<td>PV Roof [m(^2)]</td>
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<td>1498</td>
<td></td>
<td>1281</td>
</tr>
<tr>
<td>Water Collection [m(^3)/y]</td>
<td></td>
<td>2087</td>
<td></td>
<td>1784</td>
</tr>
</tbody>
</table>
“...the selection of one of these designs does not lock you in to use all aspects of that option, most of the time the best design is a compromise of all four.”

Nick Zeman, Owner Team Express

“While you will be choosing one of these four options to proceed with the next quarter, you still have a whole quarter of development to go, which is a great opportunity to bring in your favorite and the most innovative aspects of each of these four options into your final design.”

Michael Seaman, Owner Team Express
The Fusion

“ECOINDUSTRY”
- Flexibility
- Program distribution
- MEP System

“DAY ’N NIGHT”
- Exterior shading
- Additional Skylights
- Natural Ventilation

THE FINAL PROJECT

Spring 2017 | Team Express | Decision Matrix | 41
Day N’ Night
Max Height

max height

level 0

9.1m (30ft)
Max Height

3 stories above level 0:
Floor height (together with floor slab): 3.0m
Max Height

2 stories above level 0:
Floor height (together with floor slab): 4.5m

level 0

level 1

basement

4.5m (15ft)

4.5m (15ft)

3.0m (10ft)
Clear **PUBLIC/PRIVATE** division

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Student offices</th>
<th>Labs</th>
<th>Faculty offices</th>
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<tbody>
<tr>
<td>PRIVATE</td>
<td>- seminar</td>
<td>- lounge</td>
<td>- seminar</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 0</th>
<th>Lobby Café Lounge</th>
<th>S classroom</th>
<th>L classroom</th>
<th>Auditorium</th>
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<tbody>
<tr>
<td>PUBLIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>basement</td>
<td>Student lounge</td>
<td>Virtual reality studio</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Footprint

level 0
Footprint

level 0
level 1

Spring 2017 | Team Express | Restrictions | 50
Footprint

level 1

Student
- offices
- seminar

Labs

Faculty
- offices
- seminar
- lounge
Footprint

level 1

Student - offices - seminar

Labs

Faculty - offices - seminar - lounge

16m (52ft)
Structural
Cantilever Evolution

Winter Design

1.

2.

3.

4.
Winter Quarter Design: Hindered circulation through open spaces

Final Design: Free circulation paths, columns hidden in walls
**Slanted Column Connection**

- Straight column shop-welded to section of slanted column with a stiffener in the bend
- Plates shop-welded to ends of two sections of the slanted column
- Plates bolted together on-site

**Section A-A**

10 ¾” A325 Bolts
3” spacing typ.
0.5” plates
**Interior Shear Wall Connection**

- **DYWIDAG Post-Tensioning System** enables connection
- **Shop-Welded Plates** enhance constructability
- **L-Shaped Plates** prevent spalling
Post-Tensioned Roof Slab

Post-tensioned roof slab composite with top of trusses

Post-tensioning creates upward force on side trusses, reduces dead load deflections by 80%

- 8” lightweight concrete slab on metal decking
- 0.6” unbonded low-relaxation strands at 6” spacing
Temporary Columns

- Columns placed under corners of trusses during construction.

- After roof slab cures and post-tensioning is released, the columns will be removed.
Truss Fabrication

- Truss Prefabrication
- Weld and Grind
- Intumescent Paint
• End trusses will sit on abutment from shear wall.
• Shear studs on the top chord of the truss composite with the roof slab will support the top of the truss.
Conflict Resolution

Conflict:
- Architect wanted to remove the triangular shear walls.
- Structural engineers were supporting a lot of the building on them.

The architect wrote a message in the structural channel.

Structural replied with their objections

The architect and structural engineers had a subgroup meeting.

Span was utilized to sketch possible options and load paths.

We discussed the options with owners and left the meeting with a final decision.
Napping spaces were designed in the basement.

“Our favorite study break activity is taking a nap.”

“We would like to have more spaces that could be transformed for professor and student uses.”

“A café was added to the ground floor.”

“A virtual reality room with innovative collaboration technology was assigned to the basement.”

“Connections with other faculties and companies are missing from the current faculties.”

“Between classes, we like to have a drink or grab a snack with friends.”

The layout of the first floor is extremely flexible and can be transformed for any use.
Flexibility

Semi-flexible rooms
Open-flexible space
Suspended Ceiling

Closed ceiling above cellular offices
Closed ceiling above open space

Grid: 80 x 80 cm
First Floor 3D Section
Moving Walls
Student Space
Final Presentation

Two presentation areas with 49 seats, bar tables and lounge area in-between the presentation areas.
14 tables dedicated for companies/groups and 3 lounge areas
13 tables dedicated for group work (4 of them enclosed) with moving smart boards

Faculty area stays unchanged
Exhibition area created with horizontal (tables) and vertical (moving walls) display surfaces.
Retrofitting Space Allocation

Completely cleared space in case of a change of the program

Example: school of engineering > school of arts
System Description

- Ground Source Heat Pump
  - Economizer

- Raised Floor
  - Under-floor Heating
  - Swirl Diffusers with Thermostats

- Plenum Supply

- Plenum Return
Floor Sandwich

Underfloor air distribution

- return duct
- swirl diffuser
- supply duct
Area Distribution

- Faculty Office
- Department Chair's Office
- Administrative Assistant
- Faculty Lounge
- Student Office
- Auditorium
- Large Classroom
- Small Classroom
- Seminar Room
- Instructional Lab
- Server Room
- Technical Support
- Storage
- Lobby/Reception
- Student Lounge
- Kitchen
- Changing Room
- Showers
- Collaboration Space
- Virtual Reality Studio
- Cafe

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Currently</th>
</tr>
</thead>
</table>

Space Efficiency
Ratio

GROSS FLOOR AREA

ASSIGNABLE 70%
NON ASSIGNABLE 22%
STRUCTURAL 8%

USABLE AREA DISTRIBUTION

ASSIGNABLE AREA 76%
MECHANICAL 17%
RESTROOMS 5%
CIRCULATION 2%

Space Efficiency
Interactive Wall

9:38
12/05
19°C

Energy Use
10% of capacity

Today's Events:
1:30-3:00 PM
Rm 102
Interactive Wall
Use this QR Code to test out a prototype of our integrated building app!
Items You Will Need:

- Door panel: 2x
- Opaque panel: 4x
- Transparent panel: 16x
First Floor 360°
Retractable Wall
Final Presentation

Two big auditoriums with bar tables in front and under the cantilevers.
Four large classrooms with reception desks in front and bar tables under the cantilevers
Auditorium 360°
Ground Floor
Collaboration

LCFM thinking
• Integration of walkway to achieve access and maintenance opportunities

Winter design feedback
• Risk of Overheating of 1st floor
• Maintenance is critical

MEP thinking
• Overhang above the façade
• External shading
Facade Section

- Double Façade
- Vegetation
- 2nd Skin Metal Mesh
- 1st Skin Blinds
- Suspended Ceiling
- Raised Floor
- Office
Ventilation

- Hybrid System

- Mechanical – when natural is not sufficient
- Natural - when external conditions are fine

- Controls by windows
- Red light:
  - bad outside conditions

- Green light:
  - good outside conditions
Daylighting

Percentage of occupied hours where illuminance is at least 300 lux, measured at 0.85 meters above the floor plate.

- 0%
- 25%
- 50%
- 75%
- 100%
Double Green Facade
External Shading
Metal Mesh

Metal mesh
75% Transparency

East/West Facade
- Thicker Vertical Members

South Facade
- Thicker Horizontal Members
Basement

Grid Span 4m

Retaining Wall (10"")
Shear Wall (10"")
Column W14X99

Spring 2017  |  Team Express  |  Structural Floor Plan  |  109
Basement
Ground Floor

32 m

48 m

Beam W16X89

Column W14X99

Shear Wall (10")

Grid Span 4m
First Floor

32 m

48 m

Grid Span 4m

Truss
Chord W12x96
Web W12x65
Shear Wall (10”)
Girder W24X117
Beam W24X76
Slanted Column W14X90
First Floor
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 = 0.106W

**Water Table:**
- 5 feet of hydrostatic head
Gravity Load Path
Lateral Load Path

Compression

Tension
ETABS Model

ETABS Outputs
Slab Deflections

Check 1: Live Load Only (Limit: L/360)
First Floor = 0.49 < 1.75 in

Roof = 1.18 in < 1.75 in
Check 2: Dead Load + Live Load (Limit: L/240)
First Floor = 1.35 < 2.625 in

Roof = 2.55 in < 2.625 in
Mode Shapes

First Mode

Second Mode

Third Mode
Earthquake parameters:
$S_{DS} = 0.86g$
$S_{D1} = 0.35g$
Site Class D
$C_d = 5$
$I_e = 1$
$T_n = 0.113\text{ s}$
Zero Building Strategies

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

### Building Envelope

<table>
<thead>
<tr>
<th>HEAT TRANSFER COEFFICIENT</th>
<th></th>
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<tbody>
<tr>
<td>External Wall [W/m²K]</td>
<td>0.1</td>
</tr>
<tr>
<td>Slab on Grade [W/m²K]</td>
<td>0.4</td>
</tr>
<tr>
<td>Roof [W/m²K]</td>
<td>0.1</td>
</tr>
<tr>
<td>Glazing [W/m²K]</td>
<td>0.8</td>
</tr>
</tbody>
</table>

### Other Requirements

<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>Daylight factor [%]</td>
<td>2</td>
</tr>
<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

2020
Building Energy Demand

9 kW/m²/y
Water Efficiency

Rain Water

Water Collection 2000 m$^3$/y
450,000 gallon

Tanks are capable of storing monthly rainfall

Grey water

Small Tank
Landscape Watering
STV Evolution

- FISHBOWL

WINTER

FINAL
STV Evolution

- **WINTER**
  - Carbon: 90%
  - Energy: 60%
  - Water: 28%

- **FISHBOWL**
  - Carbon: 70%
  - Energy: 40%
  - Water: 30%

- **FINAL**
  - Carbon: 80%
  - Energy: 60%
  - Water: 20%
**Pile Design**

- **Updated Design:**
  - 20 Rein. Concrete Piles
    - 400 mm diameter
    - 15 m long (red)
  - 14 Rein. Concrete Piles
    - 250 mm diameter
    - 15 m long (blue)
Waterproofing

- TUFF-N-DRI XTS (A)
- WARM-N-DRI Foundation Board (B)
- Stripdrain (C)

- Sump pumps in elevator pits and under-seating storage
Sequencing Video
Superstructure Schedule

<table>
<thead>
<tr>
<th></th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Floor Slab (Conc. On metal deck)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superstructure</td>
<td></td>
<td></td>
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<tr>
<td>Core Walls (3 lifts)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Laydown Precast Auditorium seats in Basement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Floor Columns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Trusses Installation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slanted Columns Installation</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>First Floor Girders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Girders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Trusses Installation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Floor Beams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Floor Slab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Beams</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Slab</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove Temporary C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lift precast tiered flooring into place
-Auditorium
-Large Classroom
Weld truss systems on ground
Use cranes to lift into place
4D CAD Troubleshooting

- Precast Auditorium Seating – Possible clash with Large Trusses
- Just in time Delivery to Site
Steel Beams – Necessary Propping before casting Ground Floor Slab
I was going through the simulation of the structure and I just wanted to ask about this step... when it's time to erect the steel beams in the basement they are supported on the retaining walls from one side but left unattached on the edge of the slab (opening for auditorium)... question is how will they hold up in this cantilever position? or we will need temporary support during construction?

They're not that long they can hold. Plus the prefab concrete seats will be there as well so we could probably connect to them.
Clash Detection

- Identify Clashes – Navisworks
- Use Redline Tools – Clarity
- Communicate clashes to design disciplines using clash reports

✓ Major Clashes Resolved
✓ Majority of remaining clashes deemed acceptable
Final Project Cost: € 8.75M
- € 920,000 Under Budget

TVD Evolution

Final Project Cost: € 8.75M
- € 920,000 Under Budget
Cost Breakdown

- **Shell**
  - €2,500,000
  - 29%

- **Interiors**
  - €940,000
  - 11%

- **Services**
  - €3,500,000
  - 40%

- **General Conditions**
  - €700,000
  - 8%

- **Substructure**
  - €400,000
  - 5%

- **Equipment and Furnishing**
  - €150,000
  - 2%

- **Specialty Construction**
  - €130,000
  - 1%

- **Building Sitework**
  - €370,000
  - 4%
Slovenian CM Collaboration

Create Takeoff

Obtain Slovenian Pricing

Enter into Values & Quantities into TVD
# Auto-Updating Takeoff

<table>
<thead>
<tr>
<th>A</th>
<th>Stage A-B</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>About this column...</td>
<td>About this stage...</td>
<td>About this column...</td>
</tr>
</tbody>
</table>

- **Structural Bracing System**

**Excel - Quantity Takeoff**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>W-Wide Flange</td>
<td>W24X76</td>
<td>02 Roof</td>
<td>Beam</td>
</tr>
<tr>
<td>2</td>
<td>W-Wide Flange</td>
<td>W24X76</td>
<td>02 Roof</td>
<td>Beam</td>
</tr>
<tr>
<td>3</td>
<td>W-Wide Flange</td>
<td>W24X76</td>
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<td>Beam</td>
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<tr>
<td>4</td>
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<tr>
<td>8</td>
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<td>02 Roof</td>
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</table>

**Revit - 3D Model**

**Flux.io**
Life-Cycle Concept

- EFFICIENT DESIGN
  - Create an efficient building related to space, cost, risk and future operations.

- ADDITIONAL PROGRAM
  - Integrate Opportunities for additional income.

- OPTIMIZING O&M
  - Reduce O&M Cost by integration of innovative Technologies and sustainable MEP-Systems.

- FINANCIAL STRUCTURE
  - Optimizing the financial structure to reduce interest payments.
PV Panels

“ECO | NDUSTRY”

"Forgotten area Roof – Let’s make it an efficient space.”

- Energy production PV-panels: 189,000 kw/h p.a.
- Energy consumption by facility: 86,000 kw/h p.a.
- Overproduction/Feed into grid: 103,000 kw/h p.a.
- Net Operating Income: 697,000€
- Return on Investment: after 8 years
- Reduces Energy consumption from grid by around 50%
- 20 years of performance guarantee
- Reduced Rent: - 25,000€ p.a.
Pavegen Floor Tiles

"ECO | INDUSTRY"

„Usage of natural movement to create energy.“

- Massive price drop
- Efficiency increase in the last 5 years
- Energy production 18,000 kW/h/y
- Reduced grid energy by 15%
- Return on investment after 5 years
- Replacement after 10 years

"ECO | INDUSTRY"
Robotic Cleaning

“ECO | INDUSTRY”

“Being more ecologic by using innovative technologies from the industry.”

- Robots can be programmed to clean the assigned areas like the open spaces and circulation areas.
- Fully automatic battery charging, fresh water supply, and drainage of the dirty water through a service station.
- Robot uses 85% less water than traditional cleaning practices, because of higher efficiency and a water recycling system.
- LCC impacts:
  - Operation: -15,000 € p.a.
  - Maintenance: +2,000 € p.a.
  - Replacement: +75,000 € in 25 years
  - Rent: -8,000 € p.a.

- References:
  - https://www.intellibotrobotics.com
  - http://www.adlatus.eu

- Cleans up to 5000m² per shift expanded operation time
Outsourcing

- Go Hybrid!
  - Local & Cloud Computing
  - To get the most out of both IT-systems!

Benefits:
- Flexibility to changing requirements
- Availability from all around the Globe
- Security/ownership for sensible Data
- Reduces IT-Operation-Cost through Lifecycle by around 50%
- Increases Space efficiency by 2%
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>POINTS</th>
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<td>Location and Transportation</td>
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<td><strong>TOTAL</strong></td>
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Risk Identification

Planning | Construction

- Flooding
- Earthquake
- Vandalism
- Fire
- Soil
- Miscalculation
- Supplier/Contractor
- Estimation
- Collaborational
- Accidental

Operation

- Earthquake
- Flooding
- Fire
- Operation
- Functional change
- Income
- Interest
- Management
- Service
- Technological Change
- Maintenance
- Vandalism
- Inflation
ABC-RISK-ANALYSES PREVENTION

- Planning
- Flooding
- Earthquake
- Vandalism
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- Soil
- Miscalculation
- Supplier/Contractor
- Estimation
- Collaborational
- Accidental

Probability vs. Consequences
Operation

ABC-RISK-ANALYSES PREVENTION

- Earthquake
- Flooding
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- Functional change
- Income
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- Vandalism
- Inflation
Risk Cost Evolution

**TOTAL RISK COST**

- Standard Risk Cost
- Riskmanagement

**RISK COST p.a.**

- Planning & Construction
- Operation Period

-71%

-64%

-72%
Operation & Maintenance
4.9 Mio €

Replacement
1.1 Mio €

Total
6.0 Million €
Financial Structure

DEBT SERVICE COVER RATIO

- ECONDUSTRY DSCR
- REQUIRED DSCR

LOAN LIFE COVER RATIO

- ECONDUSTRY LLCR
- REQUIRED LLCR

LOAN - OVERVIEW

- SENIOR LOAN
- JUNIOR LOAN
- ADDITIONAL LOAN
Cost Evolution

Cost Evolution

CONSTRUCTION | O+M | REPLACEMENT | RISK | INTEREST | LCC 25Y. | BASIC RENT

- €

CONSTRUCTION | LCC | RENT

WINTER | MEP SYSTEM | FISHBOWL | PV-ROOF | ROBOTIC | FINAL - FIN. ENG.
Cash Flow

EXPENDITURES P.A.  INCOME P.A.

- Expenditure Positions
  - Construction
  - Operation & Maintenance
  - Replacement
  - Risk
  - Interest Cost

- Income Positions
  - Rent
  - Café
  - VR-Studio
  - PV-Roof

- Break even after Year 18

Summary
User Perspective - Occupant Well-Being

- Daylighting
- Water Reuse
- Fitness Availability
- Air Quality
- Floor Height
- Lightness
- Vegetation
- Resting Areas
- Carbon Emissions
- Nutritional Options
- Collaboration Technology
- Computer Availability
- Internet Connectivity
- Virtual Reality
- Building Interaction
- Hallway widths
- Availability of elevators
- Handicap access
- Open vs. Private Space
- Emergency Egress
- Earthquake Risk
- Flood Risk
- Fire Risk
- Construction Safety Risks

Winter Scoring - 74
Value for Money

User Perspective - Occupant Well-Being

- Construction Safety Risks
- Fire Risk
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- Emergency Egress
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- Availability of elevators
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Fishbowl Scoring - 88
Winter Scoring - 74
Value for Money

User Perspective - Occupant Well-Being

- Final Scoring - 101
- Fishbowl Scoring - 88
- Winter Scoring - 74
Value for Money

Private-Public-Partnership

- Winter:
  - 268 € LCC p.a./ m2 GFA

- Fishbowl:
  - 264 € LCC p.a./ m2 GFA

- Final:
  - 242 € LCC p.a./ m2 GFA
Value for Money

Value for Money Evolution

- Winter: 102% OCCUPANT POV - DPR, 98% PPP POV, 90% LCC/m2
- Fishbowl: 121% OCCUPANT POV - DPR, 98% PPP POV, 90% LCC/m2
- Final: 138% OCCUPANT POV - DPR, 111% PPP POV, 90% LCC/m2
Value for Money

Revit Model
Flux.io
Room Schedule
Material Takeoff

TVD
STV
LCC
DPR Challenge
Lessons

“Less is more.”

Rok - Arch

“Collaborate with other disciplines and other cultures.”

Ying - SE

“It’s easier to discuss in person than in cyber.”

Ewa - MEP

"Always have a back-up plan for when someone has a bad connection."

Aleshia - SE
Learned

"Pay attention during the meetings."

Samer - CM

"Don't get caught up in the little details."

Elisa - CM

"Stop thinking in silos, interdisciplinary collaboration creates powerful solutions to reach the shared target!.

Frank - LCFM
Thank You

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