Island team

Simge
- Stanford University
- Construction Manager
- from Turkey

Tianlong
- Stanford University
- Structural Engineer
- from China

Ronja
- Aalborg University
- Architect
- from Denmark

Jacob
- Technical University of Denmark
- Construction manager
- from Denmark

Sebastian
- Bauhaus University
- Structural Engineer
- from Colombia

Nicolas
- ETH Zurich
- MEP Engineer
- from Switzerland
Island owners

Renate
Paola
Hussain
Mikki
Jure
Location location location

Vibrant culture  Social people  Tropic  Disasters

Wild nature  Post-Disaster
Natural hazards

Earthquake

Risk Category: III
Site Class: D

Wind (Hurricane)

Design Wind Speed: 175 mph
Hurricane Maria: Category 5
Climate of Puerto Rico

Windrose and sun angle

Temperature and sun hours
Climate of Puerto Rico

Monthly rainfall

<table>
<thead>
<tr>
<th></th>
<th>Avg Rainfall [mm]</th>
<th>Future Rainfall [mm]</th>
<th>Average Relative Humidity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>60</td>
<td></td>
<td></td>
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<tr>
<td>Mar</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun</td>
<td>120</td>
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<tr>
<td>Jul</td>
<td>140</td>
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<tr>
<td>Aug</td>
<td>180</td>
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<td>Sep</td>
<td>160</td>
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<tr>
<td>Oct</td>
<td>140</td>
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<tr>
<td>Nov</td>
<td>120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>100</td>
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</tbody>
</table>

Precipitation Events

Puerto Rico and the U.S. Virgin Islands

<table>
<thead>
<tr>
<th></th>
<th>Number of Events with Precipitation Greater Than 3 inches</th>
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</thead>
<tbody>
<tr>
<td>1950-54</td>
<td></td>
</tr>
<tr>
<td>1960-64</td>
<td></td>
</tr>
<tr>
<td>1970-74</td>
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<td>1980-84</td>
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<td>1990-94</td>
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<td>2000-04</td>
<td></td>
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<tr>
<td>2010-14</td>
<td></td>
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</table>

5-Year Period
Goals

Modern Educational Building

Building for Puerto Ricans

Resilient
Local Typologies
Design alternatives winter

Rainbow

Movement
“We like the movement better”
Evolution of BIG idea

Rainbow

Movement
Embrace ... Community
Nature/Climate
Bamboo
Technology
Site context

Av. Universidad, San Juan, Puerto Rico

OUR SITE

LIBRARY

THEATER

STUDENT ACTIVITY CENTER

SCHOOL OF ARCHITECTURE

COLLEGE OF EDUCATION
Site context

Av. Universidad, San Juan, Puerto Rico
Design evolution

Placing footprint

Extruding footprint excavating to the North

Creating space between the functional rooms adding circulation

Filling the space with light

Self sustaining - living machine and PV panels

Hurricane and Earthquake protection
Organization of space

STAFF
CLASSROOMS
PUBLIC
LABS

ATRIUM
COLLABORATION
LIVING MACHINE

STAFF
CLASSROOMS
PUBLIC
MAKERSPACE
Flexible study spaces

Larger classrooms

Ground Floor
Heart of the building
Room organization

Basement
- Storage
- Firestair and elevator
- Showers
- Toilets
- Mechanical shaft
- Mechanical room
- Instructional lab
- Wood workshop
- Lab manager
- 3D print

First floor
- Auditorium
- Small classroom
- Seminar room
- Study areas
- Study booth
- Kitchen

Second floor
- Faculty office
- Chairs office
- Senior administration office
- Student office
- Faculty lounge
- Print and administrative assistance
Flexible study spaces

Smaller classrooms

First Floor
Main circulation
Means of egress
View through atrium

Ground Floor
Study Spaces around atrium

View towards road

Semi private booths

First Floor

First Floor
Material Procurement
Recycled concrete aggregate (RCA)

Pros:
- Absorb surrounding CO2
- Reduce virgin aggregates

Application:
- Floor slab: $f'_c = 4$ksi, 80% RCA replacement
- Beam/Column: $f'_c = 6$ksi, 15% RCA replacement

Kwan et al., 2001
Why bamboo

WOOD

GLOBAL WARMING

EROSION

HARVEST ONCE EVERY TEN YEARS

IRREGULAR EMPLOYMENT

IRREGULAR INCOME

BAMBOO

ANNUAL CROP

LABOR INTENSIVE

REGULAR INCOME

0 5 10 15 20 25 YEARS

0 5 10 15 20 25

Environmental Bamboo Foundation, 2003
Bamboo as structural material

Bamboo Tower - Parque del Cafe, Colombia

Height= 59 feet
High seismicity area!

<table>
<thead>
<tr>
<th>Item (kN/cm²)</th>
<th>Spruce</th>
<th>Bamboo</th>
<th>Steel (St37)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Modulus</td>
<td>1100</td>
<td>2000</td>
<td>21000</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>4.3</td>
<td>6.2-9.3</td>
<td>14</td>
</tr>
<tr>
<td>Tension strength</td>
<td>8.9</td>
<td>14.8-38.4</td>
<td>16</td>
</tr>
<tr>
<td>Bending strength</td>
<td>6.8</td>
<td>7.6-27.6</td>
<td>14</td>
</tr>
<tr>
<td>Shearing strength</td>
<td>0.7</td>
<td>2</td>
<td>9.2</td>
</tr>
</tbody>
</table>

*Deutsche Bauzeitung 9/97

Life cycle:
- Non-treated and exposed bamboo: more than 2 years.
- Treated bamboo: more than 90 years (testified in Japanese Buildings)
Structural system overview

- PV panel parapet
- Bamboo roof truss
- Column
- PT beam
- Base isolator
- Shear wall
- Retaining wall
Structural framing - Basement

<table>
<thead>
<tr>
<th>Element</th>
<th>$f'_c$ (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column 16x16&quot;</td>
<td>6</td>
</tr>
<tr>
<td>Isolator 25.5&quot; (underneath)</td>
<td>6</td>
</tr>
<tr>
<td>Wall 6&quot;</td>
<td>6</td>
</tr>
<tr>
<td>Foundation Beam 16x16&quot;</td>
<td>4</td>
</tr>
<tr>
<td>Isolated footing 106x106x22&quot;</td>
<td>4</td>
</tr>
<tr>
<td>Isolated footing 115x115x24&quot;</td>
<td>4</td>
</tr>
<tr>
<td>Wall foundation 40x24&quot;</td>
<td>4</td>
</tr>
</tbody>
</table>
Structure plans

Ground floor
- Column 16x16”
- Wall 6”
- PT Beam 16x18”
- PT Beam 10x15”

First floor
- Column 16x16”
- Wall 6”
- PT Beam 16x18”
- PT Beam 10x15”

Second floor
- Column 16x16”
- Wall 6”
- PT Beam 16x18”
- PT Beam 10x15”

Floor system: PT Slab 8”
HVAC systems

... and comfort definition

Primary Systems

Cooling
Ground source heat pump + local cogeneration

Water heating
Thermal collectors

Electricity
PV systems

Secondary Systems

Offices and classrooms
Visible ducts and ceiling fans
Decentral AHU

Auditorium
Plenum displacement ventilation
Central AHU

Open spaces
Ceiling fans only

Human Comfort

Operative temperature 28 °C
Air speed 0.8 m/s
Relative humidity 75%

Comfort calculation by CBE Thermal Comfort Tool, for metabolic rate of 1 met and clothing level of 0.5 clo

HVAC concept inspired by TRANSOLAR “NUS SDE4” and FutureCitiesLab research “3for2 beyond efficiency”
Climate zones

- **Basement**
  - Climatized: 17’000 sf
  - Natural Vent.: 16’000 sf

- **Ground floor**
  - Mech. Room: 2 x 370 sf

- **First floor**
  - Vertical Shaft: 2 x 84 sf

- **Second floor**
Basement and ground floor
First and second floor

Supply air
Return air
AHU's
Fans
Shaft
Natural ventilation
ATRIUM
BASEMENT
AUDITORIUM
SECOND FLOOR
PLANNING
HAZARDS
INFORMATION
Makerspace

Workshop

3D

Basement

Hand-free door handle

Hospital face mask

3D print workshop

Wood workshop
For more details regarding living machine concept, please refer to appendix slides.
Net positive water

Numbers in thousand litres
Metrics generated via STV tool and monthly rain data for San Juan

Rain collection: 1’200
Recycled waste water: 8’400
Total living machine recycling: 9’600
Public water grid: 2’700
Landscape + Other buildings: 3’400
Toilets: 5’700
Efficiency losses: 500
Taps + Showers: 2’700
Living machine

Basement

Bird of Paradise

Colocasia Esculenta

Japanese sweet flag

Peace Lily
Auditorium floor sandwich

Ceiling air return

Bamboo acoustic paneling

Displacement air supply
Load summary

Live load

<table>
<thead>
<tr>
<th>Location</th>
<th>Load (psf)</th>
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</thead>
<tbody>
<tr>
<td>Offices</td>
<td>50</td>
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<tr>
<td>Lounge</td>
<td>100</td>
</tr>
<tr>
<td>Auditorium</td>
<td>100</td>
</tr>
<tr>
<td>Server Room and Lab</td>
<td>100</td>
</tr>
<tr>
<td>Storage Room</td>
<td>125</td>
</tr>
<tr>
<td>Classrooms</td>
<td>40</td>
</tr>
<tr>
<td>First-floor Corridor</td>
<td>100</td>
</tr>
<tr>
<td>Corridor above first floor</td>
<td>80</td>
</tr>
<tr>
<td>Roof</td>
<td>20</td>
</tr>
</tbody>
</table>

100 psf
80 psf
50 psf
Reinforcement detailing

Columns & Post-tensioned (PT) beams

16x16” Column section
Reinforcement ratio: 3.1%
Cover: 2”

16x18” Beam typical section
Reinforcement ratio: 0.96% (PS), 1.5% (non-PS)
Cover: 1.5”

Reinforcement detailing

Shear wall

PT Slab

0.6” φ low-relaxation strand
Gr. 270, 3/4” cover

Typical wall section
Basement to Roof

Strand @ 12”, typical layout (e.g. auditorium)
Bamboo partition wall

Concrete Column

Gypsum board

Beam or slab

Seismicflex Joint

Bamboo Culm 4"

Section A-A

Capacity: 20 kN

Capacity: 22 kN

Bamboo Culm 4"

Gypsum board

Acoustic dampers
Max Deflection = 1.24 in (long-span beam)
Allowed deflection = (40*12)/240 = 2 in

Column design (Rebar percentage)

Max rebar percentage in Columns = 3.11 %
Max rebar percentage in Walls = 1.85 %
ATRIUM
BASEMENT
AUDITORIUM
SECOND FLOOR
PLANNING
HAZARDS
INFORMATION
Office daylight simulation

Second Floor
Office floor sandwich
Facade optimization

... by generative design

Geometry generation → Bamboo shading generation → Evaluation with thermal simulation → Most optimal solution minimizes window radiation while allowing for acceptable daylight.
Optimization of bamboo roof

Geometry generation and generation of design options in Dynamo

Structural analysis in Robot

Evaluation of analysis results in

Most optimal solution minimizes weight and connections

Update model in revit
Optimization of bamboo roof

Optimal solution

6 trusses
Truss Height: 3 ft
Discretization: 8
Top chords and diagonals: Bamboo culm 2.5"x1/4"
Bottom chord: Bamboo culm 4"x0.313"
Energy systems

Pictures: Ecotap Sl2 and Tesla Powerpack
Roof PV: 145,000
Thermal collectors: 24,000
Grid electricity: 5,000
E-Bike charging: 5,000
Facade PV: 30,000

Building consumption: 132,000
Hot water: 42,000
Lighting: 29,000
Room utility: 20,000
Battery losses: 9,000
Cooling: 32,000

For community: 67,000

Net positive energy... achieved with battery system
Reducing carbon footprint

... with battery systems and photovoltaics

Green-house-gas emissions of our buildings lifecycle

Year 0: Building construction

Total lifetime GHG reduced by 50%* due to PV and battery integration!

* Reduction from 202'000 t CO2 eq. to 106'000 t CO2 eq.
Data generated from STV tool, hourly Energy+ simulation and dynamic battery interaction calculation
Educate occupants

... about building performance

Battery display

Monitors

Visible ducts

Seminar room

Too high power consumption!
- Try turning off the light.

14:35:10
Monday
Temp: 27°
RH: 70%

Light

Cooling

Plugs
Sustainability nudging

...design for occupant behaviour change

Best performing room: Renate Fruchter's office

13:46:03
08 May 2021

Ground Floor
ATRIUM
BASEMENT
AUDITORIUM
SECOND FLOOR
PLANNING
HAZARDS
INFORMATION
Site constraints & challenges

Limited site entrance/exit

Protection of trees
For more details regarding site equipment, please refer to appendix slides.
### ALICE: Peak workflow day

<table>
<thead>
<tr>
<th>Task</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climbing Platform - Basic Wall</td>
<td>01/11/2025</td>
<td>01/12/2025</td>
</tr>
<tr>
<td>Cure - Basic Wall</td>
<td>01/11/2025</td>
<td>01/18/2025</td>
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<tr>
<td>Climb Platform - Basic Wall</td>
<td>01/13/2025</td>
<td>01/14/2025</td>
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<tr>
<td>Pour Concrete - Level0_STRUCT_Fri</td>
<td>01/13/2025</td>
<td>01/14/2025</td>
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<tr>
<td>Pour Concrete - Basic Wall</td>
<td>01/13/2025</td>
<td>01/14/2025</td>
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<tr>
<td>Cure - Level0_STRUCT_Framing [G]</td>
<td>01/14/2025</td>
<td>01/24/2025</td>
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<tr>
<td>Install Rebar - Basic Wall</td>
<td>01/14/2025</td>
<td>01/15/2025</td>
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<tr>
<td>Close Forms - Basic Wall</td>
<td>01/14/2025</td>
<td>01/15/2025</td>
</tr>
<tr>
<td>Close Forms - Basic Wall</td>
<td>01/14/2025</td>
<td>01/15/2025</td>
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<tr>
<td>Installation - Level0_STRUCT_Floors</td>
<td>01/14/2025</td>
<td>01/22/2025</td>
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<tr>
<td>Cure - Basic Wall</td>
<td>01/14/2025</td>
<td>01/21/2025</td>
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<tr>
<td>Install Rebar - Basic Wall</td>
<td>01/15/2025</td>
<td>01/16/2025</td>
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<tr>
<td>Close Forms - Basic Wall</td>
<td>01/15/2025</td>
<td>01/16/2025</td>
</tr>
<tr>
<td>Setup Forms - 1. Level_ZStairs [G]</td>
<td>01/15/2025</td>
<td>01/17/2025</td>
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<tr>
<td>Pour Concrete - Basic Wall</td>
<td>01/15/2025</td>
<td>01/16/2025</td>
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</table>

**January, 2025**

<table>
<thead>
<tr>
<th></th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
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</thead>
<tbody>
<tr>
<td>13 Jan - 19 Jan</td>
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<td></td>
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<tr>
<td>20 Jan - 26 Jan</td>
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</tbody>
</table>

**01/15/2025 - Day 44 - 12 Tasks**
Peak workflow day

Zone A

Zone B

Zone C
Labour environment
Natural hazards

They’re unpredictable but now more frequent!

many more and getting stronger
Earthquake

What to consider

Evacuation

Reduce damages

Fully operational
Load summary

Lateral load

Base shear demand:
- Wind: 267 kips
- Earthquake: 911 kips

Design spectrum (DBE):
- $S_{DS}=0.72$
- $S_{D1}=0.42$
- Base isolation: ~42% shear demand reduction
Mode 1
Period = 1.15
Mass Participation X = 72%

Mode 2
Period = 0.8
Mass Participation Y = 78%

Mode 3
Period = 0.7
Mass Participation RZ = 72%
Base isolation


**Properties:**
- Diameter: 25.5”
- Axial capacity: 600 kip
- Maximum displacement: **16”**
- Design displacement: **10”** (Naeim & Kelly, 1999)
- Displacement under wind: 0.62”
Nonlinear Response History Analysis (NLRHA)

Analysis software: ETABS

Displacement:
- ASCE 41: $\delta_t = 10.7\text{ in}$
- NLRHA: $5.3\text{ in}$

Interstory Drift Ratio (IDR):
- ASCE 7: $2\%$
- NLRHA: $1.1\%$

Scale: Maximum Considered Earthquake ($MCE_R$) level

Maximum story displacement

Maximum IDR
Lateral system

**Without** base isolation: **Partial collapse**

**With** base isolation: **Fully operational**
Hurricane

What to consider...

Damages

Protection
North entrance
Bamboo entrance door

PT Beam 16x18"

Bamboo panel

Bamboo culm 6"

Wind pressure

Automatic bollards
Facade design inspired by research "3 for 2 beyond efficiency" of Future Cities Lab

Design-integrated hurricane protection

Assembly Instructions:
- Loosen bolt and remove panel
- Remove destroyed bamboo louvre
- Add new prefabricated bamboo louvre to the casing
- Attach panel to the facade system
- Adjust angle with AR, and tighten bolt

Facade

Metal Casing
Bamboo Panel
Bolt
Hurricane strategy

What happens if a hurricane is predicted?

- Close-off the building
- Louvres protects glass
- Supplying food
- Campuses opens
- Before
- After
- During

Electricity and water autonomy

The bright side

Hurricane forecast
TVD evolution

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>Delta</th>
<th>Target</th>
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<tbody>
<tr>
<td>Preliminary Estimate</td>
<td>$5,749,600</td>
<td>$5,250,390.00</td>
<td>$11,000,000.00</td>
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<tr>
<td>PV Panel System</td>
<td>$6,092,650</td>
<td>$4,907,352.00</td>
<td>$11,000,000.00</td>
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<tr>
<td>Base Isolation and Integrated Facade</td>
<td>$59,744,450</td>
<td>$1,255,551.00</td>
<td>$11,000,000.00</td>
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<tr>
<td>Facade Optimization</td>
<td>$9,494,400</td>
<td>$1,505,558.00</td>
<td>$11,000,000.00</td>
</tr>
</tbody>
</table>

Dates:
- Preliminary Estimate: 2/10/2020
- PV Panel System: 3/8/2020
- Base Isolation and Integrated Facade: 4/22/2020
- Facade Optimization: 5/1/2020
TVD clusters
# ALICE Schedule

<table>
<thead>
<tr>
<th>Pre-Construction</th>
<th>Construction</th>
<th>Facade</th>
<th>Commission</th>
</tr>
</thead>
<tbody>
<tr>
<td>01-10-24 - 21-11-24</td>
<td>22-11-24 - 05-08-25</td>
<td>25-04-25 - 09-06-25</td>
<td>06-08-25</td>
</tr>
</tbody>
</table>

**Material Procurement:**
- 01-10-24 - 31-10-24

**Interior work zones:**
- Instructional labs
- Auditorium, small & large classrooms
- Study spaces and service rooms
- Café, toilets and service rooms

**Cost Breakdown:**

<table>
<thead>
<tr>
<th>Labor</th>
<th>Equipment</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1,300,000</td>
<td>$3,700,000</td>
<td>$3,400,000</td>
</tr>
</tbody>
</table>

**Total Cost:** $8,400,000

**Timeline Events:**
- Construction starts: 21-11-24
- Hurricane season ends: 30-11-24
- Closed Structure: 09-06-25
- Lab occupancy: 25-06-25
- Hurricane season starts: 01-06-25
- Construction Ends: 05-08-25

**Duration:** 269 Days
Goals reached!
Team platforms
AI team analytics

Team meetings

AI transcription

Google Docs

Protocols

Ensuring data interoperability

Final dataset

Data download

Discord communication
Optimizing communication

... by datamining teams response times

Since our responsive times are overlapping, let's define daily office hours!

Average response per Hour

Data gained by data mining of DISCORD communication of team ISLAND

I'll ask Simge for a meeting at 19:00, since she's the most responsive then.
Understanding our team dynamics
Building trust and understanding

... for better collaboration, communication and teamwork

Ronja
Aalborg University
Architect

**Project role:**
Queen

**Hobbies:**
Architecture is everything, and everything is architecture

Best response time:
20:00

Worst response time:
01:00

**Responsiveness**

Ronja
Aalborg University
Architect

**Word profile**

Ronja
Aalborg University
Architect

**Top contributions**

HOW?
Rain
People
Rainbow
Auditorium
Materials
Section
Footprint
Atrium
Color
Team process

... at the start of our journey

Where are you guys?

What is this meeting about?

I don't remember...

I don't know

I like PV...

Who are you?

Missing understanding

No flexibility

Information loss

Bad communication

ARCH

CM

SE

CM

MEP
Team process

... at the end of our journey

Central information gathering
Daily office hours
Understanding
Clear procedures

I propose to do it like this
I understand
Let’s discuss in tomorrow’s office hour
Let me help you
I trust your decision

SE
CM
MEP
ARCH

Let me help you

I propose to do it like this
I understand
# Meetings

## … and communication summary

<table>
<thead>
<tr>
<th></th>
<th>Team Meetings</th>
<th>Sub-Group</th>
<th>Owner</th>
<th>VR Team</th>
<th>Office hours</th>
<th>Discord messages</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>zoom</td>
<td>zoom</td>
<td>zoom</td>
<td>MeetinVR</td>
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<td></td>
</tr>
<tr>
<td>February</td>
<td>6</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>1’700</td>
</tr>
<tr>
<td>March</td>
<td>10</td>
<td>11</td>
<td>2</td>
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Total data points*: 24’800  
Total tracked single words*: 305’000

*Includes Discord, Teammeeting protocols, Teammeeting transcription
VR process

Weekly meeting

Weekly meeting
VR team journey

Visual clash detection

Check of wheelchair accessibility

Interdisciplinary design

Detail sketching in 3D with real size models

Discussion of script functionality

Immersive social interaction

Owner walkthrough, joking around and being together
Design decision pivoting

.. and evolution of project components

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25-01-2020: Moving Facade
Façade system moving elements to generate power through wind.

22-02-2020: Social Facade
Creating seating along façade for social interaction. Decentralized façade system, and PV panel on top.

28-03-2020: Bamboo Facade
Facade system with sacrificial bamboo louvres protecting the façade, includes PV panel on top, and AHU inside

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<th>Bamboo facade</th>
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EMBRACE TECHNOLOGY
IT integration

- Enhance interdisciplinary team collaboration, data exchange and trust
- Project optimization
- Integrate user behaviour

- Team data analysis to enhance collaboration
- Optimization of design solutions with parametric generative design
- Nudge user towards more responsible energy and water use

- Dynamic team-specific time-responsive risk analysis
- Automated material takeoffs for TVD and STV tracking
- Scheduling with ALICE
EMBRACE INDUSTRIALIZED CONSTRUCTION
DPR challenge

**Share risks**
- Make risks transparent for all stakeholders

**Align goals**
- Use shared risks to align common goals for the project

**Share rewards**
- Achieving goals, leads to shared rewards across the board

---

**Shared risk and reward trust-based decision framework**

**Communication and goal alignment optimization**

**Performance-driven prefabrication decision process**

---

**Dynamic technological iteration evaluation**

- Identify goal indicators
- Evaluate iteration
- Achieve goals
EMBRACE RESILIENCE
Embrace everyday life

- Carbon emissions
- Ecological footprint
- Air pollution
- Community awareness
- Mobility

- Bamboo carbon capture
- Recycled concrete, reduced landfill usage
- Net positive water
- Net positive energy
- User informing and education + Workshop
- Promote E-Mobility

Financial returns
Embrace extremes hazard events

- Hurricanes
- Earthquakes
- Destruction
- Droughts
- Power blackout

PV wind protection

Base isolators for earthquake resilience

Food, electricity and water distribution

Net positive energy + water

Sacrificial louvres
Lessons learned

"Appreciate your teams differences"

"Simple solutions are the answer for complex problems"

"Really learn to Trust and Listen"

"Always keep the final goal and the bigger picture in mind"

"Have an open mind and prepare for change"

"Plans will never work exactly, but they are the key for progress"

Wise words by BIM master Jacob: Always Remember to click “relinquish all mine”, and “synchronize”
# Thank you to our owners and mentors

**Owners:**
- Renate Fruchter
- Paola Gonzalez
- Hussain Parsianfar
- Jure Česnik
- Mikki Seidenschchnur

**Mentors:**
- Humberto Cavallin
- Sven Steiger
- David Bendet
- Jakob Feldeger
- Nick Arrenson
- Prashant Sharma
- Glenn Katz
- Mazen Faloughi
- Leonardo Rischmoller
- Adam Mastalir
- Joseph Hewling
- Martin Henriksen
- Bharath Seshadri
- Gregory Luth
- Erik Kneer
- Kate Cuddington
- Guido Morgenthal
- Justin Schwaiger
- Nilanda Cai
- Arthur Cao
- Eduardo Miranda
- Gregory Deierlein
- Erik Narhi
- Maryanne Wachter
- Adam Pekala
Thank You
Appendix
Footprint placement

... additional considerations

Solar Optimization

CFD Analysis: Optimal cross ventilation
North entrance
Elevations
Embrace both HVAC ideas

Rainbow Concrete

Central AHU
Fan-assisted comfort

Movement Steel

Decentral AHU
Plenum air distribution
Passive chilled beams

Embrace

Decentral AHU
Fan-assisted comfort
Why save water?

San Juan, Puerto Rico – Tens of thousands of people in Puerto Rico will face water rationing due to increasingly dry conditions in a U.S. territory still struggling to recover from Hurricane Maria. They could be without water starting next week.

Puerto Rico extends water rationing as drought deepens after arid July

- Number of people to receive water only every third day rises to 300,000
- Nearly 13% of island under extreme drought and 39% under severe one

A deepening drought in Puerto Rico that has affected 3.5 million people forced the government to extend severe water rationing measures to more municipalities. Right now, two-thirds of Puerto Rico is classified as “abnormally dry.” This is enough to affect crops and pastures.

Increasing risk of droughts

Shifts of plants and species

Water rationing required
Living machine

Treatment wetlands

Disinfection

Equalization

Waste water tank

Overflow to sewers / terrain in case of heavy rain

Reclaimed water tank
Energy reduction measures

And comparison to other metrics

Impact of design measures on energy consumption

Comparison of total energy demand

Data based on results of DesignBuilder Energy+ Simulation
Most inputs based on ASHRAE recommendations
Energy production and consumption

Scenario with no batteries

Grid Electricity: 40,000

PV: 175,000

Total Input: 239,000

Building Consumption: 132,000

E-Bike Charging Station: 12,000

Delivered to Community: 95,000

Hot Water: 42,000

Lighting: 29,000

Room Electricity: 20,000

Efficiency Losses: 9,000

Cooling: 32,000

Thermal Collectors: 24,000
PV and battery systems

Hourly system interaction

PV / Battery System Interaction with Electricity Grid
(800 m2 PV with 1 Tesla PowerPack)
Isolated Footings

16#5 @ 6.7''
L=100''

Reinforcement Typical Isolated Footing
Plan View
Local Material:

- Steel & Pipes Inc.
- Marxuach Precast Solution
- Acha Trading – Interiors
- United Glass Co.
- Cemex
- Tesoroen Maderas – Wood
- Vista Systems – Curtain walls
- ACR Systems – HVAC
- Clary Cooperation – Electrical
- CED – PV Elements

Construction Site
Construction equipment
Intro VR video
Figure table and references

Slide 4: [https://static1.squarespace.com/static/554a8b04e4b01cb58c4d6eca/5cefe74f54bfbd16000162320f/5cefe89fdff870000167bb0a/1583382282371/Carnaval-Ponceo-2018_c0756a66-5056-a36a-085bf236ebe4aceb.jpg?format=750w](https://static1.squarespace.com/static/554a8b04e4b01cb58c4d6eca/5cefe74f54bfbd16000162320f/5cefe89fdff870000167bb0a/1583382282371/Carnaval-Ponceo-2018_c0756a66-5056-a36a-085bf236ebe4aceb.jpg?format=750w)


Slide 42: [preciousplasticzurich, eth_studentprojecthouse, JMU 3SPACE, Create AAU](http://preciousplasticzurich.eth_studentprojecthouseJMUAASPACECreateAAU)

Slide 47: [sustainablewater.com](http://sustainablewater.com)

