This tree's leaf, which here the East
In my garden propagates,
On its secret sense we feast
Such as sages elevates.

Is it but one being single
Which as same itself divides?
Are there two which choose to mingle
So that one each other hides?
As the answer to such question
I have found a sense that's true:
Is it not my songs' suggestion
That I'm one and also two?
BorysDrawing.wmv
Dieses Baums Blatt, der von Osten
Meinem Garten anvertraut,
Gibt geheimen Sinn zu kosten,
Wie's den Wissenden erbaut.

**Ist es ein lebendig Wesen.**

Das sich in sich selbst getrennt,
Sind es zwei, die sich erlesen,
Daß man sie als eines kennt.
Solche Frage zu erwidern
Fand ich wohl den rechten Sinn,
Fühlst du nicht an meinen Liedern,
**Daß ich Eins und doppelt bin.**
RIVER TEAM
DRONE
LATENCY
THE LEAF
TIMELINE
PHOTOSYNTHESIS

BUILDING
HEALTH
THE STEM

FLOOD
FLOOD

ANALYSIS BEFORE DRONE

![Graph showing probability vs severity with labels: Vandalism, Flood, and Integration in cityscape.](image-url)
FLOOD

SOLUTIONS BEFORE DRONE
DRONE TEAM PROCESS
DRONE DEVELOPMENT

SPARSE POINT CLOUD

GPS

SURFACE MODEL

February 15

March 15

March 15

TEXTURE

APRIL 15
DRONE DEVELOPMENT
FLOOD

FIND PLACEMENT

211.5

211

210.5

210

HIGHEST EVER

PROBABILITY ~ 0%

PLACEMENT

1.5%

?
ZERO PROBABILITY FLOOD
FLOOD DATA ANALYSIS 100 YEARS
FLOOD

FIND PLACEMENT

HIGHEST EVER  PROBABILITY ~ 0%  PLACEMENT
1.5%  0%  > 210.9
RISK COST
OVER 25 YEARS

$ ~350,000
FLOOD

FIND PLACEMENT

211.7

211.5

211

210.5

210

HIGHEST EVER

PROBABILITY ~ 0%

PLACEMENT

1.5%

0%
THE STEM

TEAM PROCESS - LATENCY
LATTENCY DEFINITION

EVERY ACTION HAS A REACTION
LATENCY - KPI

Response Latency

Issue noticed by team-
member

Resolution Latency

Necessary Parties
made aware

Issue resolved
LATENCY ALERT

IT JUMP OUT AND BITES YOU!
“Unfortunately, the Mission Bay Team could not find a way to measure latency that did not require **significant time and effort by team members.**”

**Issue:**

- **People Rank:** 1
- **Tools Rank:** 3
- **Info Rank:** 5
LATENCY REDUCTION

Decision Delay

Data Entry Overhead

Revit

Quantity Takeoff
Room Schedule

TVD
STV
Cash Flow

Print

Discussion

Decision
LATENCY REDUCTION

SOLVING ISSUES DURING MEETING

Subgroup Meetings

<table>
<thead>
<tr>
<th>Subgroup Meetings and Minutes:</th>
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<tbody>
<tr>
<td>27</td>
</tr>
<tr>
<td>28</td>
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<tr>
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<td>36</td>
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<tr>
<td>37</td>
</tr>
<tr>
<td>38</td>
</tr>
</tbody>
</table>

Sprints within Sprints
LATENCY REDUCTION

Optimizing Electrical System

- 12 Hours
- 4 Weeks

Optimizing Building Siting

- 5 Days
- 8 Weeks
LATENCY - KPI

Response KPI = 0.5 Days

Resolution KPI = 2 Days

Issue noticed by team-member

Necessary Parties made aware

Issue resolved
THE STEM

FLOOR PLANS
ARCHITECTURAL - GROUND FLOOR

- INSTRUCTIONAL LAB
- SEMINAR ROOM
- SMALL CLASSROOM
- LARGE CLASSROOM
- ADMINISTRATION
- STUDENT OFFICES
- FACULTY OFFICES
- MECHANICAL
- RENTABLE
- STORAGE
ARCHITECTURAL - GROUND FLOOR
MECHANICAL - GROUND FLOOR

HVAC SYSTEM
STRUCTURAL - FIRST FLOOR

CLT & GLULAM

- 4m x 3.3m 320mm
- 8m x 3.3m 320mm
- 6m x 2.5m 320mm
- 8m x 2.5m 320mm
- 240 x 600mm 8m span
MECHANICAL - FIRST FLOOR

HVAC SYSTEM
STRUCTURAL - SECOND FLOOR

CROSS LAMINATED TIMBER (CLT) & GLULAM

3 Segments
200 x 1000mm
20m span

8m x 5.3m
320mm

5m x 2.5m
240mm

8m x 2.5m
320mm

240 x 600mm
8m span
SECTION CUT
MECHANICAL - THIRD FLOOR

HVAC SYSTEM
STRUCTURAL - ROOF

CLT & GLULAM

4m x 3.3m
320mm

5.3m x 3.3m
320mm

5m x 2.8m
240mm

8m x 2.8m
320mm

8m x 2.8m
320mm

240 x 600mm
8m span
THE STEM

TEAM PROCESS - LINKING
STV & CASH FLOW

- Revit
  - Quantity Takeoff
  - Room Schedule

- TVD
- STV
- Cash Flow
- Rent
- Discussion

Costs:
- ENERGY COST
- WATER SERVICE COST
- WASTE WATER COST
REVIT, STV, & CF

INFLUENCE ON LC

RISK
$ ~350,000

OPERATION
$ ~4,400,000
TVD & RENT

Diagram:
- Revit
  - Quantity Takeoff
  - Room Schedule
- TVD
- STV
- Cash Flow
- Rent
- Discussion
TARGET VALUE DESIGN

Target: $8.5M

Cost: $9.5M

TVD - TARGETS BY CLUSTER

- A Substructure
- B Shell
- C Interiors
- D Services
- E Equipment and Furnishing
- F Specialty Construction
- G Building Sitework
- H General Conditions

- TARGET VALUE
- ESTIMATED VALUE
- VALUE DELTA
TVD & LIFE CYCLE COSTS

INFLUENCE ON LCC

INTEREST
$ ~5,200,000

RISK
$ ~350,000

REPLACEMENT
$ ~2,200,000

MAINTENANCE
$ ~2,600,000

OPERATION
$ ~4,400,000

CONSTRUCTION
$ ~9,400,000
OVERALL LCC

- CONSTRUCTION: $~9,400,000
- OPERATION: $~4,400,000
- MAINTENANCE: $~2,600,000
- REPLACEMENT: $~2,200,000
- RISK: $~350,000
- INTEREST: $~5,200,000
THE VEINS

SYSTEMS INTEGRATION - STRUCTURAL
SITE ACCESS

- CONGESTED AREA
- NARROW ROADS
  - 17ft (5.1m) WIDE
SLAB DEVELOPMENT

CLT & GLULAM
Concrete Composite System
EVOLUTION - DATA

CONCRETE

FLOOR-TO-FLOOR

2.4m
FLOOR SYSTEM EVOLUTION

Timber Beam System

Concrete Composite System

-40% Water
-30% CO2
EVOLUTION - DATA

CONCRETE VS. TIMBER

FLOOR-TO-FLOOR

2.4m
FLOOR SYSTEM EVOLUTION

320mm CLT Slab

Timber Beam System

+ 30cm usable floor height

Concrete Composite System
EVOLUTION - DATA

TIMBER

FLOOR-TO-FLOOR

2.7m

+30cm
FLOOR ANALYSIS

1. SINGLE SPAN

- Δ_{\text{allow}} = 2.3 \text{ cm} \quad Δ_{\text{analysis}} = 2.2 \text{ cm}

2. CANTILEVERED SLAB

- Δ_{\text{allow}} = 2.0 \text{ cm} \quad Δ_{\text{analysis}} = 1.3 \text{ cm}
SHERPA CONNECTIONS

Girder to Column 140x570mm
Screws: 54 pcs. 8 x 160mm

Slab to Girder
80 x 250mm
Screws: 25 pcs. 8 x 100mm

22 kN/m
LATERAL - PLAN VIEW

Core Walls

Wind Load

0.51 kN/m²
LATERAL - LOAD TRANSFER

![Diagram showing lateral load transfer with forces and connections]

<table>
<thead>
<tr>
<th>Force</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Shear</td>
<td>40 tapping screws/m</td>
</tr>
<tr>
<td>Shear</td>
<td>5 tapping screws/m</td>
</tr>
</tbody>
</table>

- Force: 300 kN
- Connection: 500 mm
SOFISTIK ANALYSIS

Deflection ~ 1.1 cm

Stress 12.7 MPa

Deflection x 5000
THE VEINS

SYSTEMS INTEGRATION - CONSTRUCTION
STRUCTURAL SEQUENCE

CoreSection.wmv
SITE LOGISTICS
EARLY SPRING SETUP

NORTH

LAYOUT

SCAFFOLD

35m
THE VEINS

SYSTEMS INTEGRATION - HEATING AND COOLING

SE MEP CM
FOUNDATION

MICROPILES + GROUND SOURCE WATER = ENERGY PILES
ENERGY PILES

NEED = 18.9 kW

80 Piles

7.5 m

50 W/m

GET = 30 kW
CAPILLARY CEILINGS
CAPILLARY CEILINGS

SUMMER

18 °C

26 °C

80 W/m²
CAPILLARY CEILINGS

WINTER

26 °C

75 W/m²

20 °C
CAPILLARY CEILINGS

CONNECTION IN ROOM

- Supply
- Return
- Capillary pipe
- Room distribution
- Push lock connection
THE VEINS

SYSTEMS INTEGRATION - ELECTRICITY

MEP  CM  LCFM
SUSTAINABLE TARGET VALUE

JUST HEAT PUMP

- Carbon: 119%
- Energy: 80%
- Water: 42%

TARGET

RESULT

TVD: $9.1M
RENT: $0.975M
FIRST ITERATION

MICRO SHADE POWER

PV

S = 50 W/m²
E/W = 40 W/m²
SUSTAINABLE TARGET VALUE

MICROSHADE POWER

CARBON 88%

WATER 41%

ENERGY 57%

TVD $9.4 M

RENT $0.977 M

TARGET

RESULT
SECOND ITERATION

PRODUCE ENERGY THROUGH PV

STORE WITH TESLA BATTERY
SUSTAINABLE TARGET VALUE

+ PV ROOF + TESLA BATTERY

**CARBON**
55%

**WATER**
41%

**ENERGY**
33%

**TVD**
$9.5 M

**RENT**
$0.963
THE SKIN

FACADE - STRUCTURAL
Tension

Compression

WINTER STARTING POINT

3@3.2 m

7 m
ARCHITECTURAL EVOLUTION

PARAMETRIC MODELING

MODEL PHYSICS
STRUCTURAL ANALYSIS
STRUCTURAL EVOLUTION

TOPOLOGY OPTIMIZATION

TYP. 200x200 mm

Compression
Tension
FINAL DESIGN
DELAUNAY CONNECTION

1

2
DELAUNAY CONNECTION

Example: 10mm plate, M12 screws
DELAUNAY CONNECTION

M30 Screw

10 mm Plate

50 mm Pipe Connector

200x200 mm Timber Beam
DELAUNAY CONNECTION
FACADE

CUSTOM GLAZING VS. SPIDER CLAMPS
FACADE - SECTION DETAIL

SPIDER CLAMPS

Ext. Structural Glazing - 30 mm

Spider Clamp

GluLam Col. 300x300mm

Bolt Ø16 mm

CLT Slab 320 mm

Steel HSS 280x100x10 mm
FACADE - SHADING

MicroShade vs. SageGlass
## FACADE - SHADING

### PROS & CONS

<table>
<thead>
<tr>
<th>Feature</th>
<th>MicroShade Power</th>
<th>Sageglass</th>
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</thead>
<tbody>
<tr>
<td>Thermal efficiency</td>
<td>✓</td>
<td>❌</td>
</tr>
<tr>
<td>Daylight above 2 %</td>
<td>✓</td>
<td>❌</td>
</tr>
<tr>
<td>Reduce solar gain</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maintenance cost</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cleaning cost</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Energy positive</td>
<td>✓</td>
<td>❌</td>
</tr>
</tbody>
</table>
FACADE - SHADING

MICROSHADE POWER

U-Value
0.9 W/m²K

PV
S = 50 W/m²
E/W = 40 W/m²
FACADE - SHADING

MICRO SHADE POWER

49%

19%

49%
THE SKIN

FACADE - ACOUSTICS
INTERIOR GLASS
SOUTH & WEST
Inspiration

Pink noise
AUDITORIUM

must get dark but still want to show beautiful interior to public
THE SKIN

FACADE - ALGAE

A  SE  MEP  CM  LCFM
FUNCTIONALITY

$\text{CO}_2$
ALGAE GLASS PANELS
CHALLENGE COST

ALGAE GLASS PANELS

NO PAYOFF
ALGAE PLASTIC BAGS
PAYOFF

CHALLENGE COST

ALGAE GLASS PANELS
INFLUENCE ON RENT

Rent without algae

Rent with algae
BENEFITS

FOOD

CO2 REDUCTION: 1%

WATER EDUCATION
PHOTOSYNTHESIS

SUN
WATER
CO2
DAYLIGHT FACTOR

GROUND FLOOR
DAYLIGHT FACTOR

FIRST FLOOR
DAYLIGHT FACTOR

SECOND FLOOR
WATER

BUILDING WATER SUPPLY

RAINWATER

ALGAE

STREAM

TANK

PLANTRONICS
ENERGY

OPTIMIZATION

HEAT PUMP

+ MICROSHADING

+ PV ROOF
+ BATTERY

OPTIMIZATION
SUSTAINABLE TARGET VALUE

ENERGY OPTIMIZATION + WATER

CARBON
50%

ENERGY
29%

WATER
19%

TARGET
RESULT

TVD
$ 9.5 M

RENT
$ 0.96 M
CERTIFICATIONS
DGNB

Deutsche Gesellschaft für Nachhaltiges Bauen e.V.
RESULTS

67.7%  95/126
CRITERIA SCORING

- Location: MAX 20, SCORES 10
- Sustainable Sites: MAX 10, SCORES 10
- Water: MAX 10, SCORES 10
- Energy: MAX 30, SCORES 30
- Materials: MAX 10, SCORES 5
- Indoor Quality: MAX 15, SCORES 10
- Innovation: MAX 5, SCORES 5
PHOTOSYNTHESIS

WATER
WATER ABUNDANCE
WATER USE

- Municipal
- Sewage
- Rain

Water Service Type

m3 per year

- $2.1
- $3.0
- $5.6

- $1.0
- $2.0
- $3.0
- $4.0
- $5.0
- $6.0

$ in K

M3 / yr

- 100
- 200
- 300
- 400
- 500
- 600
- 700
- 800
- 900

$-

Graph showing water use in M3/yr and corresponding costs in $ in K for different water service types: Municipal, Sewage, and Rain.
WATER COST

Rent p.a. $960k
Our Equity p.a. $97k
Total Water Use p.a. $11.2k
CHARITABLE CAUSE

SHARING THE WATER

Transform an entire community or school with a gift of $10,000 or more.

Have questions about sponsoring a project? Please get in touch with our team.

📞 646.688.2323   💌 sponsoraproject@charitywater.org
OCCUPANT INTERACTION

CONSCIOUS STREAM
WATER SUMMARY

ALGAE

ENERGY PILES

DRONE

USER EDUCATION

PLANTRONICS

STREAM

RAINWATER COLLECTION
SPECIAL THANKS TO:

Greg Luth, SE Mentor
Justin Schwaiger, SE Mentor
Eric Borchers, SE Mentor
Erik Kneer, SE Mentor
Luis Rivera, MEP Mentor
John Nelson, MEP Mentor
Stefan Thielemann, MEP Mentor
Christian A. Hviid, MEP Mentor
Glenn Katz
Danny Hall, AEC Alumnus
Norman Hallermann, Drone
Drew Wenzel, Google
Roy Griffith, Clark Pacific
Martin Scheiber, Clark Pacific
Plamen Ivanov, Clark Construction
Jim Day, Clark Construction
Matthias Ehrlich, KfW
Björn Wündsch, LCFM Mentor

Super owner/mentor: Renate Fruchter

Our Owners:
Flavia Grey, Norayr Badasyan, Mandy Bugzel,
Fernando Castillo, Paweł Wołejsza
LESSONS LEARNED

No matter how great a system or process seems, no one will use it unless it’s simple and it jumps out and bites them. - Ryan, CM

ALWAYS inform the owners! - Janine, LCFM

Collaboration is a key. - Borys, A

When you talk you tell what you know, when you listen you learn something new. - Marie, MEP

Be humble and ask questions. You have something to learn from everyone. - Luke, SE

Present what you did! - Steve, SE

Share early, share often. - Tyler, CM
LATENCY SUMMARY

LINKING

PLUG-IN

DRONE

DATA ENTRY

OVERHEAD

PEOPLE, INFORMATION, TOOLS
Retaining Wall

- Length per element: 3 m
- 10 mm Stirrup
- 14 mm Longitudinal Rebar, each 20 cm
INDOOR CLIMATE

![Graph showing indoor climate conditions and hours above certain thresholds.

- > 60%: 300 hours
- < 25%: 500 hours
- CO2: 0 hours
- > 26 C: 100 hours
- < 20 C: 50 hours

Legend: EN 15251]
<table>
<thead>
<tr>
<th></th>
<th>WITH HEAT PUMP</th>
<th>MICROSHADE POWER</th>
<th>+ PV ON ROOF + BATTERY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARBON [%]</td>
<td>119</td>
<td>88</td>
<td>55</td>
</tr>
<tr>
<td>WATER [%]</td>
<td>42</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>ENERGY [%]</td>
<td>80</td>
<td>57</td>
<td>33</td>
</tr>
<tr>
<td>RENT [$]</td>
<td>975,000</td>
<td>977,000</td>
<td>963,000</td>
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## ELECTRICITY

<table>
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<th>ENERGY + WATER</th>
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<td>ENERGY [%]</td>
<td>80</td>
<td>57</td>
<td>33</td>
<td>29</td>
</tr>
<tr>
<td>TVD [*10^6]</td>
<td>9.1</td>
<td>9.35</td>
<td>9.5</td>
<td>9.5</td>
</tr>
<tr>
<td>RENT [$]</td>
<td>975,000</td>
<td>977,000</td>
<td>963,000</td>
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