Andrew Long [CM]
Zuzanna Koltsowska [ARCH]
Moafak Kata [LCFM]
Deborah Duan [SE]
Andrew Long [CM]
Jefferson Hang [SE]

OWNERS: Joanna Huey & Dimitra Ioannidou
CLIMATE

Good Construction Weather
Low Threat of Weather Delay
Water Management Required
BIG IDEA - CACTUS
SYMMETRY
MODULARITY
tough skin or cuticle...

water storing tissue

vascular bundle

cells for holding water
TEMPERATURE CONTROL

[Images and diagrams related to temperature control and CO₂ processing]
UCLA – 1. ROYCE HALL
UCLA – 2. WESTWOOD BLVD. & STRATHMORE AVE
UCLA – 3. CALIFORNIA NANOSYSTEMS INSTITUTE
SITE CONDITIONS

- tunel to student housing
- bus stops
- campus
- public transport
- heavy transportation

OUR SITE
SUN OPTIMIZATION
FOOTPRINT EXTENSION

[Diagram of a shield with an extended boundary indicated by a dashed line]
ENTRANCES AS CONNECTION TO OUTSIDE
PREVIOUS OPTIONS
# Decision Matrix

<table>
<thead>
<tr>
<th>Concrete</th>
<th>Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>85.67%</td>
<td>85.03%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Concrete</th>
<th>Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>85.08%</td>
<td>85.33%</td>
</tr>
</tbody>
</table>
MAJOR CHANGES

EXPANDED FOOTPRINT

STAIR ORIENTATION
BASEMENT FLOOR PLAN

Department Legend
- Large Classrooms
- Seminar Room
- Rest Rooms
- Vertical Circulation
- Instructional Labs
- Storage
- Mechanical Room
- Server Room
- MEP
- Elevator
- Technical Space
- Auditorium
- Social Space

Dimensions:
- 113 ft
- 130 ft
- 86.5 ft
- 45 ft
2nd FLOOR PLAN

Central Team
Arch
SE
CM
MEP
LCFM

129 ft

Decoration Legend
- Administration
- Faculty Office
- Rest Rooms
- Vertical Circulation
- Social Space
- MEP
- Elevator
- Faculty Lounge
- Dean's Office

N
NATURAL VENTILATION
VIEW FROM THE TUNNEL
VIEW OF AN ENTERANCE
VIEW OF ATRIUM 2ND FLOOR
3D STRUCTURAL MODEL
LATERAL LOADS

Risk Category III
Seismic Design Category D

\[ F_x = 478 \text{ kip} \]

\[ F_x = 306 \text{ kip} \]

\[ F_x = 152 \text{ kip} \]

\[ V = 936 \text{ kip} \]

\[ S_s = 2.256 \text{ g} \]
\[ S_1 = 0.823 \text{ g} \]

15 ft Sandy Soil
5 ksf Bearing Capacity

Water Table
### Gravity Loads

<table>
<thead>
<tr>
<th>Dead Loads</th>
<th>PSF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor Covering</td>
<td>1</td>
</tr>
<tr>
<td>Partitions/Walls</td>
<td>15</td>
</tr>
<tr>
<td>Ceiling</td>
<td>5</td>
</tr>
<tr>
<td>Mechanical</td>
<td>3</td>
</tr>
<tr>
<td>Self-Weight</td>
<td>125</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>149</strong></td>
</tr>
</tbody>
</table>

**Live Loads**

- Reflective Roof (20 psf) with solar panels (3 psf) = 23 psf
- Classrooms = 80 psf
- Gathering Areas = 100 psf
- Green Roof = 100 psf

---

**Data:**

- **GRAVITY LOADS**
  - **DEAD LOADS**
    - Floor Covering: 1 psf
    - Partitions/Walls: 15 psf
    - Ceiling: 5 psf
    - Mechanical: 3 psf
    - Self-Weight: 125 psf
    - **Total:** 149 psf
  - **LIVE LOADS**
    - Reflective Roof: 20 psf + Solar Panels: 3 psf = 23 psf
    - Classrooms: 80 psf
    - Gathering Areas: 100 psf
    - Green Roof: 100 psf
FOUNDATION – PLAN VIEW
Dimensions: 10’x10’

8 #9 bars both directions
COMBINED FOOTING

Central Team
Arch
SE
CM
MEP
LCFM
FOUNDATION CONSTRUCTION

John Deere 330 LC
2.3 cu. Ft. Bucket
26.5’ Max Dig Depth

Lull 1044C-54
38’ Reach, 54’ Lift
10,000 lb Capacity
RETAINING WALLS – PLAN VIEW
RETAINING WALLS – TYPICAL

12” Concrete Wall
10’ at Base

#9@16” O.C.

#7@14” at Heel
#7@15.25” at Toe

Soil

14’

2”

3’ 7’
10" Concrete Wall
8' at Base

#7@18" O.C.

#7@18" at Heel
#7@18" at Toe

18"
3"
BASEMENT – PLAN VIEW

BEAMS
- 12” x 24”
- 12” x 20”
- 10” x 16”

COLUMNs
- 16” x 16”
- 12” x 12”

Dimensions:
- 104 ft
- 130 ft

Sections:
- 45’-0”
- 86’-6”
AUDITORIUM PLAN

VULCRAFT STEEL JOISTS

18 @ 4 ft 4 in O.C.

45 ft
AUDITORIUM JOIST CONNECTIONS

- SHEARFLEX® SCREW BY NUCOR-VULCRAFT
- E-CLOSURE BY NUCOR-VULCRAFT
- JOIST BY NUCOR-VULCRAFT
- EXTENDED SEAT
- MASONRY ANCHORS BY OTHERS
- CONCRETE TIE BEAM BY OTHERS

PICTURES COURTESY OF VULCRAFT

36"
STEEL JOIST ERECTION

Broderson IC80-3F
18,000 lb. Capacity
30 Ft. Horizontal Reach

36LH15
1656 lbs.

Position 1
1st FLOOR – PLAN VIEW

BEAMS
- 12” x 24”
- 12” x 20”
- 10” x 16”

COLUMNS
- 16” x 16”
- 12” x 12”

Dimensions:
- 104 ft
- 110 ft

Beam and column specifications are indicated in the plan view diagram.
1. Solar Panels
2. Reflective Roof
3. 10” Concrete Slab
4. Mechanical Duct
5. Actuated Windows
6. Balcony
#11 Rebars
#4 Stirrups
#6 Rebars

Exterior Beam Column Connection
2nd FLOOR – PLAN VIEW

BEAMS
- 12” x 20”
- 10” x 16”

COLUMNS
- 16” x 16”
- 12” x 12”
POST TENSIONED SLABS

Slab Thickness: 10"

10 tendons spaced evenly

Tendons
0.5” Diameter – 7 Wire Strand
270 ksi Strength

26’ - 0”
22’ - 0”
20’ - 0”
20’ - 0”
0’ - 0”
17 ft
POST TENSIONED SLABS

Eccentricities = 3"
LATERAL SYSTEM - 3D VIEW
SHEAR WALL DETAILS – PLAN VIEW

24.00 in
No. 11 @ 3" O.C.
{9 sets}

16.00 in

1.84 in

9.60 in
No. 11 @ 3.2" O.C.
{4 sets}

18.00 ft

No. 4 hoops and crossties @ 8" O.C.

No. 5 @ 12" O.C.
Northridge Ground Motion
DEFLECTION RESULTS

DEFLECTED SHAPE – EW DIRECTION

DEFLECTED SHAPE – NS DIRECTION

\[ T_n = 0.4453 \text{ sec} \]

<table>
<thead>
<tr>
<th>Floor</th>
<th>( \Delta \text{ [in]} \text{ EW} )</th>
<th>IDR [%] EW</th>
<th>( \Delta \text{ [in]} \text{ NS} )</th>
<th>IDR [%] NS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(^{st})</td>
<td>0.80</td>
<td>0.50</td>
<td>0.73</td>
<td>0.46</td>
</tr>
<tr>
<td>2(^{nd})</td>
<td>2.07</td>
<td>0.90</td>
<td>1.92</td>
<td>0.84</td>
</tr>
<tr>
<td>3(^{rd})</td>
<td>3.47</td>
<td>0.93</td>
<td>3.20</td>
<td>0.84</td>
</tr>
</tbody>
</table>
SITE LOGISTICS

Soil Storage

Erosion Control

Pump 1

Rest Area

Recycling

Storage

Green Trailer

Soil Storage

Pump 2

Truck Entrance

Truck Wash

Refuel
CONCRETE PLACEMENT

Putzmeister 47Z-Meter
128’ Horizontal Reach
19.4 cu. Ft. Hopper
BIM INTEGRATION

INTEGRATION

WALK THROUGH

SIMULATION

Clash Detection

Timeliner

CENTRAL TEAM  ARCH  SE  CM  MEP  LCFM
VIRTUAL REALITY: THE CAVE
VIRTUAL REALITY: THE CAVE
VIRTUAL REALITY: THE CAVE
VIRTUAL REALITY: THE CAVE
4D/5D MODELING

Autodesk Quantity Takeoff
CONSTRUCTION SCHEDULE

195 Days

Start:
August 24th, 2015

Finish:
May 24th, 2016
Steel Joists
Installed: 10/20/2015

Create Float
Computer Labs Finished on February 2\textsuperscript{nd}, 2016

Green Roof Installed on February 16\textsuperscript{th}, 2016
CONSTRUCTION BUDGET

<table>
<thead>
<tr>
<th>Budget</th>
<th>Initial Estimate</th>
<th>Winter Quarter</th>
<th>Spring Quarter</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTRUCTION BUDGET</td>
<td>$7,500,000.00</td>
<td>$7,068,000.00</td>
<td>$7,031,000.00</td>
</tr>
<tr>
<td>DISCOUNTED BUDGET</td>
<td>$7,567,000.00</td>
<td>$6,330,000.00</td>
<td></td>
</tr>
<tr>
<td>INITIAL ESTIMATE (RS MEANS SF)</td>
<td>$7,500,000.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Contingency, $37,000.00

Budget: $7.5M = $7.07M (2012) (2% Inflation)
COSTS OVERVIEW

- **Construction**
  - $7,030,000 (35%)
- **O&M**
  - $5,572,680 (28%)
- **Replacement**
  - $1,615,167 (8%)
- **Risks**
  - $331,063 (2%)
- **Interest**
  - $5,357,076 (27%)
# PROJECT PROFITABILITY

## NOI yield all cash

<table>
<thead>
<tr>
<th>NOI</th>
<th>1. full business year</th>
<th>11.20%</th>
</tr>
</thead>
</table>

## Multiple all cash

- 8.93

## Sensitivity of 1. year: Yield of cash value

<table>
<thead>
<tr>
<th>Total investment</th>
<th>ROCE</th>
<th>11.20%</th>
<th>Net Rent (80%)</th>
<th>11.20%</th>
<th>Net Rent (90%)</th>
<th>11.20%</th>
<th>Net Rent (100%)</th>
<th>11.20%</th>
<th>Net Rent (110%)</th>
<th>11.20%</th>
<th>Net Rent (120%)</th>
<th>11.20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>6,505,644</td>
<td>+ 80.00%</td>
<td></td>
<td>11.20%</td>
<td>11.20%</td>
<td>9.95%</td>
<td>8.96%</td>
<td>8.14%</td>
<td>7.46%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,318,850</td>
<td>90%</td>
<td></td>
<td>12.60%</td>
<td>12.60%</td>
<td>11.20%</td>
<td>10.08%</td>
<td>9.16%</td>
<td>8.40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8,132,055</td>
<td>100%</td>
<td></td>
<td>14.00%</td>
<td>14.00%</td>
<td>12.44%</td>
<td><strong>11.20%</strong></td>
<td>10.18%</td>
<td>9.33%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8,945,261</td>
<td>110%</td>
<td></td>
<td>15.40%</td>
<td>15.40%</td>
<td>13.68%</td>
<td>12.32%</td>
<td>11.20%</td>
<td>10.26%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9,758,466</td>
<td>+ 120.00%</td>
<td></td>
<td>16.80%</td>
<td>16.80%</td>
<td>14.93%</td>
<td>13.44%</td>
<td>12.21%</td>
<td><strong>11.20%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Investment Percentage</th>
<th>Net Rent (80%)</th>
<th>Net Rent (90%)</th>
<th>Net Rent (100%)</th>
<th>Net Rent (110%)</th>
<th>Net Rent (120%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80%</td>
<td>728,418</td>
<td>819,470</td>
<td>910,522</td>
<td>1,001,575</td>
<td>1,092,627</td>
</tr>
<tr>
<td>90%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>110%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The highlighted values indicate the maximum yield for each ROCE level.
FINANCING

2 Loans system

2 Loans

1st loan for construction phase
- SWAP: 2.08%

2nd loan for operation phase
- SWAP: 3.50%

1 Loan system

1 Loan

Conditions for construction phase
- SWAP 3.45%

Conditions for operation phase
- SWAP 3.45%
<table>
<thead>
<tr>
<th></th>
<th>2 LS</th>
<th>1 LS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>$5,357,076</td>
<td>$5,363,961</td>
</tr>
<tr>
<td>Amortization</td>
<td>$7,085,514</td>
<td>$7,113,777</td>
</tr>
<tr>
<td>Annuity</td>
<td>$12,442,589</td>
<td>$12,477,738</td>
</tr>
<tr>
<td>Cash value of Annuity</td>
<td>$7,080,000</td>
<td>$7,100,000</td>
</tr>
<tr>
<td>DSCR</td>
<td>$14,308,978</td>
<td>$14,349,399</td>
</tr>
<tr>
<td>2 Loan System</td>
<td></td>
<td><strong>$12,442,589</strong></td>
</tr>
</tbody>
</table>

*LS = Loans system*
FINANCIAL ENGINEERING – 2 LS

Savings! Financial Engineering!!!

*LS = Loans system
FINANCIAL ENGINEERING – 2 LS

Really? What about cash value of Annuity???

*LS = Loans system
FINANCIAL ENGINEERING – 2 LS

Scenario 1
Scenario 2
Scenario 3

*LS = Loans system

Interest
Annuity
Cash value of Ann.
CASH VALUE OF LIFE CYCLE COSTS

- **Cash value of LCC**: $10,253,083
- **LCC/m²**: $2,873
- **LCC/ft²**: $267
- **Scores for criterion LCC**: 96

- Construction costs structural design
- Construction costs technical facilities
- Irregular payments structural design
- Irregular payments technical facilities
- Regular maintenance structural design
- Regular maintenance technical facilities
- Cleaning off 25 years
- Energy off 25 years
- Water/waste water off 25 years
## LIFE CYCLE RENT

<table>
<thead>
<tr>
<th>Total rent over LC</th>
<th>$17,364,048</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total rent over LC/year</td>
<td>$694,562</td>
</tr>
<tr>
<td>Total rent over LC/month</td>
<td>$57,880</td>
</tr>
<tr>
<td>Total rent over LC/day</td>
<td>$1,929</td>
</tr>
<tr>
<td>Total rent over LC/hour</td>
<td>$80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Uniform rent</th>
<th>Total income + rent</th>
<th>Total expenditures + annuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>$173,640</td>
<td>$418,108</td>
<td>$337,552</td>
</tr>
<tr>
<td>2017</td>
<td>$694,562</td>
<td>$1,074,284</td>
<td>$854,790</td>
</tr>
<tr>
<td>2041</td>
<td>$520,921</td>
<td>$877,601</td>
<td>$693,414</td>
</tr>
</tbody>
</table>
LONG LIFE COVER RATIO (LLCR)
Total Income: $13,178,545.13
Total cash value of income: $10,134,379.00
Total expenditures: $4,612,490.80
Total cash value of expenditures: $3,547,032.65
INCOME – CAFÉ

Café employee 25,00%
Café expenditures 10,00%

<table>
<thead>
<tr>
<th>Café size</th>
<th>500,00 ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income/ft²/day</td>
<td>$2.25</td>
</tr>
<tr>
<td>Income/day</td>
<td>$1,126.21</td>
</tr>
<tr>
<td>Income/month</td>
<td>$33,786.23</td>
</tr>
</tbody>
</table>
### Income - Rent

#### Graph:
- **Rent per year**
- **Uniform rent**

#### Table:
<table>
<thead>
<tr>
<th>Year</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform rent</td>
<td>$173,640</td>
<td>$694,562</td>
<td>$520,921</td>
</tr>
</tbody>
</table>

#### Calculations:
- **Total rent over LC** | $17,364,048
- **Total rent over LC/year** | $694,562
- **Total rent over LC/month** | $57,880
- **Total rent over LC/day** | $1,929
- **Total rent over LC/hour** | $80
### Winter Quarter

**DGNB**

- Bronze
- Silver
- Gold

**LEED**

- Passed
- Silver
- Gold
- Platinum

- Building standard
- German legal
- 2012
- Team Central

### Spring Quarter

**DGNB**

- Bronze
- Silver
- Gold

**LEED**

- Passed
- Silver
- Gold
- Platinum

- Building standard
- German standard
- Team Central
Why DGNB?

German standard is one of the DGNB requirements!!!
## Life Cycle Costs

<table>
<thead>
<tr>
<th>Economic Criteria</th>
<th>DGNB</th>
<th>LEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Life Cycle Costs</td>
<td>Blue</td>
<td>Blue</td>
</tr>
<tr>
<td>17 Performance (Space efficiency, Feasibility of Conversion)</td>
<td>Blue</td>
<td>Light Blue</td>
</tr>
</tbody>
</table>

- **High Requirements**
- **Medium Requirements**
- **Low Requirements**
- **Does Not Contain**
**SUSTAINABILITY CERTIFICATION**

**DGNB**
Team Central Achieved 
**GOLD**

**LEED**
Team Central Achieved 
Platinum in USA

<table>
<thead>
<tr>
<th>Topics</th>
<th>Degree of performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological quality</td>
<td>88%</td>
</tr>
<tr>
<td>Economical quality</td>
<td>93%</td>
</tr>
<tr>
<td>Socio-Cultural and Functional quality</td>
<td>75%</td>
</tr>
<tr>
<td>Technical quality</td>
<td>94%</td>
</tr>
<tr>
<td>Process quality</td>
<td>91%</td>
</tr>
<tr>
<td>Location quality</td>
<td>70%</td>
</tr>
</tbody>
</table>

**DGNB - Degree of Performance**

- **Location quality**: 70%
- **Process quality**: 91%
- **Technical quality**: 94%
- **Socio-Cultural and Functional quality**: 75%
- **Economical quality**: 93%
- **Ecological quality**: 88%
VALUE TO MONEY

- Energy Efficiency
- Water Efficiency
- Elevator
- Photovoltaic System
- Café
That’s matter of opinion!!!

Accumulated Cash flow after O+M, Interest and Risk

Accumulated Cash flow after all LCC

Total Investment

Breakeven Point

$8,132,055.14
LIFE CYCLE ANALYSIS (LCA) PROCESS

RESULTS
- Development calculation
- Income
- Sustainability Certification
- Financing

Building information

LC aspects, financing, income

Risks, ecological aspects

Construction costs, resource consumptions
BIM COLLABORATION

(Central File)
TYPICAL WEEKLY MEETINGS

WINTER QUARTER

RIGID

SPRING QUARTER

FLEXIBLE
TYPICAL WEEKLY TIME CYCLES

Fall Quarter

Saturday
Team Meeting
- PRESENTING

Individual

Wednesday
Team Meeting
- PRESENTING

Individual

Spring Quarter

Thursday
Team Meeting
- Time Setup

INDIVIDUAL

SUBGROUP

INDIVIDUAL

SUBGROUP
PRODUCT-ORGANIZATION-PROCESS

Product

Organization

Process

CENTRAL TEAM

ARCH

SE

CM

MEP

LCFM
Ever tried. Ever failed. No matter, try again, fail again, fail better.
LESSONS LEARNED

I learned that I really don’t know anything…but hopefully I know something because of this class.

Set deadlines. Meet deadlines.
LESSONS LEARNED

Europeans love emoticons!

CONSTRUCTION MANAGER
LESSONS LEARNED

NO NO NO!!! HAVE FUN AND WIN!!!
THANK YOU!