TEAM CENTRAL - UCLA

EVA
GERMANY

HAN
CHINA

MELISSA
USA

ALEŠ
SLOVENIA

TAWA
USA

NICOLAJ
DENMARK

BIRTHE
DENMARK

CM
RYAN
USA

LCFM
NORAYR
GERMANY

SE
MANDY
GERMANY

A
JAKOB
DENMARK

LCFM
CM
SE
SE
CM
A
MEP
SITE LOCATION
CONDITION ON SITE
CLIMATE CONDITIONS

Temperature and precipitation

- 80°F
- 60°F
- 40°F

Relative humidity

- 100%
- 70%
- 40%

Sun position

- Solstice
- Equinox
- Solstice

Wind speeds

- 55+ kph
- 55 kph
- 40 kph
- 30 kph
- 19 kph
- 16 kph
- 12 kph
- 7 kph
- 2 kph
SITE CHALLENGES & OPPORTUNITIES

- CONNECTION
- LA TRAFFIC
- ABUNDANCE OF SUNLIGHT
- DEEP WATER TABLE
- EARTHQUAKE
THE LUNGS

EVA // HAN // MELISSA // ALEŠ // TAWA // NICOLAJ // BIRTHE
1st BIG IDEA - THE LUNG

LA: THE MOST POLLUTED CITY IN USA

OXYGEN TO CO\textsuperscript{2} REVERSE?

ADMINISTRATION VS. EDUCATIONAL

MEDICAL CENTRE NEARBY
CONCEPT EVOLUTION

DOUBLE DIAMOND ON SITE

SPLITTING BUILDING OPENING TOWARDS COMMUNITY

INTRUDUCING GREEN ELEMENTS SHADING, FLOW AND VIEWS

ENCLOSING GARDEN
THE BUILDING TO LUNG FOR!
ROOF PLAN

Gayley Ave

Le Conte Ave

NORTH

A
2 x Large Classroom
4 x Restroom
2 x Handi. Restroom
2 x Emergency exit
Technical Room
2 x Instructional Lab
VIEW IN THE GARDEN
FLOOR 2

- 4x Small Classroom
- 6x Student Office
- 3x Seminar Room
- Collaborative Space
- Auditorium
- 6x Restroom
- 3x Handicap. Restroom
- Emergency Exit
- 10x Faculty Office
- Admin. Assist.
- 6x Open Office
VIEW OF ADMINISTRATION WING
EARTHQUAKE!! .....Fasten your seatbelts.
SITE CONDITIONS

Soil conditions

Bearing Capacity 5000 psf

Seismic loads

Sandy soil

Water table: 15 feet

USGS-Provided Output

\[
\begin{align*}
S_s &= 2.245 \, g \\
S_M &= 2.245 \, g \\
S_L &= 0.823 \, g \\
S_{MS} &= 1.234 \, g \\
S_{DL} &= 0.823 \, g
\end{align*}
\]

MCE\textsubscript{R} Response Spectrum

Design Response Spectrum
## BUILDING LOADS

<table>
<thead>
<tr>
<th>Use</th>
<th>Uniform (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>50</td>
</tr>
<tr>
<td>Classroom</td>
<td>40</td>
</tr>
<tr>
<td>Auditorium</td>
<td>100</td>
</tr>
<tr>
<td>Roof</td>
<td>40</td>
</tr>
<tr>
<td>Stairs</td>
<td>100</td>
</tr>
<tr>
<td>Corridors</td>
<td>100</td>
</tr>
</tbody>
</table>

Total base shear 906 kip

- 568 kip
- 310 kip
- 29 kip
STRUCTURAL SOLUTIONS

Steel Design

Concrete and Steel Design
Columns W12
BRBF A_core = 5 in^2
Beams W12 typical
Diagonal HSS
Slabs 3” concrete over 2” metal deck
Columns W12
Beams W12 typical
Steel truss 3'
Slabs 3” concrete over 2” metal deck
HORIZONTAL LOAD PATH

- tension
- compression
Integrated beam

Bracing - BRBF

concept of Buckling Restrained Braces

lateral support against buckling

encasing mortar

yielding steel core

"unbonding" material between steel core and mortar

steel tube
CONCRETE - FLOOR 2

- Shear walls 12”
- RC columns 18” x 18”
- Steel columns W12
- Steel beams W12
- RC beams 18” x 14”
- RC beams 18” x 12”
- RC beams 18” x 18”

NORTH
CONCRETE - ROOF

- Shear walls 12"
- RC columns 18” x 18”
- Steel columns W12
- Steel beams W12
- RC beams 18” x 16”
- RC beams 18” x 12”
- Steel Truss 3’
VERTICAL LOAD PATH

tension  compression
HORIZONTAL LOAD PATHS

- tension
- compression
- AAC (Autoclaved Aerated Concrete) light weight precast composite floor slab
- 30 % lighter
UCLA cogeneration plant

- Heating
- Cooling
- Electricity
- Inlet
- Exhaust
- AHU
- MEP room

 MEP room
UFAD - GROUND FLOOR

- Supply duct
- Outline of plenum
- Return duct
- Vertical supply duct
- Vertical return duct
- Vertical inlet
- Vertical exhaust
- MEP room
FLOOR SANDWICH

<table>
<thead>
<tr>
<th></th>
<th>Overhead</th>
<th>UFAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$14.05/SF</td>
<td>$14.51/SF</td>
</tr>
<tr>
<td>GWP embodied</td>
<td>1.4%</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

- **Overhead**: MEP, Overhead, UFAD, Supply, Return, Chilled beam, Cooling, sprinkling, cable tray
- **UFAD**: 42

The table compares the cost and GWP embodied values for Overhead and UFAD systems.
STV - LUNG

Steel

Carbon (kg CO$_2$-eq)

Water (kg H$_2$O-eq)

Energy (MJ)

Concrete

Carbon (kg CO$_2$-eq)

Water (kg H$_2$O-eq)

Energy (MJ)
<table>
<thead>
<tr>
<th><strong>EQUIPMENT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concrete Pump</strong></td>
</tr>
</tbody>
</table>
| BPL2525-5KVM39X | 1 | ● Boom Length : 39m  
                        ● Max Concrete Output : 210 cubic yards / hour |
| **Excavator** | Unit | Technical Parameters |
| John Deere G250LC | 1 | ● Max Digging Depth : 25ft.  
                        ● Arm Digging Force : 25,224–25,628 lb. |
| **Mobile Crane** | Unit | Technical Parameters |
| Grove TMC540 | 1 | ● Max Lift Capacity : 40 ton  
                        ● Boom Length : 31m (+7.9~13.7m extension) |
| **Forklift** | Unit | Technical Parameters |
| Caterpillar P6000-LE | 1 | ● Max Lift Capacity : 6000 lb.  
                        ● Maximum Lift Height : 15.5 ft. |
| **Scissor Lift** | Unit | Technical Parameters |
| GS 3390RT | 1 | ● Max Lift Capacity : 2500 lb.  
                        ● Maximum Working Height : 39ft. |
SCHEDULE - LUNG STEEL

Start: 09/30/2019

Preliminaries completion: 10/15/2019

Structural frame completion: 03/26/2020

Instrumental lab delivery: 04/28/2020

Whole building completion: 06/17/2020

Landscaping completion: 09/10/2020
SCHEDULE - LUNG CONCRETE

**Start**:
- Preliminaries completion: 09/17/2019
- Structural frame completion: 03/10/2020
- Instrumental lab delivery: 04/24/2020
- Whole building completion: 06/01/2020
- Landscaping completion: 08/24/2020
SITE LOGISTICS

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminaries completion</td>
<td>10/15/2019</td>
</tr>
<tr>
<td>Structural frame completion</td>
<td>03/26/2020</td>
</tr>
<tr>
<td>Instructional lab delivery</td>
<td>04/24/2020</td>
</tr>
</tbody>
</table>
COST ESTIMATE

Steel
$9.3 mil

Concrete
$9.5 mil

H General Conditions, $1,280,000 , 14%
G Building Site Work, $510,000 , 5%
E Equipment & Furnishing, $840,000 , 9%
D Services, $2,300,000 , 25%
CM

A Substructure, $540,000 , 6%
B Shell, $2,600,000 , 28%
C Interiors, $1,140,000 , 12%

H General Conditions, $725,000 , 7%
F Specialty Construction, $250,000 , 3%
E Equipment & Furnishing, $840,000 , 9%
D Services, $2,320,000 , 24%
C Interiors, $1,110,000 , 12%
2nd BIG IDEA - EPICENTER

LA: THE MOST DIVERSE CITY IN USA

EARTHQUAKE ZONE

INTERSECTION OF COMMUNITIES
CONCEPT EVOLUTION

L-SHAPE ON SITE

ADJUSTED TO CONTEXT
POINTING TOWARDS COMMUNITY

INTRODUCING GREEN ELEMENTS
SHADING, FLOW AND VIEWS

PLACEMENT OF AIR-CLEANING
FACADE
THE BUILDING AT THE EPICENTER OF IT ALL!
SECTION OF EDUCATIONAL AREA
VIEW OF ADMINISTRATION AREA
FLOOR 1

- 3 x Small Classroom
- 2 x Student Office
- Seminar Room
- Auditorium
- Collaborative Space
- 6 x Restroom
- 1 x Handicap. Restroom
VIEW OF ROOF TERRACE
AIR-CLEANING DOUBLE FACADE

- AIR-CLEANING FACADE
- PLANT FACADE
- GLASS FACADE
The facade cleans the air of every car that passes the building.
Steel design

Concrete and steel design
BASEMENT

- **Shear walls 10"**
- **Retaining walls 12"**
- **Slab foundations 12"**
- **Waterproof concrete**
- **RETTAINING WALL concrete 12"**
- **membrane waterproofing system**
- **waterproofing mortar**
CONCRETE - GROUND FLOOR

Shear walls
RC columns 18” x 18”
Steel columns W16
RC beams 12” x 16”
CONCRETE ROOF

Steel diagonals W14

RC columns 18” x 18”

Steel columns W16

Steel beams W14

RC beams 18” x 18”
VERTICAL LOAD PATHS

tension

compression
HORIZONTAL LOAD PATHS

- tension
- compression
- Adding vertical columns
- 31% displacement reduction

d = 2.22"

d = 1.53"
Columns W14

BRBF A_core = 6.5 in^2

Beams W8 - W14 typical

Slabs 3” concrete over 2” metal deck
STEEL ROOF

- Columns W14
- BRBF A_core = 6.5 in^2
- Beams W8 - W14 typical
- Columns W16
- Steel Beams W14
- Steel Diagonals W14

Slabs 3” concrete over 2” metal deck
HVAC CONCEPT

UCLA cogeneration plant

- Heating
- Cooling
- Electricity
- Inlet
- Exhaust
- AHU
- MEP room

MEP room
UFAD - BASEMENT

- Supply duct
- Outline of plenum
- Return duct
- Vertical supply duct
- Vertical return duct
- Vertical inlet
- Vertical exhaust
- MEP room
HYBRID VENTILATION CONCEPT
## FLOOR SANDWICH

<table>
<thead>
<tr>
<th></th>
<th>UFAD</th>
<th>Hybrid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air quality</strong></td>
<td>Controlled</td>
<td>Uncertain</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>$14.51/SF</td>
<td>$14.51/SF</td>
</tr>
<tr>
<td><strong>User control</strong></td>
<td>Diffuser</td>
<td>Diffuser and window</td>
</tr>
<tr>
<td><strong>System control</strong></td>
<td>Standard</td>
<td>Complex</td>
</tr>
</tbody>
</table>

- Supply
- Return
- Radiant ceiling
- Cooling, sprinkling, cable tray
STV - EPICENTER

Steel

Carbon (kg CO₂-eq)

Water (kg H₂O-eq)

Energy (MJ)

Concrete

Carbon (kg CO₂-eq)

Water (kg H₂O-eq)

Energy (MJ)
SCHEDULE-EPICENTRE STEEL

Start
09/30/2019

Preliminaries completion
10/15/2019

Structural frame completion
03/25/2020

Instrumental lab delivery
04/28/2020

Whole building completion
06/21/2020

Landscaping completion
09/09/2020
SITE LOGISTICS

Epicentre-Concrete

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminaries completion</td>
<td>09/02/2019</td>
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<td>03/26/2020</td>
</tr>
<tr>
<td>Instructional lab delivery</td>
<td>04/23/2020</td>
</tr>
</tbody>
</table>
COST ESTIMATE

Steel
$9.0 mil

Concrete
$9.2 mil
AIR QUALITY CHALLENGE

THE LUNG
Outside in

THE EPICENTER
Outside out
CONSTRUCTION COST COMPARISON

**Construction Cost Comparison**

- Lung Steel
- Lung Concrete
- Epi Steel
- Epi Concrete

**Updated TVD**

- H General Conditions: 7%
- C Interiors: 15%
- B Shell: 25%
- A Substructure: 10%
- D Services: 28%
- E Equipment and Furnishings: 7%
- F Specialty Construction: 5%
- G Building Sitework: 7%
## Risk Assessment Matrix

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>PROBABILITY</th>
<th>Frequency of Occurrence Over Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>I Project Failure</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>II Degraded Project</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>III Impact to Project objectives</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>IV Little impact to project</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
## QUALITATIVE RISK ANALYSIS

<table>
<thead>
<tr>
<th></th>
<th>Steel</th>
<th>Concrete</th>
<th>Steel</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Procurement</td>
<td>C,II</td>
<td>C, III</td>
<td>B,II</td>
<td>B,III</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>B,II</td>
<td>B,II</td>
<td>B,III</td>
<td>B,III</td>
</tr>
<tr>
<td>Constructability &amp; Delays</td>
<td>B,II</td>
<td>B,II</td>
<td>C, III</td>
<td>C, III</td>
</tr>
<tr>
<td>Occupancy Delays</td>
<td>C,III</td>
<td>D,III</td>
<td>C,III</td>
<td>D,III</td>
</tr>
<tr>
<td>Accidents</td>
<td>D,III</td>
<td>D,III</td>
<td>C, III</td>
<td>C, III</td>
</tr>
<tr>
<td><strong>Points</strong></td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>19</td>
</tr>
</tbody>
</table>
ADDITIONAL CONSTRUCTION PLANS

Pull Planning
Sustainability
Safety Walks

PlanGrid
BuildBiller

Collaboration
4D & 5D Technology

etc......
LIFE CYCLE COST

What we see
35% LCC Cost

What is actually coming
65% LCC Cost

Operation and Maintenance
- Space
- Consumptions

MEP (STV)

CM (TVD)

Initial and Replacement Costs

SE

Safety Solution

Risk Costs

Rent

Debt Service

LCFM LCC

Rent

LIFE CYCLE COST
ADDITIONAL INCOME

Green Cafe

Rent the auditorium to public
TARGET RENT - LUNG STEEL

TVD = $9,300,000

STV = GWP: 111%

Rent Lung Steel = $885,000

Total O+M+R Costs
TVD = $9,500,000

STV = GWP: 154%

Rent Lung Steel = $885,000
Rent Lung Concrete = $895,000

Total O+M+R Costs:
- Replacement: $28,967; 7%
- Repair: $44,517.93; 10%
- Refuse: $7,688.46; 2%
- Security: $16,593.05; 4%
- Cleaning: $111,558.51; 26%
- Heating and Cooling: $72,151.26; 17%
- Management: $24,687.21; 6%
- Caretaker: $20,295.42; 5%
- Water: $40,571.35; 11%
- Waste Disposal: $1,202.52; 0%
- Electricity: $49,719.04; 12%

LCFM
TARGET RENT - EPICENTER STEEL

TVD = $9,000,000

STV = GWP: 161%

Total O+M+R Costs

Rent Lung Steel = $885,000
Rent Lung Concrete = $895,000
Rent Epicenter Steel = $820,000
TARGET RENT - EPICENTER CONCRETE

TVD = $9,110,000

STV = GWP: 197%

Rent Lung Steel = $885,000
Rent Lung Concrete = $895,000
Rent Epicenter Steel = $820,000
Rent Epicenter Concrete = $830,000

Total O+M+R Costs

EPI CENTER CONCRETE - SUM $375,237,54
- Replacement: $34,797; 9%
- Caretaker: $15,115,93; 4%
- Management: $18,440,61; 5%
- Water: $38,771,42; 11%
- Waste Disposal: $1,202,52; 0%
- Electricity all: $37,588,04; 10%
- Heating and Cooling: $72,351,26; 19%
- Cleaning: $105,780,88; 28%
- Security: $12,394,57; 3%
- Repair: $33,253,19; 9%
- Refuse: $5,743,73; 2%

LCFM
<table>
<thead>
<tr>
<th></th>
<th>Steel</th>
<th>Concrete</th>
<th>Steel</th>
<th>Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction time</td>
<td>48 weeks</td>
<td>48 weeks</td>
<td>48 weeks</td>
<td>51 weeks</td>
</tr>
<tr>
<td>Early Occupancy Date</td>
<td>April 28</td>
<td>April 24</td>
<td>April 28</td>
<td>April 23</td>
</tr>
<tr>
<td>Construction risk</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>Construction cost</td>
<td>$9,300,000</td>
<td>$9,500,000</td>
<td>$9,000,000</td>
<td>$9,200,000</td>
</tr>
<tr>
<td>GWP</td>
<td>113%</td>
<td>117%</td>
<td>112%</td>
<td>116%</td>
</tr>
<tr>
<td>Energy (MJ) 50 years</td>
<td>107,114,158</td>
<td>109,216,392</td>
<td>104,645,905</td>
<td>106,378,151</td>
</tr>
<tr>
<td>Water (kgH₂O-eq) 50 years</td>
<td>396,805,056</td>
<td>400,207,452</td>
<td>401,373,496</td>
<td>404,714,683</td>
</tr>
<tr>
<td>Life cycle cost</td>
<td>$432,000</td>
<td>$423,000</td>
<td>$375,000</td>
<td>$375,200</td>
</tr>
<tr>
<td>Rent</td>
<td>$885,000</td>
<td>$895,000</td>
<td>$820,000</td>
<td>$830,000</td>
</tr>
</tbody>
</table>
CRITERIA FOR DECISION MATRIX

Scoring of the criteria

- Design Team
- Owners
- Users

Decision weighting:
- 50% Owners
- 45% Design Team
- 5% User
DECISION MATRIX

Best - 4 Points
Worst - 1 Point

Lung Steel: 256
- Functionality: 4
- Construction cost: 1
- Earthquake challenge: 0
- Consistency Big Idea: 2
- Complexity: 0
- Atmosphere: 3
- Air Quality Challenge: 0
- Energy (MJ) 50 years: 2
- Aesthetics: 1

Lung Concrete: 201
- Functionality: 2
- Construction cost: 3
- Earthquake challenge: 0
- Consistency Big Idea: 1
- Complexity: 0
- Atmosphere: 3
- Air Quality Challenge: 0
- Energy (MJ) 50 years: 2
- Aesthetics: 0

Epicenter Steel: 301
- Functionality: 3
- Annual Rent: 5
- Construction cost: 1
- Earthquake challenge: 2
- Consistency Big Idea: 0
- Complexity: 1
- Atmosphere: 3
- Air Quality Challenge: 0
- Energy (MJ) 50 years: 2
- Aesthetics: 1

Epicenter Concrete: 241
- Functionality: 2
- Annual Rent: 4
- Construction cost: 3
- Earthquake challenge: 1
- Consistency Big Idea: 0
- Complexity: 1
- Atmosphere: 2
- Air Quality Challenge: 0
- Energy (MJ) 50 years: 2
- Aesthetics: 0

TEAM
WINNER

TEAM
No Emails!
COORDINATION | COLLABORATION

TEAM
COORDINATION | COLLABORATION

TEAM
Team Process Example: **Peer Review**

- **Issue**
  - no designated person to submit
  - delayed response in Slack

- **Conflict Resolution**
  - team meeting agenda item
  - listen to each perspective
  - brainstorm solutions

- **Solution**
  - new role = submission lead
  - thumbs up
THANK YOU!

NICOLAJ
A
CM

HAN

MELISSA
SE

ALEŠ
SE

TAWA
CM

EVA
LCFM

BIRTHE
MEP