Greetings from TEAM CENTRAL CALIFORNIA
The Cast

Project Team and Owners
Project Members

Team

Anders Hefting (MEP)
DTU Copenhagen, Denmark

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UW Madison, USA

Wenjie Kong (CM)
Stanford University, USA

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Bauhaus University, Germany
Project Members

Owners

Renate Fruchter (Superowner)
USA

Sohan Mone (SE)
USA

Kourosh Salehzadeh (CM)
Sweden

Borys Wesolowski (A)
Poland

Vikash Soni (MEP)
India
The Set

Project Location and Site
Macro Location

At the Heart Of The Sunshine State

Annual Temperature Distribution

Annual Rainfall Distribution

3.254 h sun p.a.
Site View - South West

Entrance to UCLA Campus
Neighbourhood View - North West

Concrete, Traffic, & More Concrete
SWOT Overview

Site Characteristics

**Hazards**
- Earthquakes
- Santa Ana Winds

**Weather**
- Mild/ Hot Climate
- Intense Sun
- Water Shortage

**Site**
- Dense, Sandy Soil
- Deep Water Table
- Tight Site

**Surroundings**
- Noise-Sensitive Neighbourhood
- Concrete Architecture

**Traffic**
- Traffic Jams
- Air Pollutions
- Good Connections
Winter Quarter

Concept Selection

Integrate Disciplines - Build Sustainably - Meet Owner Preferences
The Trailer

Big Idea and Project Overview
Concept Development

The Big Idea

Circularity

User Well-Being

THE CRADLE
A Building For People & Planet
# Challenges

## Integrating People, Building and Planet

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<th>People</th>
<th>Planet</th>
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<td><strong>Prefabication</strong></td>
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<td>Time, Cost &amp; Quality Rewards</td>
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<td>Be Inclusive</td>
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<td>Be Efficient</td>
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<td>Circularity</td>
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<td></td>
<td></td>
<td>Tracking</td>
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</table>
Architecture - Structure - Services - Integration - Construction

Envisioning A Cradle For People and Planet
Building the Cradle

Concept Development

People Flow  Subtracting Mass  Extruding Cantilevers  Framing through Excavation
Building the Cradle
Ground Floor

- Workshop
- Auditorium
- Stair, Shaft, Restroom, Showers
- Large Classroom
- Storage (Under Audi.)
- Mechanical Room A
- Mechanical Room B
Building the Cradle
Section - Atrium

Be Inclusive

Newspaper Wood
Mosa.
Interactive Smart Wall
PLANETREUSE
Building the Cradle

Section - Auditorium
Building the Cradle
First Floor

114’

Seminar Room
Auditorium
Stair, Shaft, Restroom, Storage
Small Classroom
VR - Lab
Instructional Lab
Space Plans

A Cradle For Innovation

CREATE

CONTROL

COLLABORATE

COMPETE

See

Do

Be Inclusive

Think

Connect
Engaging the Occupants

Workshop & Events
Repairing and Sharing

Guidance & Feedback
Making Waste Collection Fun
Structure

Architecture - Structure - Services - Integration - Construction

Ensuring Safety and Serviceability
Los Angeles, California

Seismic Parameters

Risk Category: III
Site Class: C

SDC D Seismic design category
$F_a$ 1.2 Site amplification factor at 0.2s
$F_v$ 1.4 Site amplification factor at 1.0s

Design Horizontal Response Spectrum

Sa(g)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40

Period (s)
0
2
4
6
8

Highest hazard
Lowest hazard

LA

≥ IX
VIII
VII
VI
V
IV
III
Engineered Timber

Total Height 38'

Lateral Resisting System
CLT Rocking Walls

Cantilever Support
Steel-Timber Truss

Framing System

CLT Panels

Glulam

Beams

Columns
## Gravity Design
### Safety in the Day-to-Day

<table>
<thead>
<tr>
<th>Usage</th>
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<tr>
<td>Offices</td>
<td>50</td>
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<tr>
<td>Small Classrooms</td>
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<tr>
<td>Large Classrooms</td>
<td>60</td>
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<tr>
<td>Auditorium</td>
<td></td>
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<tr>
<td>Upper Floor Corridors</td>
<td>80</td>
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<td>Ground Floor Corridors</td>
<td>100</td>
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<tr>
<td>Lobby &amp; Stairs</td>
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<td>MEP Room &amp; Storages</td>
<td>125</td>
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**RFEM Model:** Design Timber and Steel Members
Framing Plan

Foundation and Slab on Grade

36” x 36” x 12” Isolated Footing
80” x 80” x 20” Isolated Footing
80” x 20” Strip Footing
12” x 24” Grade Beam
24” x 27” Concrete Column
27” x 32” Concrete Column

6” Reinforced Concrete Slab on Grade
Cantilever Support

Ensuring Serviceability

All Steel Truss Members
HSS8x8x3/8

Allowable Deflection: L/180 = 38x12/180 = 2.53” > Maximal Actual: 1.22”
Keeping the Cantilevers Safe
Typical Locations and Auditorium

Ensuring Serviceability

Typical Locations

Allowable Deflection: \( \frac{L}{360} = \frac{19 \times 12}{360} = 0.633'' > \text{Max. Actual} = 0.553'' \)

Auditorium

Allowable Deflection: \( \frac{L}{360} = \frac{38 \times 12}{360} = 1.26'' > \text{Max. Actual: 1.12''} \)
Typical Connections
Designing for (Dis)Assembly

Column to Foundation

Column to Column

Be Efficient
Typical Connections

Designing for (Dis)Assembly

Panel to Column

Beam to Beam

Panel to Panel

Be Efficient
Seismic Design

Safety in the Unexpected

Lateral Loads

**DBE**
- 231 KIP
- 339 KIP
- 138 KIP
- 72 KIP

Base Shear = 790 KIP

**MCE**
- 362 KIP
- 508 KIP
- 208 KIP
- 108 KIP

Base Shear = 1186 KIP

Seismic Analysis in ETABS

First Mode shape
T1=1.15 sec

Be Flexible
Rocking Walls

Design for Resilience

Connections to Frame - Ductile Krawinkler Butterfly Fuses
Deformation Limited to Fuses
Krawinkler Fuses
Design for Resilience

Properties:
- Predictable + Controlled Deformation
- Easily Replaceable
- Simple Fabrication

Benefits:
- Limit Extent of Damage
- Prevent Building Closure
- Reduce Cost to Repair

Resilience: Existing Constantly In Danger

Be Flexible
Performance Based Engineering
Design for Resilience

Design Basis Earthquake (<1.2% Story Drift)

- Story Drift = 1.1%
- Immediate Occupancy (IO)
- No Building Closure

Max. Considered Earthquake (<5% Story Drift)

- Story Drift = 1.7%
- Collapse Prevention (CP)
- Occupant Safety Ensured

Non-Linear Analysis of Simplified Beam-Truss Model
Backbone Curve Definition
Integrating People, Building & Planet

Building The Cradle

Circularity

User Well-Being

DfD: Structural Connections
Timber Structures

Rocking Walls for Earthquake Safety
Services

Architecture - Structure - Integration - Construction

Adaptable Ventilation and Independent Energy Supply
Primary Energy System

Self-Sufficient Micro-Grid

Primary Energy Production
PV Panels (Roof & Skylight)

Energy Transformation
PV & Battery Inverters

Energy Storage
Energy Pod Batteries

Back-Up Energy
Connection to University Grid

Electricity Distribution
Daytime: Direct
Nighttime: Batteries
Secondary System

Underfloor Ventilation System

Be Flexible
Ventilation Use Schematic

Indoor Climate Zones

Ground Floor

First Floor

Second Floor

- Variable use - Classrooms
- Exhaust - Toilets, technical rooms
- Heavy load - Auditorium

- Continuous use - Atrium, hallways
- Continuous use - Offices

Be Efficient
System Integration

Distribution Plans

Ground Floor

First Floor

Second Floor

Electric

MEP

Shaft
Supply
Exhaust

Return inlet
Supply outlet

Be Flexible
Responsive Ventilation

Regulation through IoT

Low outside air pollution

Hot Air Blown Into Atrium

High outside air pollution

Hot Air Taken To AHU

Be Flexible
Ventilation Resilience

Prepared for Disruption

Normal Conditions

One Broken AHU or Floor Closure

Two Broken AHUs

Power Failure
Hydraloop Cascade System

6 Units for Water Recycling

Building Water Consumption: ~ 85%
Integrating People, Building & Planet

Building The Cradle

Circularity

User Well-Being

Independent Energy Supply

Hydraloop Water Treatment

Resilient Ventilation

Flexible Thermal Control

Natural Ventilation
Facade Design and Construction
The Iconic Facade

A Collaborative Design Process

CM

Having similar panels will reduce construction time!

SE

We need structural support in the cantilevers and simple connections for DfD!

A

What about circular materials?

MEP

The most important is daylight inside!
Skylight and Facade Design

Simple, Effective Shading

Circular design needs a simple, but efficient shading solution!

 MEP

South East Classroom

Low Sun

9 AM

12 AM

3 PM
Skin

Facade Panel Design

Ground Floor

First Floor

Second Floor

Type A

Type B

Type C

Type D

Type E
Skin

Facade Panel Design

Schematic Connection
Balancing Safety, Design and Cost

- **Rammed Earth**: $75/sf
  - Good thermal properties!
  - The panel weight is a nightmare!

- **Accoya Wood**: $200/sf
  - Accoya is too expensive! We can’t afford it!

- **Plywood**: $80/sf
  - Wood will be a nice contrast to the concrete!

- **Aluminium**: $90/sf
  - How about aluminium offcut?

**MEP**

**SE**
Peak Day Workflow

Facade Installation Process
Peak Day Workflow

Construction KPI

- Truck Delivery to Material Laydown Area: 1 min ± 10 sec
- Truck Unloading: 15 min ± 5 min
- Crane Lifting Panels to Erection Zone: 10 min ± 3 min
- Installing Panels: 20 min ± 5 min
- Truck Leaves: 1 min ± 10 sec
Peak Day Workflow

Panel Delivery and Installation Time

Upper Control Limit
60.37 min

Average Time
46.23 min
Integrating People, Building & Planet

Building The Cradle

DfD: Facade Panels
Circular Materials

User Well-Being
Controllable Shading No Glare

Circularity
Architecture - Structure - Services - Integration - Construction

Atrium Design and Construction
Atrium Design

A Cradle for Innovation

How can we build the cantilevered spaces?

MEP
It is too dark in the hallways!

CM

SE
We will make a secondary support for the skylights!

A
The skylight area has to be match nicely with the cantilevers!
Skylight Design

Integrating Lighting and Structural Design

First Iteration

Second Iteration
What the Owners Want

Rewards
- Better Quality
- Lower Cost
- Shorter Time
Evaluation Prefab Options

What the Construction Managers See

- Risks
- Overhead Work
- High Edges
- Spatial Conflicts

Fuzor
Steps to Sharing Risk & Reward

DPR Challenge

Risk Matrix

Prefab Evaluation

Shared Risk and Reward
Assembling the Atrium

To Industrialize or Not to Industrialize?

Prefab Panels?

Prefab Boxes?

Traditional Assembly?
Assembling the Atrium

Shared Risk between Parties & Phases

Mitigate in Construction
- Delay Impact
- Spatial Conflicts

Affected Parties
- GC, Subs, Owners

Avoid in Planning
- Injuries
- Heavy Lifts
- Defective Work

Affected Parties
- GC, Subs

Affected Parties
- GC, Subs, Users, Architects, Owners
Prefab Evaluation
Measuring Safety Risks

Injuries
Cutting/Welding

Heavy Lifts
Item Weight/Size

Defective Work
Components Installed on Site

Single Elements
Cutting on Site
6 - 9 lbs (studs)
3’x12’ (gypsum)
21 Windows, 84 Boards, Cladding/Studs/Insulation

Prefab Panel
No Cutting/Welding
72/154 lbs
9’x12’x8”/ 19’12”x8”
28 Panels (3 Types)

Prefab Box
No Cutting/Welding
520 lbs
19’x19’x12’
7 Boxes
Prefabrication

Measuring Logistics Constraints

**Single Elements**
- Interior Works
- Parallel MEP Works
- Drywall Crew
- Carpenter Crew
- 45% Crew Utilization

**Prefab Panel**
- Interior Works
- Parallel MEP Works
- Assembly Crew
- 49% Crew Utilization

**Prefab Box**
- Structural Sequence
- Critical Path
- Assembly Crew
- 45% Crew Utilization

**Delay Impact**
- Critical Path

**Conflicts**
- Trades on Site
Space Plans

Comparing Rewards

Rewards
- Shorter Time
- Lower Cost
- Better Quality

Single Elements
- 191 Working Days
- 8,542,000 USD
- Manual Component Assembly

Prefab Panels
- 188 Working Days
- 8,511,000 USD

Prefab Boxes
- 177 Working Days
- 8,490,000 USD

Exposure to Outdoor Pollution and Sun

Can we optimize schedule & costs?
Optimizing The Chosen Scenario

Panel Assembly

Unlimited Resources

Base Schedules

Adjusted Crew No.

Labor Crews: 3 > 5  
El. Crews: 1 > 3  
HVAC Crews 1> 3

Project Duration: 175 Workdays  
(excl. Site Preparation, Excavation & Landscaping)
Integrating People, Building & Planet

Building The Cradle

Prefab Panels

Circularity

User Well-Being

Natural Light in All Rooms
Architecture - Structure - Services - Integration - Construction

Turning Designs into Reality
Construction Implications

Safety at the Construction Site

Risk Matrix

- Noise on site
- Heat, intense sunlight
- Dust/ Air pollution
- Falling/ Slipping
- Open electrical equipment
- Lack of knowledge/experience of staff
- Noise off site
- Work below lifted elements
- Misunderstanding of instructions
- Non-compliance with instructions
- Work with risk for eye injuries
- Work/installation of heavy components
- Inappropriate equipment use
- Work area interfering with vehicle path
- Work in high winds
- East winds
- South winds
- Santa Ana Winds

SITE SAFETY

Safety Rules

BIM on Site

Morning Meetings

Smart Devices

Temporary Support
Construction Implications

Safety in Emergencies

- Noise on site
- Heat, intense sunlight
- Dust/ Air pollution
- Falling/ Slipping
- Open electrical equipment
- Lack of knowledge/experience of staff
- Noise off site
- Work below lifted elements
- Misunderstanding of instructions
- Non-compliance with instructions
- Work with risk for eye injuries
- Work/installation of heavy components
- Inappropriate equipment use
- Work area interfering with vehicle path
- Work only
- Eastern US
- The West
- Santa Ana Winds

- Fall Protection
- Covid-25 precautions
- Evacuation Assembly Point
- Emergency Training
- Mobile Hazard Reporting
Site Layout

Excavation

Residential Area

Highway

Le Conte Ave

Le Conte Ave

Le Conte Ave

Le Conte Ave

Volvo ECR 25
Max. digging depth: 10ft
Electric motor: 30kW

Legend
- Excavator
- Dump Truck
- Site Trailer
- Portable Toilet
- Hand washing station
- Recycling Bins
- Tire Washing Pad
- Parking
- Rental site office
- Heavy transport
- Light transport (dumpster etc.)
- Gates
- Evacuation point
- Site Fencing (Noise blocking wall)
Site Layout

Substructure

Legend
- Concrete Pump
- Site Trailer
- Portable Toilet
- Hand washing station
- Recycling Bins
- Material Laydown
- Tire Washing Pad
- Parking
- Rental site office
- Heavy transport
- Light transport (dumpster etc.)
- Gates
- Evacuation point
- Site Fencing (Noise blocking wall)

Putzmeister 28Z - Meter
Reach from front of truck: 70'
Reach depth: 55'
4D Fuzor Animation

Building The Cradle
Combining Human And AI Scheduling

MS Project Baseline Schedule

ALICE - Schedule Optimization

Project Duration: 175 Workdays
(excl. Site Preparation, Excavation & Landscaping)

Site Work & Close-Out: 50 Workdays

Total: 225 Workdays

Time Impact

253 Workdays
## Economic Impact

### Project Budget

<table>
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<th>Description</th>
<th>Amount</th>
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<td>Initial Construction Grant</td>
<td>USD 12,000,000</td>
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<td>Budget Increase</td>
<td>USD 14,400,000</td>
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<td>Budget</td>
<td>USD 15,211,485</td>
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<tr>
<td>Target</td>
<td>USD 15,200,000</td>
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- **Grant Year**: 2020
- **Construction Year**: 2024
- **Expected Inflation**: 2.25%
- **Return On Investment**: 3.00%
Cost Breakdown

Comparing Target and Cost Distribution

Target

Cost
Cost Breakdown

Comparing Target and Estimated Costs

Target Value
$ 15.2 M

Estimated Cost
$ 15.1 M

Square Foot Cost
$ 475/SF
Cost Evolution

Understanding Design/Cost Impacts

- Underfloor Ventilation Accoya Wood Facade
- Traditional HVAC Rammed Earth Facade
- Pretty Plastic Atrium Plywood Facade
- Newspaper Wood Atrium Aluminium Facade Skylight Design

Targets:
- April 3 Fishbowl
- April 17 DPR Week
- April 24
- May 1 Spring Presentation
Focus on National Suppliers

- **Spokane/Tracy**: Structural Steel & Wood
- **Los Angeles**: Curtain Walls, Exterior Windows, Interior Windows & Doors, PV Panels, Concrete & Rebar, Equipment Rental, Facade Cladding
- **Canada**: Timber Supply
- **Milwaukee**: Water Treatment
- **Chesapeake**: Aluminium Supply
- **Mexico**: PV Panel Fabrication
- **Arizona**: Insulation
- **Georgia**: Ventilation Systems
The Box Office Records

Project KPIs and Summary
Building The Cradle

Concept Background

Circularity

User Well-Being

Recycling Workshop
Waste Collection
Prefab Panels
Learning Type Spaces
Smart Green Walls
Meeting Spaces
Plaza & Atrium
Earthquake Safety
Flexible Thermal Control
Resilient Ventilation

DfD: Facade Panels
Circular Materials
Independent Energy Supply
Water Treatment
DfD: Structure Connections
Timber Structures

Natural Ventilation
Interactive Smart Wall
Natural Light in All Rooms
Focus on User Well-Being

People

- No Indoor Air Pollution
- Water Reuse
- Designated Eating Spaces
- Daylight Simulation
- Aesthetic Circulation
- Flexible Thermals
- Acoustic Ceilings
- Material Recycling
- Restorative Spaces
- Community Spaces
Planet

Circularity Tracking

39%  
April 8th

69%  
April 12th

83%  
May 2nd
Product and Process Goals

Integrating People, Building and Planet

[Diagram showing the integration of People, Building, and Planet]
The Oscar Shortlist

Challenge Summaries
Sustainability Challenge

Resilience

Be Flexible
- Rocking Walls: Less Damage & Downtime
- Adaptable UF Ventilation System

Be Ready
- Self-Sufficient Energy Supply
- Disruption Response in Use and Construction

Be Efficient
- Material Re-Use
- Design for Disassembly
- Hydraloop Water Treatment

Be Inclusive
- Open Repair Workshops
- Nudging Users to Circular Thinking
- Learning Type Spaces

Be Welcoming
- Atrium & Plaza: Innovation & Meeting Point
- Focus on Occupant Well-Being
DPR Challenge

Industrialization - Risk & Reward

Identifying Risk
- Project Team Risk Matrix
- Type & Phase Classification
- Ranking Impact & Probability

Sharing Risks & Rewards
- Risk Management Strategies
- Inclusion of Affected Parties
- Planning & Construction Responsibilities

Measuring Risks & Rewards
- Cost
- Schedule
- Quality
- Logistics
- Safety

Human

VR & AI
Buro Happold Challenge

Intelligent Interoperability

Product
- One Click LCA
- Circularity Tracking

Process & Product
- ALICE Technology
- Prefab Evaluation

Process
- Fuzor
- Quantity Take-Offs for Cost Estimate

Organization
- Excel
- Team Survey Statistics

Better Informed Decisions
- AI Result Validation
- Transparent Communication
- Reaction to Team Inefficiency

Quicker Response to Changes
- Faster Cost Estimates
- Direct Accurate Model Data

Impact Understanding
- 44% Circularity Increase
- 28 Days Shorter Schedule
- Team Strategy Evaluation
Behind The Scenes

Team Process
Spring Quarter Structure

Our IT Ecosystem

Coordination

Communication

Collaboration
Project Journey

Improving Collaboration and Coordination

Team Voting Average

Response Time

Feedback

Transparency

March 22
End WQ

March 29
Revision

April 5
Fishbowl

April 12
Start SQ

April 19

April 26

Test Period

Use with All Team Mates

Discipline Days

asana

slack
Spring Quarter Structure

A Week In Team Central

Daily Subgroup Meetings

VR
Mo
A Day

VR
Tue
SE Day

Wed
MEP Day

Thu
CM Day

Fri
Weekly Class

Sat
Survey & Project Update

VR
Sun
Team Meeting

10 Min - 5 Hours
2 - 3 Team Mates

2 - 3 Hours
2 - 6 Teammates

2 Hours
Team & Owner
Team and Owner Integration

Virtual Design and Construction

Design Exploration

Clash Detection

User Experience

Site Logistics
Only through dialogue and discourse can concepts become concrete.

When everyone puts their ego aside and replaces “me” with “us”, things work nicely and goals can be achieved perfectly.

Don’t be afraid to share crazy ideas! Your team can help you refine it into something realistic.

As a multidisciplinary team you can achieve so much more in a design than individual professions could!

Try to put yourself into the other disciplines’ perspective – it makes the interaction easier and better!

All the high-tech enable us to visualize our ideas and make our design and construction process more efficient!
Outtakes and Credits
Concept Iterations

Digital Team

Concerts

Daily Zoom Meetings

Zoom meeting, audio only

Zoom meeting with video

Professional Chef

Just a by the by: "private" messages sent to individual people during a Zoom meeting show up in the end-of-meeting transcript along with all other public messages. Tell your friends, save a life.

Budget Struggles

Mini Golf and Selfies in VR

Director’s Cut

Outtakes

Our building is super cool but we are poor. We don’t have that much money😢

Poor CMs😢😢😢

can set up a donation box in 2020 so we are rich by 2025 😁

We can advertise and collect money

To become rich CMs, hahaha

gofundme.com 😳

Anders

Hahaha I see. I would have to beg for money 😞
Credits

Thank You!

Super Owner
Renate Fruchter

Owners
Borys Wesolowski
Kourosh Salehzadeh
Sohan Mone
Vikash Kr Soni
Credits

Thank You!

Mentors
Sven Staiger
Kai Stedtler
Greg Luth
John Nelson
Adhamina Rodriguez

Carlo Markmeyer
Forest Peterson
Plamen Ivanov
Prashant Sharma
Mike Miller
Glenn Katz

... And Everyone Else Who Contributed To Making This Project An Unforgettable Experience!