1:1 IAP – Troll Station

Group 4
Anaelle Mathieu
Niels Koenraad
Luca Marchetti
Aashna Singh
Sohyun Park
Ilai Debazi

00 **Index**
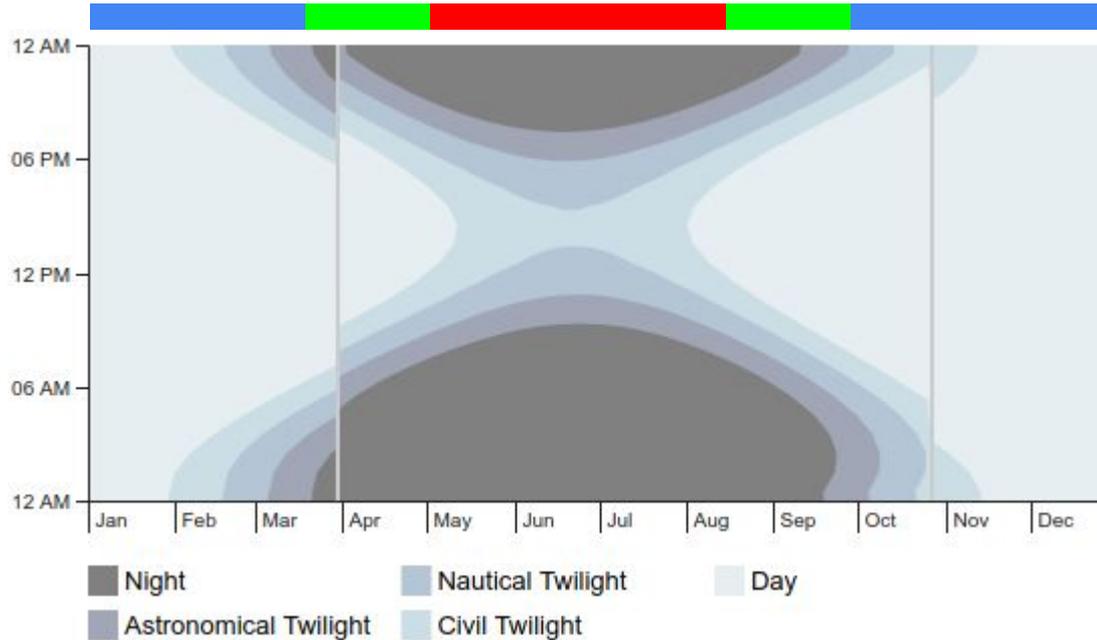
Night
Astronomical Twilight
Nautical Twilight
Civil Twilight
Day

Arctic Summer (Midnight Sun) (~ 4 months)

Arctic Winter (Polar Night) (~ 4 months)

Transition (Spring+Autumn) (~ 4 months)

■ **Arctic Summer (Midnight Sun)**
(~ 4 months)

■ **Arctic Winter (Polar Night)**
(~ 4 months)

■ **Transition (Spring+Autumn)**
(~ 4 months)

Aurora

Polar Stratospheric Clouds (PSC)

Diamond Dust

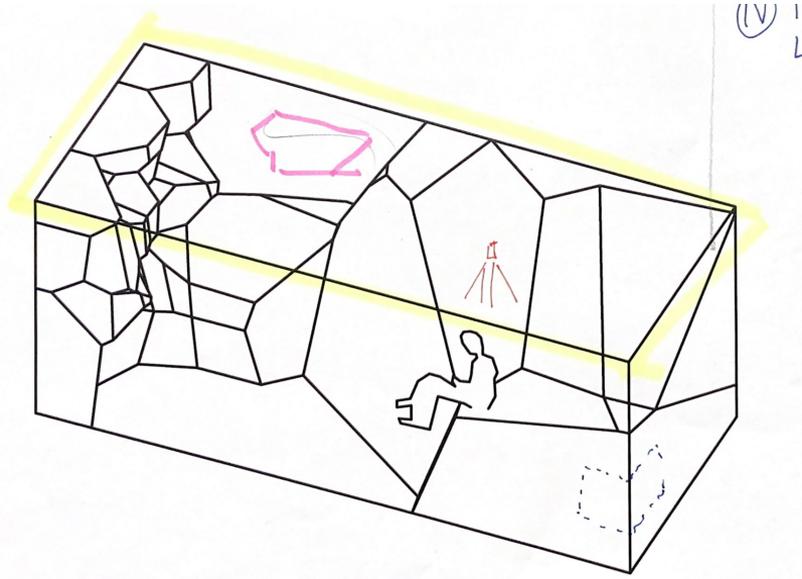Lenticular Clouds

Integration of Light

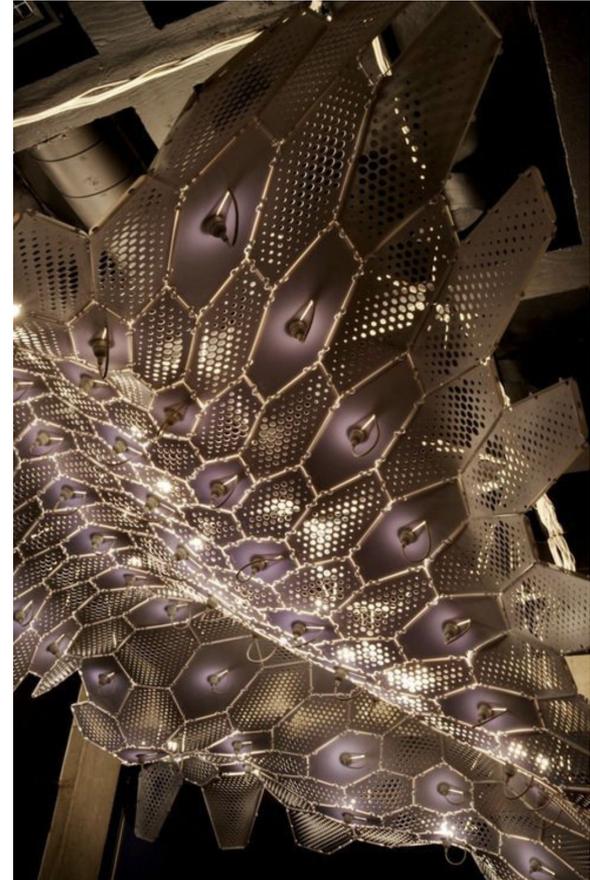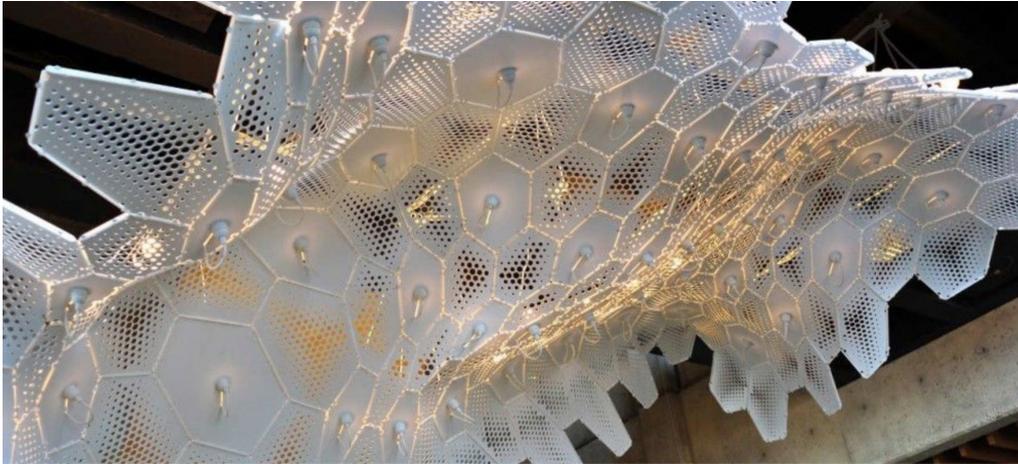**(I) Skylight**   **(II) Light as Spectacle**   **(III) Individual Lighting**   **(IV) Light Therapy**

02 Integration of light: **Skylight**

- \+ Human Activity Recognition (HAR)
- \+ Reacting to different temporalities
- \+ Performative Uses (i.e. Wind blowing through leaves
- \+ Hue, brightness and color-temperature
- \+ Panels integrate Ventilation; fire detection; adaptive lighting; environmental sensors; acoustic absorption

1:1 Interactive Architecture Prototype - Troll Station

02 Integration of light: **Skylight**

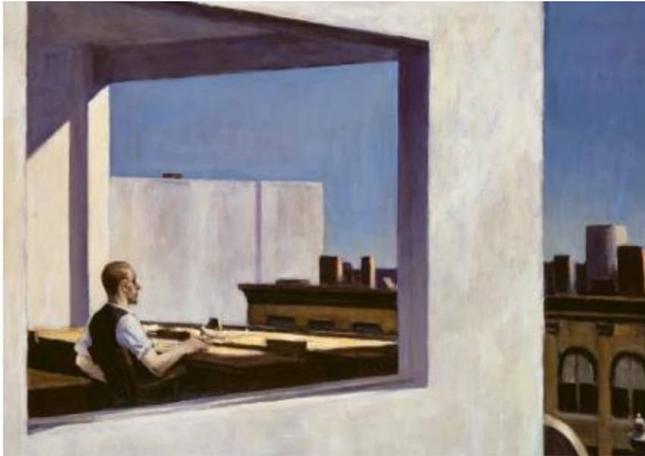**(I)** **Skylight**
- \+   Human Activity Recognition (HAR)
- \+   Reacting to different temporalities
- **+**   **Performative Uses (i.e. Wind blowing through leaves**
- \+   Hue, brightness and color-temperature
- \+   Panels integrate Ventilation; fire detection; adaptive lighting; environmental sensors; acoustic absorption

(II) Light as Spectacle (Walls, Window)
+ Computer Vision (CV) translates outdoor environment into spectacle
+ Reacting to different temporalities
+ **Performative**
+ Cognitive Stimulation and Psychological orientation
+ Shows live from outside
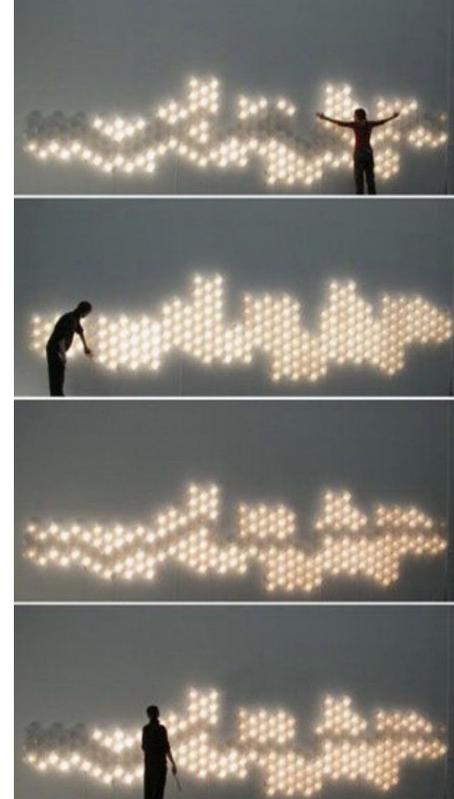
(II) **Light as Spectacle (Walls, Window)**
- + Computer Vision (CV) translates outdoor environment into spectacle
- + Reacting to different temporalities
- + Performative
- **+ Cognitive Stimulation and Psychological orientation**
- + Shows live from outside

(III) **Individual Lighting**
+ Autoregressive Integrated Moving Average (ARIMA) and Ventilation Autoregressive (AR)
+ Personalized circadian cycle
+ Personalized atmospheric lighting
+ Personalized Hue and Brightness
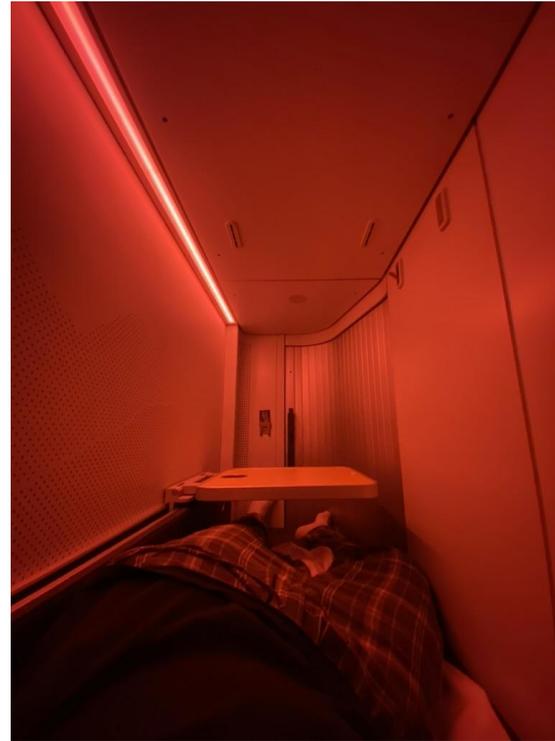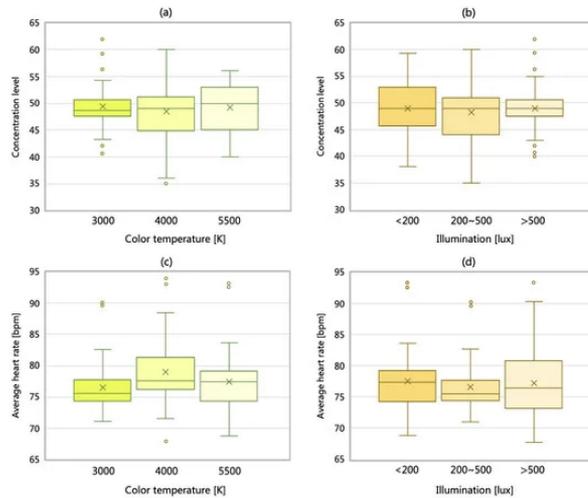
(IV) **Light Therapy**
- +   Red-light (630–850nm) for recovery + mood
- +   10,000 lux daylight therapy for winter activation
- +   adaptive circadian cycle (seasonal sunrise–sunset + summer dimming) (ML) (DL)
- **+**   **AI–controlled lux/CCT via biometric feedback (ML) (DL)**
- +   glare-free integrated panels with timed exposure

03 Physiological Implication: **Effects on the body**

■ **Arctic Winter (Polar Night)**
(~ 4 months)

■ **Arctic Summer (Midnight Sun)**
(~ 4 months)

■ **Transition (Spring+Autumn)**
(~ 4 months)

Melatonin elevation, depressive symptoms, phase delay

Sleep suppression, circadian desynchronization

Rhythm instability, adaptation stress

Period	Approx. Months	Light Duration	Color Temperature	Contrast	Circadian Risk
Winter (Polar Night)	~4 months (mid-May–mid-Aug)	0h direct sun	Cool starlight / deep blue	High night contrast	Melatonin elevation, depressive symptoms, phase delay
Summer (Midnight Sun)	~4 months (mid-Nov–mid-Feb)	24h sun	Cool-white, high UV	Low horizon contrast	Sleep suppression, circadian flattening
Transition (Spring + Autumn)	~4 months total (Mar–Apr + Sep–Oct)	Rapid change (0→24h or 24→0h)	Warm pastel gradients at low sun angle	High chromatic variation	Rhythm instability, adaptation stress

03 Physiological Implication: **Effects on the body**

SLEEP WAKE CYCLE

LEVEL IN BLOODSTREAM

NOON   6 PM   MIDNIGHT   6 AM   NOON

● **CORTISOL**   ● **MELATONIN**

The hormonal dance between cortisol and melatonin is the true **"biological clock"**
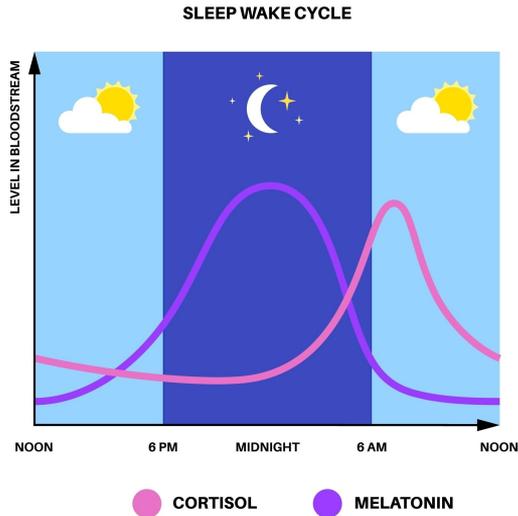
To rebalance these hormones, especially in Antarctica, we must act on three levels: **Light, Temperature, and Timing.**

Circadian Hygiene Strategies:

- The Morning "Light Shower"
  Exposure to cool light (high color temperature, >5000K, 10000 lux) and high intensity for at least 20–30 minutes immediately upon waking. It synchronizes the start of the "16-hour wakefulness" that will eventually trigger melatonin production.

- The "Artificial Sunset"
  Two hours before sleep, transition to warm (<2700K) and dimmed lights, eliminating blue frequencies, allowing melatonin levels to rise.

- Stress Management
  If cortisol remains high in the evening, due to work stress or intense exercise, melatonin cannot take over. If sensors detect a high heart rate or restless movement in the evening, the system can further dim the lights and shift the palette toward amber tones to induce relaxation.

03 Physiological Implication: Lights & 24/7 Activities

Deep Sleep (III)(IV)
0-5 lux - 1800-2200 K; Light must be virtually absent

Wake-up – Light Shower (IV)
5-10.000 lux - >5000 K; Cortisol stimulation

Hygiene (Morning) (III)
300-500 lux - 4000-5000 K; Bright, neutral light for activation

Breakfast (I)(II)
250-400 lux - 3500-4500 K

Light Stretching (III)
200-300 lux - 3500-4000 K

Gear Prep (III)
500-750 lux - 4000-5000 K, High visibility for safety

Deep Focus Work (III)
750-1000 lux - 5000-6500 K, High illuminance improves attention and cognitive performance

Lunch (I)(II)
300-400 lux - 3000-3500 K, warmer to aid post-work relaxation and digestion

General work (III)
500-600 lux - 4000-5000 K, Standard professional lighting

Shower (III)
150-300 lux - 2700-3000 K

Community Dinner (I)(II)
200-350 lux - 2700-300 K; warm atmosphere

Debrief (I)(II)
300 lux - 3000-3500 K

Social Gaming (I)(II)
150-300 lux - 2700-3000 K, soft ambient light

Relax (I)(II)
50-150 lux - 2200-2700 K, Stimuli reduction

Reading (III)
300-500 lux - 2700-3000 K; Direct localized spot

Music (III)
50-200 lux - 2200-2700 K; Sensory, non-functional atmosphere

Storage Access (III)
200-300 lux - 3000-4000 K; functional but not overly activating
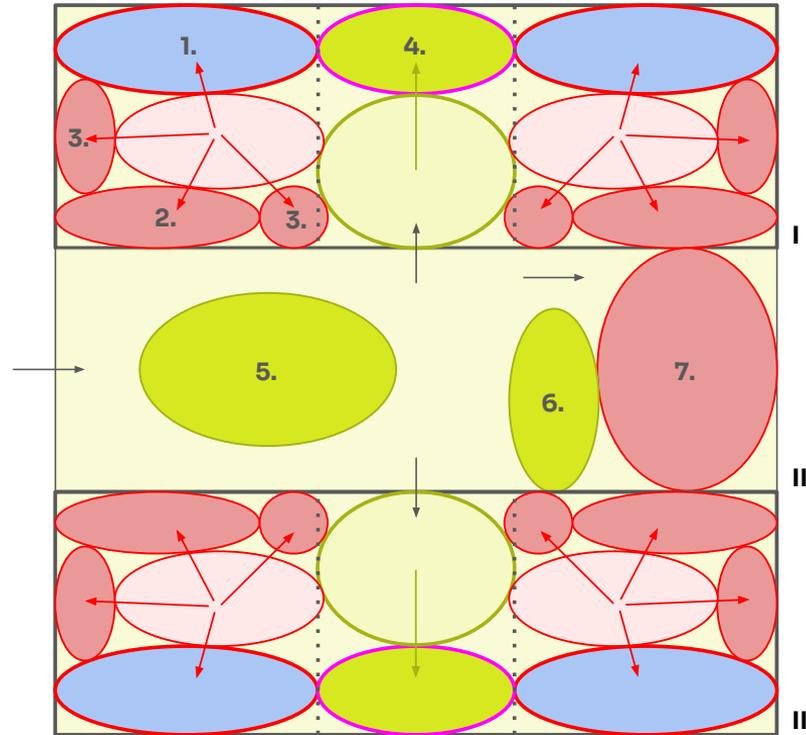
Final Hygiene (III)
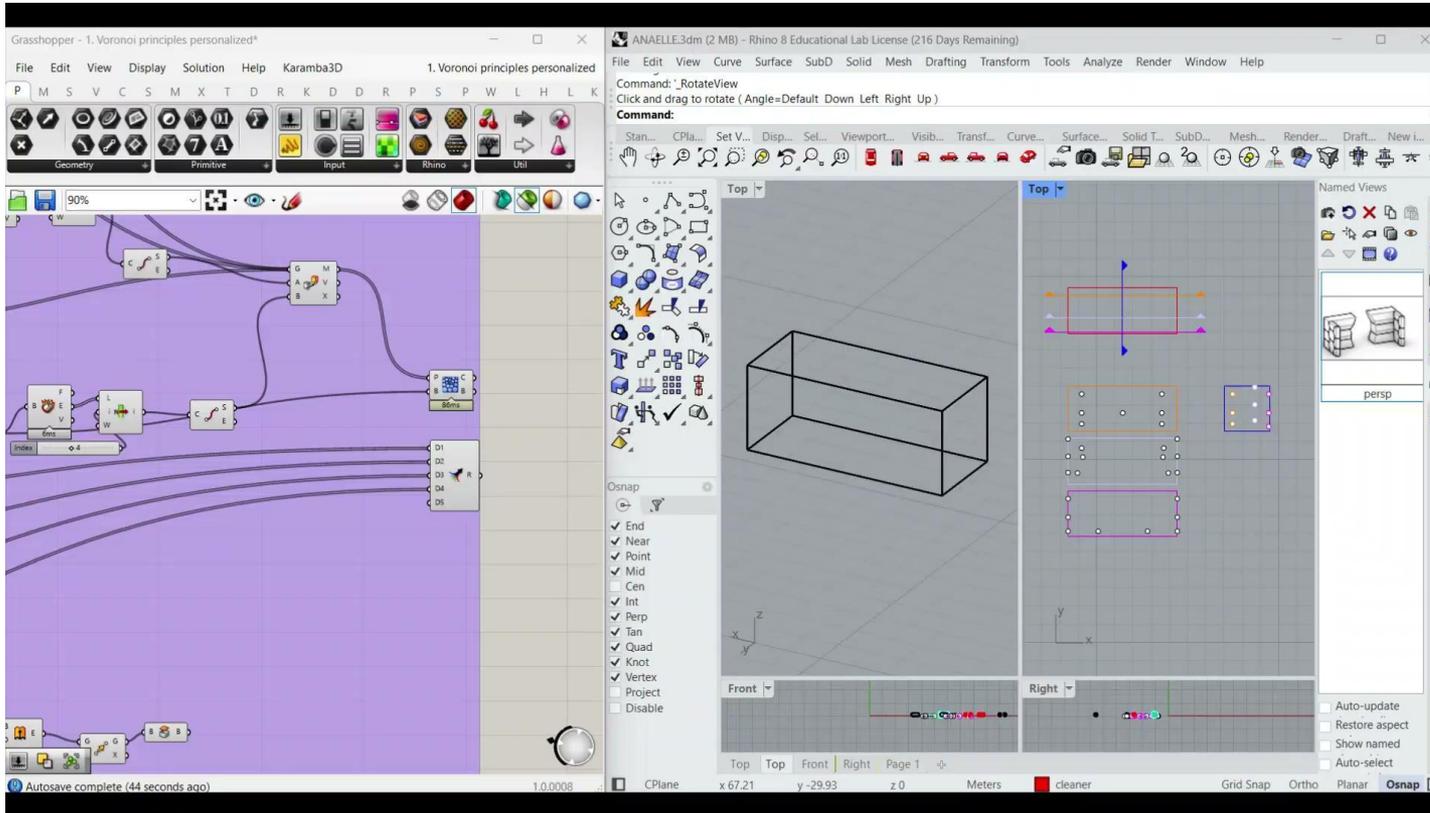100-200 lux - 2200-2700 K; Ultra-warm

Sleep (III)(IV)
0-5 lux - 1800 K, Total darkness or minimal safety light

1. - Deep Sleep
- Wake-up - Light Shower
- Music
- Reading
- Relax

2. - Deep Focus Work
- General Work
- Reading

3. - Personal Storage

4. - Reading
- Music
- Relax (Lounge)

5. - Breakfast
- Lunch
- Dinner
- Debrief
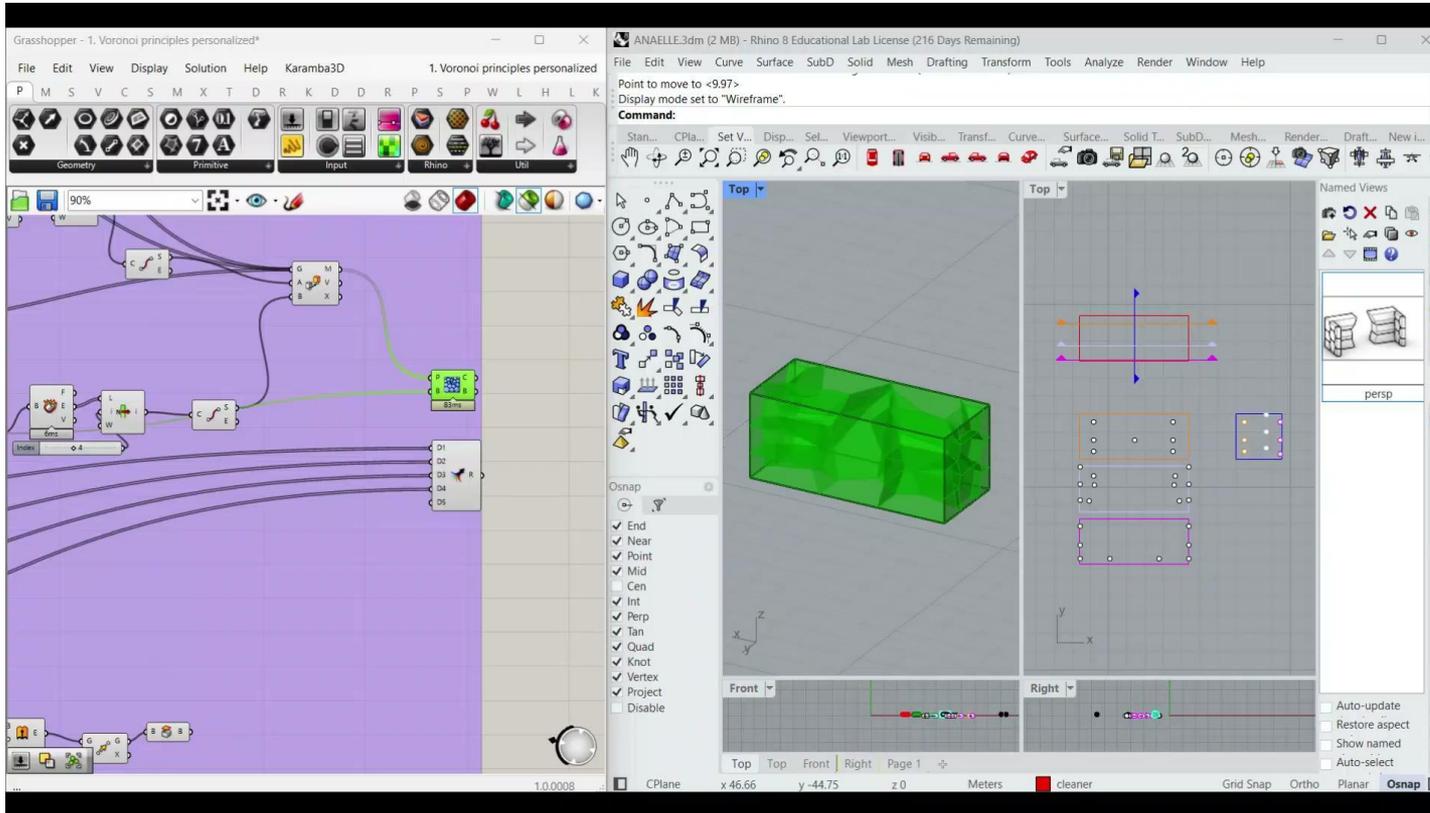- Socializing

6. - Kitchen

7. - Hygiene
- Shower
- Toilet

FROM 2D to 3D voronoi
To make a more controllable 3d voronoi a grasshopperscript was made to locate the points starting from chosen sections
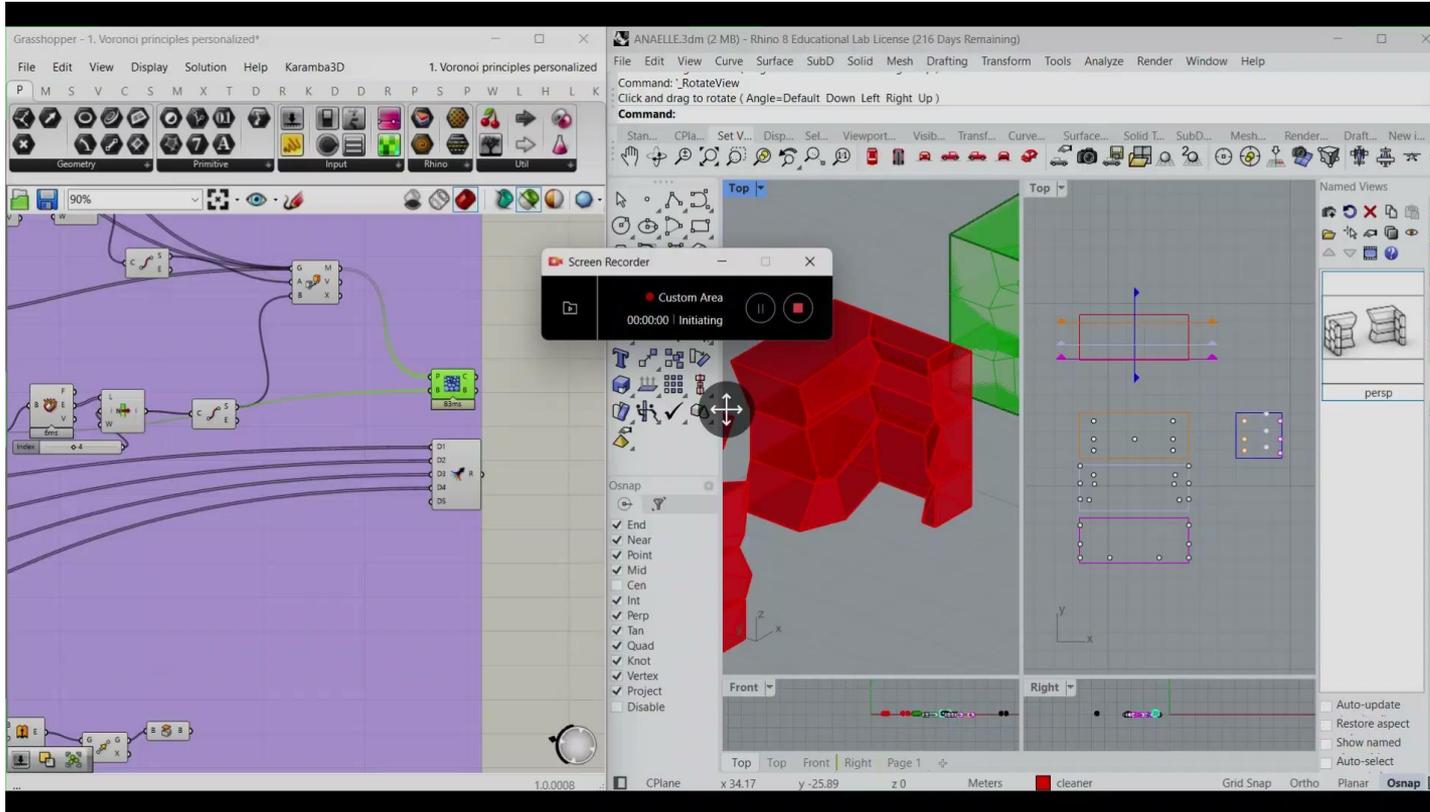
3D voronoi
At the exact section the voronoi will be as drawn in 2D.

But Makes a lot of angles in direction where it is not desirable influencing its folding capacity
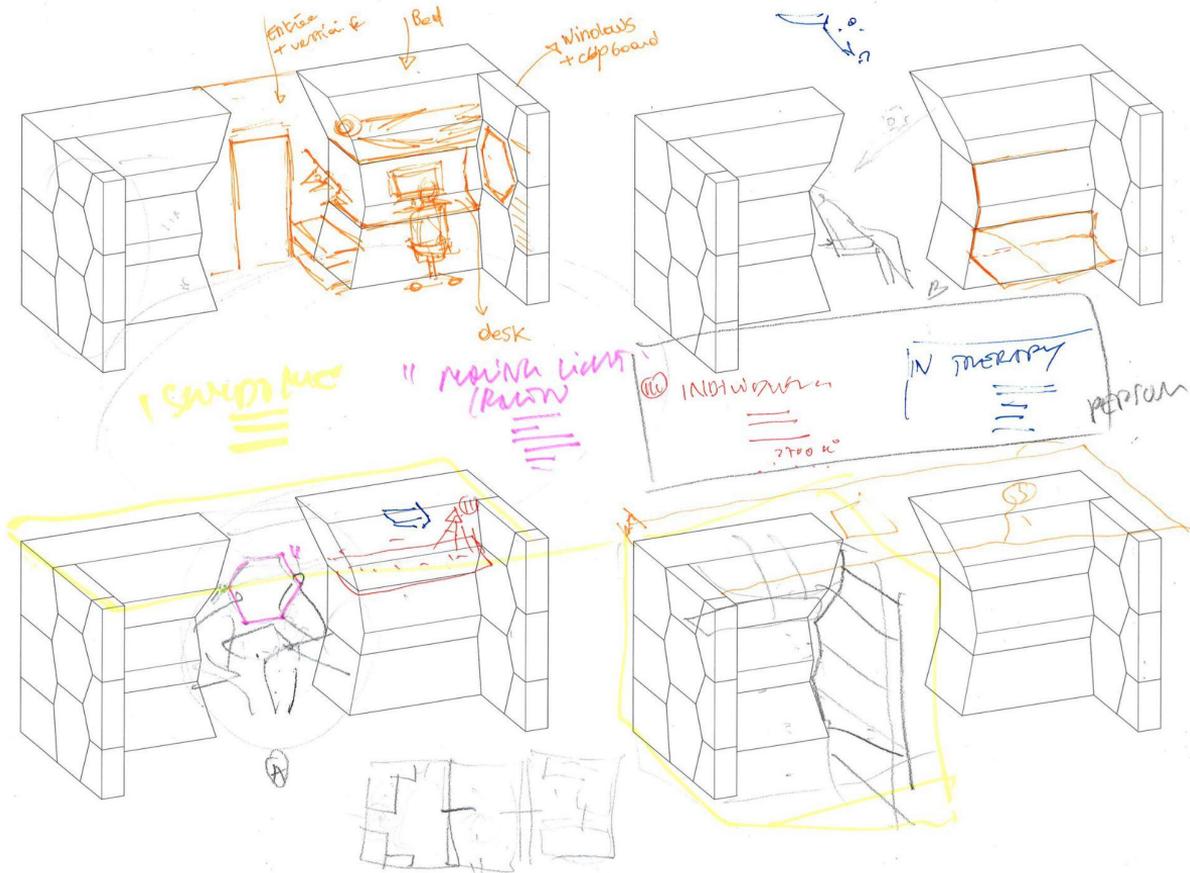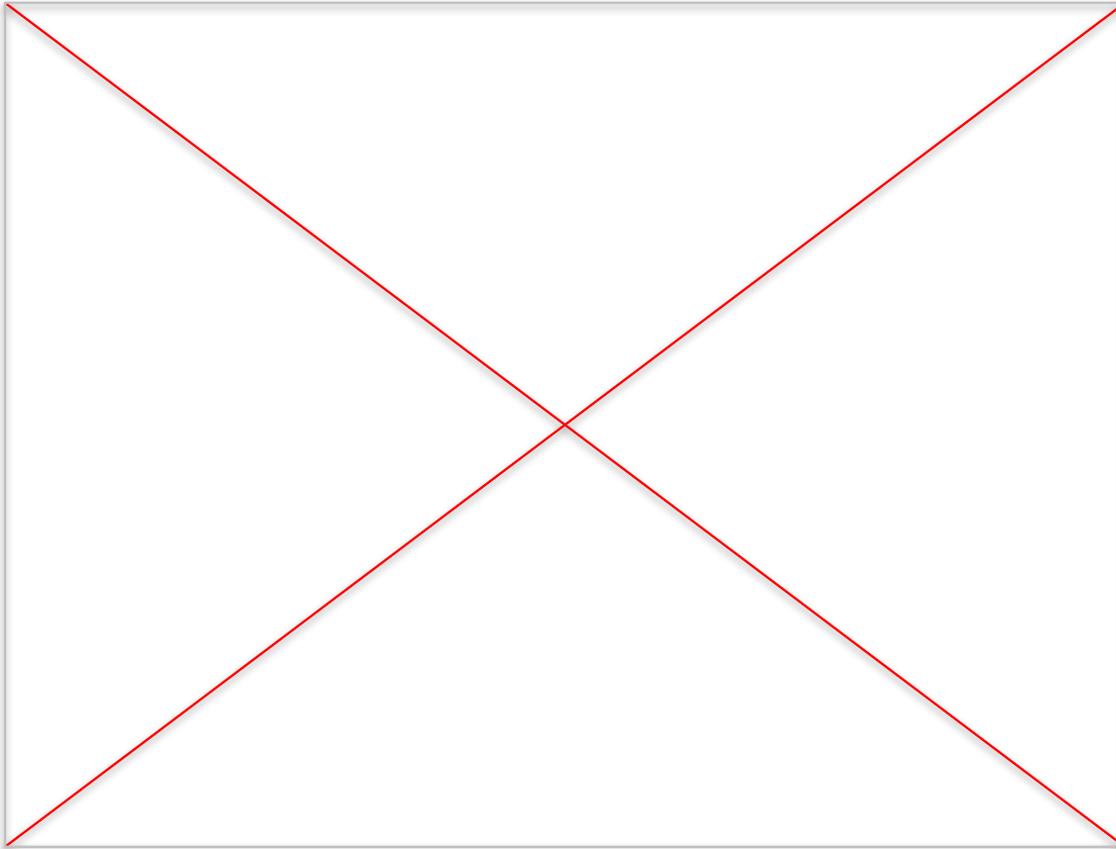
Design Process

3D voronoi
Use a 2d voronoi that
you extrude + 2d voronoi
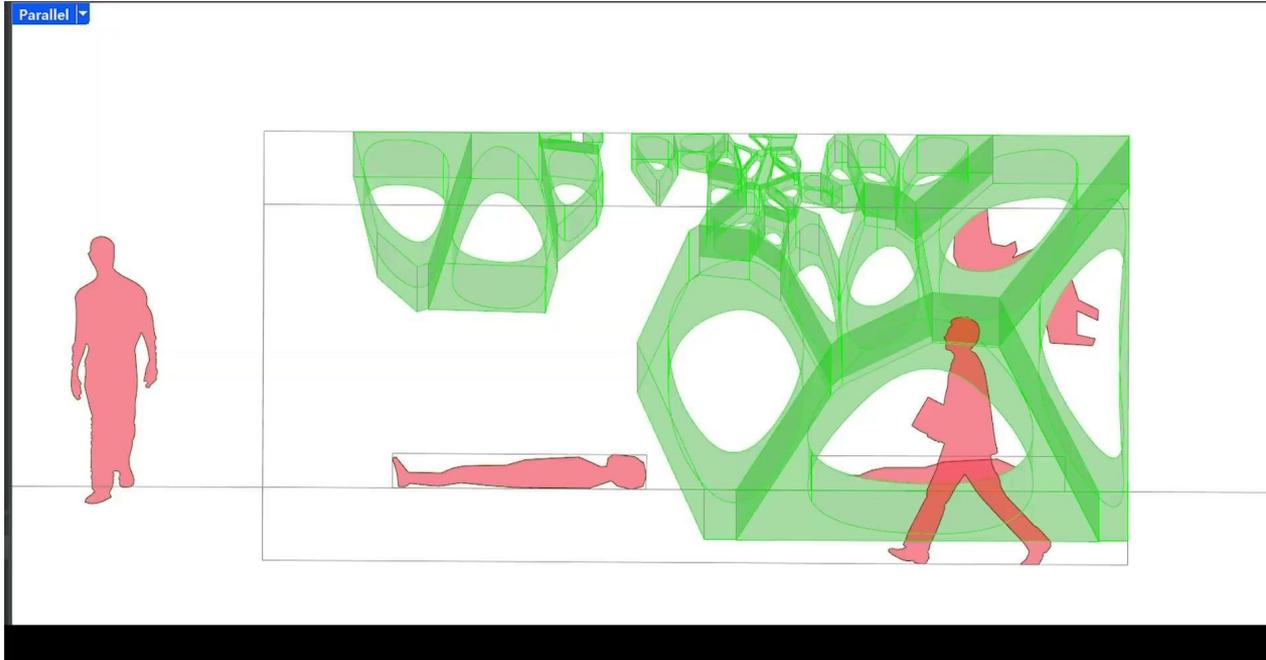in other direction

Design Process

Design study 2

3d Voronoi Volume Optimization

Work Process
1 Generate random points in Python
2 Form a 3d Voronoi
3 Generate Iterative Variation
4 Volume analysis through Galapagos
(Select three maximum volume cells)
5 Bake corresponding masses

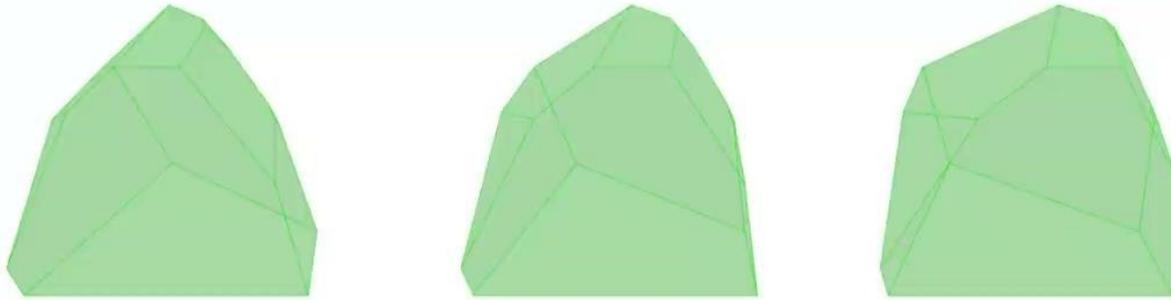**Design Process**

Design study 3

2d Voronoi Volume Optimization

Work Process
1 Generate random points in Python
2 Form a Mesh – Generate Voronoi form
3 Extrude based on area of each sell

Design Process
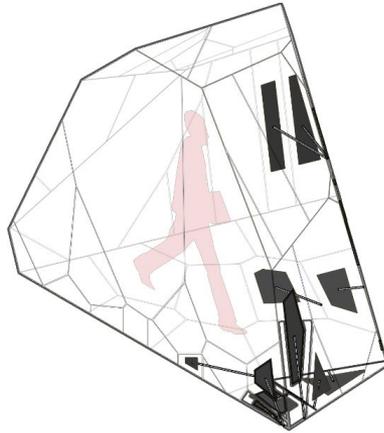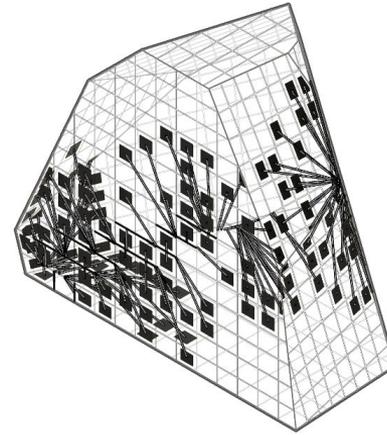
Perspective

Light installation study:
Voronoi, Orthogonal, Hexagonal

Design Process

the integration of lighting with the orthogonal vs. Voronoi-based design

Voronoi

Orthogonal

When installing LED strips and cables, a Voronoi-based approach is efficient in terms of wiring configuration and material quantity.