Earthshine Cocktail Bar

Week 7

Report outline v1

Problem statement

Define the problems

Beyond “surviving” to “living”: Now we landed on the Moon, then what? [1]

If space engineering determines whether we can “survive,” like Mir, then spatial psychology determines whether we can “live,” and maintain mental health.

Mir [2]

1. Moony Tubes. MIT Media Lab
2. Мир. Available at: https://scifiportal.eu/frankfurt-germany-exhibition-on-design-for-the-soviet-space-program/

simplify

Problem statement

Plumb line: cognitive disorder due to lack of gravity vertical

In low gravity, the human vestibular system (gravity receptors in the inner ear) becomes disordered, and the brain can no longer rely on gravity as an absolute reference for "below". [1]

Because of this, The Apollo 11, 12, and 14 astronauts reported multiple serious visual misjudgments while walking on the lunar surface. [2]

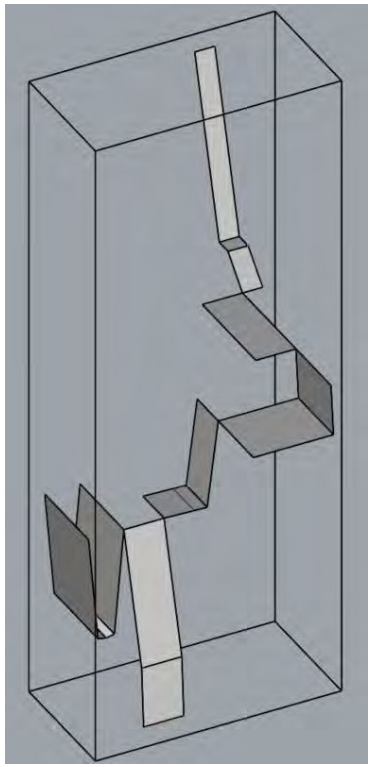
1. Morfoisse, T. et, al. (2024). Modality-Independent Effect of Gravity in Shaping the Internal Representation of 3D Space for Visual and Haptic Object Perception https://www.jneurosci.org/content/jneuro/44/13/e2457202023.full.pdf
2. NASA. (1971). Visual Optics in Space Flight. https://ntrs.nasa.gov/api/citations/19710024584/downloads/19710024584.pdf

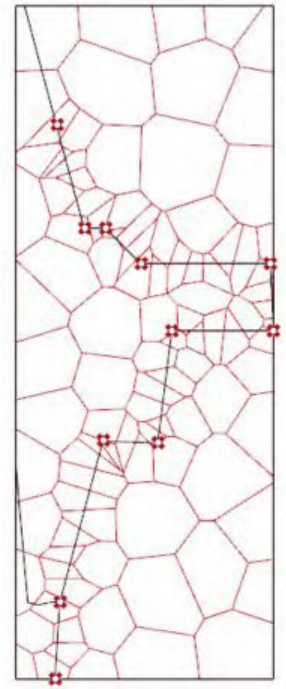
To methods

Problem statement

The brain gradually abandons the “plumb line" and instead relies entirely on the visual vertical and the vertical line of objects.

In our world, the vertical direction is a special dimension. Studies of architecture on earth is based on spatial cognition in a gravitational field. This determines the horizontal characteristics of daily behavior. Horizontal activities are more convenient and easier, while leaving one isotropic surface to enter another (such as reaching the next floor) requires additional work (displacement vertical to gravity).





1. Figure: Jonathan’s approach to space representation. Configuration of inclined/ angled planes

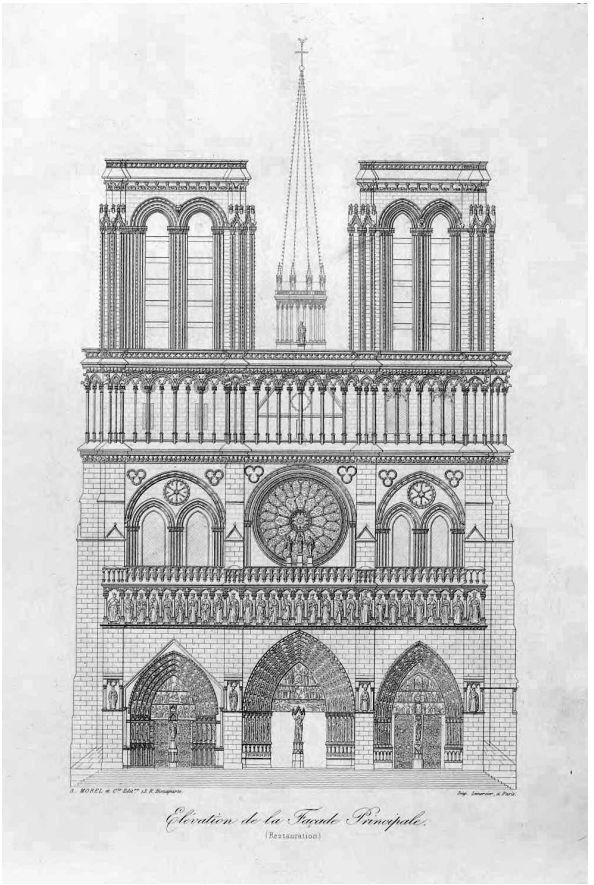
simplify

Problem statement

Humans perceive space not through measurement, but visual anchors.

In stratified buildings, each surface is at a different height and is often given different symbolic meanings. But when there's no or less "below" or "above" hierarchy, people's cognition, habits, … will inevitably change as well.

So that's the ultimate meaning of lifestyle in space colonization



1. Figure: Notre Dame front elevation

Relevance

Why it is important

Spatial disorientation prevention

In architectural interaction, poor spatial perception design can lead to severe cognitive load, or even illusion. [1]

1. Gibson, J.J. (2014). Ecological Approach To Visual Perception

Relevance

UN SDGoals

The study of space psychology aims to prevent astronauts from experiencing cognitive decline, depression, or social conflict, which can be fatal in extra-terrestrial environments.

Relevance

UN Goals

New ways about spatial thinking will give rise to new technologies that improve the quality of human life with limited resources.

Relevance

UN Goals

Research on how to utilize parallax in extremely limited condition is helpful for both resource resilience (circular) and mental resilience that could apply to dense-city building retrofit

Objective & Motivation

~~**Learn to die in the Anthropocene**~~

Architectural:
Space colonization: Indicate a guideline for about lunar lifestyle more than just survival, and bring technological consciousness where humanity was no longer merely living on Earth and working with it, but the outside.

Technical:
Space-resilience, Embody cognition to spatial cues, ISRU Robot building and maintenance

Research and / or design questions

simplify

Based on Spatial Orientation in Microgravity of NASA

Challenge:

1. Because lunar bases are extremely enclosed and isolated environments, the core of psychological research lies in the **Isolated, Confined, and Extreme** challenge.

2. **Sensory deprivation and monotony**: Prolonged exposure to a monotonous environment can lead to dulled intelligence, irritability, and hallucinations.

3. **Imbalance** between privacy and social interaction: Within a limited space, members cannot obtain complete privacy while simultaneously facing social isolation (from earth).

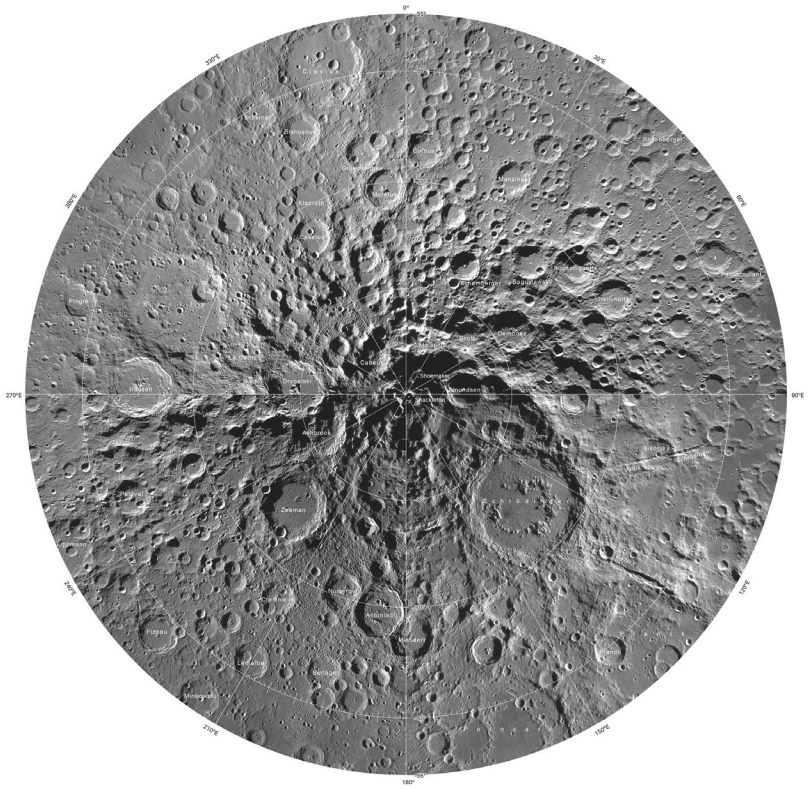
Oman C, M. et, al. (2006). The Role of Visual Cues in Microgravity Spatial Orientation. https://ntrs.nasa.gov/citations/20030068201

Scope

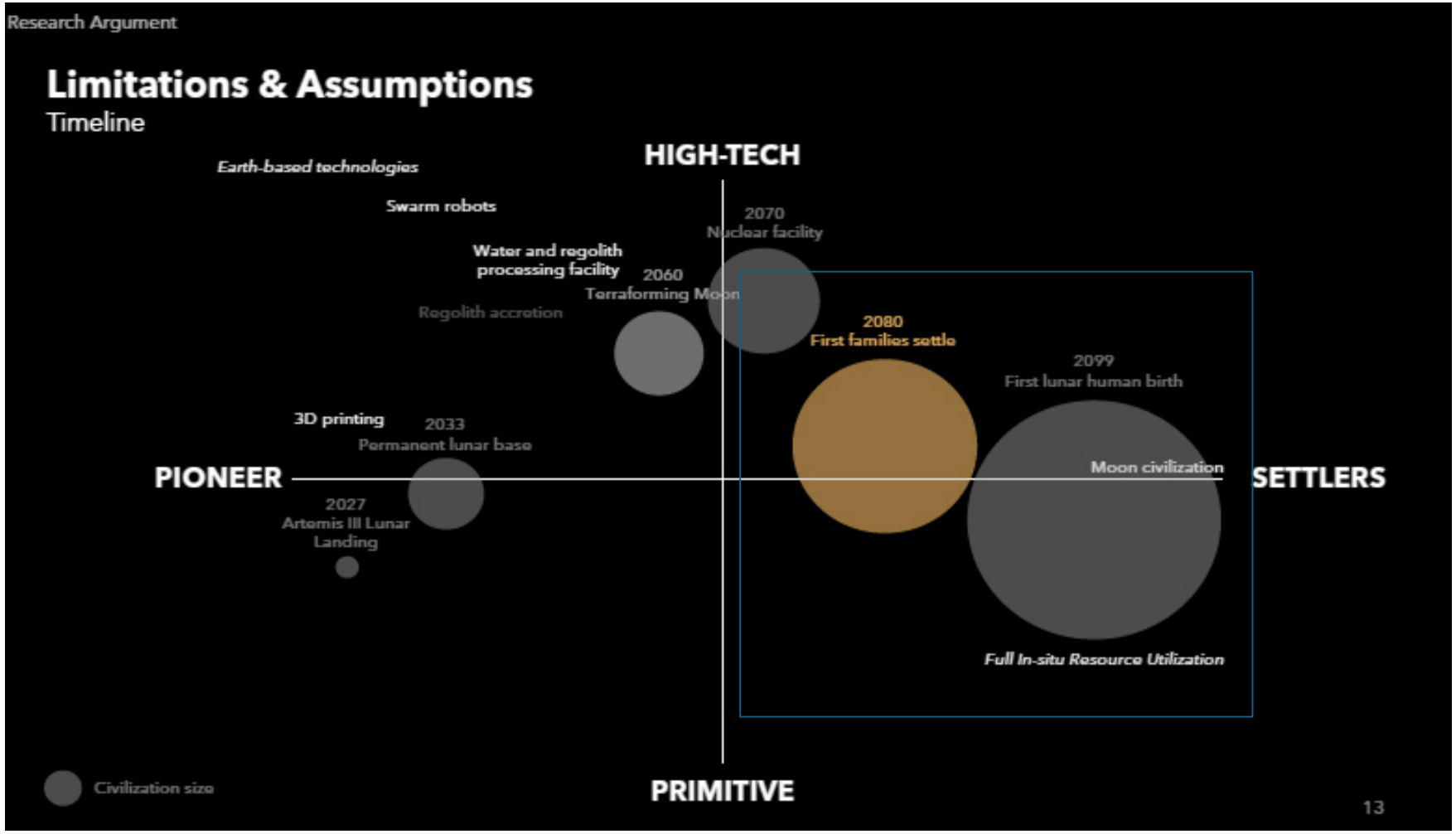
location, core design and challenge

Location: Lunar South Pole. On high points of rim at Shackleton Crater (-50 ~ 0 °C)

Designed phase: after successful landings of multiple short-term lunar modules, this habitat is considered to be permanent, lasting over 100 years while continuing expanding to form a habitat



Scope



1. Figure: Developed from Regina Tania Tan

Scope

Helium-3 harvest and transport

Energy source: solar to nuclear fusion

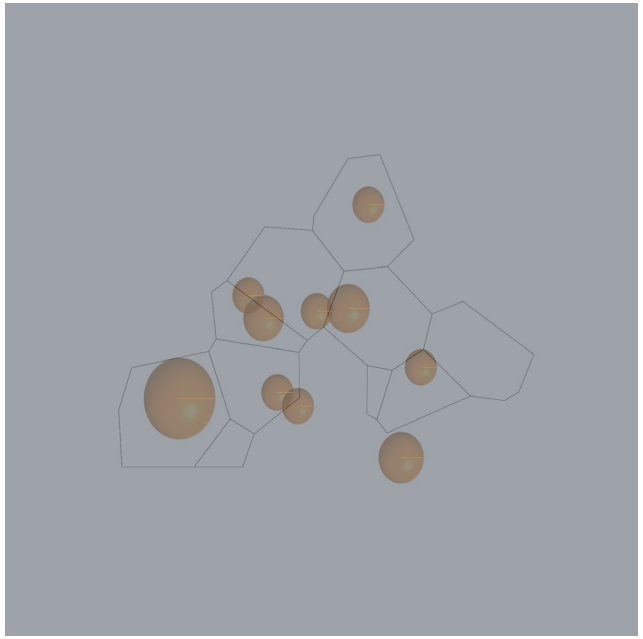
Freight station: centralized infrastructure

Just leave them, explained, and **not** included in planning?

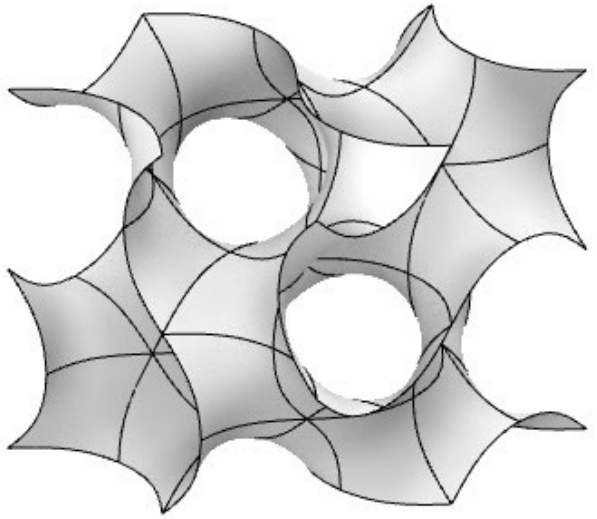
1. Figure: ESA. Helium-3 mining on the lunar surface.

Methods

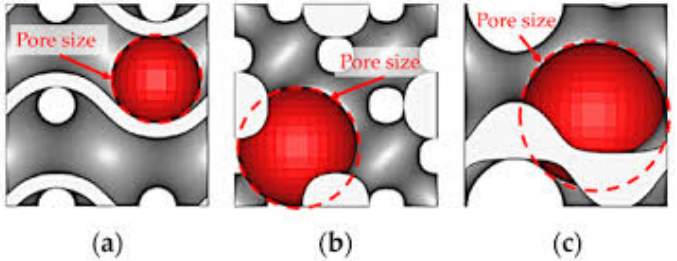
Computational



Voronoi
provide visual anchors



Gyroid
provide visual connection



Mix
design gradients and
network topology

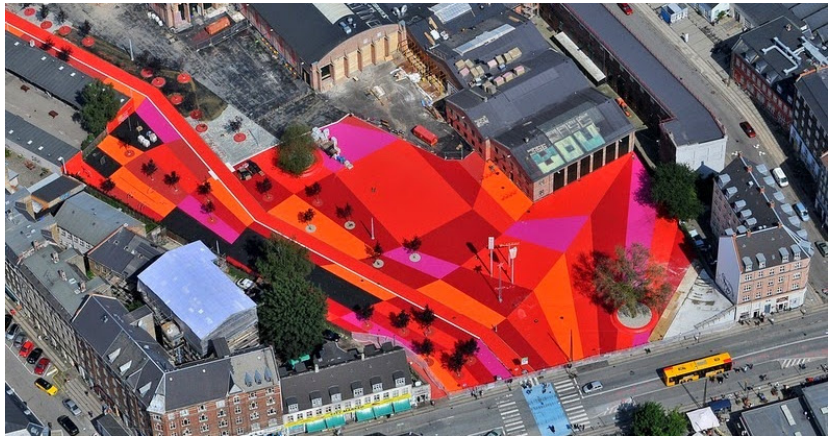
Methods

Computational

Precedent:

Superkilen / Topotek 1

By BIG Architects + Superflex



Methods

~~Movement study~~ → **visual study**

Cognitive
Light integration

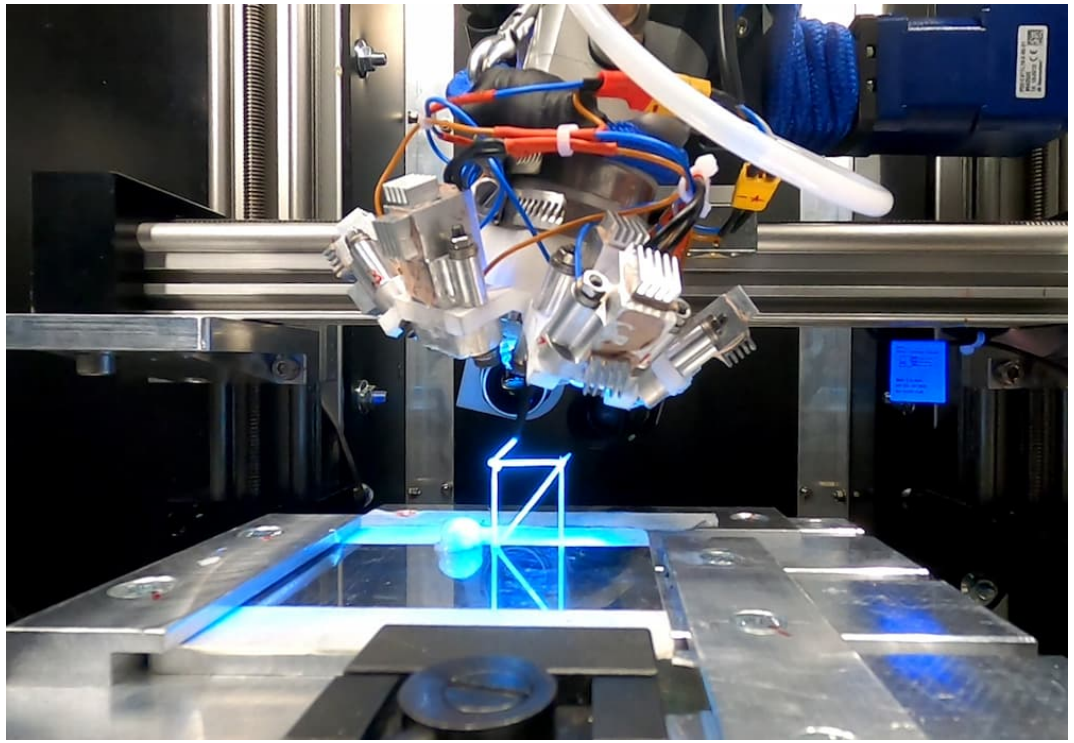
Grivity, 2013

2001 Space Odyssey, 1968

Architecture fit movement → user adjust gesture to what they perceive

Methods

Materialization



3D printing of prototype. This layered shape seems to rebel the “plumb line”

1. Figure: 3D printing in outer space. https://press.igus.co.uk/2021/10/12/3d-printing-in-outer-space-students-test-igus-linear-axes-in-near-zero-gravity-flights/

Methods

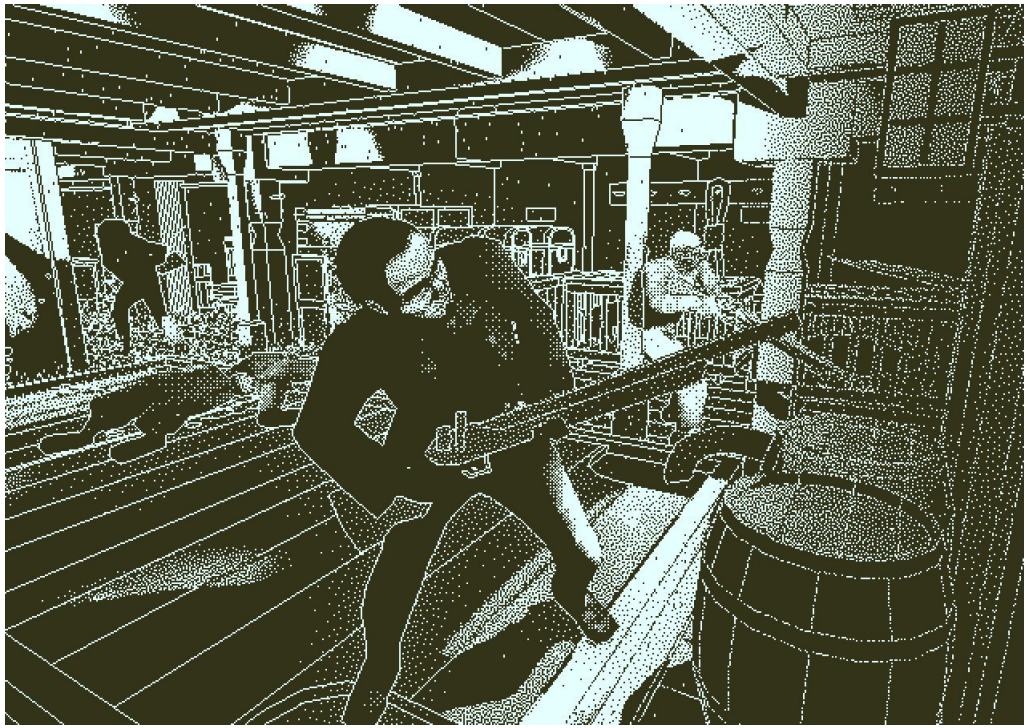
Experiment

VR – visual simulation

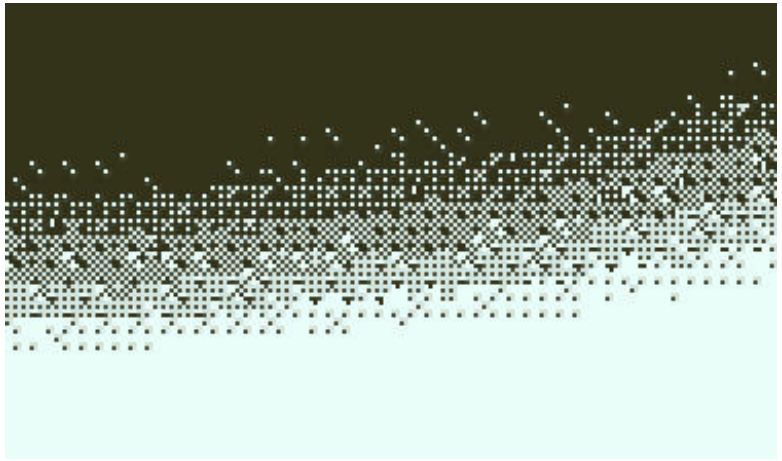
1. Figure: Epic Games Developer

Methods

Experiment



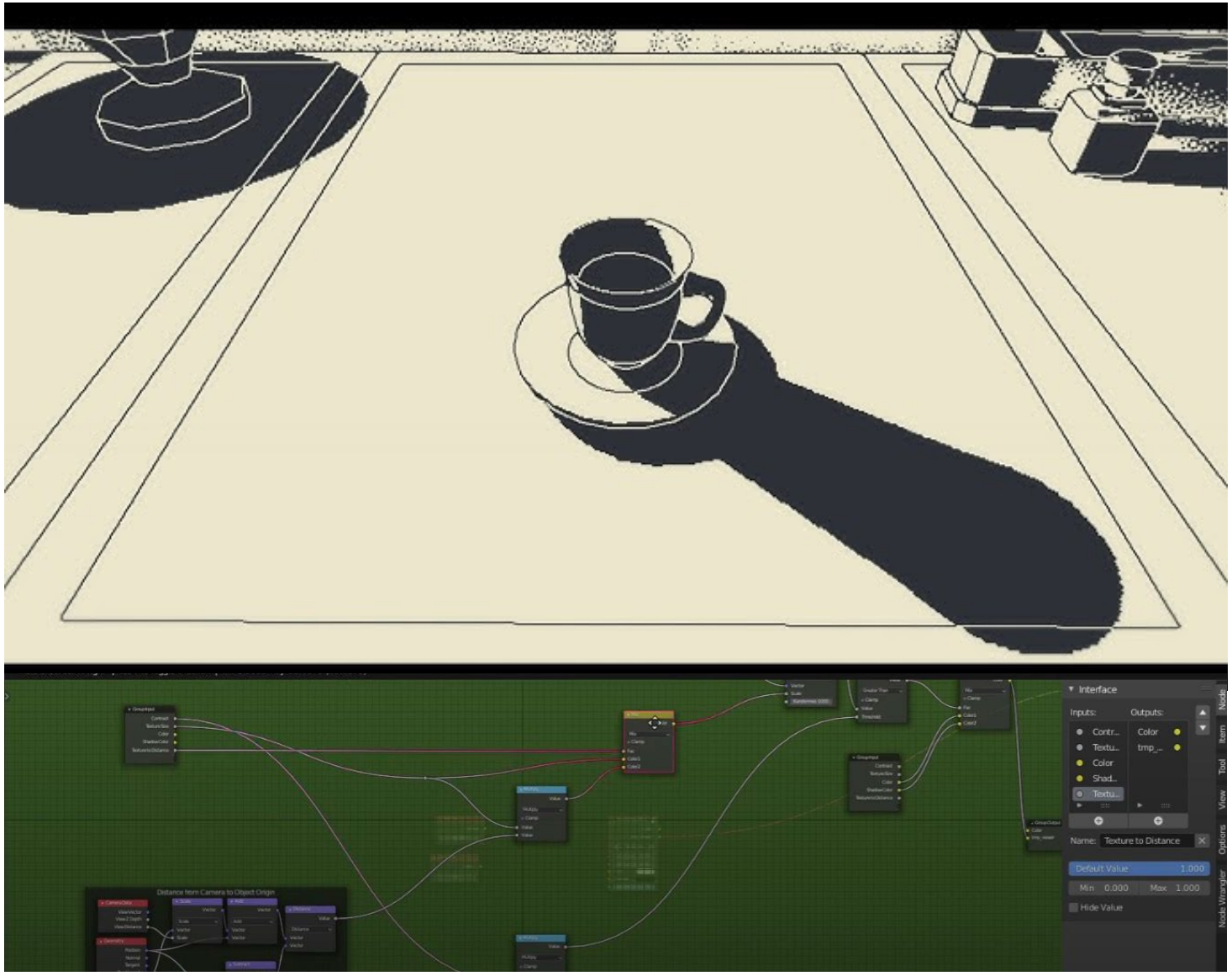
Precedent:
Return of the Obra Dinn
2018, video game



1. Figure: Lucas Pope

Methods

Experiment – reproduce attempt (game menu scene)



Theoretical Framework

Key words: cognitive science, neuroarchitecture

This framework will focus on how the brain's physical structures respond to spatial geometry and gravity, by designing **vision anchors** based on **visual vertical** rather than gravity vertical.

Theoretical Framework

Monumental?

Key words: cognitive science, neuroarchitecture

Lack of built precedent, but

The Salk Institute, Louis Kahn
(neuroarchitecture)

Roden Crater & Skyspaces, James Turrell
(light integration)

Plan

Develop visual study
– then return to space distribution development again

Develop light integration

VR prototype?