# Final Project MAT 236 – Nefeli Manoudaki

## NeuroTermite Forms

I propose to create a series of generative 3D structures consisting of 5 to 7 pieces. These structures will emerge from algorithms that combine principles of termite mound construction with patterns derived from brain organoid firing data. Each piece will offer a unique interpretation of how neural activity might be expressed as physical architecture, inspired by termite-like building behaviors.

The final works will be presented as both digital renders and 3D-printed physical sculptures. I plan to start by using this process as a personal tool to generate a variety of forms. If it proves successful, I can develop an intuitive graphic user interface (GUI) to make it available as a visual tool for others.

## Concept and Innovation

This series creates a unique bridge between neuroscience and biodigital architecture by:

* Using brain organoid firing patterns as the "decision-making" data source
* Implementing termite construction behaviors as the generative algorithm
* Creating an emergent aesthetic where complex structures self-organize from simple rules
* Materializing digital simulations into physical 3D-printed artifacts

The neural data will influence parameters like trail intensity, interaction range, trail intensity, and the field the termites are operating on, while the termite algorithms will determine how these parameters translate into physical form.

## Technical Implementation Pipeline

The project will utilize a multi-software pipeline to generate, refine, and materialize the structures:

1. Neural Data Analysis (Max MSP or TouchDesigner):

* Process brain organoid firing dataset
* Extract meaningful parameters from neural activity patterns
* Transform these parameters into OSC messages that can influence termite behavior

1. Simulation & Visualization (Processing):

* Extend my existing 3D termite construction simulation (from previous assignment)
* Receive OSC data to modulate termite behaviors based on neural inputs
* Visualize the building process in real-time using point-based representation
* Allow for parameter adjustment to create varied architectural forms

1. Data Export (Processing):

* Export point cloud data as CSV files with position and metadata
* Alternatively, export basic geometry as OBJ files when appropriate
* Capture different developmental stages of each structure

1. Form Refinement (Blender or Rhino/Grasshopper):

* Import point cloud data into 3D modeling software
* Use metaballs or mesh skinning techniques to create organic forms
* Apply mesh smoothing, structural optimization, and printability checks
* Prepare final models for 3D printing

1. Physical Fabrication (3D Printing):

* Print the refined structures (PLA or Resin)
* Apply post-processing techniques to enhance physical qualities

References

* [Turtles, Termites, and Traffic Jams](https://mitpress.mit.edu/9780262680936/turtles-termites-and-traffic-jams/)
* [Self-Organization in Biological Systems | Princeton University Press](https://press.princeton.edu/books/paperback/9780691116242/self-organization-in-biological-systems?srsltid=AfmBOoqfF9j8Q-_J5jxvt7HeaAZPIKj2a27hjhCijc42Qvz4oAGvnrye)
* [Termites as architects — Harvard Gazette](https://news.harvard.edu/gazette/story/2010/10/termites-as-architects/)

Inspirations

* [Michael Hansmeyer - Project Overview](https://www.michael-hansmeyer.com/projects)
* [Man-Nahāta](https://oxman.com/projects/man-nahata)-Oxman
* [Andy Lomas - Digital Chemotaxis](https://andylomas.com/digitalChemotaxis.html)

## Challenges

* Creating meaningful mappings between neural data and termite behaviors
* Converting point-based structures into printable meshes
* Ensuring structural integrity for physical fabrication
* Balancing emergent behavior with aesthetic control
* Finding the right granularity of termite agents to express neural complexity

## Evaluation Criteria

* Technical integration: How successfully does the multi-software pipeline function?
* Data representation: Do the structures meaningfully reflect the neural data inputs?
* Aesthetic quality: Are the resulting forms visually compelling and distinctive?
* Series coherence: Do the works function together as a unified exploration?
* Physical translation: How successfully are the digital forms realized as 3D prints?
* Interdisciplinary value: Does the series meaningfully bridge neuroscience and art?