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3D-Printed Ceramic Bricks for Modular Oyster Habitat Restoration Along Seawalls

Presenters: Lily Boyer & Ella Champ

Faculty Leads: Dr. William Ellis & Professor Tina Piracci

Undergraduate Researchers

Ella Champ

- Sophomore
- Bachelor of Science Mechanical Engineering, University of South Florida

Lily Boyer

- Senior
- Bachelor of Science Environmental Science and Policy, concentration in Sustainability, University of South Florida

Primary Investigators

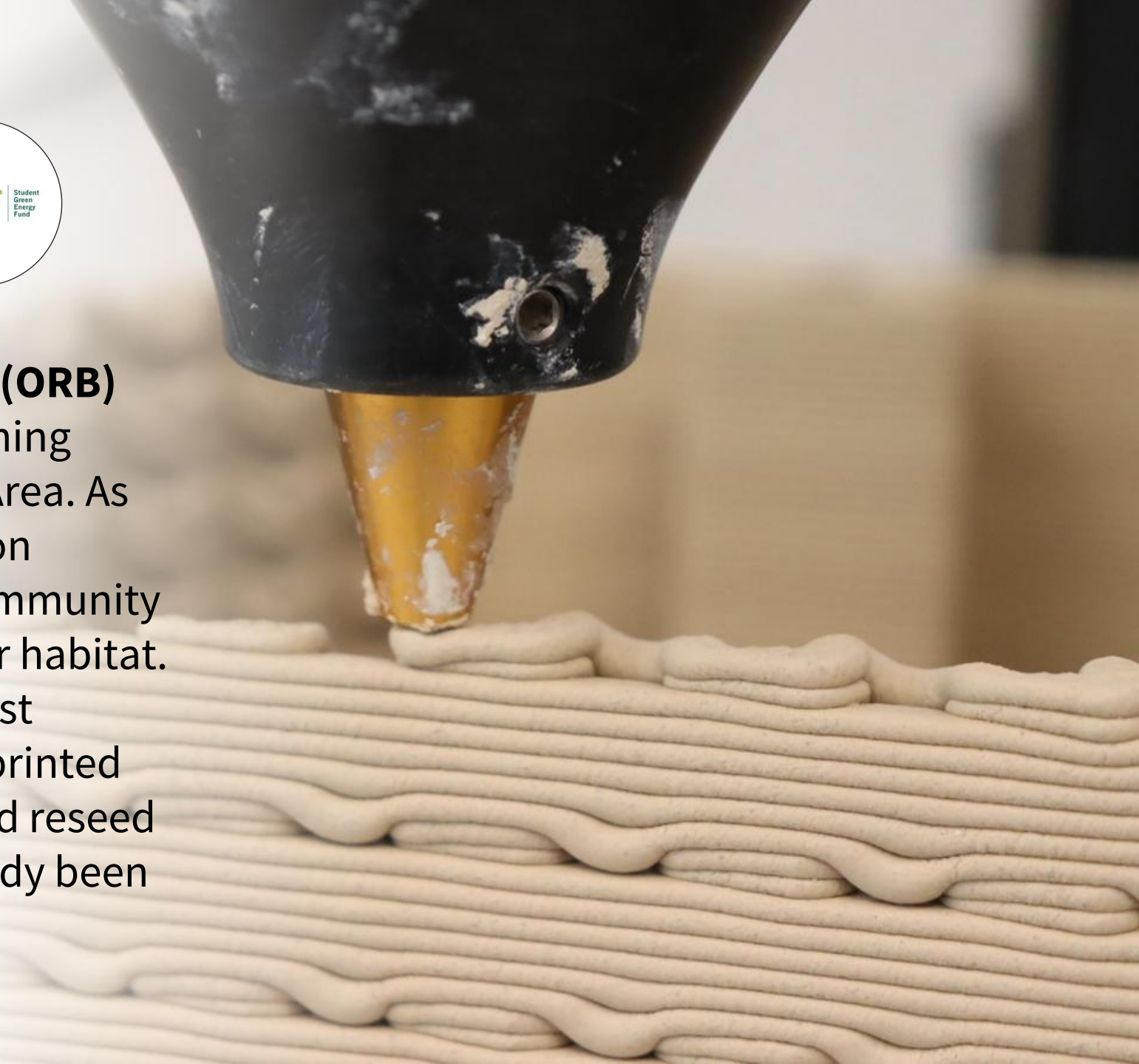
Dr. William Ellis

- Bachelor of Science in Zoology, University of Florida
- Master of Science in GIS, Johns Hopkins University
- Master of Science Biology, South Carolina University
- Ph.D. Biology, University of South Florida

Professor Tina Piracci

- Bachelor of Fine Arts, minors in Engineering, Business, and Visualization & Design University of South Florida
- Master of Science Architecture, University of California, Berkeley

The **Oyster Restoration Brick (ORB)** project aims to replenish declining oyster populations in the Bay Area. As the use of synthetic materials on seawalls has increased, our community has seen a drastic loss of oyster habitat. Our work investigates a low-cost propagation system using 3D-printed ceramics to provide habitat and reseed areas where oysters have already been eradicated.



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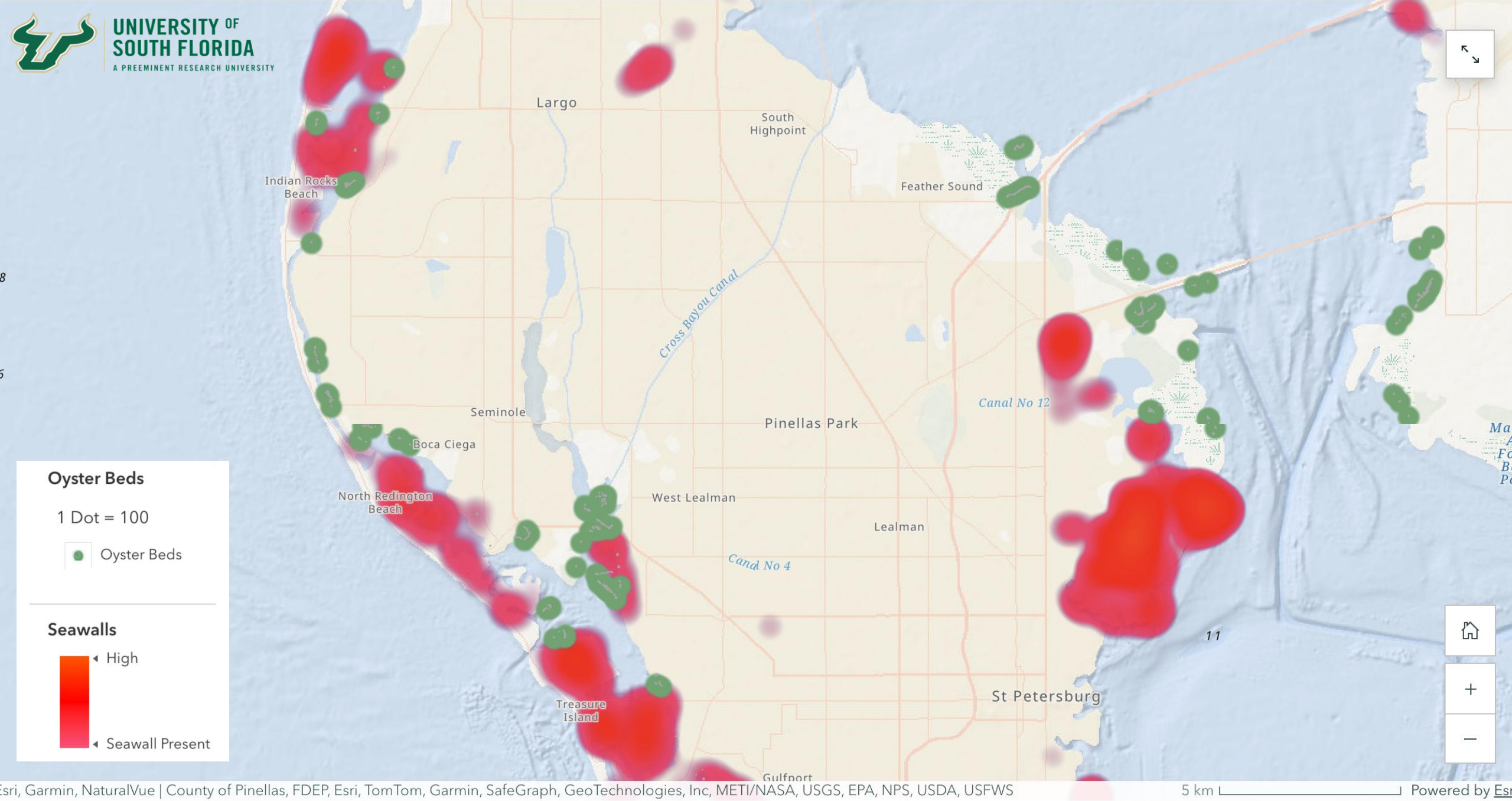
Motivation and Target Problem

- Proposed by Dr. Ellis from the Department of Integrative Biology to combat oyster population decline due to seawall development.
- It's estimated that 85% of FL oyster reefs have been lost. (NOAA Fisheries, 2024)
- Construction of both cement and synthetic seawalls decreases the surface area available for oyster growth.



Mapping the Divide: The inverse relationship between seawalls and oyster populations

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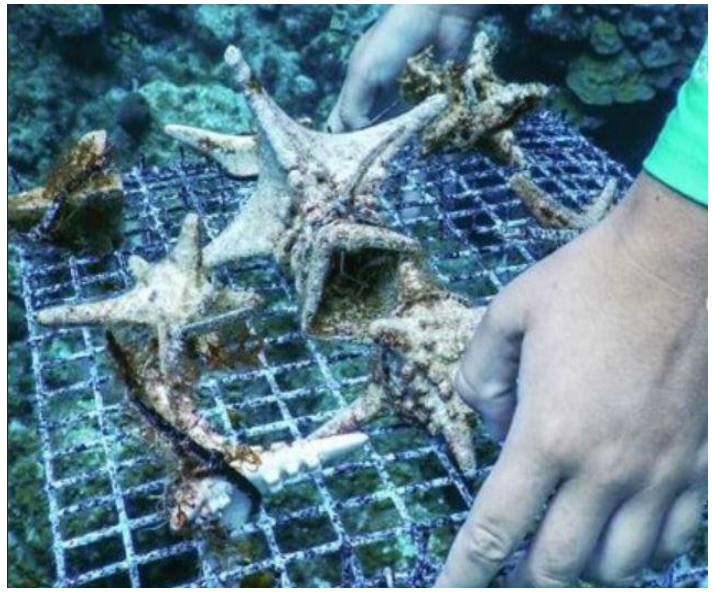
Design Criteria and Proposed Solution

What do our gulf oysters need?

- ❑ Intertidal substrate
- ❑ High surface area
- ❑ High surface complexity to offer protection from predators
- ❑ New recruits for reef maintenance

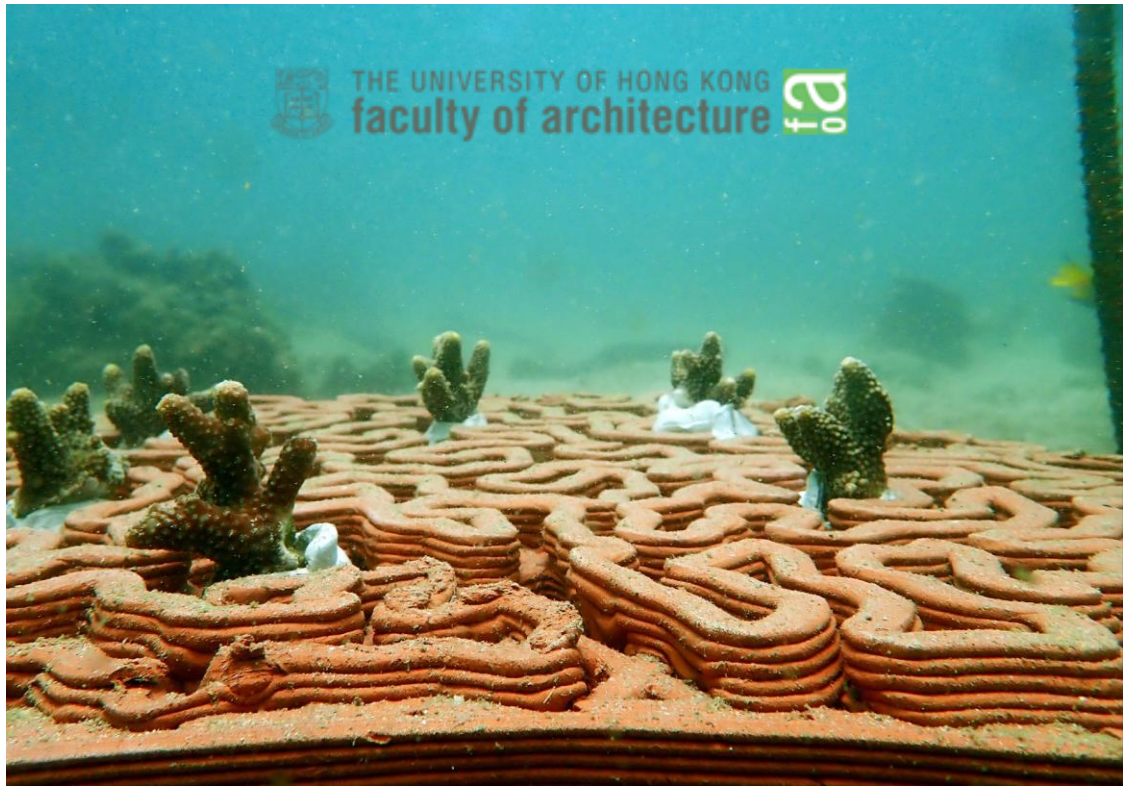


Guidance & Previous Implementation

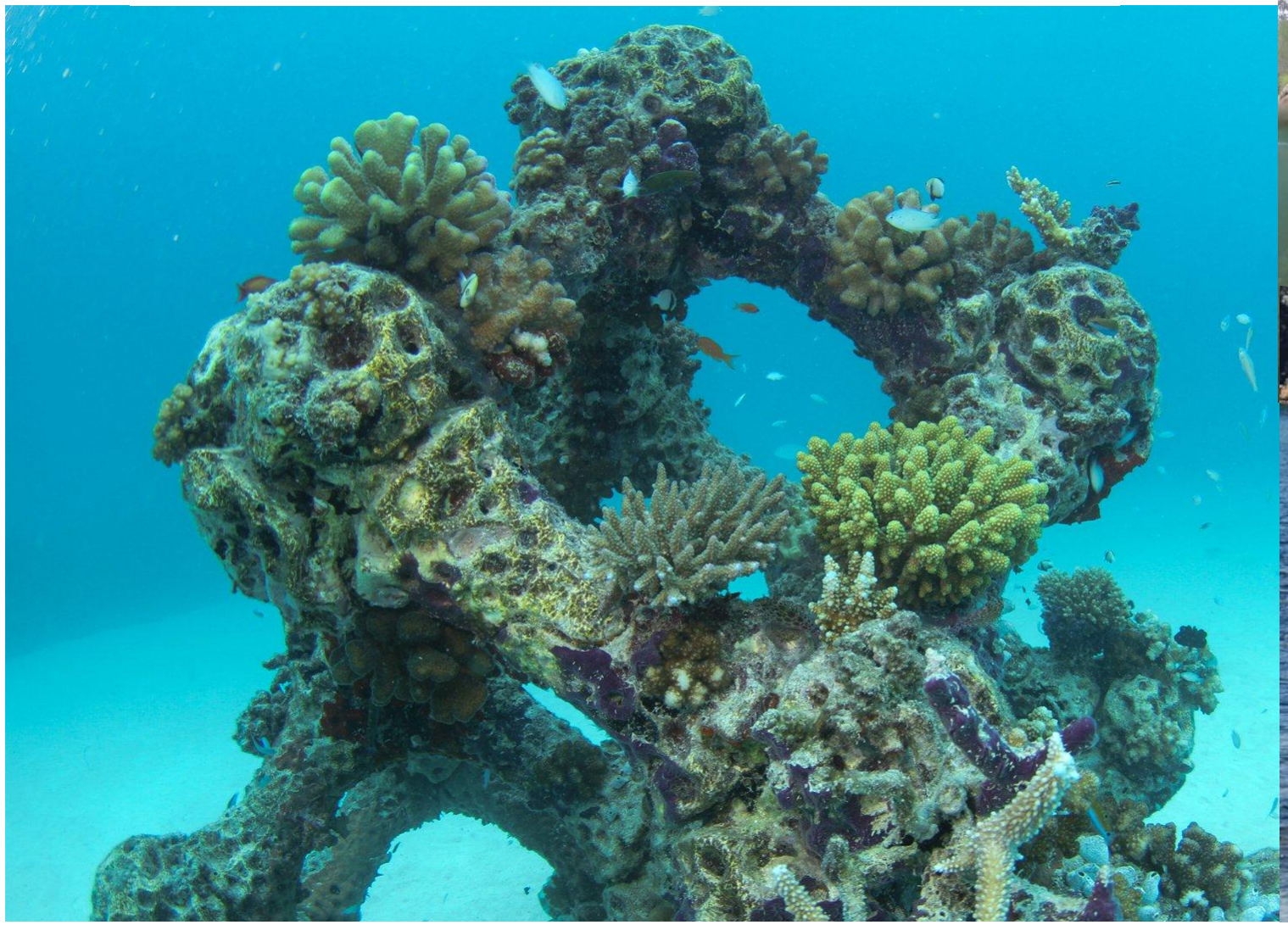
- When researching & teaching at UC Berkeley, Prof. Piracci facilitated the design & production for thousands of **coral seeding units** used in restoration efforts

- **Clay 3D printed bird habitats** for marine birds facing decline due to erosion in partnership with CCA and the Emerging Objects team

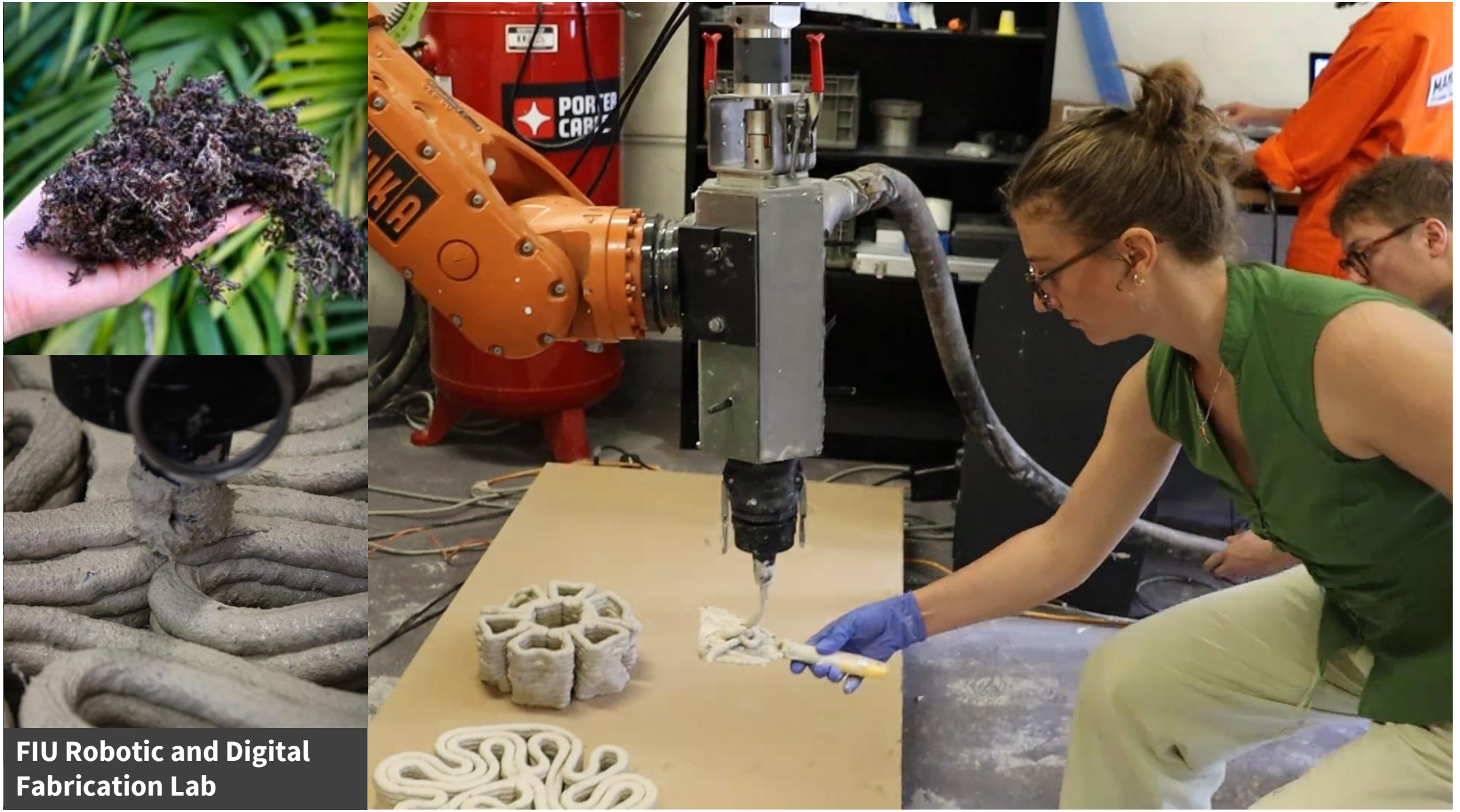
Established Restoration Projects that Utilize 3D Printed Ceramics for Local Ecology



REEF DESIGN LAB




KUKA
PORTER
CABLE



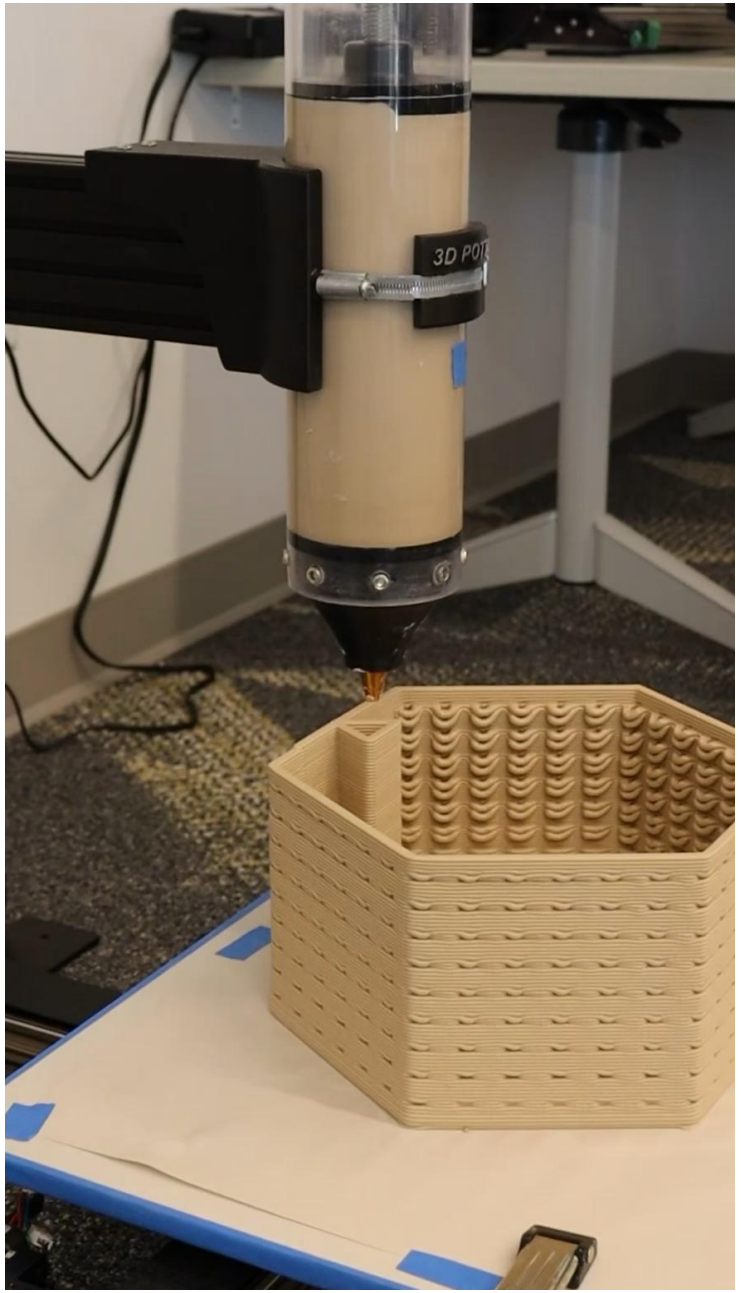
FIU Robotic and Digital Fabrication Lab

Additive Manufacturing for Ecological Design

Why 3D Printing?

- Interior looping textures allow small protective spaces for the larvae to develop past most vulnerable stage for areas facing harshest declines.

- This project is an invitation to use 3D printing to contribute positively to environmental efforts.



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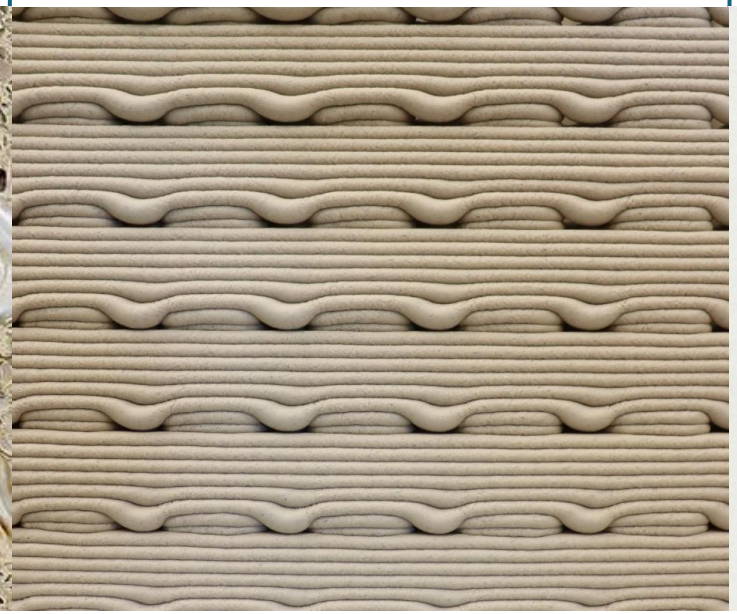
Micro-

Material properties

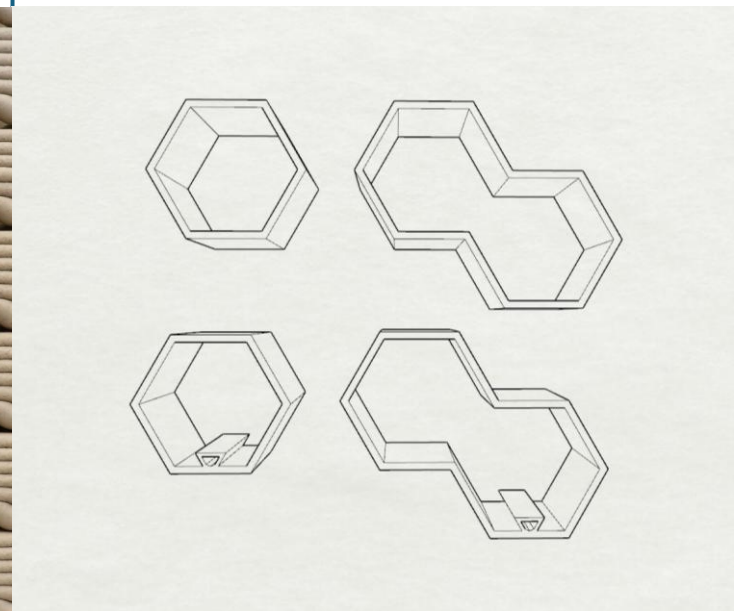
Meso-

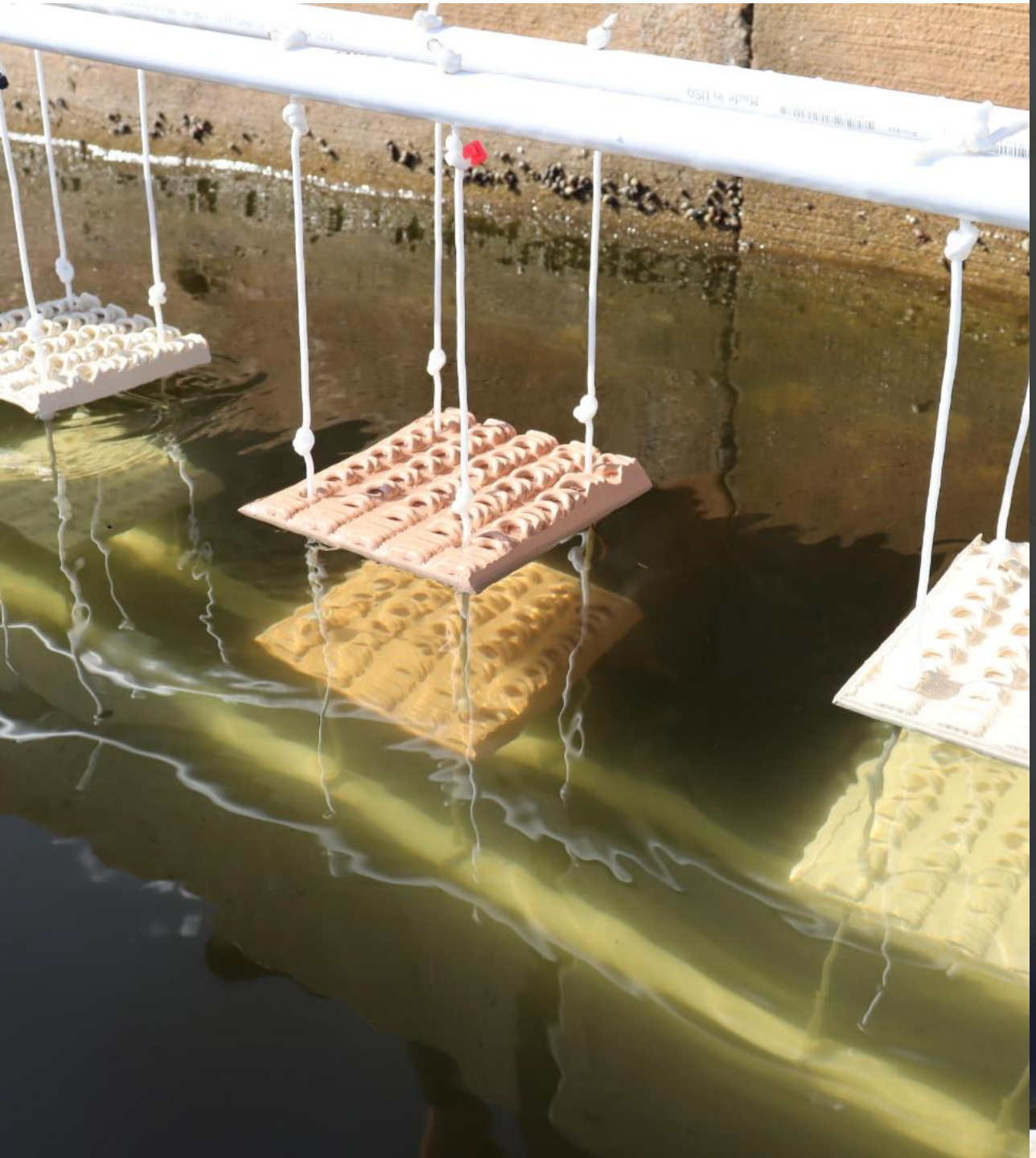
Printed texture as a mediator between material and environment



Macro-

Assemblies that perform as coastal infrastructure





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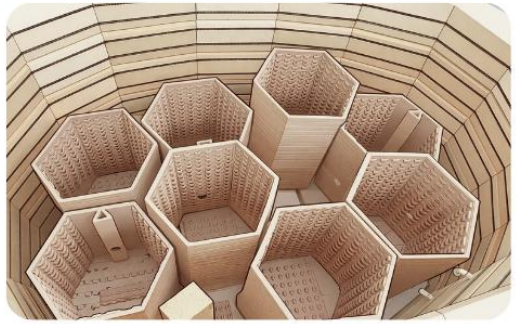
Printing bricks

Preparing clay for printing



Firing bricks in kiln

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G-code

G## X## Y## Z## F##

G- type of command, linear, circular?

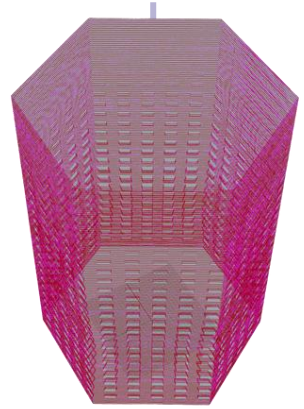
X, Y, Z- declares position or coordinates

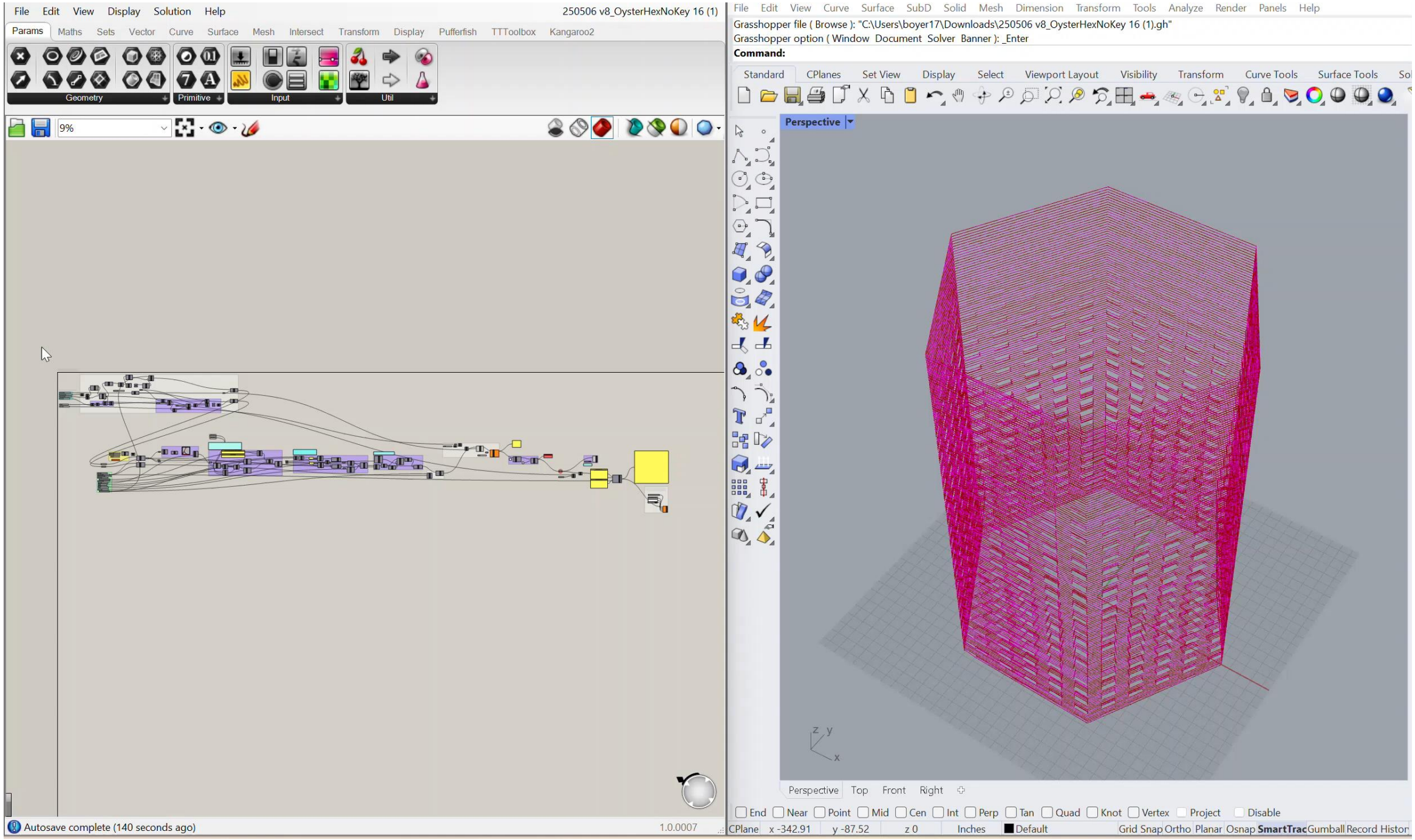
F- Feed rate (mm/s)

```
G1 X126.633 Y87.900 Z0.000 E93.603 F3000
G1 X126.111 Y88.804 Z0.000 E100.245
G1 X119.281 Y100.633 Z0.000 E187.207
```

Rhinoceros®
modeling tools for designers

Grasshopper
ALGORITHMIC MODELING FOR RHINO

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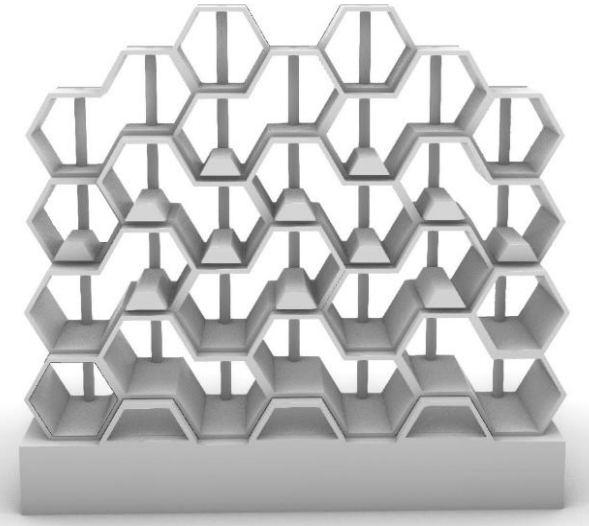


August 13th, 2025

Spat development after 15 days

October 16th, 2025

64 days after installment

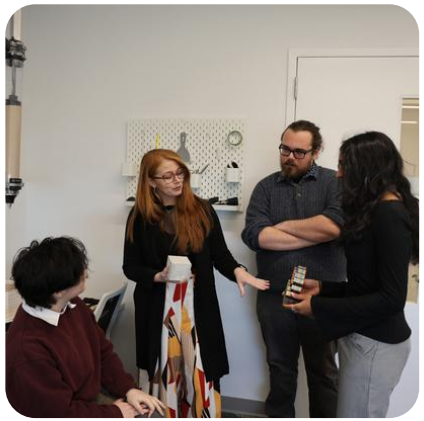
October 16th, 2025
64 days after installment

January 27th, 2026
197 days after installment

Preliminary Results

Broader Impact

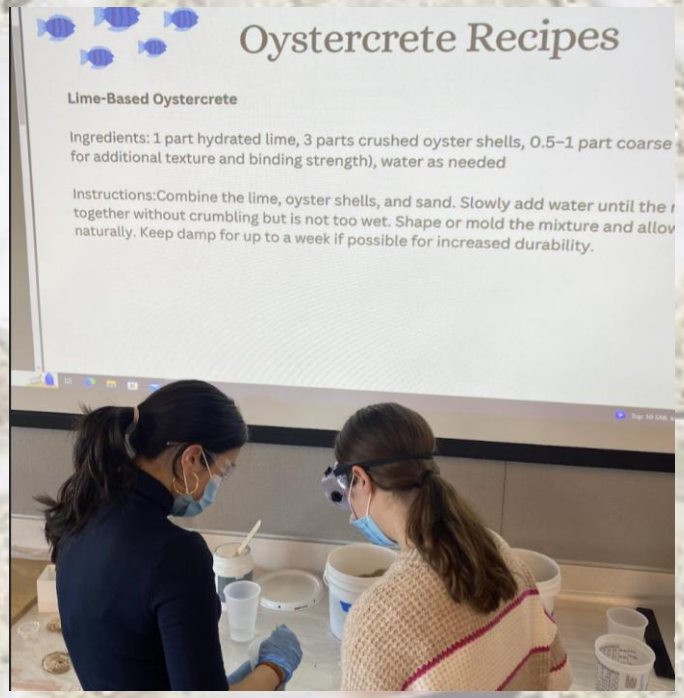
Education



Scalability & Open-Source Restoration

Environmental Impact

Community Stewardship



Middle school partnerships for 'oystercrete' propagation units.

Oystercrete: Recycled oyster shells into calcium oxide (quicklime) for ideal larval recruitment

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- **Thank You to Our Partners & Sponsors!**
  Tampa Bay Environmental Restoration Fund, USF Green Energy Fund, Clay Co-op, Dr. Ellis & his students through support of Integrative Biology Department USFSP, Professor Piracci through support of Judy Genshaft Honors College, Honors Art & The Environment I & II student researchers, Ian Blair-Catala's thesis project, USF 3D Hab Lab student org, USF Art Department, St. Raphael's Middle School, Shorecrest High School, Laguna Clay Company, 3D Potter, Ocean Prime Restaurant, collaborators at MIT through Element Engineers & Clearwater Marine Aquarium
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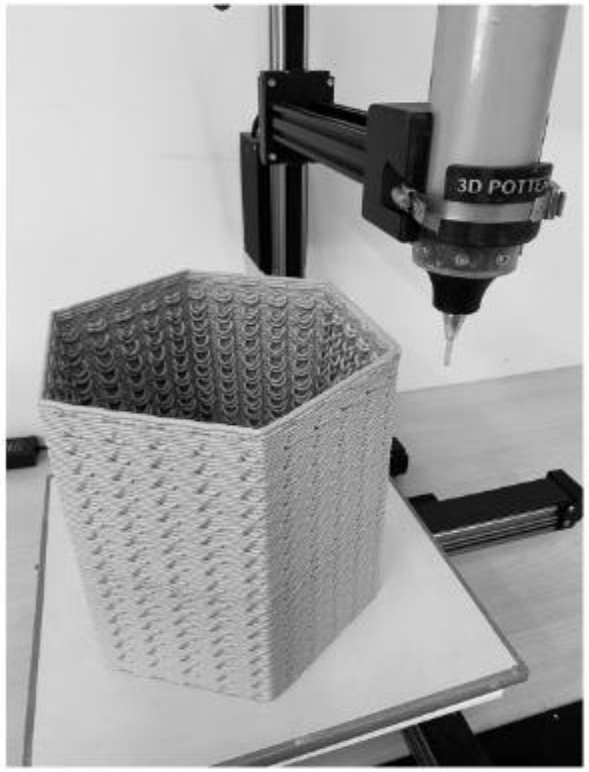


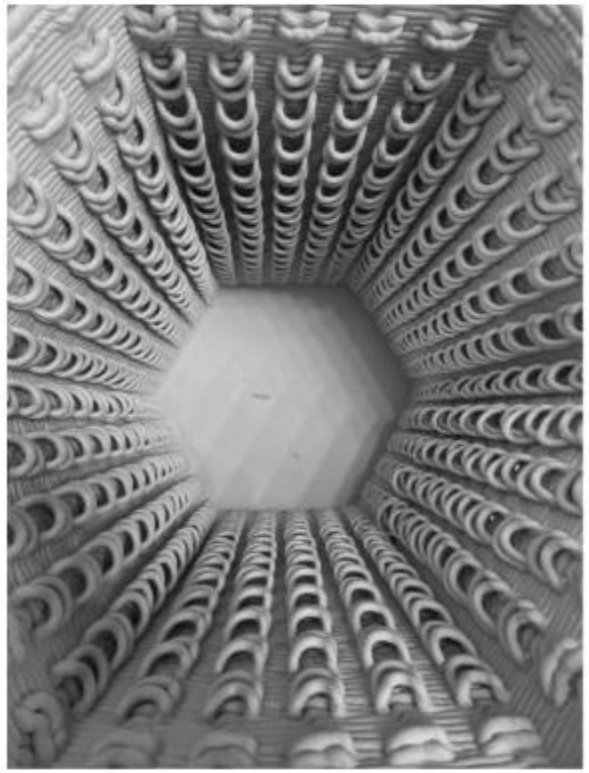
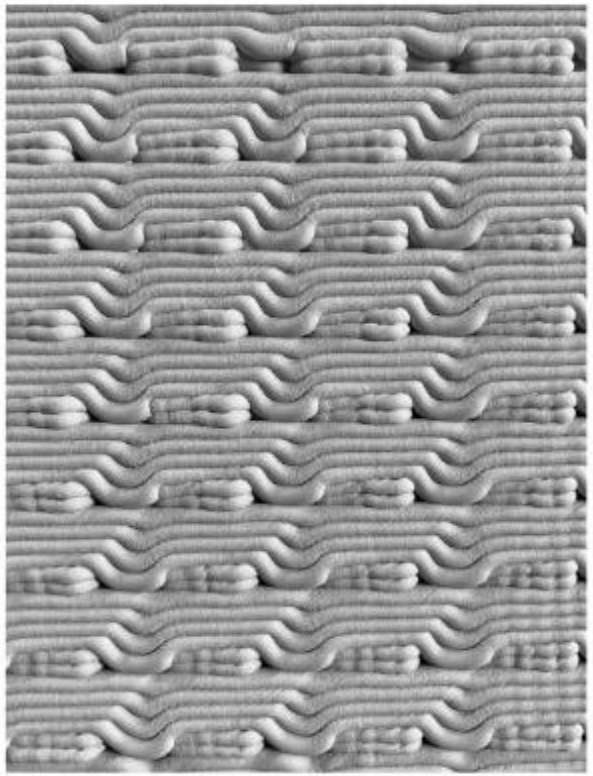

Questions?