ENTS NODE ENCLOSURE

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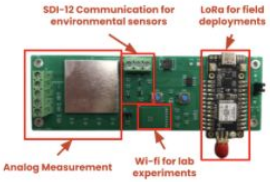
Overview

UCSC and UCSD researchers created the open source Environmentally Networked Sensor (ENTS) as an easy and low cost way of conducting environmental research[1]. This enclosure is deployed outdoors for weeks on end with sensors. We were tasked with creating an optimized enclosure for marsh deployments.

GitHub

DirtViz

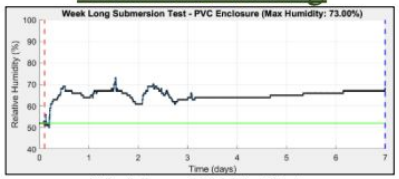


ENTS Node Diagram

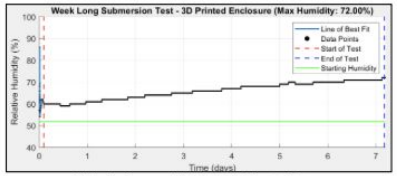
Enclosure Requirements

- **Waterproof**
- **Low cost (< $40)**
- **Allows for passage of sensor cables**
- Deployable for one week
- Allows wireless data transmission
- Reproducible by lab researchers
- UV resistant
- Non-toxic to the environment

Enclosure Testing



Week-Long PVC Test Data



Week-Long 3D Print Test Data

Enclosure Designs

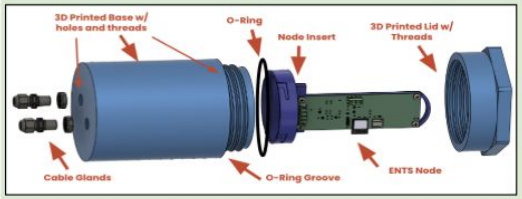
PVC

Exploded View of all Components

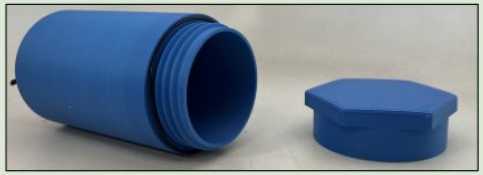
Assembled PVC Enclosure

- Off-the-shelf PVC (SCH 40) Components
- Passed Week-Long Submersion Test

3D PRINTED



Exploded View of all Components



Assembled 3D Printed Enclosure

- PLA, 7 Perimeters, 40% Infill, Sealant
- Passed Week-Long Submersion Test

INDIVIDUAL COMPONENTS

Node Insert Module

- 3D printed twist-lock insert secures ENTS node to enclosure
- Allows for sensor cable management space

Exploded View of Insert and Node

Insert and Node Assembly

Exploded View of Cable Gland[3]

O-Ring and CAD of O-Ring Gland

Silicone Coating Sealant

Cable Glands

- Allows for passage of sensor cables while maintaining waterproof rating

O-Rings

- Provides a waterproof seal for 3D printed enclosure
- Follows industry standards and design analysis[2]

Sealants

- Increases waterproofness and longevity of enclosure
- Reduces toxicity of materials to environment

Design Comparison

	3D Printed	PVC
Raw Cost	$28	$35
Build Time	15 minutes	30 minutes
Idle Time	20 hours	2.5 hours
Tool Requirements	3D printer, sealant, O-Ring Lubricant	PVC cement, power drill, saw
Concerns	Longevity, reproducibility	Size, scalability

Enclosure Instruction Manual

Conclusions

- Both enclosures were deployed for a week with no water leaking inside

Future Recommendations:

- More long-term testing
- Optimize 3D printing settings

Impact on Society

- Lowers cost and access barrier for independent environmental researchers and labs across universities
- Enclosures may release microplastics into deployed environments, but this risk was reduced by introducing sealants
- Allows UC researchers to invest resources used on previous enclosures elsewhere

Acknowledgements

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- **Engineering Staff:** Chris Cassidy, UCSD MAE
- **Course Teaching Assistants:** Jackie Chen & Jackelin Amorin, UCSD MAE

References

(1) Madden, John, et al. "Hardware to Enable Large-scale Deployment and Observation of Soil Microbial Fuel Cells."

(2) Parker Hannifin Corporation. *Parker O-Ring Handbook.*

(3) RS Pro. "Black Nylon Cable Gland"