



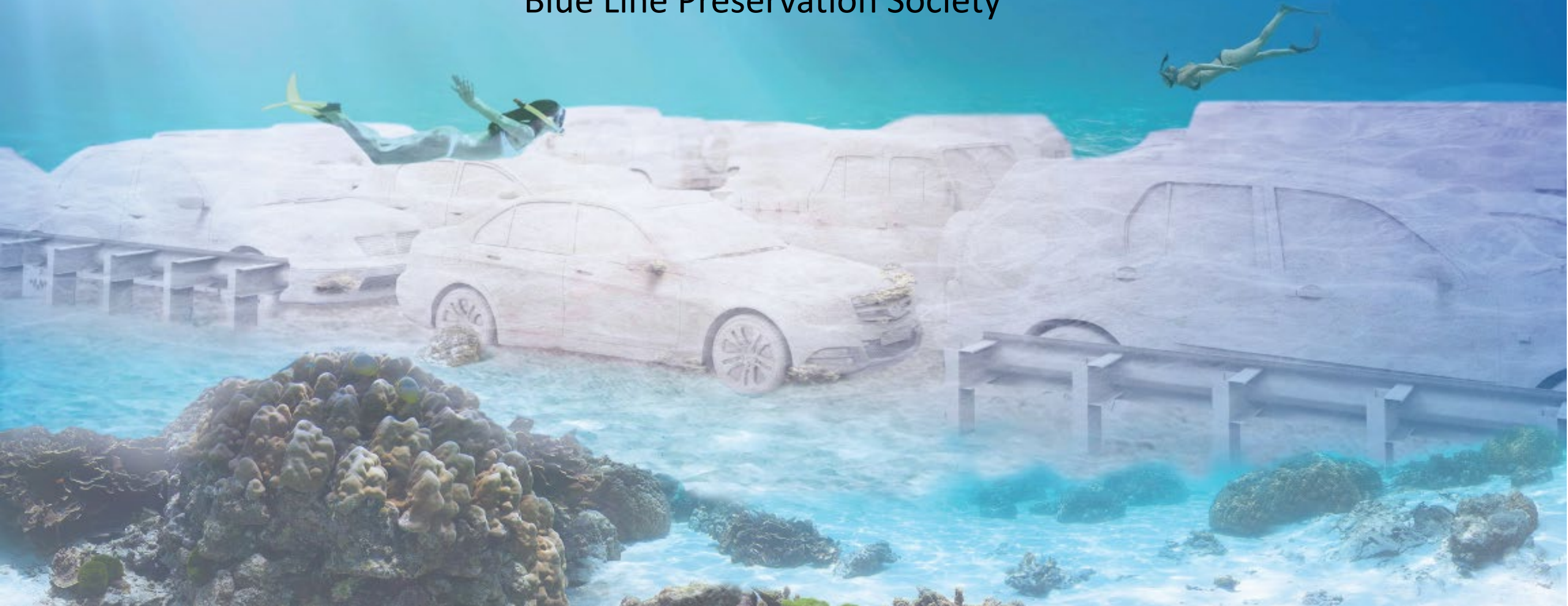
The Reefline Snorkel Trail and Artificial Reef in Miami Beach, Florida

**FSBPA 36th Annual National Conference on Beach
Preservation Technology
February 2, 2023**

**Jordon Cheifet, P.E., CFM – Cummins Cederberg
Gina Chiello – Cummins Cederberg**

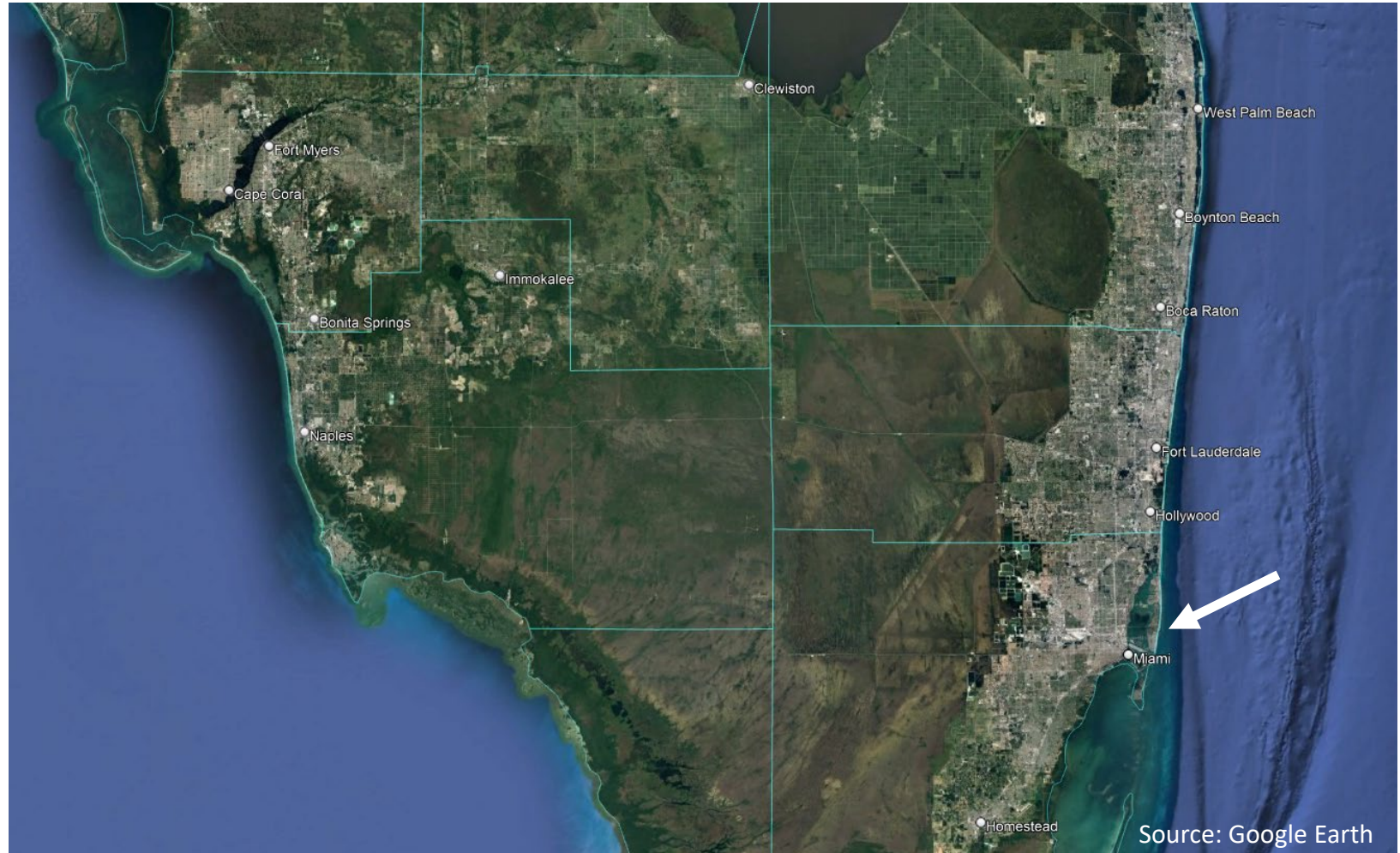
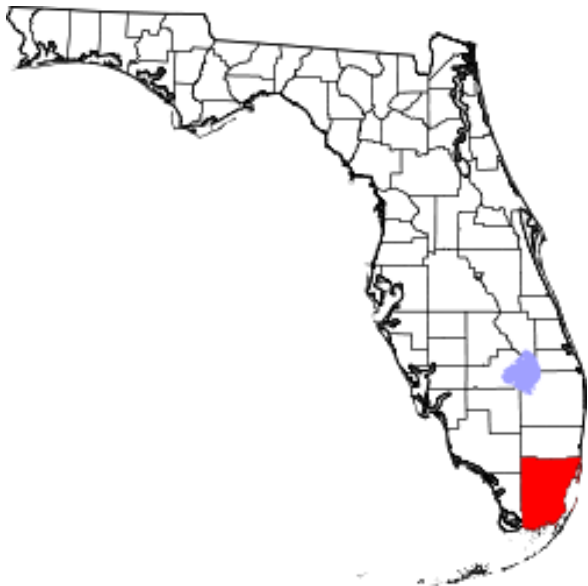
The Artificial Reef Reimagined

Blue Line Preservation Society

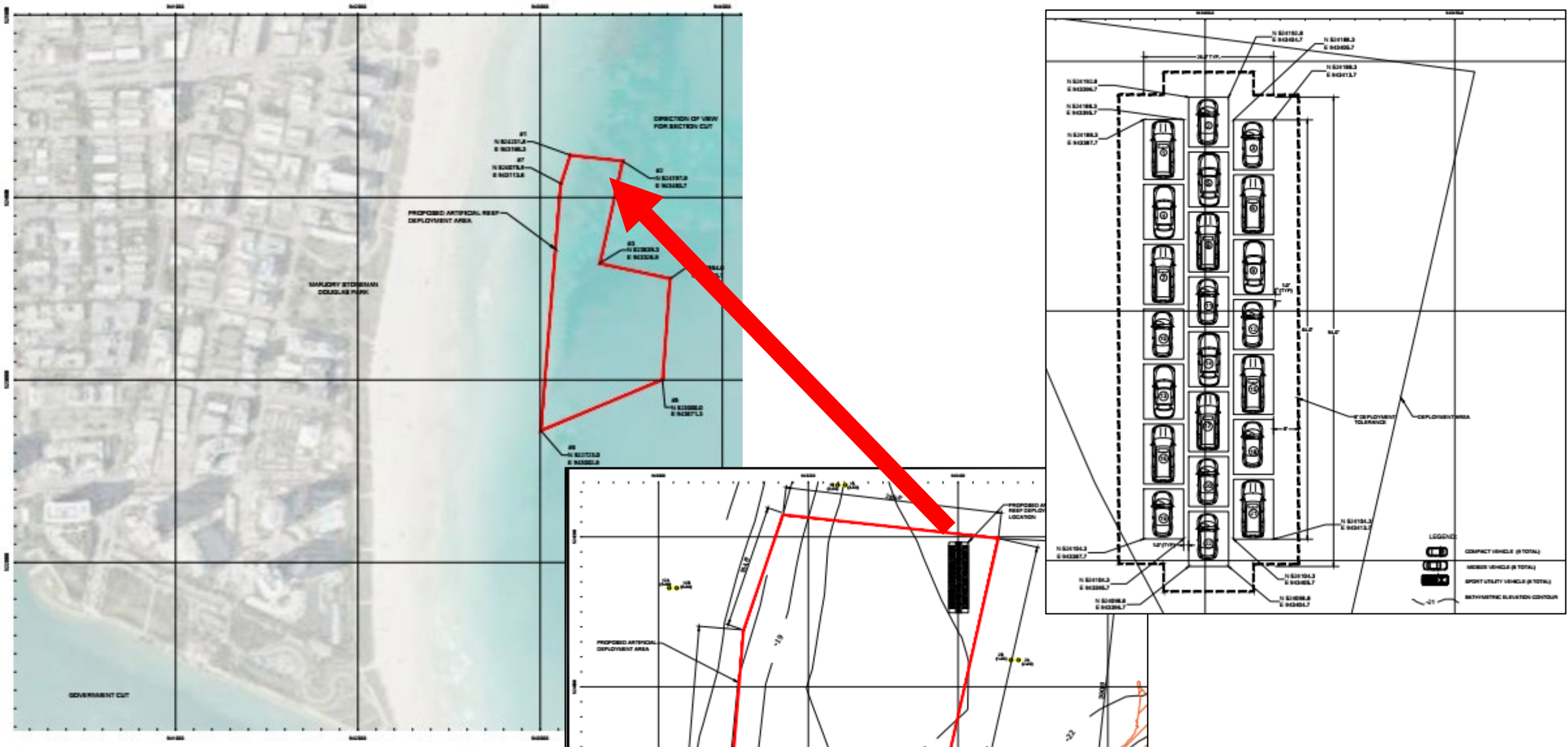


Project Location

- Miami Beach, Florida
- 4th Street



Introduction

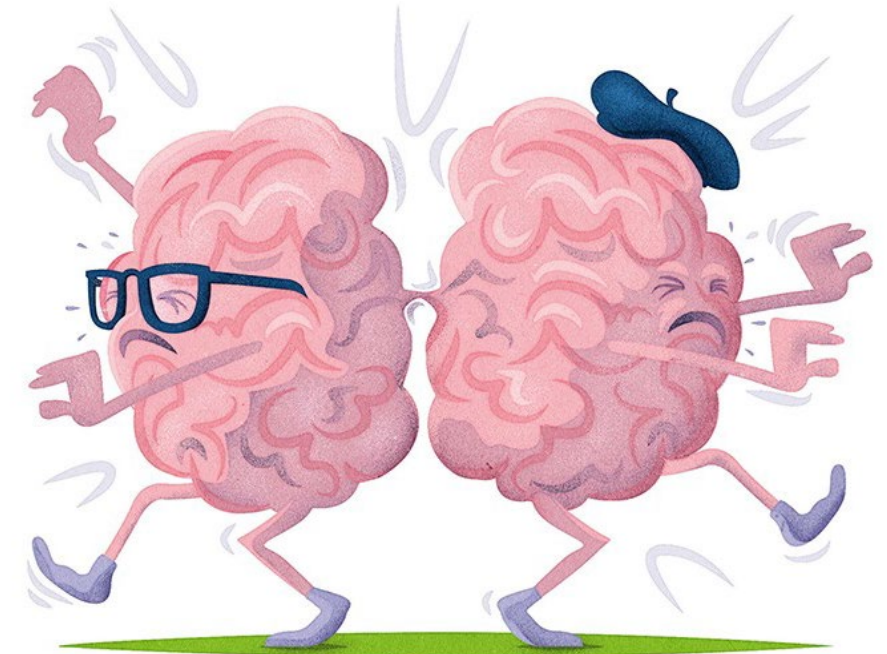


Background

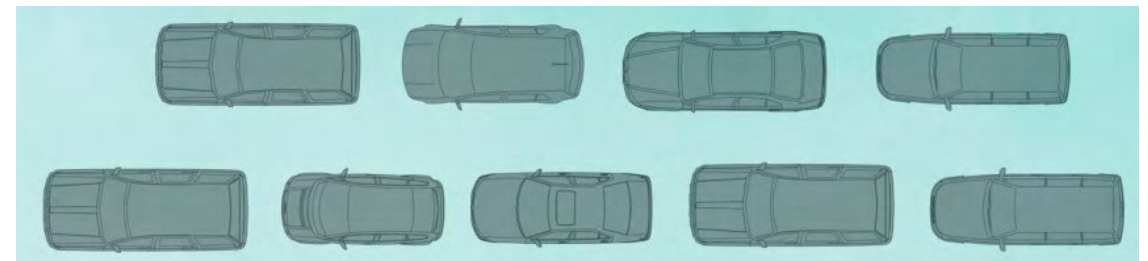
- Miami Art Week 2019
- Leandro Erlich
- *Order of Importance*



- Left vs. Right Brain
- Client's Vision vs. Constructability
- Typical FSBPA Project

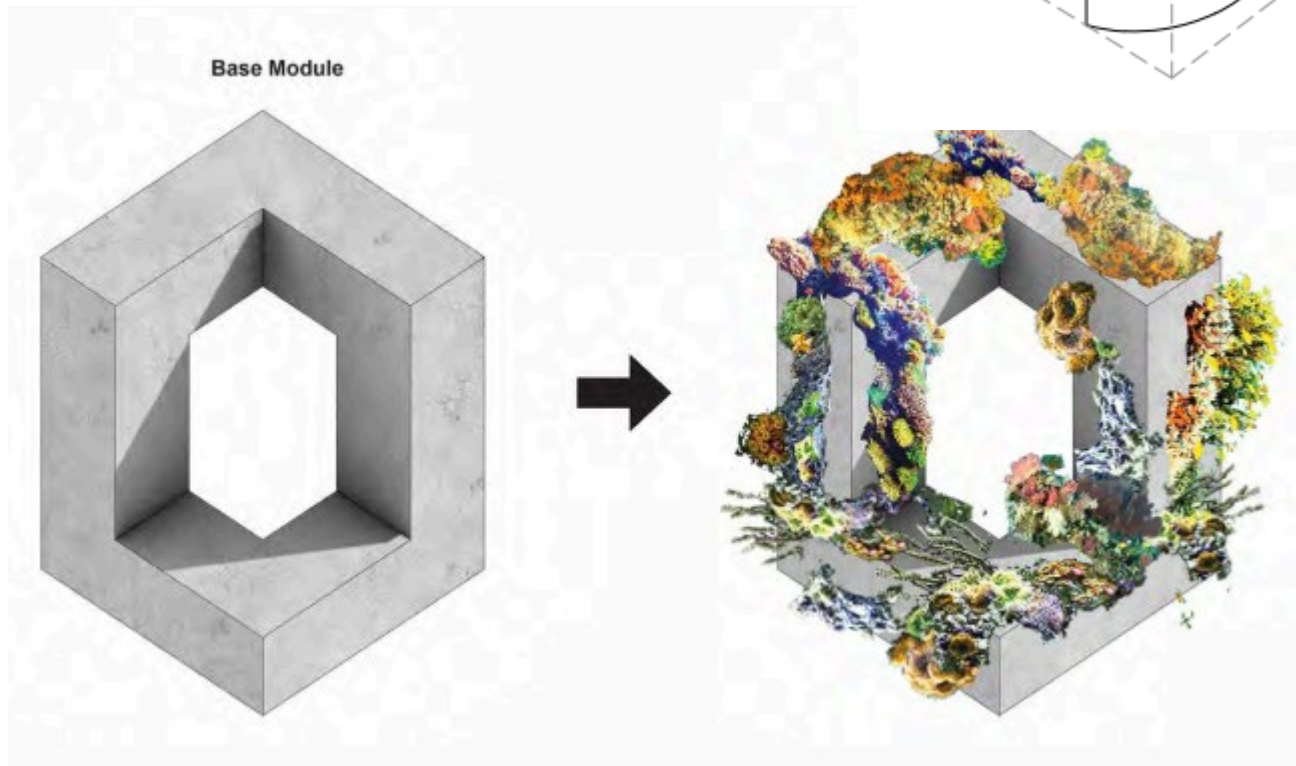
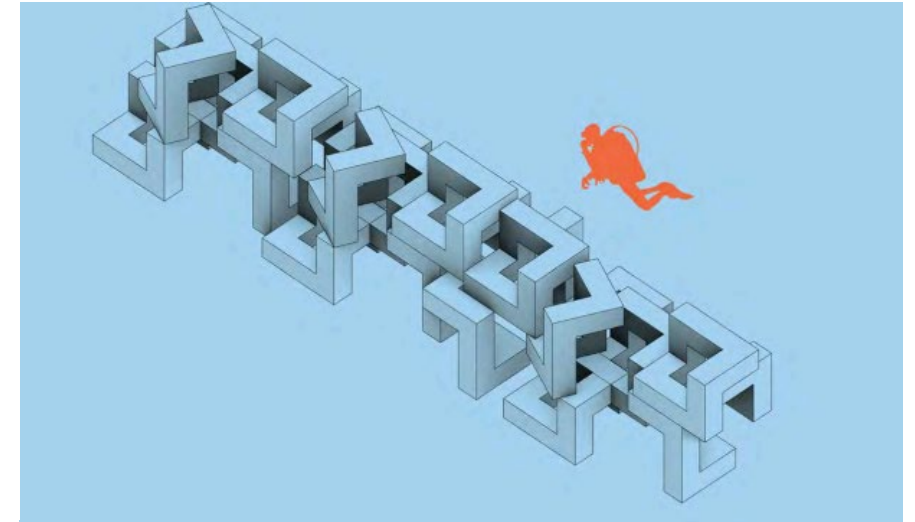
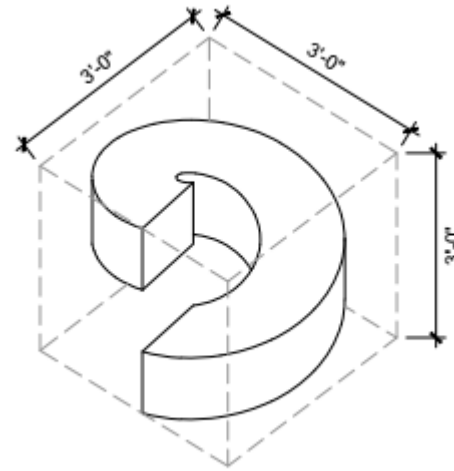


Verywellmind.com



Background

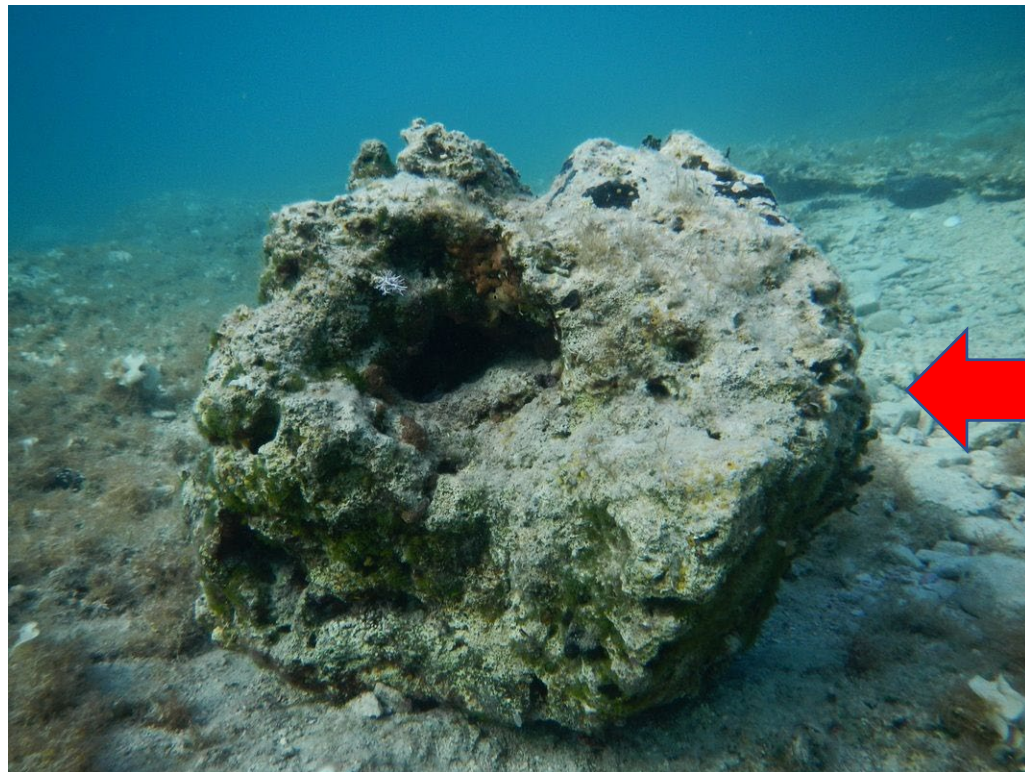
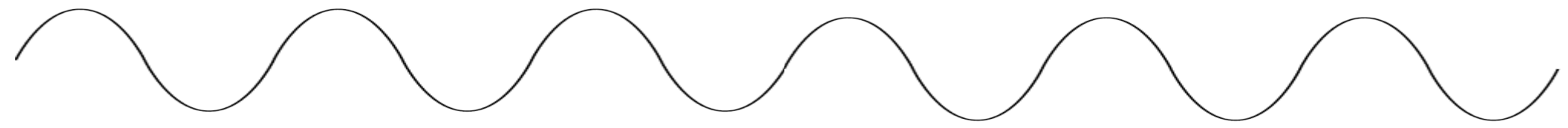
- Initial Artist Concepts
- Minimum Weight



Artist vs. Engineer







Sliding
Wide Base



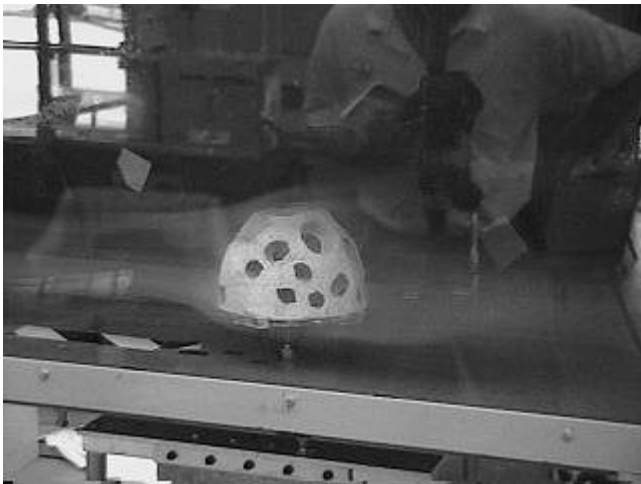
Rolling
High Center of Gravity

Modeling Techniques

Desktop Modeling

- *FIT Wave Tank & Stability Analysis of Reef Balls* – Prof. Lee Harris

$$F_{wave} = F_{drag} + F_{inertia} = F_{resistance} = \mu(F_{weight} - F_{buoyancy} - F_{lift})$$



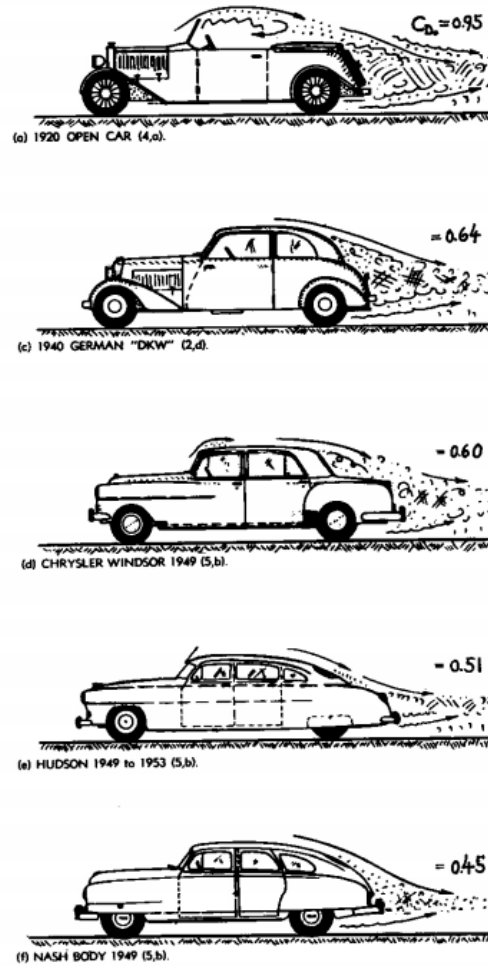
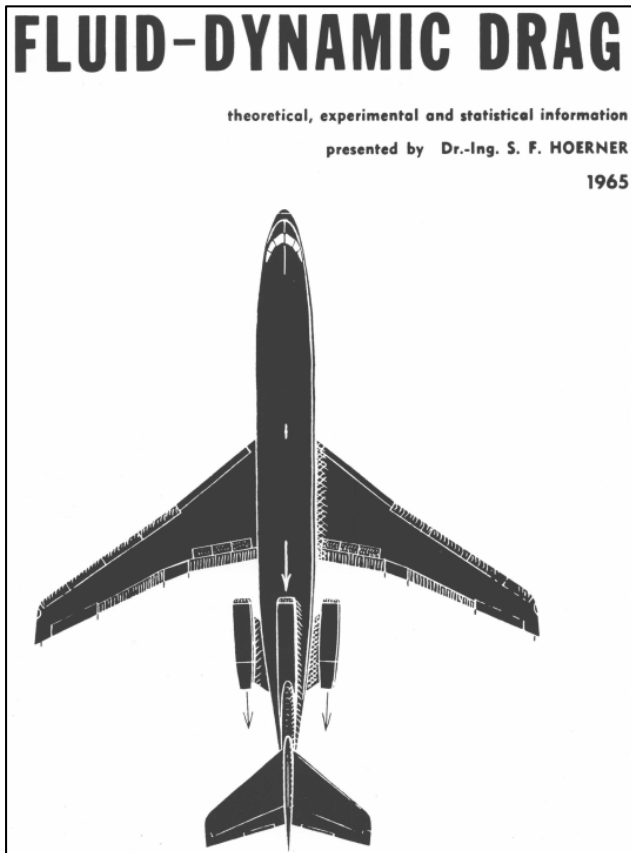
artificialreefs.org



Mbscottsdale.com

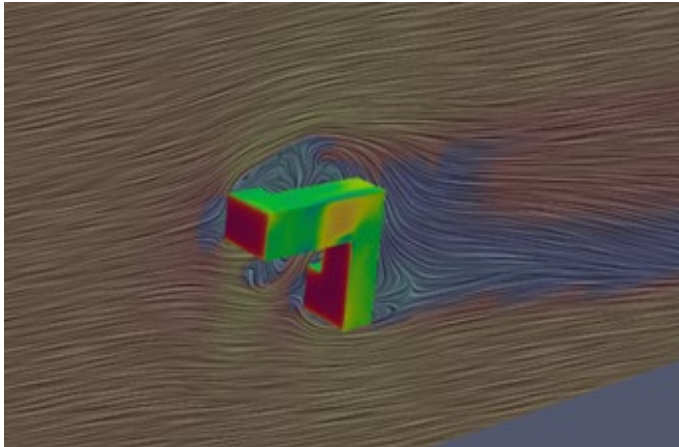
Desktop Modeling

- Limited drag coefficient data

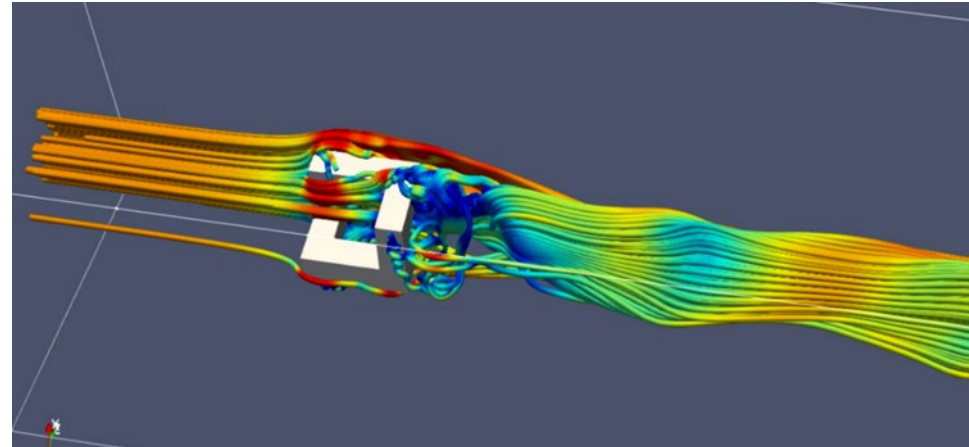


SHAPE	REF.	C_d	SHAPE	REF.	C_d
		0.47 _y		—	1.17 _y
	(c)	0.38		(a)	1.20
	(c)	0.42		(g)	1.16
	(e)	0.59 _y		(d)	1.60 _y
	(f)	0.80 _y		(e)	1.55
	(d)	0.50		(a)	1.55
		1.17			1.98
	(c)	1.17		(a)	2.00
	(b)	1.42		(a)	2.30
	(a)	1.38		(b)	2.20
	(f)	1.05 _y		(a)	2.05 _y

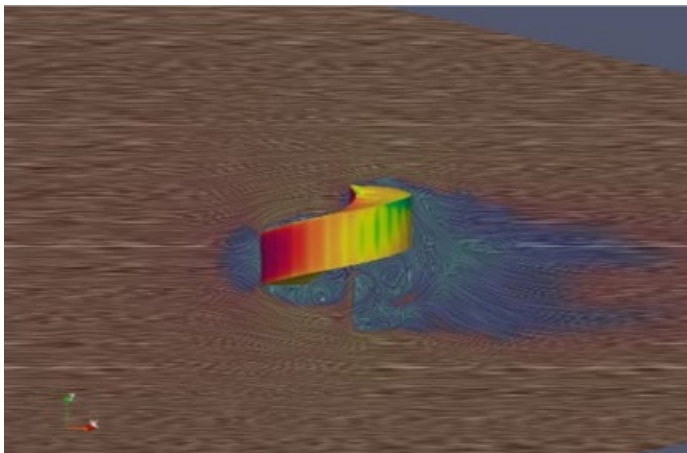
Numerical Modeling



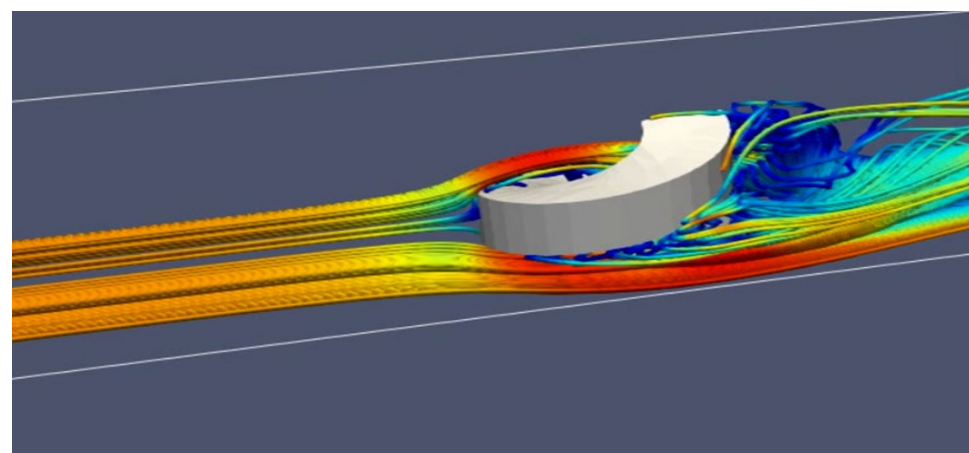
2D Streamlines - Topiary



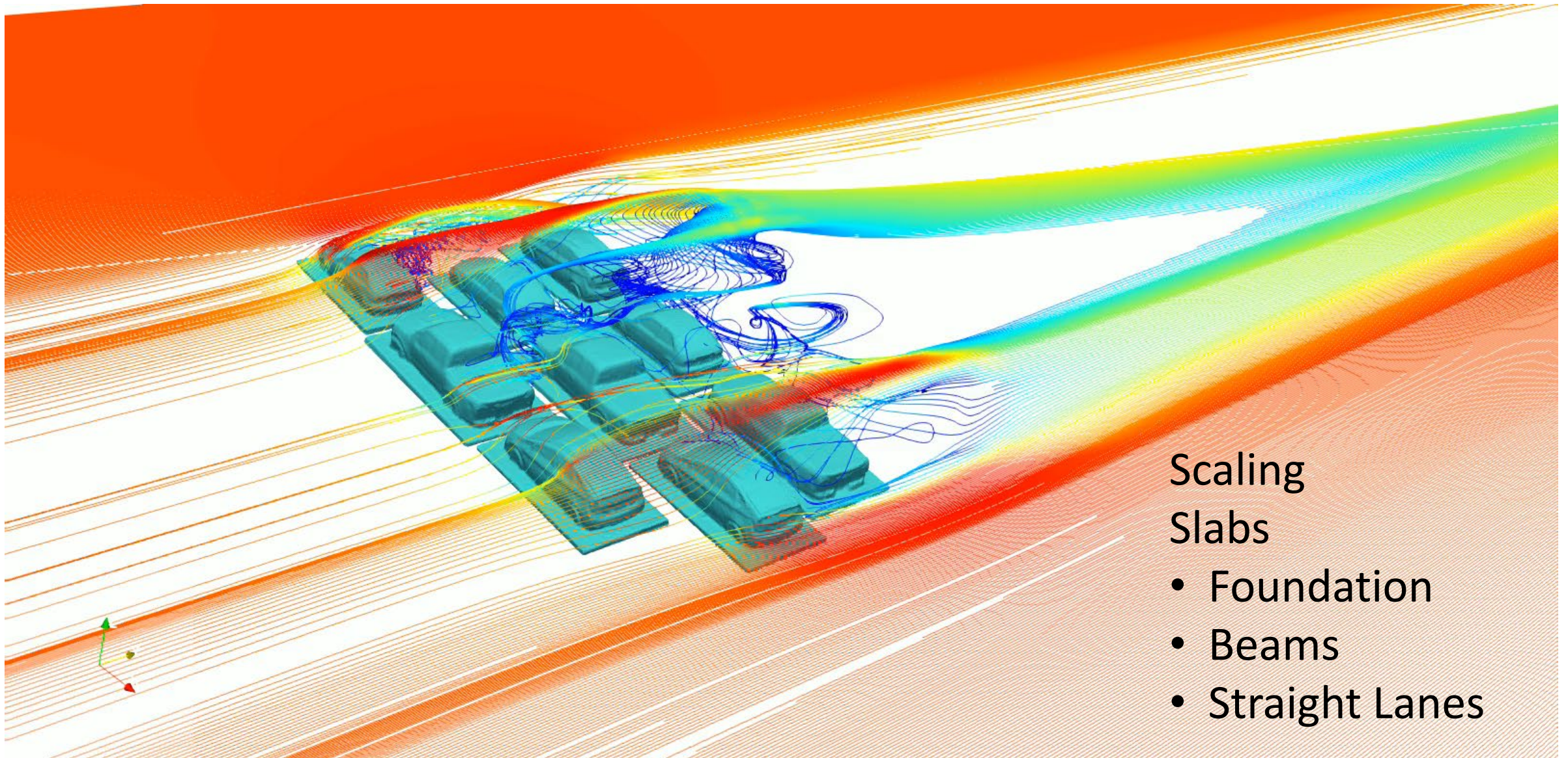
3D Streamtubes - Topiary



2D Streamlines - Spiral



3D Streamtubes - Spiral



Physical Modeling

Alfred C. Glassell Jr. SUSTAIN Laboratory

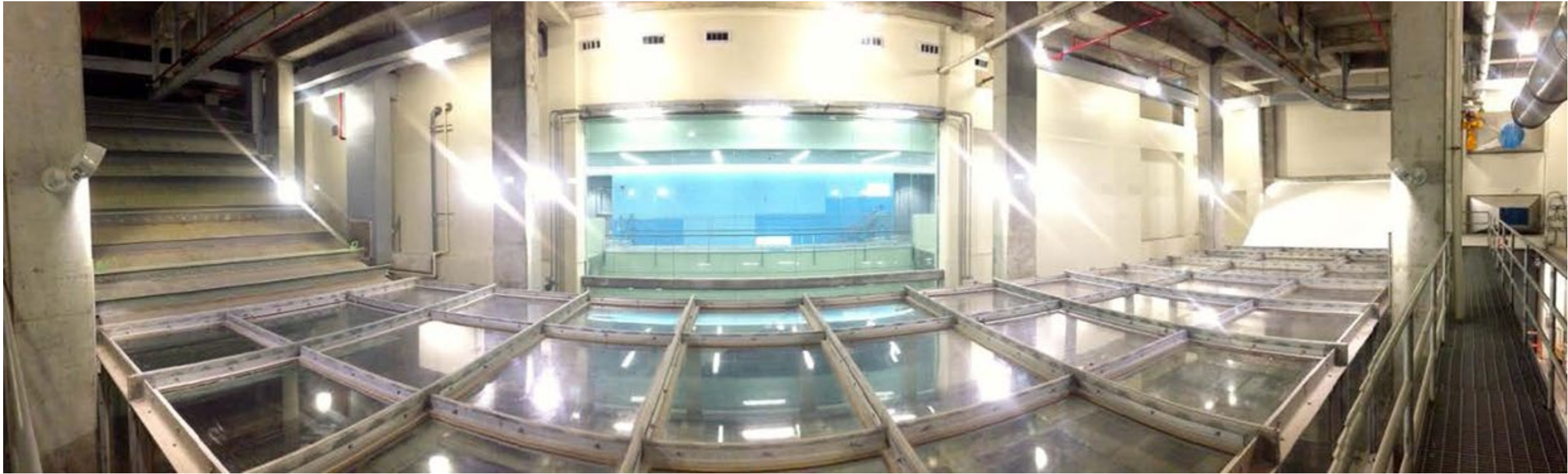
- Category 5 Winds (155 mph)
- Wave Paddle
- Total dimensions: 23-m long x 6-m wide x 2-m high



MIAMI



University of Miami



Wind & Waves

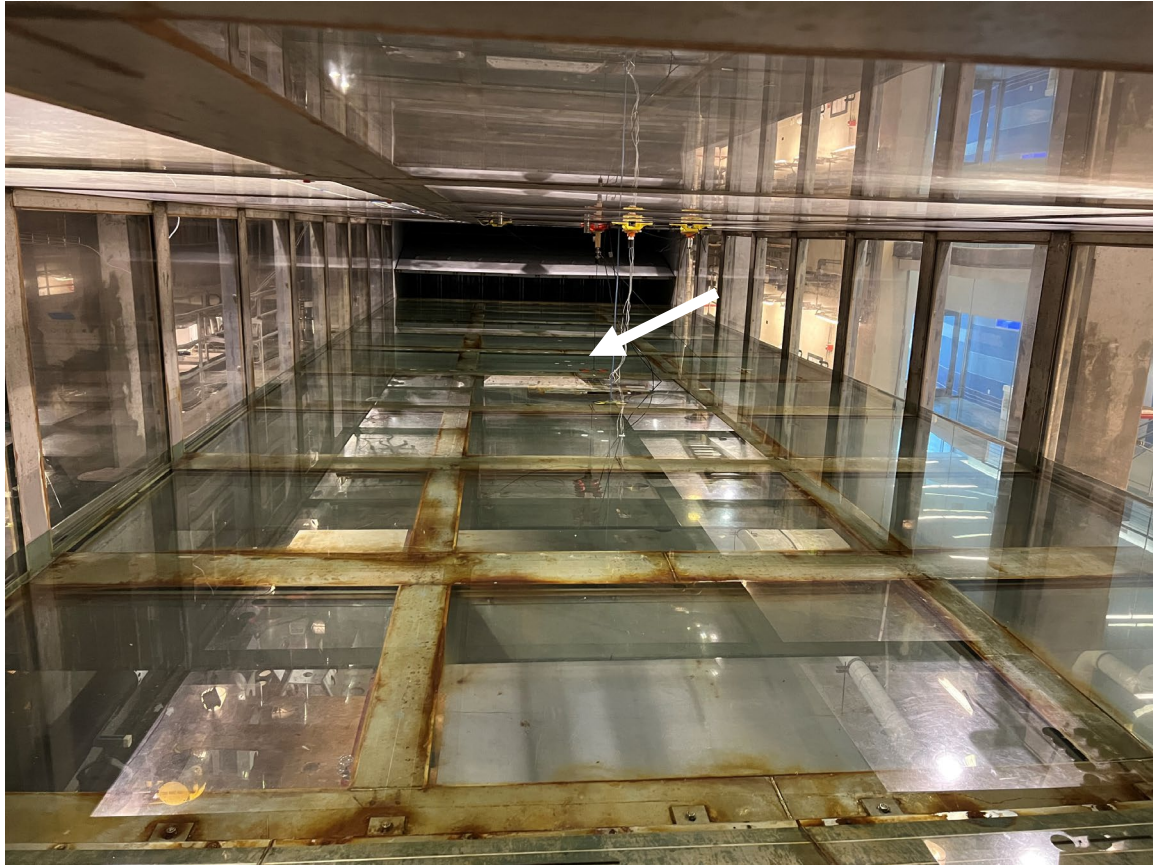


Flume

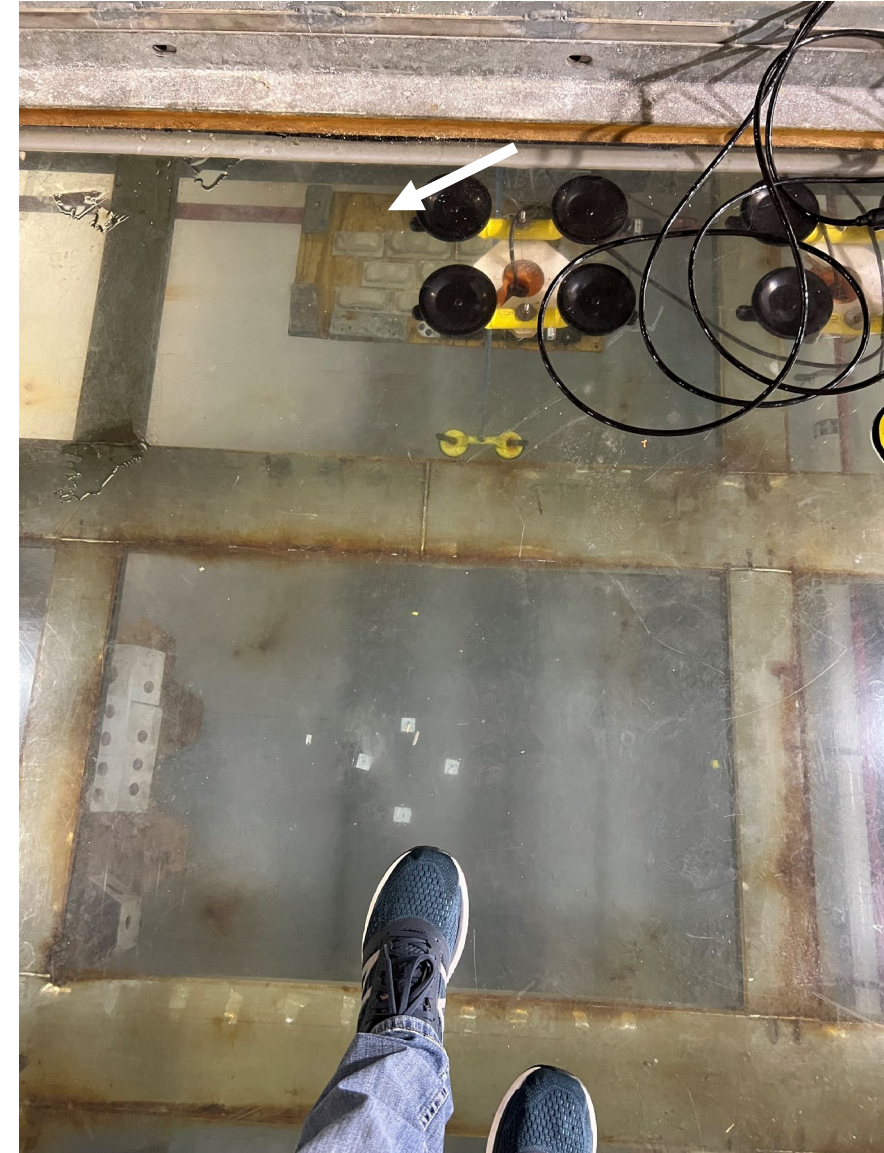
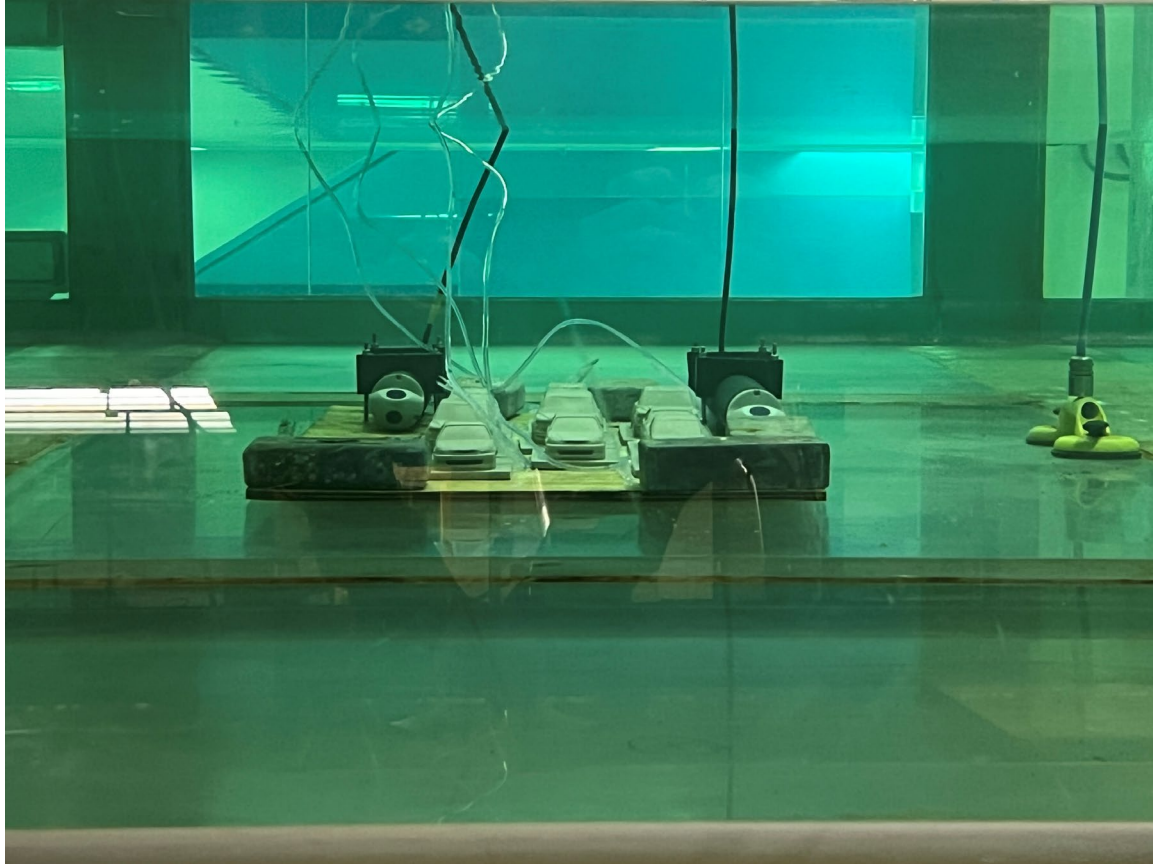


Sloped Shoreline









Extreme and Surfing Waves

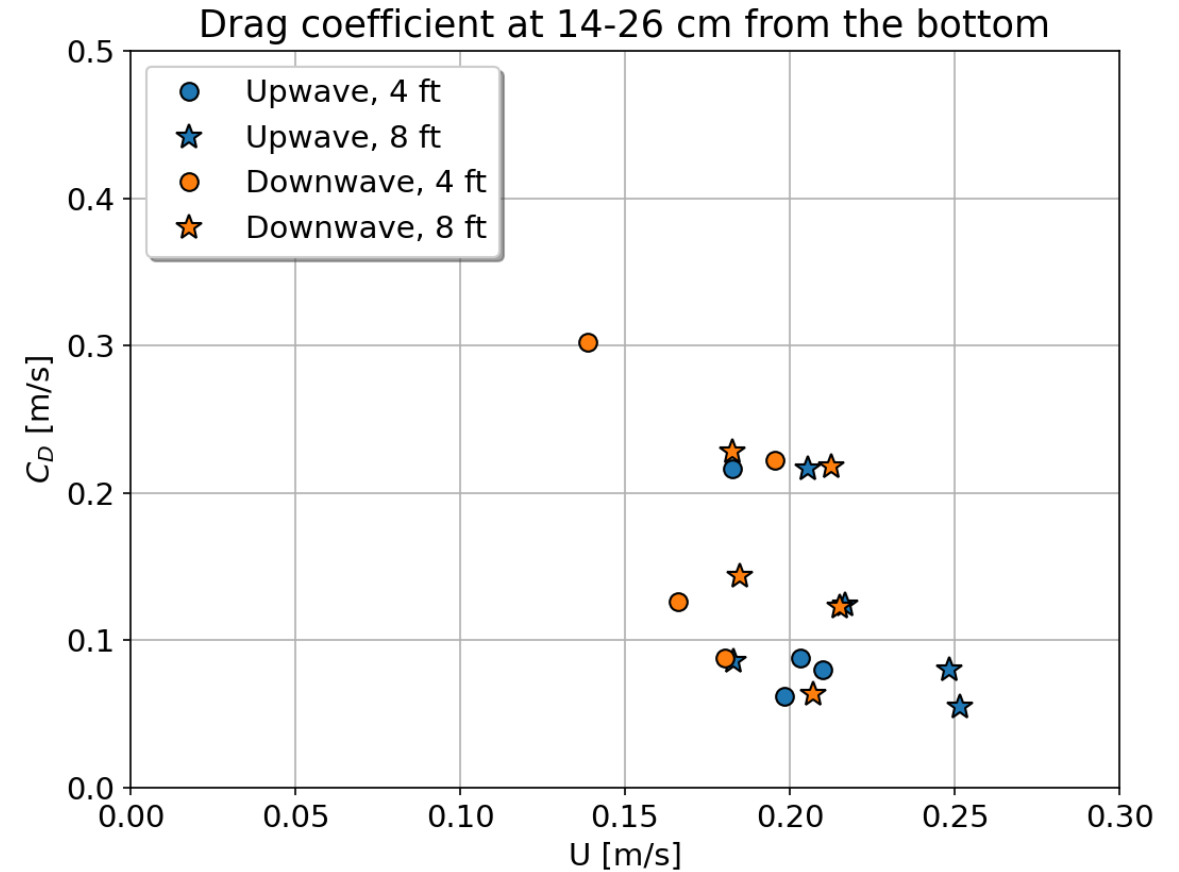


Results Comparison

- Published $C_d = 1.05$
- Numerical Modeling $C_d = 0.5$
- Physical Modeling $C_d = 0.3$

Factor of Safety

- 100% - 200% difference
- Initial ~15 Ton Minimum Weight
- Final ~10 Ton Minimum Weight



Optimization through Numerical & Physical Modeling

Lower wave forces on the individual artificial reef units

- Lighter/smaller units with the same stability
- Reduced fabrication & installation costs

More units per barge/truck load (fewer trips)

- Smaller crane to handle units (more contractor bids)
- Increased ability to handle upland using smaller equipment

Increases in efficiency during deployment for same footprint

- Fewer crane remobilizations (i.e., less time) to install units
- Smaller upland staging area

Next Steps

Questions



MIAMIBEACH

KF Knight Foundation



OMA



CORAL MORPHOLOGIC

BRIDGE



Decentraland

aorist

carbonxinc

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