The Drone Tug and Its Applications in Marine Transport

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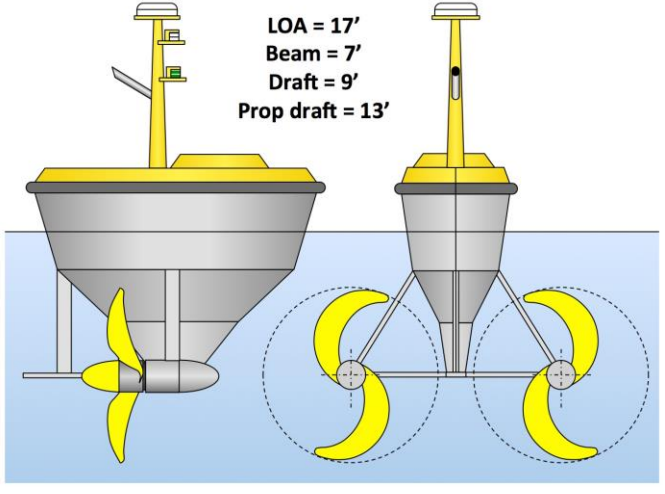
Autonomous Tow Vessels for Offshore Macroalgae Farming

- Offshore farm systems are being developed to exploit the vast U.S. EEZ.
- Seaweed transport to shoreside processing plants looms as a dominant energy need.
- Efficiency of low-speed transport possible D <-> V^2
- Autonomy enables low speed
- Drone Tug emerges
  - Low speed
  - Large diameter, slow turning
  - Ultra- efficient
  - Remote control/autonomy



ARPA-E concept paper Jan. 2017

Autonomous Tow Vessels for Offshore Macroalgae Farming

The Project Team:

C.A. Goudey & Associates

Project management, design, integration, testing, market development.

Response Marine

Naval architecture, CAD, construction supervision

Robotic Marine Systems

Electronics, sensor integration, autonomy, telemetry

Hydrocomp, Inc.

Propeller analysis, propulsion optimization

Woods Hole Oceanographic Institution & Marine Biological Laboratory

Farm integration, outreach

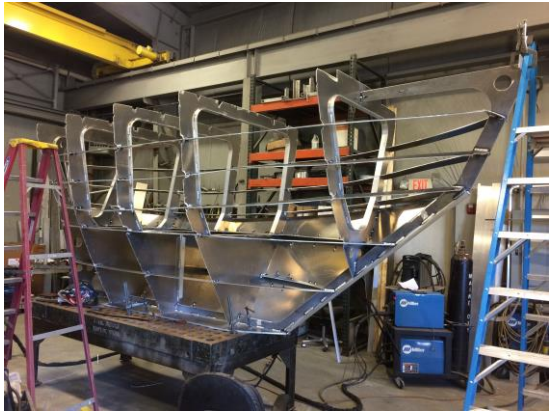
Massachusetts Institute of Technology

Route optimization

Technical path

1. Prototype 1 design – April to August

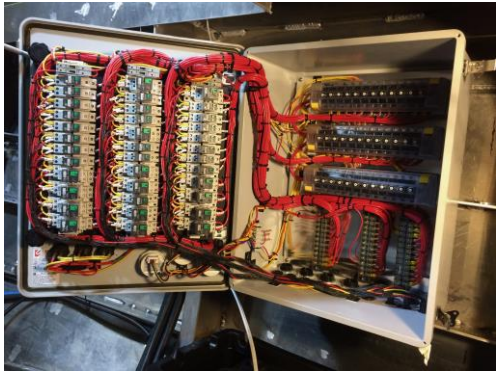
- Robust and self righting
- Using off-the-shelf components



2.Fabricate – July to November

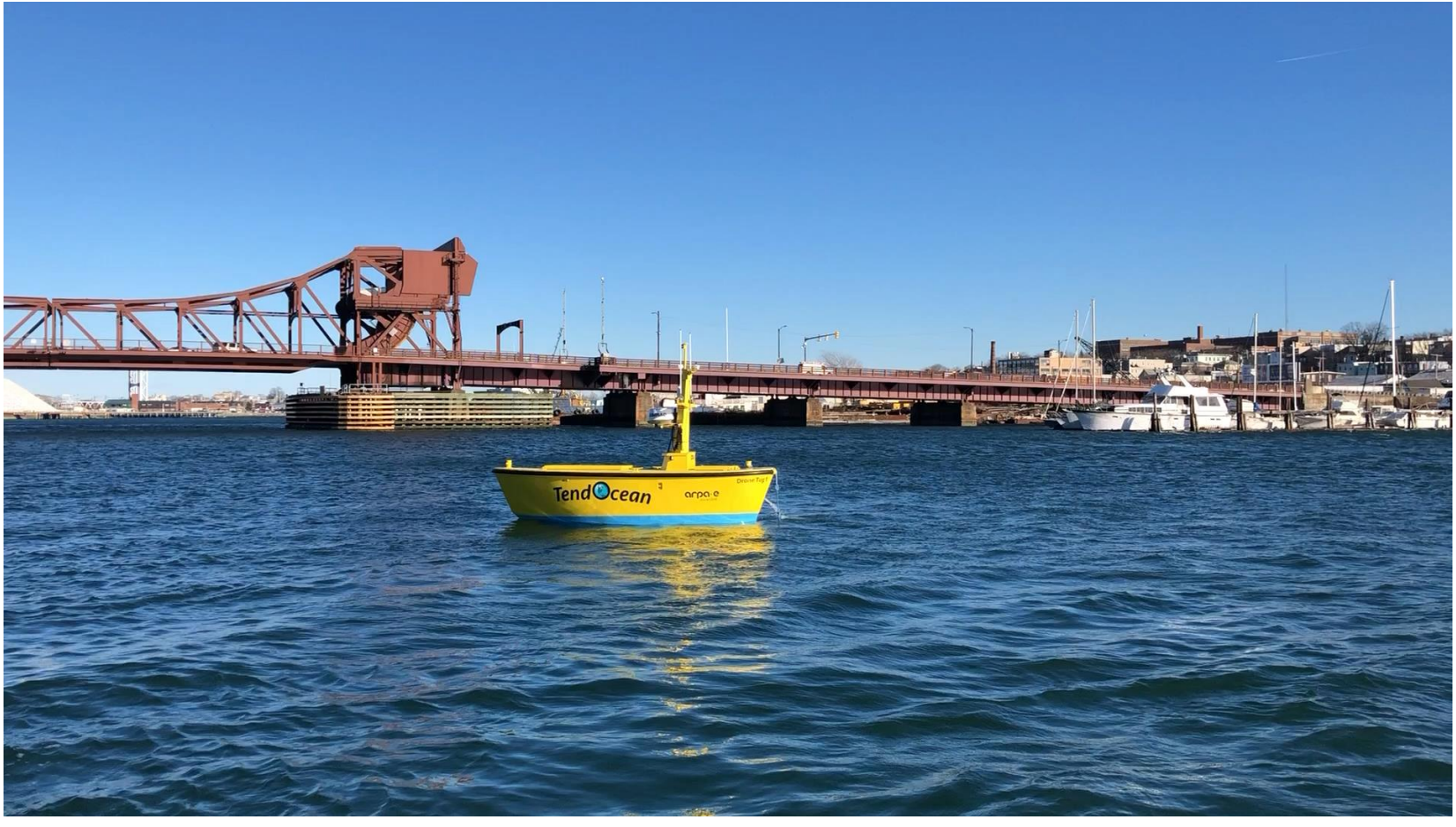
- Water-jet cut aluminum
- Steel keel & thruster wings

3.Instrumentation and remote control – June to Feb.



4. Sea trials – Feb 23 - 28

Sea Trials Boston Harbor Feb 23-28, 2019



Sea Trials Boston Harbor Feb 23-28, 2019

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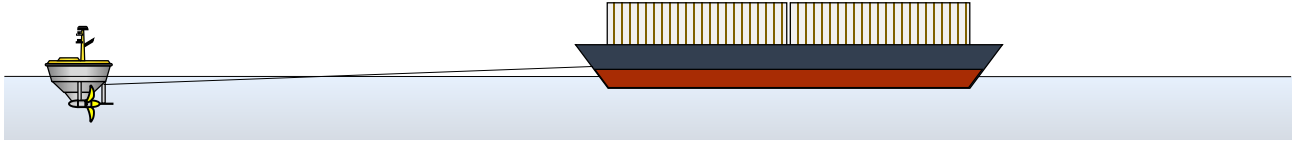
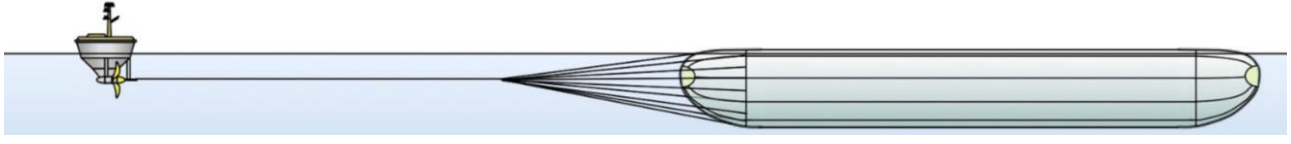
Drone Tug Opportunities

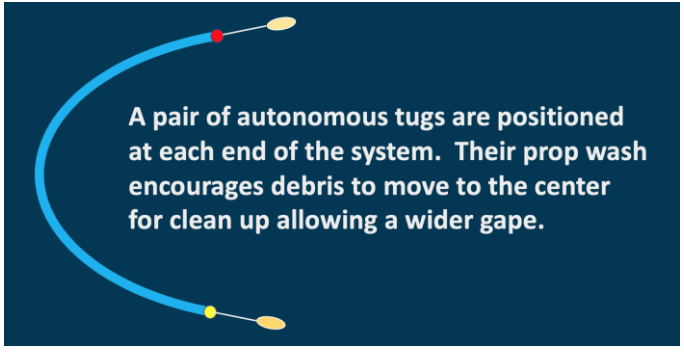
- Improve propulsion performance –using HydroComp simulations.
- Consider all-electric propulsion that meets mission requirements. Include tidal-power extraction
- Other maritime applications
  - Harbor tug – swarm of drones under pilot control
  - Coastal trade – last-100-mile container delivery.



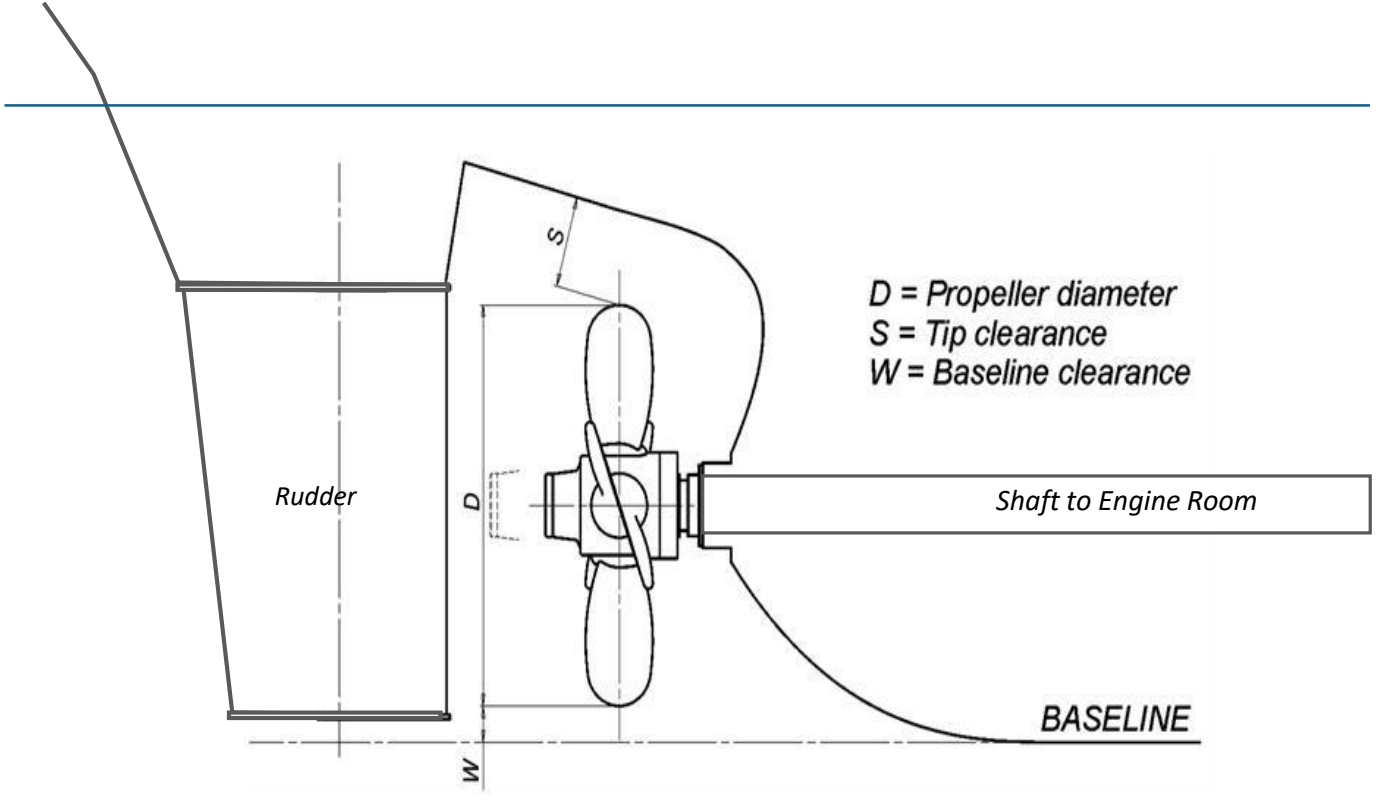
  - Fresh water transport



  - Commercial fishing – pair trawling
  - Oil spill cleanup
  - Rescue towing
  - Ocean Cleanup
  - Naval logistics?



The Naval Architect's Conundrum: Limited propeller aperture



The Problem

- *Draft limitations*
- *Cavitation*
- *Fixed shaft position*
- *Wide operating range*
- *Tradition*

The Solution

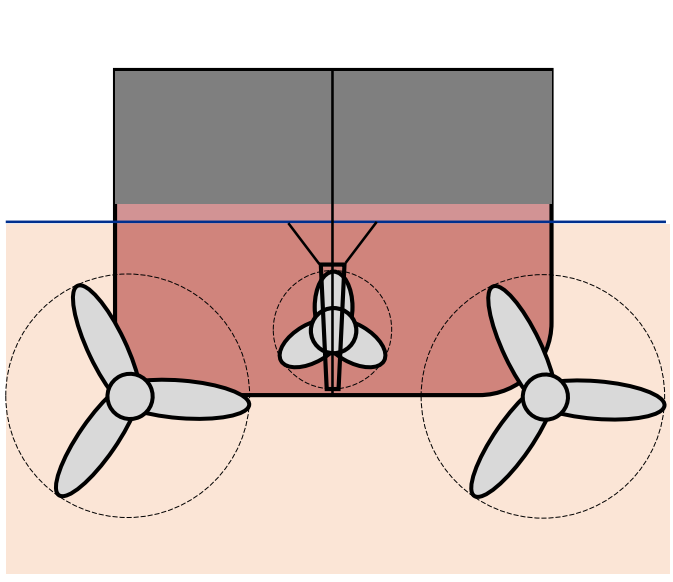
- *Pod propulsion*
- *Variable depth*
- *Adjustable position*
- *Focused design*
- *Innovation*

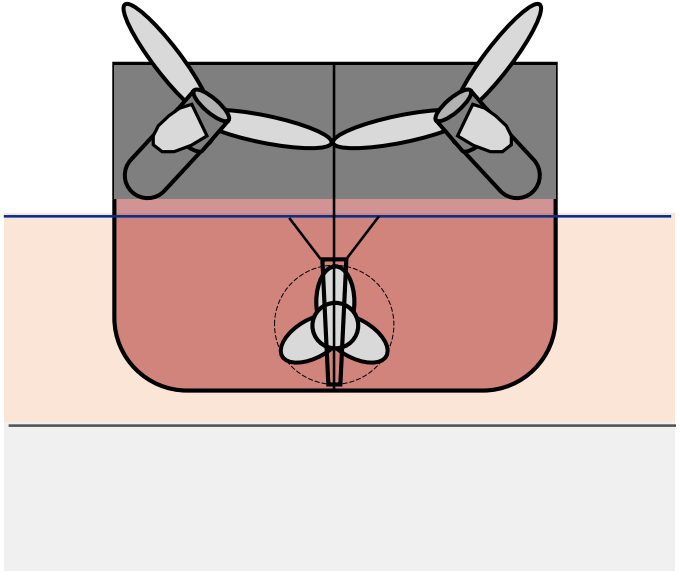
To date, pod propulsion has not been fully exploited.

Drone Tug's propulsion principles have broad application.

Most ships would benefit from larger propellers

- Retractable, ultra-efficient propellers for open water





- Large-diameter, slow-turning propellers require far less power for a given amount of thrust.
- There are numerous ways to implement pivoting, retractable thrusters.

Thank you for your attention

Any questions?

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