The Drone Tug and Its Applications in Marine Transport

Clifford A. Goudey
Founder & Engineer

C.A. Goudey & Associates
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 $D \leftrightarrow V^2$

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


4. Sea trials – Feb 23 - 28

2019 CMR Entrepreneur Forum
July 17-18, 2019
Woods Hole Oceanographic Institution
Sea Trials Boston Harbor Feb 23-28, 2019
Sea Trials Boston Harbor Feb 23-28, 2019
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
  - Rescue towing
  - Naval logistics?

A pair of autonomous tugs are positioned at each end of the system. Their prop wash encourages debris to move to the center for clean up allowing a wider gape.
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?

Please contact us at:

cliff@cagoudey.com  
dom@cagoudey.com