

# Who's the Captain Now?

## Designing an Autonomous Vessel

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# Outline

- Autonomous Vessels
- Our project
  - History
  - Mission
  - Design
  - Operation
- Results
- Future plans and needs
- Questions and discussion



# Autonomous Vessels

- Autonomous systems (drones)
  - Dirty
  - Dangerous
  - Dull
- Many examples of small vessels
- Active research field
- Autopilots found on most crewed vessels both commercial and private



Images:

[www.saildrone.com](http://www.saildrone.com)  
[www.autonautusv.com](http://www.autonautusv.com)  
[www.whoi.edu](http://www.whoi.edu)  
[yachtpals.com](http://yachtpals.com)





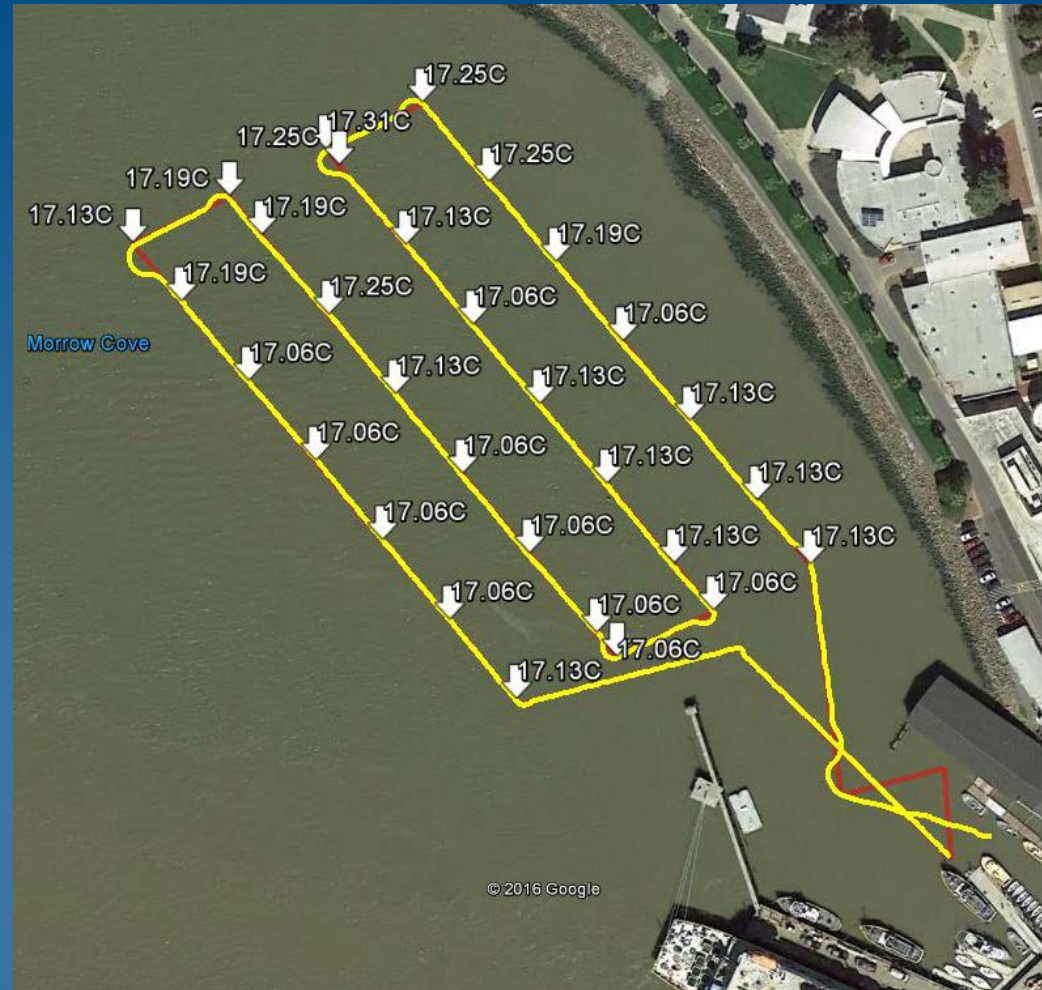
# Autonomous Shipping

- Recent program at Rolls-Royce
- Norway has established a test zone (Trondheimsfjord)
- This scale brings up issues of economics and ethics along with the technological challenges.



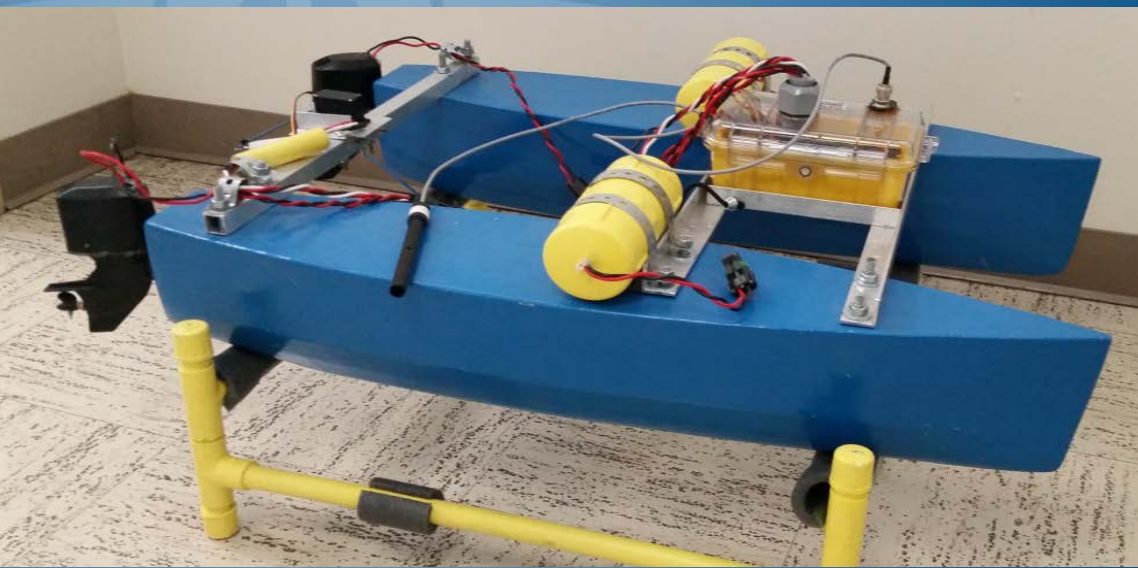
# Dumbo Mission

- Built and operated by students
  - Use off-the-shelf autopilot
  - Hobby grade hardware
- One hour voyages in Carquinez Strait
- Deliver accurate oceanographic measurements



# *Dumbo* History

- First version: Mechanical Engineering Capstone project
- Remotely piloted
- Solid foam hulls with externally mounted gear



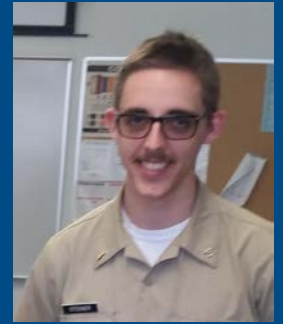


# History- Rose Hendrix

- 2014 COAST funding to add autonomous systems
- Existing hulls hollowed out to put systems inside



# History- Jake Steiner



- 2015 COAST funding
  - new hulls
  - new propulsion
  - more sensors





# *Dumbo* Construction

- Wooden/fiberglass construction
- Hobby ROV thrusters
- APM open source autopilot system
- Payload system measures Temperature, Salinity, Dissolved Oxygen
- Measurements at specified waypoints
- Data is stored on SD card



# APM (Ardupilot) Autopilot

- Multirotor drone guidance package: GPS, compass, attitude sensors, telemetry
- Ground vehicle firmware for boat
- Several control station options
- Open source hardware and software
- Documentation is disorganized, takes time to understand the complex system



APM:Plane



APM:Rover

Images:  
<http://ardupilot.org/>



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# *Dumbo* limitations

- Only GPS/Compass sensor
  - No collision avoidance (operator responsibility)
  - No route checking (operator responsibility)
- A Captain is required for safe operation
- Maintenance and reliability





# Operations: Path Planning



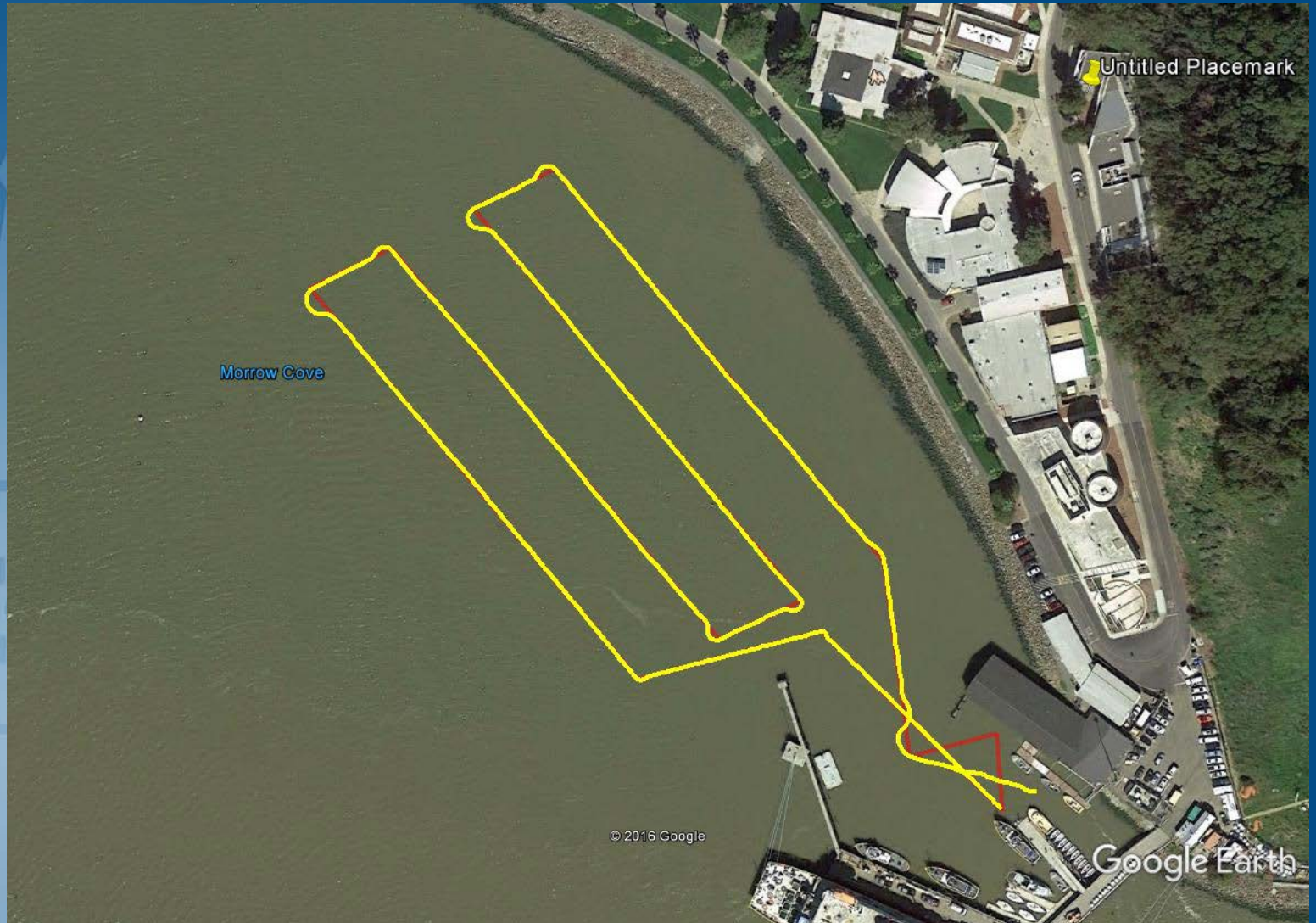
# Planned Path



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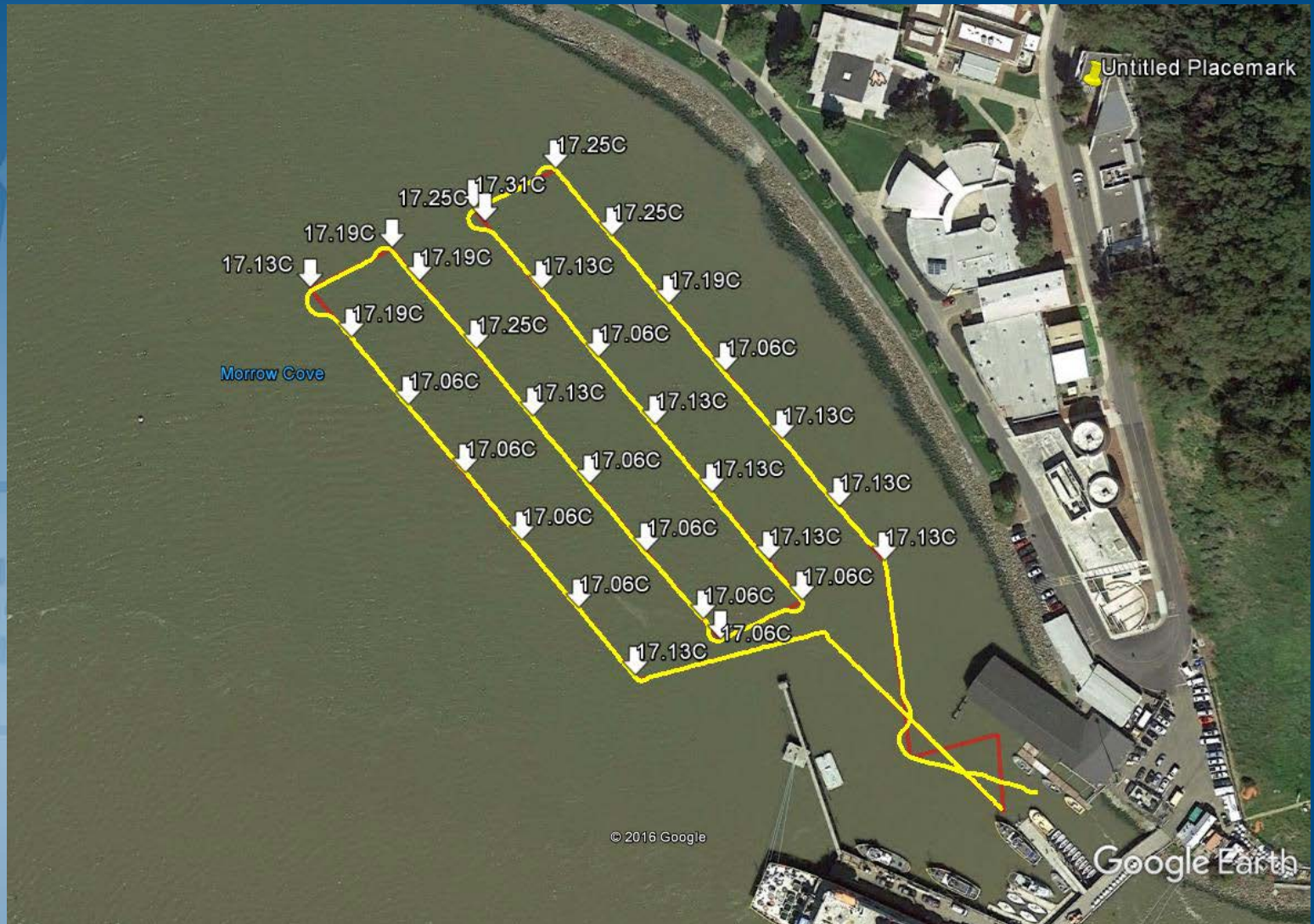
# Navigation Results



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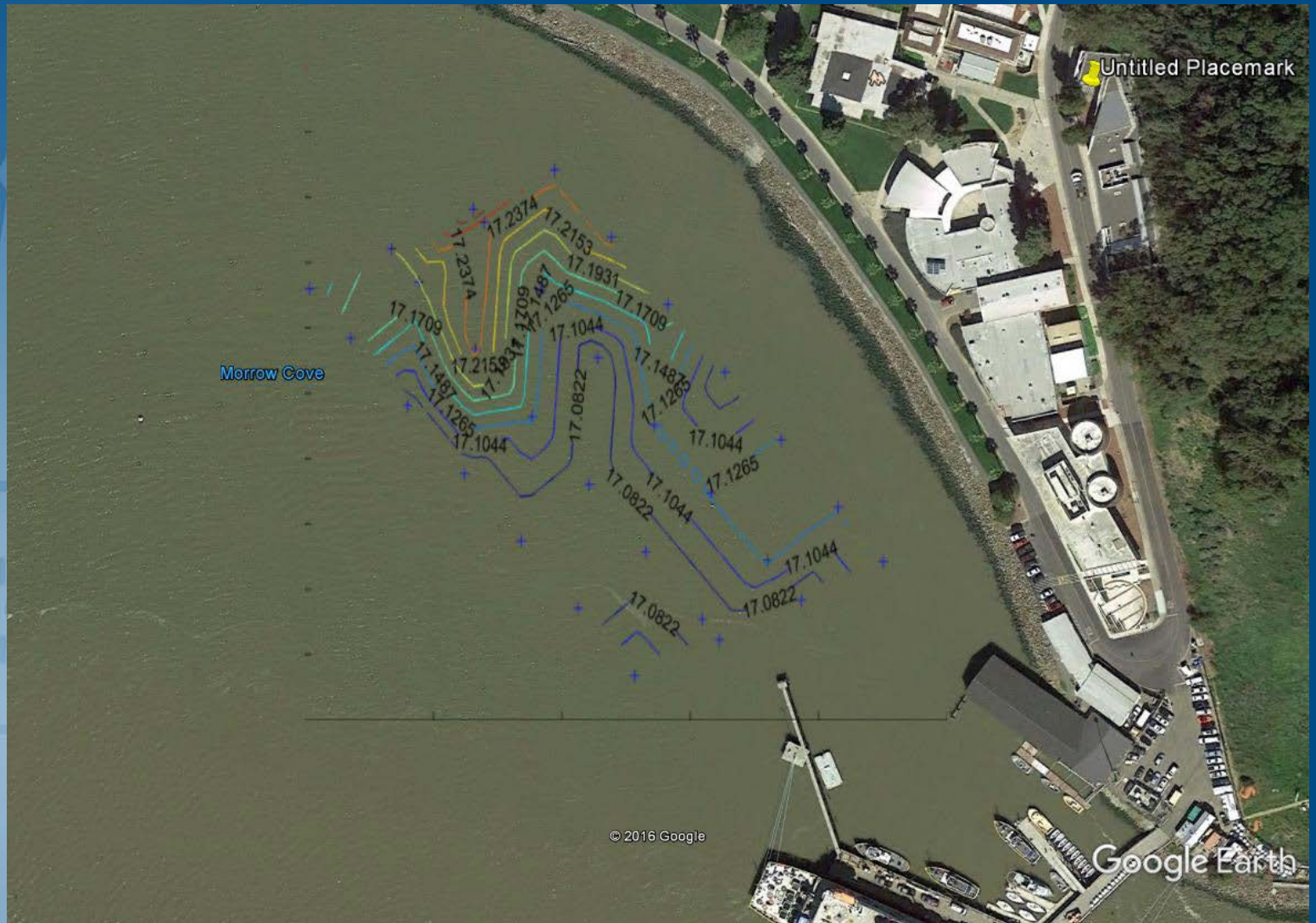


# Oceanographic Measurements (Temperature)



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# Isotherms



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# Future Goals

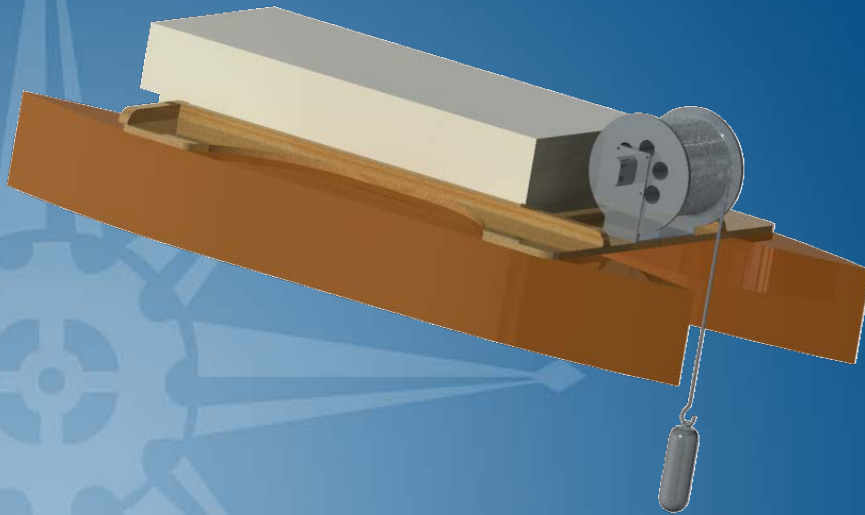
- Volunteers welcome: [mholden@csum.edu](mailto:mholden@csum.edu)
- Students to operate the boat regularly
  - Quality oceanographic observations for scientists
  - Record of operations/maintenance for engineers and economists





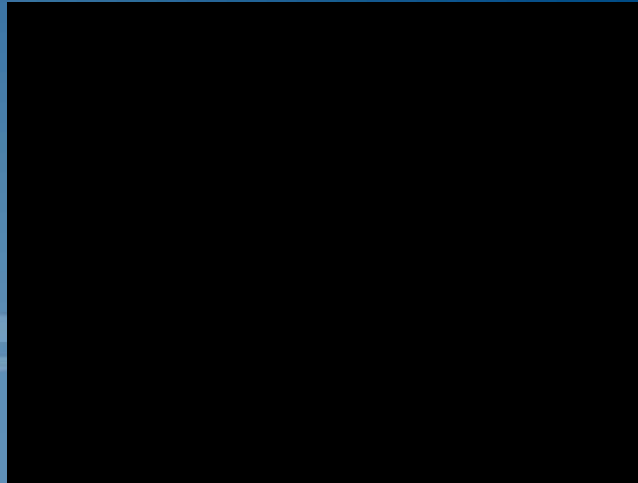
# Future Work

- 2016-17 Capstone project
  - New sensor payload for measurements at depth



- Next boat: what is your mission?

# Follow the voyage



# Thanks

- Students
  - Jake Steiner
  - Rose Hendrix
  - Alec Safreno
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  - Leo Baclig
  - Jack Lavariega
  - Oleg Kilafly