Multi-Domain Vehicle Concept for Detecting Oil-Based Water Pollution

Abigail Berube, Nicholas Grumski, Tyler Guertin, Drake Hamblin, Zachary Rivernider, and Jeremy Trembley

Project Motivations

Oil Pollution in the Baltic Sea

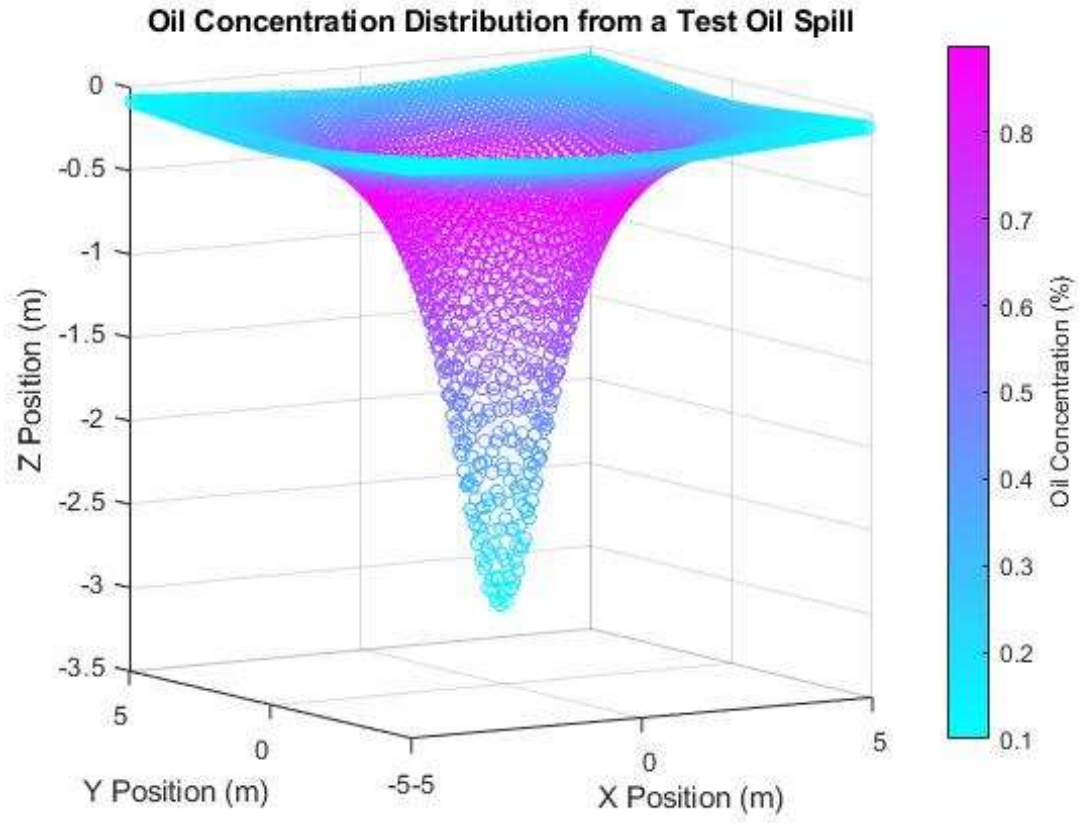
- 788 spills between 2004 and 2020
- Intentional discharging of oil

Current Technology

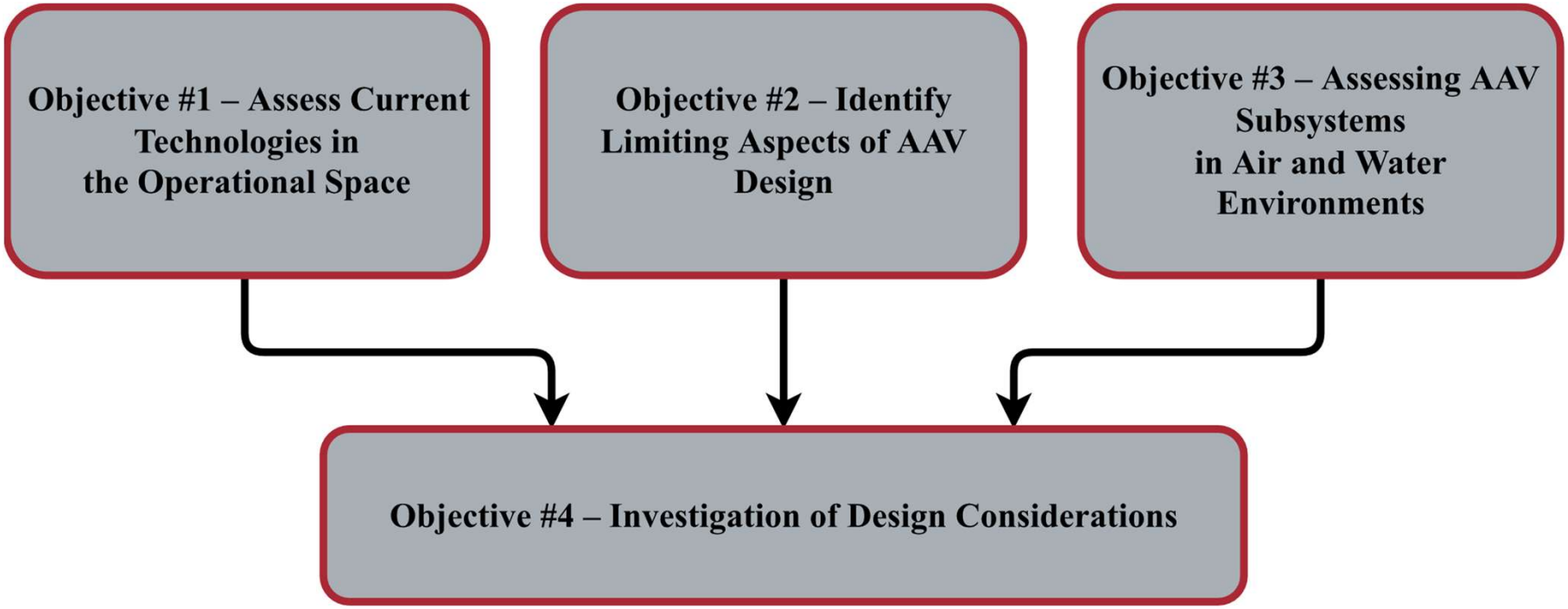
- Focused on pipeline monitoring
- Autonomous oil detection is not exact

Project Goals

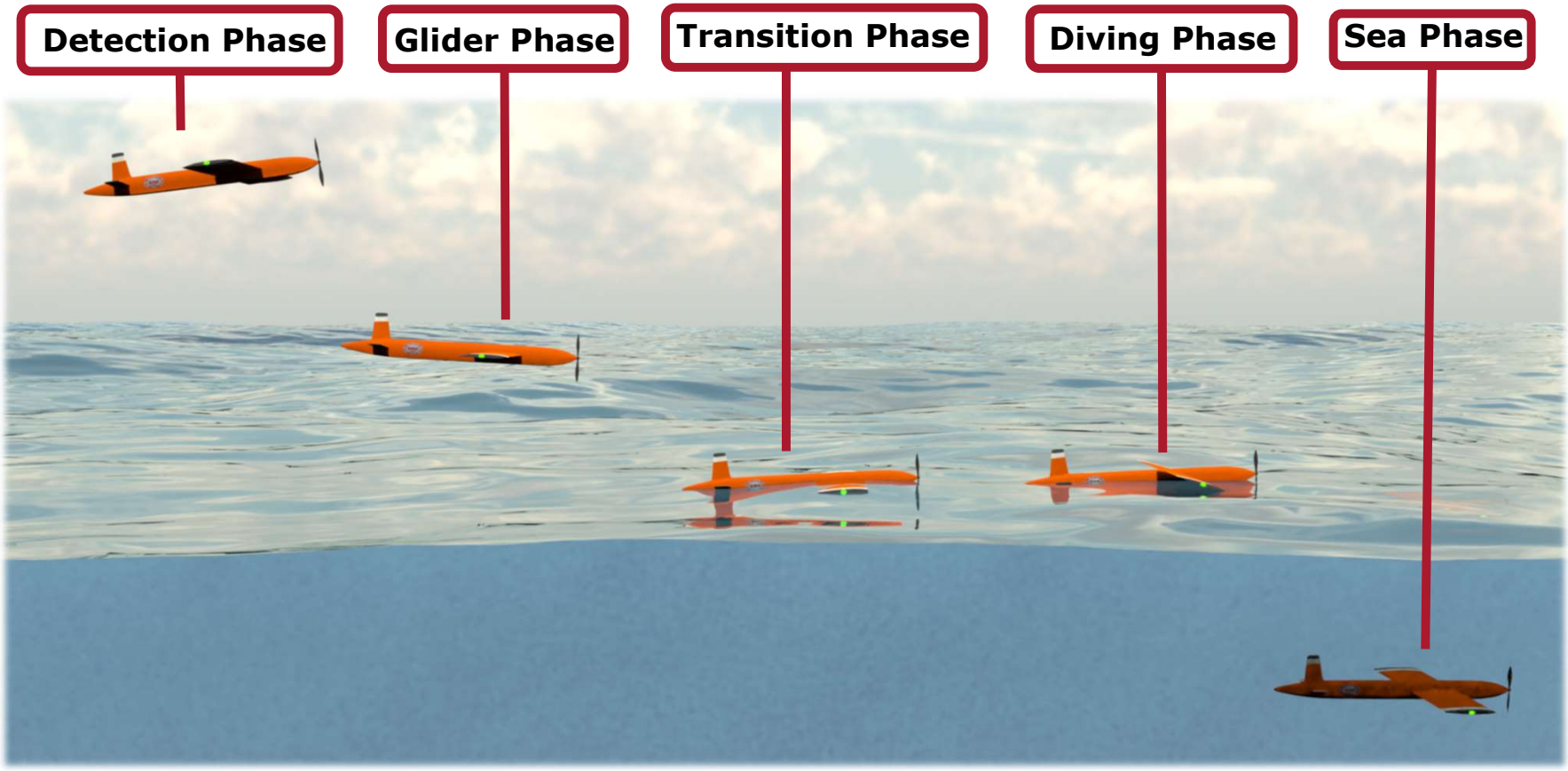
- 3D Mapping of Oil Spill
- Conceptual Vehicle Design
- Identifying Mission Design
- Intended Impacts of the Vehicle



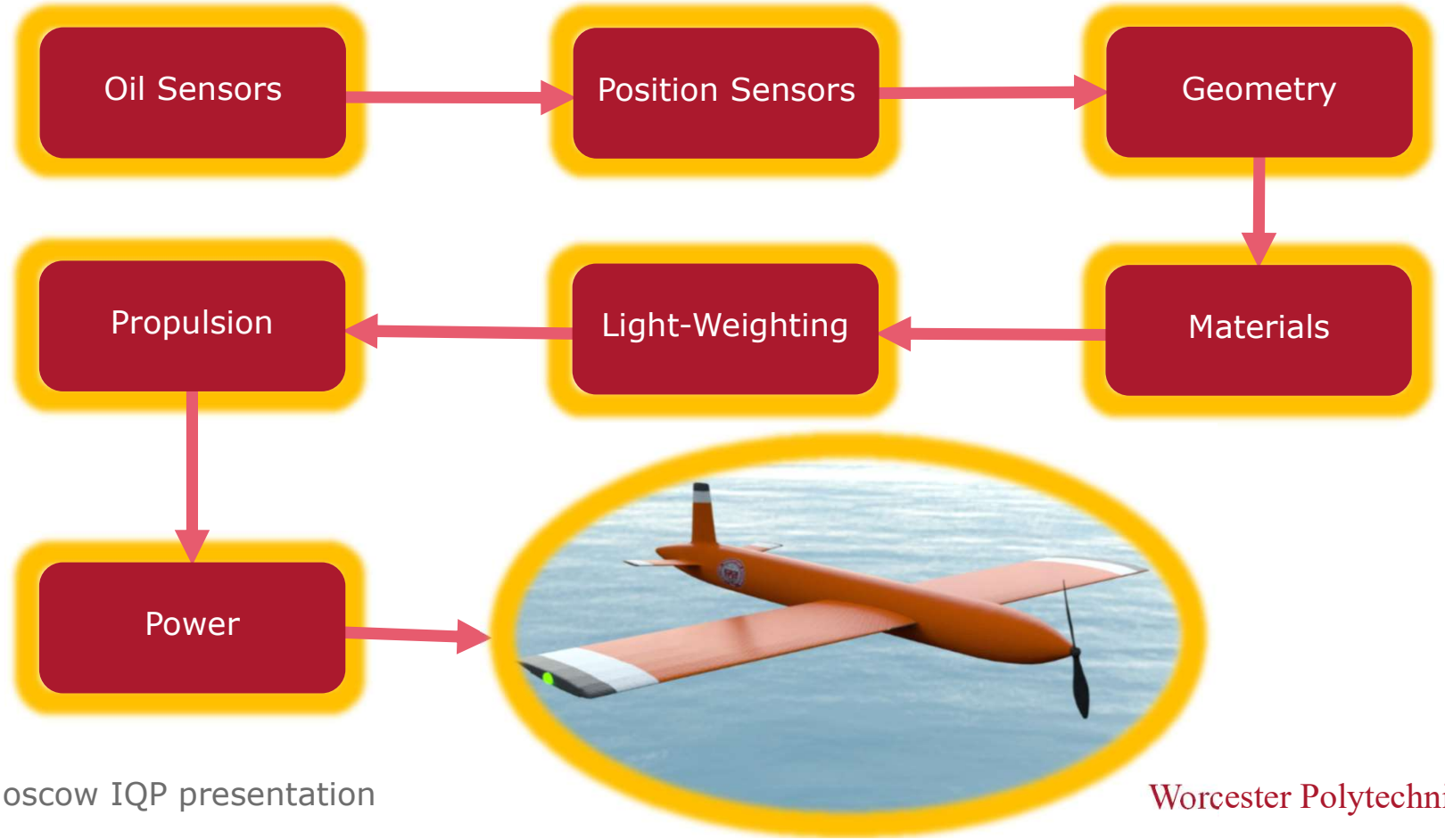
Methodology



Conceptual Vehicle Mission Design



AAV Functionality Aspects



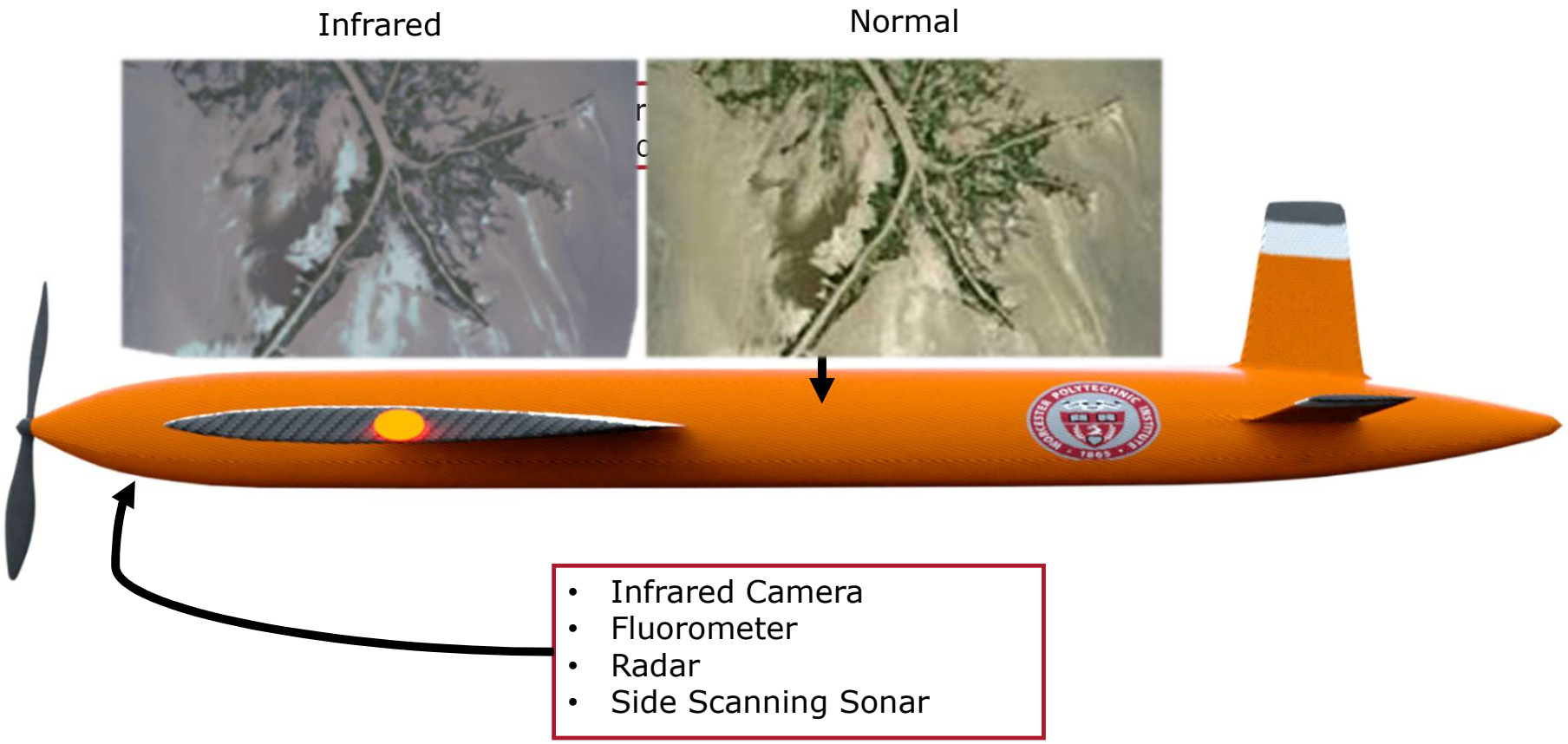
Slide 6

J0 Slow down animations and point
Jeremy, 2022-04-28T11:26:13.489

J0 0 Try and time yourself better
Jeremy, 2022-04-28T11:26:28.490

RZ0 1 - Master Oogway (Probably)
Rivernider, Zachary, 2022-04-29T10:34:23.464

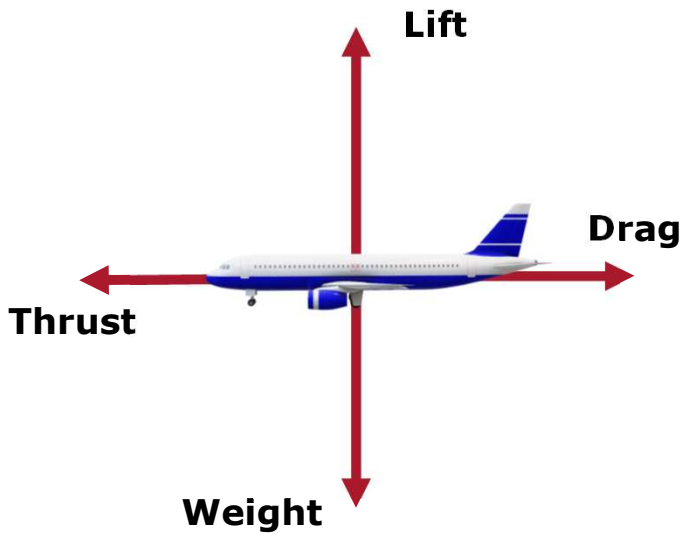
Oil Perception and Vehicle Autonomy Sensors



Selection of Vehicle Geometry

Rotorcraft

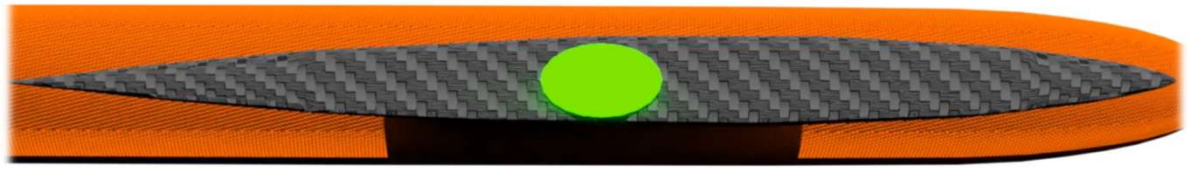
Fixed-Wing



GT10

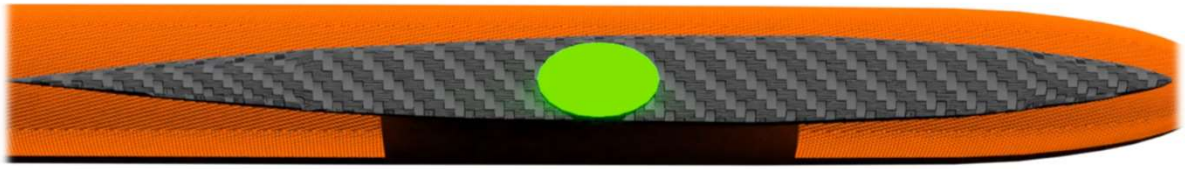
Discussion on Wing Design

Water



Wing Rotation

Air



Aileron/Flap Rotation

Slide 9

BAD0 maybe just pictures less words
Berube, Abigail D., 2022-04-26T11:38:56.313

GT1 Be explicit with choice
Guertin, Tyler, 2022-04-26T14:54:13.404

GT1

Wing Actuation Analyses (Water)

TJ0

Simulation	Main Concern	Min. Drag (N) @ Angle (°)	Comments
Water Wing (1 m/s)	Drag	0.1 N @10°-12°	• Small amount of drag occurring at Max AOA • L/D not prevalent
Water Flap (1 m/s)		0.25 N @ 0°	• Min. Drag at 0° • Less lift achieved in water

Slide 10

TJ0 In air down is bad in water up is bad
Trembley, Jeremy, 2022-04-26T11:41:58.075

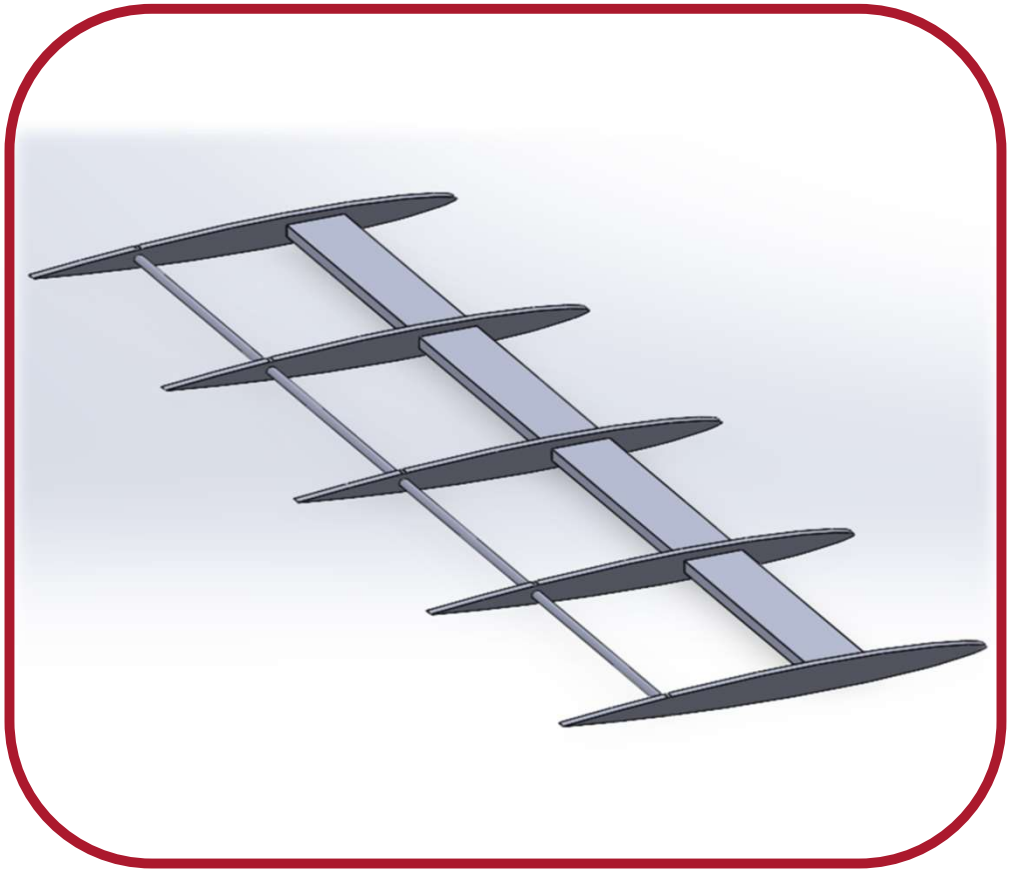
TJ0 0 not quite what you said, and im not sure this is the slide
Trembley, Jeremy, 2022-04-26T11:42:18.732

GT1 Motivations
Guertin, Tyler, 2022-04-26T14:12:21.215

Wing Actuation Analyses (Air)

Simulation	Main Concern	Max L/D @ Angle (°)	Comments
Air Wing (20 m/s)	L/D Ratio	Unstable	• Unstable L/D • Drag is small
Air Flap (20 m/s)		9.5 @ 7.5° - 10°	• High L/D • Stable L/D ratio trend

Light-weighting the Wing



Volume is Linear with mass

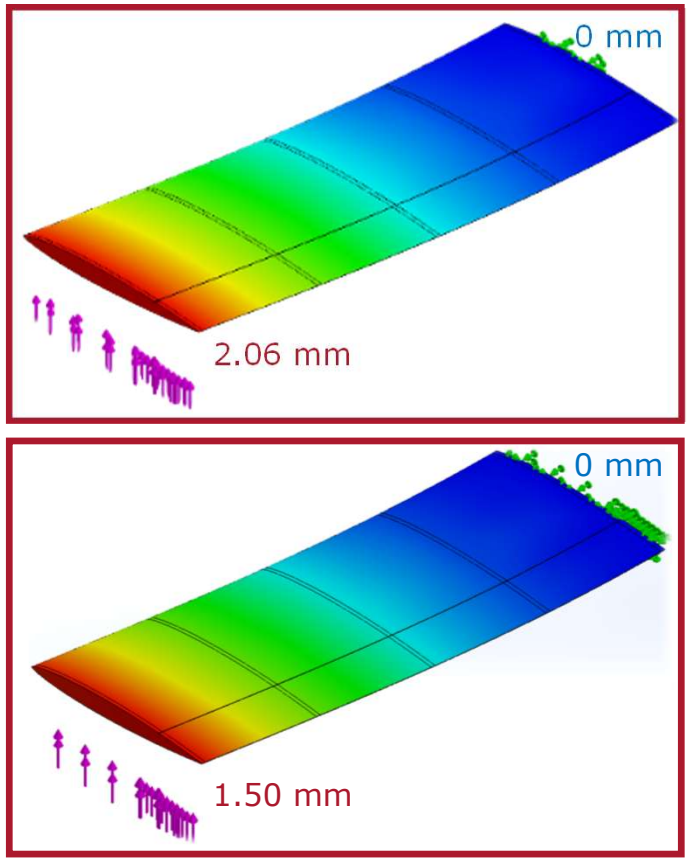
Solid Wing Without Spars
409.29 Cubic in.

Hollow Wing With Spars
33.15 Cubic in.

91.9 % Decrease in Volume
=
91.9 % Decrease in Mass

BAD0

Applications of Materials to AAVs



Aluminum Alloy

Carbon Fiber Composite

- Material Considerations
  - Lightweight
  - Durable
  - Resistant
    - Corrosion from seawater
    - Deformation
- Best choice: carbon fiber

Slide 13

BAD0 table ends of wings rather than have the color
Berube, Abigail D., 2022-04-26T13:29:46.373

BAD0 0 bending a ruler example
Berube, Abigail D., 2022-04-26T14:55:51.600

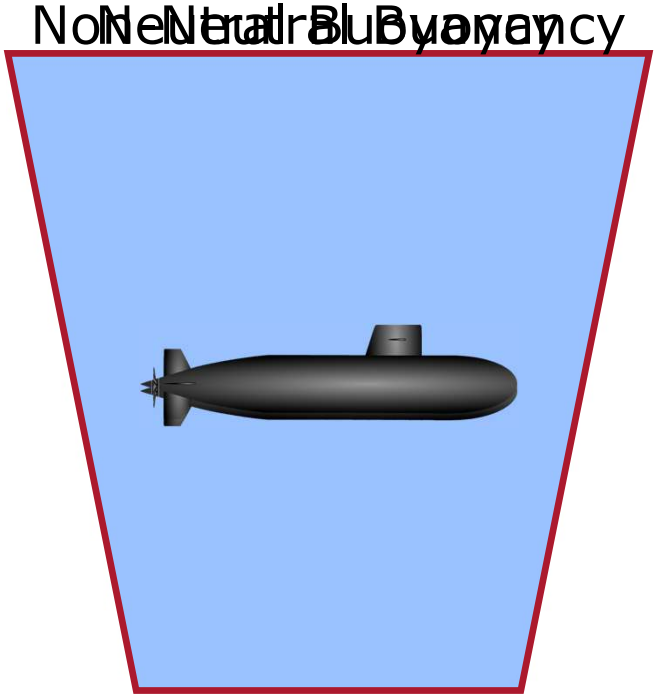
Power and Buoyancy Considerations

Sustainable Power

- Oxygen, Hydrogen, and batteries
- Batteries are simple and customizable

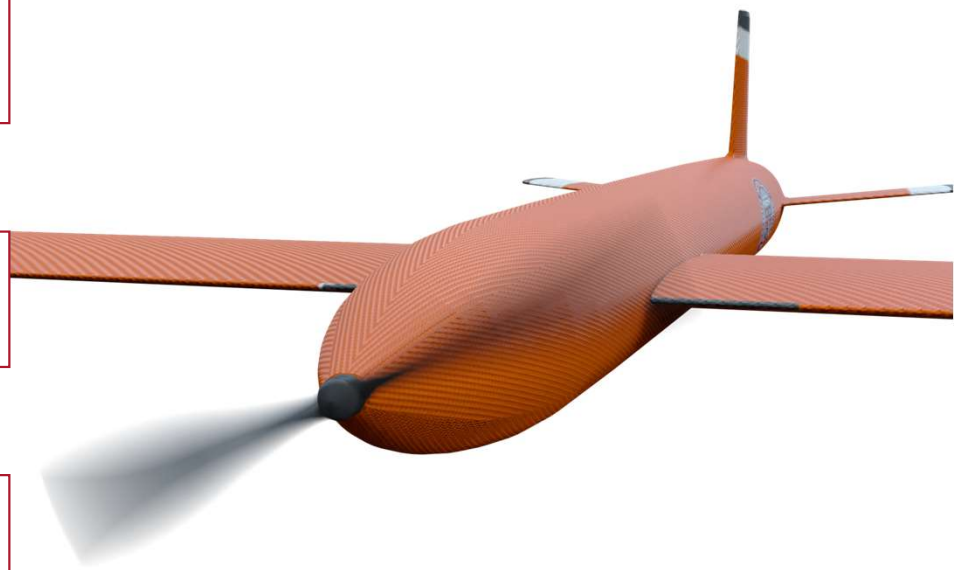
Buoyancy

- Ability to sink or float in water
- Variable Buoyancy
  - System to manually change buoyancy
- Neutral Buoyancy
  - Always maintain the same depth in water

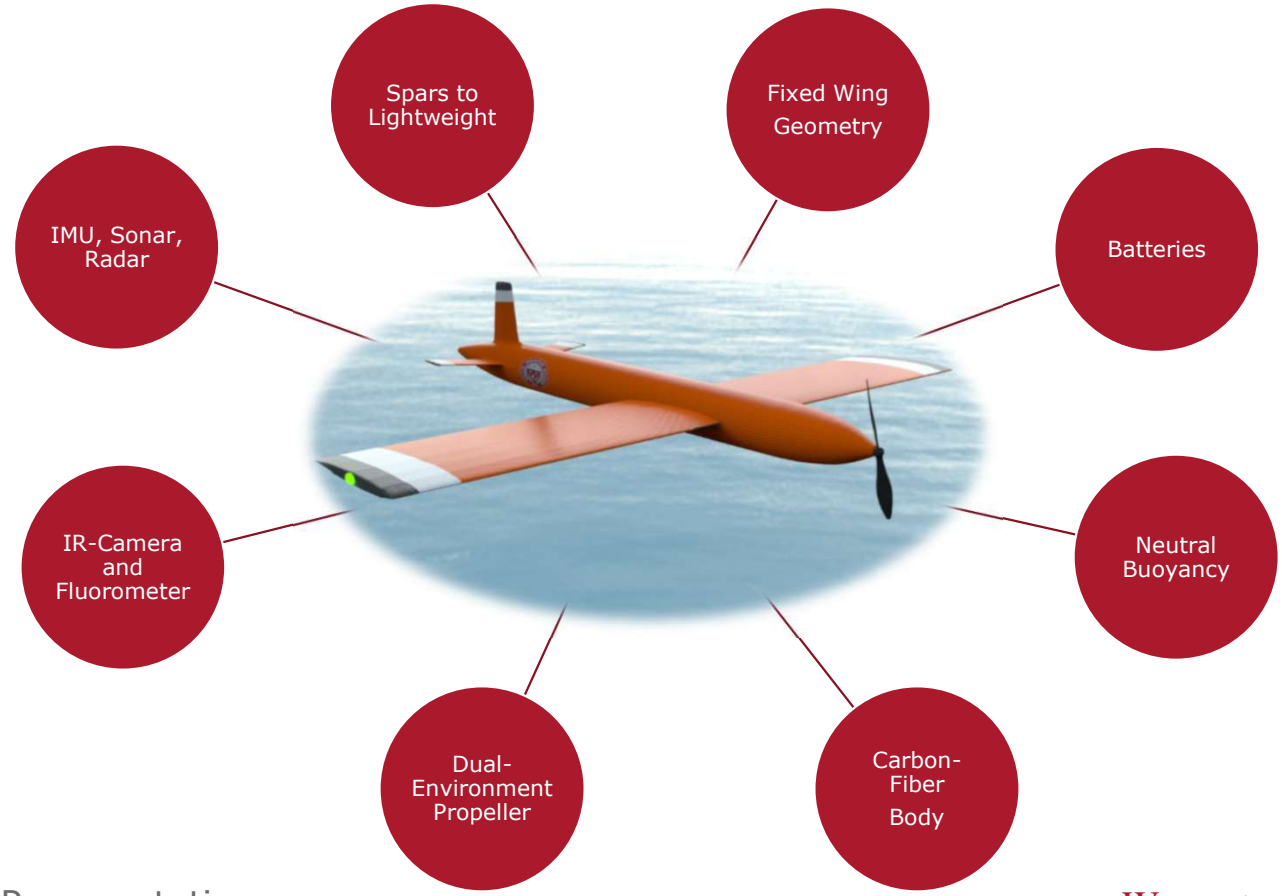


Single Propeller Propulsion

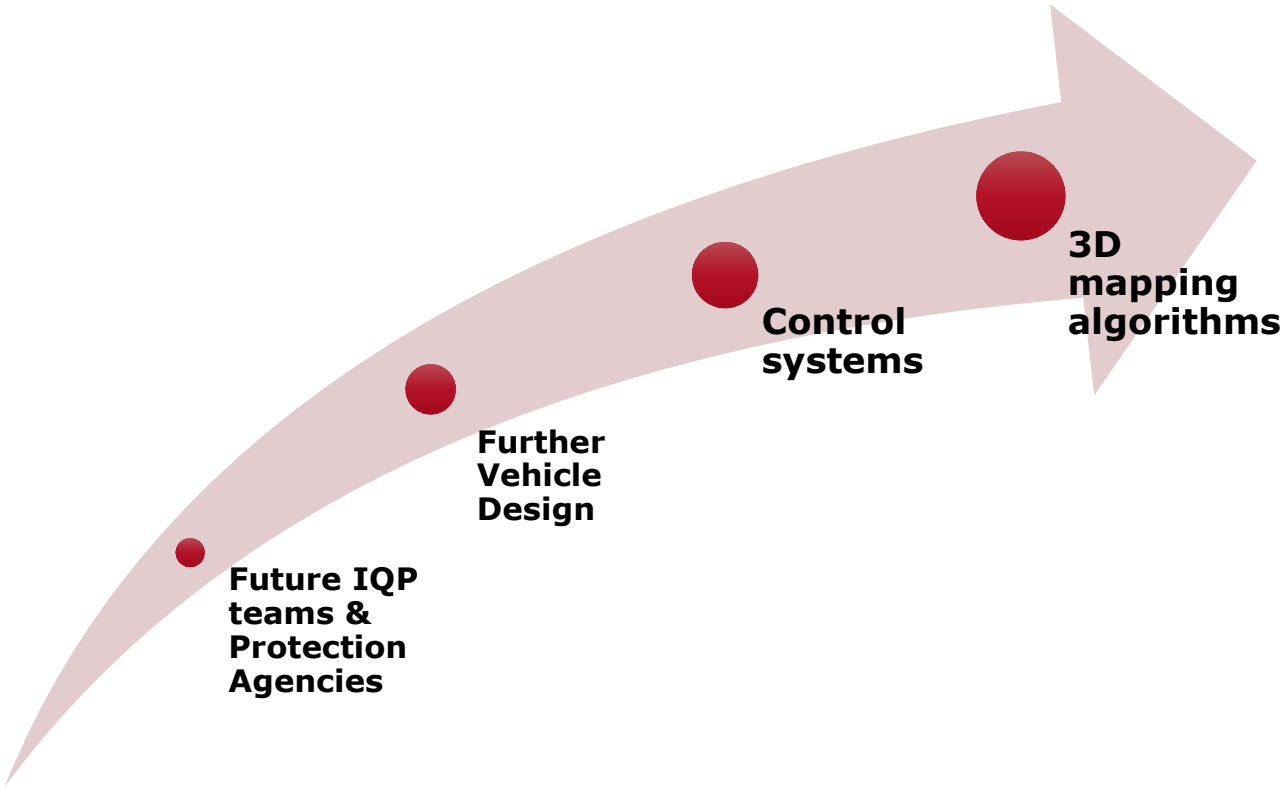
- Simplified
- Multi-Use
- Sustainable



Summary


Spars to Lightweight
Fixed Wing Geometry
IMU, Sonar, Radar
Batteries
IR-Camera and Fluorometer
Neutral Buoyancy
Dual-Environment Propeller
Carbon-Fiber Body

Conclusions and Going Forward



Thank You!

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  - Dr. Michael Buckholt (WPI)
  - Dr. John Bergendahl (WPI)
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  - Michael Lypen (Marine Science Technician, USCG)
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