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Marine Hydrokinetic Device Modeling: Project Elements and Partnerships

MHK Device Research Kickoff Meeting
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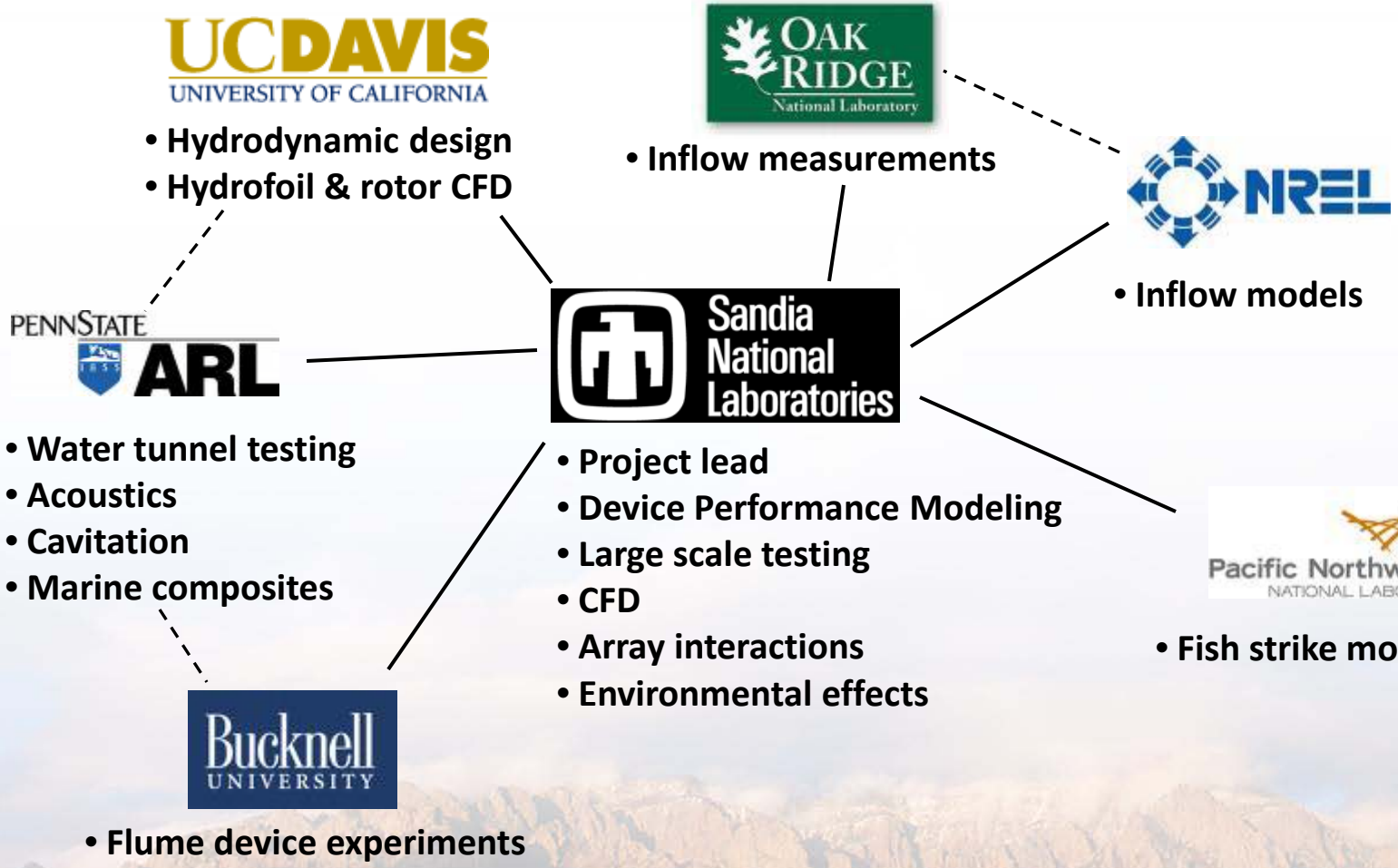
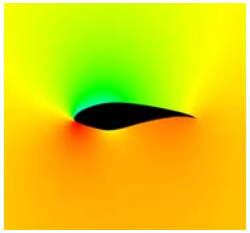
MHK Device Modeling Team



Device Modeling Focus Areas

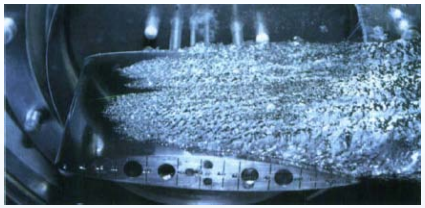
Hydrofoil Development



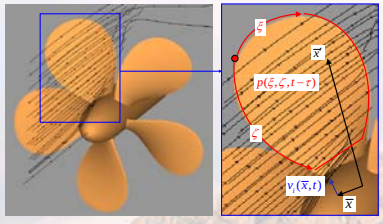
Performance Modeling

Lab Testing and Validation

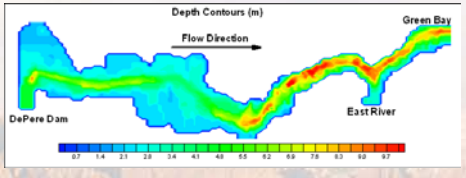
Cavitation



Hydro-Acoustics



Device Array and Environmental Effects



Marine Composites

Hydrofoil Development

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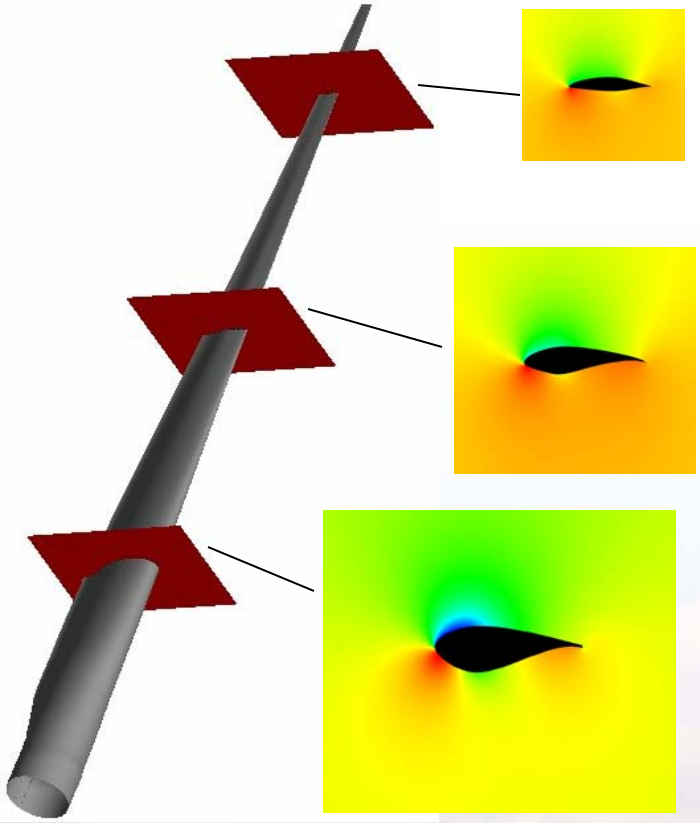
Wind turbine airfoils



Research Activities:

- Hydrofoil CFD analysis
- Water tunnel testing

Special considerations:

- Bio-fouling
- High free-stream turbulence
- Sediment-laden flow
- Cavitation
- Lower blade aspect ratio
- Hydro-Structural optimization

Cavitation

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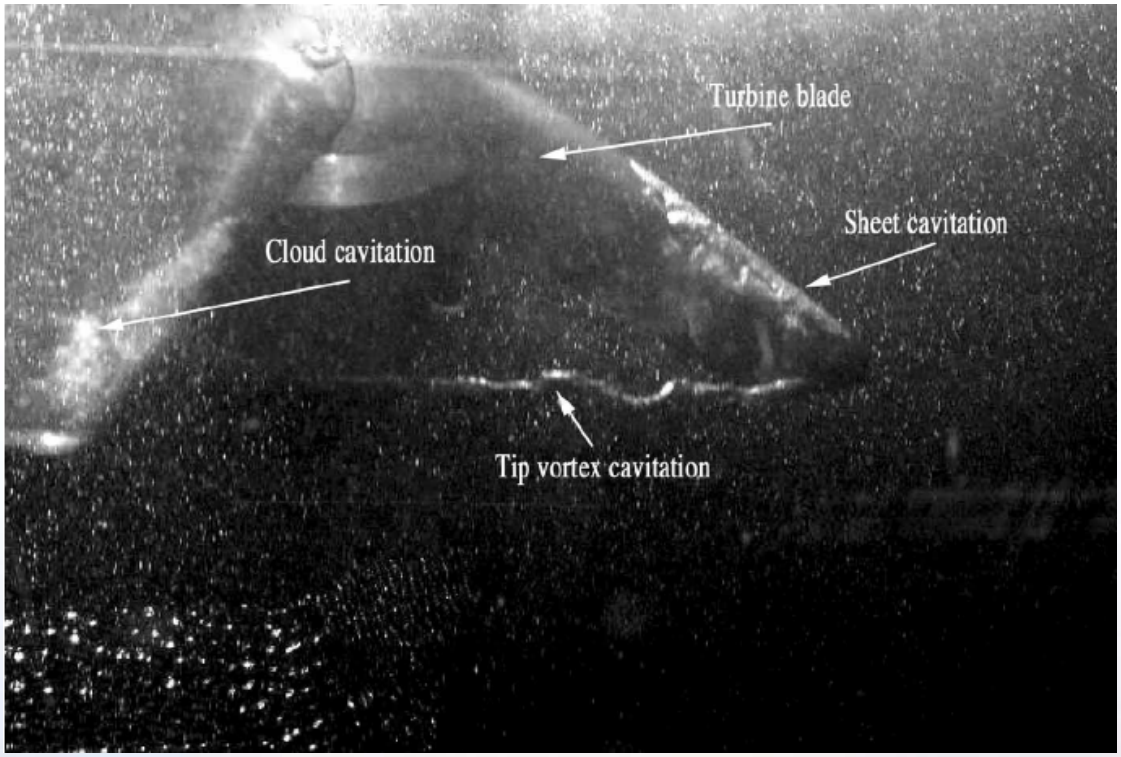

From: Wang et al. Proc. IMechE Vol 221 Part A: Power and Energy, 2007

Research Topics

- How does cavitation constrain the design (and impact **cost of energy**)?
- Potential impact on downstream structures.
- Impact on performance and noise.
- Cavitation avoidance strategies.
- Cavitation-resistant materials.

Device Performance Modeling

- **Program Objectives**
  - Create design and analysis tools specific to marine power devices
  - Create and apply a modeling framework to support device research and testing
- **Prediction of power, loads, and wake properties of single marine current turbines**
  - Steady and turbulent inflow conditions
  - Surface wave effects
  - Interactions with the environment

Free Vortex Wake Modeling

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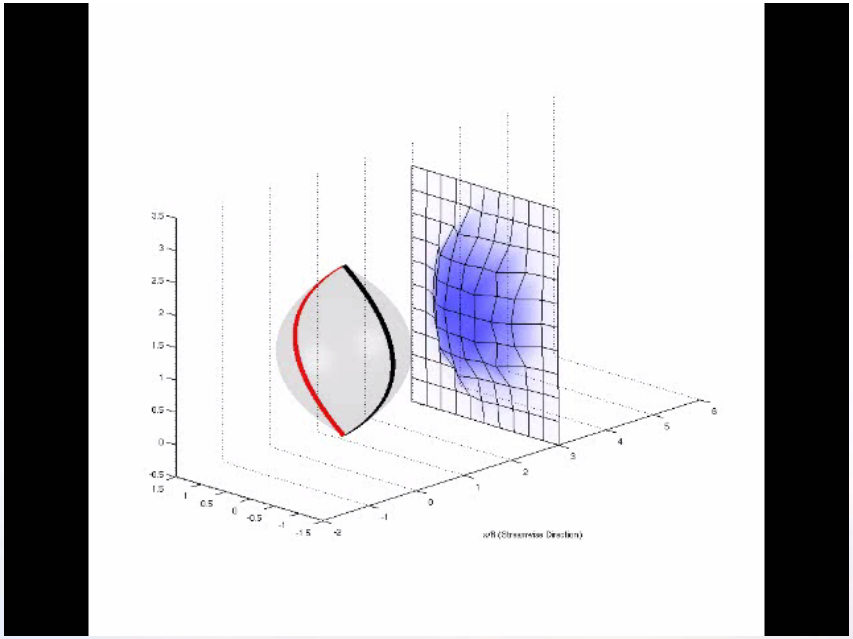
VDART3 Vortex Filament Code



Current and Planned Improvements

- Modernize code structure
- Add horizontal-axis turbine geometry
- Add channel floor and free surface boundaries
- Model blade support struts and viscous losses
- Model the tower/pylon wake
- Add cavitation onset prediction
- Model shrouded turbines
- Excitation by a turbulent inflow

Rotor Navier-Stokes CFD

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Research Activities:

- Support rotor design activities
- Define parameters for array & environmental impact studies
- Analyze complex flow configurations (inflow shear, tower interactions, nacelle design, etc.)

Laboratory Testing

- Generate performance, acoustic, and cavitation data for model validation
- Identify and quantify important hydrodynamic processes in MHK devices

ARL Ultra High Speed Cavitation Tunnel

ARL Garfield-Thomas Water Tunnel

ARL 12” Diameter Water Tunnel

Bucknell Sedimentation Flume

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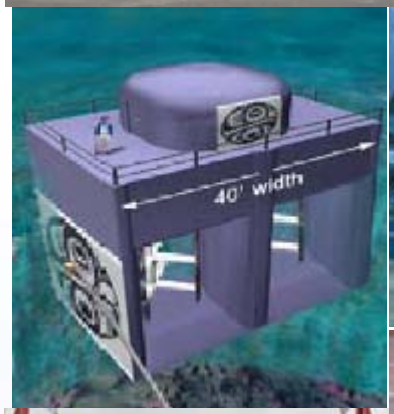
Device Configuration and Design

There are many proposed configurations for tidal/ocean turbines







Challenge: How do we provide technical value to a relatively immature and highly diverse industry?

- Maintain a focus on fundamental and widely applicable modeling/testing capabilities
- Remain open-minded to new ideas
- Maintain awareness of technology developments

***There is also a need for "reference" designs.**

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Thank You

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