

WEC Design Optimization

2.1.3.704

Marine and Hydrokinetics Program

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Project Overview



Project Summary
<ul style="list-style-type: none">• Empower developers to execute WEC design optimization, enabling both the performance improvements and enhanced design space understanding.• Open-source tool with powerful modeling approach to enable fast and realistic solutions.

Project Information
Project Principal Investigator(s)
Ryan Coe
WPTO Lead
Bill McShane

Project Objective & Impact
<ul style="list-style-type: none">• Improved design performance: Design performance, measured in LCOE and other relevant metrics that deliver value to the developer, will be systematically improved, as it has in many other application cases, such as aerospace, automotive, and wind turbine design, via design optimization.• Enhanced design space understanding: WEC design is a relatively new field, and thus there remains much to be learned about the fundamental tradeoffs for WEC designs that can help designers more instinctively understand the design process.

Project Partners/Subs
Oregon State University
Project Duration
<ul style="list-style-type: none">• July 2018• December 2020

Marine and Hydrokinetics (MHK) Program Strategic Approaches

Data Sharing and Analysis

Foundational
and
Crosscutting
R&D

Technology-
Specific
Design and
Validation

Reducing
Barriers to
Testing

Foundational and Crosscutting R&D

- Drive innovation in components, controls, manufacturing, materials and systems with early-stage R&D specific to MHK applications
- Develop, improve, and validate numerical and experimental tools and methodologies needed to improve understanding of important fluid-structure interactions
- Improve MHK resource assessments and characterizations needed to optimize devices and arrays, and understand extreme conditions
- Collaboratively develop and apply quantitative metrics to identify and advance technologies with high ultimate techno-economic potential for their market applications

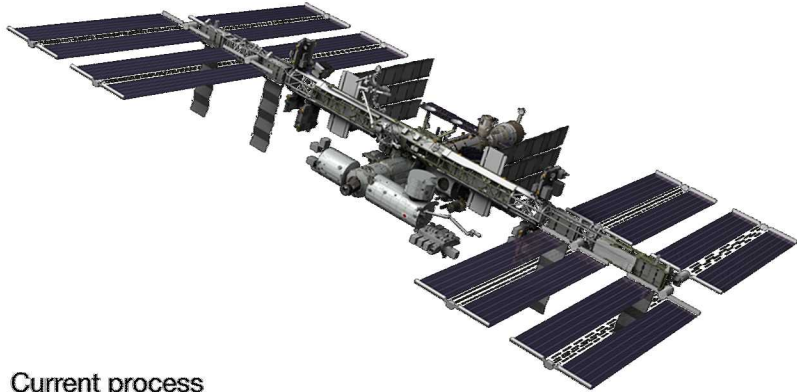
- The open-source WEC Design Optimization tool created by this project provides an efficient and powerful means of improving the performance of WEC designs.
- Objective functions, with which to perform design optimization studies, are a critical part of this project. Both by incorporating existing metrics and introducing new functions, this project will strive to provide broadly applicable guidance on selecting objective functions.

Project Budget



FY17	FY18	FY19 (Q1 & Q2 Only)	Total Project Budget (FY17 - FY19 Q1 & Q2)	
Costed	Costed	Costed	Total Costed	Total Authorized
\$0K	\$4K	\$60K	\$64K	\$280K

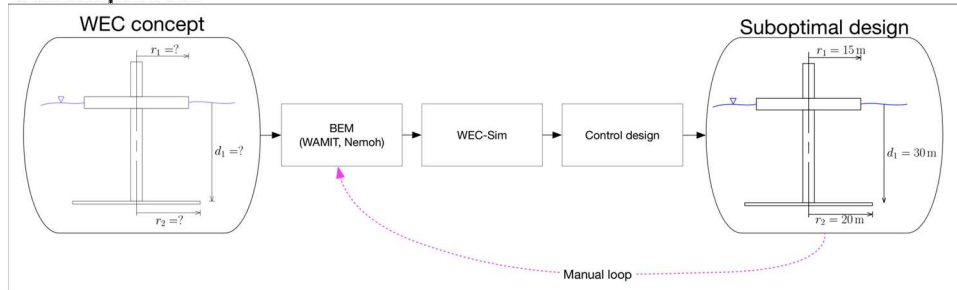
Management and Technical Approach



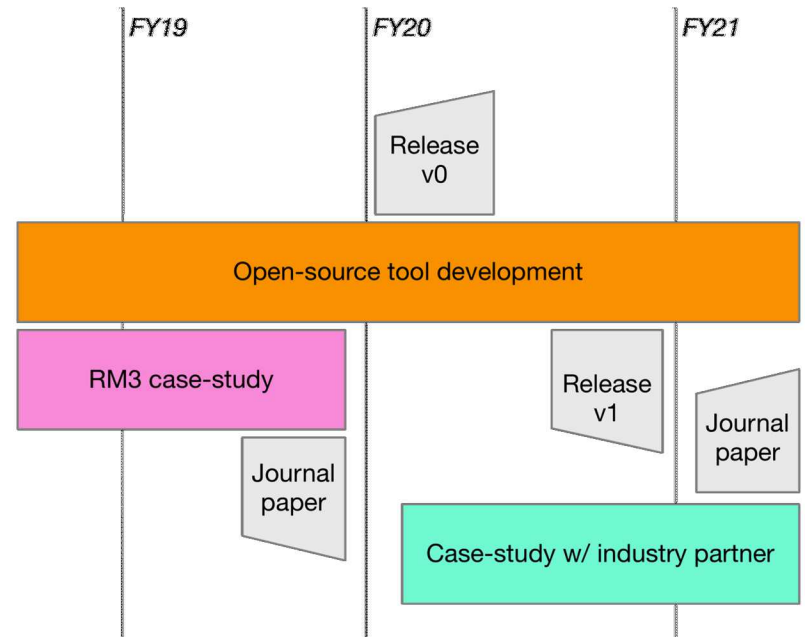
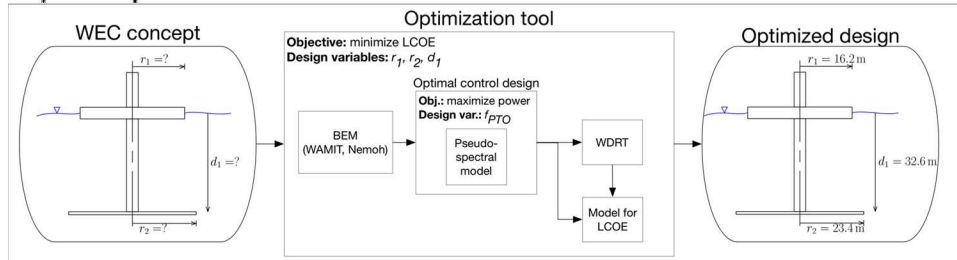
- *Pseudo spectral method¹ allows for efficient optimal control solution with constraints*
- *Allows for co-design, with stand-in controller*

¹Recently leveraged for International Space Station maneuver using gyroscopes (no fuel)

Current process



Improved process



End-User Engagement and Dissemination Strategy



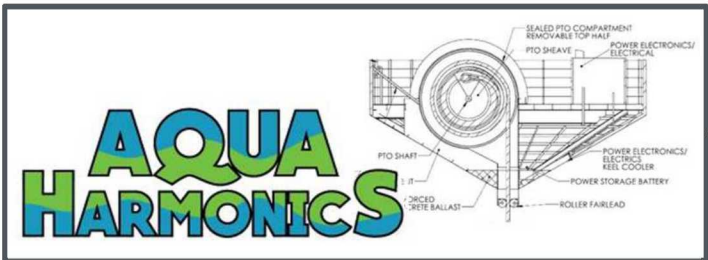
Open-source tool for WEC developers and researchers to apply to their own problems



Open-source case-study to investigate application of design optimization tool and showcase usage



Webinars to demonstrate usage and receive user feedback

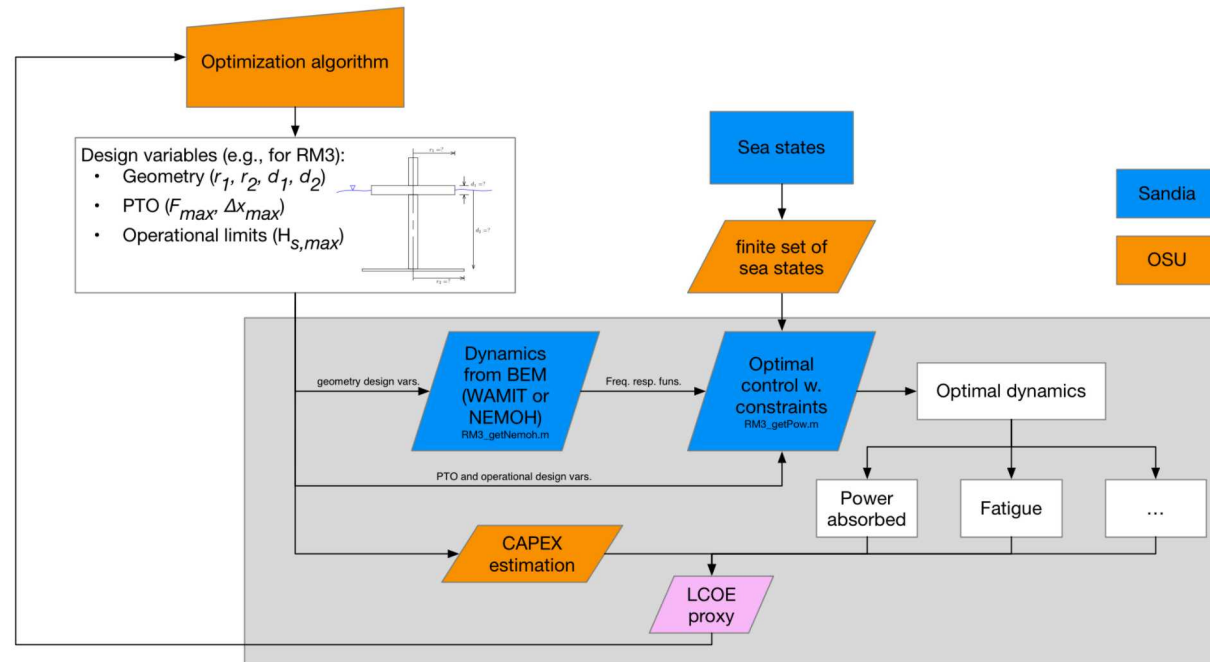


Private developer collaboration and published case-study

Technical Accomplishments

- **Review of previous metrics and objective functions:** By completing a review of existing work, both in the area of WEC design optimization and also in the area of general WEC performance assessment, this project will be able to employ meaningful (in terms of LCOE as well as so-called “beyond LCOE” factors) objective functions in design optimization. This will provide designers who use the tool with a framework for performing their own studies.
- **Alpha version of code:** An internal development version of the WEC Design Optimization tool has been created and is currently undergoing verification.

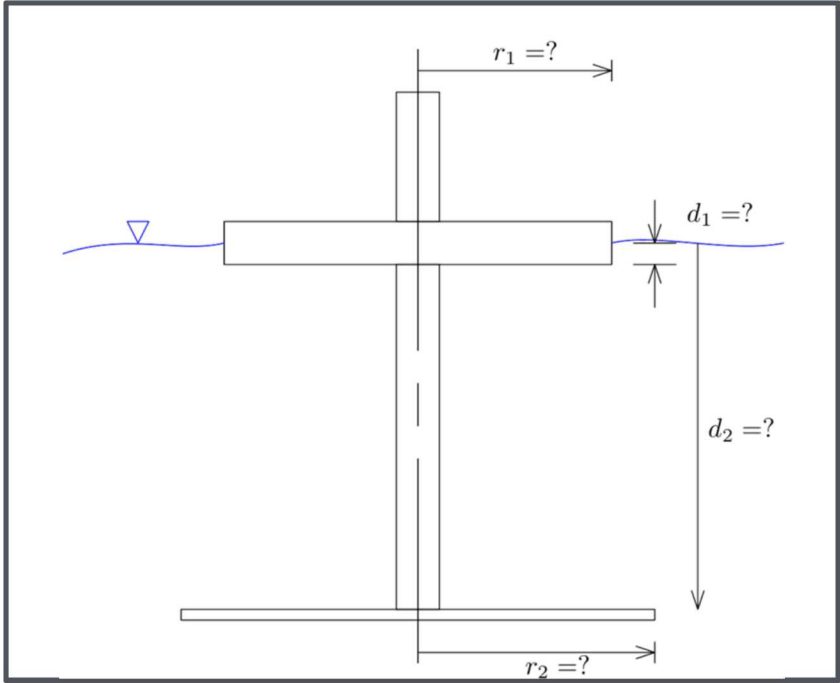
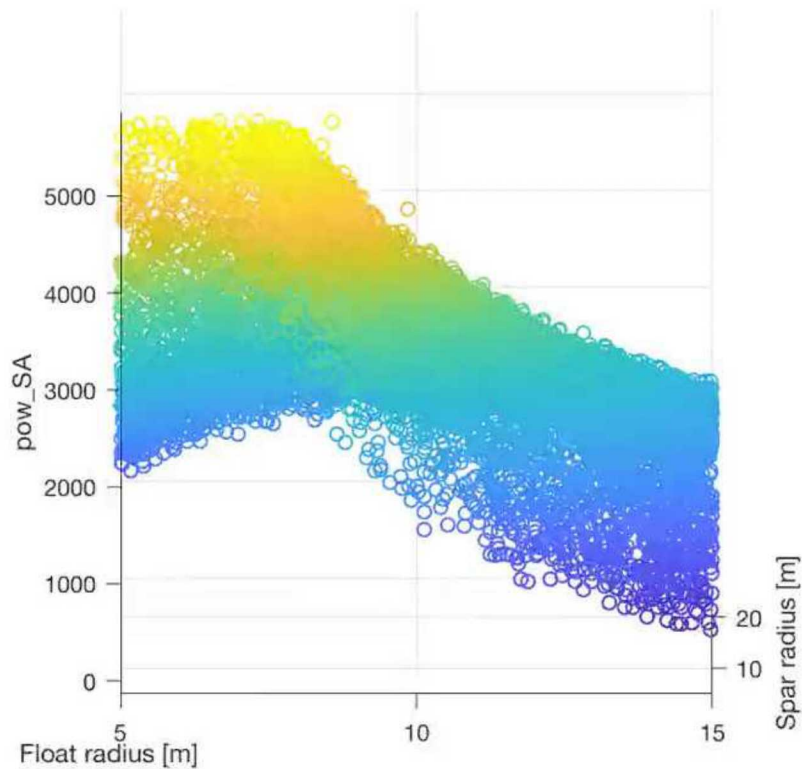
- **Case study of RM3 WEC:**
Using the alpha version of the WEC Design Optimization tool, a case-study of the Reference Model 3 (RM3) has been completed. This case study provides an example usage of the tool as well as some critical information on the usage of various objective functions and optimization algorithms.



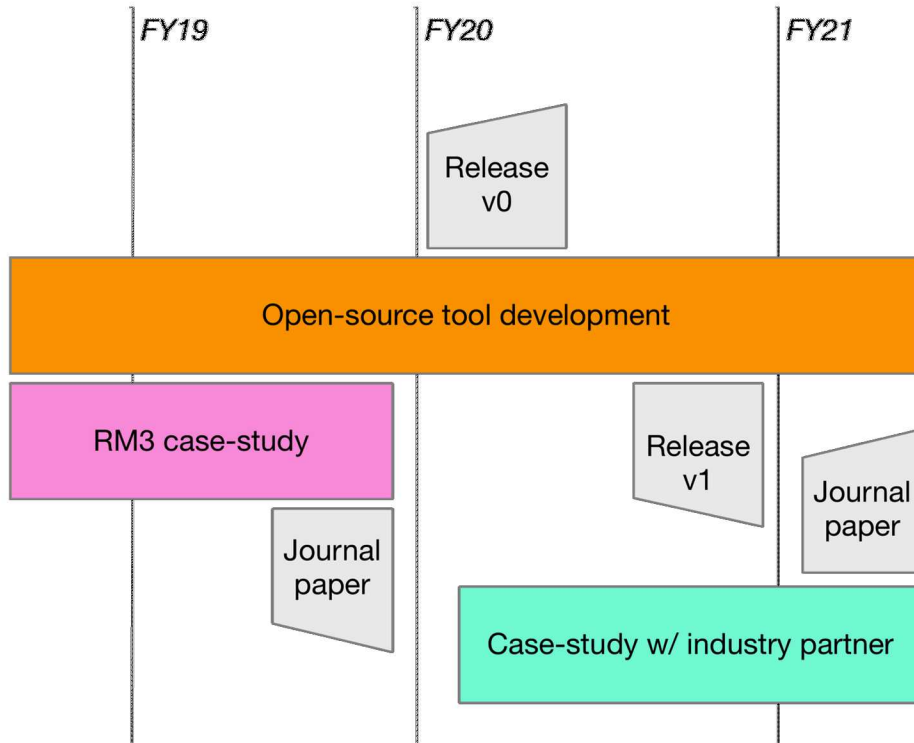
Progress Since Project Summary Submittal



Initial results from a case-study with the Reference Model 3 (RM3)



Future Work



- **Open-source release of code:** An initial open-source release of the WEC Design Optimization tool is planned for mid FY20.
- **Webinars and presentations:** The release of the open-source tool will be accompanied by webinars and conference presentations to help engage interested users and receive feedback.
- **Industry partner collaboration:** A case study will be performed in collaboration with a WEC developer to provide a direct impact to industry and learn more about the application of the tool so that it can be improved for future users.