

## CASEY M. HARWOOD

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### EDUCATION

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The University of Michigan, Ann Arbor, MI  
Ph.D., Naval Architecture and Marine Engineering Nov. 2016  
Dissertation: “The Hydrodynamic and Hydroelastic Responses of Rigid and Flexible Surface-Piercing Hydrofoils in Multi-Phase Flows”  
Committee chairs: Yin Lu Young and Steven L. Ceccio

The University of Michigan, Ann Arbor, MI  
M.S.e., Naval Architecture and Marine Engineering Dec. 2014  
Research Topics: Experimental and numerical investigations of ventilation on rigid surface-piercing bodies  
Advisor: Yin Lu Young

The Webb Institute, Glen Cove, NY  
B.S., Naval Architecture and Marine Engineering May 2011  
Thesis: “Hydrodynamic Design of a Hydrofoil System for a High-speed Catamaran”  
Advisor: Jacques B. Hadler

### AWARDS, HONORS, FELLOWSHIPS, AND GRANTS

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#### FUNDED GRANTS

Office of Naval Research – #N00014-18-1-2197 (PI) April, 2018 – April, 2021  
*Experimental Measurements of Waves and Vessel Dynamics in the Surf Zone for Modeling and Simulation Validation*  
Total Award: \$517,820 (Total project expenditures of \$882,820)  
Sponsor: ONR Code 30 – Program Officer: Troy Hendricks

Office of Naval Research – #N00014-17-1-2554 (Co-PI w/ Prof. Pablo Carrica) April, 2017 – April, 2019  
*Hydrodynamic Studies for Submersible Amphibious Combat Vehicles*  
Total Award: \$433,752  
Sponsor: ONR Code 30 - Program Officer: Troy Hendricks

#### PENDING GRANTS

Cadent Technologies – PENDING (Co-PI on Phase II with Dr. Ezequiel Martin) June, 2018 – June, 2019  
*Reduced Cavitation, High Efficiency Outboard Propulsors for Small Planing Craft – Phase II*  
Budget: \$304,777 for phase II (\$604,777 total)  
Sponsor: Cadent Technologies, Inc. (Prime Sponsor ONR)

#### AWARDS AND FELLOWSHIPS

National Science Foundation GRFP Fellow May 2013 - May 2016  
University of Michigan Rackham Regents Fellow Sep. 2011 - Sep. 2012

### ACADEMIC APPOINTMENTS

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The University of Iowa, Iowa City, IA Jan. 2017 – Present  
Assistant Professor  
Department of Mechanical Engineering

## RESEARCH INTERESTS

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- Experimental fluid dynamics
- Fluid-structure interactions
- Lifting surfaces and propellers
- Multi-phase flow (cavitation and ventilation)
- Alternative energy harvesting
- Instrument design and data acquisition
- Reduced-order, surrogate, and inverse modeling
- Numerical methods

## PEER-REVIEWED PUBLICATIONS

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### JOURNAL ARTICLES

- [1] Isaac Di Napoli, Yin Lu Young, Steven Ceccio, and Casey Harwood. “Design and Benchmarking of a Low-cost Shape Sensing Spar for In-situ Measurement of Deflections in Slender Lifting Surfaces in Complex Multiphase Flows”. In: *Smart Materials and Structures* (2018). Submitted.
- [2] C. M. Harwood, M. Felli, M. Falchi, N. Garg, S. L. Ceccio, and Y. L. Young. “The Hydroelastic Response of a Surface Piercing Hydrofoil in Multiphase Flows: Part II – Modal Parameters and Generalized Fluid Forces”. In: *Journal of Fluid Mechanics* (2018). Submitted.
- [3] C. M. Harwood, M. Felli, M. Falchi, N. Garg, S. L. Ceccio, and Y. L. Young. “The Hydroelastic Response of a Surface-piercing Hydrofoil in Multiphase Flows: Part I - Passive Hydroelasticity”. In: *Journal of Fluid Mechanics* (2018). Submitted.
- [4] Jacob Ward, Casey M. Harwood, and Yin Lu Young. “Inverse Method for Hydrodynamic Load Reconstruction on a Flexible Surface-piercing Hydrofoil in Multi-phase Flow”. In: *Journal of Fluids and Structures* 77 (2018), pp. 58–79.
- [5] Yin Lu Young, Casey M. Harwood, Francisco Miguel M., Jacob C. Ward, and Steven L. Ceccio. “Ventilation of Lifting Bodies: Review of the Physics and Discussion of Scaling Effects”. In: *Applied Mechanics Reviews* 69.1 (Jan. 2017), pp. 010801–010801-38.
- [6] Casey M. Harwood, Yin Lu Young, and Steven L. Ceccio. “Ventilated Cavities on a Surface-piercing Hydrofoil at Moderate Froude Numbers: Cavity Formation, Elimination and Stability”. In: *Journal of Fluid Mechanics* 800 (Aug. 2016), pp. 5–56.
- [7] Casey M. Harwood and Yin Lu Young. “A Physics-based Gap-flow Model for Potential Flow Solvers”. In: *Ocean Engineering* 88 (2014), pp. 578–587.

### ARTICLES IN CONFERENCE PROCEEDINGS

- [1] T. J. Wright, C. M. Harwood, H. Yoon, and Y. L. Young. “Dynamic Hydroelastic Response of a Surface-Piercing Strut in Waves”. In: *SNAME Maritime Convention*. SNAME, 2018.
- [2] Yin Lu Young, Casey M. Harwood, and Jacob C. Ward. “Sensing and Control of Flexible Hydrodynamic Lifting Bodies in Multiphase Flows”. In: *SS18 SPIE Smart Structures and Materials*. Denver, 2018, pp. 1–21.
- [3] C Harwood, J E Martin, I Di Napoli, A Arnold, and P Carrica. “Experimental and Numerical Investigation into the Drag and Wave-Making of a Blunt Submersible”. In: *The 32<sup>nd</sup> Symposium on Naval Hydrodynamics*. August. Aug. 10, 2018.
- [4] Yin Lu Young, Hyunse Yoon, Tristan Wright, Casey Harwood, Ann Arbor, and Iowa City. “The Effect of Waves and Ventilation on the Dynamic Response of a Surface-Piercing Hydrofoil”. In: *The 32<sup>nd</sup> Symposium on Naval Hydrodynamics*. August. Aug. 10, 2018, pp. 5–10. Forthcoming.

- [5] Casey M. Harwood, Jacob C. Ward, Mario Felli, Massimo Falchi, Steven L. Ceccio, and Yin Lu Young. “Experimental Measurements and Inverse Modeling of the Dynamic Loads and Vibration Characteristics of a Surface-piercing Hydrofoil”. In: *Fifth International Symposium on Marine Propulsors*. Espoo, Finland, 2017.
- [6] Casey M. Harwood, Jacob C. Ward, Yin Lu Young, and Steven L. Ceccio. “Experimental Investigation of the Hydro-elastic Response of a Surface-piercing Hydrofoil in Multi-phase Flow”. In: *Proceedings of the 31<sup>st</sup> Symposium on Naval Hydrodynamics*. Monterey, CA, Sept. 13, 2016.
- [7] Jacob C. Ward, Casey M. Harwood, and Yin Lu Young. “Inverse Method for Determination of the in Situ Hydrodynamic Load Distribution in Multi-phase Flow”. In: *Proceedings of the 31<sup>st</sup> Symposium on Naval Hydrodynamics*. Monterey, CA, Sept. 13, 2016.
- [8] Casey M. Harwood, Andrew J. Stankovich, Yin Lu Young, and Steven L. Ceccio. “Combined Experimental and Numerical Study of the Free Vibration of Surface-piercing Struts”. In: *Proceedings of the International Symposium on Transport Phenomena and Dynamics of Rotating Machinery*. Honolulu, HI, Apr. 10, 2016.
- [9] Casey M. Harwood, Kyle A. Brucker, Francisco Miguel Montero, Yin Lu Young, and Steven L. Ceccio. “Experimental and Numerical Investigation of Ventilation Inception and Washout Mechanisms of a Surface-piercing Hydrofoil”. In: *Proceedings of the 30<sup>th</sup> Symposium on Naval Hydrodynamics*. Hobart, Tasmania, Nov. 5, 2014.
- [10] Casey M. Harwood, Antoine Ducoin, and Yin Lu Young. “Influence of Gap Flow on the Cavitating Response of a Rectangular Hydrofoil”. In: *Proceedings of the 2012 Propeller and Shafting Symposium*. Norfolk, VA: Society of Naval Architects and Marine Engineers, Sept. 12, 2012, pp. 11–12.

## PRESENTATIONS

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### INVITED PRESENTATIONS

- [1] Casey M. Harwood. “Flexing, Fluttering, and Singing: Fluid-structure Interactions in the Marine Environment”. MIE Graduate Seminar. University of Iowa, Iowa City, IA, Mar. 23, 2017.
- [2] Casey M. Harwood. “Ventilation of Rigid and Flexible Surface-piercing Hydrofoils”. Mechanical and Industrial Engineering Faculty Candidate Seminar. University of Iowa, Iowa City, IA, Mar. 21, 2016.
- [3] Casey M. Harwood. “Ventilation of Rigid and Flexible Surface-piercing Hydrofoils”. NAME Department Seminar. University of Michigan, Ann Arbor, MI, Jan. 22, 2016.
- [4] Casey M. Harwood. “An Experimental and Numerical Study of Ventilation of a Surface-piercing Strut”. Ocean Engineering Department Seminar. University of California at Berkeley, Berkeley, CA, Nov. 24, 2014.
- [5] Casey M. Harwood. “A Physics-based Gap Flow Model for Potential-flow Solvers”. SNAME H-8 Panel Meeting. Bethesda, MD, Jan. 2014.
- [6] Casey M. Harwood. “Experimental and Numerical Investigation of Ventilation Inception and Washout Mechanisms”. SNAME H-8 Panel Meeting. Bethesda, MD, Jan. 2014.
- [7] Casey M. Harwood. “Influence of Gap Size on the Hydrodynamic Response of 3-d Foils in Fully-wetted and Cavitating Flow”. SNAME H-8 Panel Meeting. Bethesda, MD, Feb. 23, 2012.

### CONFERENCE PRESENTATIONS

- [1] Casey M. Harwood, Yin Lu Young, Mario Felli, Massimo Falchi, and Steven Ceccio. “Scaling of Natural Ventilation and Vaporous Cavitation on a Surface-piercing Hydrofoil”. In: *International Symposium on Transport Phenomena and Dynamics and Rotating Machinery*. International Symposium on Transport Phenomena and Dynamics and Rotating Machinery. Maui, HI, Dec. 16, 2017.
- [2] Casey M. Harwood, Jacob Ward, Yin Lu Young, Mario Felli, Massimo Falchi, and Steven Ceccio. “The Hydroelastic Response of a Flexible Surface-piercing Strut in Wetted, Ventilated, and Cavitating Flows”. In: *Bulletin of the American Physical Society*. APS 69<sup>th</sup> Annual Division of Fluid Dynamics. Vol. 61. Portland, OR: American Physical Society, 2016.

- [3] Casey M. Harwood, Yin Lu Young, and Steven L. Ceccio. “Hydrodynamic and Structural Response of Surface-piercing Struts in Ventilated Flows”. In: NEEC Annual Meeting. Poster Presentation. Bethesda, MD, Apr. 7, 2015.
- [4] Casey M. Harwood, Yin Lu Young, and Steven L. Ceccio. “Experimental Investigation of Atmospheric Ventilation on a Surface-piercing Hydrofoil”. In: University of Michigan Engineering Graduate Symposium. Poster Presentation. Ann Arbor, MI, Nov. 14, 2014.
- [5] Casey M. Harwood, Yin Lu Young, and Steven L. Ceccio. “Ventilation Inception and Washout, Scaling, and Effects on Hydrodynamic Performance of a Surface Piercing Strut”. In: *Bulletin of the American Physical Society*. APS 67<sup>th</sup> Annual Division of Fluid Dynamics. Vol. 59. Pittsburgh, PA: American Physical Society, Nov. 23, 2014.
- [6] Casey M. Harwood, Francisco Miguel Montero Montero, Andrew J. Stankovich, Yin Lu Young, and Steven L. Ceccio. “Experimental Investigation of Ventilation on Rigid and Flexible Surface Piercing Bodies”. In: *17<sup>th</sup> U.S. National Congress on Theoretical and Applied Mechanics*. US National Congress on Theoretical and Applied Mathematics. East Lansing, MI, June 19, 2014.
- [7] Andrew J. Stankovich, Casey M. Harwood, Francisco Miguel Montero, Yin Lu Young, and Steven L. Ceccio. “Numerical and Experimental Analysis of the Added Mass and Resonance Frequency of a Cantilever Hydrofoil in Two-phase Flow”. In: *17<sup>th</sup> U.S. National Congress on Theoretical and Applied Mechanics*. US National Congress on Theoretical and Applied Mathematics. East Lansing, MI, June 19, 2014.
- [8] Casey M. Harwood, Andrew J. Stankovich, Francisco Miguel Montero, Yin Lu Young, and Steven L. Ceccio. “The Effects of Ventilation on the Hydrodynamic and Structural Response of Surface-piercing Struts”. In: NEEC Annual Meeting. Poster Presentation. Bethesda, MD, May 19, 2014.
- [9] Casey M. Harwood, Francisco Miguel Montero, Yin Lu Young, and Steven L. Ceccio. “Experimental Investigation of Ventilation of a Surface Piercing Hydrofoil”. In: *Bulletin of the American Physical Society*. APS 66<sup>th</sup> Annual Division of Fluid Dynamics. Vol. 1. Pittsburgh, PA: American Physical Society, Nov. 26, 2013.

## COURSES TAUGHT

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| NA320: Marine Hydrodynamics I<br>Class size: 19 (Instructor of record)   | Fall, 2016              |
| ENGR:2510 – Fluid Mechanics (Engineering Core)<br>Class size: approx. 90 | Fall, 2017 & Fall, 2018 |
| ME:3045 – Heat Transfer<br>Class size: approx. 85                        | Spring, 2018            |

## GUEST LECTURES

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|---|-------------------|
| NA520: Wave Loads on Ships and Offshore Structures<br>“Ocean Wave Spectra and the Statistical Description of Waves” | Dec. 3, 2015      |
| NA431: Marine Engineering<br>“World Energy Use - A Survey”  | Mar. 30, 2016     |
| ME:4176 – Experimental Naval Hydrodynamics<br>One-week lecture series: “Marine Propulsion Design and Experiments”   | Mar. 21, 23, 2017 |

## INDUSTRY EXPERIENCE

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Navatek LTD, Honolulu, HI Winters 2010, 2011  
Design Intern  
Assisted in the design and testing of one-quarter and one-half scale manned models of UHAC/CAAT amphibious landing craft.

Horizon Lines, Tacoma, WA / Dutch Harbor, AK Winter 2009  
Shipboard Cadet  
Serviced low- and medium-speed diesel engines and auxiliary support systems (cooling, lube and fuel oil, fire suppression, and electrical) as part of main propulsion and power-generation plants aboard the *M/V Kodiak* (Bering Sea trade-route).

Westport Shipyard, Westport, WA / Port Angeles, WA Winter, Summer 2008  
Design and Shipyard Intern  
Gained experience in fiberglass construction (hand-layup, vacuum infusion, and large-parts layup) and worked as draftsman.

## PROFESSIONAL ASSOCIATIONS AND MEMBERSHIPS

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American Physical Society 2013 - Present

Society of Naval Architects and Marine Engineers (SNAME)  
Associate Member 2007 - Present

Tau Beta Pi Collegiate Honor Society 2012 - Present

## RELEVANT SKILLS

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*Languages & Software:* L<sup>A</sup>T<sub>E</sub>X, LabVIEW, MATLAB/Octave, R  
*Design and Drafting:* AutoCAD, Rhinoceros, SolidWorks, CREO  
*Analysis and Simulation:* ANSYS FEM, ANSYS CFX, OpenFOAM, Paraview  
*Fabrication / Construction:* Carpentry, fiberglass layup techniques, basic machining