

Daniel Floryan

University of Wisconsin–Madison
Chemical and Biological Engineering
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Education

Princeton University, Princeton, NJ 2016–2019
Doctor of Philosophy, Mechanical and Aerospace Engineering
Thesis: Hydromechanics and optimization of fast and efficient swimming
Advisors: Clarence Rowley and Alexander Smits

Princeton University, Princeton, NJ 2014–2016
Master of Arts, Mechanical and Aerospace Engineering

Cornell University, Ithaca, NY 2009–2014
Bachelor of Science, *summa cum laude*, Mechanical Engineering

Cornell University, Ithaca, NY 2009–2014
Bachelor of Arts, *with distinction in all subjects*, Economics with minor in Mathematics

Research Experience

University of Wisconsin–Madison, Madison, WI Aug. 2019–Present
Postdoctoral Research Associate, Advisor: Prof. Michael Graham
Fluid mechanics, nonlinear dynamics, and machine learning.

Princeton University, Princeton, NJ June 2019–Aug. 2019
Postdoctoral Research Associate, Advisors: Prof. Clarence Rowley and Prof. Alexander Smits
Numerical optimization of swimming gaits and experimental investigation of flexible swimmers.

Princeton University, Princeton, NJ Feb. 2015–May 2019
Graduate Research Assistant, Advisors: Prof. Clarence Rowley and Prof. Alexander Smits
Dissertation work on elucidating the physics responsible for fast and efficient fish swimming. A combined analytical, experimental, and numerical approach was used.

University of Western Ontario, London, ON, Canada Dec. 2009–Aug. 2013
Research Assistant, Advisor: Prof. J.M. Floryan
Created numerical simulation to examine effects of heat, turbulence, and fluid type on convection patterns in channel flow.

Texas A&M University, College Station, TX May 2012–Aug. 2012
USRG Scholar, Advisor: Prof. William Saric
 Designed, made, and characterized a lens-and-grid type focusing schlieren system for use in the Mach 6 Quiet Tunnel. The system provided a non-intrusive diagnostic with high signal-to-noise ratio and a $\mathcal{O}(\text{MHz})$ spectral range.

Cornell University, Ithaca, NY Jan. 2012–Jan. 2013
Undergraduate Research Assistant, Advisor: Prof. Charles Williamson
 Numerically investigated the evolution of a co-rotating vortex pair in ground effect. Project has applications to safety of airplane takeoff and landing.

University of Western Ontario, London, ON, Canada May 2011–Aug. 2011
NSERC USRA Scholar, Advisor: Prof. Thomas Jenkyn
 Created a GUI for radiostereometric analysis. Vastly improved upon former system, automating and streamlining several processes.

University of Western Ontario, London, ON, Canada May 2010–Aug. 2010
Research Assistant, Advisors: Prof. Roi Gurka and Prof. Gregory Kopp
 Conducted an experimental investigation of starling aerodynamics. Performed particle image velocimetry (PIV) on live birds in a hypobaric wind tunnel.

Awards and Honours

Porter Ogden Jacobus Honourific Fellowship¹, 2018–2019 (Princeton University)

School of Engineering and Applied Science Award for Excellence, 2017 (Princeton University)

Brit and Eli Harari Post Generals Fellowship, 2017–2018 (Princeton University)

Sayre Award for Academic Excellence, 2015 (Princeton University)

Daniel and Florence Guggenheim Foundation Fellowship, 2015–2016 (Princeton University)

Charles W. Lummis Scholarship, 2014–2015 (Princeton University)

The Sibley Prize for highest standing in mechanical engineering program, 2014 (Cornell University)

Frank O. Ellenwood Prize for highest standing in heat and power courses, 2014 (Cornell University)

Dean's Honour List, all semesters (Cornell University)

Ontario Graduate Scholarship, 2014 (declined)

NSERC Canada Graduate Scholarship, 2014

Killam Canadian Scholarship, 2013 (Cornell University)

Omicron Delta Epsilon, 2013 (Cornell University)

Phi Beta Kappa, 2013 (Cornell University)

ELI Undergraduate Student Research Award, funded by Boeing, 2013 (Cornell University)

¹The Porter Ogden Jacobus Fellowship is Princeton University's top honour for graduate students

ELI Undergraduate Student Research Award, funded by Boeing, 2012 (Cornell University)

Undergraduate Student Research Grant, 2012 (Texas A&M University)

NSERC Undergraduate Student Research Award, 2011

S.T.A.R. Scholarship, 2009–2010 (Cornell University)

Governor General’s Academic Medal, 2009 (Government of Canada)

Publications

In Preparation

- [1] D. Floryan and C.W. Rowley. Adjoint optimization of fish swimming.
- [2] A.J. Smits, D. Floryan, T. Van Buren, and C.W. Rowley. Recent developments in understanding fish-like propulsion. *Progress in Aerospace Sciences* (invited).
- [3] D. Floryan and A.J. Smits. Nonlinear damping in flexible swimmers.
- [4] M.D. Graham and D. Floryan. Exact coherent state Navier-Stokes solutions. *Annual Review of Fluid Mechanics* (invited).
- [5] D. Floryan and M.D. Graham. Wavelet representation of turbulent flows.
- [6] J.M. Floryan and D. Floryan. Pumping by thermal waves.

Under Review

- [1] T. Van Buren, D. Floryan, L. Ding, L.H.O. Hellström, and A.J. Smits. Turbulent pipe flow response to a step change in surface roughness.
- [2] D. Floryan and C.W. Rowley. Distributed flexibility in inertial swimmers.
- [3] A. Goza, D. Floryan, and C.W. Rowley. Connections between resonance and nonlinearity in swimming performance of a flexible heaving plate.
- [4] D. Floryan, T. Van Buren, and A.J. Smits. Swimmers’ wakes are not reliable indicators of swimming performance.

Published

- [1] D. Floryan, T. Van Buren, and A.J. Smits. Large-amplitude oscillations of foils for efficient propulsion. *Physical Review Fluids*, 4(9), 093102, 2019.
- [2] T. Van Buren, D. Floryan, and A.J. Smits. Scaling and performance of simultaneously heaving and pitching foils. *AIAA Journal*, 57(9), 3666–3677, 2019 (invited).
- [3] D. Floryan and C.W. Rowley. Clarifying the relationship between efficiency and resonance for flexible inertial swimmers. *Journal of Fluid Mechanics*, 853, 271–300, 2018.
- [4] D. Floryan, T. Van Buren, and A.J. Smits. Efficient cruising for swimming and flying animals is dictated by fluid drag. *Proceedings of the National Academy of Sciences*, 115(32), 8116–8118, 2018.

Commentary: G.K. Taylor. Simple scaling law predicts peak efficiency in oscillatory propulsion. *Proceedings of the National Academy of Sciences*, 115(32), 8063–8065, 2018.

- [5] T. Van Buren, D. Floryan, N. Wei, and A.J. Smits. Flow speed has little impact on propulsive characteristics of oscillating foils. *Physical Review Fluids*, 3(1), 013103, 2018.
- [6] D. Floryan, T. Van Buren, and A.J. Smits. Forces and energetics of intermittent swimming. *Acta Mechanica Sinica*, 33(4), 725–732, 2017 (invited).
- [7] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Scaling the propulsive performance of heaving and pitching foils. *Journal of Fluid Mechanics*, 822, 386–397, 2017.
- [8] T. Van Buren, D. Floryan, D. Quinn, and A.J. Smits. Non-sinusoidal gaits for unsteady propulsion. *Physical Review Fluids*, 2(5), 053101, 2017.
- [9] T. Van Buren, D. Floryan, D. Brunner, U. Senturk, and A.J. Smits. Impact of trailing edge shape on the wake and propulsive performance of pitching panels. *Physical Review Fluids*, 2(1), 014702, 2017.
- [10] S.T.M. Dawson, M.S. Hemati, D. Floryan, and C.W. Rowley. Lift Enhancement of High Angle of Attack Airfoils Using Periodic Pitching. AIAA Paper 2016–2069.
- [11] D. Floryan and J.M. Floryan. Drag reduction in heated channels. *Journal of Fluid Mechanics*, 765, 353–395, 2015.
- [12] J.W. Hofferth, R.A. Humble, D. Floryan, and W.S. Saric. High-Bandwidth Optical Measurements of the Second-Mode Instability in a Mach 6 Quiet Tunnel. AIAA Paper 2013-0378.
- [13] M.Z. Hossain, D. Floryan, and J.M. Floryan. Drag reduction due to spatial thermal modulations. *Journal of Fluid Mechanics*, 713, 398–419, 2012.

Book Chapters

- [1] T. Van Buren, D. Floryan, and A.J. Smits. “Bio-inspired underwater propulsors,” in *Bio-Inspired Design*, editors L. Daniel and W. Soboyejo. Cambridge University Press, 2020.

Presentations

Invited Talks

- [1] D. Floryan. Hydromechanics and optimization of fast and efficient swimming. Department of Power and Aeronautical Engineering, Warsaw University of Technology, Warsaw, Poland, November 8, 2019.
- [2] D. Floryan. Hydromechanics and optimization of fast and efficient swimming. Department of Mechanical Engineering and Computer Science, Częstochowa University of Technology, Częstochowa, Poland, November 7, 2019.
- [3] D. Floryan. Flexible inertial swimmers. Applied and Computational Mathematics Seminar, Department of Mathematics, University of Wisconsin-Madison, Madison, WI, USA, September 13, 2019.
- [4] D. Floryan. Fast and efficient underwater propulsion inspired by biology. Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA, February 21, 2019.

- [5] D. Floryan. Fast and efficient underwater propulsion inspired by biology. Department of Chemical Engineering, University of Wisconsin–Madison, Madison, WI, USA, January 31, 2019.
- [6] D. Floryan, T. Van Buren, and A.J. Smits. Effects of combining heave, pitch and flexibility on swimming performance. 47th AIAA Fluid Dynamics Conference, Denver, CO, USA, June 5–9, 2017.

Conference Presentations

- [1] D. Floryan, X. An, and C.W. Rowley. Efficient optimization of swimming gaits. Proceedings of the 72nd Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Seattle, WA, USA, November 23–26, 2019.
- [2] D. Floryan, T. Van Buren, and A.J. Smits. Performance and scaling of flexible inertial swimmers. Proceedings of the 11th International Symposium for Turbulence and Shear Flow Phenomena, Southampton, UK, July 30–August 2, 2019.
- [3] D. Floryan and C.W. Rowley. Distributed flexibility in inertial swimmers. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Princeton, NJ, USA, April 2–3, 2019.
- [4] D. Floryan, T. Van Buren, and A.J. Smits. Large-amplitude oscillations of foils for efficient propulsion. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Princeton, NJ, USA, April 2–3, 2019.
- [5] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Big and slow: large-amplitude motions for highly efficient swimming. Proceedings of the 71st Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Atlanta, GA, USA, November 18–20, 2018.
- [6] D. Floryan and C.W. Rowley. Resonance in linear inviscid swimmers. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Bethlehem, PA, USA, September 27–28, 2018.
- [7] D. Floryan and C.W. Rowley. Optimal stiffness distributions in linear inviscid swimmers. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Bethlehem, PA, USA, September 27–28, 2018.
- [8] D. Floryan, T. Van Buren, and A.J. Smits. The birds and the bees (and the fish). Thousand Islands Fluid Dynamics Meeting, Gananoque, ON, Canada, April 27–29, 2018.
- [9] D. Floryan, C.W. Rowley, and A.J. Smits. Distributed flexibility in inertial swimmers. Proceedings of the 70th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Denver, CO, USA, November 19–21, 2017.
- [10] C.W. Rowley and D. Floryan. A framework for distributed flexibility in swimmers. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Boston, MA, USA, September 19–20, 2017.
- [11] A.J. Smits, T. Van Buren, and D. Floryan. Simplifying fish propulsion. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Boston, MA, USA, September 19–20, 2017.
- [12] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Scaling laws for the performance of rigid propulsors intended for underwater locomotion. Proceedings of the 10th International Symposium for Turbulence and Shear Flow Phenomena, Chicago, IL, USA, July 6–9, 2017.
- [13] C.W. Rowley, M. Fairchild, and D. Floryan. Nonsinusoidal gaits for improved thrust and efficiency of fishlike swimmers. 47th AIAA Fluid Dynamics Conference, Denver, CO, USA, June 5–9, 2017.
- [14] D. Floryan, C.W. Rowley, and A.J. Smits. Adjoint-based optimization of fish swimming gaits. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Charlottesville, VA, USA, March 9–10, 2017.

- [15] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Scaling propulsive performance. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Charlottesville, VA, USA, March 9–10, 2017.
- [16] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Scaling the propulsive performance of fish-like swimming. Sixth Annual Winter Workshop on Neuromechanics and Dynamics of Locomotion, New Orleans, LA, USA, January 19–20, 2017.
- [17] D. Floryan, C.W. Rowley, and A.J. Smits. Adjoint-based optimization of fish swimming gaits. Proceedings of the 69th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Portland, OR, USA, November 20–22, 2016.
- [18] T. Van Buren, D. Floryan, D. Brunner, U. Senturk, and A.J. Smits. Effect of trailing edge shape on the wake and propulsive performance of pitching panels. Proceedings of the 69th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Portland, OR, USA, November 20–22, 2016.
- [19] N. Wei, D. Floryan, T. Van Buren, and A.J. Smits. Cyber-physical experiments on the efficiency of swimming protocols. Proceedings of the 69th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Portland, OR, USA, November 20–22, 2016.
- [20] D. Floryan, C.W. Rowley, and A.J. Smits. Towards adjoint-based optimization of fish swimming gaits. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Princeton, NJ, USA, September 29–30, 2016.
- [21] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Fundamental analysis for pitch and heave motions. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Princeton, NJ, USA, September 29–30, 2016.
- [22] T. Van Buren, D. Floryan, A.J. Smits. Trailing edge impact on wake and performance of pitching panels. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Princeton, NJ, USA, September 29–30, 2016.
- [23] N. Wei, D. Floryan, T. Van Buren, and A.J. Smits. Cyber-physical experiments with a bio-inspired propulsion system. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Princeton, NJ, USA, September 29–30, 2016.
- [24] D. Floryan, C.W. Rowley, and A.J. Smits. Thrust enhancement of oscillating foils. Complex Motion in Fluids Summer School, Zenderen, Netherlands, June 19–24, 2016.
- [25] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Thrust enhancement of an oscillating foil. Thousand Islands Fluid Dynamics Meeting, Gananoque, ON, Canada, April 22–24, 2016.
- [26] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Propulsive performance of complex swimming gaits. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, West Chester, PA, USA, March 8–9, 2016.
- [27] D. Floryan, T. Van Buren, C.W. Rowley, and A.J. Smits. Effects of actuation waveform shape on the performance of pitching and heaving panels. Proceedings of the 68th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Boston, MA, USA, November 22–24, 2015.
- [28] R. Lisazo, T. Van Buren, D. Floryan, D. Hartsough, E. Oshima, C.W. Rowley, and A.J. Smits. Performance of an unsteady plate with a two-dimensional body attached upstream. Proceedings of the 68th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Boston, MA, USA, November 22–24, 2015.

- [29] W. Schleicher, D. Floryan, T. Van Buren, A.J. Smits, and K. Moored. Bio-inspired Propulsion with Functionally Graded Materials. Proceedings of the 68th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Boston, MA, USA, November 22–24, 2015.
- [30] M. Saadat, T. Van Buren, D. Floryan, A.J. Smits, and H. Haj-Hariri. Strouhal number for free swimming. Proceedings of the 68th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Boston, MA, USA, November 22–24, 2015.
- [31] D. Floryan, C.W. Rowley, and A.J. Smits. Optimizing gaits for fish swimming. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Bethlehem, PA, USA, September 21–22, 2015.
- [32] D. Floryan, T. Van Buren, D.B. Quinn, C.W. Rowley, and A.J. Smits. Effects of actuation waveform shape on the performance of a pitching foil. Thousand Islands Fluid Dynamics Meeting, Gananoque, ON, Canada, May 1–3, 2015.
- [33] T. Van Buren, D.B. Quinn, D. Floryan, K. Hartl, and A.J. Smits. Experiments on free swimming with drag, and the effects of actuation waveform. ONR MURI Review Meeting, Program Manager: Robert Brizzolara, Boston, MA, USA, March 2–3, 2015.
- [34] D. Floryan and J.M. Floryan. Pressure Losses in Heated Channels. Proceedings of The Canadian Society for Mechanical Engineering International Congress 2014, Toronto, ON, Canada, June 1–4, 2014.
- [35] D. Floryan and J.M. Floryan. Use of distributed heating for drag reduction. Thousand Islands Fluid Dynamics Meeting, Gananoque, ON, Canada, May 30–June 1, 2014.
- [36] J.M. Floryan and D. Floryan. On the intensification of the Super-ThermoHydrophobic Effect. Proceedings of the 14th Pan-American Congress of Applied Mechanics, Santiago, Chile, March 24–28, 2014.
- [37] J.M. Floryan and D. Floryan. Drag reduction due to spatial thermal modulations. Proceedings of the 66th Annual Meeting of the American Physical Society, Division of Fluid Dynamics, Pittsburgh, PA, USA, November 24–26, 2013.
- [38] M.Z. Hossain, J.M. Floryan, and D. Floryan. The Super-ThermoHydrophobic Effect. Proceedings of the 23rd International Congress of Theoretical and Applied Mechanics, Beijing, China, August 19–24, 2012.
- [39] A.J. Kirchhefer, D. Floryan, W. Bezner-Kerr, C.G. Guglielmo, G.A. Kopp, and R. Gurka. A Case Study of Unsteady Wings: The Wake of a Freely Flying European Starling (*Sturnus Vulgaris*). Proceedings of the 7th International Symposium on Turbulence and Shear Flow Phenomena, Ottawa, ON, Canada, July 28–31, 2011.

Teaching Experience

Princeton University, Princeton, NJ
Assistant in Instruction, Mechanics of Fluids (MAE 222)
 Introductory fluid mechanics course for mechanical engineers.

Spring 2017

Princeton University, Princeton, NJ
Assistant in Instruction, Automatic Control Systems (MAE 433)

Spring 2016

Lab component of classical/modern controls course for mechanical engineers.

Cornell University, Ithaca, NY

Fall 2012

Teaching Assistant, Introductory Fluid Mechanics (MAE 3230)

Introductory fluid mechanics course for mechanical engineers.

Cornell University, Ithaca, NY

Fall 2010–Spring 2011

AEW Facilitator, Multivariable Calculus and Differential Equations

Academic Excellence Workshops in multivariable calculus and differential equations.

Outreach and Service

University and Departmental

GSG MAE Representative

2016–2019

The Mechanical and Aerospace Engineering department's representative for the Graduate Student Government

MAE Graduate Student Committee

2016–2019

Member of the Mechanical and Aerospace Engineering department's graduate student committee, serving as a liaison between graduate students and the department

SEAS Orientation on Advising

2016

Guided new graduate students in the School of Applied and Engineering Science on navigating the advisor-advisee relationship

MAE Committee on Climate and Inclusion

2015–2019

Founding member of a committee whose goal is to assess the department's climate for underrepresented groups and make recommendations in the spirit of finding best practices that ensure all members of the department feel respected, included and supported by our community

Harlem Prep to Princeton

2015–2019

Organizer of an annual trip for Harlem Prep 4th graders in which students participate in lab demos in the Mechanical and Aerospace Engineering department

Gas Dynamics Lab Demos

2015

Organizer of an annual trip for Chinese middle school- and high school-aged students in which students participate in fluid dynamics lab demos

Professional

Membership:

American Institute of Aeronautics and Astronautics

American Physical Society

Session chair:

American Physical Society DFD Meeting (2017)

Reviewing

AIAA Journal
Bioinspiration and Biomimetics
International Journal of Heat and Fluid Flow
Journal of Fluid Mechanics
Journal of Fluids and Structures
Physical Review Fluids
Physical Review Letters
Physics of Fluids
PLOS One
Science Advances
Scientific Reports

Mentorship

Masters students

Rodrigo Lisazo (ISAE-SUPAERO), body effects in fish swimming 2015

Undergraduate students

Hoang Le (Princeton '22), energy harvesting using fluid-structure interactions	Summer 2019
Nick Chen (Princeton '20), energy harvesting using fluid-structure interactions	Summer 2017
Nathan Wei (Princeton '17), cyber-physical fluids facility	2016–2017
Devon Hartsough (Princeton '18), robotic swimmers	Summer 2015
Emile Oshima (Princeton '17), robotic swimmers	Summer 2015

Last updated: November 27, 2019