



David Lentink

Assistant Professor of Mechanical Engineering

Bio

BIO

Lentink's lab studies every aspect of biological flight as an inspiration for designing aerial robots. We focus on key biological questions which we probe with new engineering methods to find inspiration for aerial robots that can fly like animals. Our comparative biological flight research ranges from maple seeds, insects and bats to birds such as swifts, parrotlets, lovebirds, doves and a wide range of hummingbirds. For in-depth comparative biomechanics research we focus on bird flight. We use biofluid dynamics and other quantitative engineering disciplines including robotics as research tools to mechanistically understand and embody animal flight performance. We translate our integrative and comparative biological research driven by scientific curiosity to aerial robot design to solve the engineering challenge of autonomous flight in complex cluttered environments and turbulent atmospheric conditions.

ACADEMIC APPOINTMENTS

- Assistant Professor, Mechanical Engineering
- Member, Bio-X

HONORS AND AWARDS

- Inaugural Steven Vogel Young Investigator Award, Journal Bioinspiration & Biomimetics (2018)
- Gilbreth Lecturer, National Academy of Engineering (2017)
- CAREER Award, National Science Foundation (2016)
- Recognized as one of 40 scientists under 40 by the World Economic Forum, Annual Meeting of the New Champions, Dalian, China. (2013)
- 100kE Dutch Academic Year Prize, 100kE (2010)
- Biophysics thesis award, Dutch Society for Biophysics and Biomedical Technology (2009)
- Zoology Award, Royal Dutch Zoological Society (2009)
- Bolk Prize, Netherlands Society for Anatomy (2008)
- Ritsema van Eck Award, Delft University of Technology (2006)
- Most Exotic Micro Air Vehicle (MAV) Award, First American-European MAV contest (2005)
- Elsevier Young Scientist Award, Society for Experimental Biology (2005)
- AIAA best Fluid Dynamics conference paper, AIAA (2003)
- Dobbinga Award, Delft University of Technology (2003)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Editorial Board Member, Journal of Bioinspiration & Biomimetics (2010 - present)
- Reviewing Editorial Board member, eLife (2016 - present)

- Alumnus, Young Academy of the Royal Netherlands Academy of Arts and Sciences (2011 - 2016)

PROFESSIONAL EDUCATION

- PhD, cum laude, Wageningen University, The Netherlands , Experimental Zoology (2008)
- MS, BS, Delft University of Technology, The Netherlands , Aerospace Engineering (2003)

LINKS

- My Lab: <http://lentinklab.stanford.edu/>

Teaching

COURSES

2019-20

- Aerial Robot Design: AA 248E, ME 171E, ME 271E (Aut)
- Introduction to Sensors: ME 220 (Spr)

2018-19

- Aerial Robot Design: AA 248E, ME 171E, ME 271E (Aut)
- Introduction to Sensors: ME 220 (Spr)

2017-18

- Aerial Robot Design: AA 248E, ME 171E, ME 271E (Aut)
- Introductory Fluids Engineering: ME 70 (Spr)
- Seminar in Fluid Mechanics: ENGR 298 (Aut)

2016-17

- Aerial Robot Design: ME 271 (Aut)
- Biomechanics of Flight: ME 303 (Win)
- Introductory Fluids Engineering: ME 70 (Spr)

STANFORD ADVISEES

Doctoral Dissertation Advisor (AC)

Eric Chang, Sebastian Hendrickx-Rodriguez, Ben Hightower, Kenneth Hoffmann, Lindsay Jeffries, Laura Matloff, Will Roderick

Master's Program Advisor

Charvi Aggarwal, Preston Culbertson, Spencer Diehl, Roshail Gerard, Jun En Low

Doctoral Dissertation Co-Advisor (AC)

Trevor Halsted

Doctoral (Program)

Elliot Weiss

Publications

PUBLICATIONS

- **How lovebirds maneuver through lateral gusts with minimal visual information.** *Proceedings of the National Academy of Sciences of the United States of America*
Quinn, D., Kress, D., Chang, E., Stein, A., Wegrzynski, M., Lentink, D.

2019

- **Biomechanics of hover performance in Neotropical hummingbirds versus bats.** *Science advances*
Ingersoll, R., Haizmann, L., Lentink, D.
2018; 4 (9): eaat2980
- **How birds direct impulse to minimize the energetic cost of foraging flight.** *Science advances*
Chin, D. D., Lentink, D.
2017; 3 (5)
- **In vivo recording of aerodynamic force with an aerodynamic force platform: from drones to birds.** *Journal of the Royal Society, Interface / the Royal Society*
Lentink, D., Haselsteiner, A. F., Ingersoll, R.
2015; 12 (104)
- **Leading-edge vortices elevate lift of autorotating plant seeds.** *Science*
Lentink, D., van Dickson, W., B., van Leeuwen, J., L., Dickinson, M., H.
2009; 324: 1438 – 1440
- **The scalable design of flapping micro air vehicles inspired by insect flight.** *In: Flying insects and robots.*
Lentink, D., Jongerius, S., R., Bradshaw, N., L.
edited by Floreano, D., Zufferey, J. -C., Srinivasan, M., V.
Springer.2009
- **Rotational accelerations stabilize leading edge vortices on revolving fly wings.** *J. Exp. Biol.*
Lentink, D., Dickinson, M., H.
2009; 212: 2705 – 2719
- **How swifts control their glide performance with morphing wings.** *Nature*
Lentink, D., Müller, U., K., Stamhuis, E., J., de Kat, R., van Gestel, W., Veldhuis, L., L.M.
2007; 446: 1082 – 1085
- **How Hummingbirds Reorient Forces During Maneuvering Flight**
Hightower, B., Ingersoll, R., Shorr, D., Chin, D., Lentink, D., Hightower, B.
OXFORD UNIV PRESS INC.2019: E100
- **A Bird's-Eye View of Regulatory, Animal Care, and Training Considerations Regarding Avian Flight Research.** *Comparative medicine*
Baker, S. W., Tucci, E. R., Felt, S. A., Zehnder, A., Lentink, D., Vilches-Moure, J. G.
2019
- **How the hummingbird wingbeat is tuned for efficient hovering.** *The Journal of experimental biology*
Ingersoll, R., Lentink, D.
2018; 221 (Pt 20)
- **Accurate fluid force measurement based on control surface integration** *EXPERIMENTS IN FLUIDS*
Lentink, D.
2018; 59 (1)
- **Adaptive control of turbulence intensity is accelerated by frugal flow sampling.** *Journal of the Royal Society, Interface*
Quinn, D. B., van Halder, Y., Lentink, D.
2017; 14 (136)
- **The biomechanical origin of extreme wing allometry in hummingbirds** *NATURE COMMUNICATIONS*
Skandalis, D. A., Segre, P. S., Bahlman, J. W., Groom, D. E., Welch, K. C., Witt, C. C., McGuire, J. A., Dudley, R., Lentink, D., Altshuler, D. L.
2017; 8: 1047
- **How pigeons couple three-dimensional elbow and wrist motion to morph their wings** *JOURNAL OF THE ROYAL SOCIETY INTERFACE*
Stowers, A. K., Matloff, L. Y., Lentink, D.
2017; 14 (133)
- **Inspiration for wing design: how forelimb specialization enables active flight in modern vertebrates.** *Journal of the Royal Society, Interface*
Chin, D. D., Matloff, L. Y., Stowers, A. K., Tucci, E. R., Lentink, D.

2017; 14 (131)

- **High-speed surface reconstruction of a flying bird using structured light.** *journal of experimental biology*
Deetjen, M. E., Biewener, A. A., Lentink, D.
2017; 220: 1956-1961
- **A new low-turbulence wind tunnel for animal and small vehicle flight experiments** *ROYAL SOCIETY OPEN SCIENCE*
Quinn, D. B., Watts, A., Nagle, T., Lentink, D.
2017; 4 (3)
- **Lift calculations based on accepted wake models for animal flight are inconsistent and sensitive to vortex dynamics** *BIOINSPIRATION & BIOMIMETICS*
Gutierrez, E., Quinn, D. B., Chin, D. D., Lentink, D.
2017; 12 (1)
- **Touchdown to take-off: at the interface of flight and surface locomotion** *INTERFACE FOCUS*
Roderick, W. R., Cutkosky, M. R., Lentink, D.
2017; 7 (1)
- **Lift calculations based on accepted wake models for animal flight are inconsistent and sensitive to vortex dynamics.** *Bioinspiration & biomimetics*
Gutierrez, E., Quinn, D. B., Chin, D. D., Lentink, D.
2016; 12 (1): 016004-?
- **Fruit fly scale robots can hover longer with flapping wings than with spinning wings.** *Journal of the Royal Society, Interface*
Hawkes, E. W., Lentink, D.
2016; 13 (123)
- **Flapping wing aerodynamics: from insects to vertebrates** *JOURNAL OF EXPERIMENTAL BIOLOGY*
Chin, D. D., Lentink, D.
2016; 219 (7): 920-932
- **Flapping wing aerodynamics: from insects to vertebrates.** *journal of experimental biology*
Chin, D. D., Lentink, D.
2016; 219: 920-932
- **The biophysics of bird flight: functional relationships integrate aerodynamics, morphology, kinematics, muscles, and sensors** *CANADIAN JOURNAL OF ZOOLOGY*
Altshuler, D. L., Bahlman, J. W., Dakin, R., Gaede, A. H., Goller, B., Lentink, D., Segre, P. S., Skandalis, D. A.
2015; 93 (12): 961-975
- **Feather roughness reduces flow separation during low Reynolds number glides of swifts** *JOURNAL OF EXPERIMENTAL BIOLOGY*
van Bokhorst, E., de Kat, R., Elsinga, G. E., Lentink, D.
2015; 218 (20): 3179-3191
- **The role of passive avian head stabilization in flapping flight.** *Journal of the Royal Society, Interface / the Royal Society*
Pete, A. E., Kress, D., Dimitrov, M. A., Lentink, D.
2015; 12 (110)
- **The role of passive avian head stabilization in flapping flight.** *Journal of the Royal Society, Interface / the Royal Society*
Pete, A. E., Kress, D., Dimitrov, M. A., Lentink, D.
2015; 12 (110)
- **Power reduction and the radial limit of stall delay in revolving wings of different aspect ratio** *JOURNAL OF THE ROYAL SOCIETY INTERFACE*
Kruyt, J. W., Van Heijst, G. F., Altshuler, D. L., Lentink, D.
2015; 12 (105)
- **Folding in and out: passive morphing in flapping wings.** *Bioinspiration & biomimetics*
Stowers, A. K., Lentink, D.
2015; 10 (2): 025001-?
- **Folding in and out: passive morphing in flapping wings** *BIOINSPIRATION & BIOMIMETICS*
Stowers, A. K., Lentink, D.

2015; 10 (2)

- **How Lovebirds Maneuver Rapidly Using Super-Fast Head Saccades and Image Feature Stabilization.** *PloS one*
Kress, D., van Bokhorst, E., Lentink, D.
2015; 10 (6)
- **How Lovebirds Maneuver Rapidly Using Super-Fast Head Saccades and Image Feature Stabilization.** *PloS one*
Kress, D., van Bokhorst, E., Lentink, D.
2015; 10 (6)
- **Hummingbird wing efficacy depends on aspect ratio and compares with helicopter rotors.** *Journal of the Royal Society, Interface / the Royal Society*
Kruyt, J. W., Quicazán-Rubio, E. M., Van Heijst, G. F., Altshuler, D. L., Lentink, D.
2014; 11 (99)
- **Gliding Swifts Attain Laminar Flow over Rough Wings** *PLOS ONE*
Lentink, D., de Kat, R.
2014; 9 (6)
- **Bioinspired flight control.** *Bioinspiration & biomimetics*
Lentink, D.
2014; 9 (2): 020301-?
- **Gliding Swifts Attain Laminar Flow over Rough Wings.** *PloS one*
Lentink, D., de Kat, R.
2014; 9 (6)
- **Small aspect ratio differences impact hover efficacy among 12 hummingbird species** *Annual Meeting of the Society-for-Integrative-and-Comparative-Biology (SICB)*
Kruyt, J. W., Quicazan-Rubio, E. M., Van Heijst, G. J., Altshuler, D. L., Lentink, D.
OXFORD UNIV PRESS INC.2013: E118–E118
- **Flight Artists: An outreach project that enables the general public to film natural flight using the worlds most advanced high-speed camera** *Annual Meeting of the Society-for-Integrative-and-Comparative-Biology (SICB)*
Lentink, D., Fiaz, A. W.
OXFORD UNIV PRESS INC.2013: E124–E124
- **Flying like a fly.** *Nature*
Lentink, D.
2013
- **Vortex interactions with flapping wings and fins can be unpredictable.** *Biol. Lett.*
Lentink, D., van Heijst, G., J.F., Muijres, F., T., van Leeuwen, J., L.
2010
- **Nature inspired flight – beyond the leap.** *Bioinspir. Biomim.*
Lentink, D., Biewener, A., A.
2010; 5
- **Structural analysis of a dragonfly wing.** *J. Exp. Mech.*
Jongorius, S., R., Lentink, D.
2010; 50: 1323-1334
- **Biofluiddynamic scaling of flapping, spinning and translating fins and wings.** *J. Exp. Biol.*
Lentink, D., Dickinson, M., H.
2009; 212: 2691 – 2704
- **Automated visual tracking for studying the ontogeny of zebrafish swimming.** *J. Exp. Biology.*
Fontaine, E., Lentink, D., Kranenbarg, S., Müller, U., K., van Leeuwen, J., L., Barr, A., H.
2008; 211: 1305 – 1316
- **Vortex-wake interactions of a flapping foil that models animal swimming and flight.** *J. Exp. Biology.*

Lentink, D., Muijres, F., T., Donker-Duyvis, F., J., van Leeuwen, J., L.
2008; 211: 267 – 273

- **Wake visualization of a heaving and pitching foil in a soap film.** *Exp. Fluids*

Muijres, F., T., Lentink, D.
2007; 43: 665 – 673

- **Turning on a Dime.** *Science*

Müller, U., K., Lentink, D.
2004; 306: 1899 – 1900