

Andrew Ning

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Research Interests

Multidisciplinary Optimization, Aerodynamics, Wind Energy, Aircraft Design, Aero/Structural Analysis, Uncertainty Quantification

Education

PhD, Stanford University, Aeronautics and Astronautics, Sep 2011

Dissertation: Aircraft Drag Reduction Through Extended Formation Flight
National Defense Science and Engineering Graduate Fellow

MS, Stanford University, Aeronautics and Astronautics, Apr 2008

GPA: 4.07/4.0

BS, Brigham Young University, Applied Physics with University Honors, Aug 2006

Minor: Mathematics
Honors Thesis
GPA: 3.97/4.0

Professional Experience

Assistant Professor, Brigham Young University, Mechanical Engineering, July 2014–present.

Senior Engineer, National Renewable Energy Laboratory, Mar 2014–July 2014

Postdoctoral Researcher, National Renewable Energy Laboratory, Nov 2011–Mar 2014

Research Assistant, Stanford University, Apr 2007–Sep 2011

Visiting Researcher, National Aeronautics and Space Administration, Jan 2011–July 2011

Lead Developer, Complete Solar Solution, Apr 2010–Sep 2011

Intern: Aerodynamics Analyst, Orbital Sciences, Summer 2007

Intern: Mechanical Design, Honeywell International, Summer 2006

Journal Articles

Published

1. Gebraad, P., Thomas, J. J., **Ning, A.**, Fleming, P., and Dykes, K., “Maximization of the Annual Energy Production of Wind Power Plants by Optimization of Layout and Yaw-Based Wake Control,” *Wind Energy*, Vol. 20, No. 1, pp. 97–107, Jan. 2017.
doi:10.1002/we.1993

2. **Ning, A.**, and Petch, D., “Integrated Design of Downwind Land-based Wind Turbines using Analytic Gradients,” *Wind Energy*, Vol. 19, No. 12, pp. 2137–2152, Dec. 2016.
doi:10.1002/we.1972
3. **Ning, A.**, “Actuator Cylinder Theory for Multiple Vertical Axis Wind Turbines,” *Wind Energy Science*, Vol. 1, No. 2, pp. 327–340, Dec. 2016.
doi:10.5194/wes-1-327-2016
4. Damiani, R., **Ning, A.**, Maples, B., Smith, A., and Dykes, K., “Scenario Analysis for Techno-Economic Model Development of U.S. Offshore Wind Support Structures,” *Wind Energy*, Sep. 2016.
doi:10.1002/we.2021
5. Barrett, R., and **Ning, A.**, “Comparison of Airfoil Precomputational Analysis Methods for Optimization of Wind Turbine Blades,” *IEEE Transactions on Sustainable Energy*, Vol. 7, No. 3, pp. 1081–1088, Jul. 2016.
doi:10.1109/TSTE.2016.2522381
6. Fleming, P., **Ning, A.**, Gebraad, P., and Dykes, K., “Wind Plant System Engineering through Optimization of Layout and Yaw Control,” *Wind Energy*, Vol. 19, No. 2, pp. 329–344, Feb. 2016.
doi:10.1002/we.1836
7. **Ning, A.**, Damiani, R., and Moriarty, P., “Objectives and Constraints for Wind Turbine Optimization,” *Journal of Solar Energy Engineering*, Vol. 136, No. 4, p. 041010, Nov. 2014.
doi:10.1115/1.4027693
8. **Ning, A.**, “A Simple Solution Method for the Blade Element Momentum Equations with Guaranteed Convergence,” *Wind Energy*, Vol. 17, No. 9, pp. 1327–1345, Sep. 2014.
doi:10.1002/we.1636
9. **Ning, A.**, Kroo, I., Aftosmis, M. J., Nemec, M., and Kless, J. E., “Extended Formation Flight at Transonic Speeds,” *Journal of Aircraft*, Vol. 51, No. 5, pp. 1501–1510, Sep. 2014.
doi:10.2514/1.C032385
10. Xu, J., **Ning, A.**, Bower, G., and Kroo, I., “Aircraft Route Optimization for Formation Flight,” *Journal of Aircraft*, Vol. 51, No. 2, pp. 490–501, Mar. 2014.
doi:10.2514/1.C032154
11. Kless, J., Aftosmis, M., **Ning, A.**, and Nemec, M., “Inviscid Analysis of Extended Formation Flight,” *AIAA Journal*, Vol. 51, No. 7, pp. 1703–1715, Jul. 2013.
doi:10.2514/1.j052224
12. **Ning, A.**, Flanzer, T., and Kroo, I., “Aerodynamic Performance of Extended Formation Flight,” *Journal of Aircraft*, Vol. 48, No. 3, pp. 855–865, May 2011.
doi:10.2514/1.C031046
13. **Ning, A.**, and Kroo, I., “Multidisciplinary Considerations in the Design of Wings and Wing Tip Devices,” *Journal of Aircraft*, Vol. 47, No. 2, pp. 534–543, Mar. 2010.
doi:10.2514/1.41833

In Review

1. Barrett, R., and **Ning, A.**, “Integrated Free-Form Method for Aerostructural Optimization of Wind Turbine Blades,” *Wind Energy*, Jan. 2017, (in review).
2. Tingey, E., and **Ning, A.**, “Development of a Parameterized Reduced-Order Vertical-Axis Wind Turbine Wake Model,” *AIAA Journal*, Nov. 2016, (in review).
3. Tingey, E., and **Ning, A.**, “Trading Off Sound Pressure Level and Average Power Production for Wind Farm Layout Optimization,” *Renewable Energy*, Oct. 2016, (in review).

4. Thomas, J., Gebraad, P., and **Ning, A.**, “Improving the FLORIS Wind Plant Model for Compatibility with Gradient-based Optimization,” *Wind Engineering*, May 2016, (in review).

Conference Publications

1. Stanley, A. P. J., Thomas, J., **Ning, A.**, Annoni, J., Dykes, K., and Fleming, P., “Gradient-Based Optimization of Wind Farms with Different Turbine Heights,” *Wind Energy Symposium*, Grapevine, TX, AIAA, Jan. 2017.
doi:10.2514/6.2017-1619
2. Padrón, S., Stanley, A. P. J., Thomas, J., Alonso, J. J., and **Ning, A.**, “Polynomial Chaos for the Computation of Annual Energy Production in Wind Farm Layout Optimization,” *Journal of Physics: Conference Series*, Oct. 2016, p. 032021.
doi:10.1088/1742-6596/753/3/032021
3. Ingersoll, B., Ingersoll, K., DeFranco, P., and **Ning, A.**, “UAV Path-Planning using Bézier Curves and a Receding Horizon Approach,” *AIAA Modeling and Simulation Technologies Conference*, Washington, DC, Jun. 2016.
doi:10.2514/6.2016-3675
4. Moore, K., and **Ning, A.**, “Aerodynamic Performance Characterization of Leading Edge Protrusions on Small Propellers,” *AIAA Aerospace Sciences Meeting*, San Diego, CA, Jan. 2016.
doi:10.2514/6.2016-1786
5. Tingey, E., and **Ning, A.**, “Parameterized Vertical-Axis Wind Turbine Wake Model Using CFD Vorticity Data,” *ASME Wind Energy Symposium*, San Diego, CA, Jan. 2016.
doi:10.2514/6.2016-1730
6. Duffield, M., **Ning, A.**, and McLain, T., “Optimization-Based Path Planning for Separation Assurance on Small Unmanned Aircraft,” *AIAA Guidance, Navigation, and Control Conference*, San Diego, CA, Jan. 2016.
doi:10.2514/6.2016-2194
7. Barrett, R., Freeman, I., and **Ning, A.**, “Effect of Airfoil and Composite Layer Thicknesses on an Aerostructural Blade Optimization for Wind Turbines,” *IEEE Conference on Technologies for Sustainability*, Ogden, UT, Jul. 2015.
doi:10.1109/SusTech.2015.7314346
8. Tingey, E., Thomas, J., and **Ning, A.**, “Wind Farm Layout Optimization Using Sound Pressure Level Constraints,” *IEEE Conference on Technologies for Sustainability*, Ogden, UT, Jul. 2015.
doi:10.1109/SusTech.2015.7314339
9. Thomas, J., Tingey, E., and **Ning, A.**, “Comparison of Two Wake Models for Use in Gradient-based Wind Farm Layout Optimization,” *IEEE Conference on Technologies for Sustainability*, Ogden, UT, Jul. 2015.
doi:10.1109/SusTech.2015.7314347
10. **Ning, A.**, Hayman, G., Damiani, R., and Jonkman, J., “Development and Validation of a New Blade Element Momentum Skewed-Wake Model within AeroDyn,” *33rd ASME Wind Energy Symposium*, Kissimmee, FL, Jan. 2015.
doi:10.2514/6.2015-0215
11. **Ning, A.**, and Dykes, K., “Understanding the Benefits and Limitations of Increasing Maximum Rotor Tip Speed for Utility-Scale Wind Turbines,” *Journal of Physics: Conference Series*, Jun. 2014, p. 012087.
doi:10.1088/1742-6596/524/1/012087

12. Gray, J., Hearn, T., Moore, K., Hwang, J., Martins, J., and **Ning, A.**, “Automatic Evaluation of Multidisciplinary Derivatives Using a Graph-Based Problem Formulation in OpenMDAO,” *15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference*, Atlanta, GA, Jun. 2014.
doi:10.2514/6.2014-2042
13. Dykes, K., **Ning, A.**, King, R., Graf, P., Scott, G., and Veers, P., “Sensitivity Analysis of Wind Plant Performance to Key Turbine Design Parameters: A Systems Engineering Approach,” *32nd ASME Wind Energy Symposium*, National Harbor, Maryland, Jan. 2014.
doi:10.2514/6.2014-1087
14. **Ning, A.**, Damiani, R., and Moriarty, P., “Objectives and Constraints for Wind Turbine Optimization,” *31st ASME Wind Energy Symposium*, Grapevine, TX, Feb. 2013.
doi:10.2514/6.2013-201
15. Kless, J., Aftomis, M., **Ning, A.**, and Nemec, M., “Inviscid Analysis of Extended Formation Flight,” *7th International Conference on Computational Fluid Dynamics*, Big Island, Hawaii, Jul. 2012.
16. Xu, J., **Ning, A.**, Bower, G., and Kroo, I., “Aircraft Route Optimization for Heterogeneous Formation Flight,” *53rd AIAA Structures, Structural Dynamics and Materials Conference*, Honolulu, Hawaii, Apr. 2012.
doi:10.2514/6.2012-1524
17. **Ning, A.**, and Kroo, I., “Compressibility Effects of Extended Formation Flight,” *29th AIAA Applied Aerodynamics Conference*, Honolulu, Hawaii, Jun. 2011.
doi:10.2514/6.2011-3812
18. **Ning, A.**, Flanzer, T., and Kroo, I., “Aerodynamic Performance of Extended Formation Flight,” *48th AIAA Aerospace Sciences Meeting*, Orlando, Florida, Jan. 2010.
doi:10.2514/6.2010-1240
19. **Ning, A.**, and Kroo, I., “Tip Extensions, Winglets, and C-Wings: Conceptual Design and Optimization,” *26th AIAA Applied Aerodynamics Conference*, Honolulu, Hawaii, Aug. 2008.
doi:10.2514/6.2008-7052
20. Chipman, D., **Ning, A.**, and Allred, D., “Intermediate Martian Atmospheric Study and Demonstrator,” *SpaceOps 2006 Conference*, Rome, Italy, Jun. 2006.
doi:10.2514/6.2006-5942

Other Publications

1. Dykes, K., Platt, A., Guo, Y., **Ning, A.**, King, R., Parsons, T., Petch, D., Veers, P., and Resor, B., *Effect of Tip-Speed Constraints on the Optimized Design of a Wind Turbine*, Golden, CO, National Renewable Energy Laboratory, Oct. 2014.
2. Dykes, K., **Ning, A.**, King, R., Graf, P., Scott, G., and Veers, P., *Sensitivity Analysis of Wind Plant Performance to Key Turbine Design Parameters: A Systems Engineering Approach*, Golden, CO, National Renewable Energy Laboratory, Feb. 2014.
3. **Ning, A.**, *AirfoilPrep.py Documentation*, National Renewable Energy Laboratory, Sep. 2013.
4. **Ning, A.**, *pBEAM Documentation*, National Renewable Energy Laboratory, Sep. 2013.
5. **Ning, A.**, *CCBlade Documentation*, National Renewable Energy Laboratory, Sep. 2013.
6. **Ning, A.**, “Aircraft Drag Reduction through Extended Formation Flight,” PhD thesis, Stanford University, 2011.
7. **Ning, A.**, “Creation of an Intermediate Environment and Utilizing Switchable Microwave Absorbent Material to Aid in Performing Work on Mars,” Undergraduate Honors Thesis, Brigham Young University, 2006.

External Research Awards

NSF Center for Unmanned Aircraft Systems, \$40,000, 09/01/16–08/31/17, “Optimization of Heterogeneous Group of Vehicles for Achieving Multiple Mission Level Objectives,” PI: Cammy Peterson, Co-PI: Andrew Ning.

FCL Tech (Facebook), \$443,700, 05/02/16–05/01/19, “Conceptual Design of High Altitude Long Endurance Aircraft Using Multidisciplinary Optimization,” PI: Andrew Ning, Co-PIs: John Hedengren, Tim McLain.

FCL Tech (Facebook), \$426,785, 05/02/16–05/01/19, “Efficient High-Fidelity Aeroelastic Analysis and Design of Long Endurance Aircraft,” PI: Andrew Ning, Co-PI: Michael Scott.

Twig & Wire, \$19,800, 12/14/15–06/30/16, “Wind Energy: Power Estimates for a Novel Vertical Axis Wind Turbine Design,” PI: Julie Crockett, Co-PI: Andrew Ning.

National Science Foundation, \$199,935 (BYU) and \$200,000 (Stanford), 09/01/2015–08/31/2017, “Large-Scale, Integrated, and Robust Wind Farm Optimization Enabled by Coupled Analytic Gradients,” Grant #1539384, PI: Andrew Ning, Co-PI: Juan Alonso.

National Institutes of Health, \$423,245, 04/01/2015–03/31/2018, “Quantitative Characterization of Essential Tremor for Future Tremor Suppression,” PI: Steven Charles, Co-PIs: Jon Blotter, Andrew Ning, Mark Hallett.

National Renewable Energy Laboratory, \$159,077, 09/24/2014–09/23/2017, “Systems Engineering of Wind Turbines and Plants,” PI: Andrew Ning.

Internal Research Awards

Department Undergraduate Mentoring Award, \$4,000, 1/1/16–12/31/16, “Efficient Genetic Algorithms for Engineering Design,” PI: Andrew Ning.

BYU Research Initiation Grant, \$10,000, 11/24/15–12/31/16, “Aeroelastic Optimization of Wings and Blades using Isogeometric Analysis,” PI: Michael Scott, Co-PI: Andrew Ning.

BYU Office of Research & Creative Activities Mentoring Environment Grants, \$20,000, 01/01/2015–12/31/2016, “Vertical Axis Wind Turbine Wake Model Development,” PI: Andrew Ning.

External Invited Presentations

1. “Wind Energy Design Optimization,” National Renewable Energy Laboratory, Boulder, CO, Aug 2016.
2. “Free-form Aerostructural Optimization of Wind Turbine Blades,” Ryan Barrett and Andrew Ning, AWEA WINDPOWER, New Orleans, LA, May 2016.
3. “Large-scale Wind Farm Optimization and Uncertainty Quantification,” Windfarms 2016, Dallas, TX, May 2016.
4. “Wind Farm Optimization and UQ,” Wakebench Annual Meeting, Albuquerque, NM, Mar 2016.
5. “Wind Energy Design Optimization,” Sandia National Laboratories, Albuquerque, NM, Mar 2016.
6. “Aeroelasticity and Multidisciplinary Analysis for Long Endurance UAVs,” NSF Center for Unmanned Aircraft Systems Industry Advisory Board Meeting, Boulder, CO, Aug 2015.
7. “Workshop: Python for Scientific Computing,” Utah Fluids Conference, BYU, Aug 2015.

8. "Advances in Wind Energy and the Role of Multidisciplinary Optimization," IEEE Conference on Technologies for Sustainability, Ogden, UT, July 2015.
9. "Downwind Wind Turbine Optimization," Wind Energy Systems Engineering Workshop, NREL, Boulder, CO, Jan 2015.
10. "Optimization within Integrated Design," DOE A2e Wind-Plant System Design and Analysis (IW-PSDA) Assessment Meeting, Jan 2015.
11. "Optimization-Driven Design of Wind Turbines with High Tip Speeds," Colorado State University, Department of Mechanical Engineering Seminar, Apr 2014.
12. "Optimization-Driven Design of Wind Turbines for High Tip Speeds," Brigham Young University, Mechanical Engineering Department Graduate Seminar, Feb 2014.
13. "Wind Turbine Optimization," University of Michigan, Ann Arbor, MI, Oct 2013.
14. "Design Optimization of Downwind Rotors with Segmented Blades," Boulder Fluid Dynamics Seminar, University of Colorado, Boulder, CO, Oct 2013.
15. "TWISTER Physics-Based Rotor and Tower Models," Tutorial, NREL Wind Energy Systems Engineering Workshop, Boulder, CO, Feb 2013.
16. "Objectives and Constraints for Wind Turbine Optimization," NREL Wind Energy Systems Engineering Workshop, Broomfield, CO, Jan 2013.
17. "Aircraft Drag Reduction Through Extended Formation Flight," Airbus, Filton UK, Dec 2011.
18. "Aircraft Drag Reduction Through Extended Formation Flight," National Wind Technology Center, Boulder, CO, Sep 2011.
19. "Compressibility Effects of Extended Formation Flight," Army Aeroflightdynamics Directorate, Moffett Field, CA, Aug 2011.
20. "Aircraft Drag Reduction Through Extended Formation Flight," Applied Modeling & Simulation (AMS) Seminar Series, NASA Ames, Moffett Field, CA, July 2011.
21. "Aerodynamics of Extended Formation Flight," Sandia, Albuquerque, NM, Apr 2011.

Internal Invited Presentations

1. "Aircraft Multidisciplinary Design Optimization and Aerodynamics," USTAR Meeting, Provo, UT, Mar 2016.
2. "Large Scale Design Optimization," Condensed Matter Group, BYU, Feb 2016.
3. "Large Scale Design Optimization with Mixed Variables," Air Force Research Laboratory Utah Visit, BYU, Feb 2016.
4. "Applied Mathematics in Wind Energy Systems Design," Applied Math Seminar, BYU, Sep 2015.
5. "Multidisciplinary Design Optimization in Wind Energy and Aeronautics," Chemical Engineering Department Graduate Seminar, BYU, Feb 2015.
6. "Wind Energy: Today and Into the Future," BYU Energy Club, Provo, UT, Dec 2014.
7. "Multidisciplinary Design Optimization of Aircraft and Wind Turbines," MAGICC Lab, Provo, UT, Nov 2014.
8. "Nonlinear Optimization for Engineers: An Overview of the Fundamentals," National Renewable Energy Laboratory, Boulder, CO, Sep 2013.

Honors and Awards

BYU Department of Mechanical Engineering 2016 Outstanding Researcher Award

Finalist for MIT Technology Review's 35 Innovators Under 35, 2016

National Defense Science and Engineering Graduate (NDSEG) Fellowship, 2007–2010

Airbus “Fly Your Ideas” Competition, Finalist Top 5 out of 225 teams

Honeywell Bravo Award — in recognition of technical excellence provided in the design of a bearing spring-cage to address vibration issues in the HTF7000 engine, 2006

BYU Honors Program Robert K. Thomas Scholarship, 2006

Rocky Mountain NASA Space Grant Fellowship, 2005

BYU Religious Education Student Symposium Writing Contest Winner, 2005

BYU Office of Research and Creative Activities (ORCA) Grant Recipient, 2004, 2005

BYU University Scholarship, 2004-2006

National Merit Scholarship, 2000

Patents

U.S. Patent 7,699,526, “Support Dampers for Bearing Assemblies and Methods of Manufacture,” J. W. McMurray, M., Alam, D. K. Spencer, S. A. Ning, 4 Apr 2010.

Professional Service

Member of AIAA Multidisciplinary Design Optimization Technical Committee (2016–)

- Session Co-Chair, Aeroelastic Optimization, AIAA SciTech 2017, Grapevine, Texas, Jan. 9–13, 2017.
- Education Subcommittee

IEA Wind Task 37 Technical Expert (2015–)

- Developing benchmark MDO studies for wind turbine/farm design
- Developing a common ontology for wind turbine/farm analysis

American Institute of Aeronautics and Astronautics, Senior Member

Journal Reviewing

2017: AIAA Journal, IEEE Transactions on Sustainable Energy

2016: Cambridge Textbooks, Wind Energy (3 articles), Renewable Energy (3 articles), TORQUE (2 articles), AIAA SciTech (4 articles), AIAA Aviation (3 articles), Optimization & Engineering

2015: Wind Energy, Renewable Energy (4 articles), Journal of Turbomachinery, Journal of Fluids Engineering, Aerospace Science and Technology, Journal of the American Helicopter Society, AIAA SciTech (3 articles), BYU Graduate Fellowships

2014: Journal of Solar Energy Engineering (2 articles), Wind Energy, Optimization & Engineering, Renewable Energy, Journal of Mechanical Design, Aerospace Science and Technology, Journal of Guidance, Control, and Dynamics, ASME Turbo Exposition, BYU ORCA Grant Proposals

2013: Wind Energy (4 articles), Renewable Energy (2 articles), The Science of Making Torque from Wind (2 articles), Journal of Defense Modeling and Simulation, Journal of Ocean and Wind Energy

2012: Wind Energy (3 articles), Journal of Solar Energy Engineering

2010: Journal of Aircraft

University Service

Faculty Advisor, BYU American Institute of Aeronautics and Astronautics Chapter, 2016–present.

Coursework Committee Lead, Department PhD Working Group, 2016–present.

Member, Department Graduate Committee, 2015–present.

Member, Mechanics of Materials PhD Qualifying Examination Committee, 2015–present.

Reviewer, BYU Graduate Fellowships, 2015.

Reviewer, BYU ORCA Grant Proposals, 2014, 2015, 2016.

Courses Taught

ME EN 372, Mechanical System Design Fundamentals, Fall 2014, Fall 2016

ME EN 412, Applications of Fluid Dynamics, Fall 2015, Fall 2016

ME EN 575, Optimization Techniques in Engineering, Winter 2015, Winter 2016

Capstone Coach (ME 475–476), Fall 2015–Winter 2016

Student Advisement

Graduate Students Advised

Barrett, Ryan, “Investigation into Integrated Free-Form and Precomputational Approaches for Aerostructural Optimization of Wind Turbine Blades,” MS Thesis, Brigham Young University, July 2016 (thesis defended, currently in MBA program).

Current Graduate Students

Stanley, P.J., PhD Dissertation in progress, Brigham Young University.

McDonnell, Taylor, PhD Dissertation in progress, Brigham Young University.

Mehr, Judd, PhD Dissertation in progress, Brigham Young University.

Gagakuma, Bertelsen, PhD Dissertation in progress, Brigham Young University.

Tingey, Eric, MS Thesis in progress, Brigham Young University.

Thomas, Jared, MS Thesis in progress, Brigham Young University.

Moore, Kevin, MS Thesis in progress, Brigham Young University.

Ingersoll, Bryce, MS Thesis in progress, Brigham Young University.