

# Gary K. Nave, Jr.

Engineering Science and Applied Mathematics  
Northwestern University

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Postdoctoral Scholar

## Appointments

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2020-pres **Postdoctoral Scholar**, *Engineering Science and Applied Mathematics*, Northwestern University.

Supervisor: Daniel Abrams

Research focus: I am currently studying the time dynamics of reported pain by individuals with Sickle Cell Disease. The work involves data-driven mechanistic models as well as machine learning approaches to predict the changes in pain over time.

2018-2020 **Postdoctoral Associate**, *Biofrontiers Institute*, University of Colorado Boulder.

Supervisor: Orit Peleg

Research focus: In this position, I studied the collective behavior of insects, both in honey bees and fire ants. The work involved both experimental research with honey bees and agent-based modeling methods to investigate the underlying decisions that lead to observed behaviors.

## Education

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July 2018 **Ph.D. Engineering Mechanics**, *Virginia Tech*, Blacksburg, VA.

Dissertation: *Nonlinear models and geometric structure of fluid forcing on moving bodies*

Advisors: Shane Ross and Mark Stremler

Committee: Jake Socha, Nicole Abaid, and Craig Woolsey

Research focus: In my graduate work, I focused on flow induced vibration of tandem cylinders and the dynamics of passive descent, including gliding animals. I also developed methods to detect regions of attraction and repulsion in dynamical systems and fluid flows. I conducted this research through an NSF-funded interdisciplinary research program focused on biological transport, which has exposed me to problems in biology and allowed me to collaborate with biologists working in similar areas.

### Preparing the Future Professoriate Graduate Certificate.

This program, developed by Dean Karen DePauw of Virginia Tech, is designed to prepare graduate students for a faculty career. The program features coursework on contemporary pedagogical practices and issues in higher education. Additionally, I visited 10 universities in Europe and Ecuador to gain a more global perspective on higher education.

2012 **B.S. Engineering Science and Mechanics**, *Virginia Tech*, Blacksburg, VA.

Minor: Mathematics

## Publications and Presentations

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### Journal Articles

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Nave Jr., Gary K., Nathaniel Hall, Katrina Somers, Brock Davis, Hope Gruszewski, Craig Powers, Michael Colver, David G. Schmale III, and Shane D. Ross (2021a).

“Wind dispersal of natural and biomimetic maple samaras”. In: *Biomimetics* 6.2, p. 23.

Nave Jr., Gary K., Nelson T. Mitchell, Jordan A. Chan Dick, Tyler Schuessler, Joaquin A Lagarrigue, and Orit Peleg (2020). “Attraction, Dynamics, and Phase Transitions in Fire Ant Tower-Building”. In: *Frontiers in Robotics and AI* 7, p. 25.

- Nave Jr., Gary K.**, Peter J. Nolan, and Shane D. Ross (2019). “Trajectory-free approximation of phase space structures using the trajectory divergence rate”. In: *Nonlinear Dynamics* 96.1, pp. 685–702.
- Nave Jr., Gary K.** and Shane D. Ross (2019). “Global phase space structures in a model of passive descent”. In: *Communications in Nonlinear Science and Numerical Simulation* 77, pp. 54–80.
- Chang, Brian, **Gary K. Nave Jr.**, and Sunghwan Jung (2012). “Drop formation from a wettable nozzle”. In: *Communications in Nonlinear Science and Numerical Simulation* 17.5, pp. 2045–2051.

### **Peer-reviewed Conference Proceedings**

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- Padhee, Swati, Amanuel Alambo, Tanvi Banerjee, Arvind Subramaniam, Daniel M. Abrams, **Gary K. Nave Jr.**, and Nirmish Shah (2021). “Pain Intensity Assessment in Sickle Cell Disease Patients Using Vital Signs During Hospital Visits”. In: *International Conference on Pattern Recognition*. Springer, pp. 77–85.
- Nave Jr., Gary K.**, Amy L. Hermundstad, Chelsea Corkins, Emily Garner, Jeena R. Jayamon, Mohammed Seyam, Michael Stewart, Michele Waters, and Karen P. DePauw (June 2017). “Global perspectives: graduate students’ experiences with global higher education”. In: The American Society of Engineering Education annual conference. Columbus, Ohio.
- Nave Jr., Gary K.**, Mark Stremmer, and Shane D. Ross (Aug. 2016). “Wake stiffness and its application: oscillating cylinders and flying snakes”. In: *Proceedings of the 24th International Congress on Theoretical and Applied Mechanics (ICTAM)*. Montreal, Canada.

### **Preprint available**

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- Nave Jr., Gary K.**, Swati Padhee, Amanuel Alambo, Tanvi Banerjee, Nirmish Shah, and Daniel M. Abrams (2021b). *Clustering of Pain Dynamics in Sickle Cell Disease from Sparse, Uneven Samples*. arXiv preprint arXiv:2018.13963.

### **In preparation**

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- Nave Jr., Gary K.**, Raphael Sarfati, and Orit Peleg. “The surface tension of honey bee swarms”. In preparation.
- Nave Jr., Gary K.**, Olga Shishkov, and Orit Peleg. “The dynamics of honey bee swarm formation”. In preparation.
- Nave Jr., Gary K.** and Mark A. Stremmer. “Wake stiffness as a nonlinear spring”. In preparation.

### **Invited Talks**

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- Nov 2020 **Mathematical Biology Class (open to department)**, *The College of New Jersey*.
- June 2020 **Engineering Sciences and Applied Mathematics**, *Northwestern University*.
- Apr 2019 **Applied Math Seminar**, *University of Pittsburgh*.
- Oct 2018 **Complex/Dynamical Systems Seminar**, *University of Colorado Boulder*.
- Sept 2017 **Math Biology Seminar**, *Virginia Tech*.

## Conference Presentations

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- Nave Jr., Gary K.**, Hadley Tallackson, and Orit Peleg (Jan. 2020a). *Modeling decision-making in fire ant tower and honey bee swarm formation*. Denver, Colorado: Presented at the Joint Math Meetings 2020.
- (Jan. 2020b). *The Formation of Honey Bee Swarms*. Austin, Texas: Presented at the Society for Integrative and Comparative Biology Annual Meeting.
- Nave Jr., Gary K.** and Orit Peleg (June 2019). *Coming together to climb higher: agent-based modeling of fire ant tower building*. Atlanta, Georgia: Presented at the American Chemical Society Colloids and Surface Science meeting.
- (Dec. 2018). *The surface tension of honey bee swarms*. Philadelphia, Pennsylvania: Presented at the Social Insects in the Northeast Regions meeting.
- Nave Jr., Gary K.** and Shane D. Ross (Jan. 2018). *Slow manifolds in the aerodynamic descent of animals and plants*. Denver, Colorado: Poster and short talk presented at Dynamics Days 2018.
- Nave Jr., Gary K.** (Nov. 2017). *Understanding gliding flight with the terminal velocity manifold*. Blacksburg, Virginia: Presented at the southeast regional Society of Integrative and Comparative Biology meeting.
- Nave Jr., Gary K.** and Shane D. Ross (May 2017). *Phase space structures in velocity space for gliding and falling bodies*. Mini-symposium: Recent advances in characterization of nonautonomous dynamical transport. Snowbird, Utah: Presented at the Society of Industrial and Applied Mathematics Dynamical Systems Meeting.
- Yeaton, Isaac J., Grant A. Baumgardner, Talia M. Weiss, **Gary K. Nave Jr.**, Shane D. Ross, and John J. Socha (2016). *Snakes in a Cube: high-resolution kinematics of gliding in flying snakes*. Presented at the Society for Integrative and Comparative Biology. Portland, OR.
- Nave Jr., Gary K.** and Mark Stremler (2015). *Regimes of flow induced vibration for tandem, tethered cylinders*. Presented at the 68th Annual American Physical Society Division of Fluid Dynamics Meeting. Boston, MA.
- Yeaton, Isaac J., Grant A. Baumgardner, Talia M. Weiss, **Gary K. Nave Jr.**, Shane D. Ross, and John J. Socha (2015). *What's its wave? A 3D analysis of flying snake locomotion*. Presented at the 68th Annual American Physical Society Division of Fluid Dynamics Meeting. Boston, MA.
- Nave Jr., Gary K.**, Tyler Michael, Pavlos Vlachos, and Mark Stremler (2014). *Flow-induced oscillations of tandem tethered cylinders in a channel flow*. Presented at the 67th Annual American Physical Society Division of Fluid Dynamics Meeting. San Francisco, CA.

## Teaching Experience

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### Guest Lecturing

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#### **Dynamical Models in Biology, CSCI 4314/5314, University of Colorado Boulder**

A combined undergraduate/graduate course in the Computer Science department.

**Spring 2020** I developed and taught 6 class sessions throughout the semester, and helped plan the course topics. I taught topics including Markov chains in cancer modeling, animal locomotion, cellular automata and pattern formation, and collective behavior.

**Spring 2019** I taught one class session, providing an introduction to modeling with differential equations and their behavior in phase space, using the example of the gliding behavior of flying snakes.

#### **Advanced Dynamics, ESM 6314, Virginia Tech**

A PhD-level survey course on advanced research in dynamical systems.

Taught a two-lecture series providing an introduction to the theory of smooth manifolds, including the tangent bundle, Lie groups and Lie algebras, and their relevance to the study of dynamics.

#### **Dynamics, ESM 2304, Virginia Tech**

Sophomore-level introductory engineering course.

I taught two guest lectures for a sophomore-level dynamics course. The first lecture was an introduction to the impulse-momentum equations and the dynamics of collisions. The second lecture was an introduction to rigid body rotation about a fixed axis and the parallel axis theorem.

#### **Foundations of Engineering II, ENGE 1216, Virginia Tech**

Freshman-level foundations of engineering course.

I gave guest lectures on two occasions, discussing the Engineering Science and Mechanics major at Virginia Tech and my own research, highlighting potential opportunities in engineering for undergraduate students.

### Workshops

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#### **Introduction to Agent-Based Modeling with Python**

Developed a workshop to provide a basic introduction to agent-based modeling in Python for the Quantitative Exploration and Discussion Supergroup. Offered in Spring 2020. Available at [github.com/gknave/Python\\_Intro](https://github.com/gknave/Python_Intro).

#### **Intermediate Python**

Developed a workshop to introduce fellow postdocs to practical tools for scientific research using Python. Materials available at [github.com/gknave/Python\\_Intro](https://github.com/gknave/Python_Intro).

#### **Introduction to Python**

Developed a workshop to provide a basic introduction to programming in Python for fellow postdocs. Offered in both Spring 2019 and Fall 2019. Available at [github.com/gknave/Python\\_Intro](https://github.com/gknave/Python_Intro).

#### **L<sup>A</sup>T<sub>E</sub>X Workshop**

Developed a workshop, offered twice, to provide fellow graduate students with an introduction to L<sup>A</sup>T<sub>E</sub>X, a document preparation software.

## Research Advising and Mentorship

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### **M.Eng. students**

Nathaniel Hall

### **Senior design teams**

Optimization of spacing for wake energy harvesting (2019-2020)

Flow-induced vibration energy harvester (2014-2015)

### **High school teachers**

Michael Collver

### **Undergraduate students**

Emily Walker

Aubrey Kroger

Hadley Tallackson

Brock Davis

Katrina Somers

Doug Stepp

Josam Waterman

Billy Ermlick

### **2019 CU Science Discovery program**

Mentored a team of 3 high school students to experimentally study the movement of individual honey bees under different temperature conditions. Helped the students conduct, analyze, and visualize experiments.

## Awards & Recognition

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2018 Dynamics Days 2018 Student Travel Award

### **2017 Virginia Tech Outstanding Graduate Student Leader.**

Nominated by the faculty of my department and peers and was selected to win this award through the Virginia Tech University Student Leader Awards. Granted on the basis of my leadership through organization and service to the University community.

2017 SIAM Student Travel Award

2014 NSF IGERT traineeship, MultiSTEPS

2014 Virginia Tech College of Engineering Outstanding M.S. Student

2014 Manuel Stein Scholarship

2010 Ken and Loretta Reifsneider Scholarship

## Professional Development

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Aug. 2019 **Evidence-Based Introduction to Teaching**, *Boulder, CO*.

This week-long workshop was offered by the Center for the Integration of Research, Teaching, and Learning. In the course, participants learned about active teaching techniques, discussed discipline-based education research, and put new ideas into practice by developing a microteaching module.

- Mar. 2018 **Critical Transitions in Complex Systems Winter School: Mathematical Theory and Applications**, *Wöltingerode, Germany*.  
This event is part of the activities of the “Critical Transitions in Complex Systems” Marie Curie Initial Training Network bringing together scientists and mathematicians to progress the understanding of critical transitions in complex systems ranging from ecology and climate to economic theory. Discussions covered slow-fast systems, stochastic differential equations, and equation-free detection of attracting manifolds.
- June 2017 **SHIFT 21st Century Faculty Institute**, *Blacksburg, VA*.  
Helped organize and participated in a week-long faculty development program at Virginia Tech with visiting faculty members from Universidad San Francisco de Quito.
- Nov. 2016 **Global Perspectives Program**, *Ecuador*.  
The global perspectives program is a selective program run by Dean DePauw of the graduate school at Virginia Tech. Through this program, I was selected as one of five Virginia Tech graduate students to visit Universidad San Francisco de Quito and Escuela Politecnica Nacional to help form partnerships with these universities.
- June 2016 **Global Perspectives Program**, *Switzerland, France, and Italy*.  
The global perspectives program is a selective program run by Dean DePauw of the graduate school at Virginia Tech. The program consists of two weeks of visiting higher education institutions primarily in Switzerland. Our group visited a total of 8 universities of varying size and emphasis and had a number of conversations with students, staff, and faculty about the future of higher education in Europe and around the world.
- 2014 **VTKnowledgeWorks Tech Transfer Challenge**, Finalist.  
Led a team pitching “Hydrokinetic Energy Systems” that was a finalist in the Tech Transfer Challenge, an entrepreneurial pitch competition for technology transfer from the research lab to the market.
- 2014 **ACC Clean Energy Challenge**, *University of Maryland*, Semi-finalist.  
Led a team selected as a semi-finalist in the ACC Clean Energy Challenge, a competition for schools across the Southeast United States. Our project was entitled “enVIV: Energy from Vortex Induced Vibration”
- 2013 **Ambassador Leadership Forum**, *Eastman Chemical Company*.  
Facilitated a collaborative partnership between the Virginia Tech College of Engineering and Eastman Chemical Company. As a result of this collaboration, Eastman invited myself and a group of student ambassadors under my supervision to participate in this leadership development forum.

## Work Experience

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- 2016-2018 **Graduate Research Assistant**, *BioTrans Program*, Virginia Tech.  
Virginia Tech Graduate School funded interdisciplinary research assistantship. Under this funding, I worked to understand the underlying mechanics of falling and gliding objects, such as animal gliders.
- 2014-2016 **Graduate Research Assistant**, *MultiSTEPS Program*, Virginia Tech.  
NSF-funded interdisciplinary research assistantship focused on material transport at the boundary between biologists and engineers. In the first year of the program, I conducted research projects with 3 different advisors in different fields to develop as an interdisciplinary researcher and took courses in engineering, biology, and interdisciplinary grant writing.
- 2012-2014 **Director of Undergraduate Recruiting**, *College of Engineering*, Virginia Tech.  
Coordinated all recruiting activities for the College of Engineering. Led the Dean’s Team, a group of 38 undergraduate students who aid in recruiting activities. Planned and coordinated the annual Engineering Open House for over 1,000 visitors each year. Presented daily to prospective undergraduate students.

## Service

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- 2019-2020 **Advisory Board Member**, Postdoctoral Association of Colorado (PAC) Boulder
- 2016-2018 **Founder and President**, Virginia Tech Graduate Engineering Mechanics Society
  - 2017 **Director of Programs**, Graduate Student Assembly (GSA)
- 2016-2017 **Mentor**, Virginia Tech Early Engineering Mentoring Program
  - 2016 **Funding Programs Chair**, Graduate Student Assembly (GSA)
- 2015-2017 **Mentor**, Graduate Undergraduate Mentoring Program
- 2014-2017 **Delegate**, Graduate Student Assembly
- 2015-2016 **Member**, GSA Committee on Graduate Inclusion and Diversity Policies
  - 2015 **Member**, Virginia Tech Graduate Student of the Year Selection Committee
- 2014-2015 **Advisor**, Undergraduate Senior Design team
- 2012-2016 **Mentor**, Student Transition to Engineering Program