


Jake Welde

Assistant Professor
Sibley School of Mechanical and Aerospace Engineering
Cornell University


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I develop geometric abstractions for efficient and explainable control of complex robotic systems. Using applied mathematics, optimization, and machine learning, my work exploits structural characteristics like symmetry, compositionality, and mechanical structure to design and certify algorithms that scale gracefully with system complexity. Such methods transcend individual morphologies and inform mechanism and controller design, leading towards robots that more faithfully echo the incredible example of Nature.

APPOINTMENT

Assistant Professor, Sibley School of Mechanical and Aerospace Engineering 2025 - present
Cornell University *Ithaca, NY*
Field member in Mechanical Engineering, Aerospace Engineering, Theoretical and Applied Mechanics, and Applied Mathematics.

EDUCATION

Doctor of Philosophy, Mechanical Engineering and Applied Mechanics 2025
University of Pennsylvania, General Robotics, Automation, Sensing, and Perception (GRASP) Laboratory *Philadelphia, PA*
Advisor: Vijay Kumar **Thesis Committee:** Daniel Koditschek, Michael Posa, Muruhan Rathinam, and Jim Ostrowski
Thesis: “[Geometric Methods for Efficient and Explainable Control of Underactuated Robotic Systems](#)” 
Certificate in College and University Teaching, *Center for Excellence in Teaching, Learning and Innovation*.

Master of Science in Engineering, Robotics 2020
University of Pennsylvania *Philadelphia, PA*

Bachelor of Science in Engineering, Mechanical Engineering and Applied Mechanics, magna cum laude 2019
University of Pennsylvania *Philadelphia, PA*
Minor in French and Francophone Studies. *Activities:* Underground Shakespeare Company

HONORS AND AWARDS

RSS Pioneers Cohort Member, *Robotics: Science and Systems* 2024
Selected as 1 of 30 of the “world’s top early-career researchers” in robotics for an intensive career workshop (15% acceptance rate).

John A. Goff Prize, Mechanical Engineering and Applied Mechanics, *University of Pennsylvania* 2024
This prize is “awarded annually to a graduate student in the Department of Mechanical Engineering and Applied Mechanics who has been selected by the faculty on the basis of criteria of scholarship, resourcefulness, and leadership” (1-2 PhD students per year).

Best Contribution, Neuroscience & Interpretability Track, *NeurReps Workshop @ NeurIPS 2024* 2024

Student Travel Support Award, *IEEE Conference on Decision and Control (CDC)* 2024

Outstanding Teaching Assistant Award, Mechanical Engineering and Applied Mechanics, *University of Pennsylvania* 2021

Best Paper Finalist (Unmanned Aerial Vehicles), *IEEE International Conference on Robotics and Automation (ICRA)* 2021

National Science Foundation Graduate Research Fellowship 2019

Second Place, School of Engineering Senior Design Competition, *University of Pennsylvania* 2019

Couloucoundis Prize for Best Presentation, Mechanical Engineering Senior Design, *University of Pennsylvania* 2019

Student Travel Grant Award, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* 2017

PUBLICATIONS

PREPRINTS

1. “A Weak Notion of Symmetry for Dynamical Systems”,
Jake Welde and Pieter van Goor.
Preprint, 2026.

JOURNAL ARTICLES

1. “Almost Global Asymptotic Trajectory Tracking for Fully-Actuated Mechanical Systems on Homogeneous Riemannian Manifolds”,
Jake Welde and Vijay Kumar.
IEEE Control Systems Letters (L-CSS), 2024.
2. “A Compositional Approach to Certifying Almost Global Asymptotic Stability of Cascade Systems”,
Jake Welde, Matthew D. Kvalheim, and Vijay Kumar.
IEEE Control Systems Letters (L-CSS), 2023.
3. “Dynamically Feasible Task Space Planning for Underactuated Aerial Manipulators”,
Jake Welde, James Paulos, and Vijay Kumar.
IEEE Robotics and Automation Letters (RA-L), 2021.
Best Paper Finalist (Unmanned Aerial Vehicles) at ICRA 2021.
4. “Autonomous Flight for Detection, Localization, and Tracking of Moving Targets With a Small Quadrotor”,
Justin Thomas, Jake Welde, Giuseppe Loianno, Kostas Daniilidis, and Vijay Kumar.
IEEE Robotics and Automation Letters (RA-L), 2017.

REFEREED CONFERENCE PROCEEDINGS

1. “Scalable Distributed Nonlinear Control Under Flatness-Preserving Coupling”,
Fengjun Yang, Jake Welde, and Nikolai Matni.
American Control Conference (ACC), 2026.
2. “Learning Flatness-Preserving Residuals for Pure-Feedback Systems”,
Fengjun Yang, Jake Welde, and Vijay Kumar.
IEEE Conference on Decision and Control (CDC), 2025.
3. “Leveling the Playing Field: Carefully Comparing Classical and Learned Controllers for Quadrotor Trajectory Tracking”,
Pratik Kunapuli, Jake Welde, Dinesh Jayaraman, and Vijay Kumar.
Robotics: Science and Systems (RSS), 2025.
4. “Leveraging Symmetry to Accelerate Learning of Trajectory Tracking Controllers for Free-Flying Robotic Systems”,
Jake Welde*, Nishanth Rao*, Pratik Kunapuli*, Dinesh Jayaraman, and Vijay Kumar.
IEEE International Conference on Robotics and Automation (ICRA), 2025.
**equal contribution.*
5. “The Role of Symmetry in Constructing Geometric Flat Outputs for Free-Flying Robotic Systems”,
Jake Welde, Matthew D. Kvalheim, and Vijay Kumar.
IEEE International Conference on Robotics and Automation (ICRA), 2023.
6. “Trajectory Planning for the Bidirectional Quadrotor as a Differentially Flat Hybrid System”,
Katherine Mao, Jake Welde, M. Ani Hsieh, and Vijay Kumar.
IEEE International Conference on Robotics and Automation (ICRA), 2023.
7. “Coordinate-Free Dynamics and Differential Flatness of a Class of 6DOF Aerial Manipulators”,
Jake Welde and Vijay Kumar.
IEEE International Conference on Robotics and Automation (ICRA), 2020.

PRESENTATIONS

INVITED TALKS

1. **“Geometric Abstractions for Efficient and Explainable Control of Complex Robotic Systems”**,
Safe Autonomous Systems Lab (Sylvia Herbert), UC San Diego, 2025.
2. **“Almost Global Asymptotic Trajectory Tracking for Fully-Actuated Mechanical Systems on Homogeneous Riemannian Manifolds”**,
Colloquium, Center for Applied Mathematics, Cornell University, 2025.
3. **“Geometric Methods for Efficient and Explainable Control of Underactuated Robotic Systems”**,
Robotics Seminar, Department of Computer Science, Cornell University, 2025.
4. **“Geometric Abstractions for Efficient and Explainable Control of Complex Aerial Robots”**, 2025.
 - University of Texas at Dallas, *Department of Systems Engineering*
 - Arizona State University, *School of Manufacturing Systems and Networks*
 - Villanova University, *Department of Mechanical Engineering*
 - Boston University, *Department of Mechanical Engineering*
 - Cornell University, *Sibley School of Mechanical and Aerospace Engineering*
 - North Carolina State University, *Department of Electrical and Computer Engineering*
 - University of Minnesota, *Department of Aerospace Engineering and Mechanics*
 - Colorado State University, *Department of Mechanical Engineering*
 - Massachusetts Institute of Technology, *Department of Electrical Engineering and Computer Science*
 - Massachusetts Institute of Technology, *Department of Mechanical Engineering*
5. **“Plenty of Room in the Middle: Towards Efficient and Explainable Control of Complex Robotic Systems via Symmetry, Abstraction, and Learning”**,
Robotics and Optimization for Analysis of Human Motion Lab (Ram Vasudevan), University of Michigan, 2024.
6. **“Differential Flatness and Geometric Hierarchy in Underactuated Mechanical Systems with Symmetry”**,
Joint Mathematics Meetings, 2024.
7. **“Geometric Control of Underactuated Robotic Systems: Flatness, Hierarchy, and Control-Aware Design”**,
Nikolai Matni Group, University of Pennsylvania, 2023.
8. **“The Role of Symmetry in Constructing Geometric Flat Outputs for Free-Flying Robotic Systems”**,
Kostas Daniilidis Group, University of Pennsylvania, 2022.

OTHER TALKS

1. **“Lie Group Symmetries and Continuous MDP Homomorphisms in Optimal Tracking Control Problems”**,
Joint Mathematics Meetings, 2025.
2. **“Almost Global Asymptotic Trajectory Tracking for Mechanical Systems on Homogeneous Spaces”**,
Joint Mathematics Meetings, 2025.
3. **“Geometric Tracking Control on Homogeneous Riemannian Manifolds”**,
Northeast Systems and Controls Workshop, 2024.
4. **“A Compositional Approach to Certifying Almost Global Asymptotic Stability of Cascade Systems”**,
Compositional Robotics Workshop, International Conference on Robotics and Automation (ICRA), 2023.
5. **“A Principal Bundle Perspective on Differential Flatness in Complex Robotic and Biological Systems”**,
Robophysic Focus Session, APS March Meeting, 2023.
6. **“A Geometric Perspective on Differential Flatness of Mechanical Systems with Symmetry”**,
SIAM Conference on Control and Its Applications, 2023.
7. **“Hierarchical Methods for Geometric Control of Underactuated, Free-Flying Robotic Systems”**,
Mechanical Engineering and Applied Mechanics Seminar, University of Pennsylvania, 2023.

POSTERS

1. “**Learning Flatness-Preserving Residuals for Pure-Feedback Systems**”,
Fengjun Yang, Jake Welde (presenter), and Nikolai Matni.
Structured Learning Workshop, International Conference on Robotics and Automation (ICRA), 2025.
2. “**Geometric Methods of Systematic Controller Synthesis for Underactuated Robotic Systems**”,
Jake Welde.
RSS Pioneers Workshop, Robotics: Science and Systems, 2024.
3. “**Integrated Hardware and Software Codesign for Controlling Underactuated Aerial Robots**”,
Jack Campanella (presenter), Jake Welde, and Vijay Kumar.
Northeast Systems and Control Workshop, 2024.
4. “**Towards a Lightweight Fully-Actuated Aerial Vehicle: Thrust Vectoring and Control Allocation Under Redundancy**”,
Saibernard Yogendran (presenter), Jake Welde, and Vijay Kumar.
Northeast Systems and Control Workshop, 2024.
5. “**Leveraging Symmetry to Accelerate Learning of Trajectory Tracking Controllers for Free-Flying Robotic Systems**”,
Jake Welde*, Nishanth Rao* (presenter), Pratik Kunapuli* (presenter), Dinesh Jayaraman, and Vijay Kumar.
Symmetry and Geometry in Neural Representations Workshop, Conference on Neural Information Processing Systems, 2024.
Best Contribution (Neuroscience & Interpretability Track) at NeurReps 2024. *equal contribution.
6. “**Towards Automatic Identification of Globally Valid Geometric Flat Outputs via Numerical Optimization**”,
Jake Welde and Vijay Kumar.
Geometric Representations Workshop, International Conference on Robotics and Automation, 2023.
7. “**Some Aerial Manipulators Can Exactly Track Arbitrary Smooth End-Effector Trajectories in 6 Degrees of Freedom**”,
Jake Welde and Vijay Kumar.
Northeast Robotics Colloquium, 2019.

MEDIA

- “Exploring the Interplay of Math and Machines” [↗](#), *Cornell Duffield Engineering* 2025
- “Robots in the Reading Room: GRASP Lab Brings Hands-On STEM to Roxborough Library” [↗](#), *Penn Engineering Today* 2025
- “MEAM 520 Class Breakdown” [↗](#), *GRASP Lab Presents* 2022
- “Virtual Robots: Taking Risks in an Online Classroom” [↗](#), *Penn Engineering Today* 2021
- “Game of Drones” [↗](#), *National Geographic’s “Breakthrough”* 2017
- “Penn Students Create Gingerbread Replica of Fisher Fine Arts Library” [↗](#), *34th Street Magazine* 2017

TEACHING

- MAE 2030: Dynamics**, Cornell University Fall 2025
Instructor of Record
- MEAM 520: Introduction to Robotics**, University of Pennsylvania Fall 2020 / Fall 2021
Head Teaching Assistant for Prof. Cynthia Sung and Prof. M. Ani Hsieh
- CIT 520: Introduction to Robotics**, University of Pennsylvania (online) Spring 2021
Teaching Assistant for Prof. Vijay Kumar
- MEAM 211: Engineering Mechanics - Dynamics**, University of Pennsylvania Spring 2021
Head Teaching Assistant for Prof. Michael Posa

MENTORING

DOCTORAL STUDENTS

- Pratik Kunapuli, University of Pennsylvania, Computer and Information Science 2024
“Benchmarking Controllers for Agile Aerial Manipulators”
- Katie Mao, University of Pennsylvania, Mechanical Engineering 2022
“Trajectory Planning for the Bidirectional Quadrotor as a Differentially Flat Hybrid System”

MASTERS STUDENTS

- Nishanth Rao, University of Pennsylvania, Robotics (now a PhD student at Princeton) 2024 - 2025
“Exploring Symmetries and Equivariance in Robot Learning” (Masters Thesis in Robotics)
- Jack Campanella, University of Pennsylvania, Robotics (now at Vertiq) 2023 - 2025
“Integrated Hardware and Software Codesign for Controlling Underactuated Aerial Robots” (Masters Thesis in Robotics)
- Saibernard Yogendran, University of Pennsylvania, Robotics (now at ASML) 2022 - 2024
“Towards a Lightweight Fully-Actuated Aerial Vehicle: Thrust Vectoring and Control Allocation Under Redundancy”

UNDERGRADUATE STUDENTS

- Audrey Ho, Cornell University 2025 - present
Design of a Gimbal Test Rig for Aerial Vehicle Attitude Control
- Jonathan Song, Cornell University 2025 - present
Sensor Integration and Motor Control for Aerial Robot Design
- Andre Boufama, Ollie Aizer, Ronan Alo, and Lindsay Kossoff, Cornell University 2025 - present
Hybrid Control Architectures for Advanced Aerial Vehicle Development
(This project is supported by an Undergraduate Research Award from the Office of Inclusive Excellence.)
- Eshan Singhal, University of Pennsylvania, Computer Engineering and Physics 2024 - 2025
“Control of an Agile Quadrotor Aerial Vehicle with Articulated Propellers”
- Nicole Luna, Cal Poly Pomona, Mechanical Engineering and Physics (now a PhD Student at CU Boulder) Summer 2021
“Aerial Manipulator Mechanical Design”
- Natasha Dilamani, University of Pennsylvania, Mechanical Engineering (now at Millenium) Summer 2020
“Dynamic Modeling of the Sphero, a Highly Nonholonomic System”

SERVICE

EDITORIAL SERVICE

- **Area Chair**, *Robotics: Science and Systems (RSS)* 2026
- **Associate Editor**, *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* 2026

WORKSHOP ORGANIZATION

“Geometry in the Age of Data-Driven Robotics” 2026
IEEE International Conference on Robotics and Automation (ICRA)

Organizers: Riddhiman Laha, Tobias Löw, and Jake Welde

“Equivariant Systems: Theory and Applications in State Estimation, Artificial Intelligence and Control” 2025
Robotics: Science and Systems (RSS)

Organizers: Stephan Weiss, Jake Welde, Maani Ghaffari, and Robert Mahony

“RSS Pioneers” (Early-Career Workshop) 2025
Robotics: Science and Systems (RSS)

Organizers: [link](#)  **Faculty Chairs:** Jake Welde, Frederike Dümbgen, and Yunlong Song

“Equivariant Robotics: The Role of Symmetry Across Perception, Estimation, and Control” 2024
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

Organizers: Jake Welde, Pieter van Goor, Yinshuang Xu, Rui Wang, Evangelos Chatzipantazis, Christine Allen-Blanchette, Kostas Daniilidis, and Vijay Kumar

REVIEW ACTIVITIES

- International Journal of Robotics Research (IJRR)
- IFAC Automatica
- IEEE/ASME Transactions on Mechatronics (TMECH)
- IEEE Control Systems Letters (L-CSS)
- Springer Autonomous Robots
- IEEE Robotics and Automation Letters (RA-L)
- ASME Journal of Dynamic Systems, Measurement and Control
- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE Transactions on Robotics (T-RO)
- Robotics: Science and Systems (RSS)
- IEEE Transactions on Automatic Control (TAC)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- IEEE International Conference on Automation Science and Engineering (CASE)

DEPARTMENTAL SERVICE

- **GRASP “Students, Faculty, and Industry” Seminar**, Organizing Committee Member 2023 - 2025
- **Mechanical Engineering Graduate Association**, Treasurer 2020 - 2021


DISSERTATION COMMITTEE SERVICE

- **Jovan Menezes**, Mechanical Engineering Cornell University
- **Chuwei Wang**, Mechanical Engineering Cornell University
- **Noa Kaplan**, Computer Science Cornell University
- **Fengjun Yang**, Computer and Information Science University of Pennsylvania
- **Pratik Kunapuli**, Computer and Information Science University of Pennsylvania

OUTREACH

- **Cornell University Physical Intelligence (CUPI)**, Faculty Advisor 2025 - present
- **Science Olympiad at the University of Pennsylvania**, Event Supervisor and Placement Leader 2017 - 2025
- **“Fun with Robots” Outreach Programming**, Roxborough Library, Free Library of Philadelphia 2024

FUN FACTS

My Erdős number  is at most 3 (Jake Welde ↔ Kostas Daniilidis ↔ Pavel Valtr ↔ Paul Erdős).

In my free time, I love spending time in Nature, cooking spicy food, and playing fetch with my very energetic dog Sprout.