

Purdue University Black Trailblazers in Engineering – Cover Letter – Darius Carter

1512 Rosa Terrace
Charlottesville, VA 22902

January 10, 2021

BTE Committee
Purdue University
West Lafayette, IN 47907

Dear Members of the BTE Committee,

I am writing to apply for the Black Trailblazers in Engineering program at Purdue University. I am currently a doctoral student at the University of Virginia and expect to complete my Ph.D. degree requirements by July, 2021. I am interested in continuing my academic as a faculty member at a research-intensive university. Black Trailblazer will put me in the position to achieve my research goals, develop professionally, and positively impact the minority community.

I have been growing my aerodynamics and fluid mechanics expertise for the past six years at the University of Virginia. My dissertation research with Dr. Daniel Quinn was studying near-boundary effects on Unmanned Aerial Vehicles (UAVs). In my research, we analyzed both the benefits and destabilizing effects attributed to near boundary flight. I conducted empirical flow field analysis on rotor systems near solid and water boundaries. This work will provide more understanding of near boundary flight dynamics, leading to more accurate control methods and UAV designs.

As a future faculty, I plan to expand my dissertation research into general experimental fluids UAV analysis research. I plan to leverage resources and partner with collaborators at Texas A&M to explore ways of testing fluid flows surrounding UAVs and their flight dynamics. I will study how the inertial measurement units respond to turbulent gusts. I will investigate the effect turbulent gusts have on rotor performance and examine flow interactions between multiple unmanned aerial vehicles.

Diversity and inclusion have been a core component of my identity as a black mechanical engineer. Being one of a few black people in my engineering program has fueled my passion for inclusion in STEM spaces. I have been a leader of many different organizations, explicitly addressing underrepresented students' issues, as detailed in my diversity statement. As a faculty member, I will continue my efforts to achieve equity for minority engineering students. I plan on working with my future school's diversity office on minority intervention efforts.

I have enclosed my curriculum vitae and my research and education plan. My recommender has been notified and is prepared to supply my letter of recommendation once requested. If you require any additional materials or information, I would be delighted to send it. Thank you very much for your consideration.

Sincerely,
Darius Carter

Darius J. Carter

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[LinkedIn](#)

[Google Scholar](#)

Research Interests

Fluid Mechanics, Aerodynamics, Green Energy, Drone Flight Stability, & Fluid-Structure Interaction

Education

2017 – Present PhD Candidate, Mechanical and Aerospace Engineering, University of Virginia
2013 – 2017 BS, Mechanical Engineering, Minor: Material Science, University of Virginia

Teaching Experience

2020 Teaching Assistant – MAE 3210 Fluid Mechanics
2020 Engineering Program Director Workshop Series for BRIDGE 2020
- Taught over 50 incoming undergraduate engineering students
- Designed and executed three weeks of programming

Research Experience

2017 – Present Graduate Researcher on Near-Boundary Flow Phenomena in Unmanned Aerial/Underwater Vehicles, [Smart Fluid Systems](#) & [Link Lab](#), University of Virginia
2016 – 2017 Research Assistant, [Fluid Research and Innovation Laboratory](#), University of Virginia
2016 Research Assistant, [Bio-Inspired Engineering Research Laboratory](#), University of Virginia

Fellowships & Awards

2019 Professional Development Award sponsored by the Office of Graduate and Postdoctoral Affairs Diversity Programs at University of Virginia

- 2019 [Raven Honor Society](#) at the University of Virginia
- 2018 University of Virginia School of Engineering & Applied Sciences [Dean Scholar Fellowship](#)
- 2018 [National GEM Consortium](#) – University Fellow
- 2017 The Society of P.R.I. at the University of Virginia for academic achievement, community service, and exceptional pursuit of individuality
- 2017 [UVA Today](#): Graduating Class of 2017 Spotlight
- 2016 3rd place in Technical Poster Presentation at the Virginia-North Carolina Louis Stokes Alliance for Minority Participation Research Symposium

Publications

- 2020 **Carter, D**, Bouchard, L, & Quinn, D. Influence of the Ground, Ceiling, and Sidewall on Micro Quadrotors, *AIAA Journal*, December 2020.
- 2019 Gao, S, **Carter, D**. Exploiting Ground and Ceiling Effects on Autonomous UAV Motion Planning, 2019 International Conference on Unmanned Aircraft Systems
- 2018 **Carter, D**. Insect Residue Height for Different Conditions and Coatings. *AIAA 2018 SciTech Forum*.
- 2017 **Carter, D**. Investigating the Effect of Insect Fouling on a Hot Airfoil (Undergraduate Thesis), Mechanical and Aerospace Engineering, University of Virginia.

Publications In Preparation

- 2021 **Carter, D**, Quinn, D. Rotor property dependencies in air/water ground effect, *AIAA Journal*, *In Preparation*.
- 2021 **Carter, D**, Quinn, D. Coaxial rotor wake and performance study in air/water transition region, *Journal TBD*, *In Preparation*.
- 2021 **Carter, D**, Quinn, D. Flow structures of a rotor breaching the water surface}. *Journal Fluid Mechanics*, *In Preparation*.

Presentations

- 2019 **Carter, D.**, Mazzatenta, M, Gao, S, Di Franco, C, Bezzo, N, & Quinn, D. Scaling effects on aerodynamic interactions of rotorcraft around boundaries (Presentation), Meeting of the American Physical Society Division of Fluid Dynamics, November 23rd, 2019.
- 2019 Gao, S, **Carter, D**. Exploiting Ground and Ceiling Effects on Autonomous UAV Motion Planning. (Presentation), 2019 International Conference on Unmanned Aircraft Systems, June 13th, 2019.

- 2018 **Carter, D.** How quadcopters could retain high precision near obstacles. (Presentation), Meeting of the American Physical Society Division of Fluid Dynamics, November 18th, 2018.
- 2018 **Carter, D.** Insect Residue Height for Different Conditions and Coatings. (Presentation), AIAA 2018 SciTech Forum, January 8th, 2018.
- 2017 **Carter, D.** Insect Residue Height for Different Conditions and Coatings. (Presentation), GEM Consortium Annual Board Meeting Technical Presentation Competition, September 8th, 2017.
- 2016 **Carter, D. & Bart-Smith, H.** Study of Cetacean Fluke Structures effect on Hydrodynamic Performance. (Poster), Virginia-North Carolina Alliance of Louis Stokes Alliance for Minority Participation Research Symposium, April 4th, 2016.
- 2016 **Carter, D. & Bart-Smith, H.** Study of Cetacean Fluke Structures effect on Hydrodynamic Performance. (Poster), [National Conference of Louis Stokes Alliance for Minority Participation](#), February 23rd, 2016.

Service

- 2020 – Present Search Committee for the Dean of UVA Engineering
- 2020 – Present MAE DEI Task Force on Diverse & Excellent Faculty – Committee Chair
- 2020 – Present Tomorrow Professors Today – Member
- 2019 – Present University of Virginia Graduate Recruitment Initiative Team (GRIT), SEAS Co-Chair
- 2018 – Present University of Virginia Mechanical & Aerospace Engineering Graduate Student Board, Recruitment Chair
- 2018 – Present Black Graduate and Professional Student Organization at UVA, Co-President
- 2016 – Present University of Virginia Class of 2017 Trustee, C’Ville Committee
- 2018 – 2020 Link Lab Student Committee on Culture & Livability, Social Chair
- 2013 – 2020 National Society of Black Engineers, General Member
[National Membership Chair](#), 2018-2019
 Region II Ozone Coordinator & Membership Chair, 2017-2018
 Region II Ozone Coordinator, 2016-2017
 UVA Chapter President, 2015-2016

Outreach

- 2018 – Present Content Tutoring & Mentoring for University of Virginia Athletics
- 2013 – 2018 Weekly Tutor for K-12 students, Zion Union Baptist Church
- 2015 – 2017 Tutor for Physics I, Calculus II, Statics, and Introduction to Mechanical Engineering, School of Engineering and Applied Sciences, University of Virginia

Advising

2019 – 2020	Undergraduate Student Research Assistant Megan Mazzatenta
2018 – 2019	Undergraduate Student Research Team (Caroline Pavlak, Ali Shanoon, Rachel Good, William Clark)
2018 – 2019	Undergraduate Student Research Assistant Justin Robinson
2017 – 2018	Undergraduate Student Research Assistant Peyton Hooker

Professional Memberships

National Society of Black Engineers (NSBE)

American Institute of Aeronautics and Astronautics (AIAA)

American Physical Society (APS)

Black in Robotics

Skills

MATLAB, Solidworks, Autodesk (CAD, Inventor, 3Ds Max), Python, Java, MATHCAD, Photoshop, Illustrator, Premiere, PIV Analysis, Propeller, ROS, Excel

Professional References

Daniel Quinn Ph.D. – Ph.D. Advisor

Assistant Professor, Mechanical & Aerospace Engineering, Electrical & Computer Engineering
University of Virginia, Charlottesville, VA 22902

danquinn@virginia.edu

Eric Loth Ph.D. – Ph.D. Committee & Undergraduate Research Advisor

Mechanical & Aerospace Engineering Department Chair, Rolls-Royce Commonwealth Professor
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Pamela Norris Ph.D. – Advisor

Executive Dean, School of Engineering and Applied Science
Frederick Tracy Morse Professor, Department of Mechanical and Aerospace Engineering
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Purdue University 2021 Black Trailblazers in Engineering- Research and Education Plan
Darius Carter – University of Virginia (UVA) – dariusc@virginia.edu

My goal is to become a tenure-track professor at a research-intensive university. I believe that the Black Trailblazers in Engineering is the perfect program to launch my career in academia. I will be the representation I desperately desired to see in my aerospace engineering academic experience. I am passionate about aerospace research and the ability to inspire future generations of engineers and scientists. However, as I grew into a high-functioning researcher and academic, the number of African Americans like myself dwindled rapidly, inspiring me to make a difference.

My dissertation research is on near-boundary flow phenomena on rotorcraft and UAVs. The advantages of near-boundary flight, like the "ground effect," can be hard to harness because boundary effects can also be destabilizing. To better understand these near boundary effects, I broke my dissertation into four chapters. My first chapter was a flow investigation of ground and ceiling effect on a micro aerial vehicle that turned into three conference presentations and was accepted into the AIAA Journal (Carter, 2020). I collaborated with an autonomous robotics lab. We conducted a sensorless landing and optimized path planning using the ground effect model from our experiments, which turned into a conference paper and presentation (Gao, 2019). My second project was on rotor size effect on solid/water ground effect. In project three, I will isolate the rotational speed and velocity needed to breach water to air to simulate a water/air vehicle's dynamic breaching. Lastly, in project four, I plan on discovering an optimum axial distance for a coaxial rotor that can transition through the transition region between air and water while operating efficiently in either air or water. Through my experimental fluid testing, roboticists' will visualize and understand the flow structures involved in near-boundary UAUV flight.

After my Ph.D., I will work on UAV flight dynamics and experimental rotorcraft analysis. I plan on developing a research program focusing on three main areas. The first is using Inertia Measurement Unit (IMU) response to varied turbulent sensing. By using Micro Aerial Vehicles (MAVs), which operate at a lower Reynolds number, measurements can be more sensitive to smaller-scale turbulence structures. The inability to model smaller scale turbulence is due to experiments being run on larger UAV platforms that cannot utilize more spatial representative flow analysis methods such as PIV. My second program area would be studying turbulent gusts on rotor thrust and PIV analysis. Vertical take-off and landing (VTOL) vehicles often take off in the turbulent flow field. UAVs and other VTOL systems often fly in environments where random turbulent gusts dominate. Urban airspace is a prime example of this, with the flow being disturbed by the buildings. The turbulent gusts and ground effect can make take-off and landing difficult in these environments. Utilizing my work from IMU sensing, I will detect the turbulence on a UAV system. Lastly, experimental flow analysis of interactions between multiple MAVs. Interest in UAV systems, which involve multiple UAV systems, has increased in recent years due to the increased availability of low-cost UAVs. Many control and communication problems of multiple aerial vehicle systems have been addressed. Zhou (2017) found no thrust change as two rotors decrease the radial distance between each other; however, there is an increase in thrust fluctuations. For more accurate control of multiple UAV systems, especially Micro Aerial Vehicle systems with less sensing capabilities due to size constraints, modeling their flow interactions is crucial.

Teaching and mentoring are essential to becoming the high achieving academic I strive to become. My passion for mentoring has evolved over the past three years from my academic mentoring of student-athletes and tutoring throughout my undergraduate and graduate experience. Through my semester, I gained teaching experience being a teaching assistant for the introduction of fluid mechanics through leading office hours and grading assignments. My formal training in teaching has come through the Tomorrow's Professor's Today program in the Center for Teaching Excellence at UVA. I have been involved in many workshops learning inclusive teaching methods, handling microaggressions in the classroom, course design techniques, and many more. As a faculty member, I plan to utilize my Trailblazer program experience to create an active and inclusive learning environment where all students' views are respected. Ideas I plan to implement in my classroom: a robust peer-to-peer learning system and a hybrid flipped-classroom model. As both a student and teaching assistant, I have seen first-hand the enhanced comprehension of students from these two active learning approaches.

As an African American man in engineering, I have had many challenges in my STEM pursuit. However, much of my success has been a product of the many academic interventions given to me. An example of this was the Bridge program I did with other minority students before my freshman year of college. This program connected students for three weeks in the summer, where we took prep classes, went to workshops, and learned from our upperclassmen mentors. Programs like this are vital to the experience and academic success of many minority students like me (May, 2003). I will collaborate on some grants for new intervention techniques with my school's diversity office.

Being a black man in engineering has been a challenging experience, which has empowered me to make the experience easier for others. I have experienced isolation and feelings of not belonging by being one of the few and lacking black mentors. I combatted these feelings by making a change at my school, including the formation of three student groups, Link Lab Student Community on Culture and Livability, MAE Graduate Student Board, and Graduate Recruitment Initiative Team. My values on diversity, equity, and inclusion are based on making sure every person is valued, and their perspective is heard. I plan to continue this work by serving as a mentor to fellow minority students and doing community service work for primary school children. I believe that Purdue's Trailblazers program is the perfect platform for me to become the researcher, teacher, mentor, and role model I aspire to be.

References

- Gao, S., Di Franco, C., Carter, D., Quinn, D., & Bezzo, N. (2019, June). Exploiting ground and ceiling effects on autonomous UAV motion planning. In 2019 International Conference on Unmanned Aircraft Systems (ICUAS) (pp. 768-777). IEEE
- Carter, D., Bouchard, L., & Quinn, D. (2020) Influence of the Ground, Ceiling, and Sidewall on Micro Quadrotors, AIAA Journal Accepted
- May, G.S. and Chubin, D.E. (2003), A Retrospective on Undergraduate Engineering Success for Underrepresented Minority Students. *Journal of Engineering Education*, 92: 27-39.
<https://doi.org/10.1002/j.2168-9830.2003.tb00735.x>
- Zhou, W., Ning, Z., Li, H., & Hu, H. (2017). An experimental investigation on rotor-to-rotor interactions of small UAV propellers. In 35th AIAA applied aerodynamics conference (p. 3744). with limited preview information. *IEEE Transactions on Intelligent Vehicles*.



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January 11, 2021

To Whom It May Concern:

I am writing to recommend Darius Carter, a PhD Candidate in my lab, for the Black Trailblazers in Engineering program.

Darius's curiosity and passion for engineering education makes him a natural fit for academia. Darius was a student in my graduate fluid dynamics class, and he sat in the front row and asked more questions than any other student. I recall one time when he stayed after class to discuss a minus sign that appeared during my lecture, along with physical interpretations of the minus sign – that is the kind of scholarly curiosity I've come to expect from Darius. In the lab, Darius designed and built (from scratch) an arena for studying the flow around small quadrotors. Because of Darius's attention to usability and modular design, the arena is now being used by several students for multiple projects.

Despite being only in his second year of graduate studies, Darius is already active in our research community. Darius presented data from his quadrotor arena at the national conference of the American Physical Society: Division of Fluid Dynamics (APS DFD). I have been to APS DFD 10 years in a row, so I have a good sense of the types of presentations that come through the conference. Darius's was excellent; he has a natural ability to explain complex ideas in a logical sequence, and the talk was well-received. Since then, Darius has compiled his data for a peer-reviewed conference paper that was accepted to the International Conference on Unmanned Aircraft Systems (ICUAS) and a paper that was accepted to the American Institute of Aeronautics and Astronautics (AIAA) Journal. As part of writing those papers, he collaborated with Electrical Engineering and Computer Science students, which speaks to the interdisciplinary nature of his work. Darius is currently designing his next experiment, which will investigate how amphibious rotor thrust scales near water-air interfaces.

Darius has also positioned himself as a leader in the effort to increase diversity in the next generation of engineers. He has been active in NSBE since his time as an undergraduate student. When he and I first discussed options for graduate school, Darius said it was important to him that he stay active in NSBE, no matter how demanding the graduate work became. True to his word, he has been active in research, successful in all his classes, and remains active in NSBE, most recently as National Membership Chair, where he oversaw the membership of 20,000+ members and 700+ chapters.

What makes Darius especially well-suited for academia is his commitment to effective mentoring. He has mentored four undergraduate students in my lab. I'm often hesitant to arrange graduate mentoring, because sometimes graduate students find it burdensome. Not so with Darius. He actively sought out the opportunity and went out of his way to set up meetings with the students. When middle and high school students come to visit our lab, Darius jumps at every opportunity to help.

I believe Darius has what it takes to have a long and successful academic career. Please don't hesitate to contact me with any questions about my recommendation.

Kind regards,

A handwritten signature in black ink that reads "Daniel Quinn".

Daniel Quinn

Assistant Professor
Mechanical and Aerospace Engineering; Electrical and Computer Engineering
University of Virginia