

## **MOBLE BENEDICT**

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## **INTERESTS**

To generate disruptive and revolutionary innovations through opportunity-driven, interdisciplinary, fundamental research related to the broad areas of *aeromechanics, design, development, and autonomous control of high performance next generation vertical flight concepts, green aviation, aircraft concepts for planetary exploration, high efficiency vertical axis wind turbines, and unmanned underwater vehicles*. To balance research between experiments and computational analyses; between fundamental understanding and its application to real-life problems, and to tackle multi-disciplinary barrier problems, generate high-level scholarly work, and create a team environment for productivity.

## **EDUCATION**

### **University of Maryland (2004 – 2010)**

Ph.D. in Aerospace Engineering

Thesis: “*Fundamental Understanding of the Cycloidal-Rotor Concept for Micro Air Vehicle Applications*”

Thesis Advisor: Prof. Inderjit Chopra

### **Indian Institute of Technology (IIT) Bombay (2003 – 2004)**

Master of Technology in Aerospace Engineering

Master’s Thesis: “*Aeroelastic Design and Manufacture of an Efficient Ornithopter Wing*”

Thesis Advisor: Prof. K. Sudhakar

### **Indian Institute of Technology (IIT) Bombay (1999 – 2003)**

Bachelor of Technology in Aerospace Engineering

## **EMPLOYMENT**

### **Assistant Professor of Aerospace Engineering, August 2014 – onward**

Texas A&M University, College Station

### **Assistant Research Scientist, July 2012 – August 2014**

Alfred Gessow Rotorcraft Center, University of Maryland, College Park

### **Postdoctoral Research Associate, January 2011 – June 2012**

Alfred Gessow Rotorcraft Center, University of Maryland, College Park

### **Graduate Research Assistant, September 2004 – December 2010**

Alfred Gessow Rotorcraft Center, University of Maryland, College Park

## HONORS AND AWARDS

- One of the 5 **phase-II winners** globally for the \$2M Boeing GoFly Prize ([link](#)).
- One of the 10 **phase-I winners** (from 600 global entries) for the \$2M Boeing GoFly Prize ([link](#)).
- 2018 university nominee for the Gordon Betty Moore Foundation **Moore Inventor Fellowship**.
- **Best Paper Award** in the Modeling and Simulation session (AIAA Aviation Conference 2019).
- TAMU College of Engineering **2018 Young Faculty Fellow Award**.
- TAMU College of Engineering **2017 Dean’s Excellence Award**.
- **2016 François-Xavier Bagnoud Award** from American Helicopter Society (AHS) for career-to-date contributions to vertical flight technology under the age of 35 ([link](#)).
- \$25K **Grand Prize Winner** of the Lockheed Martin 2012 Innovate the Future Global Challenge for “Cycloidal Wind Turbine” idea (winner was selected out of 500 entries) ([link](#)).
- **2012 Young Engineer-Scientist of the Year Award** from AIAA ([link](#)).
- **6 Best Paper Awards** at American Helicopter Society Forums 2011, 14, 16, 17, 18 and 19.
- **2 Robert L. Lichten Awards** from American Helicopter Society (one per year) (2016 and 2017).
- **13 AIAA student conference prizes** (8 first places, 4 second places and 1 third place).
- Athena Award 2010.
- Ann Wylie Fellowship 2009.
- University of Maryland Future Faculty Fellow 2008.
- **Best Paper Award** at the International Seminar on Advances in Aerospace Sciences, Bangalore, India, December 2003.

## PUBLICATIONS IN ARCHIVAL JOURNALS

### JOURNAL PAPERS PUBLISHED

1. \*Walther, C., \*Coleman, D., and **Benedict, M.**, “Force and Flowfield Measurements to Understand Unsteady Aerodynamics of Cycloidal Rotors in Hover at Ultra-Low Reynolds Numbers,” *International Journal of Micro Air Vehicles*, Vol. 11, March 2019, pp. 1-18.
2. \*Runco, C., \*Coleman, D., and **Benedict, M.**, “Design and Development of a 30 g Cyclocopter,” *Journal of the American Helicopter Society*, Vol. 64, No. 1, January 2019, pp. 1-10.
3. \*Walther, C., \*Saemi, F., **Benedict, M.**, and Lakshminarayan, V. K., “Aerodynamics of Symmetric versus Asymmetric Pitching of a Cycloidal Rotor Blade in Hover at Ultra-Low Reynolds Numbers,” *Journal of Aircraft*, January 2019, pp. 1-22.
4. \*Runco, C., \*Himmelberg, B., and **Benedict, M.**, “Experimental Studies on a Mesoscale Cycloidal Rotor in Hover,” *Journal of Aircraft*, December 2018, pp. 1-10.

5. \*Coleman, D., \*Gakhar, K., **Benedict, M.**, Tran, J., and Sirohi, J., “Aeromechanics Analysis of a Hummingbird-like Flapping Wing in Hover,” *Journal of Aircraft*, Vol. 55, No. 6, July 2018, pp. 2282-2297.
6. \*Halder, A., and **Benedict, M.**, “Role of Blade Flexibility on Cycloidal Rotor Hover Performance,” *Journal of Aircraft*, Vol. 55, No. 5, July 2018, pp. 1773-1791.
7. \*Halder, A., \*Walther, C., and **Benedict, M.**, “Unsteady Hydrodynamic Modeling of a Cycloidal Propeller,” *Ocean Engineering*, Vol. 154, April 2018, pp. 94-105.
8. \*Coleman, D., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Development of a Robotic Hummingbird Capable of Controlled Hover,” *Journal of the American Helicopter Society*, Vol. 62, No. 3, July 2017, pp. 1 – 9.
9. Shrestha, E., Martz, V., Yeo, D., **Benedict, M.**, and Chopra, I., “Development of a Meso-Scale Cycloidal-Rotor Aircraft for Micro Air Vehicle Application,” *International Journal of Micro Air Vehicles*, Vol. 9, No. 3, 2017, pp. 218 – 231.
10. **Benedict, M.**, \*Coleman, D., Mayo, D. B., and Chopra, I., “Experiments on a Rigid Wing Undergoing Hover-Capable Flapping Kinematics at MAV-Scale Reynolds Numbers,” *AIAA Journal*, Vol. 54, No. 4, October 2016, pp. 1145 – 1157.
11. Elena, S., Hrishikeshavan, V., **Benedict, M.**, Yeo, D., and Chopra, I., “Development of Control Strategies for a Twin-Cyclocopter in Forward Flight,” *Journal of the American Helicopter Society*, Vol. 61, No. 4, October 2016, pp. 1 – 9.
12. Winslow, J., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Design, Development and Flight Testing of a High Endurance Micro Quadrotor Helicopter,” *International Journal of Micro Air Vehicles*, Vol. 8, No. 3, September 2016, pp. 155 – 169.
13. **Benedict, M.**, Jarugumilli, T., and Chopra, I., “Effects of Asymmetric Blade-Pitching Kinematics on Forward Flight Performance of a Micro-Air-Vehicle-Scale Cycloidal-Rotor,” *Journal of Aircraft*, Vol. 53, No. 5, 2016, pp. 1568-1573.
14. Shrestha, R., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Hover Performance of a Small-Scale Helicopter Rotor for Flying on Mars,” *Journal of Aircraft*, Vol. 53, No. 4, 2016, pp. 1160-1167.
15. **Benedict, M.**, Mullins, J., Hrishikeshavan, V., and Chopra, I., “Development of a Quad Cycloidal-Rotor Unmanned Aerial Vehicle,” *Journal of the American Helicopter Society*, Vol. 61, No. 2, April 2016, pp. 1 – 12.
16. **Benedict, M.**, Lakshminarayan, V. K., Johnathan, P., and Chopra, I., “Aerodynamics of a Small-Scale Vertical Axis Wind Turbine with Dynamic Blade Pitching,” *AIAA Journal*, Vol. 54, No. 3, 2016, pp. 924 – 935.
17. **Benedict, M.**, Winslow, J., Hasnain, Z., and Chopra, I., “Experimental Investigation of Micro Air Vehicle Scale Helicopter Rotor in Hover,” *International Journal of Micro Air Vehicles*, Vol. 7, No. 3, October 2015, pp. 231 – 255.
18. Mayo, D., Lankford, J., **Benedict, M.**, Chopra, I., “Aeroelastic Analysis of Avian-Based Flexible Flapping Wings for Micro Air Vehicles,” *Journal of the American Helicopter Society*, Vol. 60, No. 3, 2015, pp. 1-18.
19. Mayo, D., Lankford, J., **Benedict, M.**, Chopra, I., “Experimental and Computational Analysis of Rigid Flapping Wings for Micro Air Vehicles,” *Journal of Aircraft*, Vol. 52, Special Section on Second High Lift Prediction Workshop (2015), pp. 1161-1178.
20. Hrishikeshavan, V., **Benedict, M.**, and Chopra, I., “Identification of Flight Dynamics of a Cyclocopter Micro Air Vehicle in Hover,” *Journal of Aircraft*, Vol. 52, No. 1, 2015, pp. 116 – 129.

21. Lind, A. H., Jarugumilli, T., **Benedict, M.**, Lakshminarayan, V. K., Jones, A. R., and Chopra, I., “Flowfield studies on a micro-air-vehicle-scale cycloidal rotor in forward flight,” *Experiments in Fluids*, Vol. 55, November 2014, pp. 1 – 17.
22. Jarugumilli, T., **Benedict, M.**, and Chopra, I., “Wind Tunnel Studies on a Micro Air Vehicle-Scale Cycloidal Rotor,” *Journal of the American Helicopter Society*, Vol. 59, No. 2, April 2014, pp. 1 – 10.
23. **Benedict, M.**, Jarugumilli, T., Lakshminarayan, V. K., and Chopra, I., “Effect of Flow Curvature on the Forward Flight Performance of a MAV-Scale Cycloidal Rotor,” *AIAA Journal*, Vol. 52, No. 6, 2014, pp. 1159 – 1169.
24. **Benedict, M.**, Shrestha, E., Hrishikeshavan, V., and Chopra, I., “Development of a Micro Twin-Rotor Cyclocopter Capable of Autonomous Hover,” *Journal of Aircraft*, Vol. 51, No. 2, 2014, pp. 672 – 676.
25. **Benedict, M.**, Gupta, R., and Chopra, I., “Design, Development and Flight Testing of a Twin-Rotor Cyclocopter Micro Air Vehicle,” *Journal of the American Helicopter Society*, Vol. 58, No. 4, October 2013, pp. 1 – 10.
26. **Benedict, M.**, Jarugumilli, T., and Chopra, I., “Effect of Rotor Geometry and Blade Kinematics on Cycloidal Rotor Hover Performance,” *Journal of Aircraft*, Vol. 50, No. 5, 2013, pp. 1340 – 1352.
27. Seshadri, P., **Benedict, M.**, and Chopra, I., “Understanding Micro Air Vehicle Flapping-Wing Aerodynamics Using Force and Flowfield Measurements,” *Journal of Aircraft*, Vol. 50, No. 4, July 2013, pp. 1070 – 1087.
28. Zachary, H., A., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Design, Development, and Flight Test of a Small-Scale Cyclogyro UAV Utilizing a Novel Cam-Based Passive Blade Pitching Mechanism,” *International Journal of Micro Air Vehicles*, Vol. 5, No. 2, June 2013, pp. 145 – 162.
29. Seshadri, P., **Benedict, M.**, and Chopra, I., “A Novel Mechanism for Emulating Insect Wing Kinematics,” *Journal of Bioinspiration and Biomimetics*, Vol. 7, No. 3, September 2012, pp. 1–15.
30. Malhan, R., **Benedict, M.**, and Chopra, I., “Experimental Studies to Understand the Hover and Forward Flight Performance of a MAV-scale Flapping Wing Concept,” *Journal of the American Helicopter Society*, Vol. 57, No. 2, April 2012, pp. 022002-1 - 022002-11.
31. **Benedict, M.**, Mataboni, M., Chopra, I., and Masarati, P., “Aeroelastic Analysis of a Micro-Air-Vehicle-Scale Cycloidal Rotor in Hover,” *AIAA Journal*, Vol. 49, No. 11, November 2011, pp. 2430 – 2443.
32. **Benedict, M.**, Jarugumilli, T., and Chopra, I., “Experimental Optimization of MAV-Scale Cycloidal Rotor Performance,” *Journal of the American Helicopter Society*, Vol. 56, No. 2, April 2011, pp. 022005-1 - 022005-11.
33. **Benedict, M.**, Ramasamy, M., and Chopra, I., “Improving the Aerodynamic Performance of Micro-Air-Vehicle-Scale Cycloidal Rotor: An Experimental Approach,” *Journal of Aircraft*, Vol. 47, No. 4, July-August 2010, pp. 1117 – 1125.
34. **Benedict, M.**, Ramasamy, M., Chopra, I., and Leishman, J. G., “Performance of a Cycloidal Rotor Concept for Micro Air Vehicle Applications,” *Journal of the American Helicopter Society*, Vol. 55, No. 2, April 2010, pp. 022002-1 - 022002-14.

**JOURNAL PAPERS ACCEPTED**

35. \*McElreath, J., **Benedict, M.**, and Tichenor, N., “Cycloidal Rotor Blade Tip Vortex Analysis at Low Reynolds Number,” Accepted for publication in *AIAA Journal*.

36. **Benedict, M.**, Garber, J., and Lakshminarayan, V. K., “Towards Understanding the Physics of a Small-Scale Cycloidal Wind Turbine,” Accepted for publication in the *Renewable Energy Journal*.
37. \*Yang, X., \*Sudhir, A., \*Halder, A., and **Benedict, M.**, “Nonlinear Aeroelastic Analysis for Highly Flexible Flapping Wing in Hover,” Accepted for publication in the *Journal of the American Helicopter Society*.

#### **JOURNAL PAPERS SUBMITTED**

38. \*Halder, A., and **Benedict, M.**, “Understanding Upward Scalability of Cycloidal Rotors for Large-Scale UAS Applications,” Submitted to the *Journal of the American Helicopter Society*.

#### **PUBLICATIONS IN CONFERENCE PROCEEDINGS**

39. \*Halder, A., and **Benedict, M.**, “Understanding Upward Scalability of Cycloidal Rotors for Large-Scale UAS Applications,” Proceedings of the Transformative Vertical Flight Meeting, San Jose, CA, January 21-23, 2020.
40. \*Yang, X., and **Benedict, M.**, “Computational Studies to Understand Flight Stability and Control of a Robotic Hummingbird,” Proceedings of the Transformative Vertical Flight Meeting, San Jose, CA, January 21-23, 2020.
41. \*Halder, A., and **Benedict, M.**, “Free-Wake Based Nonlinear Aeroelastic Modeling of UAV scale Cycloidal Rotor,” Proceedings of the AIAA Aviation Conference, Dallas, TX, June 17–21, 2019.  
*(Best Paper Award Winner in the Modeling and Simulation Session)*
42. \*Coleman, D., and **Benedict, M.**, “Flight Dynamics Identification, Maneuverability, and Gust Tolerance of a Robotic Hummingbird in Hover,” Proceedings of the 75<sup>th</sup> Annual National Forum of the Vertical Flight Society, Philadelphia, PA, May 13–16, 2019.
43. \*Denton, H., **Benedict, M.**, Kang, H., and Hrishikeshavan, V., “Development of a Gun-Launched Rotary-Wing Micro Air Vehicle,” Proceedings of the 75<sup>th</sup> Annual National Forum of the Vertical Flight Society, Philadelphia, PA, May 13–16, 2019.  
*(Best Paper Award Winner in the Advanced Vertical Flight Session)*
44. \*Saemi, F., **Benedict, M.**, and Beals, N., “Semi-Empirical Modeling of Group 1 UAS Electric Powertrains,” Proceedings of the 75<sup>th</sup> Annual National Forum of the Vertical Flight Society, Philadelphia, PA, May 13–16, 2019.  
*(2018 American Helicopter Society Robert L. Lichten Award Runner-Up)*
45. \*Halder, A., \*Kellen, A., and **Benedict, M.**, “Aeroacoustic Analysis of UAV-Scale Cycloidal Rotor: An Experimental and Computational Approach,” Proceedings of the 75<sup>th</sup> Annual National Forum of the Vertical Flight Society, Philadelphia, PA, May 13–16, 2019.
46. \*Yang, X., and **Benedict, M.**, “Coupled CFD-CSD Based Aeroelastic Analysis of a Highly Flexible Flapping Wing in Hover,” Proceedings of the Vertical Flight Society Autonomous VTOL Technical Meeting and Electric VTOL Symposium, Meza, AZ, January 29-31, 2019.
47. \*Kellen, A., \*White, J., and **Benedict, M.**, “Development of a UAV-Scale Cyclocopter,” Proceedings of the Vertical Flight Society Autonomous VTOL Technical Meeting and Electric VTOL Symposium, Meza, AZ, January 29-31, 2019.

48. \*Coleman, D., and **Benedict, M.**, “A Truly Biomimetic Hover-Capable Flapping Wing Robot,” Proceedings of the 74<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 15–17, 2018.  
*(Best Paper Award Winner in the Advanced Vertical Flight Session)*
49. \*McElreath, J., **Benedict, M.**, and Tichenor, N., “Tip Vortex Measurements on a Cycloidal Rotor Blade at Ultralow Reynolds Numbers,” Proceedings of the 74<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 15–17, 2018.  
*(2018 American Helicopter Society Robert L. Lichten Award Runner-Up)*
50. \*Runco, C., and **Benedict, M.**, “Understanding Flight Dynamics of a Meso-Scale Twin-Cyclocopter,” Proceedings of the 74<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 15–17, 2018.
51. \*Kellen, A., and **Benedict, M.**, “Experimental Investigation of UAV-Scale Cycloidal Rotor Aerodynamic Performance in Hover,” Proceedings of the 74<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 15–17, 2018.
52. \*Halder, A., and **Benedict, M.**, “Nonlinear Aeroelastic Coupled Trim Analysis of a Twin-Cyclocopter in Forward Flight,” Proceedings of the 74<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 15–17, 2018.
53. \*Yang, X., Badrya, C., Lankford, J., and **Benedict, M.**, “CFD Analysis for Flexible Flapping Wing in Hover Flight,” Proceedings of the 74<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 15–17, 2018.
54. \*Walther, C., \*Coleman, D., and **Benedict, M.**, “Understanding Unsteady Aerodynamics of Cycloidal Rotors in Hover at Ultra-low Reynolds Numbers,” Proceedings of the AIAA SciTech, Kissimmee, FL, Jan 8–12, 2018.  
*(2018 AIAA International Student Conference Winner in graduate category)*
55. \*Yang, X., and **Benedict, M.**, “Nonlinear Aeroelastic Coupled Trim Analysis of Flapping Wing MAV in Hover,” Proceedings of the American Helicopter Society International Technical Meeting on Aeromechanics Design for Transformative Vertical Flight, San Francisco, CA, January 16–18, 2018.
56. \*Kellen, A., and **Benedict, M.**, “Experimental Optimization of UAV-Scale Cycloidal Rotor,” Proceedings of the American Helicopter Society International Technical Meeting on Aeromechanics Design for Transformative Vertical Flight, San Francisco, CA, January 16–18, 2018.
57. \*Halder, A., and **Benedict, M.**, “Nonlinear Aeroelastic Modeling of Cycloidal Rotor in Forward Flight,” Proceedings of the American Helicopter Society International Technical Meeting on Aeromechanics Design for Transformative Vertical Flight, San Francisco, CA, January 16–18, 2018.
58. \*Walther, C., \*Coleman, D., **Benedict, M.**, and Lakshminarayan, V. K., “Experimental and Computational Studies to Understand Unsteady Aerodynamics of Cycloidal Rotors in Hover at Ultra-low Reynolds Numbers,” Proceedings of the 73<sup>rd</sup> Annual National Forum of the American Helicopter Society, Fort Worth, TX, May 9–11, 2017.  
*(2017 American Helicopter Society Robert L. Lichten Award Winner)*
59. \*Yang, X., \*Sudhir, A., \*Halder, A., and **Benedict, M.**, “Aeroelastic Analysis for Highly Flexible Flapping Wing in Hover,” Proceedings of the 73<sup>rd</sup> Annual National Forum of the American Helicopter Society, Fort Worth, TX, May 9–11, 2017.  
*(Best Paper Award Winner in the Modeling and Simulation Session)*

60. \*Halder, A., \*Walther, C., and **Benedict, M.**, “Unsteady Hydrodynamic Modeling of a Cycloidal Propeller,” Proceedings of the 5<sup>th</sup> International Symposium on Marine Propulsion, Helsinki, Finland, June 12 – 17, 2017.
61. \*Runco, C., \*Himmelberg, B., and **Benedict, M.**, “Performance and Flowfield Measurements of a Meso-Scale Cycloidal Rotor in Hover,” Proceedings of the 73<sup>rd</sup> Annual National Forum of the American Helicopter Society, Fort Worth, TX, May 9–11, 2017.
62. \*Kellen, A., and **Benedict, M.**, “Performance Measurements of UAV-Scale Cycloidal Rotor,” Proceedings of the 73<sup>rd</sup> Annual National Forum of the American Helicopter Society, Fort Worth, TX, May 9–11, 2017.
63. \*Halder, A., and **Benedict, M.**, “Nonlinear Aeroelastic Coupled Trim Analysis of a Cyclocopter in Hover,” Proceedings of the 73<sup>rd</sup> Annual National Forum of the American Helicopter Society, Fort Worth, TX, May 9–11, 2017.
64. \*Coleman, D., \*Gakhar, K., **Benedict, M.**, and Tran, J., “Experimental Studies towards Understanding the Aeromechanics of a Flexible Robotic Hummingbird Wing in Hover,” Proceedings of the 73<sup>rd</sup> Annual National Forum of the American Helicopter Society, Fort Worth, TX, May 9–11, 2017.
65. \*Himmelberg, B., and **Benedict, M.**, “Performance Measurements of Meso-Scale Cycloidal Rotors in Hover,” Proceedings of the AIAA SciTech, Grapevine, TX, Jan 9–13, 2017.
66. \*Runco, C., \*Coleman, D., and **Benedict, M.**, “Development of a cantilevered rotor-based meso-scale cyclocopter,” Proceedings of the 7<sup>th</sup> American Helicopter Society International Specialists' Meeting On Unmanned Rotorcraft Systems, Meza, AZ, January 24-26, 2017.
67. \*Coleman, D., and **Benedict, M.**, “Linearized Flight Dynamics of a Robotic Hummingbird in Hover,” Proceedings of the 7<sup>th</sup> American Helicopter Society International Specialists' Meeting On Unmanned Rotorcraft Systems, Meza, AZ, January 24-26, 2017.
68. \*Runco, C., \*Coleman, D., and **Benedict, M.**, “Development of the World’s Smallest Cyclocopter,” Proceedings of the 72<sup>nd</sup> Annual National Forum of the American Helicopter Society, West Palm Beach, FL, May 17–19, 2016.  
*(2016 American Helicopter Society Robert L. Lichten Award Winner)*
69. \*Coleman, D., and **Benedict, M.**, “System Identification of a Robotic Hummingbird in Hovering Flight,” Proceedings of the 72<sup>nd</sup> Annual National Forum of the American Helicopter Society, West Palm Beach, FL, May 17–19, 2016.  
*(Best Paper Award Winner in the Advanced Vertical Flight Session)*
70. \*Yang, X., \*Sudhir, A., and **Benedict, M.**, “Nonlinear Aeroelastic Model for Highly Flexible Flapping Wings in Hover,” Proceedings of the 72<sup>nd</sup> Annual National Forum of the American Helicopter Society, West Palm Beach, FL, May 17–19, 2016.
71. Shrestha, E., Yeo, D., Hrishikeshavan, V., **Benedict, M.**, and Chopra, I., “Gust Disturbance Rejection Study of a Cyclocopter Micro Air Vehicle,” Proceedings of the 72<sup>nd</sup> Annual Forum of the American Helicopter Society, West Palm Beach, FL, May 17–19, 2016.
72. \*Halder, A., and **Benedict, M.**, “Understanding Effect of Blade Flexibility on Cycloidal Rotor Hover Performance,” Proceedings of the American Helicopter Society Technical Meeting on Aeromechanics Design for Vertical Lift, San Francisco, CA, January 20–22, 2016.
73. \*Runco, C., \*Coleman, D., and **Benedict, M.**, “Design and Development of a Meso-Scale Cyclocopter,” Proceedings of the AIAA SciTech, San Diego, CA, Jan 4–8, 2016.

74. \*Coleman, D., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Design, Development and Flight-Testing of a Robotic Hummingbird,” Proceedings of the 71<sup>st</sup> Annual National Forum of the American Helicopter Society, Virginia Beach, VA, May 5–7, 2015.
75. **Benedict, M.**, Lakshminarayan, V. K., Garber, J., and Chopra, I., “Experimental and Computational Investigation of a Small-Scale Vertical Axis Wind Turbine with Dynamic Blade Pitching,” Proceedings of the 71<sup>st</sup> Annual National Forum of the American Helicopter Society, Virginia Beach, VA, May 5–7, 2015.
76. Shrestha, E., Hrishikeshavan, V., Yeo, D., **Benedict, M.**, and Chopra, I., “Flight Dynamics Modeling and System Identification of a Cyclocopter in Forward Flight,” Proceedings of the American Helicopter Society 71<sup>st</sup> Annual Forum, Virginia Beach, VA, May 5-7, 2015.
77. Shrestha, R., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Performance of a Small-Scale Helicopter Rotor for Martian Applications,” Proceedings of the 6th American Helicopter Society International Specialists' Meeting on Unmanned Rotorcraft Systems, Chandler, AZ, January 20-22, 2015.
78. \*Coleman, D., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Design and Development of a Hover-Capable Flapping Wing Micro Air Vehicle,” Proceedings of the 6th American Helicopter Society International Specialists' Meeting on Unmanned Rotorcraft Systems, Chandler, AZ, January 20-22, 2015.
79. Winslow, J., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Design, Development and Flight Testing of a High Endurance Micro Quadrotor Helicopter,” Proceedings of the 6th American Helicopter Society International Specialists' Meeting On Unmanned Rotorcraft Systems, Chandler, AZ, January 20-22, 2015.
80. Shrestha, E., Martz, V., Yeo, D., **Benedict, M.**, and Chopra, I., “Design and Hover Testing of a 60-gram Cyclocopter,” Proceedings of the 6th AHS International Specialists' Meeting On Unmanned Rotorcraft Systems, Chandler, AZ, January 20-22, 2015.
81. **Benedict, M.**, Winslow, J., Hasnain, Z., and Chopra, I., “Performance and Flowfield Measurements of a MAV-Scale Helicopter Rotor in Hover,” Proceedings of the 70<sup>th</sup> Annual National Forum of the American Helicopter Society, Montreal, Quebec, Canada, May 20–22, 2014.
82. Elena, S., Hrishikeshavan, V., **Benedict, M.**, Yeo, D., and Chopra, I., “Development of Control Strategies and Flight Testing of a Twin-Cyclocopter in Forward Flight,” Proceedings of the 70<sup>th</sup> Annual National Forum of the American Helicopter Society, Montreal, Quebec, Canada, May 20–22, 2014.  
*(Best Paper Award Winner in the Advanced Vertical Flight Session)*
83. Mayo, D. B., Lankford, J. L., **Benedict, M.**, and Chopra, I., “Coupled CFD/CSD-Based Aeroelastic Analysis with Flowfield Measurements of Avian-Based Flexible Flapping Wings for MAV Applications,” Proceedings of the 70<sup>th</sup> Annual National Forum of the American Helicopter Society, Montreal, Quebec, Canada, May 20–22, 2014.
84. Mayo, D. B., Lankford, J. L., **Benedict, M.**, and Chopra, I., “Experimental and Computational Aerodynamic Investigation of Avian-Based Rigid Flapping Wings for MAV Applications,” Proceedings of the American Helicopter Society Specialists’ Meeting on Aeromechanics, San Francisco, CA, Jan 22–24, 2014.
85. Hrishikeshavan, V., **Benedict, M.**, and Chopra, I., “Flight Dynamics System Identification and Control of a Cyclocopter Micro Air Vehicle in Hover,” Proceedings of the 69<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 21–23, 2013.



86. Jarugumilli, T., Lind, A. H., **Benedict, M.**, Lakshminarayan, V. K., Jones, A. R., and Chopra, I., “Experimental and Computational Flow Field Studies of a MAV-scale Cycloidal Rotor in Forward Flight,” Proceedings of the 69<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 21–23, 2013.
87. **Benedict, M.**, Lakshminarayan, V. K., Johnathan, P., and Chopra, I., “Fundamental Understanding of the Physics of a Small-Scale Vertical Axis Wind Turbine with Dynamic Blade Pitching: An Experimental and Computational Approach,” Proceedings of the 54<sup>th</sup> AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Boston, Massachusetts, April 8-11, 2013.
88. **Benedict, M.**, Coleman, D., Mayo, D., B., and Chopra, I., “Force and Flowfield Measurements on a Rigid Wing Undergoing Hover-Capable Flapping and Pitching Kinematics in Air at MAV-Scale Reynolds Numbers,” Proceedings of the 54<sup>th</sup> AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Boston, Massachusetts, April 8-11, 2013.
89. Shrestha, E., **Benedict, M.**, and Chopra, I., “Autonomous Hover Capability of Cycloidal-Rotor Micro Air Vehicle,” Proceedings of the 51<sup>st</sup> AIAA Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition, Grapevine, TX, January 7–10, 2013.
90. Zachary, H., A., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Development of a Hover-Capable 500 gram Cyclogyro Utilizing a Novel Cam-Based Passive Blade Pitching Mechanism,” Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Scottsdale, AZ, January 22-24, 2013.
91. **Benedict, M.**, Mullins, J., Hrishikeshavan, V., and Chopra, I., “Development of an Optimized Quad Cycloidal-Rotor UAV Capable of Autonomous Stable Hover,” Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Scottsdale, AZ, January 22-24, 2013.
92. Jarugumilli, T., **Benedict, M.**, Lind, A. H., and Chopra, I., “Performance and Flow Visualization Studies to Examine the Role of Pitching Kinematics on MAV-scale Cycloidal Rotor Performance in Forward Flight,” Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Scottsdale, AZ, January 22-24, 2013.
93. Shrestha, E., **Benedict, M.**, Hrishikeshavan, V., and Chopra, I., “Development of a 100 gram Micro Cyclocopter Capable of Autonomous Hover,” Proceedings of the 38<sup>th</sup> European Rotorcraft Forum, Amsterdam, Netherlands, September 4–7, 2012.
94. Jarugumilli, T., **Benedict, M.**, and Chopra, I., “Experimental Investigation of the Forward Flight Performance of a MAV-Scale Cycloidal Rotor,” Proceedings of the 68<sup>th</sup> Annual National Forum of the American Helicopter Society, Fort Worth, TX, May 1–3, 2012.
95. **Benedict, M.**, Jarugumilli, T., Lakshminarayan, V., K., and Chopra, I., “Experimental and Computational Studies to Understand the Role of Flow Curvature Effects on the Aerodynamic Performance of a MAV-Scale Cycloidal Rotor in Forward Flight,” Proceedings of the 53<sup>rd</sup> AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Honolulu, Hawaii, April 23-26, 2012.
96. Seshadri, P., **Benedict, M.**, and Chopra, I., “Towards a Fundamental Understanding of Low Reynolds Number Flapping Wing Aerodynamics,” Proceedings of the 53<sup>rd</sup> AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Honolulu, Hawaii, April 23-26, 2012.

97. **Benedict, M.**, and Chopra, I., “Design and Development of an Unconventional VTOL Micro Air Vehicle: The Cyclocopter,” Proceedings of the SPIE Micro-Nanotechnology Sensors, Systems, and Applications Conference, Baltimore, MD, April 23–27, 2012.
98. **Benedict, M.**, Shrestha, E., Hrishikeshavan, V., and Chopra, I., “Development of 200 gram Twin-Rotor Micro Cyclocopter Capable of Autonomous Hover,” Proceedings of the American Helicopter Society Future Vertical Lift Aircraft Design Conference, San Francisco, CA, January 18–20, 2012.
99. **Benedict, M.**, Gupta, R., and Chopra, I., “Design, Development and Flight Testing of a Twin-Rotor Cyclocopter Micro Air Vehicle,” Proceedings of the 67<sup>th</sup> Annual National Forum of the American Helicopter Society, Virginia Beach, VA, May 3–5, 2011.  
*(Best Paper Award Winner in the Advanced Vertical Flight Session)*
100. Jarugumilli T., **Benedict, M.**, Chopra, I., “Experimental Optimization and Performance Analysis of a MAV Scale Cycloidal Rotor,” Proceedings of the 49<sup>th</sup> AIAA Aerospace Sciences Meeting including the New Horizons Forum and Aerospace Exposition, Orlando, FL, January 4-7, 2011.
101. **Benedict, M.**, Jarugumilli, T., and Chopra, I., “Experimental Investigation of the Effect of Rotor Geometry and Blade Kinematics on the Performance of a MAV-Scale Cycloidal Rotor,” Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Tempe, AZ, January 25-27, 2011.
102. Seshadri, P., **Benedict, M.**, and Chopra, I., “Control of a Biomimetic Insect-Based Flapping Mechanism for a Hovering Micro Air Vehicle,” Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Tempe, AZ, January 25-27, 2011.
103. **Benedict, M.**, Jarugumilli, T., and Chopra, I., “Experimental Performance Optimization of a MAV-Scale Cycloidal Rotor,” Proceedings of the American Helicopter Society Specialists’ Meeting on Aeromechanics, San Francisco, CA, Jan 20–22, 2010.
104. Seshadri, P., **Benedict, M.**, and Chopra, I., “Experimental Investigation of an Insect-based Flapping Wing Hovering Micro Air Vehicle,” Proceedings of the American Helicopter Society Specialists’ Meeting on Aeromechanics, San Francisco, CA, Jan 20–22, 2010.
105. **Benedict, M.**, Mattaboni, M., Chopra, I., and Masarati, P., “Aeroelastic Analysis of a MAV-Scale Cycloidal Rotor,” Proceedings of the 51<sup>st</sup> AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Orlando, FL, April 12-15, 2010.
106. Mattaboni, M., **Benedict, M.**, Masarati, P., and Chopra, I., “MAV-Scale Cycloidal Rotor Multibody Aeroelastic Analysis,” Proceedings of the 1<sup>st</sup> Joint International Conference on Multibody System Dynamics, Lappeenranta, Finland, May 25–27, 2010.
107. Malhan, R., **Benedict, M.**, and Chopra, I., “Experimental Investigation of an Avian-based Flapping Wing Concept for a Micro Air Vehicle,” Proceedings of the 66<sup>th</sup> Annual National Forum of the American Helicopter Society, Phoenix, AZ, May 11–13, 2010.
108. **Benedict, M.**, Jarugumilli, T., and Chopra, I., “Design and Development of a Hover-Capable Cyclocopter MAV,” Proceedings of the 65<sup>th</sup> Annual National Forum of the American Helicopter Society, Grapevine, TX, May 27–29, 2009.
109. **Benedict, M.**, Ramasamy, M., Chopra, I., and Leishman, J. G., “Experiments on the Optimization of the MAV-Scale Cycloidal Rotor Characteristics Towards Improving Their

- Aerodynamic Performance,” Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Scottsdale, AZ, January 20-22, 2009.
110. Seshadri, P., **Benedict, M.**, and Chopra, I., “Understanding Insect-Based Flapping Flight from a Micro Air Vehicle Perspective,” Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Scottsdale, AZ, January 20-22, 2009.
  111. **Benedict, M.**, Chopra, I., Ramasamy, M., and Leishman, J. G., “Experimental Investigation of the Cycloidal rotor for a Hovering Micro Air Vehicle,” Proceedings of the 64<sup>th</sup> Annual National Forum of the American Helicopter Society, Montreal, Canada, April 28–30, 2008.
  112. **Benedict, M.**, Sirohi, J., and Chopra, I., “Design and Testing of a Cycloidal-Rotor MAV”, Proceedings of the American Helicopter Society International Specialists’ Meeting on Unmanned Rotorcraft, Chandler, AZ, January 23-25, 2007.
  113. **Benedict, M.**, Bhattacharya, A., and Pant, R., “Economic Benefit of Operating Turboprop Regional Aircraft on Three Short Haul Routes in India”, Air Transport Research Society World Conference, Istanbul, Turkey, July 1-3, 2004.
  114. **Benedict, M.**, Sudhakar, K., Mujumdar, P.M., and Issac, K.K., “Aeroelastic Design of an Ornithopter Wing”, Proceedings of the International Seminar on Advances in Aerospace Sciences, Bangalore, India, December 17-18, 2003.  
*(Best Paper Award winner)*

## STUDENT CONFERENCE PUBLICATIONS

115. \*Harmon, M., and **Benedict, M.**, “Development of a Hybrid Aerial/Ground Transformer Platform,” Proceedings of the 2019 Annual AIAA Region IV Student Conference, University of Texas, Austin, TX, March 29-31, 2019.
116. \*McElreath, J., and **Benedict, M.**, “Force and Flowfield Measurements to Understand Unsteady Aerodynamics of Cycloidal Rotors in Hover,” Proceedings of the 2018 Annual AIAA Region IV Student Conference, University of New Mexico, Albuquerque, NM, April 13-14, 2018.
117. \*Walther, C., \*Coleman, D., and **Benedict, M.**, “Understanding Unsteady Aerodynamics of Cycloidal Rotors in Hover at Ultra-low Reynolds Numbers,” Proceedings of the 2017 Annual AIAA Region IV Student Conference, University of Houston, Houston, TX, April 28-30, 2017.  
*(First place in the graduate category)*
118. \*Gakhar, K., and **Benedict, M.**, “Experimental Analysis of the Aeromechanics and Efficiency of a Robotic Hummingbird,” Proceedings of the 2017 Annual AIAA Region IV Student Conference, University of Houston, Houston, TX, April 28-30, 2017.  
*(Second place in the undergraduate category)*
119. \*Runco, C., and **Benedict, M.**, “Development and Flight Testing of a Meso-Scale Cyclocopter,” Proceedings of the 2016 Annual AIAA Region IV Student Conference, University of Texas at Arlington, Arlington, TX, April 1-2, 2016.  
*(First place in the graduate category)*
120. \*Himmelberg, B., and **Benedict, M.**, “Performance Measurements of Meso-Scale Cycloidal Rotors in Hover,” Proceedings of the 2016 Annual AIAA Region IV Student Conference, University of Texas at Arlington, Arlington, TX, April 1-2, 2016.

- (First place in the undergraduate category)*
121. \*Kellen, A., and **Benedict, M.**, “Design, Development and Performance Measurements of a UAV-Scale Cycloidal Rotor,” Proceedings of the 2016 Annual AIAA Region IV Student Conference, University of Texas at Arlington, Arlington, TX, April 1-2, 2016.
- (Second place in the undergraduate category)*
122. \*Coleman, D., and **Benedict, M.**, “On the Development of a Robotic Hummingbird,” Proceedings of the 2015 Annual AIAA Region IV Student Conference, University of Houston, Houston, TX, April 18-19, 2015.
- (First place in the graduate category)*
123. Mills, A., **Benedict, M.**, and Chopra, I., “Investigation of the Effect of Blade Kinematics and Reynolds Number on the Aerodynamic Performance of a Small-Scale Vertical Axis Wind Turbine with Dynamic Blade Pitching,” Proceedings of the 2015 Annual AIAA Region I Student Conference, Blacksburg, VA, March 27-28, 2015.
- (First place in the undergraduate category)*
124. Muller, B., **Benedict, M.**, and Chopra, I., “Development of a 135 gram Cyclocopter at Micro Air Vehicle Scale,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Cornell University, NY, April 25-26, 2014.
- (Third place in the undergraduate category)*
125. Mullins, J., **Benedict, M.**, and Chopra, I., “Design and Development of a Flying Cyclocopter,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, University of Maryland, MD, April 5-6, 2013.
- (Second place in the undergraduate category)*
126. Shrestha, E., **Benedict, M.**, and Chopra, I., “Autonomous Hover Capability of Cycloidal-Rotor Micro Air Vehicle,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Pennsylvania State University, PA, April 13-14, 2012.
- (First place in the undergraduate category)*
127. Jarugumilli T., **Benedict, M.**, and Chopra, I., “Understanding the Effects of Number of Blades and Rotor Configuration on MAV-Scale Cycloidal Rotor Performance,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Charlottesville, VA, April 8-9, 2011.
- (Second place in the undergraduate category)*
128. Seshadri, P., **Benedict, M.**, and Chopra, I., “Aerodynamics and Control Towards A Biomimetic Hovering Flapping Wing Vehicle,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Charlottesville, VA, April 8-9, 2011.
129. Shrestha, E., **Benedict, M.**, and Chopra, I., “Design and Control of a Cycloidal Rotor Aircraft,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Charlottesville, VA, April 8-9, 2011.
130. Elliot, J.B., **Benedict, M.**, and Chopra, I., “Design and Control of a MAV Scale Quad Rotor Cyclocopter,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Blacksburg, VA, April 9-11, 2010.
131. Jarugumilli T., **Benedict, M.**, and Chopra, I., “Experimental Optimization and Performance Analysis of a MAV Scale Cycloidal Rotor,” Presented at the American

Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Blacksburg, VA, April 9-11, 2010.

*(First place in the undergraduate category)*

132. Seshadri, P., **Benedict, M.**, and Chopra, I., “Design and development of an insect based flapping wing micro air vehicle,” Presented at the American Institute of Aeronautics and Astronautics, Region I-MA, Student Conference, Norfolk, VA, April 3-4, 2009.

*\* Students advised by Dr. Moble Benedict at Texas A&M University*

## INVITED PRESENTATIONS

1. **Benedict, M.**, “Novel VTOL Micro Air Vehicle Concepts”, Invited seminar at Texas Systems Day, TAMU, College Station, March 31, 2017.
2. **Benedict, M.**, “Cycloidal Propulsion System: From UAVs to AUVs”, Invited seminar at the Naval Surface Warfare Center, Carderock, MD, October 17, 2016.
3. **Benedict, M.**, “Novel Unmanned Aerial Vehicle Concepts”, Invited seminar at M.A. College of Engineering, Kerala, India, December 11, 2014.
4. **Benedict, M.**, “Novel Hover-Capable MAV Concepts”, Invited seminar at Bell Helicopters, Dallas, TX, October 24, 2014.
5. **Benedict, M.**, “Novel Hover-Capable MAV Concepts”, Invited seminar at Aerospace Engineering Seminar Series, Texas A&M University, College Station, TX, February 26, 2014.
6. **Benedict, M.**, “Cyclogiros: A Myth to Reality”, Invited seminar at the United States Air Force Academy, Colorado Springs, CO, April 22, 2013.
7. **Benedict, M.**, and Chopra, I., “Design and Development of an Unconventional VTOL Micro Air Vehicle: The Cyclocopter”, Invited talk at the SPIE sponsored Micro- and Nanotechnology Sensors, Systems, and Applications Conference, Baltimore, MD, April 23 – 27, 2012.
8. **Benedict, M.**, “Design and Fabrication of an Aeroelastically Tailored Wing for a Flapping Wing Mini Air Vehicle”, Invited talk at the National Seminar on Micro Aerial Vehicles organized by Institution of Engineers (India), Pune, India, February 28, 2004.

## NEWS MEDIA REPORTS

“Ahead of the Jetsons: Texas A&M engineers to build flying motorcycle”, **Houston Chronicle**, May 2019. ([link](#))

“After More Than a Century, the Cyclocopter Is Making a Comeback”, **Popular Mechanics**, April 2019. ([link](#))

“Texas A&M Team wins second round of Boeing backed flight device competition”, **Houston Innovation Map**, April 2019. ([link](#))

“Aggie engineering group's design for flying vehicle taking off”, **The Eagle**, April 2019. ([link](#))

“Texas A&M’s Harmony Team develops personal flying machine for Boeing’s GoFly Prize Competition”, **The Battalion**, April 2019. ([link](#))

“Meet the 5 Winners Of GoFly Phase II”, **GoFly Prize**, March 2019. ([link](#))

“GoFly Prize Picks eVTOL Personal Fliers, Heads Toward Flyoff”, **Aviation Week**, March 2019. ([link](#))

“Would You Fly On These? Boeing-Funded Contest To Develop Personal Aircraft Picks 5 Finalists”, **Forbes**, March 2019. ([link](#))

“Russian military is building a flying vehicle with rotating paddles”, **NewScientist**, March 2019. ([link](#))

“Personal flying machine designs revealed in Boeing GoFly contest”, **CNN Travel**, June 2018. ([link](#))

“Contest Aims to Lift Personal Flying Machines Off the Page”, **New York Times**, June 2018. ([link](#))

“Military robots are getting smaller and more capable”, **The Economist**, December 2017. ([link](#))

“Paddlewheel Propulsion is now Vertical and Multi-Modal”, **AHS Vertiflite Magazine**, July 2017. ([link](#))

“Tiny drones, big questions”, **Aerospace America**, February 2017. ([link](#))

“World's Smallest Cyclocopter Brings Unique Design to Microdrones”, **IEEE Spectrum**, Nov 10, 2016. ([link](#))

“Robotic Hummingbird”, **IEEE Spectrum**, May 8, 2015. ([link](#))

“Mutant Quadrotor MAV Lifts Off After a Century of Development”, **IEEE Spectrum**, July 22, 2011. ([link](#))

## INTELLTUAL PROPERTY AND TECHNOLOGY COMMERCIALIZATION

### PATENTS

1. **Title:** A Non-Contact, Gas-Driven Bearing Using a Continuous Gas Curtain and Supersonic Flow for Levitation at Millimetric Heights, U.S. Patent Application No. 62/394,626 (*patent granted, 2019*)  
*Lead Inventor:* Adonios Karpetis; *Co-inventors:* Dean Ellis, **Moble Benedict**, Yogesh Babbar
2. **Title:** Cycloidal Rotor Micro Air Vehicle, U.S. Patent Application No. 62/441,719 (*full patent filed, 2018*)  
*Lead Inventor:* **Moble Benedict**; *Co-inventors:* Carl Runco, David Coleman
3. **Title:** Hybrid Aerial/Ground Transformer Robot Capable of Multi-Modal Locomotion, U.S. Patent Application No. 62/508,640 (*full patent filed, 2018*)  
*Lead Inventor:* **Moble Benedict**; *Co-inventors:* Hunter Denton, Vikram Hrishikeshavan
4. **Title:** Hover-Capable Flapping-Wing Aircraft, U.S. Patent Application No. 62/608,528 (*full patent filed, 2018*)  
*Lead Inventor:* **Moble Benedict**; *Co-inventor:* David Coleman
5. **Title:** Hover-Capable Aircraft, U.S. Patent Application No. 62/685,323 (*full patent filed, 2019*)  
*Lead Inventor:* **Moble Benedict**; *Co-inventors:* David Coleman, Carl Runco, Atanu Halder, Bochan Lee, Andrew Riha, Farid Saemi, Vishaal Subramanian, Eric Greenwood, Vinod Lakshminarayan,
6. **Title:** Air Launched Hover-Capable Rotary-Wing Aircraft, U.S. Patent Application No. 62/852,906 (*provisional patent filed, 2019*)  
*Lead Inventor:* **Moble Benedict**; *Co-inventors:* Hunter Denton, Hao Kang, Vikram Hrishikeshavan
7. **Title:** Vertical Flight Aircraft Autonomous Landing Using a Visual Cue, U.S. Patent Application No. 62/978,458 (*provisional patent filed, 2020*)  
*Lead Inventor:* Bochan Lee; *Co-inventors:* **Moble Benedict**

### START-UP COMPANIES

Dr. Benedict founded *Harmony Aeronautics LLC* as a direct spin-off from the Boeing GoFly effort to develop and commercialize a personal flying vehicle. The ultimate goal is to foster development of safe, quiet, ultra-compact, vertical take-off and landing capable personal flying vehicles, which could be used for a wide range of applications both in commercial as well as military sectors. The company has raised significant funds. With this funding, the company has already started developing early stage prototypes based on the licensed technology.

## FUNDED RESEARCH PROJECTS

### EXTERNAL GRANTS

1. Project Title: *Aeromechanics, Flight Dynamics and Control of a Revolutionary Tube –Launched Rotorcraft*  
Source of Support: U.S. Army Research Office.  
Period Covered: 05/14/2019 – 05/13/2024  
Award Amount: \$386,516 Total, PI (100%).
2. Project Title: *A Novel Amphibious Platform with Stowable Cycloidal Propellers*  
Source of Support: Office of Naval Research.  
Period Covered: 06/01/2018 – 05/30/2019  
Award Amount: \$200,000 Total, PI (60%).
3. Project Title: *Dynamics and Control of Hummingbird Inspired Aerial Robots*  
Source of Support: National Science Foundation.  
Period Covered: 07/01/2017 – 06/30/2020  
Award Amount: \$242,241 Total, PI (100%).
4. Project Title: *Scalable Novel Configurations for UAS Applications*  
Source of Support: Army/Navy/NASA’s Vertical Lift Research Center of Excellence.  
Period Covered: 11/25/2016 – 09/29/2021  
Award Amount: \$ 878,974 Total, PI (85%).
5. Project Title: *Phase II IUCR: Center for Unmanned Air Systems C-UAS*  
Source of Support: National Science Foundation.  
Period Covered: 03/15/2020 – 02/28/2022  
Award Amount: \$200,000 Total, Co-PI (20%).
6. Project Title: *Low Thrust Trajectory Optimization*  
Source of Support: Technology Service Corporation.  
Period Covered: 08/01/2018 – 05/31/2019  
Award Amount: \$170,000 Total, Co-PI (20%) with Dr. John Junkins and Dr. Manoranjan Majji.
7. Project Title: *Model-Based Engineering for Design Space Exploration of VTOL UASs*  
Source of Support: U.S. Army Research Office.  
Period Covered: 08/01/2017 – 08/27/2019  
Award Amount: \$142,000 Total, PI (100%).
8. Project Title: *Development of the RSQ Personal Drone Prototype*  
Source of Support: RSQ-Systems.  
Period Covered: 10/01/2017 – 09/30/2018  
Award Amount: \$100,000 Total, PI (100%).



9. Project Title: *Conceptual Modeling of Novel Configurations for UAS Applications*  
Source of Support: Army/Navy/NASA's Vertical Lift Research Center of Excellence.  
Period Covered: 10/01/2014 – 09/30/2017  
Award Amount: \$450,000 Total, Co-PI (50%) with Dr. Inderjit Chopra (UMD).
10. Project Title: *Highly-Maneuverable, High-Speed, Optimized Next-Generation Micro Cyclocopter*  
Source of Support: U.S. Army Research Office.  
Period Covered: 06/01/2018 – 05/30/2019  
Award Amount: \$342,000 Total, PI (100%).
11. Project Title: *Control of Cyclocopter for Aggressive Maneuvers and in Gusty Environments*  
Source of Support: U.S. Army Research Office.  
Period Covered: 08/15/2015 – 08/14/2016  
Award Amount: \$100,000 Total, Co-PI (50%) with Dr. Inderjit Chopra (UMD).
12. Project Title: *Instrumentation for Performance, Blade Loads and Flowfield Measurement of Novel Hover-Capable Meso-Scale Aerial Platforms (Defense University Research Instrumentation Program, DURIP)*  
Source of Support: U.S. Army Research Office.  
Period Covered: 08/15/2015 – 08/14/2016  
Award Amount: \$107,630 Total, PI (100%)

### INTERNAL GRANTS

13. Project Title: *2018 T3 Program*  
Source of Support: Texas A&M University.  
Period Covered: 04/01/2018 – 03/31/2020  
Award Amount: \$32,000 Total, Co-PI (30%) with Dr. Ryan Ewing and Dr. John Valasek.

### **PROFESSIONAL SERVICE**

**Faculty Advisor:** American Helicopter Society TAMU Student Chapter

**Society Membership:**

AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS, Senior Member  
AMERICAN HELICOPTER SOCIETY, Member

**Peer Reviews:**

JOURNAL OF AIRCRAFT (AIAA)  
Reviewer, 2011 onwards  
JOURNAL OF THE AMERICAN HELICOPTER SOCIETY

Reviewer, 2011 onwards  
AIAA JOURNAL  
Reviewer, 2013 onwards  
JOURNAL OF FLUIDS AND STRUCTURES (Elsevier)  
Reviewer, 2013 onwards  
JOURNAL OF INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES  
Reviewer, 2013 onwards  
THE AERONAUTICAL JOURNAL, ROYAL AERONAUTICAL SOCIETY  
Reviewer, 2014 onwards  
JOURNAL OF SHIP RESEARCH  
Reviewer, 2015 onwards  
JOURNAL OF GUIDANCE, CONTROL AND DYNAMICS (AIAA)  
Reviewer, 2015 onwards  
IEEE TRANSACTIONS ON ROBOTICS  
Reviewer, 2016 onwards  
NATURE ENERGY  
Reviewer, 2016 onwards  
BIOINSPIRATION & BIOMIMETICS  
Reviewer, 2017 onwards  
INTERNATIONAL JOURNAL OF MICRO AIR VEHICLES  
Reviewer, 2019 onwards  
AIAA SCIENCE AND TECHNOLOGY FORUM (SCITECH)  
Abstract reviewer, 2017 onwards  
AIAA AVIATION CONFERENCE  
Abstract reviewer, 2016 onwards

## DEPARTMENT AND UNIVERSITY SERVICE

- Led a multi-disciplinary team of 8 engineering graduate students from TAMU and researchers from NASA Langley, and NASA Ames, which was selected as *one of the 10 Phase-I winners* (out of 600 global entries) as well as *one of the 5 Phase-II winners* of the **Boeing GoFly X-Prize**, a two-year, \$2 million international competition to create a personal flying device ([link](#)).
- One of the two faculty advisors to the Aerospace Hyperloop team, which is the only A&M team that proceeded to the build/test stage of the SpaceX Hyperloop competition.
- Introduced a new helicopter track in Camp Soar 2015/16/17/18, which is a high school summer camp offered by the Aerospace Department.
- One of the few faculty members leading Aerospace Engineering in the Physics and Engineering Festival.
- Was a member of the Strategic Aerospace Research Committee.
- Represented Aerospace Department at Center for Infrastructure Renewal Building Committee.
- Delivered sophomore seminars to get the in-coming sophomores excited about aerospace and the opportunities it offers.
- Re-instated the American Helicopter Society (AHS) student chapter (faculty advisor).

## MEMBERSHIP ON GRADUATE DEGREE CANDIDATES COMMITTEES

Student Name	Degree	Student Name	Degree
David Coleman	PhD	Carolyn Walther	MS
Carl Runco	PhD	Bochan Lee	MS
Xuan Yang	PhD	Adam Kellen	MS
Atanu Halder	PhD	Hunter Denton	MS
Bochan Lee	PhD	Sunsoo Kim	MS
Farid Saemi	PhD	Thomas Fowler	MS
Sunsoo Kim	PhD	Venkata Tadiparthi	MS
Alexandre Berger	PhD	Justin Barnes	MS
Benjamin Wilcox	PhD	Han-Hsun Lu	MS
Zachary Adams	PhD	Cameron Rogers	MS
(Purdue University)		Jaewon Kim	MS
		Krista Kratty	MS

## RECORD OF STUDENT ADVISEES

<u>Doctoral Students</u>	<u>Status</u>	<u>Expected Graduation</u>
Atanu Halder	Graduated (Continuing as postdoc)	Aug 2019
David Coleman	In progress, 6 <sup>th</sup> year (Proposal: June 2017)	May 2020
Carl Runco	In progress, 6 <sup>th</sup> year (Proposal: February 2018)	May 2020
Xuan Yang	In progress, 6 <sup>th</sup> year (Proposal: July 2017)	May 2020
Bochan Lee	In progress, 4 <sup>th</sup> year	Aug 2021
Farid	In progress, 3 <sup>rd</sup> year	Aug 2022

<u>Masters Students</u>	<u>Status</u>	<u>Expected Graduation</u>
Carolyn Walther	Graduated (At Boeing)	Aug 2017
Bochan Lee	Graduated (Continuing for PhD)	May 2018
Adam Kellen	Graduated (At SWRI)	May 2019
Hunter Denton	In progress, 3 <sup>rd</sup> year	Dec 2020

<u>Undergraduate Students</u>	<u>Project</u>	<u>Graduation</u>
Adam Kellen	Develop a UAV-scale cycloidal rotor test rig.	May 2016
Hunter Denton	Develop of a robot capable of multi-modal locomotion.	May 2017
Brett Himmelberg	Measurements on a meso-scale cycloidal rotor.	May 2017
Farid Saemi	Develop servo actuation system for cycloidal rotor blades.	May 2017
Israel Casillas	Develop a folding-wing VTOL UAV.	Dec 2016
Rhett Moffett	Develop a variable-pitch vertical axis wind turbine.	May 2016
Rylan Hunter	Performance measurements on micro helicopter rotors.	Dec 2016
Suh Sukongwi	Force measurements on a high-frequency flapping wing.	May 2017
Mackenzie Breeze	Experimental studies on a variable-pitch vertical axis wind turbine.	Current UG
William Manson	Develop a novel insect-inspired rotor.	Dec 2017
Daniel Martin	Develop a small-scale Martian helicopter rotor.	May 2018

Bryan Hutzler	Develop a novel underwater propeller.	May 2018
Nicholas Lastrapes	Develop a test rig to measure the forces and flowfield on a cycloidal rotor blade at high Reynolds numbers.	May 2018
Kanika Gakhar	Lift measurements of a robotic hummingbird wing.	May 2018
Eghosasere Alao	Develop a folding-wing VTOL UAV.	Current UG
Sean McHugh	Develop an amphibious underwater platform.	May 2018
James McElreath	Force and flowfield measurements on cycloidal rotors.	Current UG
Joel White	Develop a UAV-scale cyclocopter.	Current UG
Jose Lacal	Develop a cycloidal propeller based underwater vehicle.	May 2018
Kristian Wade	Develop a cycloidal propeller based underwater vehicle.	May 2018
Michael Ritz	Develop a cycloidal propeller based underwater vehicle.	May 2018
Morgan Harmon	Develop a multi-modal air/ground transformer platform.	Current UG
Chase Wiley	Develop an amphibious underwater platform.	Current UG
Ramsay Ramsey	Develop an amphibious underwater platform.	Current UG
Jeffrey McShan	Develop a folding-wing VTOL UAV.	Dec 2016
Grant Erickson	Develop a quad-copter with tethered power.	Current UG
Joseph Heimerl	Develop a space debris capture mechanism.	Current UG

### VISITING SCHOLARS MENTORED

Yi Yang	01/01/2016 – 12/31/2016	Professor at Hunan University, China
Jianwei Sun	05/15/2016 – 08/20/2016	Student at Harbin University, China
Lovely Purbey	05/01/2017 – 07/14/2017	Student at Indian Institute of Technology, Kharagpur, India

### RECORD OF TEACHING

Course Number	Course Title	Level	Sem/Year	Course Assistance	Teaching Evaluation Score (out of 5)
AERO 689	Helicopter Design-III	Graduate	Spring/2019	None	4.88
AERO 310	Aerospace Dynamics	UG	Spring/2019	½ TA	4.20
AERO 689	Helicopter Design-II	Graduate	Fall/2018	None	4.61
AERO 302	Aerospace Engineering Laboratory	UG	Fall/2018	(With N. Tichenor and M. Naraghi)	3.95
AERO 455	Helicopter Aerodynamics	UG	Fall/2018	None	4.52
AERO 655	Helicopter Aerodynamics	Graduate	Fall/2018	None	4.50

AERO 310	Aerospace Dynamics	UG	Spring/2018	½ TA	4.42
AERO 689	Helicopter Design-I	Graduate	Spring/2018	None	4.43
AERO 302	Aerospace Engineering Laboratory	UG	Spring/2018	(With N. Tichenor and M. Naraghi)	3.59
AERO 302	Aerospace Engineering Laboratory	UG	Fall/2017	(With N. Tichenor and M. Naraghi)	3.99
AERO 302	Aerospace Engineering Laboratory	UG	Spring/2017	(With N. Tichenor and M. Naraghi)	3.79
AERO 489	Helicopter Aerodynamics	UG	Fall/2016	None	4.23
AERO 689	Helicopter Aerodynamics	Graduate	Fall/2016	None	4.38
AERO 302	Aerospace Engineering Laboratory	UG	Fall/2016	(With N. Tichenor and M. Naraghi)	3.44
AERO 310	Aerospace Dynamics	UG	Spring/2016	Grader	4.57
AERO 489	Hyperloop Design	UG	Spring/2016	None	5.00
AERO 489	Helicopter Aerodynamics	UG	Fall/2015	None	4.35
AERO 489	Hyperloop Design	UG	Fall/2015	None	3.00
AERO 689	Helicopter Aerodynamics	Graduate	Fall/2015	None	4.63
AERO 310	Aerospace Dynamics	UG	Spring/2015	1 TA	4.43

### **SPECIAL TEACHING ACTIVITIES**

- Taught two project-based design courses towards Hyperloop competition.
- Taught three project-based helicopter design courses focused on GoFly Challenge.