Chad R. Frost

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Subjects of interest

My current areas of research and application interest include architecture of multi-spacecraft missions and vehicle swarms; command and control of heterogenous mixtures of vehicle types and classes; advanced manufacturing technologies for small and nanospacecraft; and new mission design methodologies including optimization approaches. These interests are today principally implemented by staff, although I maintain an active role in initiating and guiding the work.

Professional experience

2020 - present Chief Technologist, Engineering Directorate, NASA Ames Research Center.

2018 - 2019 Acting Director of Engineering, NASA Ames Research Center.

2015 - 2018, 2019 - 2020 Deputy Director of Engineering, NASA Ames Research Center.

2012 - 2015 Chief, Mission Design Division. NASA Ames Research Center.

2007 - 2012 Autonomous Systems and Robotics Technical Area Lead, Intelligent Systems Division. NASA Ames Research Center.

2007 - 2011 Co-PI, Spacecraft Handling Qualities Center of Excellence. NASA.

2007 Collaborative and Assistant Systems Technical Area Lead, Intelligent Systems Division. NASA Ames Research Center.

2006 - 2007 Associate Principal Investigator, responsible for Flight Dynamics and Control element of the Subsonic - Rotary-Wing project within NASA's Fundamental Aeronautics program.

2005 - 2007 Collaborative and Assistant Systems Technical Area Deputy Lead, Intelligent Systems Division. NASA Ames Research Center.

2005 - 2006 Intelligent Mission Management L3 project manager, Autonomous Robust Avionics Project. NASA.

2004 - 2005 Deputy Chief (Acting), Flight Control and Cockpit Integration Branch, Army/NASA Rotorcraft Division. NASA Ames Research Center.

2003 - 2005 Intelligent Autonomous Architectures lead, Autonomous Robust Avionics Project. NASA.

2002 - 2004 Assistant Chief, Flight Control and Cockpit Integration Branch, Army/NASA Rotorcraft Division. NASA Ames Research Center.

2000 - 2004 Control Systems Engineer, Flight Control and Cockpit Integration Branch, Army/NASA Rotorcraft Division. NASA Ames Research Center.

1999 - 2000 Senior Research Engineer, Cal Poly Foundation and San Jose State University Foundation. US Army Aeroflightdynamics Directorate.

1995 - 1996 Program manager, Spacecraft Structures, Applied Aerospace Structures Corp.

1991 - 1995 Project engineer, Preece Inc.

1986 - 1988 Firefighter, United States Forest Service.

Education

1997 MSc in Aerospace Engineering, California Polytechnic State University, San Luis Obispo
Advisors: Dr. Daniel Biezad (Cal Poly), Dr. Mark Tischler (U.S. Army Aeroflightdynamics Directorate)

1990 BSc in Aerospace Engineering, California Polytechnic State University, San Luis Obispo

Training/Continuing Education

2017 FAC-COR Contracting Officer's Representative 40-hour training.

2016 - 2017 Leveraging Agency Supervisory Excellence and Resilience (LASER). 14-month cohort program developing line supervisors, NASA HQ Office of Human Capital.

2015 Congressional Operations Seminar (Government Affairs Institute, Washington D.C.)

2012 NASA Leading Through Influence.

2006 NASA Business Education Program.

2004 Strategic Leadership Boot Camp. Year-long cohort program to develop high-potential future leaders at NASA Ames Research Center.

2003 Art of Leadership Mastery.

2003 Presenting Data and Information. Edward Tufte.

2001 Interactive Development of Engineers, Administrators and Scientists (IDEAS). Year-long cohort program at NASA Ames Research Center.

Service to the profession

Engineering Industry Advisory Council, San Jose State University

2016 - present Member

American Institute of Aeronautics and Astronautics

2007 Associate Fellow

Atmospheric Flight Mechanics Technical Committee:
2002 - 2009 Member
2006 - 2009 Handling Qualities Subcommittee Chair
2004 - 2006 Publications Subcommittee Chair

Reviewer for Journal of Aircraft, Journal of Guidance, Control and Dynamics, Journal of Aerospace Computing, Information, & Communication and Journal of Spacecraft and Rockets.

American Helicopter Society

1986 - 2012 Member
2003 - 2009 Handling Qualities Technical Committee member

San Francisco Bay Area chapter:
2000 - 2001 President
1999 - 2004 Board of directors

Honors & awards

2016 Ames Honor Award - Capabilities Leadership Team.

2015 NASA Group Achievement Award - Quantum Applications of Integrated Learning Team.

2014 Space Flight Awareness Team Award - for contributions to human spaceflight programs.

2010 Aeronautics Directorate Technical Excellence in Publications Award - for paper "Dynamic Coupling and Control Response Effects on Spacecraft Handling Qualities During Docking".

2009 Ames Honor Award - Wildfire Research and Applications Partnership team.

2008 NASA Group Achievement Award - Wildfire Research Applications Partnership.

2008 NASA Certificate of Recognition - in appreciation for Federal Laboratory Consortium for Technology Transfer Far West Region Outstanding Partnership Award to the Wildfire Research and Applications Partnership (WRAP) project.

2008 NASA Group Achievement Award - Western States UAS Fire Mission Team.

2008 AIAA Distinguished Service award - Atmospheric Flight Mechanics Technical Committee.

2007 AIAA Associate Fellow.

2007 Ames Honor Award - Lunar Landing Handling Quality Simulation Team.

2007 Ames Honor Award - Western States UAS Fire Mission Team.

2007 AIAA Aerospace Software Engineering Award - for (team) development and industry adoption of CONDUIT.

2005 Schroers Award for Outstanding Rotorcraft Research, San Francisco Bay Area Chapter of the American Helicopter Society - for the Autonomous Rotorcraft Project (team).

2004 Best Paper Award, AHS International Forum Avionics and Systems session - with co-authors, for "In-flight Assessment of a Pursuit Guidance Display Format for Manually Flown Precision Instrument Approaches".

2003 NASA Group Achievement Award - Rotorcraft Aircrew Systems Concepts Airborne Laboratory (RASCAL) Team, for successfully developing and qualifying America's only full-authority variable stability helicopter.

2002 Outstanding Contribution to the Local Chapter, San Francisco Bay Area Chapter of the American Helicopter Society.

2001 Schroers Award for Outstanding Rotorcraft Research, (with team) San Francisco Bay Area Chapter of the American Helicopter Society - for development of the RASCAL fly-by-wire Black Hawk helicopter.

2001 NASA Turning Goals Into Reality award, (with team) - for successfully deploying CONDUIT on numerous government and industry flight control projects.

1998 Schroers Award for Outstanding Rotorcraft Research, (with team) San Francisco Bay Area Chapter of the American Helicopter Society - for development of the Control Designer's Unified Interface (CONDUIT) software.

1987 Co-recordholder, World's first flight of a human-powered helicopter, National Aeronautic Association.

Patents

2018 Nakamura, Faber, **Frost** and Alena: US 9,906,291 B1 Heterogenous Spacecraft Networks.

Publications & Presentations

Book chapters

2011 **Frost, C**. "Challenges and Opportunities for Autonomous Systems in Space". In: *Frontiers of Engineering: Reports on Leading-Edge Engineering from the 2010 Symposium.* National Academy Press.

Talks & Interviews

2018 **Chad Frost**, Mary Beth Wilhelm, Scott Manley and Matthew Buffington: "NASA in Silicon Velley Live - Let's Play Space Video Games!" https://www.nasa.gov/ames/nisv-podcast-live-lets-play-space-video-games

2018 **Chad Frost** and Susan De La Cruz, "Building the next generation of the Nation's wildlife tracking system". USGS Innovation Center 5th Anniversary Colloquium 2018, Reston, VA. February 28, 2018.

2018 **Chad Frost**, Mary Beth Wilhelm, Thomas Lambot, Matthew Buffington and Abby Tabor:"NASA in Silicon Valey Live - Ep. 05 - Let's Play Space Video Games!" https://www.nasa.gov/ames/nisv-podcast-live-Ep3-Lets-Play-Space-Video-Games

2018 "**Chad Frost** and Susan De La Cruz talk about the 'Social Networks' of wildlife" NASA in Silicon Valley podcast, Feb 23, 2018. https://www.nasa.gov/ames/nisv-podcast-Chad-Frost-Susan-de-La-Cruz

2016 **Chad Frost** "Environmental awareness of ecosystems using next - generation technology" USGS Innovation Center workshop on Ecosystems in a Changing World, Dec 2016.

2015 **Chad Frost** "Horizons in Smallsat applications" USGS Innovation Center workshop on A World of Changing Climate and Land Use, Dec 2015.

2013 **Chad Frost** interviewed in "NASA's 'PhoneSat' program points to satellites of the future" EDN.com, June 12, 2013. https://www.edn.com/electronics-blogs/now-hear-this/4416264/NASA-s--PhoneSat--program-points-to-satellites-of-the-future-

2010 "**Chad Frost** shares stories from NASA's autonomous systems and robotics department and his thoughts on civilian usage of UAVs." DIYDrones podcast, Jan 11, 2010. https://diydrones.com/profiles/blogs/chad-frost-shares-stories-from

Refereed research papers

2017 Mazhari, Arash Alex, Diana M. Acosta, and **Chad R. Frost**. "Strengthening innovation at NASA Ames Research Center by encouraging prototyping and collaboration." IEEE Aerospace Conference, 2017.

2016 Descamps, Arthur and **Frost, Chad** "XCube Project: Use of U-class Standard for Embedded Experiments, a Clean and Cost Effective Path, From Labs to Orbit" 13th Annual CubeSat Developers Workshop, Cal Poly State University, San Luis Obispo, CA April 20-22, 2016.

2016 Yang Yang, F., Nelson, B., Aziz, J., Carlino, R., Perez, A., Faber, N., Foster, C., **Frost, C**., Henze, C., Karacalıoğlu, A., Levit, C., Marshall, W., Mason, J., O'Toole, C., Swenson, J., Worden, S., and Stupl, J. LightForce photon-pressure collision avoidance: Efficiency analysis in the current debris environment and long-term simulation perspective. *Acta Astronautica* 126 (2016) 411–423.

2016 Nayak, M., Mauro, D., Stupl, J., Aziz, J., Colaprete, A., Dono-Perez, A., **Frost, C**., Jonsson, J., McKay, C., Sears, D. and Soulage, M., 2016. The Plume Chaser mission: Two-spacecraft search for organics on the dwarf planet Ceres. *Advances in Space Research*, 57(5), pp.1133-1146.

2015 M Busch, N Faber, S Eggl, D Morrison, A Clark, **C Frost**, BA Jaroux, V Khetawat. Mission Designs for Demonstrating Gravity Tractor Asteroid Deflection. AGU Fall Meeting, San Francisco.

2015 Jonsson, J., Mauro, D., Stupl, J., Nayak, M., Aziz, J., Cohen, A., Colaprete, A., Dono-Perez, A., **Frost, C**., Klamm, B. and McCafferty, J., 2015. Cost-Effective Icy Bodies Exploration using Small Satellite Missions. In: *Proceedings of the 66th International Astronautical Congress (IAC 2015)*; 12-16 Oct. 2015; Jerusalem; Israel

2014 Faber, N., Y. Nakamura, R. Alena, D. Mauro, **C. Frost**, G. Bhat, and J. McNair. "Heterogeneous Spacecraft Networks: General Concept and Case Study of a Cost-effective, Multi-Institutional Earth Observation Platform" In: *Proceedings of the 2014 IEEE Aerospace Conference.*

2014 Nakamura, Y., N. Faber, D. Mauro, R. Alena, **C. Frost**, G. Bhat, and J. McNair. "Heterogeneous Spacecraft Networks: Performance Analysis for Low-cost Earth Observation Missions." In: *Proceedings of the 2014 IEEE Aerospace Conference.*

2014 **Frost, C**. Expanding the Global Sensor Web with Cubesats. 11th annual Cubesat Developers Workshop, April 23-25, 2014 San Luis Obispo, California.

2011 Mueller, E., K. Bilimoria, and **C. Frost**. Effects of control power and inceptor sensitivity on lunar lander handling qualities. *Journal of Spacecraft and Rockets* 48(3), 454.

2010 Mueller, E., K. Bilimoria, and **C. Frost**. Improved Lunar Lander Handling Qualities Through Control Response Type and Display Enhancements. In: *Proceedings of the American Institute of Aeronautics and Astronautics (AIAA) Guidance, Navigation, and Control (GNC) Conference*, Toronto, Canada.

2009 Bilimoria, K., E. Mueller, and **C. Frost**. Handling Qualities Evaluation of Pilot Tools for Spacecraft Docking in Earth Orbit. In: *Proceedings of the American Institute of Aeronautics and Astronautics (AIAA) Guidance, Navigation, and Control (GNC) Conference*, Chicago, Illinois.

2009 Mueller, E., K. Bilimoria, and **C. Frost**. Dynamic Coupling and Control Response Effects on Spacecraft Handling Qualities During Docking. *Journal of Spacecraft and Rockets* 46(6).

2009 Mueller, E., K. Bilimoria, and **C. Frost**. Effects of Control Power and Inceptor Sensitivity on Lunar Lander Handling Qualities. In: *Proceedings of the Space 2009 Conference and Exposition.* AIAA-2009-6407. American Institute of Aeronautics and Astronautics.

2007 Lutz, R., A. Patterson-Hine, S. Nelson, **C. Frost**, D. Tal, and R. Harris. Using obstacle analysis to identify contingency requirements on an unpiloted aerial vehicle. *Requirements Engineering* 12(1), 41–54.

2007 Jarvis, P., R. Harris, and **C. Frost**. Evaluating UAS Autonomy Operations Software In Simulation. In: *AIAA Infotech@Aerospace 2007 Conference and Exhibit.*

2006 **Frost, C.** and G. Tucker. If You've Got It, Use It (Simulation, That Is...) In: *Proceedings of the AIAA Atmospheric Flight Mechanics Conference*, Keystone, CO.

2005 Freed, M., P. Bonasso, K. Dalal, W. Fitzgerald, **C. Frost**, and R. Harris. An architecture for intelligent management of aerial observation missions. In: *Infotech@Aerospace*. AIAA-2005-6938. Arlington, VA.

2005 Lutz, R., S. Nelson, A. Patterson-Hine, **C. Frost**, and D. Tal. Identifying contingency requirements using obstacle analysis. In: *Proceedings of the 13th IEEE International Conference on Requirements Engineering*. IEEE, pp.263–272.

2005 Schoenung, S., S. Wegener, J. Frank, **C. Frost**, M. Freed, and J. Totah. Intelligent UAV airborne science missions. *Infotech@Aerospoace*, 1–12.

2004 Moralez, E., G. E. Tucker, W. S. Hindson, **C. R. Frost**, and G. H. Hardy. In-Flight Assessment of a Pursuit Guidance Display Format for Manually Flown Precision Instrument Approaches. In: *Proceedings of the American Helicopter Society 60th Annual Forum.* Baltimore, Maryland.

2004 Sullivan, D. et al. Intelligent mission management for uninhabited aerial vehicles. In: *Proc. SPIE*. Vol. 5661, pp.121–131.

2004 Wegener, S. et al. UAV autonomous operations for airborne science missions. In: *Proceedings of the American Institute for Aeronautics and Astronautics 3rd "Unmanned. . . Unlimited" Technical Conference.*

2002 **Frost, C.**, J. Franklin, and G. Hardy. Evaluation of Flying Qualities and Guidance Displays for an Advanced Tilt-Wing STOL Transport Aircraft in Final Approach and Landing. In: *Proceedings of the Biennial International Powered Lift Conference and Exhibit.* Williamsburg, Virginia.

2002 **Frost, C.**, W. Hindson, E. Moralez, G. Tucker, and J. Dryfoos. Design and testing of flight control laws on the RASCAL research helicopter. In: *Proceedings of the American Institute of Aeronautics and Astronautics Modeling and Simulation Technologies Conference.* Monterey, CA.

2002 Moralez, E. et al. Flight Research Qualification of the Army/NASA RASCAL Variable-Stability Helicopter. In: *Proceedings of the American Helicopter Society 58th Annual Forum.* Montreal, Canada.

2000 Colbourne, J. D., L. Cicolani, M. B. Tischler, **C. Frost**, C. Tomashofski, and T. LaMontagne. System Identification and Control System Design for the BURRO Autonomous UAV. In: *Proceedings of the American Helicopter Society 56th Annual Forum.* Virginia Beach, VA.

2000 **Frost, C.**, M. B. Tischler, M. Bielefield, and T. LaMontagne. Design and Test of Flight Control Laws for the Kaman BURRO Unmanned Aerial Vehicle. In: *Proceedings of the AIAA Atmospheric Flight Mechanics Conference.* AIAA-2000-4205.

1999 Colbourne, J. D., **C. Frost**, M. B. Tischler, K. K. Cheung, D. K. Hiranaka, and D. J. Biezad. Control Law Design and Optimization for Rotorcraft Handling Qualities Criteria Using CONDUIT. In: *Proceedings of the American Helicopter Society 55th Annual Forum.* Montreal, Canada.

Published technical reports

2014 **Frost**, C. et al. *Small Spacecraft Technology State of the Art.* Tech. rep. TP-2014-216648/REV1. NASA.

2009 Bailey, R., E. Jackson, K. Bilimoria, E. Mueller, C. **Frost**, and T. Alderete. *Cooper-Harper Experience Report for Spacecraft Handling Qualities Applications.* Technical Memorandum TM-2009-215767. NASA.

2009 **Frost**, C., W. A. Decker, B. T. Sweet, and C. R. Theodore. "Flight Dynamics and Control". In: *A Status of NASA Rotorcraft Research.* Ed. by G. K. Yamauchi and L. A. Young. TP-2009-215369. NASA. Chap. 6.

1998 Tischler, M., J. Colbourne, K. Cheung, C. **Frost**, W. Levine, and V. Moldoveanu. *CONDUIT "The Control Designer's Unified Interface" Course Notes.* Tech. rep. CP-1998-10157.

Thesis

1999 **Frost**, C. "Design and optimization of a rotorcraft flight control system using the Control Designer's Unified Interface (CONDUIT)". MS thesis. California Polytechnic State University, San Luis Obispo.