

# Justin Karl, Ph.D.

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## Objectives

Make direct contributions to the future of human civilization through technically challenging research and development. Inspire a new generation of thinkers and explorers with educational outreach and mentoring.

## Core Competencies

- Research and Development
- Vehicle Design / Integration
- Failure Prediction
- Nondestructive Testing
- Structural Mechanics
- Rapid Prototyping
- Project Management
- Experiment Design

## Current Affiliations

### Lecturer, University of Central Florida, 2013-Present

Space Environment and Payload Instrumentation, Aerodynamics, Solid Mechanics, Dynamics, Machine Design, Design of Aerospace Experiments, Design of Thermofluid Experiments, Fracture Mechanics. Graduate and undergraduate course development and instruction of up to 200+ students per section. Management of multiple laboratories. Consistently rated amongst highest of college faculty in perception of instruction evaluations.

### Founder and Director, Terran Sciences Group LLC, 2012-Present

Leads research and development efforts of a small team of aerospace engineers that focus on state-of-the-art technology projects commercial space and aviation sectors. Provides space technology related solutions to private aerospace companies. Manages consulting contracts and fulfillment, as well as internal technology development.

### Collaborating Researcher, Center for Lunar and Asteroid Surface Science, 2014-Present

Provides engineering and applied science consultation and direction for CLASS node of the Florida Space Institute. Space hardware and experiment design and manufacturing.

### Senior Associate, Space Studies Institute, 2015-Present

Leverages university, industry, and government agency contacts to provide support for research-oriented space advocacy group. In preliminary stages of involvement with archiving, meeting, media, and R&D efforts.

### Payload Coordinator, Citizens in Space Project, US Rocket Academy, 2015-Present

Design, prototyping, and marketing of modular microgravity experiment developer's kit. Provider and overseer of payload development, qualification, and integration procedures and documentation.

## Educational Experience

*University of Central Florida - Orlando, FL*

**Doctor of Philosophy**, Mechanical Engineering – 2013

Dissertation- “Thermomechanical Fatigue Life Prediction of Notched Type 304 Stainless Steel”

*Embry-Riddle Aeronautical University - Daytona Beach, FL*

**Master of Science**, Aerospace Engineering – 2006

Thesis- “Automated Filtering of Acoustic Emission Data Using Frequency Principal Component Extraction”

**Bachelor of Science**, Aerospace Engineering - 2004

**Bachelor of Science**, Engineering Physics - 2004

## Career History

### Head of Engineering Development - Earthrise Space Foundation, 2013

Lead designer and project manager for a non-profit space R&D organization supporting a Google Lunar X-Prize team. Managed team of 10+ full-time aerospace engineers and up to 20+ interns. Held ultimate responsibility for performance of 2-stage lunar payload delivery system and all associated subsystems. Led efforts on additional external R&D projects, including an atmospheric dust sampling system and microgravity payloads.

**Engineering Project Lead - Structural Integrity, Siemens Energy, Inc., 2011-2013**

Managed/performed a wide-scale of activities at a combustion technologies lab facility. New material development and characterization, NDE/NDT methods, failure assessment and resolution. Handling of export-controlled technologies. Scientific problem solving with critical yet nonlinear thinking on a business-urged time scale. Responsible for development of new experimental mechanics methods for high performance energy and aerospace alloys.

**Adjunct Professor/Instructor, University of Central Florida, 2009-2013**

Solid Mechanics, Dynamics, Kinematics, Vibrations. Course development and instruction to 200+ students per section. Consistently high ratings in perception of instruction evaluations.

**Research Assistant, University of Central Florida, 2006-2013**

Development and testing of novel materials, with emphasis on performance and life predictability. Mentored/directed students on projects funded by Air Force and Army Research Labs, Office of Naval Research, Federal Aviation Administration, NASA, and United Space Alliance.

**Testing and Integration Lead - Earthrise Space, Inc. / Omega Envoy, 2008-2012**

Founding member and previous director of ESI, a non-profit space research and awareness company that provided direct support for the Omega Envoy Google Lunar X-Prize team through 2012. Testing and Integration oversight and advisement.

**Lead Researcher - SpaceEdge Research Corp, 2004-2008**

Led efforts at small space-focused research company. Developed avionics, propulsion, and NDE technologies. Consulted on microgravity tool and experiment development.

**Laboratory Instructor, Embry-Riddle Aeronautical University, 2005-2006**

Managed and provided demonstrations and lectures in Composites, Materials, and Structures and Instrumentation laboratories.

***Grant and Large Research Effort Management***

2015, **TSG/UCF/Apogee Engineers** – PI, Fused Deposition Modeling Hybrid Fuel Grain Study

2015, **NASA / FSGC** – PI, Lunar/Mars Regolith Robotic Mining System

2014, **TSG/XCOR** – PI, Fluoropolymer Composite Manufacturing Method Development

2014, **NASA / FSGC** – PI, Hybrid Rocketry Development and Outreach

2013, **Astronaut John “Mike” Lounge Research Seed Grant** – PI, Lunar Regolith Melting via IR Laser

2012, **Siemens Energy** – PI, Crack Length Measurement of Thermomechanical Fatigue Specimens

2010, **NASA ILDD Program** – Co-PI, Lunar Lander Demonstration Data

***Awards and Achievements***

**Professor of the Year**, Awarded by Pi Tau Sigma honor society (2014)

**Lightning Pitch Finalist**, Space Frontier Foundation (2014)

**Kersten Doctoral Fellow**, University of Central Florida Mechanical and Aerospace Engineering (2006-2013)

**Glass Explorer**, Granted hardware from Google, Inc. (2013)

**Featured Designer**, MakerBot Thingiverse – Parametric 3D-printed wind turbine (2012)

**Early Career Technical Presentation Award**, ASME Southeast Region (2007)

**Speaker Award**, CANCEM Applied Mechanics Conference (2007)

**Project Icarus**, ERAU student-built sounding rocket. Consulted on structural and propulsion systems. Range specs met and successfully flown from GSFC/WFF. (2006)

**Kepler Prize Finalist**, Mars-Direct-compatible combination lander/habitat/ERV with heavy focus on ISRU. (2004)

**Martian Aerial Reconnaissance Vehicle (MARV)**, Grant provided by The Mars Society. (2004)

**NASA/NSC Sponsored Opportunity**, Debugged antiquated guidance code. Refurbished ACS systems, verified sounding rocket hardware operations prior to flight readiness reviews. (1997)

### ***Technical Oversight and Advisement***

**High Power Rocket Motor Testing Systems** – Test stand development for high power rockets- temperature, pressure, and force measurement. Feed and restraint systems. (2008-2015)

**Lunar Mining Robotics System** – Advisement of multiple teams for NASA Robotic Mining Challenge. (2013-2015)

**ISRU-Fueled Pulsed Combustion Rocket** – Electrolyzed constituents of water are pulse-combusted to provide thrust for orbit adjustment and deep space missions. (2015)

**Coolant Heat Transfer Efficiency Boosting Devices** – Study of swirl-pot-style phase change devices and impact on efficiency of heat transfer in liquid cooling systems. (2014)

**Automated UAV/Rover Landing and Re-Charge System – Cornell Cup Finalist** - Design and prototyping of UAV/Rover system that allows use of solar-resupplied rover as landing/recharge pad and forward operating base for UAV. (2014-2015)

**On-Orbit Microgravity Intravenous Pump** – Development of IV pump system for use on long duration spaceflights and the ISS. Peristaltic pump system with gas removal. (2014)

**Nano-Textured Solar Cell Production** – Manufacturing method for increasing surface area of PV cells. (2013)

**Uniaxial Mechanical Test Frame** – Simplified desktop creep testing machine with controller. (2012)

**Hydrogen Fuel Cell-Powered UAV** – Extended range UAV with Fuel Cell/Electric primary drive. (2011)

**High-Temperature Extreme Environments Chamber** – Fabrication of environmental chamber used to facilitate high temperature environments with corrosive mists/flows. (2010)

**Human-Powered Vehicle** – Aeroshell design and CFD to support multiple ASME HPV teams. (2008-2009)

**Lightweight 2-Person Hovercraft** – Design through prototype phase of composite hovercraft. Tested and operated in land and water environments, with payload and two passengers. (2008)

### ***Outreach and Mentorship***

**Theta Tau Engineering Fraternity** Faculty Advisor (2015)

**Aviator Knights Flight Club** Faculty Advisor (2015)

**Space Studies Institute Externship** Mentor and Group Lead (2015)

**NASA/SpaceX CRS-5** Operational Observer Group Lead (2015)

**MAE Capstone Design** Multi-team Sponsor (2015)

**Students for the Exploration and Development of Space** Faculty Advisor (2013-2015)

**MAE Seminar Series** KSC NASA Liason (2014)

**Office of Diversity and Inclusion** Minority Engineer Mentor (2014-2015)

**Ig-Knight** Minority Motivation and Guidance Speaker (2014-2015)

**NASA/SpaceX CRS-3** Operational Observer Group Lead (2014)

**NASA/SpaceX CRS-4** Operational Observer Group Lead (2014)

**NASA/ULA Orion EFT-1** Operational Observer Group Lead (2014)

**Space Florida Lander Competition** Judge / Educator Contact (2014)

**The Mars Society** Outreach and Fundraising Liason (2013)

**Earthrise Space Foundation / Earthrise Space, Inc.** Outreach Rover Advisement and Demo Team (2010-2013)

### ***Professional Memberships***

**Aircraft Owners and Pilots Association** – Voting member since 2006

**American Institute of Aeronautics and Astronautics** – Senior Member since 2006

**American Society of Mechanical Engineers** – Professional Member since 2009

**American Society for Testing and Materials** – Participating Member since 2012

**Astronauts4Hire** – Associate Member since 2015

**Experimental Aircraft Association** – Voting Member since 2011

**Space Studies Institute** – Senior Associate Member since 2014

### ***Academic and Professional Service***

Session Chair, AIAA Propulsion and Energy (2015)

Session Chair, 2<sup>nd</sup> Space Habitation Conference (2014)

Session Chair, MAE Graduate Research Days (2014)

Chair, Engineering Mechanics: Dynamics Course Assessment Committee (2014)

Chair, Fundamentals of Aerodynamics Course Assessment Committee (2014)

Member, Mechanical and Aerospace Honors and Awards Committee (2014-2015)

Member, Mechanical and Aerospace Engineering Student Advisement Team (2014-2015)

Member, SACS/ABET Mechanical and Aerospace Engineering Accreditation Committee (2014-2015)

Member, SACS/ABET Dynamics Track Subcommittee (2014-2015)

Member, SACS/ABET Aerodynamics and Fluids Track Subcommittee (2014-2015)

Member, SACS/ABET Solid Mechanics and Machine Design Track Subcommittee (2014-2015)

Member, Fluid Mechanics Course Assessment Committee (2014-2015)

Member, Aerospace Structures Course Assessment Committee (2014-2015)

Member, Vibrations and Controls Course Assessment Committee (2014-2015)

Judge, E-Week AIAA, SEDS, and SPECS Design Competitions (2008-2015)

Judge, Capstone Design Exposition (2009-2015)

### ***Technical Publications***

**Karl, J.**, Copeland, A., and Besio, A., (2014) "A Phenomenological Predictive Model for Notched Thermo-Mechanical Fatigue of Type 304 Stainless Steel," Applied Mechanics and Materials.

Stinger, J., Soltys, M., **Karl, J.**, and Lin, K., "Method for Optics Based Guidance and Navigation Platform for Precision Lunar Landing" LPRI Whitepaper, September 2013.

**Karl, J.**, "Thermomechanical Fatigue Life Prediction of Notched Type 304 Stainless Steel," Doctoral Dissertation - University of Central Florida, July 2013.

DeMarco, J. P., **Karl, J.**, Sohn, Y., and Gordon, A. P., (2013) "Mechanical Characterization and Numerical Simulation of a Light-Weight, Aluminum A359 Metal Matrix Composite under Torsional Loading," Materials at High Temperatures.

DeMarco, J. P., Uribe, C., **Karl, J.**, Sohn, Y., and Gordon, A. P., (2013) "Mechanical Characterization and Numerical Simulation of a Light-Weight, Aluminum A359 Metal Matrix Composite under Tensile Loading," Materials at High Temperatures.

Algarni, M. S., Jia, Y., **Karl, J.**, Gordon, A. P. and Bai, Y. (2013) "Linkage Between Ductile Fracture and Extremely Low Cycle Fatigue of Inconel 718 under Multiaxial Loading Conditions," Proceedings of ASME Turbo Expo 2013.

**Karl, J.**, "Common Test Application Method- Thermomechanical Fatigue Laboratory Testing," Siemens Energy, Inc. internal publication, 2012.

**Karl, J.**, "Gas Turbine Engineering Manual- Life Prediction in Thermomechanical Fatigue," Siemens Energy, Inc. internal publication, 2012.

**Karl, J.**, "Common Test Application Method- Thermomechanical Crack Growth Measurement," Siemens Energy, Inc. internal publication, 2012.

DeMarco, J. P., Uribe, C., **Karl, J.**, Sohn, Y., and Gordon, A. P., "Modeling the Mechanical Response of Aluminum A 359-SiCp-30%." AIP Conference Proceedings. American Institute of Physics, 2012.

**Karl, J.**, and Gordon, A. P., "Life Prediction Feasibility in TMF Via Stress/Strain Data From a Viscoplasticity-Based Numerical Model," Proceedings of ASME Turbo Expo 2012.

**Karl, J.**, and Gordon, A. P., "Computational Viscoplasticity-Based Modeling of Stress/Strain Response in Thermomechanical Fatigue Loads," AIAA Aerospace Sciences Meeting, 2012.

**Karl, J.**, "Thermomechanical Fatigue Life Prediction of Notched Type 304 Stainless Steel," Dissertation Proposal - University of Central Florida, August 2011.

**Karl, J.** "Investigation of Life Prediction in Notched Specimens Subjected to Thermomechanical Loadings." Minerals, Metals and Materials Society/AIME, February 2010.

**Karl, J.**, "Fatigue Life Prediction in a Super Clean Rotor Steel," Technical Reports, Siemens Power Generation, 2009-2010.

**Karl, J.**, Schulist, M., Williams, E., and Gordon, A. P., "Real-Time Health Monitoring of Metal Structures Utilizing Electrically Conductive Coatings," 21st Canadian Congress of Applied Mechanics, 2007.

Hill, E., and **Karl, J.**, "Neural Network Burst Pressure Prediction in Composite Overwrapped Pressure Vessels," Proceedings of the AEWG Meeting, 2007.

**Karl, J.**, "Active Structural Monitoring Via Electrically Conductive Coatings," ASME Southeastern ECTC, 2007.

**Karl, J.**, Dion, S., and Spivey, N., "Acoustic Emission and Neural Networks Prediction Capability," Proceedings of the FAA Commercial Space Transportation Conference, 2006.

**Karl, J.**, "Burst Pressure Prediction in Composite Overwrapped Pressure Vessels," Proceedings of the ASNT National Conference, 2006.

**Karl, J.**, "EN-TEC Composite Pressure Vessel Winding System," Equipment Operations Handbook, Embry-Riddle Aeronautical University, 2005.

**Karl, J.**, Hill, E., "ERAU Structures and Instrumentation Procedures Guide," Lab Manual Text, Embry-Riddle Aeronautical University, 2005.

### ***Technical Presentations***

"Selective Laser Melted Regolith Structures" – GSSF Invited Talk (Pending), Abu Dhabi, UAE, May 2015

"Suborbital Spaceflight Research Capabilities" – NASA/CLASS/FSI Seminar (Pending) Orlando, FL, April 2015

“Selective Laser Melted Regolith Structures” – NewSpace 2014, San Jose, CA, July 2014

“Ionizing Radiation Protection with Melted Regolith Structures” – 2nd Space Habitation Conference, Orlando, FL, June 2014

“A Novel Guidance and Navigation Platform for Precision Lunar Landing” – Lunar and Planetary Institute, Houston, TX, October 2013

“Deep Dive – F-Engine Turbine Technologies”- Siemens Energy, Orlando, FL, August 2013

“Notched TMF Life Prediction Symposium”- Orlando, FL, July 2013

“Physical and Phenomenological Methods of Notched TMF Lifting”- Orlando, FL, March 2013

“TMF Crack Growth Testing Methods”- Siemens Energy, Orlando, FL, February 2013

“Kinematics of Space Vehicle Development” – University of Central Florida, Orlando, FL October 2012

“Computational Viscoplasticity-Based Modeling of Stress/Strain Response in Thermomechanical Fatigue Loads” – AIAA, Nashville, TN, January 2012

“Engineering Crash Course Web Training” – November 2011

“Engineering Crash Course: Hardware Development for Non-Engineers” – DefCon 19, Las Vegas, NV, August 2011

“TMF of Super Clean Rotor Steel”- Orlando, FL, April 2009

“Real-Time Health Monitoring of Metal Structures Utilizing Electrically Conductive Coatings”- CANCAM, Toronto, Canada, June 2007

“Active Structural Monitoring Via Electrically Conductive Coatings” - ASME, Miami, FL, April 2007

“Acoustic Emission and Neural Networks Prediction of Failure in Rocket COPV’s”, USAF, 45th Space Wing, Patrick Air Force Base, FL, July 2006

“Live X-Ray Radiography of a Hybrid Rocket Grain Regression”, Embry-Riddle Aeronautical University, Daytona Beach, FL, July 2006

“Radiographic Testing Techniques and Applications”, Embry-Riddle Aeronautical University, Daytona Beach, FL, March 2006

“Acoustic Emission and Neural Networks Prediction Capability”, FAA, Washington, DC, January 2006

“Burst Pressure Prediction in Composite Overwrapped Pressure Vessels,” ASNT, Orlando, FL, June 2006

### *Skills and Expertise*

**Mechanical Testing-** Expert-level MTS, Instron, and Ameritherm equipment calibration, programming, and operation.

**Mechanics of Materials-** New material development, characterization, and simulation.

**Metal and Composites Manufacturing-** Operation of manual machining equipment, welding, design and assembly, wet and dry composites lay-up. Direct experience in aircraft and spacecraft construction.

**Nondestructive Testing and Evaluation-** Expert-level Acoustic Emission, Ultrasound, and Radiographic testing. Standard-level eddy-current, penetrant, and magnetic particle testing.

**Fluid and Gas Systems-** Hydraulic and pneumatic systems under high pressures and temperatures- testing and design. Cryogenic applications and handling.

**Rapid Prototyping-** Tool path building and operation of Selective Laser Sintering, Fused Deposition Modeling, Stereolithography, and 3D Printing hardware. Design of custom fused-deposition systems.

**Computer Programming-** BASIC, C/C++, MATLAB, Maple, Visual Basic, Fortran, HTML, PHP, SQL, MySQL, Neuralworks.

**Computer Assisted Design / Manufacturing-** High-level proficiency: CATIA, SolidWorks, ANSYS Modeler, NASTRAN modeler, Standard-level proficiency: Pro/Engineer. Tool path design and CNC machine operation.

**Numerical Simulation (Structural/Mechanical)-** High-level proficiency: CATIA, COSMOS, NASTRAN, ANSYS, MATLAB.

**Numerical Simulation (Aerodynamic/Fluid)-** High-level proficiency: STAR-CCM+, Standard proficiency: Fluent, FlowWorks.

**Aircraft Manufacturing and Maintenance-** Have built and restored experimental aircraft- metal and composite construction. Tutor for certification of Aircraft and Powerplant mechanics, knowledge of relevant Federal Aviation Regulations.

**Technical Documentation-** Writing of engineering and process manuals, equipment operations, pilot operating handbooks.

**Management / Optimization** – Large team manager, practitioner of Lean, Kaizen, and 5S methodologies.

**FAA Licensed Pilot-** Private Pilot, ~80hrs Cessna 172, 10hrs Remos GX, 50hrs Piper Cherokee, 5hrs glider, 5 hrs ultralight, 5hrs aerobatic, 7 hrs Level D Falconjet Simulation, 5hrs Level D Citation X Simulation, additional co-pilot time in Piper Arrow and Cessna 152. Additional upset / unusual attitudes training.

## *Professional References*

### **Scott Keller, Ph.D.**

Research Engineer at PSM Alstom  
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### **Lynn Grabenhorst**

Coordinator, Academic Programs – University of Central Florida  
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### **Fabio Miguez**

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### **Captain Sara Ferrero**

F-16 Pilot, 100FS, 187<sup>th</sup> Fighter Wing, US ANG  
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### **Nicholas Spivey**

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