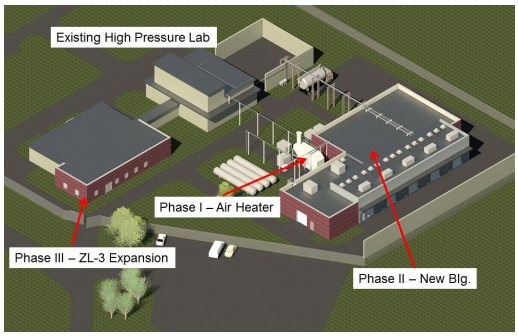
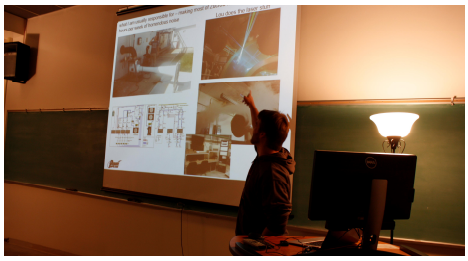
PURDUE
UNIVERSITY

Maurice J. Zucrow Laboratories

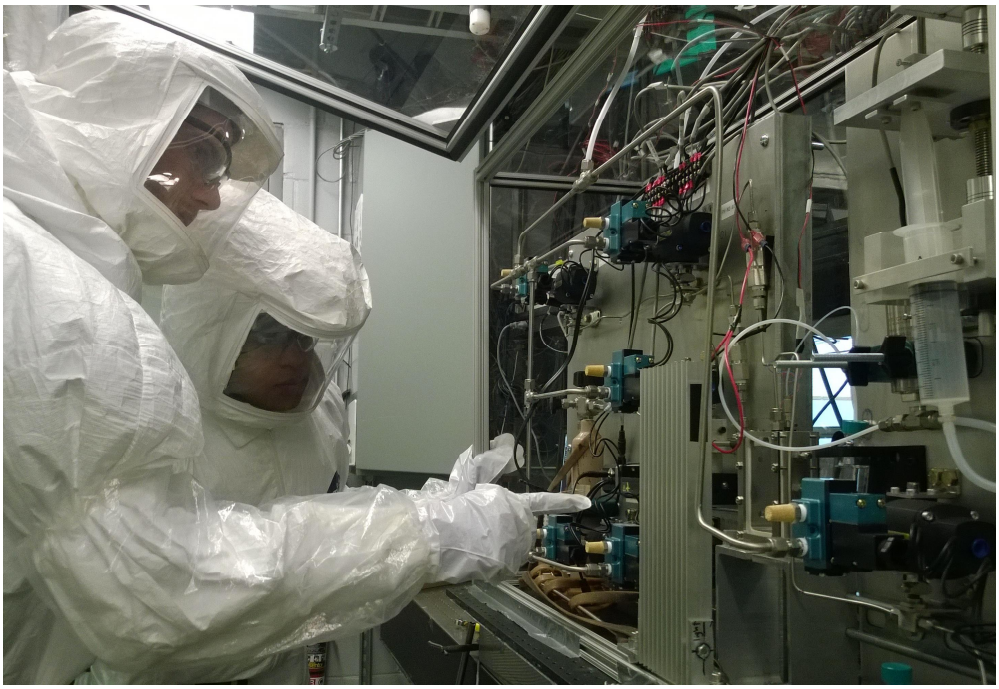
2013-2014 Annual Research Report

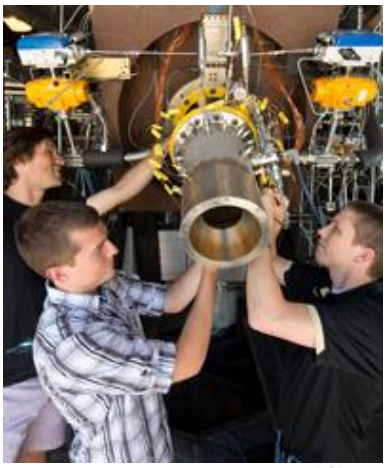


School of Mechanical Engineering



School of Aeronautics and Astronautics





PURDUE ENGINEERING

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https://engineering.purdue.edu/Zucrow/index.html

January 2015

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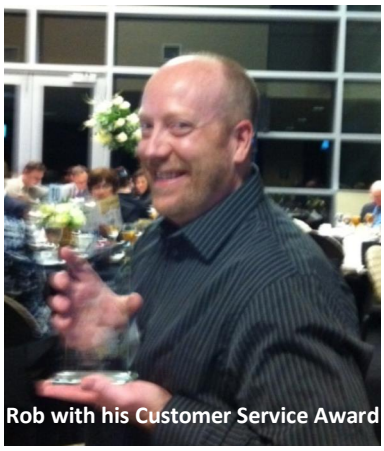
From the Director…..

Greetings from Chaffee Hall to all alumni and friends of the Zucrow Labs. The past year has been another busy year of accomplishment for our students and staff. Most notably, Zucrow staff have received several accolades in 2014. Our staff engineer Mike Bedard received a Dean of Engineering Bravo Award for his service to high profile test campaigns at the High Pressure Lab. In addition, MZL Managing Director Scott Meyer and Technician Rob McGuire were both honored at the College of Engineering Staff Awards banquet in October. Rob received the Customer Service Award and Scott was recipient of the Leadership Award. We are all proud of their accomplishments and that they continue to serve our faculty and students so well in all they do.


Rob with his Customer Service Award

We continue to make progress on funding for a new lab building as highlighted on the subsequent article in this report and are looking forward to breaking ground on this new facility in 2015. During 2014, we made major upgrades to the fuel conditioning building, ZL-6 and to the Propulsion Lab, ZL-4 in preparations for new projects and new faculty entering the lab. Professor Pourpoint made use of the renovated ZL-6 facility for MDA-sponsored research in the use of foams to mitigate hydrazine spills, and the renovated ZL-4 space will provide additional room for Professor Sonôs activities in energetic materials as well as for a material synthesis chemist that Purdue is working to hire as part of the Preeminent team formed in this area.


Neal and baby Edison

We also had two new staff members join us during the past year. Dr. Carson Slabaugh joins Dr. Emre Gunduz as Staff Scientist with office space in Chaffee Hall. Carson received his Ph.D. with Prof. Lucht and has made major contributions to our gas turbine combustion work housed at the High Pressure Lab. Dr. Gunduz joined Purdue in 2013 and works with Prof. Son in the energetic materials research area. Our other new staff member, Jarad Neal, joined us from a position at the Blue Origin Test Site in west Texas. ñNealò is well known to us having worked at the lab for several years while he was garnering his degree in Electrical Engineering Technology. While he avoids getting his photo taken, we managed to get a shot of him with his new baby boy (Edison Christofer), born on January 11th of this year.

We are also pleased to welcome two new faculty to MZL. Dr. Guillermo Paniagua recently joined us from his position at Von Karman Research Institute in Brussels, Belgium. An expert in experimental turbine flows, his work spans a number of applications from turbine heat transfer, to aerodynamics and even magnetohydrodynamics. He plans to build a major turbine facility that will complement existing compressor and combustor rigs at the laboratory. In addition, Professor Terry Meyer, an expert in laser diagnostics of sprays and combusting flows, will be joining us in June of this year. Currently a pro-


Professor Paniagua

fessor at Iowa State University, Dr. Meyer has been a leading developer of pulse-burst laser diagnostics as a tool for investigating complex two-phase and combusting flows. We will be renovating room 208 on the second floor of Chaffee Hall to accommodate Dr. Meyerôs laser lab, and we envision both he and Dr. Paniagua as being major users of our new lab building which we dearly hope to complete this year.

Finally, we look forward to continuing our MZL History Lecture series in April of this year. Drs. Robert ñBobòStrickler and Walter OôBrien plan to give talks at the event on 10 April so that our students and staff can learn more about our esteemed laboratory back in the *Zucrow days.*

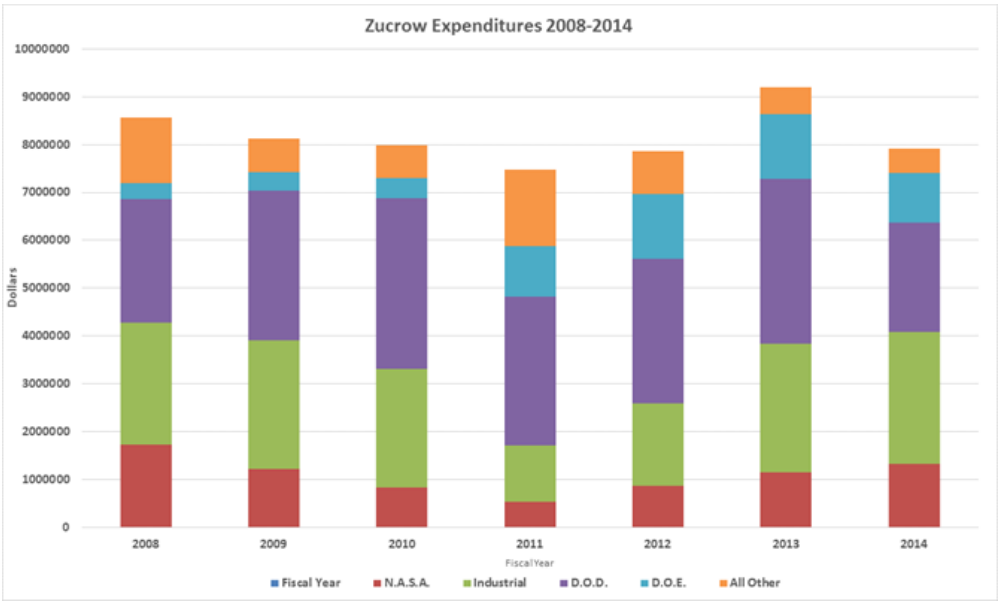
Best wishes to all for a prosperous and healthy 2015.

Sincerely,

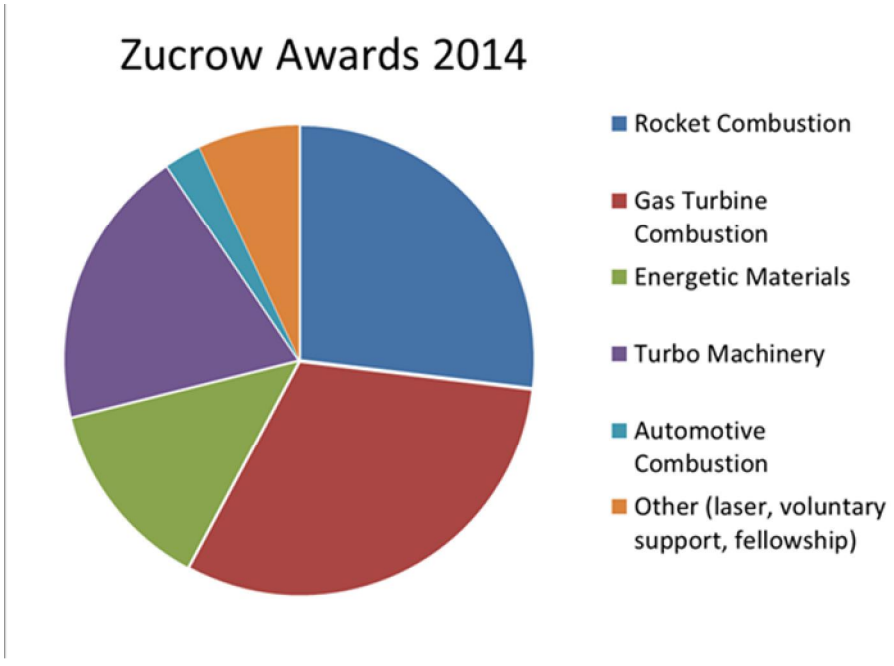
Stephen (Steve) Heister
Raisbeck Distinguished Professor,
Director Maurice J. Zucrow Laboratories

Professor Heister with Doug Ebersole, Head of AFRL Aerospace Systems Directorate and General Massiello, Commander of Air Force Research Lab. General Massiello gave the bi-annual Rolls-Royce Lecture at Purdue. (October 2014)

Zucrow Research Highlights & Finances



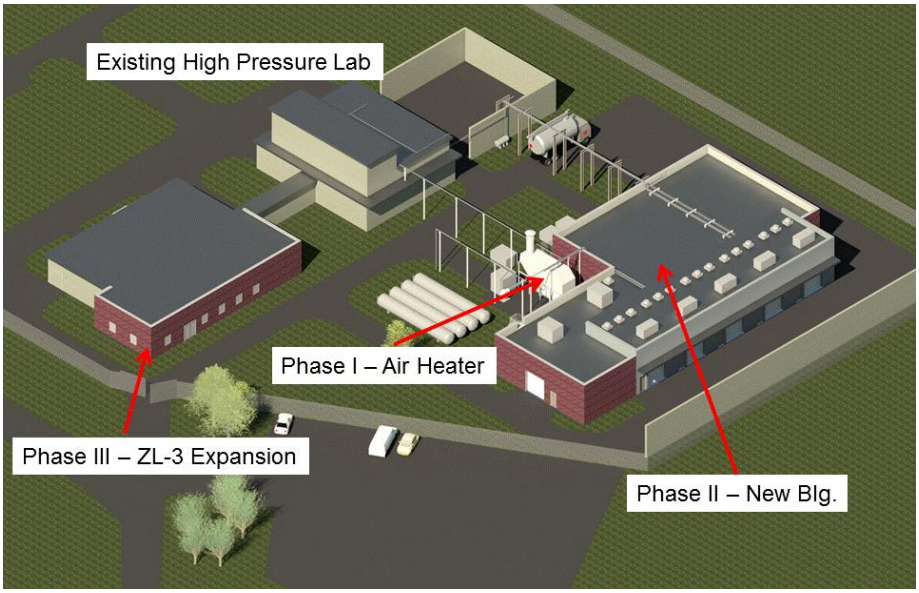
The lab continues to prosper with sustained funding at very healthy levels. Currently we support roughly 90 graduate students. Expenditures dropped this past year due mainly to the fact that our large MURI project with the Army Research Office concluded in May of 2014. However, we know that there are several large projects on the horizon and are optimistic that expenditures will actually broach the $10M mark in the next year or two. As in past years, the composition includes a healthy industrial component as well as major interactions with NASA, DoD, and DOE. Professor Key won a major award from Siemens Corporation last year to build up a new compressor rig and this activity will also begin to ramp up with site preparation and rig design during this year.



The chart at the left shows the composition of MZL research by area. With the completion of the rocket-based MURI project, gas turbine combustion now represents the single largest component of MZL work. In particular, Prof. Luchtôs work with GE has increased significantly and we are excited about his groupôs work on a new high pressure windowed combustor that will be a world-leading capability in this area when complete. Rocket combustion, energetic materials and turbomachinery also represent major areas of emphasis with a small amount of work in automotive field and some significant projects lying outside the propulsion and power field.

Progress on New Infrastructure

As you may know, we have been working diligently for the past 2-3 years to gain funding for a new lab building and increased space at the High Pressure Lab for students and staff. We thank all of you who have participated in the project and provided resources in a variety of manners.



We are pleased that the University has fully funded the first phase of our three-phase plan as outlined in the artistûs sketch on the right. The new air heater is presently being installed on a pad adjacent to the HPL Annex. A couple photos show the unit as it awaits installation and a picture of the heat exchanger unit exiting heat treat at the vendor facility. This $1.5M investment will insure that MZL maintains the nationûs most capable air system with 2200 psi capacity and a new capability to deliver air at temperatures as high as 1500 F at flows as high as 8 lbm/s. GE Aerospace is a leading customer for this capability since modern high pressure ratio gas turbine engines deliver compressor discharge temperatures in the 1500 F region.

AIR HEATER AWAITING INSTALLATION

The next step in our development process is the $5.5M new building that represents Phase II of the project. Funding for this building is moving quickly and we are quite optimistic that we will be able to complete design work and actually break ground on the facility this year. The new lab will more than triple our capabilities at HPL with 5 new test cells of the same design as the two existing HPL cells. The laser lab that lies adjacent to all five cells will provide us with a state-of-the-art capability to employ the most advanced diagnostics in this facility making it one of the most capable labs in the world.

White-hot heat exchanger exits heat treat at vendor facility

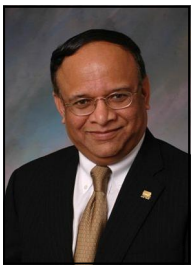
ZUCROW LABS FACULTY

Bill Anderson, Associate Professor of Mechanical Engineering (by courtesy), Associate Professor of Aeronautics and Astronautics. Research Interests: Chemical Propulsion and Design Methodoligies. Research Areas: Systematic and careful combination of analysis and experimentation on injectors, combustors, nozzles, and propellants for both rocket and air-breathing propulsion. Specific research areas include ignition, non-toxic propellants, combined cycle propulsion, combustion stability, fuel cooling, and life prediction.

Sally Bane, Assistant Professor of Aeronautics and Astronautics, PhD 2010, Caltech. Research Interests: gaseous combustion dynamics, detonations, plasma control of combustion instability, hypergolic combustion, pressure-gain combustion, energetic materials, electrostatics and ignition, experimental fluid mechanics and aerodynamics, active flow control/plasma flow control. Research Areas: Combustion, Propulsion, Fluid Mechanics, Aerodynamics.

Jun Chen, Assistant Professor of Mechanical Engineering. PhD 2004, Johns Hopkins University. Experimental fluid dynamics; development of flow diagnostic techniques; flow dynamics in stratified environment; and turbulent flow measurements and modeling.

Sanford Fleeter, McAllister Distinguished Professor of Mechanical Engineering. Research Interests: Turbomachinery fluid dynamics, Aero-mechanics, Aero-acoustics, Computational fluids. Research Areas: Fluid Mechanics and Propulsion.



Jay Gore, Reilly University Chair Professor of Engineering and Jefferson Science and Technology Fellow; Research Interests: Combustion, Turbulent reacting flows, Combustion and heat transfer in material processing, and Pollutant reduction. Research Areas: Combustion, Energy Utilization, and Thermodynamics. Bioengineering.

Steve Heister, Raisbeck Engineering Distinguished Professor for Engineering and Technology Integration, Director Maurice J. Zucrow Laboratories. Research Interests: Aerospace propulsion systems; Airbreathing and rocket engine combustors; Liquid propellant injection systems; Two-phase and capillary flows.

Nicole Key, Assistant Professor of Mechanical Engineering, by courtesy in Aeronautics & Astronautics. Research Interests: Aerothermal Aspects of Turbomachinery. Axial and Radial Compressor Performance. Experimental Methods in Fluid Mechanics. Research Area: Fluid Mechanics & Propulsion.

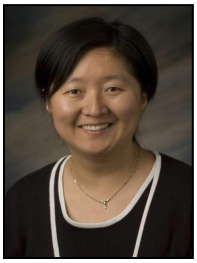
ZUCROW LABS FACULTY (cont.)

Robert Lucht, Ralph and Bettye Bailey Professor of Combustion in Mechanical Engineering. Research Interests: Laser Diagnostics. Diode-laser-based Sensors. Gas Turbine and Internal Engine Combustion. Materials Processing and Synthesis. Combustion Science. Fluid Mechanics and Heat Transfer. Research Areas: Combustion, Energy Utilization, and Thermodynamics. Fluid Mechanics & Propulsion.

I. Emre Gunduz, Research Assistant Professor. Research Interests: Nanostructured energetic materials, high performance solid and hybrid propellants, near-net shape fabrication, high-power ultrasonics, advanced imaging and characterization.

Guillermo Paniagua, Associate Professor of Mechanical Engineering. Research Areas: Fluid Mechanics and Propulsion. Research Interests: Compact high speed turbomachinery: Design, analysis (experimental-numerical), cavity and tip flows, flow control; High speed propulsion: Novel cycle development, intakes, boundary layer transition, combustion; Development of measurement techniques and data processing.

Tim Pourpoint, Associate Professor. Research Interests: Aerospace propulsion systems,. Rocket engine combustors. Liquid propellant injection systems. Hypergolic propellants. High pressure and hydrogen storage systems.



Li Qiao, Assistant Professor, Aeronautics and Astronautics. Research Interests: High-performance fuels for high-speed propulsion systems, alternative and synthetic fuels, fuel synthesis by coal/biomass gasification, endothermic fuels, nanoscale energetic materials, laser diagnostics, experimental fluid dynamics, supersonic and hypersonic combustion, and advanced propellant and propulsion concepts.

Paul Sojka, Professor of Mechanical Engineering. Research Interests: Spray and spray measurements. Fluid mechanic instability. Reseach Areas: Combustion, Energy Utilization, and Thermodynamics.

Steve Son, Professor of Mechanical Engineering. Research Interests: Multiphase combustion, particularly related to propellants, explosives, and pyrotechnics. Nanoscale composite energetic materials. Advanced energetic materials. Microscale combustion. Research Areas: Combustion, Energy Utilization, and Thermodynamics.

ZUCROW AFFILIATE FACULTY

John Abraham, Professor of Mechanical Engineering.

Alina Alexeenko, Associate Professor of Aeronautics and Astronautics Engineering.

Steve Beaudoin, Professor of Chemical Engineering.

Osvaldo Campanella, Professor of Agricultural & Biological Engineering.

Carlos Corvalan, Associate Professor of Mechanical Engineering (by Courtesy), Associate Professor of Food Science.

Timothy Fisher, James G. Dwyer Professor of Mechanical Engineering.

Klein Ileleji, Associate Professor of Agricultural & Biological Engineering.

Hukam, Mongia, Visiting Professor, School of Mechanical Engineering

Fabio Ribeiro, Professor of Chemical Engineering.

P. Veeraragha Ramachandran, Professor of Chemistry.

David Stanley, Associate Professor of Aviation Technology.

Alejandro Strachan, Associate Professor of Materials Engineering.

John Sullivan, Professor, School of Aeronautics and Astronautics.

Pavlos Vlachos, Professor of Mechanical Engineering.

Xianfan Xu, James J. and Carol L. Shuttleworth Professor of Mechanical Engineering.

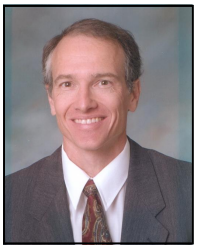
ZUCROW POST DOCS & RESEARCH SCIENTISTS

John Fabian
Senior Research Scientist

Swanand Sardeshmukh
Post Doc

Carson Slabaugh
Senior Research Scientist

ZUCROW STAFF



Steve Heister, Director and Raisbeck Engineering Distinguished Professor

Scott Meyer, Managing Director

Rob McGuire, Supervisor of Technical Services

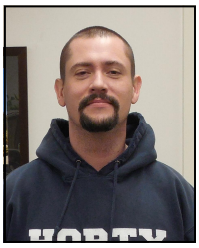
Michael Bedard, Propulsion Engineer

Charlotte Bell, Administrative Assistant to the Director

Michelle Kidd, Research Account Specialist

Edie Moffitt, Business Services

Joan Jackson, Business Services

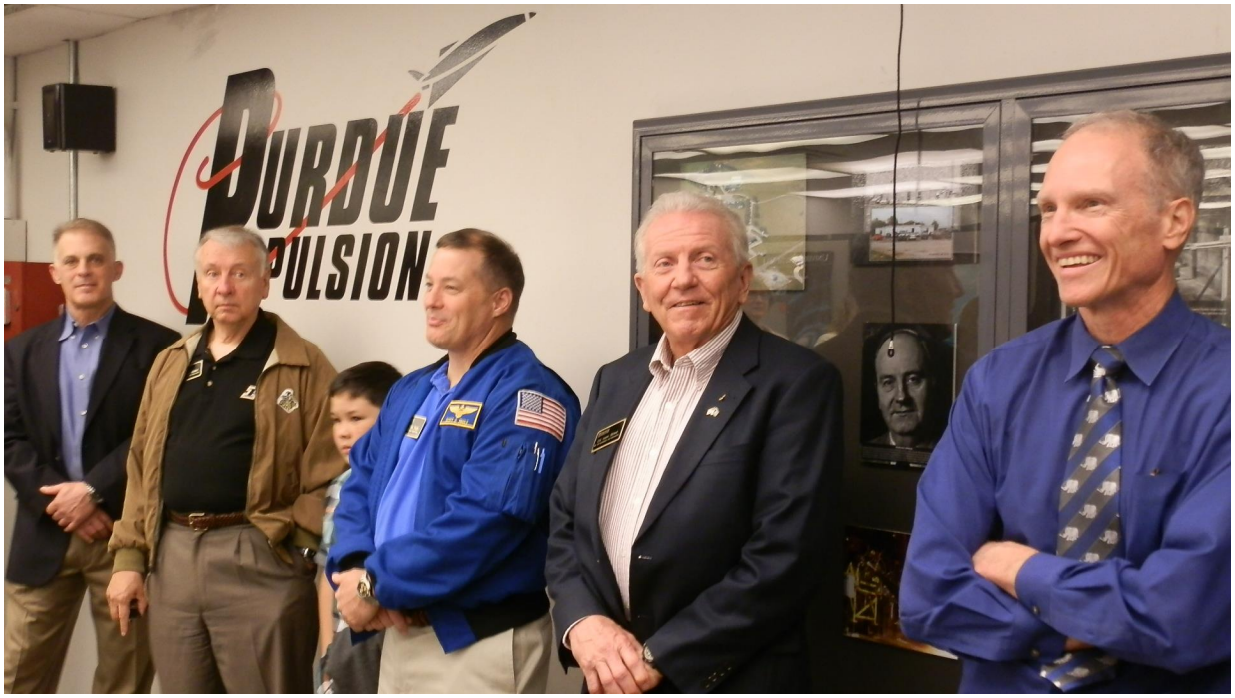


Jarad Neal, Electrical & Computer Engineering Tech

ASTRONAUTS VISITED MAURICE J. ZUCROW LABORATORIES

April 11, 2014

Astronauts David Wolf, Charlie Walker, Scott Tingle and Loren Shriver visited the Maurice J. Zucrow Laboratories on Friday, April 11th. The astronauts answered questions from graduate students, research assistants and staff. The four astronauts were given a tour of the labs and current research projects. Graduate research students in attendance were also privileged to participate in a group photo. This was a very special day at Zucrow Labs to meet such honored guests.



Maurice J. Zucrow Laboratories

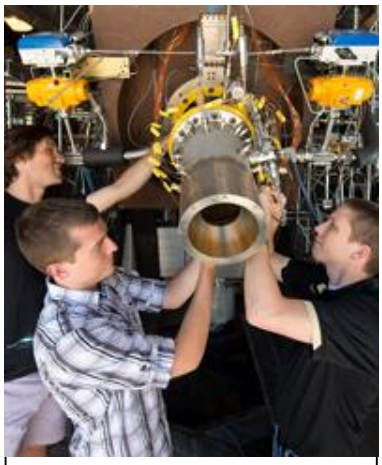
PURDUE UNIVERSITY WINTER 2014
ENGINEERING IMPACT

Maurice J. Zucrow Laboratories

Lunar-landing rocket research hits milestone with 'hot-fire' test

A Purdue University student team has designed, built and tested a critical part of a new a rocket engine as part of a NASA project to develop spacecraft technologies needed to land on the moon, Mars and other cosmic venues.

The students are making a central part of the new engine called the thrust chamber or combustor as part of NASA's Project Morpheus. The project aims to develop a prototype vehicle capable of vertical takeoff and landing using an autonomous system, as shown in this NASA video: (https://www.youtube.com/watch?v=1M5qS0Y3tDw).



From left, Purdue doctoral students Zach Hallum, Michael Bedard and Eric Meier have worked on a team to design, build and test part of a new rocket engine for a spacecraft to land on the moon, Mars and asteroids.

Purdue University photo/Mark Simons.

Such a system requires a high-performance, lightweight rocket engine, says Michael Bedard, a Purdue propulsion engineer and doctoral student.

The team in May conducted its first hot-fire test of the rocket, which uses liquid oxygen and liquid methane propellants. The rocket's thrust chamber was designed, built and tested using specialized facilities at Purdue's Maurice J. Zucrow Laboratories.

Research findings are detailed in a paper presented during the International Astronautical Congress from Sept. 29 to Oct. 3 in Toronto. The paper was authored by Bedard, Anderson, and graduate students Eric Meier and William Hallum.

The work began as a senior design project in 2010, initiated by students in a propulsion course taught by William Anderson, professor of aeronautics and astronautics.

"The students worked amazingly hard on this and were committed to finishing it," Anderson says. "It was a pretty remarkable feat."

Students not only developed the engine's thrust chamber, but also a system to liquefy methane from methane gas.

"By liquefying our own methane, we reduced the propellant cost and challenges in transporting the propellant," says Bedard, who led efforts to continue the work after completing the senior design project.

The eventual goal of the project is to build a lightweight thrust chamber, which requires a thin-walled combustor. Having a thin wall makes it essential to properly cool all of the chamber surfaces, particularly portions that heat up the

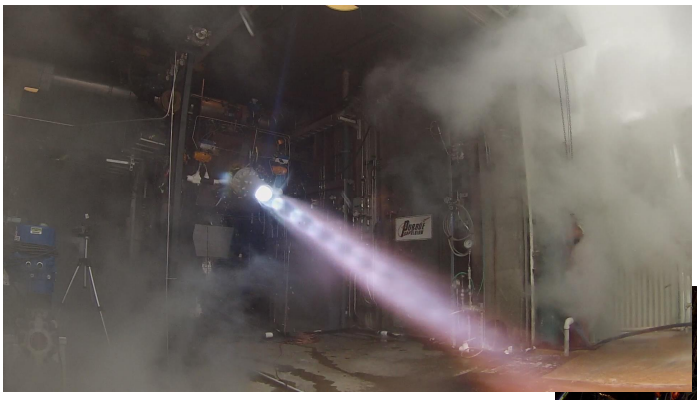
Purdue students have conducted the first 'hot-fire' test of the rocket, which uses liquid oxygen and liquid methane propellants. The students have designed, built and tested a central part of the new engine called the thrust chamber or combustor as part of NASA's Project Morpheus.

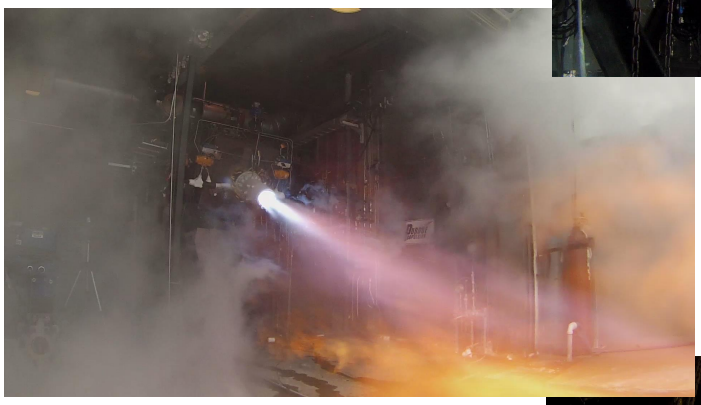
Purdue University photo/Maurice J. Zucrow Laboratories.

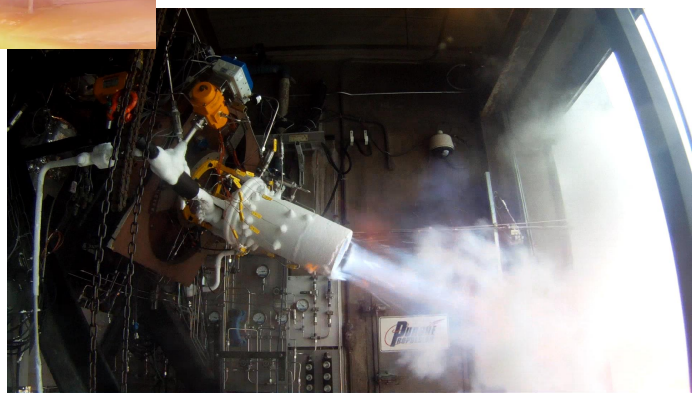
most. The recent test focused on measuring the temperature profile of the thrust chamber wall.

"Propellants burning in the chamber result in extreme temperatures along the chamber walls," Bedard says. "To cool the chamber effectively we need to know exactly where the cooling must be applied. Temperatures inside the combustor can approach 5,000 degrees Fahrenheit. The engine has to run for about two minutes at a time, so keeping the walls cool is critical. The data we are getting from these tests will help us design an optimized cooling approach."

Also involved in the project were students Thomas Feldman, Andrew Rettenmaier, Brittany Fey, Pamela Slaughter, Isaac Statnekov, Emma McKinney, David Hailey and Ryan Tatro, all of whom have graduated and are now working in the rocket industry. Information about the project is available at the Purdue Propulsion YouTube Channel: (https://www.youtube.com/watch?v=m2xytZDvmDM).text







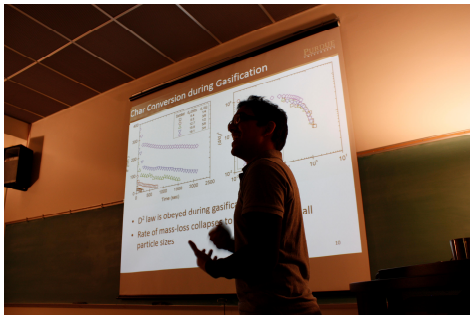
ZSA (Zucrow Student Association)

The Zucrow Student Association (ZSA) has had another successful year in its endeavors to organize professional development, outreach, and social events for the students, faculty, and staff of the Maurice J. Zucrow Laboratories (MZL). ZSA was formed in 2011 by Professor Heister to help build a support network for those working at MZL, as well as, provide a historical context to all lab activities consistent with the research and development mission of our historic lab.

"Lunch and Learn" Monthly Meeting, September 11, 2014

ZSA sponsors student research talks and a free lunch during each monthly meeting known as a "Lunch and Learn"! These professional development focused events give Zucrow students the opportunity to practice presenting their research in a relaxed yet technical environment, as well as, learn about the active research being conducted at MZL. During the lunch hour, a couple of students give 10 minute overviews of their research and answer questions from their colleagues. This year's student presentations have covered a wide range of topics including facility design, combustion instability, turbomachinery, fuel sprays, and laser diagnostics.

Along with its professional development goals, ZSA is also committed to educating younger students about propulsion, engineering, and STEM fields through outreach events. Each summer Zucrow students support a local 4H camp as they launch model rockets for their National 4H Engineering Challenge. During the school year, ZSA members lead lab tours for many different Purdue groups including K-12 STEM camp attendees, members of undergraduate aerospace related clubs, and prospective students. During some of the lab tours, ZSA has also incorporated other science activities which include resonating wine glasses and thrust measurements of model rockets on a test stand. ZSA is constantly striving to look for new ways to foster excitement for engineering!



Throughout the year, ZSA organizes social events for MZL in an effort to encourage the student, faculty, and staff to get to know each other outside of the test cells! In addition to all-lab cookouts, we have had a tailgate and a World Cup viewing party. ZSA has also teamed up with other ME and AAE graduate student groups to coordinate coffee and snack study breaks in Chaffee Hall. In addition, ZSA has held fundraising sales of various Purdue Propulsion apparel and merchandise including coffee mugs, jackets, polos, and more! ZSA hopes to continue having merchandise sales in the future so all MZL alumni can show their Purdue Propulsion pride.

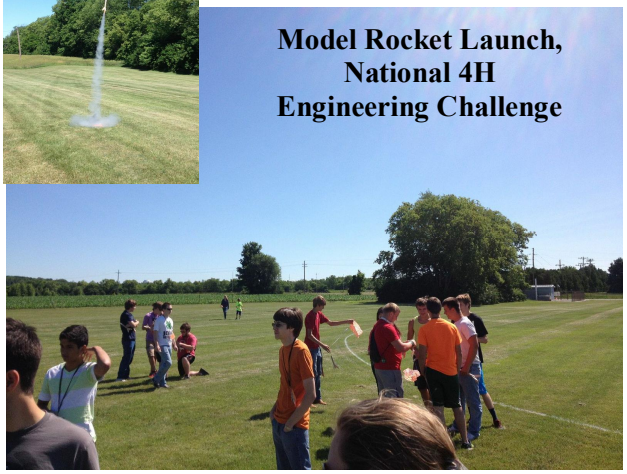
2014-2015 Zucrow Student Association Officers

President – Reid Berdanier

Treasurer – Heather Wiest

Professional Development Chair – Eric Meier

Tailgating before the Purdue vs. Northwestern game. November 22, 2014



Model Rocket Launch, National 4H Engineering Challenge

Cookouts at the Zucrow Labs

Making ice cream with liquid nitrogen.

MJZL Current Graduate Students

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Adams, Jesse	W. Anderson, S. Heister	adams207	
Adams, Zachary	J. Chen	adams31	Optimization of Cycloturbine and Cyclorotor Blade Pitching Kinematics
Anghelus, Andrei	S. Meyer	aanghelus	Non-thesis student working with Scott Meyer on SpaceX project.
Aye-Addo, Nyansafo	N. Key	payeaddo	Experimental investigation of forced response conditions in a multistage compressor.
Bangalore, Prashanth	S. Bane	pbangalo	High-Pressure Combustion and Detonation-to-Degraflation Transition in Ethylene/Nitrous Oxide Mixtures
Basak, Prithviraja	J. Gore	pbasak	
Beason, Matthew	S. Son	mbeason	Shock Induced Reaction Synthesis in Powder Mixtures
Berdanier, Reid	N. Key	rberdani	An Experimental Study of Tip Clearance Effects in a Multi-Stage Axial Flow Compressor
Bhattacharya, Sayantan	P. Vlachos, N. Key	bhattac3	
Bishop, Gina	T. Pourpoint	bishop25	Use of Fluidic Oscillators for Impingement Cooling for High Heat Flux Applications
Biswas, Sayan	L. Qiao	biswas5	Ignition of Ultra-lean Premixed Methane/Air Mixtures using a Hot Turbulent Jet
Cho, Kevin	S. Son, R. Lucht	kycho	Optical Diagnostics of Gelled Hypergolic Bipropellants
Cummock, Nick	S. Son	ncummock	undecided
De, Narendra	S. Son	nde	
Dolan, Matthew	N. Key	mpdolan	Development and Analysis of a Low Specific
Dubitsky, Andrei	S. Heister, X. Xu	adubitsk	Thermoelectric Generators for Automotive Waste Heat Recovery Systems
Engerer, Jeff	T. Fisher	jengerer	Fash boiling and desorption for transient cooling applications
Fugger, Chris	W. Anderson	cfugger	Subject: A reacting jet in an unstable crossflow
Fuller, Tristan	W. Anderson	fuller27	
Gabl, Jason	T. Pourpoint	jgabl	Solution Combustion Synthesis of Cobalt Catalysts for the Hydrolysis of Sodium Borohydride
Gao, Xiangyu	J. Chen	gao229	Wake and Loading Analysis of Wind Turbine Arrays in a Variety of Inflow Condition
Garcia, Jorge Saavedra	G. Paniagua	saavedra	Establishment Time of the Thermal Boundary Layer

MJZL Current Graduate Students (cont.)

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Gejji, Rohan	W. Anderson	rgejji	Investigation of Combustion Instability in a Lean Direct Injection Gas Turbine Combustor
Gonzalez Cuadrado, David	G. Paniagua	dgcuadrado	Experimental Assessment of Supersonic Turbines
Goyal, Vikrant	J. Gore	goyal21	
Graziano, Tyler	S. Bane	tgrazian	
Hale, Cameron	S. Bane	hale40	
Hallum, Zach	W. Anderson	whallum	Subject: combustion instability
Han, Dong	J. Gore	han193	Quantitative infrared imaging of turbulent lean pre-mixed flame
Harrison, Trey	N. Key	harri477	
Hasti, V. Raju	J. Gore	vhasti	
Hester, Sarah	S. Heister	hester1	Combustion instability of an unchoked single element combustor using gaseous oxygen and rp1
Hey, Joel	T. Fisher	heyj	Subject: Transient thermal management systems for airspace vehicles
Huang, Cheng	W. Anderson	Huang162	Multi-fidelity Computational Analysis of Combustion Instability
Hunt, Steven	S. Heister	hunt54	Thermoacoustic instabilities of supercritical fuel in parallel heated flowpaths
Isert, Sarah	S. Son	sisert	The effect of propellant formulation on microscale flame structure above solid rocket propellants
Juangphanich, Paht	G. Paniagua	pjuangph	
Kan, Brandon	S. Heister	bkkan	Pulse Detonation Rocket Engines
Kim, Jupyoung	J. Gore	kim1319	Undecided
Kittell, David	S. Son	dkittell	A Water-Based Rocket Propellant Utilizing Aluminum Nanopowder with a Protective Hydrophobic Coating
Kulakhmetov, Rufat	G. Paniagua		
Kumar, Nitish	J. Gore	kumar164	
Kumar, Rohit	J. Gore	kumar167	
Kumar, Sumeet	S. Heister	kumar94	Waste Heat Recovery in Automobile Exhaust using Thermoelectric Generators: Topological Studies and Performance Analysis
Lalit, Harshad	J. Gore	hlalit	

MJZL Current Graduate Students (cont.)

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Leng, Yujun	S. Fleeter	leng	Reduced order modeling for forced response prediction in axial and centrifugal compressor including mistuning effect and multistage interaction
Lim, Dasheng	S. Heister	lim37	Injector Dynamic Response to Passage of a Detonation Wave
Lou, Fangyuan	N. Key	louf	Inlet Distortion Effects on a High Speed Centrifugal Compressor
Mares, Jesus Jr.	S. Son	maresj	Response of Energetic Materials Under Acoustic Energy Insult
Mathews, Joshua	T. Pourpoint	mathew15	
McBain, Andrew	S. Son	amcbain	
Meier, Eric	W. Anderson, S. Meyer	ejmeier	Rocket Combustion Instability Suppressing Using Fluidic Injectors
Maesschalck, Cis	G. Paniagua	cdemaess	Optimization and Control of Tip Flows
Methel, Jeanne	N. Key	jmethel	undecided
Mugenda, Angela	S. Bane	amugenda	Combustion Characterization of Fine Hypergolic Sprays
Panda, Pratikash	R. Lucht	ppanda	Structure and Dynamics of a Reacting Jet Injected into a High Pressure Vitiated Crossflow
Powell, Michael	S. Son	powell84	
Pratt, Andrew	R. Lucht	pratta	
Rai, Ankita	J. Gore	rai8	Non-thesis
Ramachandran, Raghav	S. Son	raghav	
Rocha, Jonathan	P. Sojka	rocha0	Secondary atomization of Non-Newtonian liquids in the bag and stamen regime
Rubio, Mario	S. Son	rubio0	
Satija, Aman	R. Lucht	asatija	Development and Application of Coherent Anti-stokes Raman Scattering Systems in Reacting Flows
Saavedra, Jorge	G. Paniagua	saavedra	Establishment time of the thermal boundary layer
Schenk, Matthew	S. Heister	schenk	Non-thesis student working with Scott Meyer on SpaceX project
Schulz, David	S. Heister	dschulz	Non-thesis student working with Scott Meyer on SpaceX project
Shang, Weixiao	J. Chen	shangw	

MJZL Current Graduate Students (cont.)

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Smith, Natalie	N. Key	smith773	Experimental Investigation of Vane Clocking Effects on Stall Performance and Unsteady Boundary Layer Development in a Multistage Compressor
Snyder, Sharon	P. Sojka	snyder22	Secondary Atomization of Elastic Non-Newtonian Liquid Drops
Sousa, Jorge	G. Paniagua	fernan57	Supersonic Turbine Design
Stechmann, David	S. Heister	sstechma	Subject: High Pressure Rotating Detonation Engines for Rocket Applications
Steiner, Matt	T. Pourpoint	msteiner	Investigation of Non-Toxic High-Performance Propellant Combinations for use in Re-Lightable Hybrid Rocket Thrusters
Stoot, Steven	S. Bane, T. Pourpoint	sstoot	
Tamanampudi, Gowtham	W. Anderson	gtamanam	Development of Combustion Instability Prediction Tool by Incorporating Combustion Response Models
Tanvir, Saad	L. Qiao	stanvir	Physical properties, evaporation and combustion characteristics of nanofluid type fuels.
Terry, Brandon	S. Son	terry13	Subject: Nanoscale silicon composite energetic materials.
Tian, Shengguang	J. Gore	tian60	
Wang, Weichao	J. Gore	wang1301	Simultaneous CO concentration and temperature detection in a premixed ethylene/air flat flame
Waters, Essene	T. Pourpoint	waters5	
Wierman, Matt	W. Anderson	mwierman	Subject: Nonlinear predictive model of rocket engine combustion instability
Wiest, Heather	S. Heister	hwiest	Subject: Testing nozzle performance for supersonic business jet applications
Willits, Jared	T. Pourpoint	jwillits	Performance Characterization of Alternative Hypergolic Propellants
Zarbo, Nick	S. Meyer	nzarbo	Effect of Water and Humidity on Hypergolic Propellant Ignition Delay
Zaseck, Chris	S. Son, T. Pourpoint	czaseck	Development of High Performance Paraffin-Based Hybrid Fuels
Zhang, Robert	R. Lucht	zhan1599	
Zheng, Yutao	G. Paniagua	zheng277	
Zhou, Nina	J. Chen	zhou9	

MJZL Recent Graduates

Graduate	Advisor	Thesis Title	Career Destination
Ball, Patrick, MS 2013	N. Key	An Experimental and Computational Investigation on the Effects of Stator Leakage Flow on Compressor Performance	Rolls-Royce
Berdanier, Catherine, MS 2013	R. Lucht	Flowfield Characterization of a Piloted Lean Premixed Injedtor by Particle Image Velocimetry	
Chrzanowski, Jonathan 2014	T. Pourpoint		Orbitec
Dadson, Jennifer, MS 2013	T. Pourpoint		
Daily, Megan, MS 2013	S. Son	Electromagnetic properties of energetic materials	Los Alamos National Labs
Dennis, Jacob PhD 2014	T. Pourpoint		China Lake
Ennis, Brandon, PhD 2013	S. Fleeter	An Experimental Investigation of Wind Turbine Aerodynamic Interaction	
Feddema, Rick, MS 2013	P. Sojka		
Feldman, Thomas, MS 2013	W. Anderson	Hydrogen addition effects on combustion instability in a continuously varying resonance combustor	Blue Origin
Fineman, Claresta, MS 2013	S. Son, R. Lucht	High Shear Rheology of Hypergolic Gelled Propellants	China Lake
Finney, Heather, MS 2013	P. Sojka	Fluid dynamics of deep water multiphase jets	(undecided)
Forness, Jordan, MSAAE 2013	S. Heister	Injector Concepts for Hypergolic Propellants	SpaceX
Fox, David MSAAE 2014	T. Pourpoint		ATK
Gao, Jian PhD 2014	J. Chen		Post Doc, Johns Hopkins Univ.
Garibaldi, Oscar PhD 2014	T. Pourpoint		Universidad Tecnologica Pe Panama
Heckaman, Bryce MSME 2014	N. Key	Design of Optical Access for the Application of Laser Doppler Velocimetry in a Low Specific Speed Centrifugal Compressor	Cummins
Hester, Sarah MSAAE 2014	W. Anderson		(undecided)
Kapaku, Robert MSME 2014	J. Gore		Rolls-Royce
Kees, Devin MSAAE 2014	T. Pourpoint		Orbital Sciences Corp.
Kerlo, Ana-Elodie, PhD 2013	S. Frankel, J. Chen	Development of a Circulatory Support for the Univentricular Fontan Circulation	Post Doc, Purdue University
Krishnan, Abhishek, MS 2013	L. Qiao		
Kulkarni, Varun, PhD 2013	P. Sojka	Secondary Atomization of Non Newtonian Drops at High Weber numbers	

MJZL Recent Graduates (cont.)

Graduate	Advisor	Thesis Title	Career Destination
Lamont, Warren, PhD 2013	R. Lucht, W. Anderson	Experimental Study of a Distributed Combustion System for Stationary Gas Turbines	Power Systems Mfg. LLC
Larson, Logan, MS 2013	S. Heister	Non-thesis	NASA Glenn Research Center
Mason, B. Aaron, PhD 2014	S. Son, L. Groven		Schlumberger
Maynard, Evan, MSAAE 2014	W. Anderson		Blue Origin
McKinney, Emerald, MSAAE 2013	W. Anderson	Non-thesis	SpaceX
Miklaszewski, Eric, PhD 2014	S. Son, L. Groven		NSWE Crane
Monk, David, MSME 2014	N. Key	A Computational Analysis of the Aerodynamic and Aeromechanical Behavior of the Purdue Multistage Compressor	Siemens Energy
Morrison, Evan, MS 2013	N. Key	Development of a Three Dimensional Compressible Flow Calibration Facility for Thermal Anemometry	
Murray III, William, MSAAE 2014	N. Key	Experimental Investigation of a Forced Response Condition in a Multistage Compressor	Blue Origin
Nellums, Robert (Ross), MS 2013	S. Son	Desensitization of nanothermites using flouropolymer binders	Rocky Mountain Scientific Lab.
Newale, Ashish, MS 2013	J. Gore	Radiation Intensity Measurements and Computations of Impinging Buoyant Flames	
Park, Jeongmoon, MS 2013	S. Heister	Development of Vortex Pair Swirlers for Aerospace Applications	PhD program at Texas A&M
Pfeil, Mark, PhD 2014	S. Son	Changes in Combustion Behavior of Liquid Fuels Due to the Addition of Small Amounts of Ammonia Borane or Nano Aluminum	ARMDEC, Redstone Arsenal
Pfeil, Teandra, MS 2013	L. Groven, T. Pourpoint	Solution Combustion Synthesis of Cobalt Catalysts for the Hydrolysis of Sodium Borohydride	(undecided)
Qu, Zijie, MSME 2014	J. Chen		PhD Program, Brown Univ.
Reese, David, PhD 2014	S. Son, L. Groven	Combustion of SMX and SMX Propellants	Aerospace Corp.
Renslow, Peter, MSAAE 2014	S. Son	A Small-Scale Experiment Using Microwave Interferometry to Investigate Detonation and Shock-to-Detonation Transition in Pressed TATB	Sandia National Labs
Roa, Mario, PhD 2014	R. Lucht	Investigation of a Reacting Jet Injected into a Vitiated Crossflow using CARS, High Repetition Rate OH-PLIF, and High Repetition Rate PIV	Post Doc, UCLA
Rodrigues, Neil S., MSME 2014	P. Sojka		Industry
Rotella, Saverio (Sam), MSAAE 2014	Collicot,t, T. Pourpoint, S. Meyer		JT3, LLC Las Vegas
Sane, Anup V., PhD 2013	J. Gore	A Numerical and Experimental Study of Solid Carbon Conversion Processes in Energy Systems and Combustion	Air Products & Chemicals, Inc.

MJZL Recent Graduates (cont.)

Graduate	Advisor	Thesis Title	Career Destination
Sardeshmukh, Swanand, PhD 2013	S. Heister, C. Merkle	Comprehensive Computational Modeling of Hypergolic Propellant Ignition	Purdue, Post Doc
Seebald, Paul, PhD 2014	P. Sojka	Turbulence in Transcritical CO2 Jets	IBM
Shark, Steven, PhD 2013	S. Son	Hybrid Rocket Combustion: Advanced Fuel Additives and Mixing Studies	Blue Origin
Shipley, Kevin, MSAAE 2014	W. Anderson		Aerospace Corp.
Sippel, Travis, PhD 2013	S. Son	Characterization of Nanoscale Aluminum and Ice Solid Propellants	Iowa State Univ. of Scientific & Tech. Dept. Mech. Eng.
Sircar, Indraneel, PhD 2014	J. Gore		Celanese Corp.
Sun, Lijian, PhD 2014	S. Fleeter		(undecided)
Thompson, Andrew, PhD 2014	S. Heister		Northrop Grumman
Troiani, Alex, MSAAE 2013	S. Son, T. Pourpoint	Effects of Fuel Additives on Combustion Distribution and Stability	Virgin Galactic
Wang, Weining, MS 2013	J. Chen		

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