PURDUE UNIVERSITY

2012-2013 ANNUAL RESEARCH REPORT

Maurice J. Zucrow Laboratories

Schools of Mechanical Engineering &
Aeronautical and Astronautical Engineering

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

January 2014

CONTENTS

	PAGE
Letter from the Director	4
Research Highlights	5
Zucrow Labs Faculty	6-7
Zucrow Affiliate Faculty	8
Zucrow Labs Staff	8
Zucrow Post Docs & Visiting Personnel	8
In Memoriam—James Skifstad	9
Zucrow Labs Alumni Reunion	10-13
Zucrow Students Association (ZSA) and Reunion Photos	14
Zucrow Reunion Lab Tours—Photos	15
MJZL Development Plan Update—Air System and Building Upgrades	16-17
MJZL Current Graduate Students	18-21
MJZL Recent Graduates	22-23
Photo—Chaffee Hall Auditorium 1965	24-25

….from the Director

The past year has been a busy and productive one for the Zucrow Lab complex. At present, the lab has over 100 graduate students, 16 of which have prestigious fellowships from NASA, NSF, and DoD. Our MZL faculty continue to maintain very high research activity; as a result lab research expenditures have grown from $8M last year to nearly $9M in the current year. It is a very hard working and productive group here at the lab as faculty whose sponsored research productivity is more than double the average in the College of Engineering. Last spring, we were happy to celebrate Professor Key's promotion to Associate Professor. We also recently learned that she received the ASME IGTI Dillip R. Ballal Early Career Award for early career contributions in the turbomachinery area. Other notable faculty achievements include Professor Lucht's recognition as AIAA Fellow, and Professor Son's leadership in a College of Engineering "Preeminent Team" in Energetic Materials and Professor Anderson's new position as Associate Head of AAE with responsibility for Undergraduate Education. Professor Timothee Pourpoint also received a promotion to Associate Professor.

Our Managing Director Scott Meyer concluded two years of service as the Chair of the Rocket Test Facility Working Group, a group of industry and government test and research facility operators. Recently, we also learned that Dr. Guillermo Paniagua, an active turbine researcher presently at the Von Karman Institute in Brussels, Belgium, will be joining the lab in the fall of this year. We are excited to have a renewed presence in turbine experimental work at the lab. Lastly, our Research Account Specialist Michelle Kidd was a proud recipient of a College of Engineering Staff Award for Customer Service. All who work with Michelle know how well deserved this award is, and we are thrilled that she was recognized for her hard work and dedication.

Probably the most significant event of the year was our MZL Reunion held on 6 and 7 September. We were pleased to welcome back 70 alumni of the Rocket Lab, the Jet Propulsion Center or the Thermal Sciences and Propulsion Center as the facility has been named in the past. We had three of the six former lab directors in attendance (Dr. Bruce Reese, Dr. Joe Hoffman, and Professor Fleeter) as well as numerous alums from the decades of the 60's, 70's, and 80's.

Dr. Reese gave the keynote address at our banquet, and current MZL students and staff learned about life at the lab with "Doc" Zucrow in the 1950's and 1960's. Drs. Ron Derr, Joe Hoffman, Bob Strickler and Mike Murphy also relayed stories from the early days of the lab. On a related note, we were all greatly saddened of Prof. Skifstad's passing just prior to the event this past fall.

We continue to work in earnest to expand lab spaces as I pointed out to you in last year's letter. We now have a new air heater in procurement, and a set of preliminary building plans thanks to University support of $2.3M in the past year. Our new air heater will provide state-of-the-art capabilities that match a new facility in construction at GE Aviation and the laser lab will be a resource for numerous experiments at Zucrow, including experiments that don't need the air system.

Details on the development path are provided on pages 16 and 17 of this report. Thanks to all who have made donations to this cause; we very much appreciate your support as these funds are the main source for the current funding vision.

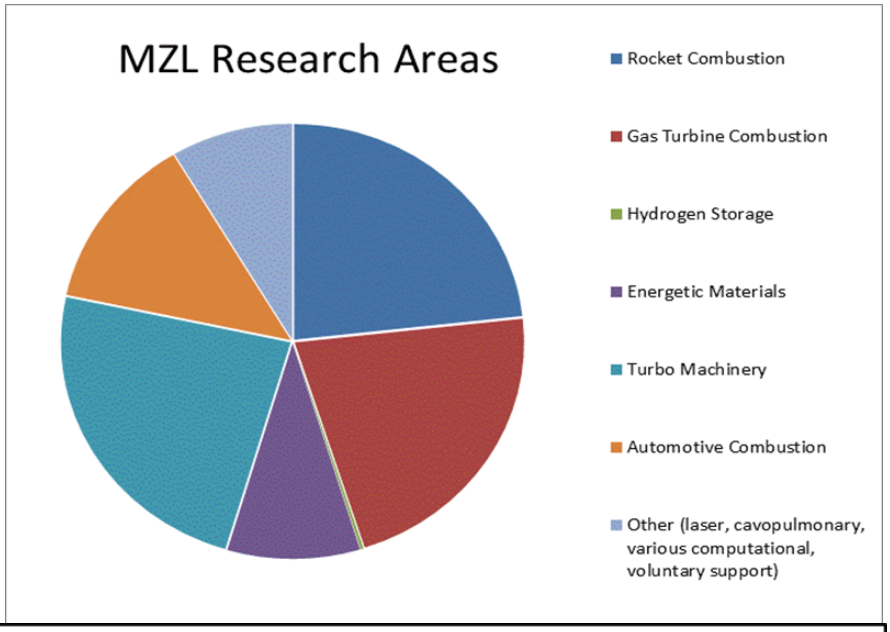
Best wishes to all for a prosperous and healthy 2014.

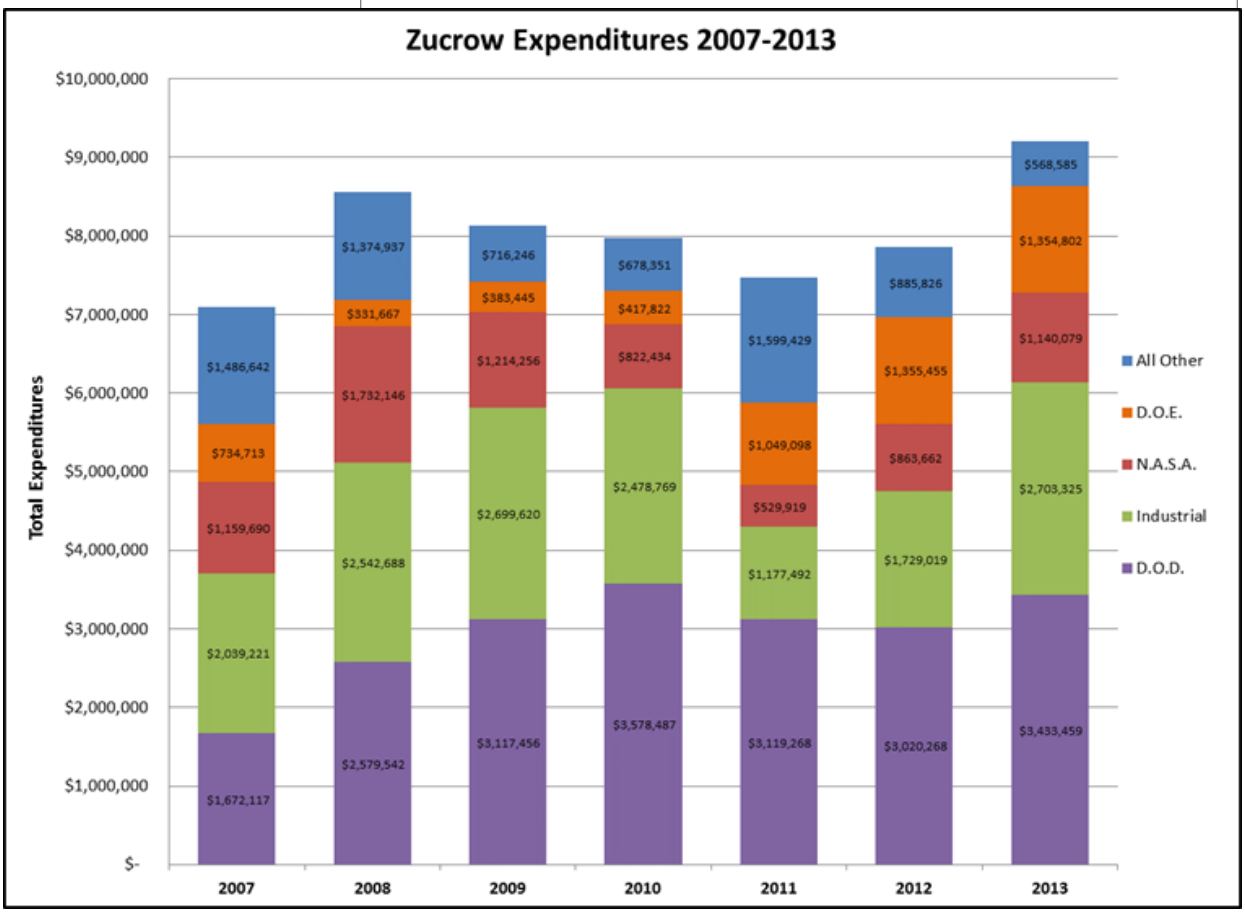
Sincerely,

Stephen (Steve) Heister
Raisbeck Distinguished Professor,
Director Maurice J. Zucrow Laboratories, and
Fellow of the American Institute of Aeronautics and Astronautics (AIAA)

MJZL Research Highlights

MJZL Research expenditures and research areas are summarized in the charts below. The lab continues to be very active, and a global view shows heavy funded activity in 15 of our 16 test cells and high utilization of general lab space as well. Lab research annual spending now exceeds $9M. In the past year, we have seen substantial growth in industrial-sponsored works by GE and Rolls-Royce as projects with Professors Key and Lucht are expanding. Other major sponsors include: AFOSR, ARO, Siemens, NIH, MDA, Sandia, GM, Caterpillar, CCTR, and ONR. Rocket combustion, turbomachinery, and gas turbine combustion areas account for approximately 2/3 of MZL research with substantial efforts in energetic materials and automotive applications as well. MZL faculty have been exceedingly productive as average expenditures on a per faculty basis exceed $600K.





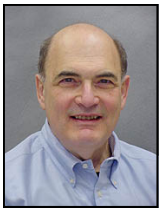
ZUCROW LABS FACULTY

John Abraham, Professor of Mechanical Engineering Research Interests: Multiphase Flows, Combustion, Internal Combustion Engines, Computational Fluid Dynamics. Areas: Combustion, Energy Utilization, and Thermodynamics.

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.

Stephen Frankel, Professor of Mechanical Engineering. Research Interests: Combustion, Turbulent reacting flows, Computational fluid dynamics, Aeroacoustics, Multiphase flow. Research Areas: Combustion, Energy Utilization, and Thermodynamics. Bioengineering.

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.

ZUCROW LABS FACULTY (cont.)

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.

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.

Hukam Mongia, Professor of Mechanical Engineering. Research Areas: Combustion, Energy Utilization, and Thermodynamics.

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.

PURDUE ENGINEERING

ZUCROW AFFILIATE FACULTY

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.

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 LABS 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

ZUCROW POST DOCS & VISITING PERSONNEL

Emre Gunduz
Research Scientist

Vinicio Magi
Visiting Researcher

Nasir Memon
Visiting Professor

Swanan Sardeshmukh
Post Doc

Mitsuaki Tanabe
Visiting Scholar

Tyler Voskuilen
Post Doc

In Memoriam . . . .

James Skifstad
1935-2013


2006

James Gary Skifstad, 78, of West Lafayette, IN, passed away at 10:35 p.m. Monday, September 2, 2013 at Wesley Manor. He was born May 17, 1935 in West Chester, PA. He married Patricia Stewart on December 22, 1956 in River Forest, IL and she survives.

Prof. Skifstad was a 1953 graduate of J.W. Sexton high school in Lansing, MI. He attended Michigan State University and graduated in 1957 with a Bachelor of Science in Mechanical Engineering where he was inducted into the honorary societies of Pi Tau Sigma and Tau Beta Pi. He then attended Purdue University where he earned his Masters and PHD in Mechanical Engineering.

Upon completing his graduate study at Purdue he spent two and half years in the Air Force at the Aerospace Research laboratories, Wright Patterson Air Force Base, Dayton, Ohio, where he served from November 4, 1963 to May 15, 1966 and conducted research on arc plasmas. Returning to Purdue to join the faculty at the Jet Propulsion Center, he became involved in research on the combustion of boron in air-augmented rockets, and in the area of the aerodynamic interactions of jets in VTOL aircraft. From 1967 to 1969 he served as Associate Director of Project SQUID, an Office of Naval Research program in jet propulsion. In September of 1971, he took a year's leave of absence from Purdue to engage in research on chemical lasers at the Army Missile Command, Redstone Arsenal, Alabama. He published extensively in professional journals and he received the Journal of American Aircraft award from the American Institute of Aeronautics and Astronautics for his article on VTOL Aircraft. A Professor of Mechanical Engineering at Purdue University, he taught for 37 years and retired as Professor Emeritus in 2003. At Purdue, he mentored many Masters and Ph.D. students who have gone on to become industry leaders. He enjoyed teaching and challenging his students to grow.


1964

A voracious reader and collector of technical books, Professor Skifstad taught himself to read both German and Russian to better understand the greatest minds in his field. Always looking to learn more, his pursuits outside of academia spanned a wide variety of disciplines: from abstract math, particle physics and string theory to computer architecture and environmental activism.

Late at night, one would often find him immersed in a book, with classical violin music playing on the stereo. Summer days and Sunday mornings were filled with tennis matches, and vacations were spent at his Lake Michigan home where he enjoyed sailing at the foot of Sleeping Bear Sand Dunes. Friends and family knew him as a quick wit that kept everyone on their toes and his children and grandchildren will remember him for games of catch and the model airplanes they built and flew together.

He is survived by his Wife, Patricia Skifstad of West Lafayette, IN, daughter, Sheryl Lee Skifstad, spouse Venugopal Vasudevan of Palatine, IL, Son, Kurt David Skifstad, spouse Grenmarie Agresar of Ann Arbor, MI, 4 Grandchildren: Geoffrey Vasudevan, Gabriela Skifstad, Darien Skifstad and Julian Skifstad.

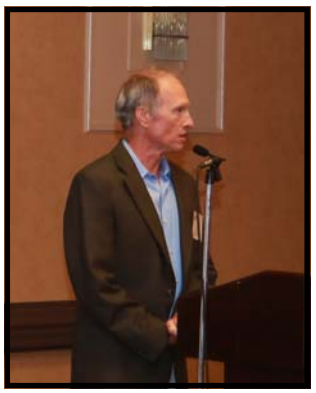
He was preceeded in death by his parents, Clinton Elroy Skifstad and Selma Marie (Eriksen) Skifstad.

ZUCROW LABS ALUMNI REUNION

September 6th & 7th, 2013

The Zucrow Labs *(aka: Rocket Labs, JPC, Thermal Sciences and Propulsion Center)* Alumni Reunion began Friday afternoon, September 6th with an open house, including tours of the labs, and a lab overview given by Steve Heister, Director MZJL. Dr. Bruce Reese (Director 1966-1973) was the keynote speaker at the Friday evening banquet. Saturday morning started with breakfast and tours of the labs, assisted by the Zucrow Students Association (ZSA). Shuttle service was then provided by ZSA from the labs to the football game. The Reunion concluded on the evening of Saturday, September 7th with an informal gathering with pizza and more conversation and reminiscing.

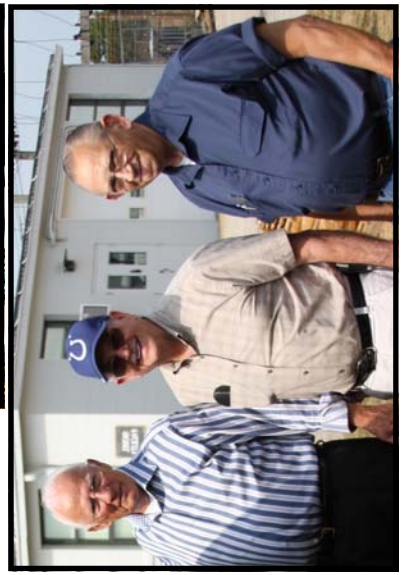
The Reunion provided an opportunity for the 70+ alumni in attendance to reminisce and learn of current research projects as they toured the labs. Current graduate students were also fascinated to learn of the way things were done in times past.



Maurice J. Zucrow Laboratories










ZUCROW LABS ALUMNI REUNION

Maurice J. Zucrow Laboratories

Zucrow Students Association (ZSA)

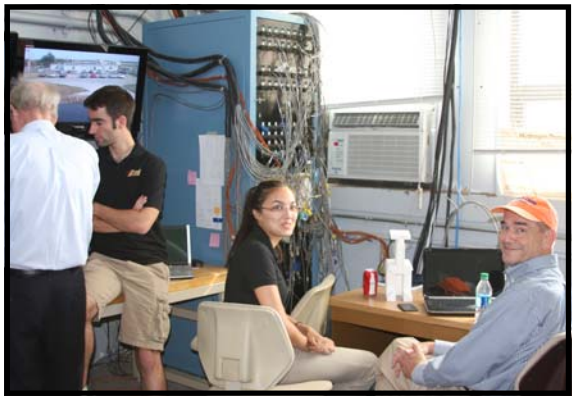
In its third year, the Zucrow Student Association (ZSA) has continued to grow in its mission to serve and represent the interests of Zucrow students and faculty by providing historical context to lab activities, organizing social events, and maintaining resources for all students consistent with the research and development mission of our historic laboratory. The events of this past year have included engineering outreach, student development, and alumni relations.

Student development includes lunchtime research talks which occur each month and give the Zucrow students an opportunity to practicing presenting their research in a relaxed, but technical atmosphere. These lunches also allow us learn about other research being conducted at the lab. During the lunch hour, a couple students give a 10 minute overview of their research and answer questions. Talks feature the wide array of active research at MJZL; and this fall we have learned about combustion instability, turbomachinery, sprays, and wind turbines.

Early in the fall semester, many students volunteered their time to help organize and setup for the Zucrow Reunion which was an enjoyable and historically educational event for all. Additionally, Zucrow students supported a local 4H group with a rocket launch for their National 4H Engineering Challenge. Regular tours of the Zucrow Lab facilities for undergraduate engineering clubs and prospective students are also supported through ZSA to better educate younger students about graduate school and the research opportunities Zucrow has to offer.

The upcoming semester will include more outreach events including a day with a local grade school class to foster excitement for propulsion, engineering, and STEM fields. ZSA will also team up with the ME and AAE graduate student groups to coordinate coffee study breaks at Chaffee once a month.

MJZL Reunion—Lab Tours



MJZL Development Plan Update—Air System and Building Upgrades

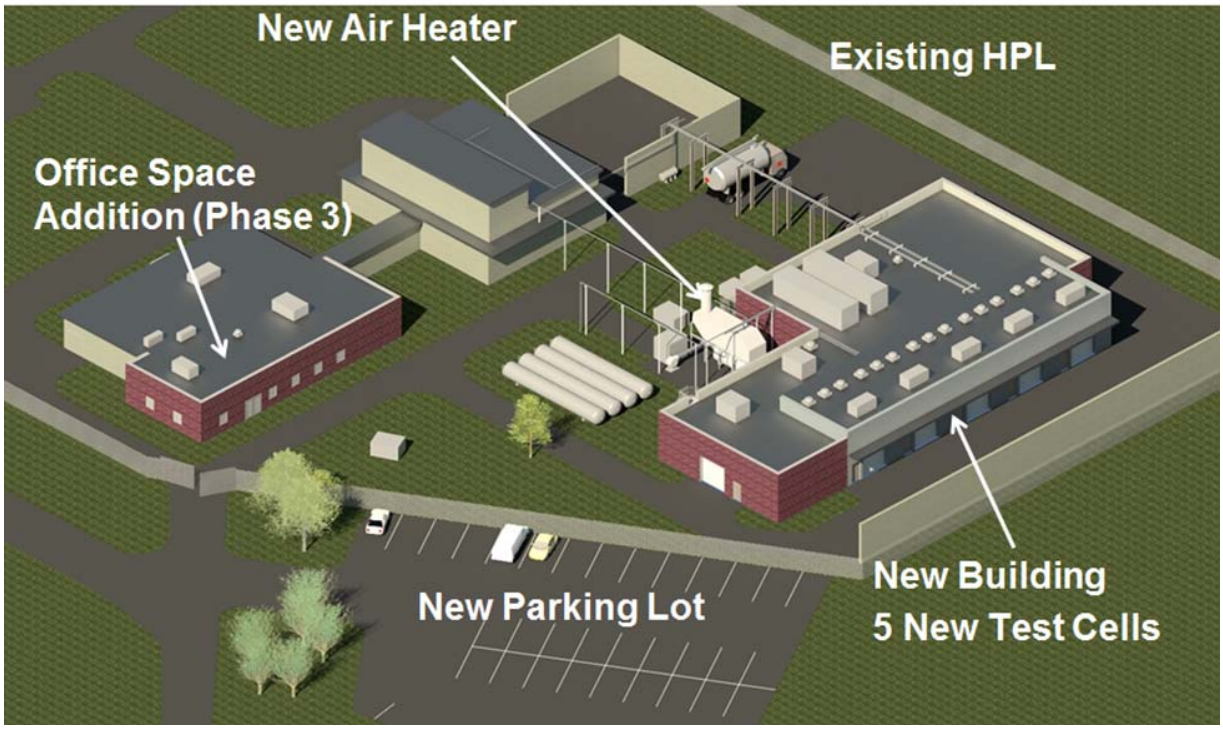
I believe that many of you are aware of our efforts to gain additional test cell space and laser lab facilities to support MZL existing projects and expansion into new areas. We conceived a three-phase plan for this undertaking:

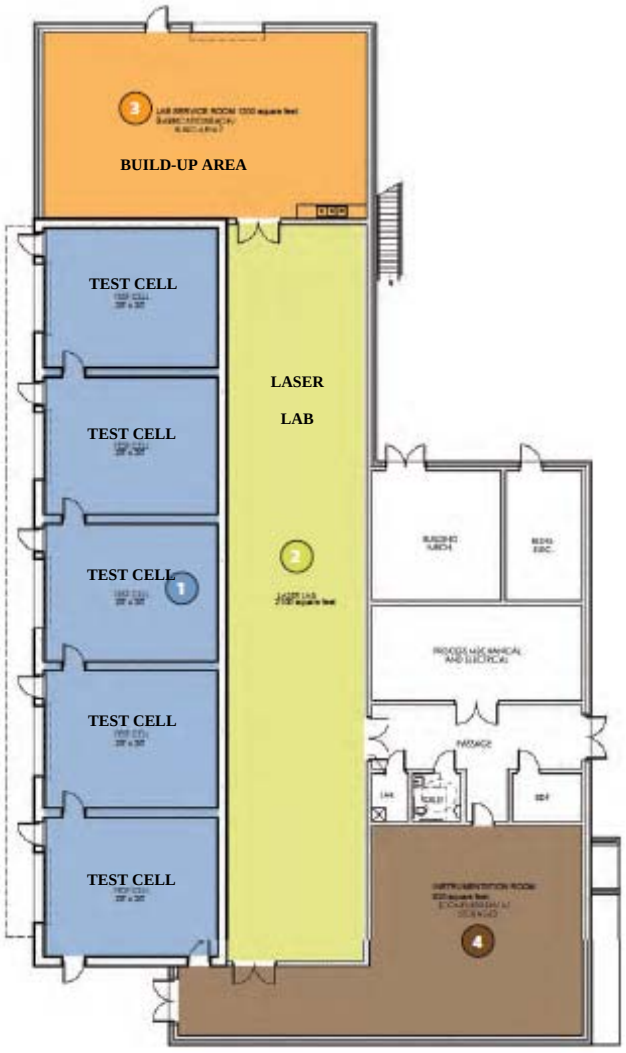
- Phase I – upgrade HPL air heater to 1500 F at 8 lb/s airflow to provide precise compressor discharge characteristics for modern gas turbine engines.
- Phase II – construct a new Airbreathing propulsion lab with unique laser diagnostics capabilities.
- Phase III – renovate and expand HPL office and control room spaces to accommodate growth in test cells, students and staff.

In late 2012, we were thrilled to learn that University leadership provided $2.3M to fund Phase I of the effort as well as to provide resources for initial architectural/engineering work on Phase II. Our new lab, pictured on the following page, is presently estimated to cost approximately $4M. The building, shown on the following page, will be designed from the start to accommodate laser diagnostics in each of the 5 new test cells. As you may know, the high repetition rate laser field is going through a tremendous development and we are now exploiting systems with KHz repetition rates that permit us to image the unsteady flows in real aerospace combustors. Within the past two years, Prof. Lucht's group at our lab has conducted high pressure, high bandwidth PLIF, PIV and CARS measurements demonstrating our team's ability to construct infrastructure for arduous experiments of this nature. It is likely that the next generation of gas turbine combustors and turbomachinery will exploit this vast resource, and we at MZL believe we have the team to provide a key role in this process.

At this point, the development teams for both ME and AAE are soliciting donations in order to permit the next hurdle in getting the Phase II building constructed. We are working in earnest to be able to get Purdue Trustee approval, followed by building detailed design and construction bids completed this year.

Phase III—HPL Renovation and Expansion





Phase II—New Lab Building

The new laboratory building will add five reinforced-concrete test cells expanding our capability for high pressure combustion research. It includes an integral laser laboratory for making previously impossible temperature and species measurements inside combustors.

Plan view of the new building shows 2000 sq ft laser lab that is adjacent to all five test cells. A fabrication shop/build area is included for preparation of test articles, instrumentation, and plumbing for rigs to be installed in the cells. High pressure pluming from the air heater will be installed in applicable test cells for airbreathing combustion, nozzle and turbomachinery experiments. Computer control for the experiments will be achieved in the Computer Data Storage room in the bottom of the building. Experiment control will be in the existing/expanded High Pressure Lab control rooms that serve as the Phase III in the development plan.

MJZL Current Graduate Students

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Beason, Matthew	S. Son	mbeason	Shock Induced Reaction Synthesis in Powder Mixtures
Bedard, Michael	W. Anderson	mbedard	Fiber Optic Spectroscopy of High Frequency Combustion Instability
Berdanier, Reid	N. Key	rberdani	An Experimental Study of Tip Clearance Effects in a Multi-Stage Axial Flow Compressor
Biswas, Sayan	L. Qiao	biswas5	Ignition of Ultra-lean Premixed Methane/Air Mixtures using a Hot Turbulent Jet
Camel, Rozzerio	J. Gore	rcamel	Quantitative Experimental and Computational Infrared Diagnostics of Turbulent Reacting Flows Under Water Suppression
Cho, Kevin	S. Son, R. Lucht	kycho	Optical Diagnostics of Gelled Hypergolic Bipropellants
Chrzanowski, Jonathan	T. Pourpoint	jchrzano	Unsteady Hydrodynamic Flows in Injector Passages
Dennis, Jacob	S. Son, T. Pourpoint	dennis4	Investigation of Condensed and Early Stage Gas Phase Hypergolic Reactions
D'Entremont, James	S. Bane	jdentremont	Control of Combustion Instability Using Plasma Discharges
Dolan, Matthew	N. Key	mpdolan	Undecided
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
Fox, David	T. Pourpoint	dcfox	Non-thesis
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, Jian	J. Chen	gao53	Application of Digital Holography to Spray Diagnostics and Zebrafish Embryonic Development Imaging by Digital Holographic Microscopy
Gejji, Rohan	W. Anderson	rgejji	Investigation of Combustion Instability in a Lean Direct Injection Gas Turbine Combustor
Goyal, Vikrant	J. Gore	goyal21	
Hallum, Zach	W. Anderson	whallum	
Han, Dong	J. Gore	han193	Quantitative infrared imaging of turbulent lean premixed flame

MJZL Current Graduate Students (cont.)

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Heckaman, Bryce	N. Key	bheckama	
Hester, Sarah	S. Heister	hester1	Combustion instability of an unchoked single element combustor using gaseous oxygen and rp1
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
Juska, Paul	S. Son, W. Anderson	pjuska	Non-thesis
Kan, Brandon	S. Heister	bkkan	Pulse Detonation Rocket Engines
Kapaku, Robert	J. Gore	rkapaku	Quantitative Imaging of Radiation Intensity From a Turbulent Sooting Flame
Kees, Devin	T. Pourpoint	djkees	Non-thesis
Kim, Jupyoung	J. Gore	kim1319	Undecided
Kittell, David	S. Son	dkittell	A Water-Based Rocket Propellant Utilizing Aluminum Nanopowder with a Protective Hydrophobic Coating
Kumar, Sumeet	S. Heister	kumar94	Waste Heat Recovery in Automobile Exhaust using Thermoelectric Generators: Topological Studies and Performance Analysis
Lakshmanan, Varun Swaminathan	W. Anderson	vlakshma	Experimental study of combustion instability
Lalit, Harshad	J. Gore	hlalit	
Leng, Yujun	S. Fleeter	leng	Reduced order modeling for forced response prediction in axial and centrifugal compressor including mistuning effect and multistage interaction
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
Mason, B. Aaron	S. Son	bamason	Impact Ignition of Intermetialic Materials
Maynard, Evan	S. Meyer	emaynar	Application of Design of Experiments to Rocket Injectors for Performance Optimization
McBain, Andrew	S. Son	amcbain	
Meier, Eric	W. Anderson, S. Meyer	ejmeier	Rocket Combustion Instability Suppressing Using Fluidic Injectors
Miklaszewski, Eric	S. Son, L. Groven	emiklasz	Oxy-fuel Combustion: Laboratory Experiments and Pilot Scale Tests
Monk, David	N. Key	monkd	A Computational Analysis of the Purdue 3-Stage Axial Compressor

MJZL Current Graduate Students (cont.)

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Mugenda, Angela	S. Bane	amugenda	Combustion Characterization of Fine Hypergolic Sprays
Murray, William	N. Key	wmurray	The Experimental Characterization of Embedded Stage Unsteady Aerodynamic Forcing Functions and Rotor Resonant Response for a Multistage Compressor
Panda, Pratikash	R. Lucht	ppanda	Structure and Dynamics of a Reacting Jet Injected into a High Pressure Vitiated Crossflow
Pfeil, Mark	S. Son, S. Heister	mpfeil	MS: Effects of Ammonia Borance on the Combustion of Ethanol
Pohl, Nicholas	N. Key, J. Chen	npohl	PhD: Characterization of Tip Leakage Vortex with Non-Intrusive Flow Field Measurements
Pratt, Andrew	R. Lucht	pratta	
Reese, David	S. Son	reesed	PhD: Combustion of SMX and SMX Propellants
Renslow, Peter	S. Son	prenslow	Small-Scale Experiment using Microwave Interferometry to Investigate Shock Initiation, Failure, and Transient Reactive Waves in Pressed TATB
Roa, Mario	R. Lucht	mroa	Subject: Laser diagnostic techniques for distributive combustion with applications to gas turbines
Rocha, Jonathan	P. Sojka	rocha0	Secondary atomization of Non-Newtonian liquids in the bag and stamen regime
Rodrigues, Neil	P. Sojka	rodri190	Spray Atomization of Non-Newtonian Impinging Jets
Rubio, Mario	S. Son	rubio0	
Satija, Aman	R. Lucht	asatija	Development and Application of Coherent Anti-stokes Raman Scattering Systems in Reacting Flows
Seebald, Paul	P. Sojka	pseebald	Turbulence in Transcritical CO2 Jets
Shipley, Kevin	W. Anderson	kevin.j.shipley.1	Computational and Experimental Investigation of Transverse Combustion Instability
Sircar, Indraneel	J. Gore	isircar	Subject: Experimental investigation of coal and biomass gasification for liquid fuel synthesis
Slabaugh, Carson	R. Lucht, S. Meyer	cslabau	High-Pressure TAPS Flame Visualization
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
Steiner, Matt	T. Pourpoint	msteiner	Investigation of Non-Toxic High-Performance Propellant Combinations for use in Re-Lightable Hybrid Rocket Thrusters

MJZL Current Graduate Students (cont.)

Student	Advisor	Email ....@purdue.edu	Thesis Topic
Sun, Lijian	S. Fleeter	lsun	CFD Modeling of Wind Turbine Wake in Wind Farms
Tanvir, Saad	L. Qiao	stanvir	
Terracciano, Andrea	W. Anderson	aterracc	
Terry, Brandon	S. Son	terry13	Subject: Nanoscale silicon composite energetic materials.
Thompson, Andrew	S. Heister	thomps79	Flashing of High Temperature Fuels in Internal Flow Passages
Venkatesh, Prashanth Bangalore	S. Bane	pbangalo	High-Pressure Combustion and Detonation-to-Degraflation Transition in Ethylene/Nitrous Oxide Mixtures
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
Yang, Yicheng	J. Gore	yang479	Non-thesis
Zarbo, Nick	S. Meyer	nzarbo	Undecided
Zaseck, Chris	S. Son, T. Pourpoint	czaseck	Development of High Performance Paraffin-Based Hybrid Fuels
Zhang, Robert	R. Lucht	zhan1599	
Zhou, Nina	J. Chen	zhou9	

MJZL Recent Graduates

Student	Advisor	Thesis Title	Career Destination
Bajaj, Chetan, MSME 2012	J. Abraham	Computational Investigations of Ignition Delay and Flame Lift-off in Diesel Jets	Cummins
Ball, Patrick, MS 2013	N. Key	An Experimental and Computational Investigation on the Effects of Stator Leakage Flow on Compressor Performance	
Berdanier, Catherine, MS 2013	R. Lucht	Flowfield Characterization of a Piloted Lean Premixed Injedtor by Particle Image Velocimetry	
Brossman, John, PhD 2012	N. Key	An Investigation of Rotor Tip Leakage Flows in the Rear-Block of a Multistage Compressor	Blue Origin
Choi, Go, PhD 2012	J. Woodall, Y. Zheng		
Dadson, Jennifer, MS 2013	T. Pourpoint		
Daily, Megan, MS 2013	S. Son	Electromagnetic properties of energetic materials	Los Alamos National Labs
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	
Finney, Heather, MS 2013	P. Sojka	Fluid dynamics of deep water multiphase jets	
Forness, Jordan, MSAAE 2013	S. Heister	Injector Concepts for Hypergolic Propellants	
Harvazinski, Matthew, PhD 2012	W. Anderson	Modeling Self-Excited Combustion Instabilities Using a Combination of Two– and Three-Dimensional Simulation	AFRL Phillips Lab
Hedman, Trevor, PhD 2012	S. Son, R. Lucht	Experimental Observation and Modeling of Solid Composite Propellants	NAWC, China Lake, CA
Iwanicki, Michael, 2012	T. Pourpoint		
Kerlo, Anna-Elodie, PhD 2013	S. Frankel, J. Chen	Development of a Circulatory Support for the Univentricular Fontan Circulation	
Krishnan, Abhishek, MS 2013	L. Qiao		
Kulkarni, Varun, PhD 2013	P. Sojka	Secondary Atomization of Non Newtonian Drops at High Weber numbers	
Lamont, Warren, PhD 2012	R. Lucht, W. Anderson	Experimental Study of a Distributed Combustion System for Stationary Gas Turbines	Power Systems Mfg. in FL
Larson, Logan, MS 2013	S. Heister	Non-thesis	
Mallory, Jennifer, PhD 2012	P. Sojka	Jet Impingement and Primary Atomization of Non-Newtonian Liquids	Western New England Univ. in MA

MJZL Recent Graduates (cont.)

Student	Advisor	Thesis Title	Career Destination
Massaro, Matt MS 2012	S. Son	Coal Fine Utilization and Analysis Using Municipal Solid Waste (MSW) Plastics and Other Binders	Gamma Technologies, Inc.
McKinney, Emerald, MSAAE 2013	W. Anderson	Non-thesis	SpaceX
Miller, Keith, MS 2012	N. Key	Design of a Centrifugal Compressor Research Facility for Low Specific Speed Applications	SpaceX, CA
Morgan, Collin, MS 2012	W. Anderson		NASA MSFC
Morrison, Evan, MS 2013	N. Key	Development of a Three Dimensional Compressible Flow Calibration Facility for Thermal Anemometry	
Nellums, Robert (Ross), MS 2013	S. Son	Desensitization of nanothermites using flouropolymer binders	Rocky Mountain Scientific Lab.
O'Neil, Patrick, MSME 2012	S. Heister	Developments in Processing and Ballistics of Dicyclopentadiene-Based Composite Solid Propellants	Pratt & Whitney in CT
Park, Jeongmoon, MS 2013	S. Heister	Development of Vortex Pair Swirlers for Aerospace Applications	
Pfeil, Teandra, MS 2013	L. Groven, T. Pourpoint	Solution Combustion Synthesis of Cobalt Catalysts for the Hydrolysis of Sodium Borohydride	
Pomeroy, Brian, PhD 2012	W. Anderson	Measurement and Analysis of Combustion Response to Transverse Combustion Instability	Aerojet in CA
Rankin, Brent, PhD 2012	J. Gore	Quantitative Experimental and Model-Based Imaging of Infrared Radiation Intensity from Turbulent Reacting Flows	AFRL, Dayton, OH
Rettenmaier, Andrew, MS 2012	S. Heister	Erosive Burning of Composite Propellants	Blue Origin
Sane, Anup, PhD 2013	J. Gore	A Numerical and Experimental Study of Solid Carbon Conversion Processes in Energy Systems and Combustion	Air Products & Chemicals, Inc.
Sardeshmukh, Swanand, PhD 2013	S. Heister, C. Merkle		Purdue, Post Doc
Shark, Steve, PhD 2013	S. Son	Hybrid Rocket Combustion: Advanced Fuel Additives and Mixing Studies	Blue Origin
Sippel, Travis, PhD 2013	S. Son	Characterization of Nanoscale Aluminum and Ice Solid Propellants	Iowa State Univ. of Scientific & Tech. Dept. Mech. Eng.
Solomon, Yair , MS 2012	W. Anderson	Gelled MMH Hypergolic Droplet Investigation	
Trebs, Adam, 2012	W. Anderson, S. Heister	The Effect of Boundary Layer Variability on Compression Ramp Injector Functionality	Aerojet CA
Troiani, Alex, MSAAE 2013	S. Son, T. Pourpoint	Effects of Fuel Additives on Combustion Distribution and Stability	Virgin Galactic
Voskuilen, Tyler, PhD 2012	J. Gore, T. Pourpoint	A Study of Hydriding Kinetics of Metal Hydrides Using a Physically Based Model	Purdue, Post Doc
Xu, Duo, PhD 2012	J. Chen	Experimental Study of Turbulent Stratified Jet	Max Planck Institute
Zakrajsek, Andrew, 2012	S. Son	Water Blast Mitigation	AFRL, Dayton, OH

Chaffee Hall Auditorium—1965

Front Row (L-R): Doyle Thompson, Nick Barsic, Charlie Bryce, Cecil Warner, Ron Derr, Charlie Merkl, Lynn Carstens, Bill Timmons, Wanda Boyd, Sandy (?), Bill Hassel, Bob Strickler, Pete Scofield, Bill Lindberg, Phil Goede

Second Row: Skip Beller, Mel L'Cuyer, Bob Osborn, John Kelly, (?), (?), Robert Gator, Bann Farquar, Tom Miller, Jonn Converse, Dick Burrick, Jim Locker, Abe Keskin

Back Row: Stu Kerschner, Gil Legmann, George Schneider, Chuck Ehresman, Dick Guhse, Joe Hoffman, Nolan James, Dave Netzer, Gordon Hurst, (?), Tom Carpenter, Bruce Reese

Maurice J. Zucrow Laboratories

Photo provided by Phil Goede

Please note: We would appreciate your input if you see any corrections for the names, or maybe fill in the blanks.