

PURDUE
UNIVERSITY

2012-2013 ANNUAL REPORT

FALL 2013

RAY W. HERRICK
LABORATORIES

177 S. Russell Street
West Lafayette, IN 47907-2099



Phone: 765-494-2132
Fax: 765-494-0787
E-mail: rhlab@ecn.purdue.edu



Top Photo: Herrick Labs 2013
Middle Photo: Herrick Labs Bldg. 1980
Bottom Photo: Herrick Labs Bldg. 1912*

** From the J.C. Allen collection, courtesy of Purdue University Libraries, Archives & Special Collections*



THE RAY W. HERRICK LABORATORIES

The Ray W. Herrick Laboratories were founded in the mid-1950's as a research laboratory for studying the effects of climate control and for the design of improved climate control equipment. Today the research is related to a much broader range of applications including transportation, engines, and information technology. The Labs have grown and evolved into a center where graduate education and engineering research are combined in close partnership with industry in order to develop people and results of great importance. The Herrick Labs goal is to sustain a culture of excellence in an environment of partnership and shared resources.

The research programs of the Herrick Labs can be described in four general areas; electro-mechanical systems, noise and vibration control, perception based engineering, and thermal systems. It is also home to the Center for High Performance Buildings, which spans several of these areas. The community at the Herrick Labs, which includes the faculty, staff, students, and sponsors, is focused on results that are both fundamental research discoveries and of practical importance to sponsors.

The educational experience at the Herrick Labs combines the traditional training of aspiring researchers with exposure to industrial needs and culture. Students study in a strong peer education environment with active mentoring from faculty and sponsors. Nearly 800 Masters and PhD candidates have graduated from the Herrick Labs.

The engagement/service programs are highlighted by the well established conference and short course activity sponsored by the Herrick Labs. In addition, technology transfer to sponsors is an integral part of a majority of the research programs. The researchers at the Herrick Labs are also widely published across the spectrum of publications from academic journals to the popular press.

MISSION

An institution dedicated to graduate education and engineering research with emphasis on technology transfer to industry.

VISION

To overcome the barriers between knowledge creation, transfer, and utilization and to become leaders of how graduate education and engineering research are done in partnership with industry.

GOALS

1. To build upon the research excellence of the *Heating, Ventilation, Air-Conditioning, and Refrigeration Research Area* and the *Electro-Mechanical Systems* and the *Noise and Vibration Control Research Area* to enhance their national and international visibility and grow the reputation of these areas as the top research programs in the world.
2. Increase the visibility of the Center for High Performance Building.
3. To identify emerging research areas that are synergistic with laboratory focus.
4. To develop a proactive evolutionary strategy for the Laboratories to ensure its long-term stability and growth.
5. To improve the educational environment at the Labs so that its graduate students are multi-functional engineers who rate as the top engineering graduates in the country.
6. To continually monitor the technology transfer process by which research results are transferred to sponsors and the engineering community such that the labs will be recognized as the premier source of practical cutting edge research in our areas of expertise.
7. To continually grow the research environment at the Labs for the benefit of the students and faculty at the Labs.

2012-2013 HIGHLIGHTS

Research

	Last Year	This Year
Research expenditures HERL only (*academic year)	\$5,016,103	\$5,844,774
Building Expenditures (*academic year)	\$10,882,857	\$13,467,228
Number of sponsors as of September 2013	31	44
Research assistants as of September 2013	85	45
Archival papers published (*calendar year)	65	74
Contracts in force for next academic year (July 2013-June 2014)	\$3,388,265	\$2,821,276

Education

Graduate students as of September 2013	85	80
MS	42	39
Ph.D.	43	41
Students graduated (*calendar year)	27	26
MS	19	14
Ph.D.	8	12
Undergraduate/graduate "research experience" students	17	11
Visiting scholars, Post Doctoral Students		
Visiting Research Assistants	13	17
Fellowships	9	5
Grant-in-Aid	4	5
Student Paper/Poster/Thesis Awards	8	5

Technology Transfer

Conferences/Workshops held (*academic year)	8	4
Conferences planned in the next 2 years (July 2013 - July 2015)	3	5
Short Courses held (*academic year)	8	3
Herrick Labs reports to sponsors (*academic year)	10	15
Conference and journal papers (*calendar year)	140	189

*Academic Year - July 2012 → June 2013

*Calendar Year - January 2012 → December 2012

Administrative and Support Staff

Professor Patricia Davies is the director of the Ray W. Herrick Laboratories. Donna Cackley is her administrative assistant. Kim Stockment serves as administrative assistant for the Herrick Laboratories' conference and short course activities. Additional support staff is provided by Miranda Gick, secretary. Orkan Kurtulus has been co-ordinating the new building technology, working with the construction company, commissioning agents, vendors and Herrick faculty and students on commissioning and training. The research programs are assisted by the mechanical and electronics shops: Ron Evans, electronic shop coordinator; Bob Brown, mechanical shop coordinator and building deputy; and Frankie Lee, mechanical technician. Students Taeha Joo, Kyle Quillen, and Tessa Groll have also been assisting.

HERRICK LABS FACULTY RESEARCH INTERESTS

- Anil K. Bajaj**, Head and Professor of Mechanical Engineering. PhD 1981, University of Minnesota. Nonlinear oscillations in structures, chaotic dynamics, stability analysis, flow-induced vibrations, perturbation techniques, mistuned structures, and localization of modes, drum and disk brake squeal-friction induced vibrations, modeling of carseat-occupant dynamics, and modeling/identification of polyurethane foam properties.
- J. Stuart Bolton**, Professor of Mechanical Engineering. PhD 1984, University of Southampton. Acoustics, models of porous noise control materials, optimal design of noise control materials and treatments, physical properties of noise control materials, analysis of tire vibration and sound radiation, nearfield acoustical holography, visualization of motor vehicle passby sound radiation, and machinery noise source identification.
- James E. Braun**, Herrick Professor of Mechanical Engineering. PhD 1988, University of Wisconsin. Thermal systems measurements, modeling, analysis, design optimization, and control optimization with applications to air conditioning and refrigeration equipment and systems.
- 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.
- Qingyan (Yan) Chen**, Reilly Professor of Mechanical Engineering. PhD 1988, Delft University of Technology. Indoor and outdoor airflow modeling by computational fluid dynamics and measurements, protection of buildings from chemical/biological warfare attacks, building ventilation systems, indoor air quality, airline cabin environment.
- George T.-C. Chiu**, Professor of Mechanical Engineering. PhD 1994, University of California at Berkeley. Mechatronics, modeling/control of digital imaging and printing systems, signature embedding for image/document security, material delivery systems for micro-fabrication, assistive devices for patient handling and movement, motion control, embedded systems/control, and perception-based engineering.
- Patricia Davies**, Professor of Mechanical Engineering, Director of the Ray W. Herrick Laboratories. PhD 1985, University of Southampton. Signal processing and data analysis applied to mechanical systems, condition monitoring, vibration measurement, sound quality and perception-based engineering, nonlinear system identification, modeling of car seat-occupant dynamics and modeling and identification of foam properties.
- Eckhard A. Groll**, Professor of Mechanical Engineering. Director of office of professional practice. PhD 1994, University of Hannover, Germany. Thermal sciences as applied to advanced HVAC&R systems, components, and working fluids: alternative refrigeration technologies, vapor compression systems, natural refrigerants, compressor research, heat exchangers analysis, miniatur refrigeration systems for electronics cooling.
- W. Travis Horton**, Assistant Professor of Civil Engineering. PhD 2002, Purdue University. Thermal sciences and energy conversion systems, including heating, air conditioning, refrigeration, and electrical systems; combined heat and power systems, and building energy modeling techniques.
- Panagiota Karava**, Assistant Professor of Civil Engineering. PhD 2007, Concordia University. Natural/hybrid ventilation, building airflows, building-integrated photovoltaic-thermal systems, building energy modeling & simulation, design & analysis of energy efficient buildings, wind effects on buildings, indoor environment.
- Charles M. Krousgrill**, Professor of Mechanical Engineering. PhD 1980, California Institute of Technology. Non-linear oscillation, elastic stability, dynamics, vibrations, rotor dynamics, chaos, automotive brake squeal/vibration, and vibration in gearing systems.
- Kai Ming Li**, Professor of Mechanical Engineering. PhD 1987, University of Cambridge, UK. Environmental acoustics, sound propagation outdoors, noise control in built environments, monitoring of natural and human produced sounds in the environment, computational acoustics, physical acoustics and wave propagation in a complex medium.
- Robert P. Lucht**, Ralph and Bettye Bailey Professor of combustion in Mechanical Engineering. PhD 1981, Purdue University. Laser diagnostics; diode-laser-based sensors; gas turbine and internal engine combustion; materials processing and synthesis; combustion science; and fluid mechanics and heat transfer.
- Peter H. Meckl**, Professor of Mechanical Engineering. PhD 1988, Massachusetts Institute of Technology. Motion and vibration control of high-performance machines, adaptive control, virtual sensing, and diagnostics. Applications to manufacturing devices, robotics, and automotive engines.
- Ming Qu**, Assistant Professor of Civil Engineering. PhD 2008, Carnegie Mellon University. Development & application of energy efficient technologies in buildings, solar cooling & heating systems, building energy supply systems, sustainable building design & analysis.
- Jeff Rhoads**, Associate Professor of Mechanical Engineering. PhD 2007, Michigan State University. Nonlinear dynamics and vibration of macro-, micro-, and nanomechanical systems, micro- and nanoelectromechanical sensor design, mechanical and electromechanical amplifiers, parametrically-excited systems, mechanical and electromechanical radio-frequency (RF) components, system dynamics.
- Gregory Shaver**, Associate Professor of Mechanical Engineering. PhD 2005, Stanford University. Modeling, design and control of advanced powertrains for the purpose of developing clean, efficient and practical approaches to utilizing conventional and alternative fuels. Coordination of combustion process with aftertreatment systems and hybrid powertrains. Novel combustion methodologies: Homogeneous Charge Compression Ignition (HCCI), clean diesel.

HERRICK LABS FACULTY RESEARCH INTERESTS (CONTINUED)

- Thanos (Athanasios) Tzempelikos**, Assistant Professor of Civil Engineering. PhD 2005, Concordia University. Design of energy-efficient buildings, indoor environment, dynamic facades, lighting controls, integration of green and renewable technologies, solar energy applications, building energy modeling & simulation.
- Bin Yao**, Professor of Mechanical Engineering. PhD 1996, University of California at Berkeley. Coordinated control of intelligent and high performance electro-mechanical/hydraulic systems; mechatronics; robotics; automotive control; optimal adaptive/robust controls; nonlinear observer design and neural networks for virtual sensing, modeling, fault detection, diagnostics, and adaptive fault-tolerant control; data fusion.

HERRICK FACULTY PROFESSIONAL ACTIVITIES

Anil Bajaj

Contributing Editor, Nonlinear Dynamics Journal

Stuart Bolton

Advisory Board Member, Noise Control Engineering Journal
Vice President for Publications, Institute of Noise Control Engineering, (2011 - 2013)
Institute of Noise Control Engineering – Member Board of Directors
Institute of Noise Control Engineering – InterNoise 2015 – INCE/KSNVE Liason
Technical Program Committee, Noise-Con 2013

Jim Braun

Editorial Board, Journal of Building Performance Simulation
Editorial Board, Building Simulation: An International Journal
Associate Editor, International Journal of HVAC&R Research
Chairman, 2012 International Refrigeration and Air Conditioning Conference, Purdue University

Yan Chen

Consultant, The Canaan Company, 2012
Editor-in-Chief, Building and Environment (BAE) Journal
Member, Advisory Board, Energy and Buildings
Departmental Academic Advisor, Department of Building Services, Hong Kong Polytechnic University

George Chiu

Fellow of the Society for Imaging Science and Technology (IS&T)
Fellow, American Society of Mechanical Engineers (ASME)
Member, Institute of Electrical and Electronic Engineers (IEEE)
Chair, Executive Committee, ASME Dynamic Systems & Control Division, 2012-present
Member, International Federation of Automatic Control (IFAC) Technical Committee on Mechatronic Systems, 2005-present
Vice-Chair, Executive Committee, ASME Dynamic Systems and Control Division, 2012-2013
Member, Executive Committee, ASME Dynamic Systems and Control Division, 2010-2012
Editor, Journal of Imaging Science and Technology, 2012-present
Member, Editorial Board, Frontiers of Mechanical Engineering, 2008-present
Associate Editor, Journal of Control Engineering Practice, 2007-present
Program Chair, the 2016 American Control Conference, Boston, MA, June 2016
Registration Chair, The 2012 American Control Conference, Montreal, Canada, June 2012

Patricia Davies

Chair of the Long Range Planning and Nominations Committee, Institute of Noise Control Engineering (INCE)
INCE Board of Directors General Chair
NoiseCon 2013 Conference
Member, Acoustical Society of America

Eckhard Groll

Regional Editor for the Americas, International Journal of Refrigeration
Guest Editor, "Making the Odd Couple Work: Combining Engineering and Language Education," Festschrift in honor of John Grandin, Online Journal for Global Engineering Education (2011 – 2012)
Advisory Board Member, Karlsruhe House of Young Scientists, Karlsruhe Institute of Technology
Director-at-Large, ASHRAE Board of Directors

HERRICK FACULTY PROFESSIONAL ACTIVITIES (CONTINUED)

Eckhard Groll (continued)

Chair, ASHRAE Data Center Working Group
 Chair, USNC/IIR (U.S. National Committee of the Int'l Institute of Refrig.), 2007-2011
 ASHRAE Advisory and Scientific Committee member: 11th CLIMA 2013 Congress, Prague Czech Republic, June 16-19, 2013
 Steering Committee Member: 15th Annual Colloquium on Int'l Eng. Education, Newport, Rhode Island, Nov. 2-4, 2012
 Steering Committee member: ASHRAE/NIST Refrigerants Conference, NIST, Gaithersburg, MD, October 29-30, 2012
 General Conference Chair: 21st Int'l Compressor Engineering Conference at Purdue, 14th Int'l Refrigeration & Air Conditioning Conference at Purdue, and 2nd Int'l High Performance Buildings Conference at Purdue, July 15-19, 2012
 International Scientific Committee Member: 8th Int'l Conf. on Compressors and Coolants, Smolenice, Slovakia, September 2-4, 2013
 Purdue University Global Council Member

Panagiota Karava

Member, American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2008-present
 Member, International Building Performance Simulation Association (IBPSA), 2005-present
 Member, American Wind Engineering Association, 2008-present
 Member, US Building Simulation Association, 2009-present
 Organizing Committee, 2nd and 3rd Int'l High Performance Buildings Conference at Purdue University, 2012
 Member, ASHRAE Technical Committee 4.3, TC 6.7, and TC 4.10, 2008-present
 Member, ASCE Technical Committee on Environmental Wind Engineering, 2009-present

Bob Lucht

Associate Editor, American Institute of Aeronautics and Astronautics Journal
 Associate Editor, Optics Express

Peter Meckl

Finance Chair, 2013 American Control Conference

Ming Qu

Secretary/Treasurer 2012-2013, Executive Committee, Solar Energy Division (SED) of ASME
 Chair, Technical Committee of Conservation and Solar Buildings, SED of ASME
 Chair, Technical Committee on Building Energy Systems and Optimization Methods, Architectural Engineering Institute, 2010-

Jeff Rhoads

Associate Editor of the ASME Journal of Vibration and Acoustics (2013-present)
 Member of the ASME International Design Engineering Division Technical Committee on Sound and Vibration (2010-present)
 Member of the ASME International Design Engineering Division Micro/Nanosystems Technical Committee (2009-present)
 Vice-Chair and Treasurer (2013-present)
 Secretary (2012-2013)
 Member of the ASME International Student Design Committee (2008-present)

Greg Shaver

Chair, ASME Automotive and Transportations Systems Technical committee
 Associate Editor, IFAC Control Engineering Practice Journal
 Associate Editor, ASME Journal of Dynamic Systems and Control

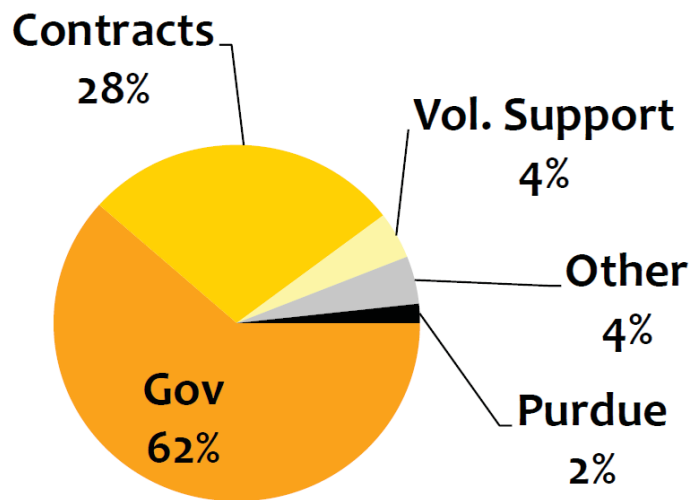
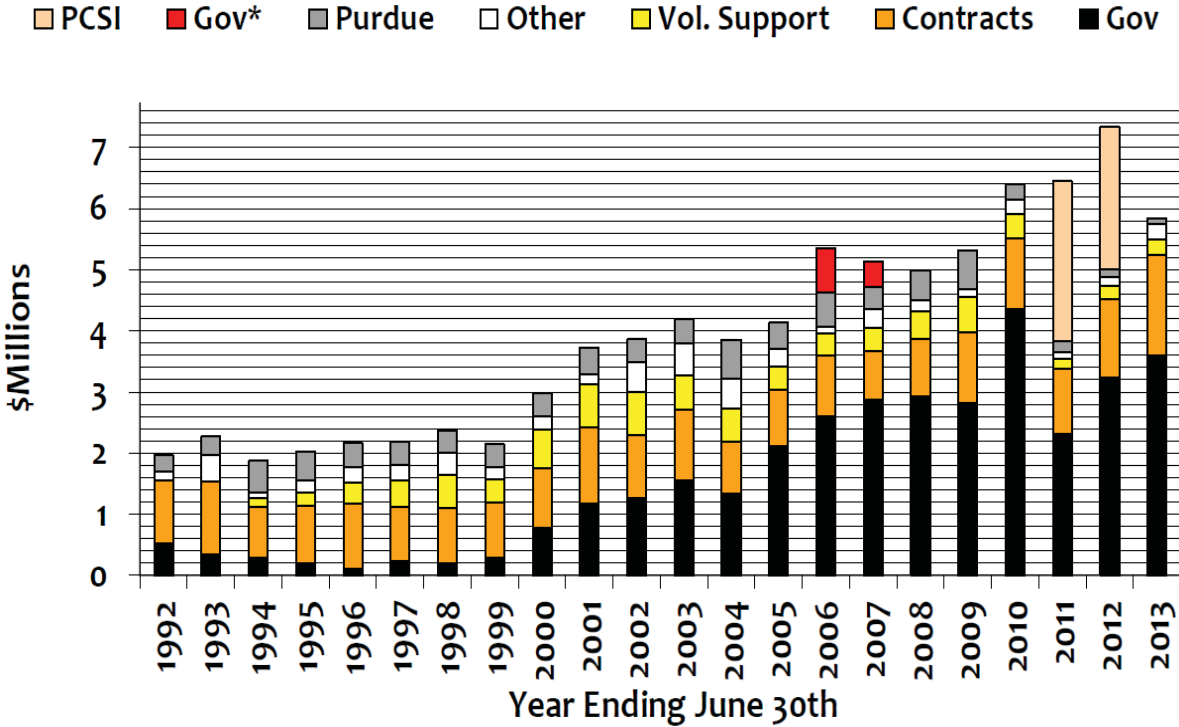
Thanos Tzempelikos

Associate Member, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 Voting Member and Subcommittee Chair of ASHRAE Fenestration Technical committee
 Member, Architectural Engineering Institute (AEI) of the American Society of Civil Engineers
 Member, International Building Simulation Association
 Member, International Solar Energy Society
 Chairman, 1st, 2nd and 3rd International High Performance Buildings Conferences, Purdue University, 2010, 2012, 2014
 Member of technical review panels for EPA, DOE, and other government-funded research proposals

2012-2013 EXPENDITURES

Shown below is the distribution of research expenditures from July 1992 to June 2013

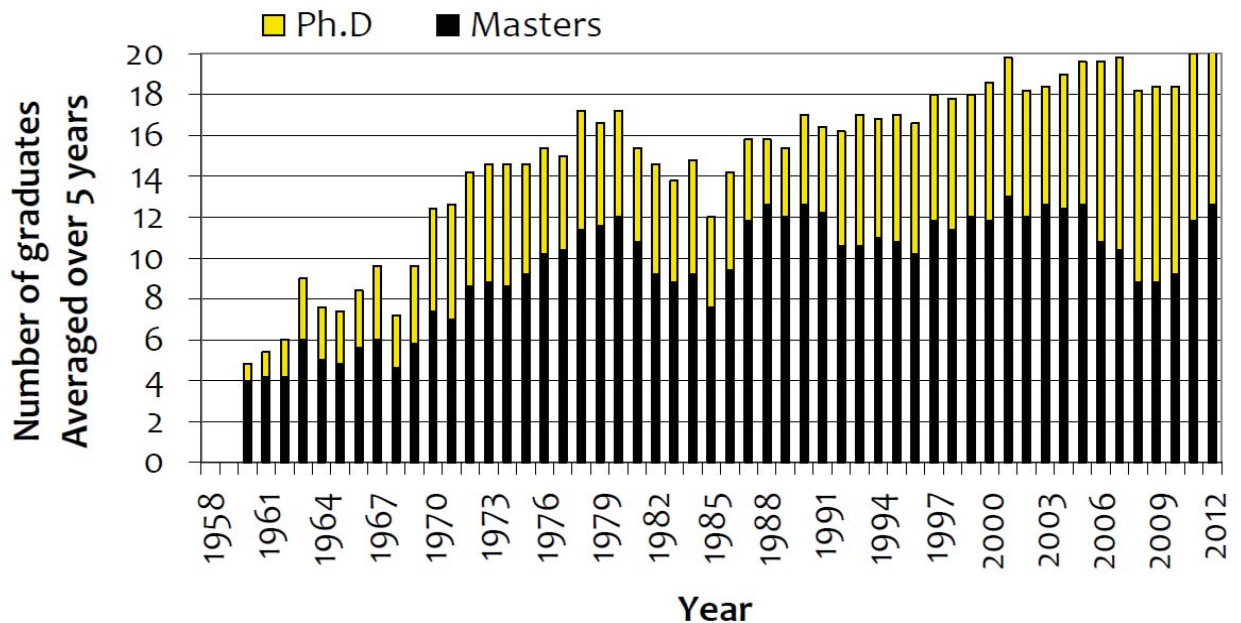
Total Herrick Laboratories Research Expenditures \$5,844,774-2013; \$5,016,103-2012
 Additional Building Expenditures: \$13,467,228-2013; \$10,882,857-2012



The Ray W. Herrick Laboratories

HERRICK LABS EDUCATION PROGRAMS

The primary educational program at the Herrick Labs is thesis based graduate education. We believe that the experiential learning, the open-ended and integrative nature of thesis based research is outstanding preparation for both academic and industrial careers. To complement the student/advisor relationship, the Labs offer a learning community to the student. This community includes an outstanding cohort of graduate students as well as a staff prepared to support and teach. In many cases, the student's research is sponsored. Sponsor representatives also participate in educational activities with the student. We also have programs where graduate students do internships in industry or government laboratories. In total we believe this is an outstanding educational opportunity for our graduate students.



Fellowships

Carrie Hall, received the Ward A. Lambert Teaching Fellowship
 Andrew Hjortland, received the Winkelman Fellowship
 Nelson James, received the GEM Fellowship
 Abhinav Krishna, received the Adelberg Fellowship
 Lu Lu, received the Ward A. Lambert Teaching Fellowship
 Brett Seward, received Fulbright Scholarship (undergrad worked with Kai Ming Li)
 Bao Tong, received the Maxine and Edward Nichols Fellowship
 Ularee Upathumchard, received the Fullbright Scholarship
 Srinivas Varanasi, received the Ward A. Lambert Teaching Fellowship
 Ashish Vora, received the Frederick N. Andrews Fellowship
 Daniel Woods, received the Frederick N. Andrews Fellowship

Grants-in-Aid

Stephen Caskey, Howard Cheung, Donghun Kim, Ki Sup Lee and Sugirdhalakshmi Ramaraj, received an ASHRAE Grant-in-Aid

Awards

Chun Chen, received the Building and Environment Journal Best Paper Award
 Tyler Dare, received International Noise Control Enging (INCE) Leo Beranek student medal for excellence in noise control studies
 Michael Hayward, student paper competition at the SAE Noise and Vibration Conference
 Brandon Sobeki, student poster competition at the SAE Noise and Vibration Conference
 David Yuill, received second place at the Purdue Air-conditioning student paper competition conference

CURRENT HERRICK LABS STUDENTS

Student	Major Professor	Thesis subject
Mohammad Abu Khater	Rhoads/Peroulis	Influence of vibration on rf components
Varun Agrawal	Yao	Adaptive robust control of flexible cable driven surgical robotic devices
Yusuf Azizi	Davies/Bajaj	Improvements to models of flexible polyurethane foam to enhance predictions of seat-occupant dynamics
Christian Bach	Braun/Groll/Horton	Investigation of methods to reduce the effects of maldistribution on evaporator performance
Yeonjin Bae	Horton	Optimization methodology for energy-efficient housing
Ammar Bahman	Braun/Groll/Horton	High efficiency air conditioning systems for hot climate regions
Nikhil Bajaj	Chiu	Print quality improvement
Shambhavi Balasubramanian	Meckl	Estimation & compensation of fuel quantity variation in multipulse injections
Udbhau Bhattiprolu	Davies/Bajaj	Modeling & system identification of structural systems incorporating nonlinear viscoelastic materials
Tim Blatchley	Braun/Groll/Horton	Secondary loop air conditioner for residential applications using propane
Jie Cai	Braun	Development & assessment of heuristic control strategies for a multi-zone commercial building employing a direct expansion system
Rui Cao	Bolton	Effect of rotation on coupled tire structural-acoustic modes
Stephen Caskey	Groll/Hutzel	Solar-assisted & thermally-integrated appliance system with centralized thermal storage
Chun Chen	Chen	Predicting transient particle transport in enclosed environments with the combined cfd & markov chain method
Howard Cheung	Braun	Mechanistic modeling of a dual-unit variable-speed ductless heat pump system
Supriya Dharkar	Groll	High cop heat pumps for commercial energy applications
Chuan Ding	Shaver	Improving efficiency & emissions control through variable valve actuation on a diesel engine
Joonyup Eun	Chiu	Print quality improvement
David Fain	Shaver	Operating range expansion of premixed charge compression-ignited combustion in a multi-cylinder diesel engine with flexible valve actuation & variable fuel reactivity
Adam Fogarty	Shaver/Meckl	Ecocar2 – rear drivetrain design
Mayura Halbe	Shaver	Operating range expansion of premixed charge compression-ignited combustion in a multi-cylinder diesel engine with flexible valve actuation & variable fuel reactivity
Dong Han	Groll	Optimizing heat pump performance
Andrew Hjortland	Braun	Virtual sensor based rtu fdd for multiple simultaneous fault diagnoses
Harshad Inamdar	Groll/Garimella	Performance of heat exchangers & heat sinks after air-side fouling & cleaning
Bilwa Jadhav	Shaver	Implementation & performance update of ecocar 2: plugging into future
Nelson James	Braun/Groll/Horton	Liquid Flooded Ericsson Power Cycle

CURRENT HERRICK LABS STUDENTS (CONTINUED)

Student	Major Professor	Thesis subject
Rita Jaramillo	Braun/Horton	Optimizing the control of free cooling & thermal energy storage options at purdue
Gurneesh Jatana	Shaver, Lucht	On-engine diode laser measurements
Bonggil Jeon	Horton	Annual hvac equipment performance comparison for existing commercial buildings
Andy Jessop	Bolton	Near-field pressure distributions to enhance sound transmission into multi-layer materials
Mingang Jin	Chen	Improvement of fast fluid dynamics with a conservative semi-lagrangian scheme
Xing Jin	Shaver	Model-based optimization of heavy-duty hybrid electric powertrains
Donghun Kim	Braun	Development of plug&plug optimal control algorithms for small commercial buildings
Janghyun Kim	Braun/Horton/ Tzempelikos	Modeling & experimental analysis of passive chilled beams
Nicholas Kim	Bolton	Optimization of multiple-layer microperforated panels as functional absorbers & duct liners
Abhinav Krishna	Groll	Analysis of a rotating spool expander for organic rankine cycles in heat recovery applications
Yi-shu Kung	Qu	An integrated system of vapor-compression chiller & absorption heat pump for efficiency improvement
Dat Le	Shaver	Parameter estimation & rate shaping control of a piezoelectric fuel injector
Seungkyu Lee	Bolton	Fan noise control
Wei Liu	Chen	Inverse prediction & optimization of thermal environment in an airliner cabin by using the cfd-based adjoint method
Yangfan Liu	Bolton	The use of equivalent source models for reduced order simulation in room acoustics
Domenique Lumpkin	Groll	Innovative oil-free compressor & expander technologies
Mark Magee	Shaver	Improving efficiency & emissions control through variable valve actuation on a diesel engine
Andrew McMullen	Davies	Assessment of noise metrics for application to large civil tilt rotor flight operations
Jacob Miller	Rhoads	Thermal & mechanical response of particulate composite plates under inertial excitation
Jelena Paripovic	Davies	Identification of low frequency dynamic behavior of surrogate explosive materials
Anchalika Pathak	Groll	Design & construction of an organic rankine cycle test stand for scroll expander performance testing
Yuan Peng	Li	Sound propagation through turbulent atmosphere
Brad Pietrzak	Shaver	Parameter estimation & rate shaping control of a piezoelectric fuel injector

CURRENT HERRICK LABS STUDENTS (CONTINUED)

Student	Major Professor	Thesis subject
Aakash Rai	Chen	Ozone-initiated chemistry in enclosed environment
Sugi Ramaraj	Braun/Horton	Econometric modeling & optimization of CHP operations of the waste power plant
Aswin Ramesh	Shaver	Improving efficiency & emissions control through variable valve actuation on a diesel engine
Leighton Roberts	Shaver	Improving efficiency & emissions control through variable valve actuation on a diesel engine
Nicholas Sakamoto	Bolton	The relation of vehicle road noise to tire dynamic characteristics
Zhu Shi	Y. Chen/J. Chen	Numerical study of entrainment in a jet flow with weak stratification
Brandon Sobecki	Bolton/Davies	Development of sound quality metrics for diesel engine component specification
Yuanpei Song	Qu	Energy efficient integrated frp-confined sandwich roof system
Vaidy Sundaram	Davies/Bajaj	Seat-occupant dynamics
Prateek Tayal	Meckl	No/No ₂ ratio for a diesel oxidation catalyst based on light-off temperature
Bao Tong	Li	Acoustical modeling of the sound field within a rigid porous layer: theory & experiments
Ularee Upathumchard	Groll	Waste heat recovery options in large gas-turbine combined power plants
Srinivas Varanasi	Bolton/Siegmund	Application-scale experiments on hybrid cellular metamaterials to evaluate low frequency barrier performance
Jebaraj Vasudevan	Horton	Geothermal heat exchange modeling/validation
Ashish Vora	Shaver	Model-based optimization of heavy-duty hybrid electric powertrains
Haojie Wang	Chen	A semi-empirical model for studying the impact of thermal mass & cost-return analysis on mixed-mode ventilation in office buildings
Yiming Wang	Li	A boundary element approach for assessing the acoustic performance of roadside noise barriers
Yuntian Wang	Shaver	Operating range expansion of premixed charge compression-ignited combustion in a multi-cylinder diesel engine with flexible valve actuation & variable fuel reactivity
Brandon Woodland	Braun/Groll/Horton	Methods of increasing net work output of organic rankine cycles for low-grade waste-heat recovery
Daniel Woods	Rhoads	Thermal & mechanical response of particulate composite plates under inertial excitation
Yan Xue	Chen	Simulations of natural ventilation in and around buildings
Bin Yang	Braun/Groll/Horton	Application of oil flooded compression with regeneration to a packaged heat pump system
Ruoyu You	Chen	Energy efficient building hub
David Yuill	Braun	Methodology for evaluating performance of diagnostics for air-conditioners
Keqin Zhou	Meckl	No/No ₂ ratio for a diesel oxidation catalyst based on light-off temperature

2012 HERRICK LABS GRADUATES

Gayatri Adi	PhD	Closed Loop Control for Biodiesel Blends in Mixing-Controlled Combustion
Whitney Bryan Belt	MSME	High Voltage Energy Storage System Design for a Parallel-Through-The-Road Plug-In Hybrid Electric Vehicle
Pranav Bhalerao	MSME	Analysis and Compensation of Fuel Quantity Variation in Multipulse Fuel Injection
Craig Bradshaw	PhD	A Miniature-Scale Linear Compressor for Electronics Cooling
Tyler Dare	PhD	Generation Mechanisms of Tire-Pavement Noise
Tom Fausett	MSME	Performance Testing of a Large Room Cooling System
Clothilde Giacconi	MSME	Sound Quality of Supersonic Aircraft Noise as Heard Indoors and Its Impact on Annoyance
Carrie Hall	PhD	Fuel-Flexible Combustion Control of Modern Compression-Ignition and Spark-Ignition Engines
Harshad Inamdar	MSME	Performance Comparison of Two-Phase Fluids in Heat Pipes for Electronics Cooling
Nicholas Kincaid	MSME	Humidity Ratio Detection as a Means of Dryer Cycle Termination
Lyle Kocher	PhD	Physically-Based Modeling, Estimation and Control of the Gas Exchange and Combustion Processes for Diesel Engines Utilizing Variable Intake Valve Actuation
Abhinav Krishna	MSME	Organic Rankine Cycle with Solution Circuit for Low-Grade Heat Recovery
Hsu Chew Lee	MSME	A Study of Low Speed Flow Noise and Its Reduction by Numerical Simulations
Andrew Marshall	PhD	Development of a Model of Startle Resulting from Exposure to Sonic Booms
Sarah McGuire	PhD	Modeling Aircraft Noise Induced Sleep Disturbance
Rick Meyer	PhD	Modeling and Control of a Fuel Cell-Battery Hybrid Vehicle
James Mynderse	PhD	Two Degree-of-Freedom Hysteresis Compensation for a Dynamic Mirror with Antagonistic Piezoelectric Stack Actuation
Sugirdhalakshmi Ramaraj	MSME	Vapor Compression Cycle Enhancements for Cold Climate Heat Pumps
Neha Ruikar	MSME	FPGA Model Based Within-a-Cycle Estimation of Rate Shaping for a Piezoelectric Fuel Injector
Ryan A. Schultz	MSME	Effect of Solid Phase Properties on the Acoustical Performance of Poroelastic Materials
Bryce Shaffer	PhD	Performance Analysis of Non-Metallic Dry Running Scroll Compressors
Jin Shen	MSME	Within-a-Cycle Flow Rate Estimation for Piezoelectric Fuel Injection
Karla Stricker	PhD	Turbocharger Map Reduction and Estimation of Effective Compression Ratio in a Modern Diesel Engine Utilizing Flexible Intake Valve Actuation
Sara Underwood	PhD	Subsurface Damage Detection in Sandwich Composites using Three-Dimensional Laser Vibrometry Measurements with Nonlinear Vibration Response Characteristics
Benjamin Warman	MSME	Data Analysis of Diesel Engine Faults
Bryan Wang	MSME	Kinematic Center of Gravity Estimation Method of Ground Vehicle Based on Dynamic Measurements

HERRICK LABS TECHNOLOGY TRANSFER PROGRAMS

2014

October 27-31 Acoustical Society of America, Fall Meeting, Indianapolis

July 14-17 Twenty-second International Compressor Engineering Conference
Fifteenth International Refrigeration and Air Conditioning Conference
Third International High Performance Buildings Conference
Compressor, Refrigeration and Buildings Short Courses

2013

August 26-28 Noise-Con 2013, Denver
International Wind Turbine Noise Conference, Denver

2012

July 14-19 Twenty-first International Compressor Engineering Conference
Fourteenth International Refrigeration and Air Conditioning Conference
Second International High Performance Buildings Conference
Compressor, Refrigeration and Buildings Short Courses

2010

July 10-15 Twentieth International Compressor Engineering Conference
Thirteenth International Refrigeration and Air Conditioning Conference
First International High Performance Buildings Conference
Introduction to Compressors (Compressors 101) Short Courses
Supermarket Refrigeration Systems Simulation Tools—Status and Recent High Performance Building Technologies Short Course

May Short Course for Delphi Company, Kokomo, IN
CLIMA World Congress, Antalya, Turkey

2009

July Los Alamos National Laboratory Dynamics Summer School, Lectures on Nonlinear Vibration
Marie Curie Action SICON, Stability, Identification, and Control in Structural Dynamics
University of Liege, Belgium, Master Series on Identification and Prognosis in Structural Systems

August INTER-NOISE 2009, Ottawa, Ontario, Canada,
Tutorial for Integrated Systems Health Management Workshop, AFRL

September 9th Healthy Buildings Conference, Syracuse, NY



MAJOR RESEARCH FACILITIES

The Thermal Systems Laboratories



These areas are where the HVAC and Refrigeration component level and system level technology research is conducted as well as research on Air Quality. In the original building there are two psychrometric rooms (1 pair) and in the new building there are four psychrometric rooms (2 pairs) with a temperature range of -10° to 130° F. Each psychrometric room is 7000 cu ft. The psychrometric rooms are designed to accommodate ASHRAE/ARI standard test procedures used in rating unitary air-conditioners and heat pumps up to a capacity of 5 tons of refrigeration (18 kW). There are two indoor air quality (IAQ) laboratories that can simulate indoor and outdoor conditions. Instrumentation includes ultrasonic anemometers, omni-directional anemometers, tracer-gas sampler and analyzer, and particle generators and analyzers. Other facilities include a psychrometric wind tunnel with dust injection system; a large HVAC equipment lab with 90 ton centrifugal chiller, various computer controlled compressor load stands for small compressors.

The Living Laboratory

The whole of the new building is a living laboratory where the building environment is being studied. It includes a 16 bore geothermal field and plug-and-play heat rejection for experiments in the engines and thermal sciences laboratories, and four nearly identical office spaces with each unit housing 20 graduate students. Each 34ft by 37ft office is reconfigurable in different ways and have separate support systems. This enables direct comparisons of alternative technologies for windows, lighting, comfort delivery, controls, and acoustic treatments. The normal temperature range is 65F to 75F but this can be extended to 55F to 85F. Relative humidity can be varied from 20% to 80%. Comfort delivery options include air supply from the ceiling, floor, or side wall along with radiant floor heating and radiant chilled beam cooling. Three of the units have double skin facades with different options for ventilation and energy recovery. All of the offices spaces have separate equipment for providing space conditioning that are well instrumented to allow direct energy comparisons.



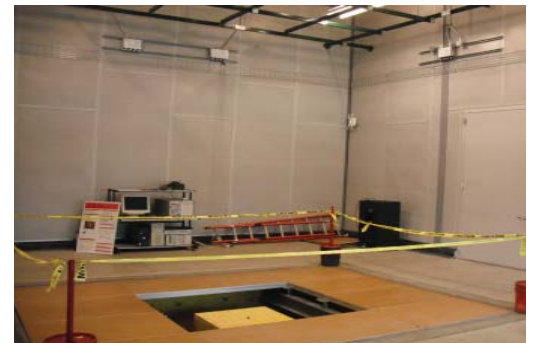
Engines Research Laboratory



The two engine test stands in the original building and the four test cells in the new building are home to engine and hybrid systems controls research that is focused on improving efficiency, reducing engine emissions and developing efficient and environmentally friendly systems for using alternative fuels. Currently the four new test cells and associated systems will support 670, 350, 150 and 150 HP engine testing, respectively, but space and utilities are planned so that upgrading to higher horsepower and higher levels of emissions testing are possible as research progresses. Other instrumentation includes a hydraulic variable valve actuation system capable of controlling 12 valves, a single cylinder rig for testing piezoelectric valve actuation, an AC dynamometer and several eddy-current engine dynamometers, as well as emissions sensing systems.

Perception-Based Engineering Laboratory

Perception Based Engineering (PBE) researchers study people's perceptions of stimuli, their influence on satisfaction, comfort, annoyance and performance and the relationship between those outcomes and the system, design and operational parameters. PBE faculty at Purdue work on projects related to touch interfaces, sound and vibration quality, image quality and depth perception, display design and graphics optimization, effects of noise on performance, and human-computer interaction. This 43ft by 28ft laboratory houses a TEAM 6 degree-of-freedom shaker, which can be covered when not in use. Lighting, temperature (55F-85F), humidity (20% to 80%) and sound can be finely controlled, and the room can be re-configured as several small isolated rooms or one larger room, thus simulated various types of environments.



MAJOR RESEARCH FACILITIES (CONTINUED)

High-Bay Flexible Laboratory & Small-Scale Vibrations Laboratory

These house Electro-Mechanical and Vibrations research. This is comprised of two parts: an open 36 ft by 87 ft high-bay area with segmented floors for vibration isolation between experiments, and a smaller laboratory for smaller scale experiments. The high-bay area has high ceilings to accommodate large systems for testing. It can house large shakers, such as a 35 kN TIRA electrodynamic shaker that can be used to reproduce vibration profiles and has in-built hydraulic power supplies for hydraulic shakers. In this area the vibration and dynamics of larger structures can be examined such as building components, vehicle suspension systems, wind turbine blades, road vehicle and aircraft and space structures. The small-scale laboratory includes apparatus for dynamic testing of materials and small structures to investigate nonlinear dynamic behavior and to identify structural and material parameters.



Acoustics, Noise and Vibration Research Area



In addition to the facilities in the High-Bay Flexible Laboratory and Perception-based Engineering areas in the new building, these facilities, currently housed in the original building, include a 25 by 20 by 18 ft reverberation room, an anechoic room with useful volume of 12 by 12 by 12 ft, a hemi anechoic room with useful volume of 41 by 27 by 18 ft and an 8 by 8 ft audiometric room for sound quality testing. There is also an acoustical materials laboratory with several types of impedance tubes for standardized acoustic material testing. The reverberation room is configured for sound transmission testing of acoustical systems. Additional facilities include a tire pavement test apparatus (TPTA) for testing tires on realistic pavements at speeds up to 50 km/hr, a two wheel chassis dynamometer with 67 inch rollers, an anechoic wind tunnel with 18 by 24 inch test section and flow velocity up 120 mph. Instrumentation includes a 64 microphone acoustical holography array and 90 channel data acquisition system, various microphones, accelerometers, shakers, a laser vibrometer, and a high speed camera.

