

PURDUE  
UNIVERSITY

# 2009-2010 ANNUAL REPORT

FALL 2010

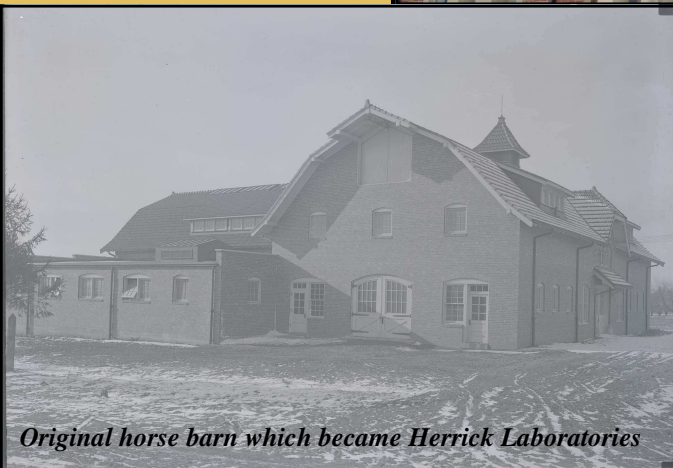
RAY W. HERRICK  
LABORATORIES

140 S. Martin Jischke Drive  
West Lafayette, IN 47907-2031

Phone: 765-494-2132

Fax: 765-494-0787

E-mail: [rhlab@ecn.purdue.edu](mailto:rhlab@ecn.purdue.edu)



*Original horse barn which became Herrick Laboratories*



**HERRICK  
LABORATORIES**  
PURDUE UNIVERSITY™

## 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. 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. 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. Almost 700 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 *Noise and Vibration Control Research Area*, the *Heating, Ventilation, Air-Conditioning, and Refrigeration Research Area* and the *Electro-Mechanical Systems* to enhance their national and international visibility and grow the reputation of these areas as the top research programs in the world.
2. To identify emerging research areas that are synergistic with laboratory focus.
3. To develop a proactive evolutionary strategy for the Laboratories to ensure its long-term stability and growth.
4. 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.
5. 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.
6. To continually grow the research environment at the Labs for the benefit of the students and faculty at the Labs.

# 2009-2010 HIGHLIGHTS

<i>Research</i>	<i>Last Year</i>	<i>This year</i>
Research expenditures (*academic year)	\$5,356,327	\$6,395,399
Number of sponsors as of September 2010	28	31
Research assistants as of September 2010	71	76
Archival papers published (*calendar year)	54	68
Contracts in force for next academic year (July 2010-June 2011)	2,201,532	5,542,937
Proposals pending in September (HL share)	5,727,713	\$8,539,178
Large multi-person proposals	\$4,834,877	\$33,395,496 (R)
	+\$11,750,000 (B)	
 <i>Education</i>		
Graduate students as of September	86	87
MS	37	44
Ph.D.	49	43
Students graduated (*calendar year)	11	18
MS	6	11
Ph.D.	5	7
Undergraduate/graduate “research experience” students	16	29
 Visiting scholars, Post Doctoral Students, Visiting Research Assistants	18	16
 Fellowships	7	6
Grant-in-Aid	2	2
Student Paper/Poster/Thesis Awards	3	7
 <i>Technology Transfer</i>		
Conferences/Workshops held (*academic year)	9	8
Conferences planned in the next 2 years	4	3
Short Courses held (*academic year)	7	2
Herrick Labs reports to sponsors (*academic year)	9	13
Conference and journal papers (*calendar year)	122	133

- Academic Year - July 2009 → June 2010 and Calendar Year - January 2009 → December 2009
- R—Research
- B—Building

## *Administrative and Support Staff*

Professor Patricia Davies serves as director of the Ray W. Herrick Laboratories. Judy Hanks is her administrative assistant. The research programs are assisted by the mechanical and electronics shops headed by Fritz Peacock, supervisor of technical services. Ginny Freeman serves as administrative assistant for the Herrick Laboratories’ conferences and short courses. Additional support staff includes Donna Cackley, secretary; Gilbert Gordon, electronic shop coordinator; Bob Brown, mechanical shop coordinator and building deputy; and Frankie Lee, mechanical technician.

*The Ray W. Herrick Laboratories*

# HERRICK LABS FACULTY RESEARCH INTERESTS

- Doug Adams**, professor of mechanical engineering. PhD 2000, University of Cincinnati. Experimental nonlinear dynamics and system identification, diagnostics and prognostics, health monitoring, system-level modeling (compressors, suspensions, exhausts, mounts).
- Anil K. Bajaj**, 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.
- Robert J. Bernhard**, currently vice president for research at Notre Dame University, but continues his road-tire research at Herrick Laboratories. PhD 1982, Iowa State University. Tire/Pavement noise, acoustics, noise and vibration control, and validation of numerical methods.
- 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**, 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**, 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. 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**, professor 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.



## HERRICK LABS FACULTY RESEARCH INTERESTS (CONTINUED)

- 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**, assistant 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**, assistant 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.
- 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  
Board of Directors, Institute of Noise Control Engineering (2007-2010)
- Jim Braun  
Associate Editor of the International Journal of HVAC&R Research  
Editorial Board, Journal of Building Performance Simulation  
Editorial Board, Building Simulation: An International Journal  
Chair, ASHRAE Research Administration Committee (RAC)  
Member, ASHRAE Technology Council  
Member, ASME Task Force on Integrated/Efficient Building Equipment and Systems  
Member, Scientific Committee for the 2009 Inter. Conference on Sustainable Development in Building and Environment, Chongqing University of China  
Member, Scientific Committee for 2009 Compressors - 7th Inter. Conference on Compressors and Coolants, Papiernicka, Slovak Republic
- Yan Chen  
Editor-in-Chief, Building and Environment (BAE) Journal  
Member, Advisory Board, Energy and Buildings  
Member, Departmental Review Panel, Dept. of Building Services, Hong Kong Polytechnic University
- George Chiu  
Member, Editorial Board, Frontiers of Mechanical Engineering in China  
Associate Editor, IFAC Journal of Control Engineering Practice  
Associate Editor, Journal of Electronic Imaging  
Secretary, ASME Dynamic Systems and Control Division
- Patricia Davies  
President, Institute of Noise Control Engineering, April 1, 2008 – 2010  
NAE Technology for a Quieter America Committee (report published Oct. 2010)  
Member, ASA Noise Committee

## HERRICK FACULTY PROFESSIONAL ACTIVITIES (CONTINUED)

Bob Lucht

Associate Editor, American Institute of Aeronautics and Astronautics Journal

Eckhard Groll

Regional Editor for the Americas, International Journal of Refrigeration  
 Advisory Board Member, Karlsruhe House of Young Scientists, Karlsruhe Institute of Technology  
 Director-at-Large, ASHRAE Board of Directors  
 Advisory Board Member, Purdue Convocations  
 Steering Committee Member, 11th Annual Colloquium on Inter. Engineering Education, Iowa State University, Ames, IA, Oct. 2009  
 Roundtable Panelist, In Times of Global Financial Crisis: Impacts on Cooperative Education & Industrial Partners, WACE (World Association of Cooperative Education) Conference, Vancouver, BC, June 2009

Panagiota Karava

Member, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)  
 Member, International Building Performance Simulation Association (IBPSA)  
 Researcher, Canadian Solar Buildings Research Network (SBRN)  
 Member, American Wind Engineering Association  
 Member, ASCE Task Committee on Computer Aided Wind Engineering, 2008-present  
 Member, Scientific Committee for the 5th International Symposium on Computational Wind Engineering, Chapel Hill, NC, May 2010  
 Member, Scientific Committee for the 1st International High Performance Building Conference, July 2010  
 Member, Scientific Committee for the 12th International Conference on Indoor Air Quality and Climate, Austin, TX, June 2011

Peter Meckl

Associate Editor, IEEE Transactions on Control Systems Technology  
 Chair, ASME Dynamic Systems and Control Conference Editorial Board

Ming Qu

Member, Board of Directors, Indiana Renewable Energy Association, 2010-  
 Chair, Technical Committee on Building Energy Systems and Optimization Methods, Architectural Engineering Institute, 2010-

Jeff Rhoads

Member, ASME Student Design Committee  
 Member, ASME Technical Committee on Vibration and Sound  
 Member, ASME Micro-and Nanosystems Technical Committee

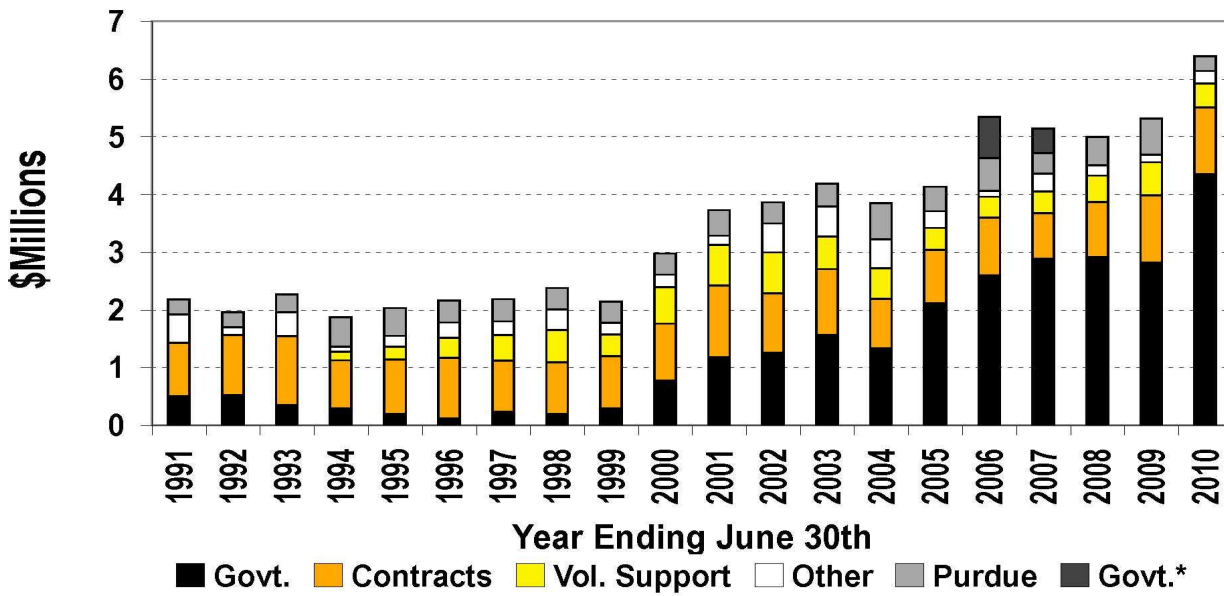
Greg Shaver

Associate Editor, IFAC Control Engineering Practice Journal

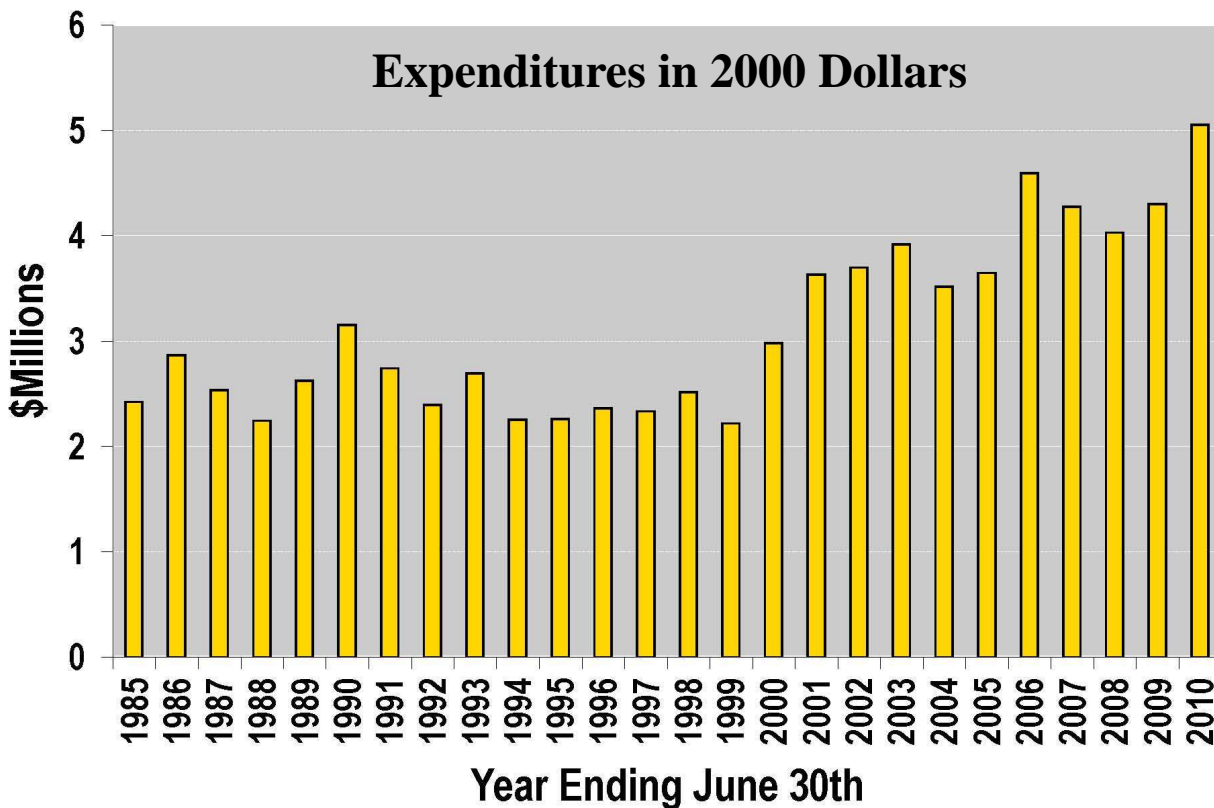
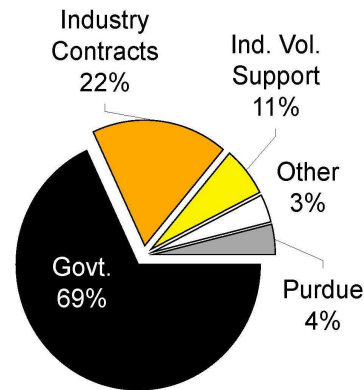
Thanos Tzempelikos

Member, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)  
 Member, Architectural Engineering Institute (AEI) of the American Society of Civil Engineers  
 Member, International Building Simulations  
 Member, International Solar Energy Society  
 Board Member, Solar Energy Society of Canada  
 Advisory Member, International Commission of Illumination, Canadian Chapter  
 Member of Organizing Committee, 1st, 2nd, 3rd, 4th Canadian Solar Buildings Conferences, 200-2010  
 Member, Undergraduate Committee, School. Of Civil Engineering, Purdue University, 2009-2010  
 Chairman, 1st International High Performance Buildings Conference, Purdue University, 2010  
 Member, Technical Advisory Committee, Indoor Air 2011 International Conference  
 Member, Steering and Technical Committee, Architectural Engineering 2011 Conference  
 Member, Technical Review Panel for Green Building Technologies, EPA, 2009

# 2009-2010 EXPENDITURES



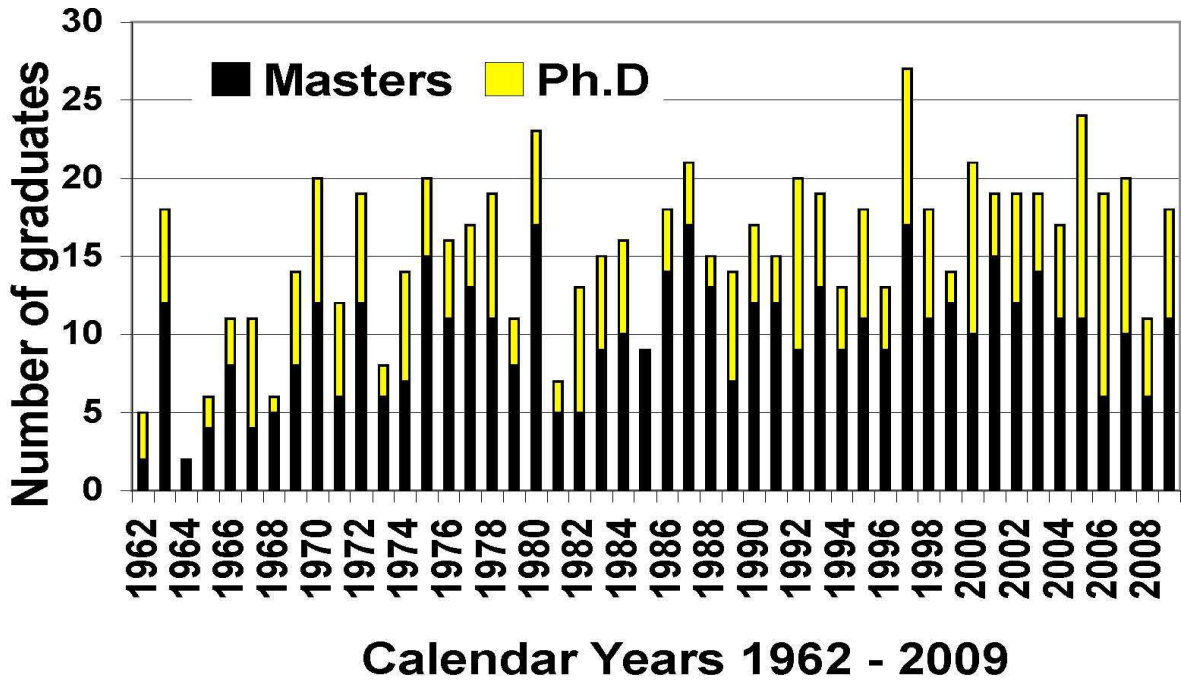
Expenditures for the 2009-2010 academic year are up from last year. These expenditures reflect a large amount of effort from our faculty, students and staff.



*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*

- Charles (Matt) Butner** received the Helen and John Lozar Fellowship
- Yiyuan Chen** received the Ross Fellowship
- Shreekant Gayaka** received the Bilsland Dissertation Fellowship
- Derek Hengeveld** was named an Air Force Research Laboratory (AFRL) Space Scholar
- Janette Jaques Meyer** won the 2009 Outstanding Service Scholarship, Purdue University
- Margaret Mathison** received the Lambert Teaching Fellowship

*Grants-in-Aid*

- Craig Bradshaw** received an ASHRAE Grant-in-Aid
- Wangda Zuo** received an ASHRAE Grant-in-Aid

*Awards*

- Andy Jessop** awarded the USDOT FAA Centers of Excellence Outstanding Student of the Year in recognition of his work for PARTNER in structural acoustics and noise control
- Carson Budde and Nate Yoder** won Best Paper Award at Annual Forum of the American Helicopter Society in the HUMS Category (Health and Usage Monitoring Systems)
- Yoon-shik Shin** won the 2009 INCE Student Paper Competition at Inter-Noise 2009 Conference
- Nate Yoder** received Best Student paper at bi-annual International Workshop on Structural Health Monitoring
- Matias Zanartu** received the Best Student Paper Award in Speech Communication at the Acoustical Society of America meeting
- Wangda Zuo** won the Best Paper Award from the U.S. Branch of the International Building Performance Simulation Association (IBPSA)



# CURRENT HERRICK LABS STUDENTS

Student	Major Professor	Thesis Subject
Gayatri Adi	Shaver	Modeling, design and control of advanced power train
Varun Agrawal	Yao	Adaptive robust control of flexible cable driven surgical robotic devices
Yousof Azizi	Davies	Modeling of polyurethane foam and seat dynamics
Christian Bach	Groll	Optimizing refrigerant distribution in evaporators
Michelle Bash	Groll	Smart Compressors
Ian Bell	Groll/Braun/King	Ericsson cycle cooler
B. Whitney Belt	Shaver	Mobile data acquisition system calibration & emission testing
David Berdy	Rhoads	Wireless sensors for structural health monitoring
Udbhau Bhattiprolu	Davies	System identification techniques for foam systems
Nasir Bilal	Adams	Prediction uncertainty in compressor modeling and simulation
Craig Bradshaw	Groll	Analysis of miniature-scale linear compressors for electronics cooling
Matt Butner	Adams	Characterizing dynamic response of structural systems that interact through an interface
Yiyuan Chen	Yao	Energy saving adaptive robust precision control of electro-hydraulic systems
Howard Cheung	Braun	Modeling and testing of ductless heat pumps
Won Hong Choi	Bolton	Tire vibration modeling
Scott Dana	Adams	Integrated blade sensing
Tyler Dare	Bernhard	Investigation of tire/pavement noise generation mechanisms
Tiffany Di Petta	Adams	Health monitoring of military vehicles
Frank Eberhardt	Davies/Bolton	Diesel engine noise
Thomas Faussett	Groll	Performance evaluation of walk-in freezer system
Kevin Foertsch	Davies	Aircraft noise
Clothilde Giacomoni	Davies	Human Response
Jitendra Gupta	Chen	Infectious disease transmissions in airliner cabins
Thanh Huy Ha	Chiu/Allebach	Electromechanical systems
Carrie Hall	Shaver	Fuel flexible combustion control
Derek Hengeveld	Braun/Groll	Development of a system design methodology or robust thermal control systems to support operationally responsive space
Julio Ho	Bolton/Wodicka	Speech acoustics
Seth Holloway	Horton	CO
Matt Houtteman	Adams	Nondestructive testing
Andrew Huang	Li	Environmental acoustics
Gurneesh Jatana	Shaver, Lucht	On-engine diode laser measurements
Andy Jessop	Bolton	Acoustic radiation from tires
Mingang Jin	Chen	FAA RITE
Ravindra Kakade	Meckl	Engine diagnostics

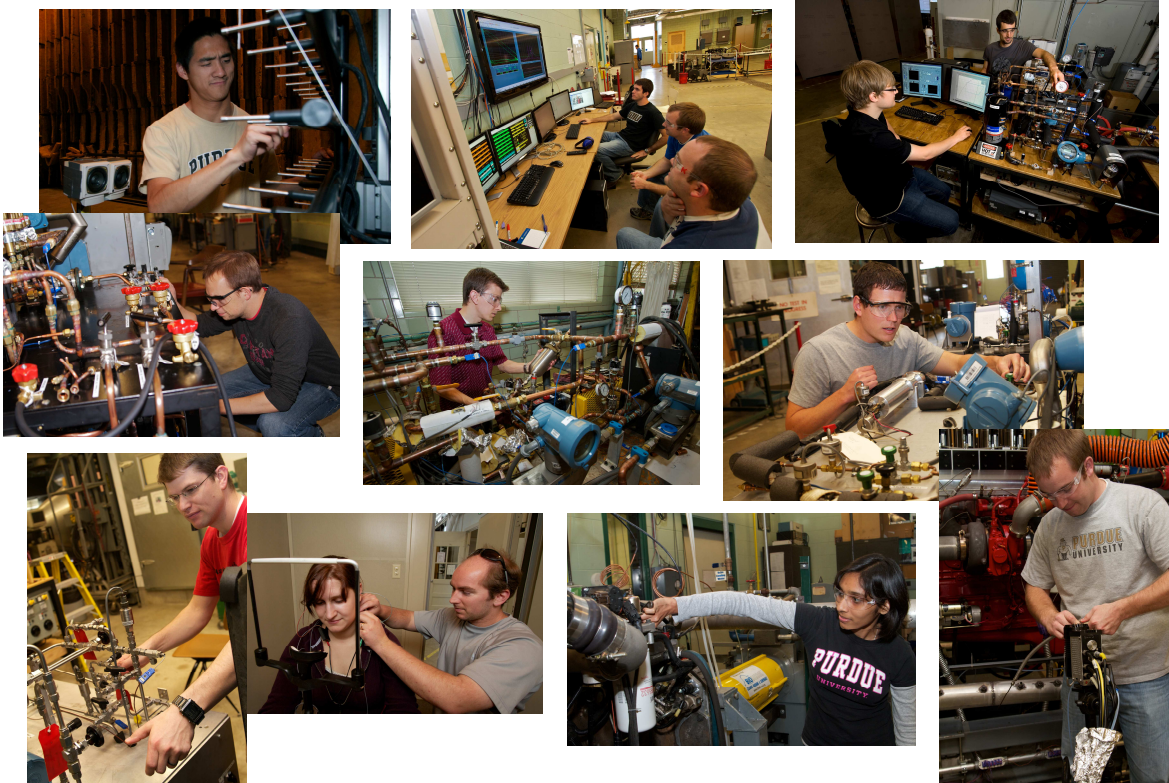
## CURRENT HERRICK LABS STUDENTS (CONTINUED)

Student	Major Professor	Thesis Subject
Nicholas Kim	Bolton	Microperforated materials
Woohyun Kim	Braun	Methods for evaluating diagnostic protocols for packaged air conditioning equipment
Lyle Kocher	Shaver	Variable valve actuation engine research
Ed Koeberlein	Shaver	Variable valve actuation engine research
Abhinav Krishna	Groll	Organic rankine cycle for electronic waste heat recovery
Vijay Kumar	Rhoads	Parametric amplification
Yan Fu Kuo	Chiu	Tone curve stabilization for color electrophotography
Hsu Chew Lee	Lee	Sound structural transmission
Ki Sup Lee	Chen	Air distribution effectiveness with stratified flows in rooms
Sangbok Lee	Chiu	HP project
Robert Leffler	Groll	Waste heat rejection options
Sheng Liu	Li	Transmission of low frequency sound above a poro-elastic ground
Yangfan Liu	Davies/Bolton	Acoustic arrays
Lu Lu	Yao	Direct/indirect adaptive robust control with quantitative parameter estimation
Vishal Mahulkar	Adams	System of systems modeling and optimization in Navy ships
Andrew Marshall	Davies	Human response to supersonic aircraft noise
Margaret Mathison	Braun/Groll	Modeling of a two-state rotary compressor
Sarah McGuire	Davies	Feasibility of constructing a survey and measurement data base for validating environmental noise metrics
Alan Meyer	Adams	Mechanics and vibrations
Janette Jaques Meyer	Adams	Modeling and simulation of rattle vibrations in car seats
Rick Meyer	Meckl	Modeling and adaptive robust control of fuel cell power systems
Ranjit More	Meckl	Diagnostics of advanced diesel fuel injectors
James Mynderse	Chiu	Motion and vibration control
Joe Poland	Groll	Acoustically enhanced heat transfer in microchannels
Aakash Rai	Chen	FAA RITE
Sugi Ramaraj	Groll	Refrigeration injected scroll compressor
Tyler Robbins	Adams	Acoustic leak detection in engine blocks
Neha Ruikar	Shaver	Controls
Chris Satkoski	Shaver	Modeling and control of piezo-electric fuel injection
Ryan E. Schultz	Meckl	Diesel particulate filter diagnostics
Ryan A. Schultz	Bolton	Porous materials
Bryce Shaffer	Groll	Conduction cooled EIE modules in liquid cooled cabinets
Hyunjun Shin	Bolton	Acoustical materials
Janene Silvers	Adams	Active vibration control of fuselage structure

# CURRENT HERRICK LABS STUDENTS (CONTINUED)

Student	Major Professor	Thesis Subject
Yuanpei Song	Groll/Braun	Low temperature high performance heat pump
Karla Stricker	Shaver	Combustion and controls
Hongdan Tao	Li	Sound structural transmission
Bao Tong	Li	Environmental acoustics
Ned Troxel	Yao	Energy saving adaptive robust precision control of electro-hydraulic systems
Sara Underwood	Adams	Composite damage detection using laser vibrometry
Teja Vadhri	Rhoads/Bajaj	Localization in cyclic systems
Dan Van Alstine	Shaver	Variable valve actuation engine research
Matt Vargo	Groll	Compressor performance testing
Bryan Wang	Adams	Prognostic-driven engineered ground vehicles
Miao Wang	Chen	Modeling low velocity large scale fluctuating flows in ventilated spaces at transitional Reynolds numbers
Ben Warman	Meckl	Analysis of diesel engine performance data to identify anomalies
Brandon Woodland	Braun/Groll	Organic rankine cycle with solution circuit for waste heat recovery
Guangqing Xue	Chen	Infectious disease transmissions in airliner cabin
David Yuill	Braun	Prognostic protocol evaluator
Joseph Yutzky	Adams	Monitoring and detection of damage in gear drive, using dynamic torque sensing
Alain Zoro	Yao	Direct/indirect adaptive robust control with quantitative parameter estimation

*The Ray W. Herrick Laboratories*



## 2009 HERRICK LABS GRADUATES

<b>Ethan Brush</b>	MSME	Development of a Dynamic Model for Subsurface Damage in Sandwich Composites
<b>Michael Bunce</b>	MSME	Optimization of Soy-Biodiesel Combustion in a Modern Diesel Engine
<b>Neha Chandrachud</b>	MSECE	Classification of the Health of Diesel Engines Using Sparse Linear Discriminant Analysis
<b>Hoyt Chang</b>	MSME	Environmental Acoustics
<b>Li-Jen Chen</b>	PhD	Investigation of Mechanical Stresses Within Human Vocal Folds During Phonation
<b>Doug Cook</b>	PhD	Systematic Structural Analysis of Human Vocal Fold Models
<b>Kamran Gul</b>	PhD	Modeling and Analysis of Engine Cold-Test Cells for Optimizing Driveline Design for Structural Reliability and Engine Assembly Defect Diagnostics
<b>Kwan Woo Hong</b>	PhD	Acoustical Estimation of Macroscopic Properties of Poroelastic Materials
<b>Kang Hou</b>	MSME	Measurement and Modeling of Micro-Perforated Panels
<b>Andrew Jessop</b>	MSME	A Study of the Effects of Panel Stiffness on Transmission of Low-Frequency Sound
<b>Woohyun Kim</b>	MSME	Evaluation of a Virtual Refrigerant Charge Sensor
<b>Robin Kusmanto</b>	MSME	Modeling and Simulation of an Optimized Wireless Network in a Naval Ship System of Systems
<b>Feng Liu</b>	PhD	Modeling and Control of a Two Component Development Process for Xerography
<b>Sagnik Mazumdar</b>	PhD	Transmission of Airborne Contaminants in Airliner Cabins
<b>Shawn McKay</b>	PhD	A Control Theory Based Hybrid Architecture to Anticipate and Shape Adversarial Behavior
<b>David Snyder</b>	MSME	Model-Based Biodiesel Blend Estimation in Diesel Engines
<b>S. Hales Swift</b>	MSME	Potential Health Effects of Aircraft Noise
<b>Tanya Wulf</b>	MSME	A Study of the Effect of Innovatively Textured Portland Cement Concrete Roadway Surfaces on Tire-Pavement Noise



# HERRICK LABS TECHNOLOGY TRANSFER PROGRAMS

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

**May** 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

**October** Symposium on Research on the Transmission of Disease in Airports and on Aircraft,  
Transportation Research Board of the National Academies, Washington DC

**November** 6th International Symposium on HVAC, Nanjing, China  
Engineering Congress on “Alternative Energy Application: Option or Necessity?”  
Kuwait City, Kuwait

2008

**July 12-17** Nineteenth International Compressor Engineering Conference  
Twelfth International Refrigeration and Air Conditioning Conference  
Compressor and Refrigeration Short Courses



*The Ray W. Herrick Laboratories*



# MAJOR RESEARCH FACILITIES

## Thermal Systems Research Area

- Two 7000 ft<sup>3</sup> psychrometric rooms with -10° to 130°F temperature range
- Two room indoor air quality (IAQ) laboratory
- Psychrometric wind tunnel with dust injection system
- Large HVAC equipment lab with 90 ton centrifugal chiller
- Two computer controlled compressor load stands for small compressors
- Many bench test facilities and special experimental setups

## Noise and Vibration Research Area

- 25 by 20 by 18 ft reverberation room
- Anechoic room with useful volume 12 by 12 by 12 ft
- Hemi anechoic room with useful volume 41 by 27 by 18 ft
- 8 by 8 ft audiometric room
- Acoustical materials laboratory
- Two wheel chassis dynamometer with 67 inch rollers
- Anechoic wind tunnel with 18 by 24 inch test section and flow velocity up 120 mph
- Three 1000 lb<sub>f</sub> hydraulic shakers with 4 inch stroke
- Two 400 lb<sub>f</sub> electromagnetic shakers
- 64 microphone acoustical holography array and 90 channel data acquisition system

## Perception Based Engineering

- 8 by 8 ft audiometric room
- Printer image quality facilities
- Binaural measurement system and sound quality estimation software
- Steering wheel vibration perception facility
- Two room indoor air quality (IAQ) laboratory
- Perception Based Engineering Lab (*future*) (combined thermal, acoustic, motion, and visual perceptions)

## Electro-mechanical Systems Research Area

- 1500 psi 3-axis electro-hydraulic robot
- Four post experimental electro-hydraulic lift system
- Diesel engine control load stand with eddy current dynamometer, EGR, and exhaust after-treatment with transient emissions analyzers
- Gasoline engine control load stand with eddy current dynamometer and transient emissions analyzer
- Prognostics modeling and simulation facility
- Thermal/acoustic test facility
- Environmetrics material conditioning chamber
- MTS static/dynamic/fatigue test apparatus
- Large inventory of vibration and acoustics sensors and actuators

# NEW HERRICK LABS BUILDING NEWS

This has been a very exciting year, first getting the NIST award, which has led to going forward on Phase I of the new Herrick Building. This will include the following components that will occupy 35,640 sq. ft. of assignable space.

## Living Laboratory (third floor of blue part)

- Reconfigurable HVAC&R and Air Quality systems in student office space to test out new building technologies.
- Whole building a testbed for building energy management strategies: geothermal
- Integrated focus on occupants and building

## Thermal Sciences and Large Scale Machine Research (orange)

- Equipment and system focused: compressors, heat exchangers, furnaces, advanced refrigeration systems, heating and cooling systems, small-scale refrigeration systems, etc.
- Combination of specialized rooms and open flex space with plug and play utilities

## Engines (green), Vibrations, Electromechanical Systems (light purple)

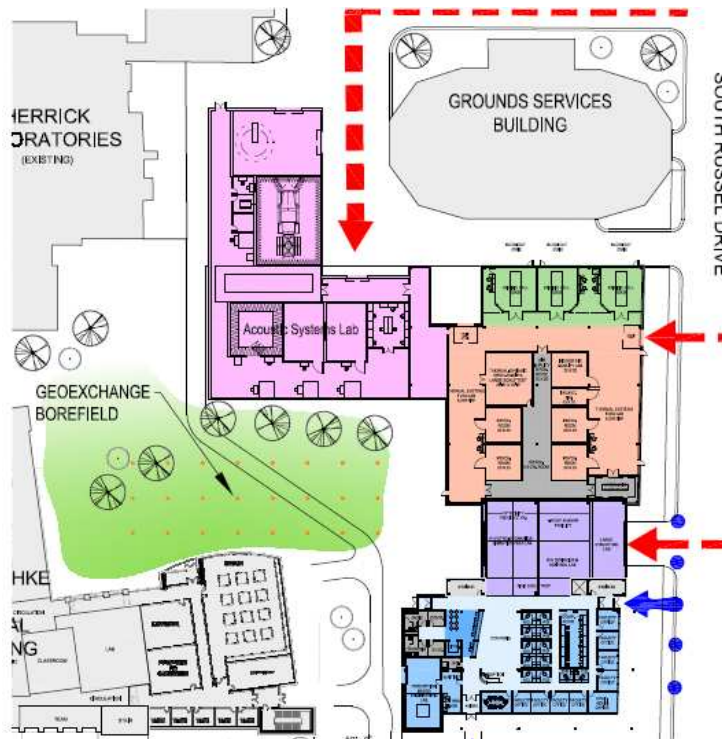
- Original plan scheduled for 4 test cells
- Space included to insert a chassis dynamometer in the semi-anechoic chamber (Phase II)
- Flex space for vibration and electromechanical system experiments

## Perception-Based Engineering (blue)

- Laboratory for human response testing: temperature, humidity, air quality, acoustics, vibrations (2D), lighting will all be controllable

## Administrative Space (blue)

- Faculty, staff and post-doc offices and additional student offices as well as the conference rooms, the kitchen area, and space for group interactions – both academic and social!



A preliminary layout for both Phases I and II (future acoustics wing) is shown in the figure above. The architects (Flad) and architectural engineers (AEI), working with the faculty, are in the process of refining the building design and we have just completed a detailed design review. It looks a little different to this but the main blocks are essentially the same. We have some add-alternates in the design: a 4<sup>th</sup> engines test cell and additional flexible space in both the thermal sciences and electromechanical systems laboratory. We are also seeking and working with potential donors for some of the building systems components to help us make those add alternates part of Phase I. The design for Phase II stops here until funds are available to complete that acoustics wing project. Phase III will be a renovation of the round barn (show pavilion to the north of the site) which would be a great space for our technical services, storage, rig fabrication and preparation, and staging for multiple ongoing experiments in the facilities.

