Schools of Mechanical and
Civil Engineering
Purdue University

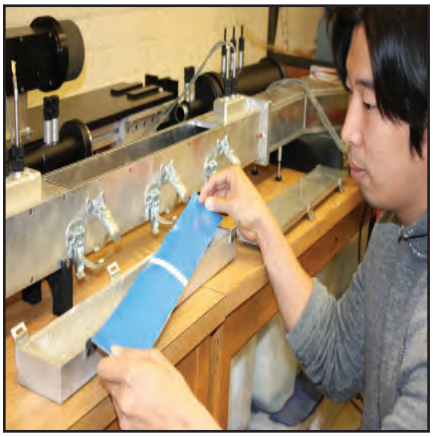
2017-2018
ANNUAL REPORT

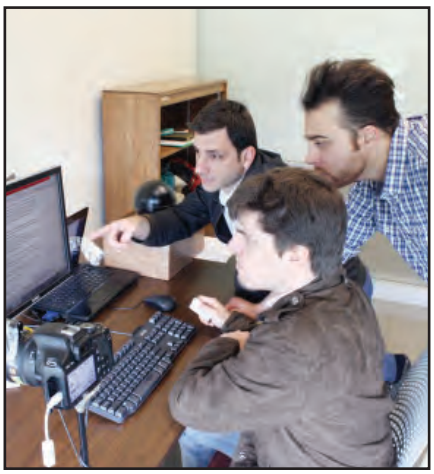
FALL 2018

RAY W. HERRICK LABORATORIES

**Home of the
Center for High
Performance Buildings**

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





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HERRICK LABORATORIES
PURDUE UNIVERSITY

THE RAY W. HERRICK LABORATORIES

The Ray W. Herrick Laboratories turned 50 years old in 2008. Today we are part of the School of Mechanical Engineering, but the 25+ Mechanical Engineering faculty and Architectural Engineering faculty who do research here collaborate on interdisciplinary research projects with faculty in the other Schools of Engineering and also with the faculty in the College of Science and College of Health and Human Sciences and the College of Technology. There are four main technical areas of research with some overarching themes related to energy utilization and efficiency, reduction of pollutants in the environment, quality of life, and sustainability and safety.

The main technical areas are:

1. High Performance Buildings, Thermal Systems and Air Quality
2. Noise and Vibration Control, which includes research on Acoustics, Dynamics, and Materials
3. Electromechanical Systems & Advanced Engines: Controls, Signal Processing, Sensing, Estimation, Diagnostics and Prognostics, Intelligent Systems/Materials
4. Perception-Based Engineering: Modeling of Human Response for Machine and System Optimization

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 900 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 through engineering research with an emphasis on technology transfer

VISION

To overcoming barriers between knowledge creating, transfer, and utilization for the advancement of society

GOALS

1. Grow educational outreach activities, including fundamental, applied, and experimental short courses.
2. Build on research excellence of following research area: Noise and vibration control, Integrated thermal and power systems, and the build environment
3. Provide the education environment of the labs so that its graduate students are multi-disciplinary engineers who rate as the top engineering graduates' in the country
4. Recognize and promote the value of Herrick through effective brand management (internally and externally)
5. Maximize utilization of the new facilities (PBE, engine test, geothermal, etc.)
6. Continue recruiting top faculty, grad students, and staff to ensure long term stability and growth. Maintain world-class facilities.
7. Become a more multi- and inter-disciplinary laboratory by inviting researchers from additional departments across Purdue to become involved in research at Herrick.
8. Develop a testing program to support staff and infrastructure

2017-2018 HIGHLIGHTS

Research	Last Year	This Year
Research Expenditures HLAB Aug 2017-July 2018	$6,782,327	**$7,860,581**
Proposals Pending	$12,588,622	**$13,954,911**
Number of Sponsors as of Sept 2018	75	**49**
Archival Journal Papers Published Jan-Dec 2017	99	**89**
Contracts in Force for July 2018-June 2019	$6,859,414	**$7,454,570**
Current Students		
Graduate Students as of Sept 2018	124	**129**
MS	42	**36**
Ph.D.	82	**93**
Research Assistants	74	**76**
Fellowships	12	**18**
Teaching Assistants	16	**23**
Undergraduate/Graduate "Research Experience" Students	36	**27/11**
Post Docs - Sept 1, 2017-Aug 31, 2018 (Current/Expired)	17*	**12(7/5)**
Students Graduated-Jan-Dec 2017	32	**27**
MS - Totals (Thesis/Non-Thesis)	21	**20 (12/8)**
Ph.D.	11	**7**
Visiting Researchers - Sept 1, 2017-Aug 31, 2018		
Visiting Research Assistants (Current/Previous)	17	**14(8/6)**
Technology Transfer		
Conferences/Workshops Held-Aug 2017-July 2018	3	**9**
CHPB Members Meetings-Aug 2017-July 2018	2	**2**
Conferences Planned in the Next 2 Years-Aug 2018-July 2020	9	**3**
Short Courses Held Aug 2017-July 2018	3	**5**
Sponsor Reports (Herrick Lab Reports) to Sponsors	13	**6**
Conference & Journal Papers Jan-Dec 2017	193	**201**

ADMINISTRATIVE AND SUPPORT STAFF

Professor Patricia Davies is the Director of Ray W. Herrick Laboratories. Donna Cackley is her administrative assistant with Cindy Cory being the Herrick secretary. Brian Barrett serves as conference coordinator for all Herrick Laboratories' conferences and short courses. Orkan Kurtulus serves as the Senior Research Associate helping support the setup of the operation of projects that utilize experimental facilities within the thermal system laboratory. The various research programs are assisted by: Charlie Baxter, Technical Services Supervisor and Research Engineer; Bob Brown, Mechanical Shop Coordinator and Building Deputy; Ryan Thayer, Engine Test Cell and Lab Technician, and Frank Lee, Mechanical Technician.

HERRICK LABS FACULTY RESEARCH INTERESTS

Andres Arrieta, Assistant Professor of Mechanical Engineering; PhD 2010, University of Bristol, United Kingdom. Structural nonlinearity, nonlinear vibrations, adaptive structures, smart materials, morphing structures, multistable structures, compliant structures, programmable structures, nonlinear metamaterials and energy harvesting systems.

Anil Bajaj, William E. and Florence E. Perry Head 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.

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, microperforated noise control materials, analysis of tire vibration and sound radiation, fan noise control, nearfield acoustical holography, visualization of motor vehicle passby sound radiation, and machinery noise source identification.

Brandon Boor, Assistant Professor of Civil Engineering and Environmental and Ecological Engineering (by courtesy); PhD 2015, University of Texas at Austin. Aerosol science with applications to: indoor air quality, HVAC filtration, human exposure assessment, biological particulate matter, nanoaerosols, and urban air pollution.

James Braun, Herrick Professor of Engineering and Director of the Center for High Performance Buildings; PhD 1988, University of Wisconsin. Thermal systems measurements, modeling, analysis, design optimization, and control optimization with applications to high performance building systems, advanced HVAC&R equipment and small-scale power production.

David Cappelleri, Associate Professor of Mechanical Engineering; PhD 2008, University of Pennsylvania. Multi-scale robotic manipulation and assembly; mobile micro robotics, micro aerial vehicles, mechatronics, medical robotics, agricultural robotics, MEMS - micro-electro-mechanical systems, and automation for the life sciences.

Jun Chen, Associate Professor of Mechanical Engineering; PhD 2004, Johns Hopkins University. Experimental fluid dynamics; advanced flow diagnostics techniques; benchmark experiments and modeling, applied fluid dynamics.

Qingyan (Yan) Chen, James G. Dwyer Professor of Mechanical Engineering; PhD 1988, Delft University of Technology. Indoor and outdoor airflow modeling by computational fluid dynamics and measurements, building ventilation systems, indoor air quality, airline cabin environment, energy-efficient building design and analysis.

George Chiu, Assistant Dean for Global Engineering Programs, Professor of Mechanical Engineering; PhD 1994, University of California at Berkeley. Mechatronics, modeling/control of digital imaging and printing systems, functional printing and digital fabrication, motion and vibration control and perception, and embedded system design.

Patricia Davies, Director, Ray W. Herrick Laboratories and Professor of Mechanical Engineering, PhD 1985, University of Southampton; United Kingdom. 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 identification of viscoelastic material properties.

Shirley Dyke, Professor of Mechanical and Civil Engineering, PhD 1996, University of Notre Dame. Structural dynamics and controls, damage detection and structural condition monitoring, cyber-physical systems, real-time hybrid simulation, cyberinfrastructure development, and machine vision.

James Gibert, Assistant Professor of Mechanical Engineering, PhD 2009, Clemson University. Dynamic modeling of nonlinear systems, modeling of manufacturing systems, dynamics of closed and open cell foam packaging system, energy harvesting systems, vibrations and rolling resistance of non-pneumatic tires, ultrasonic additive manufacturing and optimization of mechanical systems.

Marcial Gonzalez, Assistant Professor of Mechanical Engineering, PhD 2011, California Institute of Technology. Development of predictive, machano-chemicals models and multi-scale numerical methods that provide new inside into the behavior of materials and structures, that enable design and optimization of manufacturing process and product performance.

HERRICK LABS FACULTY RESEARCH INTERESTS

Eckhard Groll, Associate Dean for Undergraduate and Graduate Education/Reilly Professor of Mechanical Engineering, PhD 1994, University of Hannover, Germany. Thermal sciences as applied to advanced HVAC&R systems, components, and working fluids: compressor research, alternative refrigeration technologies, vapor compression systems, components, natural refrigerants, heat exchangers analysis, and Organic Rankine Cycle analysis.

Travis Horton, Associate Professor of Mechanical Engineering (by Courtesy) and 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.

Neera Jain, Assistant Professor of Mechanical Engineering, PhD 2013, University of Illinois at Urbana-Champaign. Dynamic modeling, optimization, and control of energy, transportation, and building systems; model predictive control; optimal plant and control co-design; integrated energy management and storage; human-machine interaction modeling and control; psychophysiological sensing.

Panagiota Karava, Jack and Kay Hockema Associate Professor of Civil Engineering, PhD 2008, Concordia University. Smart buildings, Human-building interactions, self-tuned environments, smart and connected energy-aware residential communities.

Donghun Kim, Research Assistant Professor, PhD 2015, Purdue University. Dynamic modeling, optimization, system identification, and control of thermal systems, technologies for building energy savings and electric peak demand reduction.

Charles Krousgrill, 150th Anniversary Professor and 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.

Yangfan Liu, Assistant Professor of Mechanical Engineering, PhD 2016, Purdue University. Acoustic source modeling and sound field reconstruction, active noise control, room acoustics simulation and auralization, noise control treatments, and human perception of noise.

Peter Meckl, Assistant Head of Mechanical Engineering and 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, Associate Professor of Civil Engineering; PhD 2008, Carnegie Mellon University. Development & application of energy efficient technologies in buildings, solar cooling & heating systems, sorption systems, building envelope, building energy supply systems, sustainable building design & analysis.

Jeff Rhoads, 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.

Fabio Semperlotti, Assistant Professor of Mechanical Engineering; PhD 2009, Pennsylvania State University. Wave propagation, acoustic and elastic metamaterials, structural health monitoring, structural dynamics and vibration control, smart and adaptive structures, and fractional calculus.

Gregory Shaver, Professor of Mechanical Engineering; PhD 2005, Stanford University. Modeling, design and control of advanced powertrains for for commercial vehicles. Improving safety, efficiency, and emissions-mitigation in commercial vehicles via connectivity-enabled controls and automation.

Thanos (Athanasios) Tzempelikos, Associate Professor of Civil Engineering and Mechanical Engineering (by Courtesy); PhD 2005, Concordia University. Indoor environmental quality in buildings, thermal and visual comfort, multi-functional dynamic facades, daylighting controls, building energy modeling, human-building interactions, radiant systems and solar energy applications in buildings**.**

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

Andres Arrieta
Member: ASME Adaptive Structures and Material Systems Branch, 2017-present, Active Material Technology and Integrated Systems, 2016-Present, Symposium Co-Chair, Integrated System Design and Implementation, Smart Materials, Adaptive Structures and Intelligent Systems Conference (SMASIS) September 2016-present

Anil Bajaj
Contributing Editor, Nonlinear Dynamics Journal

Stuart Bolton
Fellow: Acoustical Society of America, Institute of Noise Control Engineering, Advisory Board Member, Noise Control Engineering Journal; Institute of Noise Control Engineering – Member Board of Directors; Institute of Noise Control Engineering – InterNoise 2015 – INCE/KSNVE Liaison

Brandon Boor
Chair, International Society of Indoor Air Quality & Climate (ISIAQ) Scientific and Technical Committee 12: Source, Monitoring, and Evaluation: Aerosols; Chair, American Association for Aerosol Research (AAAR) Bylaws Committee; Active member of ASHRAE SSPC 52.2, TC 2.4, and TAG to ISO/TC 142

Jim Braun
Fellow: ASHRAE, Editorial Board, Journal of Building Performance Simulation, Editorial Board, an International Journal Chairman, 2018, International Refrigeration and Air Conditioning Conference, Purdue University

David Cappelleri
Member, IEEE Robotics & Automation Society Technical Committee on Micro/Nano Robotics & Automation; IEEE Robotics & Automation Technical Committee on Mechanisms & Design; ASME Design Engineering Division Mechanisms & Robotics Committee; Associate Editor for ASME Journal of Mechanisms and Robotics, Journal of Micro-Bio Robotics, and IEEE Robotics and Automation Letters.

Jun Chen
Associate Editor, ASME Journal of Fluids Engineering, Vice-Chair, Fluid Mechanics Technical Committee, ASME, Track Co-Organizer, ASME - JSME - KSME Joint Fluids Engineering Conference 2019.

Qingyan (Yan) Chen
Editor-in-Chief, Building and Environment (BAE) Journal (2007-); Departmental Academic Advisor, Hong Kong Polytechnic University (2011-2016); Advisory Committee, EoN Center, RWTH Aachen University, Germany (2011-2016); Visiting Professor, Tianjin University, China (2008-2018); Fellow ASHRAE and ISIAQ

George Chiu
Fellow: Society for Imaging Science and Technology (IS&T); American Society of Mechanical Engineers (ASME); Editorial Board, Frontiers of Mechanical Engineering, 2008-Present; Program Chair, 2016 American Control Conference, Boston, MA, June; Editor-in-Chief Elect, IEEE/ASME Transactions on Mechatronics, 2016 Chair; Member Editorial Board, Frontiers of Mechanical Engineering, 2008-Present

Patricia Davies
Fellow: Institute of Noise Control Engineering (INCE); Acoustical Society of America; Member: American Society of Mechanical Engineering; Vice President for Technical Activities: International-INCE.

James Gibert
Secretary: ASME Technical Committee on Modeling, Dynamics, and Control of Adaptive Systems

Marcial Gonzalez
Faculty Committee Member, National Institute for Pharmaceutical Technology and Education, (NIPTE), 2015-present; Member, Granular Materials Committee, Engineering Mechanics Institute, EMI, 2017-present

Eckhard Groll
Fellow: ASHRAE, Regional Editor for the Americas of International Journal of Refrigeration; Member of ASHRAE, USNC/IIR (U.S. National Committee of the Int'l Institute of Refrigeration); IIR (President of Commission B2 Refrigeration Equipment); ASME, ASEE, and DKV (German Society of Refrigeration and Climate Technology); General Conference Chair of 24nd Int'l Compressor Engineering Conference at Purdue, 17th Int'l Refrigeration and Air Conditioning at Purdue, and 5th Int'l High Performance Buildings Conference at Purdue, July 9-12, 2018

HERRICK FACULTY PROFESSIONAL ACTIVITIES

Travis Horton
Paper Reviewer for: International Journal of Refrigeration, Applied Energy, Energy, ASHRAE, and Renewable Energy; Secretary for TG1.Optimization, ASHRAE; Proposal Reviewer for projects related to sustainability for the USDA; Member of the United States National Commission for the International Institute of Refrigeration

Neera Jain
Special Sessions Chair for the 2018 IFAC Conference on Cyber-Physical and Human Systems; Co-organizer of Invited Session for the 2019 American Control Conference titled Energy Management in Aerospace Vehicles; Member of Program Committee, 2020 American Control Conference

Panagiota Karava
Editor: Energy and Building; Member: American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2008-Present; US Building Performance Simulation Association (IBPSA) 2009-Present; Organizing Committee, 2nd and 3rd Int'l High Performance Buildings Conference at Purdue University, 2012 & 2014

Donghun Kim
Member of: ASME (Energy Systems Technical Committee), ASHRAE (Corresponding Member, TC 1.4 Control Theory and Application and TC 7.5 Smart Building Systems) and IEEE

Kai Ming Li
Fellow: Acoustical Society of America and Institution of Mechanical Engineers (UK); Associate Editor: Journal of Acoustical Society of America, Applied Acoustics; Member: Membership Committee of the Acoustical Society of America; Co-Chair: American National Standards Institute (ANSI) Working Group on "Method for determining the acoustic impedance of ground surface"

Yangfan Liu
Editorial Assistant for Applied Acoustics; Reviewer for Applied Acoustics, Noise Control Engineering Journal and Journal of Sound and Vibration, Mechanical Systems and Signal Processing, Chair/Organizers for Inter-Noise 2018, Chicago, USA, Active Noise Control Session and Inter-Noise 2019, Madrid, Spain, Active Noise Control Session

Peter Meckl
Finance Chair, 2013 American Control Conference; Member, ASME Dynamic Systems and Control Executive Committee, 2014; Editor, ASME Dynamic Systems and Control Magazine, 2015

Jeff Rhoads
Fellow: American Society of Mechanical Engineers, Associate Editor: ASME Journal of Vibration and Acoustics, 2013-Present; Member: ASME Design, Materials, and Manufacturing (DMM) Segment Leadership Team, 2015-Present; ASME International Design Engineering Division
Technical Committee on Sound and Vibration, 2010-Present;ASME International Design Engineering Division Micro/ Nanosystems Technical Committee, 2009-Present

Fabio Semperlotti
Member: Program Committee of SPIE's Smart Structure/NDE Symposium, 2013-Present; ASME Technical Committee for Vibration and Sound (TCVS), 2014-2017; ASME Structural Health Monitoring Technical Committee, 2013-Present; ASCE EMI Structural Health Monitoring Technical Committee, 2014-Present

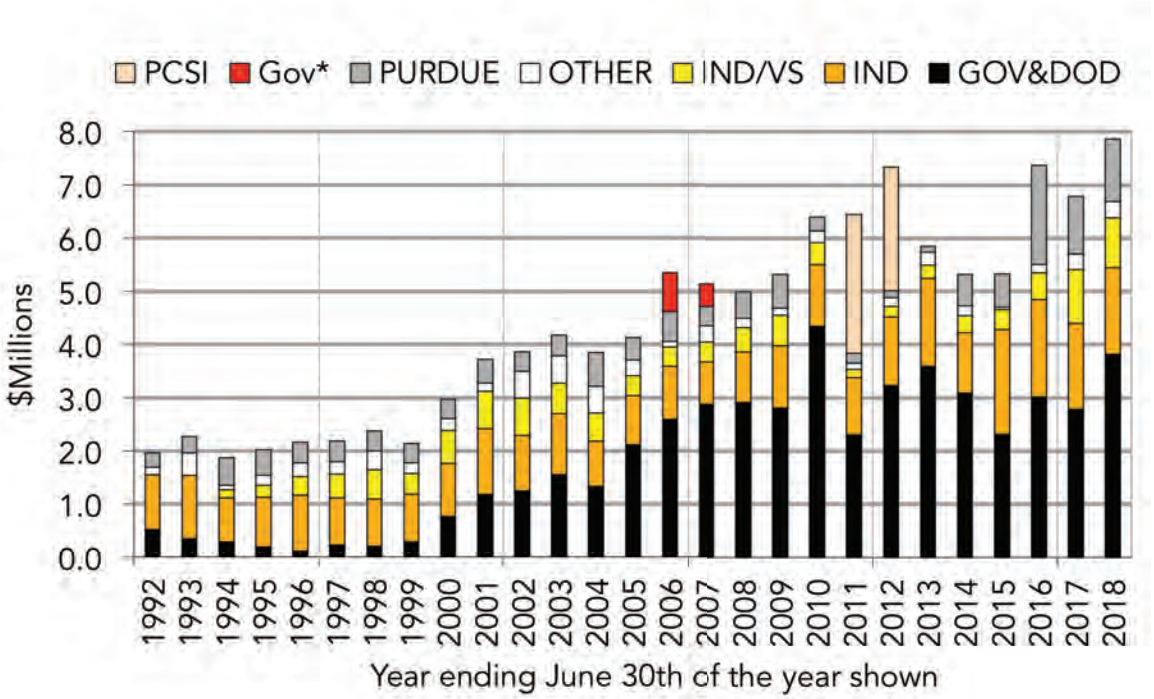
Thanos Tzempelikos
Member, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE); Member: International Building Simulation Association (IBPSA); Chairman, 5th International High Performance Buildings Conference at Purdue (2018); Associate Editor, ASCE Journal of Energy Engineering; Editorial Board, Building and Environment journal

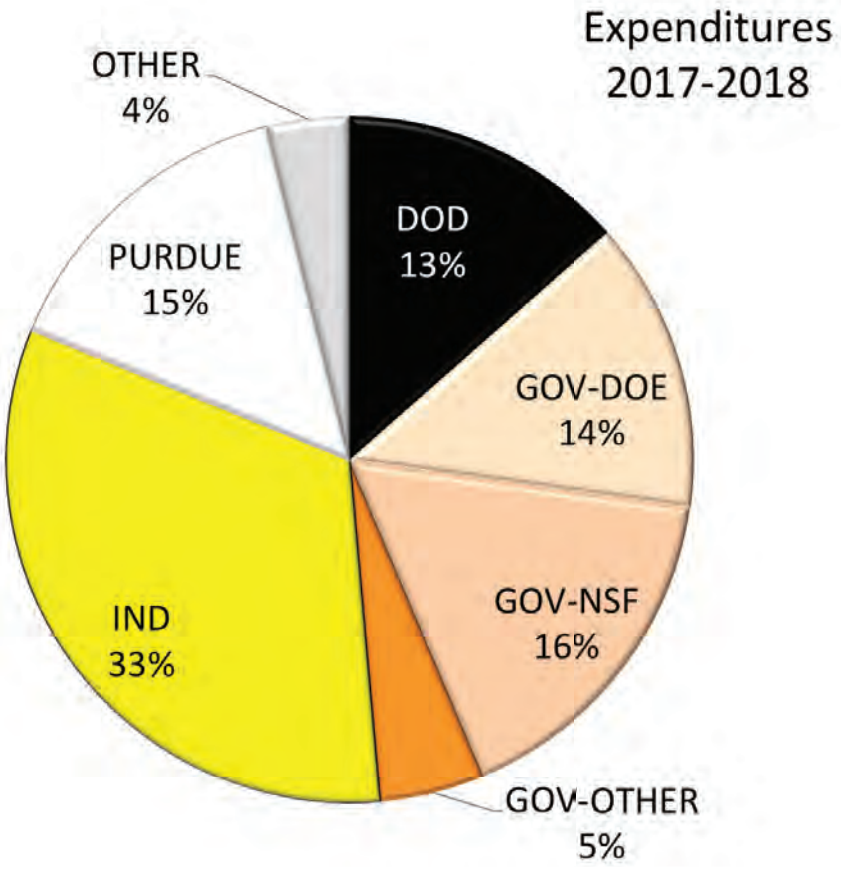
Bin Yao
Fellow: American Society of Mechanical Engineering, Senior Member of IEEE; Member: Editorial Board of the International Journal of Control, Automation and Systems; Award Committee and Past Technical Editor: IEE/ASME Trans. Mechatronics Granular Materials Committee, Engineering Mechanics Institute, EMI, 2017-present

2017-2018 RESEARCH EXPENDITURES

Shown below is the distribution of research expenditures from July 1987 - June 2018.

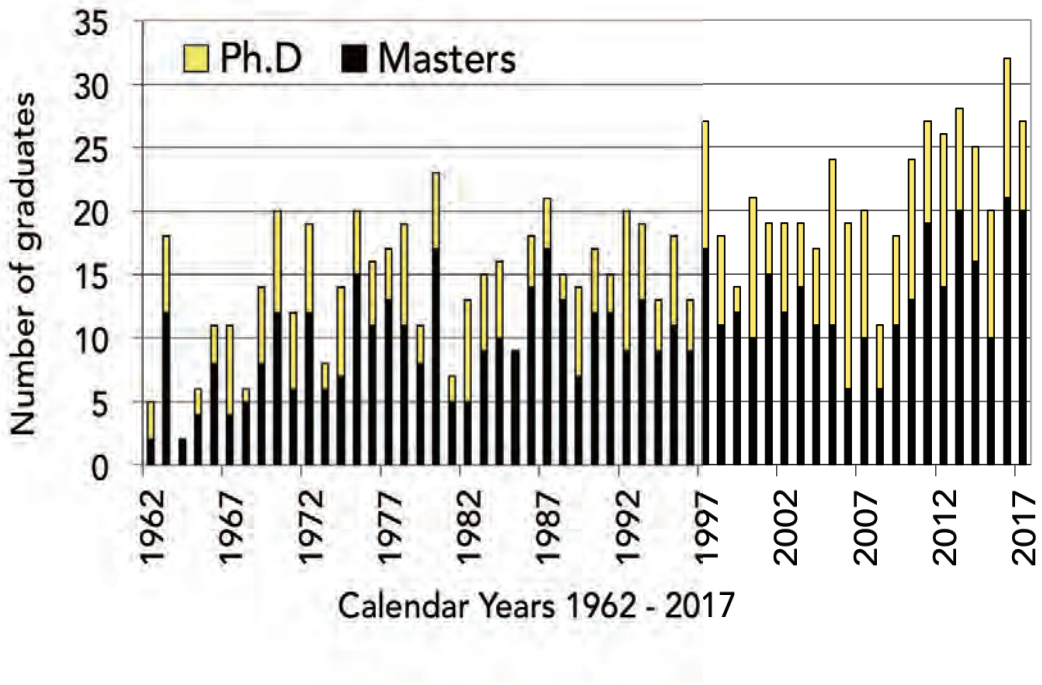
Total Herrick Laboratories Research Expenditures $7,860,581 2017-2018 $6,782,327 2016-2017





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

Hejia Zhang received the Ross Fellowship
Trevor Bird received the Herrick Fellowship and National Science Foundation Graduate Research Fellowship
Jill Joffe received the National Science Foundation Graduate Research Fellowship and the Purdue Doctoral Fellowship
Katy Riley received the National Science Foundation Graduate Research Fellowship
Salvador Rojas received the George Washington Carver Fellowship
Allison Murray received the Fontaine Fellowship

Grants-in-Aid

Parveen Dhillion, Vatsal Shah, and Riley Barta received the ASHRAE Grad Student Grant-in-Aid

Awards

Connor Pyles won 3rd place in TCVS Student Paper Competition at IDETC 2018
Xinye Zhang won 1st place in the Student Paper Competition at 2018 International Compressor Engineering Conference
Rita Jaramillo won 2nd place in the Student Paper Competition at 2018 International Compressor Engineering Conference
Yutong Xue won the Inter-Noise Best Paper Award and the Acoustical Society of America Spring 2018 Conference Minneapolis
Wei Liu won Best Paper Award at the 2018 Proceedings of Roomvent and Ventilation

CURRENT HERRICK LAB STUDENTS

Agarwal, Ankit	Gonzalez	Thermo-Mechanical Characterization of Enerpetic and Mock-Enerpelic Materials
Akash, Kumar	Jain	Mathematical Characterization of Human-Machine Interactions
Allen, Cody	Shaver	Advancing Diesel Engines Via Cylinder Deactivation
An, Ze	Cappelleri	3D Simultaneous Localization and Mapping (SLAM) with Mobile Robots
Barta, Riley	Groll	Multi-Temperature Refrigerated Container Systems (MTRCS) Analysis
Bird, Trevor	Jain	Dynamic Modeling & Control of a PEM Fuel Cell-Micro-CHP System
Black, Brady	Shaver	Connectivity/Automation-Enabled Controls for Class 8 Truck Fuel Savings
Boston, (Matt) David Matthew	Arrieta	Design Tools and Testing for On-Demand Selective Compliance Morphing Structures
Brendel, Leon	Groll	A Residential Heat Pump Solution to Enable High Efficiency with a Near-Zero GWP Refrigerant
Browne, Florian (Rian)	Jain	Advanced Control of Castrip LLC Caster Roll Gap
Carr, Daniel	Davies	Ford Road and Wind Noise
Caskey, Stephen	Groll	Thermally Integrated Residential Appliances (TIRA)
Cheng, Li	Horton	Geothermal
Choi (Brad), Jongseong	Dyke	Active Citizen Science for Lifecycle Assessment
Choi, Won Hong	Bolton	Study of Structure-Borne Noise Generation by the Acoustic Cavity Mode of a Tire
Chowdhury, Arindam	Cappelleri	Applications of Deep Learning to Robotics and Computer Vision
Cummock, Nick	Son/Rhoads	Shock Sensitivity of Explosives in Response to Dynamic Insult
Deng, Zhipeng (Steven)	Chen, Y.	Recognition of Building Occupant Behaviors From Indoor Environment Parameters by a Data Mining Approach
Desai, Akash	Shaver	High BMEP Gasoline Engine Control Systems
Dhamankar, Shveta	Shaver	High Efficiency Medium/Heavy-Duty Engines via Variable Valve Actuation
Dhillon, Parveen	Braun	Advanced Control of Rooftop Units
Ding, Wei	Semperlotti	Fractional Calculus for Continuum Mechanics and Homogenization
Feng, Jianxiong	Li	Quantification of uncertainties in predicting aircraft noise
Fleck, Trevor	Rhoads	Energetic Materials Printing
Foster, John	Shaver	High Efficiency Natural Gas Engines
Ganne, Rajakumar	Meckl	Diagnostics and Control of Diesel SCR Aftertreatment System
Ganti, Sai Sanjit	Semperlotti	Topological Acoustics
Gohil, Karan Nitinkumar	Jain	Modeling and Control of Advanced Thermal Energy Storage (TES) Modules
Gosala, Dheeraj	Shaver	Fuel-Efficient Emissions Reduction from Diesel Engines Via Advanced Gas Exchange Management
Grantz, Christian	Arrieta	Mechanical Bi-Stable Switches for Vibration Suppression
Guerrero de la Peña, Ana	Jain	What's Next in Freight Transportation
Halbrooks, David	Braun/Groll	Localized Thermal Comfort Delivery System
Ham, Sang Woo	Karava	Cyber-Sees
Han, Dong	Groll	Optiziming Heat Pump Performance
Hao, Haitian	Semperlotti	Thermoacoustics
Hao, Kairui	Kim, D.	Evaluation of Thermal Batteries Integrated with Renewable Electricity Production
He, Dazhuang	Chen, J.	Aero Acoustic Noise prediction of axial fans
Hollkamp, John	Semperlotti	Acoustic Metamaterials for Vibration and Noise Control
Hoshing, Vaidehi	Shaver	Augmented Framework for Economic Viability-Based Powertrain Design and Emissions Analysis of Medium/Heavy - Duty Plug-In Hybrid Electric Vehicles
Hou, Xiaodong	Braun	Synergy: Plug-and Plug Cyber-Physical systems to enable buildings
Hwang, Myungwon	Arrieta	Nonlinear Dynamics in Lattices of Multi-Stable Elements
Ibitayo, Ifeoluwa	Shaver	Connectivity/Automation-Enabled Controls for Class 8 Truck Fuel Savings
Jain, Kaushal K.	Meckl	Development of Urea-SCR Dosing ControlStrategies for a Diesel Electric Hybrid Car

CURRENT HERRICK LABS STUDENTS

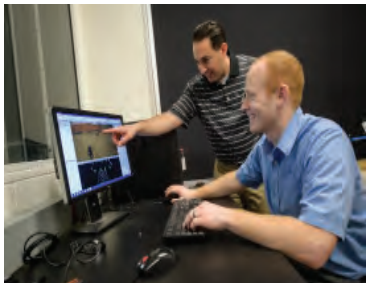
James, Nelson	Braun/Groll	Investigation of Chemical Looping for High Efficiency Heat Pumping
Jana, Aniruddha	Shaver	Analytical and Phase Field Models of Lithium Dendrite Growth
Jathar, Krutartha	Bolton	Tire Noise Measurements
Jiang, Jinglin	Boor	Purdue AirSense-Indoor Aerosol Research
Joe, Jaewan	Karava	High Performance Buildings
Joffe, Jill	Rhoads	Acoustics-Based IED Detection and Defeat
Jokar, Mehdi	Semperlotti	Holographic Damage Detection
Joodaky, Amin	Gibert	Transient & Random Packing Dynamics of Cushion Foams
Joshi, Mrunal C.	Shaver	Enabling Ultra-High Engine System Efficiency Via Flexible Valve Actuation
Kim, Huijeong	Karava	Human/Building Interactions
Kim, Michael	Tzempelikos	Smart, Low-Cost Sensing Systems for Advanced Daylighting Controls
Kwarteng, Vanessa	Bilionis/Karava	Methods for Smart and Connected Communities
Law, Che Kun	Cappelleri	Mobile Robotics for Precision Agriculture
Lee, Kyeongsuk	Karava	Design and Control of Human Centered Buildings
Lee, Seungjae	Tzempelikos	Development of Self-Tuned Indoor Thermal Environments
Lenjani, Ali	Dyke	Active Citizen Engagement to Enable Lifecycle Management
Lepak, Wesaam	Davies/Bolton	Modeling and Evaluation of HVAC&R Equipment Noise
Li, Ang	Chen, J	Noise Control of High Speed Centrifugal Fan
Li, Ruoyi	Bin Yao	Intelligent & High-Performance Control of Industrial Robots
Liu, Haotian	Groll	Evaluating Adhesive Bonding of Aluminum and Copper in HVAC&R Applications
Liu, Ting-Wei	Semperlotti	Design and testing of topological acoustic metamaterials
Liu, Xiaoqi (Claire)	Karava	Uncertainty impact on predictive control of buildings
Liu, Xiaoyu	Dyke	3D Mapping Indoor Locations for Navigation
Lu, Zechao	Chen, Y & J	Innovative Design of a Kitchen Range Hood
Lumpkin, Domenique	Groll	Regenerative air cycle heat pump for commercial and individual appliances
Lyle, Dennis	Gibert	Mechanical Analysis of UAM
Ma, Jiacheng	Braun	Dynamic Modeling of Air Conditioners and Heat Pumps
Ma, Jie	Horton	Separate Sensible and Latent Cooling Systems for Residential and Light Commercial Buildings
McArthur, Daniel	Cappelleri	Autonomous Aerial Manipulation with UAV's
McConnell, Miranda	Rhoads	Additive Manufacturing of Nonmetallic Igniters
Meng, Lingwei	Arrieta	SMART Materials
Miers, Collier	Gibert	PCM: Optimizing Material Properties: Enthalpy and Thermal Conductivity
Mina, Tamzidul	Yao	Dynamics and Controls of Mobile Robots
Mo, Zhuang	Bolton	Sound Transmission
Murray, Allison	Rhoads	Portable Integrated Microscale Sensors
Nair, Siddharth	Semperlotti	Acoutic Resonators
Nash, Austin	Jain	Dynamic Modeling and Control of MicroCHP Systems
Ore, Jonathan Paul	Groll	Vaiable Valve Actuation
Patnaik, Sansit	Semperlotti	Fractional Calculus for Structural Health Monitoring (SHM)
Patra, Adarsh	Rhoads	Secure Micro-Electro-Mechanical Systems
Pyles, Conor	Rhoads	Coupled Micro-Electro-Mechanical Systems Resonators
Qiu, Weijin	Shaver	Natural Gas Engines for Stationary Power Generation
Radkar, Vaishnavi	Meyer/Shaver	In-Cylinder Engine Sensor
Ramaraj, Sugi	Braun/Horton	Free cooling technologies
Range, Allison Rose	Rhoads	Thermomechanical Response of Particulate Composite Energetic Materials Under Mechanical Vibration

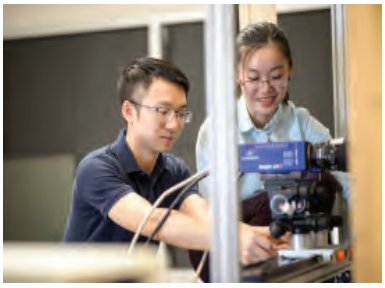
CURRENT HERRICK LABS STUDENTS

Rayasam, Sree Harsha	Shaver	Natural Gas Engine Controls
Riley, Katherine	Arrieta	Programmable Morphing Structures with Multi-Stable Elements
Rivas, Jose	Arrieta	Selective Complaince for Morphing Structures
Rohleder, Cai	Groll	Vapor Compression Refrigeration System for Cold Storage on Spacecrafts
Rojas, Salvador	Arrieta	Soft Robotics from Bioinspired Spring Origami
Salts, Nick	Groll	Direct Current Micro-Grid House
Schuster, Dan	Horton	Campus Sustainability
Shah, Vatsal Manilal	Groll	Oil Management in Tandem Compressors
Shang, Weixiao	J. Chen	Laser Diagnostic of Complex Flow Field
Shi, Tongyang	Bolton	Acoustics and Noise Control
Shi, Zhu	Chen, Y	Investigation of the Thermal and Ventilation Performance of Stratified Air Distribution Systems Coupled with Passive Chilled Beams
Shin, Hyun Jun	Bolton	Sound Transmission
Siefker, Zac	Rhoads/Braun	Carbon Dioxide Sensors for Buildings
Son, Forrest	Chiu	Heat Pump Performance Testing
Song, Guochenhao	Liu/Davies	Annoyance Thresholds of Tones in Noise as Related to Building Services
Sun, Mingyu	Meckl	Supervisory Control of a Plug-In Hybrid Vehicle
Sung, Weonchan	Bolton/Davies	Sound Quality of HVAC Equipment
Tao, Hongcheng	Gibert	Dynamic Behavior of Discontinuous Metamaterial Unit Cells
Taylor, Alexander	Shaver	Connected and Automated Class 8 Trucks and Diesel Engine Air Handling Strategies for Fuel Efficient Aftertreatment Thermal Management
Thakkar, Aman	Arrieta	Nonlinear Dynamics and Property Programming in 2D Architectured Materials
Thomas, Josiah	Chiu	Bandwidth Limited Control Systems
Thor, Weimin	Bolton	Fan Noise Control
Udani, Janav Parag	Arrieta	Reconfiguration of Morphing Structures Exploiting Dynamics
Vos, Kalen Russell	Shaver	Enabling Variable Valve Actuation to Infl uence the Gas Exchange Over the Operating Range of a Turbocharged Diesel Engine for Fuel Effi ciency and Aftertreatment Thermal Management
Wagner, Danielle	Boor	Nandi Clean Kitchen Study
Walls, Marlon	Rhoads	Additive Manufacturing of Energetic Materials
Wang, Jie	Chiu	Special Nuclear Materials
Wang, Xuchen	Bolton/Liu	Mitigation of Unwanted Enhancement in Active Noise Control Systems
Wang, Yiming	Li	Computational Acoustics
Wickham, Jason	Son/Rhoads	The Effect of Interface Adhesion on Localized Heating in Explosives
Wu, Puyuan	J.Chen	Laser Diagnostic of Complex Flow Field
Wu, Tianren	Boor	Indoor Aerosol Research
Xiao, Yingying	Braun	Synergy: Plug-and-Plug Cyber-Physical Systems to Enable Buildings
Xiong, Jie	Tzempelikos	Personalized Visual Preferences and Implementation on Adaptive Building Controls
Xu, Xueyang	Groll	Compressor Performance Analysis
Xue, Yutong	Bolton	Structural Damping
Zhang, Xinye	Groll	Performance Analysis of Natural Gas Compressors for Residential and Commerical Applications
Zhang, Hejia	Tzempelikos	IPerception-Based Thermal Control and Impact on Building Energy Use
Zhang, Xu	Shaver	High BMEP Gasoline Engine Control Systems
Zhidan, Zhao	Horton	Inverse Modeling Techniques for Vapor Compression Systems
Zhuang, Yongjie	Liu	Robust Controller Design for Active Noise Control of a Spatial Region

2017 HERRICK LAB GRADUATES

Aaron Anderson	MSME	Design of a Twisting Multi-Stable Actuator
Nikhil Bajaj	Ph.D.	Microresonator-Based Sensors with Feedback-Enabled Nonlinearities
Suyash Bhangale	MSME	Non-Thesis Performance Testing of Unitary Split-System Heat Pump
Youyi Bi	Ph.D.	An Interdisciplinary Approach for Understanding Information Utilization in Engineering and Product Design
Tim Blatchley	MSME	Secondary Loop Residential Heat Pump Design, Performance, and Cost Analysis Utilizing R290
Nicholas Brenn	MSME	Non-Thesis Data Mining at the ReNEWW House
Rui Cao	Ph.D.	Investigation of Noise and Vibration in Tires Through Analytical Modeling, Tests, and Simulations
Trevor Fleck	MSME	Additive Manufacturing of Energetic Materials and Its Uses in Various Applications
Aswin C. Henry	MSAAE	Performance Augmentation of Compliance-based Morphing Wings Through Optimizati-on and Nonlinearity
John Hollkamp	MSME	Non-Thesis Model-Order Reduction of Lumped Parameter Systems Via Fractional Calculus
Kaushal K. Jain	MSME	Modeling of NH3 Storage in Vanadia-Based SCR Catalyst for UREA-Dosing Control in a Diesel-Electric Hybrid Car
Xing Jin	Ph.D.	Physics-Based Computationally Effi cient Battery Degradation Model and Electric Ma-chine Scaling Strategy for Hybrid Electric Vehicle Design Optimization
Mrunal Joshi	MSME	Diesel Engine Cylinder Deactivation for Improved System Effi ciency While Maintaining Elevated Aftertreatment Temperatures
Dayi Lai	Ph.D.	Modeling Thermal Comfort in Outdoor Environments
Aaron Linden	MSME	Non-Thesis In Home Hydroponics Appliance
Wei Liu	Ph.D.	Inverse Design of Enclosed Environment by CFD-Based Adjoint Method
Haotian Liu	MSME	Performance Analysis of an Updraft Tower System for Dry Cooling in Large-Scale Power Plants
Yeshaswi Menghmalani	MSME	Dynamic Modeling and Validation of Power Generators
Eeshan Mitra	MSME	Effects of Time-Varying Mesh Stiffness and Its Modifi cations on Planetary Gear Dyna-mics
Whitney Novotny	MSME	Inkjet Printing of Metallic Initiators
Andria Rae Nyenhuis	MSME	Non-Thesis Rainwater Storage Appliance
Sarah Small	MSME	Thermally Integrated Residential Appliances
Tao, Hongcheng	MSME	Non-Thesis Dynamic Behavior of Discontinuous Metameaterial Unit Cells
Janav Udani	MSME	Non-Thesis Nonlinear Dynamics and Control of Multistable Systems
Matthew Van Voorhis	MSME	Implementation of Aftertreatment System to Enable Tailpipe Emmissions Measurements of a Variable Valve Actuation Enabled Camless Diesel Engine
Bin Yang	Ph.D.	Modeling of an Oil Free Carbon Dioxide Compressor Using Sanderson-Rocker Arm Motion (S-RAM) Mechanism





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 psychometric 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 psychometric 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.

MAJOR RESEARCH FACILITIES

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 fl oors 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 profi les 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 fl ow 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.

Perception-Based Engineering Laboratory

Perception Based Engineering (PBE) researchers study people's perceptions of stimuli, their infl uence 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 fi nely controlled, and the room can be re-confi gured as several small isolated rooms or one larger room, thus simulated various types of environments.

HERRICK LABS TECHNOLOGY TRANSFER ACTIVITIES

2020
July 12-16
Twenty-fifth International Compressor Engineering Conference
Eighteenth International Refrigeration and Air Conditioning Conference
Sixth International High Performance Buildings Conference

2018
July 9-12
Twenty-fourth International Compressor Engineering Conference
Seventeenth International Refrigeration and Air Conditioning Conference
Fifth International High Performance Buildings Conference

July 8
Short Course - Compressor 103-Generalized Simulation Framework for Positive Displacement Compressors and Expanders
ShortCourse -The Transition to Flammable Refrigerants
Workshop - 2018 Intelligent Building Operations (IBO)

May 15-18
Short Course - Advanced Noise Control Technology: Microperforated Materials
June18-22
Short Course - Acoustics and Noise Control
July 21
Workshop - Real-Time Hubrid Simulation to Enable Multi-Hazard Engineering, Asia-Europe

2017

May 15-19
Short Course - Acoustics and Industrial Noise Control
July 17-20
Short Course - Signal Processing
Oct 23
Short Course - Aeroacoustics
Dec 12-13
Workshop - 1st MECHS Workshop: Breaking Barriers & Building Capacity

2016

July 11-14
Twenty-third International Compressor Engineering Conference
Sixteenth International Refrigeration and Air Conditioning Conference
Fourth International High Performance Buildings Conference

July 10
Short Course - Oil Management in Compressors and Their Systems
Short Course - Final Frontiers in Vapor Compression Cycle Effi ciency
Workshop - 2016 Intelligent Building Operations (IBO)

2015

August 2-5
General Chair, 2015 ASME International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, Boston, Massachusetts, Professor J. Rhoads

March 16-20
Short Course - HVAC&R System Modeling and Simulation using Engineering Equation Solver, Kulthorn-Kirby, Bangkok, Thailand, Professor W. T. Horton