RAY W. HERRICK LABORATORIES
ANNUAL REPORT

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Fall 2019

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MESSAGE FROM
THE DIRECTOR

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Patricia Davies

We, the team at the Ray W. Herrick Laboratories, have achieved a lot over the last 14 years, the term of my Directorship. It was possible because of the legacy of the former directors: Bill Fontaine, Ray Cohen and Bob Bernhard, who created and strengthened the foundations of the Herrick Laboratories, and the hard work, creativity, and dedication of the faculty, students and staff at the Laboratories.

Bill's vision for a laboratory where a community of graduate students, faculty and technical support staff worked with industry on industry-relevant problems, is still at the core of what we do at the Laboratories today, though our funding base and application areas have broadened over the years.

Faculty who have been at the Laboratories for a while have worked with some companies for many years on different projects, and their industrial sponsors have become friends. Companies look to hire our students because of the strength of the students' education at Purdue, in the classroom, in their research, and through their interactions with sponsors. It is always a pleasure to see our students' growth from when they start at the Laboratories to when they graduate. At conferences, here at Purdue and elsewhere at our technical societies, it is always nice to interact with our former students and hear how much they valued their time at the Laboratories, not only because of the technical work, but also because of the friendships formed while being part of this community.

Bill Fontaine's mode of operation, where all space and equipment is shared and we always try to accommodate each other's evolving research needs, is still practiced today. This is a very important part of the experience of working at the Laboratories. Students have to be more organized and students have to help each other. Helping other students has the reward of broadening their knowledge beyond their own research project. The technical support staff have to balance many demands on their time. Students working with the shop and being accommodating so everyone's needs can be met, is another part of the collaborative culture.   The Herrick faculty also benefit from this community approach: funds go further and accommodation of each other's needs fosters collegiality, which makes our workplace more enjoyable, and makes it easier to put teams together to solve problems.   When we interview potential new faculty, we always try to assess how community-spirited they will be. Our perspective is that by sharing we can achieve more together.

As we move forward, it feels a little like an action replay of what was going on at the start of my directorship when we were trying to raise money for the last expansion of the Labs.   The old building is not in great shape and current thoughts are it will go away in the future. While I love the old building, we are continually running into limitations in utilities, infrastructure, and old HVAC&R systems that always seem to need

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repair. We are using all of the research space in the original building, and we have even repurposed some of the old office space for research. So, if it is to go away, there is a critical need for another new building, an expansion beyond the vision for the new Acoustics Wing.   The fund raising, the NIST Construction Grant (an American Recovery and Reinvestment Act funded initiative), the design and construction of the 2013 HLAB building was a very interesting time for the Laboratories. The HLAB building was only possible because of the support of many people and organizations, a great vision for the high performance buildings research theme – perfected by Prof. Jim Braun over several large center proposals, and a willingness to keep trying – the construction grant proposal was funded only after several rounds of proposals.   I wish Jeff Rhoads the very best as he takes over the Ray W. Herrick Directorship and addresses the next set of infrastructure expansion challenges.

Space for experimental research is a continuing challenge as the Laboratories grow. Our newer faculty hires have been successful at establishing their programs and Jeff Rhoads is currently heading a faculty search that is likely to result in more Herrick Laboratories faculty hires, and thus even greater demands for space.   Without the new building, it would have been impossible to accommodate the faculty growth that was a result of the large expansion of student numbers in engineering.

The Herrick Labs continue to be very successful. Here are some recent highlights. The NASA Resilient Extra Terrestrial Habitats Institute proposal that Prof. Shirley Dyke told the Industrial Advisory Committee about at the meeting last year, was funded. This is a large center activity involving several universities: Purdue University, the University of Connecticut, Harvard University, and the University of Texas San Antonio. From Herrick Labs., Shirley, Jim Braun, George Chiu and David Cappelleri are all involved. Neera Jain is part of a team just awarded an NSF grant on Cognitive Autonomy for Human Cyber-Physical Systems: Turning Novices into Experts. This is also an interdisciplinary, multi-university initiative. The University of New Mexico part of the collaboration is led by Meeko Oishi, an electrical and computer engineering professor. Neera and ME Associate Professor Tahira Reid have been studying how to measure human trust of machines, and in this research they will be using this knowledge to improve human-machine interaction. Jeff Rhoads and the PERC team led by Steve Beaudoin in Chemical Engineering ran another very successful energetic materials summit this summer, and the energetic materials research at Herrick in collaboration with Zucrow Labs' Professor Steve Son continues to grow.   The Center for High Performance Buildings Consortium also continues to be very successful. Panagiota Karava, Davide Ziviani and Jim Braun have been designing with their research team a flexible, reconfigurable office test facility to be housed in the Perception-based Engineering Laboratory. This facility will be used to understand how new approaches to lighting, heating and cooling in building environments impact occupant comfort. Eckhard Groll, recently appointed as Head of Mechanical Engineering, is heading up the 2020 Purdue Refrigeration, Compressor and High Performance Buildings Conferences organization team. With the help of Brian Barrett, Herrick Events Coordinator, we are in good shape for another set of successful conferences. Brian is also working with Stuart Bolton on the 2020 SAPEM conference on acoustics of poroelastic materials which Herrick Labs will host next year in December.

Donna Cackley (administrative assistant) and Bob Brown (shop technician and building deputy) retired this year. Both have been at Purdue University for a very long time. Bob was at the Labs for over 30 years. We wish them well in their retirement. We welcome Robin Sipes, our new administrative assistant at the Labs., who joins us from the College of Science. To meet the increasing demand on the technical support team, we welcome two new shop members: Clint Terrell and Rob Hughes. Thanks to the HERE gift from the Herrick Foundation last year, we are also able to hire undergraduate engineering and engineering technology students to help the technical team.   Charlie Baxter, Head of Technical Services, now has a team of four experienced technicians and three undergraduates. This helps us significantly in addressing the technical needs of the 28 professors and over 130 researchers at the Laboratories.

PATRICIA DAVIES
Director of Ray W. Herrick Laboratories

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THE RAY W. HERRICK LABORATORIES
AT A GLANCE

The Ray W. Herrick Laboratories turned 60 years old in 2018. Today we are part of the School of Mechanical Engineering, but the 28+ 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
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

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L A B O R A T O R I E S

RESEARCH	LAST YEAR	THIS YEAR
Research Expenditures HLAB Aug 2018-July 2019	$7,860,581	$8,199,045
Proposals Pending	$13,954,911	$18,422,093
Number of Sponsors as of September 2019	49	58
Archival Journal Papers Published Jan-Dec 2018	89	122
Contracts in Force for July 2019-June 2020	$7,454,570	$7,039,496

STUDENTS		
Graduate Students as of September 2019	129	127
MS	36	39
Ph.D.	93	88
Research Assistants	76	83
Fellowships	18	20
Teaching Assistants	23	13
Undergraduate/Graduate "Research Experience" Students	27/11	13/13
Post Docs - Sept 1, 2018 - Aug 31, 2019 (Current/Left)	12 (7/5)	18 (12/6)

STUDENTS GRADUATED-JANUARY-DECEMBER 2018	27	31
MS	20 (12/8)	17 (6/11)
Ph.D.	7	14

VISITING RESEARCHERS - SEPT 1, 2018 - AUG 31, 2019		
Visiting Research Assistants (Current/Previous)	14 (8/6)	25 (8/17)

TECHNOLOGY TRANSFER		
Conferences/Workshops Held - Aug 2018 - July 2019	3	5
CHPB Members Meetings - Aug 2018 - July 2019	2	2
Conferences Planned in the Next 2 Years - Aug 2019 - July 2021	9	5
Short Courses Held - Aug 2018 - July 2019	3	0
Sponsor Reports (Herrick Lab Reports) to Sponsors	13	6
Conference & Journal Papers - Jan-Dec 2018	193	280

ADMINISTRATIVE AND SUPPORT STAFF

Professor Patricia Davies is the Director of Ray W. Herrick Laboratories. Robin Sipes is her Senior Administrative Assistant with Cindy Cory being the Herrick Admin Assistant. 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; Ryan Thayer, Senior Engineering Technician; Frank Lee, Senior Engineering Technician; Clint Terrell and Robert Hughes, Senior Engineering Technicians.

FACULTY RESEARCH INTERESTS

ANDRES ARRIETA, ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2010, UNIVERSITY OF BRISTOL, UNITED KINGDOM
Adaptive structures Dynamics of smart material systems, Morphing of compliant structures, Structural nonlinearity, Elastic instabilities, Multi-stable structures, Shape programmable matter

ANIL K. BAJAJ, WILLIAM E. AND FLORENCE E. PERRY HEAD OF MECHANICAL ENGINEERING: Ph.D 1981, UNIVERSITY OF MINNESOTA
Modeling of nonlinear systems, Structural dynamics and localization, Flow-induced vibrations, Impacting systems, Bifurcations and chaos

ILIAS BILIONIS, ASSISTANT PROFESSOR AT THE SCHOOL OF MECHANICAL ENGINEERING, DIRECTOR OF THE PREDICTIVE SCIENCE LABORATORY, PH.D. 2013, APPLIED MATHEMATICS, CORNELL UNIVERSITY.
Artificial intelligence technologies that enable human engineers to accelerate the pace of innovation. Physics-informed machine learning methods for uncertainty quantification and propagation, inverse problems, filtering and system identification problems.

J. STUART BOLTON, PROFESSOR OF MECHANICAL ENGINEERING: PH.D 1984, UNIVERSITY OF SOUTHAMPTON
Acoustics Active and passive noise control Sound field visualization Structural acoustics and wave propagation in structures Noise control material modeling Applied signal processing

BRANDON E. BOOR, ASSISTANT PROFESSOR OF CIVIL ENGINEERING: Ph.D 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 E. BRAUN, HERRICK PROFESSOR OF ENGINEERING, AND DIRECTOR OF THE CENTER FOR HIGH PERFOR-MANCE BUILDINGS: Ph.D1988, UNIVERSITY OF WISCONSIN
Adaptive structures Dynamics of smart material systems, Morphing of compliant structures, Structural nonlinearity, Elastic instabilities, Multi-stable structures, Shape programmable matter. Modeling, analysis, and control of thermal systems

DAVID CAPPELLERI, ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2008, UNIVERSITY OF PENNSYLVANIA
Multi-scale robotic manipulation and assembly Mobile micro/nano robotics Micro/nano aerial vehicles Micro-Bio robotics Mechatronics MEMS/NEMS Automation for the life sciences

JUN CHEN, ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2004, JOHNS HOPKINS UNIVERSITY
Experimental fluid dynamics Development of flow diagnostic techniques Flow dynamics in stratified environment Turbulent flow measurements and modeling

QINGYAN (YAN) CHEN, JAMES G. DWYER PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 1988, DELFT UNI-VERSITY OF TECHNOLOGY
Indoor and outdoor airflow modeling by computational fluid dynamics (CFD) and measurements Building ventilation systems Indoor air quality (IAQ) Energy analysis

GEORGE T. C. CHIU, ASSISTANT DEAN FOR GLOBAL ENGINEERING PROGRAMS, PROFESSOR OF MECHANICAL EN-GINEERING: Ph.D 1994, UNIVERSITY OF CALIFORNIA AT BERKELEY
Dynamic systems and control Mechatronics Digital and functional printing and fabrication Motion and vibration control and perception Embedded systems and real-time control

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PATRICIA DAVIES, DIRECTOR, RAY W. HERRICK LABORATORIES AND PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 1985, UNIVERSITY OF SOUTHAMPTON; UNITED KINGDOM
Sound quality Signal Processing Data analysis System modeling and identification Condition monitoring of machinery Perception-based engineering Seat-occupant modeling

SHIRLEY J DYKE, PROFESSOR OF MECHANICAL ENGINEERING AND CIVIL ENGINEERING: Ph.D 1996, UNIVERSITY OF NOTRE DAME
Structural Dynamics and Control Cyber-physical Systems Machine Vision Real-time Hybrid Simulation Damage Detection and Structural Condition Monitoring Cyberinfrastructure Development

JAMES GIBERT, ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2009, CLEMSON UNIVERSITY
Vibrations and nonlinear dynamics Smart material systems Non-pneumatic tires Optimization of mechanical systems Additive manufacturing

MARCIAL GONZALEZ, ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2011, CALIFORNIA INSTITUTE OF TECHNOLOGY
Predictive, multi-scale modeling and simulation of microstructure evolution in confined granular systems, with an emphasis in manufacturing processes and the relationship between product fabrication and performance. Application areas of interest include: (i) particulate products and processes (e.g., flow, mixing, segregation, consolidation, and compaction of powders), (ii) continuous manufacturing (e.g., Quality by Design, model predictive control, and reduced order models), and (iii) performance of pharmaceutical solid products (e.g., tensile strength, stiffness, swelling and disintegration), biomaterials (e.g., transport and feeding of corn stover) and energetic materials (e.g., deformation and heat generation under quasi-static, near-resonant and impact conditions, and formation and growth of hot spots) materials.

ECKHARD GROLL, WILLIAM E. AND FLORENCE E. PERRY HEAD OF MECHANICAL ENGINEERING, AND REILLY PRO-FESSOR OF MECHANICAL ENGINEERING: Ph.D 1994, UNIVERSITY OF HANNOVER, GERMANY
Thermal sciences as applied to advanced HVAC&R systems, components, and working fl uids: compressor research, alternative refrigeration technologies, vapor compression systems, components, natural refrigerants, heat exchangers analysis, and Organic Rankine Cycle analysis.

W. TRAVIS HORTON, ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING (BY COURTESY), ASSOCIATE PRO-FESSOR OF CIVIL ENGINEERING: Ph.D 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: Ph.D 2013, UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Dynamic modeling and optimal control; model predictive control; decentralized control Thermodynamics-based optimization; entropy generation minimization; exergy analysis Integrated energy management and storage in distributed energy systems, building systems

PANAGIOTA KARAVA, JACK AND KAY HOCKEMA ASSOCIATE PROFESSOR IN CIVIL ENGINEERING: Ph.D 2008, CONCORDIA UNIVERSITY
Smart buildings, intelligent building operation, system identification, model predictive control • Human-building interactions, personalized control, self-tuned environments • Smart and connected energy-aware residential communities • Energy efficient and mixed-mode buildings, innovative energy and comfort delivery systems • Solar technology integration in building operation

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FACULTY RESEARCH INTERESTS

CHARLES M. KROUSGRILL, 150TH ANNIVERSARY PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 1980, CALIFORNIA INSTITUTE OF TECHNOLOGY
Dynamics Nonlinear vibration of continuous systems Stability analysis

KAI MING LI, PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 1987, UNIVERSITY OF CAMBRIDGE, UNITED KINGDOM
Adaptive structures Dynamics of smart material systems, Morphing of compliant structures, Structural nonlinearity, Elastic instabilities, Multi-stable structures, Shape programmable matter

YANGFAN LIU, ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2016, PURDUE UNIVERSITY
Acoustic Source Modeling and sound field reconstruction Active noise control Room acoustics simulation and auralization Noise control treatments Human perception of noise

PETER H. MECKL, ASSISTANT HEAD OF MECHANICAL ENGINEERING, AND PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 1988, MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Motion and vibration control Adaptive control Intelligent control using fuzzy logic and neural networks Engine and emissions diagnostics Robotics

MING QU, ASSOCIATE PROFESSOR OF CIVIL ENGINEERING: PhD 2010, Ph.D 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.

JEFFREY RHOADS, PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2007, MICHIGAN STATE UNIVERSITY
Nonlinear dynamics and vibration of macro-, micro-, and nanomechanical systems, micro- and nanoelectromechanical sensor design, mechanical and electromechanical amplifiers,

FABIO SEMPERLOTTI, ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2009, PENNSYLVANIA STATE UNIVERSITY
Structural Health Monitoring Wave propagation Structural dynamics and vibration control Adaptive structures Periodic structures and acoustic metamaterials Energy harvesting Thermoacoustics

GREGORY SHAVER, PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 2005, STANFORD UNIVERSITY
Model-based system and control design of commercial vehicle power trains Connected and automated commercial vehicles Internal combustion engine & after-treatment system design and controls Flexible valve actuation in diesel and natural gas engines

ATHANASIOS (THANOS) TZEMPELIKOS, PROFESSOR OF MECHANICAL ENGINEERING (BY COURTESY), PROFESSOR OF CIVIL ENGINEERING: Ph.D 2005, CONCORDIA UNIVERSITY
Adaptive structures Dynamics of smart material systems, Morphing of compliant structures, Structural nonlinearity, Elastic instabilities, Multi-stable structures, Shape programmable matter

BIN YAO, PROFESSOR OF MECHANICAL ENGINEERING: Ph.D 1996, UNIVERSITY OF CALIFORNIA AT BERKELEY
Adaptive and robust control Nonlinear control Precision control of mechanical systems Vehicle control Robotics

DAVIDE ZIVIANI, RESEARCH ASSISTANT PROFESSOR, ASSOCIATE DIRECTOR OF CENTER FOR HIGH PERFORMANCE BUILDINGS (CHPB): Ph.D, 2017, GHENT UNIVERSITY, GHENT, BELGIUM
HVAC&R technologies; advanced heat pumping systems; non-vapor compression cycles; not-in-kind cooling and heating technologies; waste heat recovery; positive displacement compressors and expanders; working fluids; CFD applied to positive displacement machines; smart buildings and communities; deep learning techniques applied to HVAC&R systems.

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L A B O R A T O R I E S

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 - Special Issues' Nonlinear Dynamics

ILIAS BILIONIS
The mission of the predictive science laboratory is to create artificial intelligence technologies that enable human engineers to accelerate the pace of innovation. The applications of the lab range from purely technical (e.g., electric machines, high-performance materials) to sociotechnical (e.g., smart buildings, extra-terrestrial habitats). Specifically, the group develops physics-informed machine learning methods for uncertainty quantification and propagation, inverse problems, filtering and system identification problems.

STUART BOLTON
Fellow: Acoustical Society of America, Institute of Noise Control Engineering; Institute of Noise Control Engineering – Member Board of Directors

BRANDON BOOR
Chair, International Society of Indoor Air Quality & Climate (ISIAQ) Scientifi c 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; Active member of ASHRAE SSPC 52.2, GPC 35, 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; Fellow: IBPSA

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-); Fellow ASHRAE and ISIAQ

GEORGE CHIU
Fellow: Society for Imaging Science and Technology (IS&T); American Society of Mechanical Engineers (ASME); Editor-in-Chief, IEEE/ASME Transactions on Mechatronics, 2017-present; Editorial Board, Frontiers of Mechanical Engineering, 2008-Present; Director, American Automatic Control Council, 2018-present; General Chair, 2021 American Control Conference, New Orleans, LA; Panel member, Research Grant Council, Hong Kong, 2016-present

FACULTY PROFESSIONAL ACTIVITIES

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; Noise-Con 2020 and Inter-Noise 2021 Organizing Committees.

SHIRLEY DYKE
Co-organizer: 2020 Asia-Pacific-Europe Summer School on Smart Structures, 2020 ANCRiSST Conference; Road Infrastructure Reimagined: 2019 Workshop on Intelligent Infrastructure for Road Transportation Editorial Board: Smart Structures and Systems; International J. of Lifecycle Performance Eng.; Journal of Structural Control and Health Monitoring; ACM Transactions on Cyber-Physical Systems

JAMES GIBERT
Symposium Co-Organizer ASME SMASIS 19 (Smart Materials and Adaptive Structures) The Modeling, Dynamics, and Control of Adaptive Systems; Member, ASME Technical Committee on Modeling, Dynamics, and Control of Adaptive Systems (2013-); Member, ASME, Adaptive Structures and Material System (2013-); ASME Technical Committee on Vibration and Sound TCVS, Student Paper Competition Committee (2018-)

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; Fellow American Council on Education; Regional Editor for the Americas of International Journal of Refrigeration; President of Section B Refrigeration and Thermodynamics; Member of USNC/IIR (U.S. Nat'l Committee of the Int'l Institute of Refrigeration); ASME, ASEE, and DKV (German Society of Refrigeration and Climate Technology); General Conference Chair of 25th Int'l Compressor Engineering Conf. at Purdue, 18th Int'l Refrigeration and Air Conditioning Conf. at Purdue, and 6th Int'l High Performance Buildings Conf. at Purdue, July 11-14, 2020.

TRAVIS HORTON
Paper Reviewer for: International Journal of Refrigeration, Applied Energy, Energy, ASHRAE, and Renewable Energy; TG1.Optimization Committee, 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; Organizing committee of the 4th Intelligent Building Operations workshop, July 2018

KAI MING LI
Fellow: Acoustical Society of America and Institution of Mechanical Engineers (UK); Editor in-Chief: Applied Acoustics; Associate Editor: Journal 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"

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FACULTY PROFESSIONAL ACTIVITIES

YANGFAN LIU
Editorial Assistant for Applied Acoustics; Reviewer for Journal of Acoustical Society of America, Applied Acoustics, Noise Control Engineering Journal, Journal of Sound and Vibration, Mechanical Systems and Signal Processing, ASME Journal of Fluids Engineering, ASME Journal of Vibration and Acoustics; Serve as Chairs/Organizers for Academic Conferences: Noise-Con 2019 (Aug. 2019, San Diego, USA, Active Noise Control Session), Inter-Noise 2019 (Jun. 2019, Madrid, Spain, Active Noise Control Session) Inter-Noise 2018 (Aug, 2018, Chicago, USA, 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, 2013-2019, Member: ASME International Design Engineering Division Technical Committee on Sound and Vibration, 2010-Present (Vice-Chair 2018-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; Associate Editor for ASME Journal of Vibration and Acoustics, EMI Technical Committee on Architected Materials

GREGORY SHAVER
Member: ASME, SAE

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

DAVIDE ZIVIANI
Member: ASHRAE; Research Chair: ASHRAE TC 8.1 "Positive Displacement Compressors"; Vice-Chair: ASHRAE TC 8.3 "Absorption and Heat Operated Machines"; Member: ASHRAE TC 8.11 "Unitary and Room Air-Conditioners and Heat Pumps"; Member: ASHRAE TC 1.3 "Heat Transfer and Fluid Flow"; Editorial Committee Member and Board Member (January, 2020): Knowledge Center for Organic Rankine Cycles (KCORC) Foundation; International Institute of Refrigeration (IIR): Member of Commission B2 "Refrigerating equipment"

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L A B O R A T O R I E S

2018-2019 RESEARCH EXPENDITURES

Shown below is the distribution of research expenditures from July 1987 - June 2019.
Total Herrick Laboratories Research Expenditures **2018-2019:** $8,199,045 **2017-2018:** $7,860,581

Legend: GOV&DOD | IND | IND/VS | OTHER | PURDUE | Gov* | PCSI

$Millions

MONTH ENDING JUNE 30TH OF THE YEAR SHOWN

EXPENDITURES 2017-2018
- PURDUE 15%
- OTHER 4%
- IND/VS 12%
- IND 21%
- GOV&DOD 49%

EXPENDITURES 2018-2019
- PURDUE 12%
- OTHER 7%
- IND/VS 6%
- IND 23%
- GOV&DOD 52%
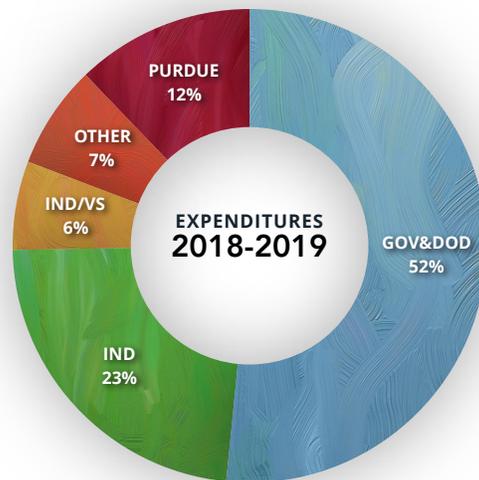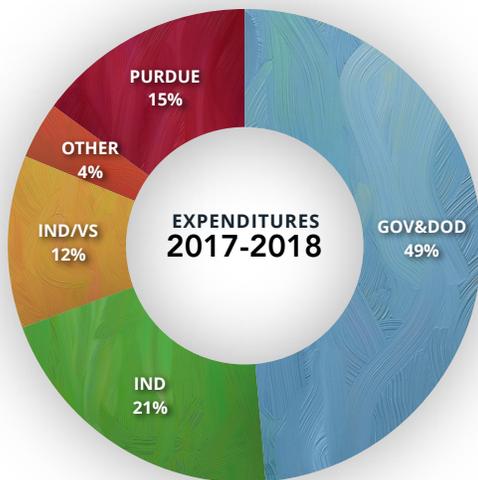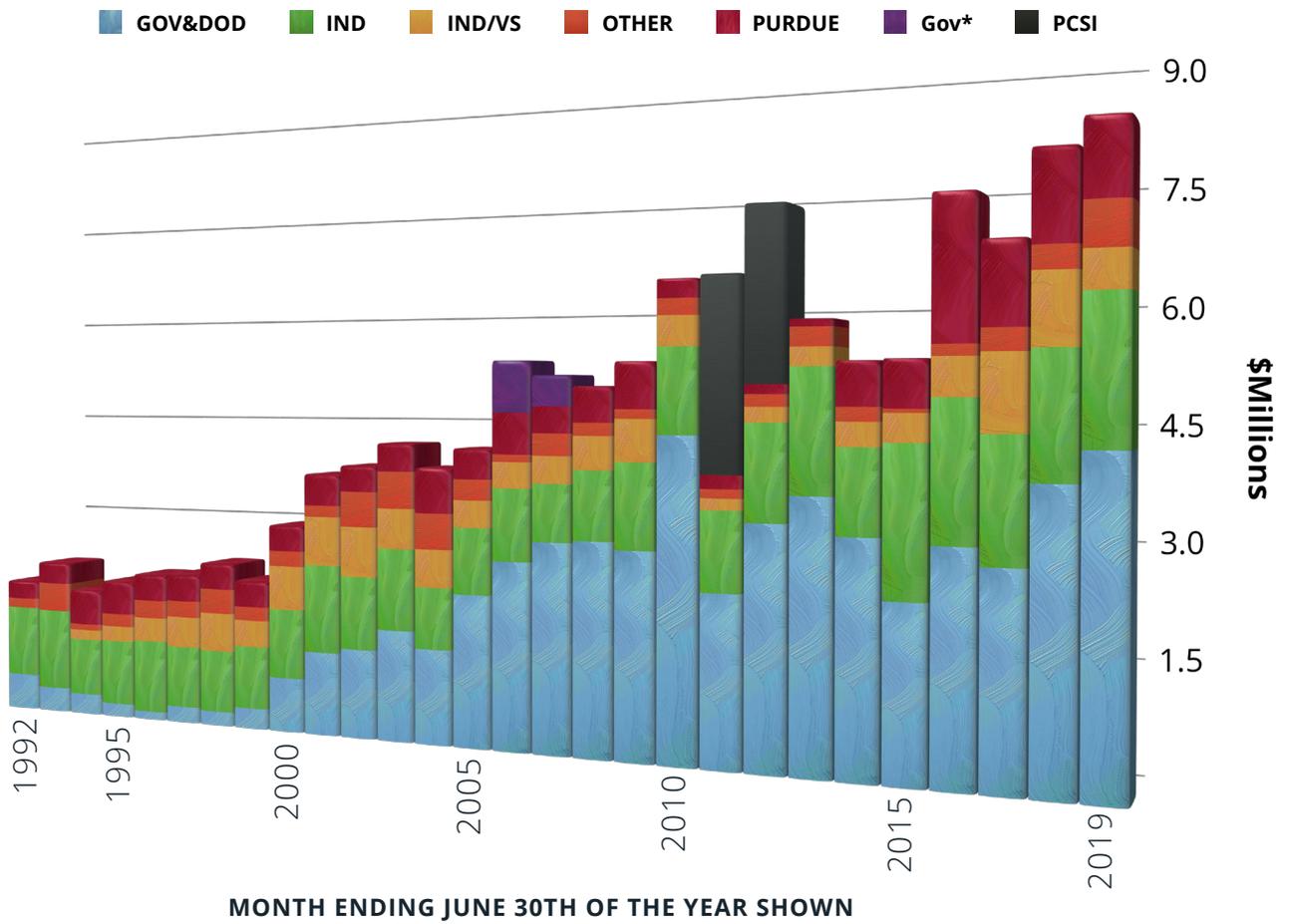
RAY W. HERRICK
LABORATORIES

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.
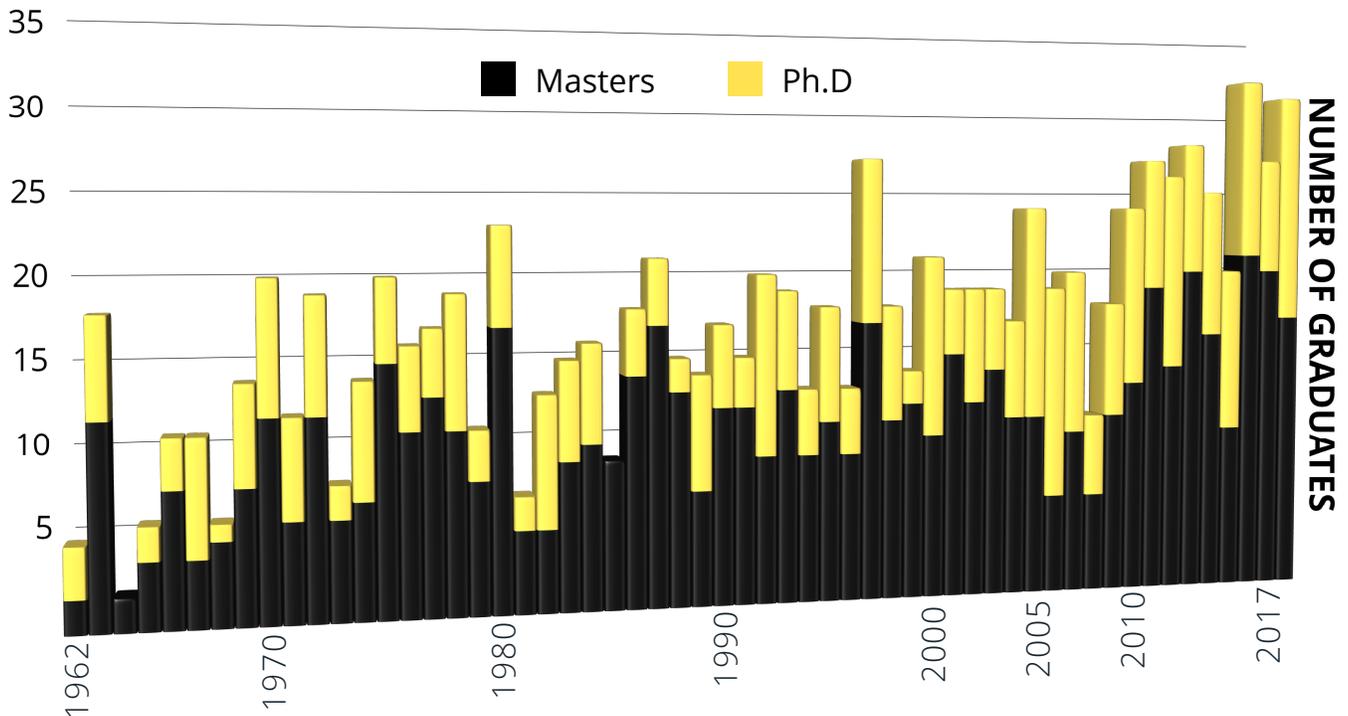
FELLOWSHIPS
Kumar Akash: Bilsland Dissertation Fellowship
Andrew Hagen: Grant Arrasmith Fellowship
Tyler Swedes: Arrasmith Fellowship
Yutong Xue: Ward A. Lambert Teaching Fellowship

GRANTS-IN-AID
Jonathan Ore: ASHRAE Grad Student Grant-in-Aid Award and the Life Member Club Grant Recipient

AWARDS
Trevor Bird: 2019 DSCC Energy Systems Best Paper Award
Sansit Patnaik: 1st place in TCVS Student Paper Competition at ASME-IDETC 2019.
Xinye Zhang: 1st place in the Best Student Paper Competition at the 11th International Conference on Compressors and their Systems (2019)
Yongjie Zhuang: Student Paper Competition Winner at NOISE-CON 2019

CURRENT HERRICK LAB STUDENTS

NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Agarwal, Ankit	Ph.D.	Gonzalez	Microstructure Evolution and Mechanical Properties of Energetic Composites Under Cyclic Loading and Time Recovery
Agnihotri, Shubham	MSME	Shaver	Evaluation of HEV implantation in a class 8 truck
Akash, Kumar	Ph.D.	Jain	Reimagining Human-Machine Interactions Through Trust-Based Feedback
An, Ze	MSME	Cappelleri	Agricultural Robotics
Andress, Stephanie (Stevie)	MSME	Rhoads	Additive Manufacturing of Energetic Materials
Ashta, Shubham	Ph.D.	Shaver	High efficiency class 8 truck platooning via connectivity-enabled control systems
Barta, Riley	Ph.D.	Groll	Multi-Stage Two-Evaporator Transcritical CO_2 Refrigeration Cycle Test Skid
Bird, Trevor	Ph.D.	Jain	Dynamic Modeling, Control, and Optimization of Micro-CHP Systems
Black, Brady	MSME	Shaver	Using a Cummins X15 to Validate Simulation Fuel Consumption Predictions
Boston*, (Matt) David Matthew	Ph.D.	Arrieta	Design and Manufacturing of a Multi-Stable Selectively Stiff Morphing Section Demonstrator
Brendel, Leon	Ph.D.	Groll	Refrigerator for Space Applications
Browne, Florian (Rian)	Ph.D.	Jain	Iterative Learning Control for Time-Delayed and Time-Varying Systems
Carr*, Daniel	Ph.D.	Davies	Perception of Time-Varying Wind Noise in Vehicles
Chen, Zeshen	Ph.D.	Yao	Modeling and Precise Manipulation Control of Robotic Devices with Cable-Pulley Transmissions
Cheng*, Li	Ph.D.	Horton	Low-Cost and Standardized Thermostat Testing Apparatus Used in Load-Based Testing
Choi, Jongseong (Brad)	Ph.D.	Dyke	Active Citizen Science for Lifecycle Assessment
Choi, Won Hong	Ph.D.	Bolton	A Laboratory Procedure for Measuring the Dispersion Characteristics of Loaded Tires
Chowdhury, Arindam Bhanja	Ph.D.	Cappelleri	Deep Learning for Robotics Applications
Coleman, Nadia	MSME	Cappelleri	Robotic Swarm Control
Cummock, Nick	Ph.D.	Son/Rhoads	Shock Sensitivity of Explosives in Response to Dynamic Insult

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NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Damle, Nishad	MSME	Groll	High-Temperature Organic Rankine Cycle for Waste Heat Recovery Applications
Deng, Zhipeng (Steven)	Ph.D.	Chen, Y.	HVAC Control System for Multi-Occupant Offices by Using Occupants' Physiological Signals from Wristband
Desai, Akash	Ph.D.	Shaver/Meckl	ARPA-E NEXTCAR
Deshmukh, Vrushali	MSME	Shaver	Emission Performance optimization with biodiesel blends
Dhamankar, Shveta	Ph.D.	Shaver	Autonomous Systems Development Tools
Dhillon, Parveen	MSME	Braun	Load-Based Testing to Characterize the Performance of RTUs with Integrated Economizers
Ding, Wei	Ph.D.	Semperlotti	Fractional Order Models for Metamaterial Analysis
Droege, Miles	MSME	Shaver	High Efficiency Class 8 Truck Operation Via Connectivity-Enabled Control Systems
Emegoakor, Chisom	MSME	Shaver	Improving Diesel Engine and After-Treatment System Fuel Efficiency and Emissions Through Implementation and Control of Variable Valve Actuation(VVA)and Cylinder Deactivation (CDA)
Feng, Jianxiong	Ph.D.	Li	Prototype Development for NVH Testing of Planetary Gear Set Sub-Assembly
Fleck*, Trevor	Ph.D.	Rhoads	Mechanical Characterization of Additively Manufactured Al/PVDF Reactive Structures
Foster, John	MSME	Shaver	Natural Gas VVA Test Cell
Ganne, Rajakumar	MSME	Meckl	Control of UREA Dosing in SCR System
Gohil, Karan Nitinkumar	MSME	Jain	Reduced-Order Modeling of Thermal Energy Storage Modules
Guerrero de la Peña, Ana	Ph.D.	Jain	Powering What's Next in Freight Transportation
Hagen, Andrew	MSME	Rhoads	Acoustic Properties of Energetic Materials
Ham, Sang Woo	Ph.D.	Karava	Online Building Energy Model to Evaluate Heating and Cooling-Related Behavior Changes for Eco-Feedback in a Multifamily Residential Building
Hao*, Haitian	Ph.D.	Semperlotti	Thermoacoustics of Solids
Hao, Kairui	MSME	Kim, D.	CHPB
He, Dazhuang	MSME	Chen, J.	Theoretical Analysis of the Noise and Vibration Generated by Gas Pressure Pulsation in Hermetic Compressors

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NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Hollkamp, John	Ph.D.	Semperlotti	Applying Fractional-Order Operators to Ducts with Acoustic Black Hole Terminations
Huang, Chunxu	MSME	Boor	HVAC Filtration
Hung, Yu-Wei	Ph.D.	Horton	Efficient Mapping Method for Energy Recovery Wheel Simulation
Hwang, Myungwon	Ph.D.	Arrieta	Input-Independent Frequency Responses through Transition Waves in Bistable Lattices
Jain*, Kaushal K.	Ph.D.	Meckl	Modeling, Estimation, and Control for Urea-SCR
Jiang, Chufan	Ph.D.	Shaver	Autonomous System Tools
Jiang, Jinglin	MSME	Boor	Purdue AirSense-Indoor Aerosol Research
Jokar, Mehdi	Ph.D.	Semperlotti	Holographic Damage Detection
Joodaky, Amin	Ph.D.	Gibert	Measurement and Reproduction of Truck 6-DOF Motions in Package Transportation
Joshi*, Mrunal C.	Ph.D.	Shaver	Sensor Selection Frameworks for High BMEP Gasoline Engines
Kim, Huijeong	Ph.D.	Karava	User-Centric Eco-Feedback Design for Multi-Family Residential Buildings
Kim, Junyoung	Ph.D.	Braun	Optimization of Chemical Looping Heat Pumps
Kim, Michael	Ph.D.	Tzempelikos	A New Daylighting Control Framework Based on Low-Cost Camera Sensor Via Luminance Acquisition
Koranne, Vishvesh Sunil	MSME	Gibert	Nonlinear Vibrations in Web-Like String Networks
Krane, Patrick	Ph.D.	Jain/Marconnet	Packaged Propane Heat Pumps with Secondary Loops and Variable-Temperature Metal-Hydride Energy Storage
Kuo, Ting-Chun	MSME	Karava	Cybersees-Human-Centered Systems to Enable Sustainable Buildings
Kwarteng, Vanessa	Ph.D.	Karava/Bilionis	Modeling of Low-Income Occupants Energy Decisions
Lee, Kyeongsuk	Ph.D.	Karava	Smart User-Interactive Systems for Optimal Indoor Environment and HVAC Contorl of Commercial Buildings
Lee, Seungjae	Ph.D.	Tzempelikos	Smart and Less Intrusive User-Interface for Self-Tuned HVAC Systems
Lenjani, Ali	Ph.D.	Dyke	Thermal Management Case Study (Reference Implementation)

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NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Lepak, Wesaam	MSME	Davies/Bolton	Localizing Noise Sources Using ASL and WBH
Li, Ang	MSME	Chen, J	Aerodynamic and Aeroacoustic Analysis of a Bladeless Fan
Li, Ruoyi	Ph.D.	Bin Yao	intelligent & High-Performance Control of Industrial Robots
Li, Xuan	MSME	Y. Chen	Artificial Intelligence for Building Controls
Liang, Changkuan (Steven)	Ph.D.	Groll/Braun	Automated Charge Testing
Liu*, Haotian	Ph.D.	Groll	Adhesive Bonding in HVAC&R Applications
Liu, Jiawei	Ph.D.	Bolton	Radiation modes for acoustical analysis
Liu, Ting-Wei	Ph.D.	Semperlotti	Design and testing of topological acoustic metamaterials
Liu, Xiaoqi (Claire)	Ph.D.	Karava	Uncertainty impact on predictive control of buildings
Liu, Xiaoyu	Ph.D.	Dyke	3D Mapping Indoor Locations for Navigation
Liu, Ziping	Ph.D.	Shaver	Autonomous Systems Development Tools
Lu, Zechao	Ph.D.	Chen, Y & J	Aerodynamic Optimization of Next Generation Range Hood
Lumpkin*, Domenique	Ph.D.	Groll	Building Efficacy: An Exploratory Study
Lyle, Dennis	Ph.D.	Gibert	Modeling and Exploiting Ultrasonic Additive Manufacturing for the Development of Metal Matrix Composites
Ma, Jiacheng	MSME	Braun	Dynamic Modeling of Air Conditioners and Heat Pumps
Ma, Jie	Ph.D.	Horton	Automated Compressor Performance Mapping
Mah, Dongjun	Ph.D.	Tzempelikos	Visual Preferences and Controls
Mo, Zhuang	Ph.D.	Bolton	Carbon-Fiber Porous Material Acoustic Modeling
Morris, Jacob	MSME	Rhoads	Thermomechanical Behavior of Explosives at High Frequency
Murray, Allison	Ph.D.	Rhoads	Portable Integrated Microscale Sensors
Nair, Siddharth	MSME	Semperlotti	Acoustic Resonators
Nash, Austin	Ph.D.	Jain	Hierarchical Combined Plant and Control Design (Co-Design) for Thermal-Fluid Systems
Nihiser, Nathan	MSME	Li	Chrysler Innovation Project

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NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Ore, Jonathan Paul	Ph.D.	Groll	The DC Microgrid House Phase II: Residential Conversion of AC to DC Power to Promote Energy Efficiency
Patnaik, Sansit	Ph.D.	Semperlotti	Fractional-Order Elastodynamics for Nonlocal Attenuating Media
Peoples, Joseph	Ph.D.	Horton/Ruan	Radioactive Cooling Paints
Petri, Trevor	MSME	Rhoads	Thermomechanics of Energetic Materials
Pyles, Conor	Ph.D.	Rhoads	Chemical Vapor Detection Via Coupled Electromechanical Resonators
Qiu, Weijin	Ph.D.	Shaver	Robust Control of Off-Highway Marine Natural Gas-Fueled Engines
Ramaraj, Sugi	Ph.D.	Braun/Horton	Optimal Operation of a CCHP System
Range*, Allison Rose	Ph.D.	Rhoads	Thermomechanical Behavior of Explosives at High Frequency
Rayasam, Sree Harsha	MSME	Shaver	Natural Gas Engine Controls
Ren, Junyan	MSME	Groll	High-Temperature Organic Rankine Cycle for Waste Heat Recovery Applications
Riley, Katherine	Ph.D.	Arrieta	Programmable structures with spatially distributed mechanical properties
Rivas, Jose	Ph.D.	Arrieta	Selective Compliance for Morphing Structures
Rojas, Salvador	Ph.D.	Arrieta	Compliant Robotics with Simplified Actuation Based on Bioinspired Spring Origami
Ruan, Jianqi (Jack)	Ph.D.	Jain	Castrip Setpoint Determination
Salts, Nick	Ph.D.	Groll	Chiller Experimental Testing Facility
Schuster, Dan	Ph.D.	Horton	Campus Sustainability
Shah, Vatsal Manilal	MSME	Groll	Oil Return and Retention in Unitary Split System Gas Lines with HFC and HFO Refrigerants
Shelly, Tyler	MSME	Groll/Weibel	Electric Vehicle Battery Thermal Management
Shi, Zhu	Ph.D.	Chen, Y	Thermal and Ventilation Performance of a Coupled Displacement Ventilation and Chilled-Beam System
Siefker, Zac	Ph.D.	Rhoads/Braun	Building-Integrated Microscale Sensors for CO_2-Level Monitoring
Song, Guochenhao	MSME	Liu/Davies	Annoyance Due to Noise in Buildings
Soto-Martinez, Daniel Alberto	Ph.D.	Rhoads	Acoustic-Based IED Detection and Defeat
Sung, Weonchan	Ph.D.	Davies	Sound Quality Evaluation of Refrigerated Truck Noise

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NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Swedes, Tyler	MSME	Shaver	Evaluation of Production-Intent Hybrid Electric Class 8 Truck
Tao, Hongcheng	Ph.D.	Gibert	Energy-Harvesting Metamaterials with Embedded Triboelectric Generators
Thakkar, Aman	Ph.D.	Arrieta	Vibrations from Phase Transformations in PCXM Cellular Materials for Energy Harvesting and Damping
Thor, Weimin	MSME	Bolton	Source Identification of a Bladeless Fan by Using SONAH in Cylindrical Coordinates
Udani, Janav Parag	Ph.D.	Arrieta	Dynamic Design of Bi-Stable Oscillators with Synchronized Switching
Wagner, Danielle	Ph.D.	Boor	Occupancy Sensing with Chair-Appended Thermocouples
Walls, Marlon	MSME	Rhoads	Conductive Energetic Material Using Carbon Nanofiller
Wang, Jie	Ph.D.	Chiu	Control of Roll-to-Roll Printing Processes
Wang, Yiming	MSME	Li	Doppler's Effect on Aircraft Noise Propagation
Wu, Puyuan	Ph.D.	J.Chen	Characterization of the Oil Droplet Distribution in Rotary Compressors
Wu, Tianren	Ph.D.	Boor	Indoor Aerosol Research
Xiong, Jie	MSME	Tzempelikos	An Online Visual Preference Elicitation Learning Framework
Xu, Yunpeng	Ph.D.	Yao	High Performance Control of Electro-Hydraulic Systems with Better System Efficiency
Xue, Yutong	Ph.D.	Bolton	Modeling and Design of Multi-Functional Acoustic Materials
Zhang, Xinye	Ph.D.	Groll	Performance Analysis of Natural Gas Compressors for Residential and Commercial Applications
Zhang, Hejia	Ph.D.	Tzempelikos	Satisfying Personalized Thermal Preferences Using New Sensing Network and Localized Air Conditioning Control
Zhang, Qianlong	Ph.D.	Semperlotti	Acoustic Metamaterials
Zhang, Xu	MSME	Shaver	Sensor Selection Frameworks for High BMEP Gasoline Engines
Zhao, Zhidan	Ph.D.	Horton	Development and Application of A Physical-Based Inverse Model for Residential DX Unit
Zhou, Yifei	Ph.D.	Meckl/Shaver	Empirical Engine Modeling
Zhuang, Yongjie	Ph.D.	Liu	Cone Programming Reformulation of Active Noise Control Filter Design

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2018 HERRICK LAB GRADUATES

NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Bahman, Ammar	Ph.D.	Groll, E.	Analysis of Packaged Air Conditioning System for High Temperature Climates
Gosala, Dheeraj	Ph.D.	Shaver, G.	Fuel-Efficient Emissions Reductions From Diesel Engines Via Advanced Gas-Exchange Management
Hahn, Jaesik	Ph.D.	Reid, T.	How Heat Affects Human Hair: Thermal Characterization and Predictive Modeling of Flat Ironing Results
Hjortland, Andrew	Ph.D.	Braun, J.	Automated Fault Detections, Diagnostics, Impact Evaluation, and Service Decision-Making for Direct Expansion Air Conditioners
Hoshing, Vaidehi	Ph.D.	Shaver, G.	Augmented Framework for Economic Viability-Based Powertrain Design and Emissions Analysis of Medium/Heavy-Duty Plug-In Hybrid Electric Vehicles
Inamdar, Harshad	Ph.D.	Groll, E.	Performance of Finned Heat Exchangers After Air-Side Fouling and Cleaning
James, Nelson	Ph.D.	Groll, E.	Investigation of Chemical Looping for High Efficiency Heat Pumping
Jaramillo, Rita	Ph.D.	Braun, J.	A Multi-Agent Control Approach for Optimization of Central Cooling Plants
Joe, Jaewan	Ph.D.	Karava, P.	Agent-Based Approach for System Identification and Optimal Control of High Performance Buildings
Paripovic, Jelena	Ph.D.	Davies, P.	Identification of the Low Frequency Dynamic Behavior of Surrogate Explosive Materials
Ramesh, Aswin	Ph.D.	Shaver, G.	Utilization of Variable Valve Actuation to Improve Fuel Efficiency and Aftertreatment Thermal Management in Diesel Engines
Sadeghi, Amir Seyed	Ph.D.	Karava, P.	Visual Preferences and Human Interactions with Shading and Electric Lighting Systems
Taylor, Alex	Ph.D.	Shaver, G.	Diesel Engine Air Handling Strategies for Fuel Efficient Aftertreatment Thermal Management and Connected and Automated Class 8 Trucks
You, Ruoyu	Ph.D.	Chen, Y.	Investigating Airflow Distribution and Contaminant Transport in Commercial Aircraft Cabins
Angre, Harshil	MSME	Meckl, P.	Control of UREA Dosing for UREA SCR System in a Diesel-Powered Vehicle
Boston, David Matthew	MSME	Arrieta, A.	Demonstrator for Selectively Control Implementation of a Plug-In Hybrid Electric Vehicle

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NAME	DEGREE	PROFESSOR(S)	THESIS SUBJECT
Heitkamp, Caleb	MSME	Rhoads, J.	Experimental Wave and Material Property Measurements for an Elastomer Binder and Particulate Composite Material
Kyle, Trevor	MSME	Rhoads, J.	Synthesis of Inhomogeneous Waves Using the Least-Squares Method
Lavernia, Alejandro	MSME	Groll, E.	Micro-Scale Waste Heat Recovery from Stationary Internal Combustion Engines by Sub-Critical Organic Rankine Cycle Utilizing Scroll Machinery
Odstrcil, Troy	MSME	Shaver, G.	Variable Valve Actuation Strategies for Improving Aftertreatment System Efficiency in Modern Diesel Engines over the Heavy-Duty Federal Test Procedure Certification Cycle
Patil, Akash	MSME	Braun, J.	Development and Evaluation of Automated Virtual Refrigerant Charge Sensor Training Kit
Son, Forrest	MSME	Chiu, G.	Piezoelectric Inkjet Printed Aluminum Bismuth (III) Oxide: The Effects of Printing Parameters on Burning Rate
Sun, Mingyu	MSME	Meckl, P.	Artificial Neural Networks Control Strategy of a Parallel Through-the-Road Plug-In Hybrid Vehicle
Tam, Aaron	MSME	Braun, J.	Optimal Design and Control of Residential Air Conditioning Equipment with Integrated Thermal Storage
Wagner, Danielle	MSME	Boor, B.	Dynamics of Fine and Ultrafine Particulate Matter in Biomass Burrning Kitchens in Western Kenya: Field Sampling Methodology and Modeling Framework
Akash, Kumar	MSME	Jain, N.	Non-thesis: A Closed-Loop Framework for Increasing Trust in Human-Machine Interactions
Chowgule, Revati	MSME	Davies, P.	Non-thesis: Characterization of the Dynamics of CONFOR Foam Undergoing Impulsive Excitation
Hurkat, Yash	MSME	Braun, J.	Non-Thesis: Modelling of the ReNEWW Hosue
Karthikeyan, Ganesh Ram Ramanujam	MSME	Cappelleri, D.	Non-Thesis: Software In-the-Loop Simulation for Custom Aerial Vehicles
Panicker, Malavika	MSME	Meckl, P.	Non-thesis: Control of an Adaptive Refrigeration Cycle
Yedla, Abhilash	MSME	Meckl, P.	Non-Thesis: Supervisory Control Implementation pf a Plug-In Hybrid Electric Vehicle

RAY W. HERRICK
L A B O R A T O R I E S

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 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.

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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 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.
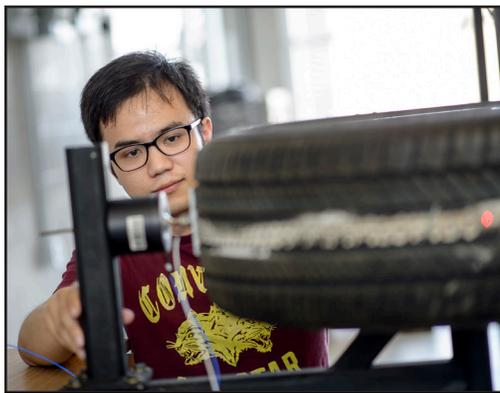
ACOUSTICS, NOISE AND VIBRATION RESEARCH AREA

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.

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.
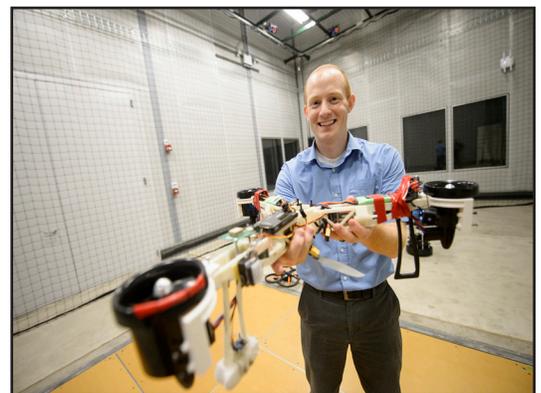
HERRICK LABS TECHNOLOGY TRANSFER ACTIVITIES

2020

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

DEC. 15-17   SAPEM: **S**ymposium on the **A**coustics of **P**oro-**E**lastic **M**aterials

2019

MAY 21-25   Purdue Energetic Materials Summit

2018

JULY 21   Workshop - Real-Time Hubrid Simulation to Enable Multi-Hazard Engineering, Asia-Europe

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
Short Course -The Transition to Flammable Refrigerants
Workshop - 2018 Intelligent Building Operations (IBO)

JUNE 18-22   Short Course - Acoustics and Noise Control

MAY 15-18   Short Course - Advanced Noise Control Technology: Microperforated Materials

2017

DEC 12-13   Workshop - 1st MECHS Workshop: Breaking Barriers & Building Capacity

OCT 23   Short Course - Aeroacoustics

JULY 17-20   Short Course - Signal Processing

MAY 15-19   Short Course - Acoustics and Industrial Noise Control