RAY W. HERRICK LABORATORIES



HOME OF THE CENTER FOR HIGH PERFORMANCE BUILDINGS







Ray W. Herrick Laboratories

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GRADUATES	

2021 - 2022 Herrick **Graduates** 36

RAY W. HERRICK LABORATORIES **AT A GLANCE**

The Ray W. Herrick Laboratories turned 60 years old in 2018. We are part of the School of Mechanical Engineering. 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 faculty in the College of Science, College of Health and Human Sciences, and the Purdue Polytechnic Institute. There are five 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
- 5. Manufacturing and Materials

The educational experience at Herrick combines the traditional training of aspiring researchers with exposure to industrial, governmental, and societal needs. Nearly 900 Masters and Ph.D. candidates have graduated from the Ray W. Herrick Laboratories.

Technology transfer to industry partners and disseminating through peer-reviewed publications, conferences, and short courses is an integral part of a majority of the research programs at Herrick Labs. The researchers 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 creation, 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 in the following research areas: Noise and vibration control, integrated thermal and power systems, and the built 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 new facilities;
- 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; and
- 8. Develop a testing program to support staff and infrastructure.

Ray W. Herrick Laboratories



FY2021 - FY2022 HIGHLIGHTS

RESEARCH - FISCAL YEAR Research Expenditures Proposals Submitted Number of Sponsors	FY2021 \$16,577,687 \$36,859,531 53	FY2022 \$15,992,402 \$32,586,723 72			
			STUDENTS		
			Graduate Student Researchers	163	173
			MS	55	66
Ph.D.	108	107			
Undergraduate Student Researchers	49	100			
Post-Doctoral Researchers	7	13			
STUDENTS GRADUATED					
MS	9	26			
Ph.D. / Post Doc	16	19			
VISITING RESEARCHERS					
Visiting Research Assistants	1	5			

PURDUE DAY OF GIVING

Thanks to the incredible generosity of Purdue alumni, faculty, staff, retirees, students, parents, and friends, the University is positioned to help our students pursue their goals like never before. During the 2022 Day of Giving the University raised a record \$68.2M from over 26,000 gifts!





HERRICK PROGRAMS & DEMOGRAPHICS

The primary educational mission at Herrick is thesis-based graduate programs and studies. We believe that the experiential learning, the open-ended, and integrative nature of thesis-based research is an outstanding preparation for both academic and industrial careers. To complement the student/advisor relationship, Herrick offers 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. There are also opportunities for students to do internships in industry or government laboratories. In total, Herrick provides an outstanding educational opportunity for our graduate students.

MASTERS & PH.D. STUDENTS



6

HERRICK SPONSORS

TOP 5 FEDERAL SPONSORS



TOP 5 INDUSTRIAL SPONSORS





FY2020 - FY2022 RESEARCH EXPENDITURES

Shown below is the distribution of research expenditures for FY2019 - FY2022.





HERRICK STUDENT AWARDS & SUCCESSES

2022 - 2023 RAY W. HERRICK ASSISTANTSHIP

The Ray W. Herrick Assistantship was established by the Herrick Foundation in 1990 to support HVAC&R graduate research. To receive this prestigious award, a student must be doing, or intending to do, thesis-based research on a HVAC&R problem of interest to industry exclusively at the Ray W. Herrick Laboratories. Yidan is pursuing a Ph.D. degree with a research focus on advanced compressor modeling and testing to study complex coupled thermo-acoustic phenomena. Yidan's work encompasses both HVAC&R compressor and NHV (noise, harshness, and vibration) that has a long history and legacy at Herrick Laboratories.



Yidan Cui was selected as the recipient of the 2022 - 2023 Ray W. Herrick Assistantship!

CONFERENCE AWARDS

HERRICK CONFERENCE AWARDS

This July, Purdue students participated in the Student Paper Competition at the 2022 Purdue Conferences. Winners included: **Dongjun Mah**, First Place, Buildings Conference; **Andrew Fix**, Second Place, Refrigeration & Air-Conditioning Conference; **Parveen Dhillon**, Third Place, Refrigeration & Air-Conditioning Conference; and **Abhignan Saravana**, First Place, Compressor Conference.









CONFERENCES

At the Society of Automotive Engineers Noise and Vibration Conference and Exposition, **Zhuang Mo** was awarded 2nd place and **Jianxiong Feng**

received 3rd place. **Sansit Patnaik** received 2nd place in the 2022 Poromechanics Committee Student Paper Competition at the EMI 2022 Conference.







HERRICK STUDENT AWARDS & SUCCESSES

Salvador Rojas and **Katherine Riley** each received a Best Paper Award at the 5th International Conference on Reconfigurable Mechanisms and Robots (ReMAR 2021).

Andrew Fix was selected for the IBUILD Fellowship Program managed by Oak Ridge National Laboratory with the support of U.S. Department of Energy, Building Technologies Office (BTO).

Jiselle Thornby received the Women in Defense Scholar Award. Since 1990, Women In Defense has awarded over \$1,000,000 to more than 200 deserving recipients pursuing education toward a career in national security.

Elias Pergantis was the recipient of the Onassis Foundation Scholarship for his work on smart buildings connected with DC Nanogrid House.

The International Refrigeration and Compressor Course (IRCC) coorganized by Herrick Labs, Purdue University, Technical University Dresden and Oklahoma State University featured several Herrick students. Although international travel was still challenging during Summer 2021, students from Oklahoma State University managed to join the Herrick students for a hybrid experience.

HERRICK RESOURCE COMMITTEE

The Herrick Laboratories Student Resource Committee (HSRC) is a student-run committee that provides Herrick students, faculty, and staff with opportunities for personal and professional growth. The Herrick Student Resource Committee was led by Zachary Siefker and Nikhil Carneiro in 2021 – 2022.

Moving forward, and as we continue our recovery from the pandemic, the focus will center on re-attaining and improving the community aspect in the laboratory's workspace. This will connect with similar efforts across the School of Engineering to ensure students are reintegrating to campus life after the COVID pandemic while promoting a healthy work/life balance. Different social and professional activities such as picnics, outdoor games (sport intramurals, winter activities), and skill-focused seminars will be pursued. Additionally, our community outreach will branch from the typical food drive to include

volunteering at community centers in the Greater Lafayette area. In addition, the HLRSC would like to host monthly technical discussions with industry partners. These efforts will be led by Daniel Soto-Martínez and Reynolds Manion in 2022 – 2023. If you would like to participate, please contact Daniel or Reynolds.















SELECT FACULTY SUCCESS STORIES

Andres Arrieta was featured in a story involving his research of "morphing" wings, which are bi-stable structures to switch a wing's shape and stiffness with a minimum amount of energy. Arrieta specializes in building structures that are bi-stable; like a slap bracelet, they snap backand-forth between two stable states, with very little force required to actuate.



The National Science Foundation (NSF) has awarded **James Gibert** a 5-year \$600,000 CAREER grant, one of their most prestigious awards in support of early-career faculty. "The overall goal of this CAREER project is to investigate the physics, and establish a mathematical foundation, that governs the interplay between topology and nonlinear and time-dependent material behavior in heterogeneous mechanical metamaterials."





BRAUN

The National Science Foundation (NSF) awarded **Neera Jain** a CAREER grant, one of their most prestigious awards in support of early-career faculty. Neera also received Purdue's Violet Haas Award. The award, given out annually by the Butler Center, is named for Violet Haas, an electrical engineering professor from 1962 to 1986, who was instrumental in the early development of the Purdue chapter of the Society of Women Engineers. Neera also received the **Early Career Teaching Award** at the 2022 Faculty and Lecturer Excellence Awards Banquet

A Purdue research team led by **Panagiota Karava**, Jack and Kay Hockema Professor in Civil Engineering, received a grant of nearly \$1 million from the National Science Foundation to develop cyber-physical systems (CPS) aimed at reducing the energy consumption of buildings.







SELECT FACULTY SUCCESS STORIES

Tian Li was awarded with a \$1M, one-year ARPA-E grant under Harnessing Emissions into Structures Taking Inputs from the Atmosphere (HESTIA) program.



Greg Shaver has been elected as a fellow of Society of Automotive Engineers (SAE). The SAE Fellow Membership designation is awarded to an elite group of professionals who have made a significant impact on the mobility industry

through leadership, research, publishing, innovation, and volunteering. Greg was also the recipient of the **Impact on Industry Award** at the 2022 Faculty and Lecturer Excellence Awards Banquet.

Davide Ziviani was awarded the Teaching for Tomorrow Fellowship for 2021-2022. Annually, the award is given to those that demonstrate talent for teaching and their contributions to the University.

A team composed of Professors David Warsinger, **James Braun** and **Davide Ziviani** was awarded \$2M by the U.S. DOE Advanced Manufacturing Office (AMO) to develop a hybrid vapor-selective membrane heat exchanger for efficient passive and active convective drying

FACULTY PROMOTIONS

Effective August 2022, the following faculty have received promotions. **Brandon Boor** and **Neera Jain** have been promoted to Associate Professors. **David Cappelleri** and **Travis Horton** have been promoted to Full Professors. Congratulations!



PROFESSORS







CAPPELLERI









HERRICK SUCCESS STORIES

Contract Testing

This past year we executed 6 contract testing agreements at Herrick across 2 disciplines. These agreements are a great opportunity to do small scale testing utilizing our technical staff to impact product development in industry.

Here are a few words from Gopal Mathur at Acoustic Meta Materials on the importance of laboratory testing for Acoustic Meta Materials. "Prototyping and testing at AMM are ongoing processes where the designers/ developers seek continuous validation from standard testing process. Testing is the single most effective way of knowing how a product will perform in the market before it performs. Prototype testing of our futuristic designs/products at Herrick laboratories, Purdue University has provided us with the valuable asset of a standard laboratory setting with dependable instrumentation and technical support. It has helped us validate our engineering tools/methods and projects and to select the best performing design. Testing has allowed us far more quantitative decision-making that also hastens the discovery of what works and what doesn't. The ultimate goal of experimental testing of pre-production prototypes is that it contributes towards the validation of our futuristic designs, which can then be marketed to generate revenue for the company."

Herrick Conferences

The 50th Anniversary of the Herrick Conferences was held July 11 - 14, 2022. This marked the first in-person conference since 2018. 352 papers were presented to more than 650 attendees from over 30 countries.

The first International Compressor Conference was held at Purdue in 1972. This year we were joined by several special guests including Johney Green from NREL, Johnson Space Center Director Vanessa Wyche and XM Radio Founder Gary Parsons.

The 2024 Conferences will be held July 15 - 18, 2024.







HERRICK SUCCESS STORIES

NASA Visit

Vanessa E. Wyche, the director of NASA's Johnson Space Center was the keynote speaker for the 2022 Herrick Conferences. Director Wyche spent time at the Ray W. Herrick Laboratories learning about ReTHi and other incredible work happening around the labs.





U.S. administrator for nuclear security and Purdue University alumna Jill Hruby (ME, '81), received an honorary doctorate from the College of Engineering on May 13, 2022 at the university's spring commencement.

Jennifer Rumsey

Ray W. Herrick would like to congratulate ME Alum, and friend of the laboratories, Jennifer Rumsey for her promotion to CEO of Cummins, effective August 1, 2022. Cummins has deep roots in research at Herrick Laboratories.

Industrial Advisory Committee

The Industrial Advisory Committee (IAC) has continued to be a integral part of a successful relationship with industry and the labs. The IAC has increased their presence by changing the format to two annual meetings. The spring meeting is a business review while the fall maintains a focus on student projects. A special thank you to our 2021-2022 IAC Members:

Marcus Bianchi, NREL	Carl Johnson, Retired
Dan Conrad, Hussmann Corp.	Brian Joyal, Veridiam
Robert Comparin, Emerson	Christopher Kafura, Carrier
Jon Douglas, Johnson Controls	Jason LeRoy, Trane Technologies
Kirk Drees, The Drees Group, LLC	Mary Lombardo, Collins Aerospace
David Florkiewicz, Ford	Terry Manon, Retired
Daniel Fotsch, Rolls-Royce Corporation	Mike Moaveni, Detroit Edison Company
Joseph Gahimer, Cummins	John Nalevanko, Ford
John Galbraith, Daikin Applied Americas	Robert Parrin, Bobkat Partners, LLC
Paul Gloeckner, Cummins	Steve Sorenson, Toyota Technical Center
John Grace, Retired	Brad Till, Boeing Commercial Airplanes
Nishi Gupta, Change Logic	Don Ufford, NIST
Neal Herring, Raytheon Technologies	Fred Vance, Aero Technolgies

Welcome to our new 2022-2023 members: Rudy Chervil (Daikin), Danan Dou (John Deere), Doug Hansel (Allison Transmission), Jim McCarthy (Eaton), and Kevin Mercer (Rheem).



NEW HERRICK FACULTY

STARTING AUGUST 2022

KEVIN KIRCHER

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING

BIO: Kevin works on control, optimization, and machine learning methods for energy systems in buildings, focusing on their interactions with the power grid. He is particularly interested in new technologies for efficient electric heating. Kevin likes to validate methods through field experiments, often in collaboration with campus building operators.

EDUCATION

- Postdoctoral Associate in Electrical Engineering and Computer Science, Massachusetts Institute of Technology
- Ph.D. in Mechanical Engineering, Cornell University, '19
- MS in Mechanical Engineering, Cornell University, '16
- MEng in Engineering Physics, Cornell University, '09
- BS in Applied Mathematics and Physics, University of Wisconsin-Milwaukee, '08



STARTING AUGUST 2023

RILEY BARTA

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING

BIO: Riley Barta currently is the Refrigeration Team Leader and Alexander von Humboldt Research Fellow at the Bitzer Chair of Refrigeration, Cryogenics and Compressor Technology at the Technical University of Dresden. He will join the Herrick faculty in August 2023. His research team conducts experimental and numerical research on vapor compression systems for a broad range of applications, waste heat utilization, refrigerant mixtures and behavior with lubricants, and aircraft fuel cell thermal management.

EDUCATION

- Ph.D. in Mechanical Engineering, Purdue University, '20
- MS in Mechanical Engineering, Purdue University, '16





HERRICK FACULTY RETIREMENTS

The 2021-2022 academic year saw the retirement of two long-time Herrick faculty. We are forever grateful for their contribution and impact they made to the Labs, Industry, and the Purdue community. We wish them the best in their retirements.



QINGYAN (YAN) CHEN

JAMES G. DWYER PROFESSOR OF MECHANICAL ENGINEERING PH.D., DELFT UNIVERSITY OF TECHNOLOGY, '88

RESEARCH INTERESTS:

Indoor and outdoor airflow modeling by computational fluid dynamics (CFD) and measurements

- Building ventilation systems - Indoor air quality (IAQ) - Energy analysis



KAI MING LI

PROFESSOR OF MECHANICAL ENGINEERING PH.D., UNIVERSITY OF CAMBRIDGE, '87

RESEARCH INTERESTS:

Computational acoustics • Physical acoustics • Control of environmental noise • Outdoor sound propagation • Prediction and abatement of transportation noise • Speech intelligibility in built environments



WERNER SOEDEL, 1936 - 2022

Werner Soedel, who served as a Professor of mechanical engineering at Purdue for 41 years, passed away. Dr. Soedel was born in 1936 in Prague, Czechoslovakia, to Hermann Soedel and Gertrud Fritsche Soedel. In 1967, Purdue University appointed Dr. Soedel Assistant Professor of Mechanical Engineering. In 1971 and 1975 he was promoted to Associate and Full Professor of Mechanical Engineering, respectively. Later, in 2002, he was named the Herrick Professor of Engineering Chair. He served as chairman of the Mechanics Area Committee of the School of Mechanical Engineering from 1983 until his retirement in 2008.

Dr. Soedel's interests in teaching and research were in Mechanics, particularly the vibrations of solids, liquids and gases. This included structural vibrations and acoustics. His research extended to mathematical modeling and computer simulation of machinery dynamics. He was also very interested in the history of Mechanics. Dr. Soedel was author or co-author of 234 publications in scientific journals and conference proceedings. He received the Purdue Mechanical Engineering Solberg Teaching Award twice, in 1972 and 1976. He also received the Ruth and Joel Spira Award in 1978. In 1986, he was awarded the National Ralph Coates Roe Award for Teaching and Research by the American Society of Engineering Education. Dr. Soedel served on the Editorial Board of the Journal of Sound and Vibration, published in England, and was the American Editor of this journal from 1989 until 2008. He was named an Outstanding Mechanical Engineer by Purdue in 2013.











IN REMEMBRANCE

LILA COHEN, 1925 - 2021

Lila Cohen, wife of former Herrick Director Ray Cohen, passed away this past December. Born on October 31, 1925, Lila loved entertaining in her gracious home. As her final legacy, she published a cookbook, "From My Kitchen To Yours", in November 2021, with all proceeds benefiting The Caring Place, in Valparaiso, Indiana. Lila was also a lifelong volunteer and activist for causes that enrich the lives of community, women and children.

Those wishing to honor Lila's memory are encouraged to donate to The Caring Place, Inc., 607 Bullseye Lake Road, Valparaiso, IN 46383.

https://thecaringplace.harnessapp.com/wv2/donate.





CENTER FOR HIGH PERFORMANCE BUILDINGS (CHPB)

2021 CHPB MEMBERSHIPS & PROJECT FUNDING

During 2020, CHPB featured 15 company members and 10 projects were funded spanning equipment, sensing, and building envelope topics.





2022 PROJECT FUNDING

CHPB has funded 11 projects with 15 different faculty members as PI/Co-PI. In addition, CHPB also seed-funded 4 additional projects through the first two quarters to enable additional research and attract new companies.

2022 MEMBERS





HERRICK CENTER UPDATES

CENTER FOR HIGH PERFORMANCE BUILDINGS

During the last academic year, the CHPB has seen a growth in membership, faculty, research endeavors and educational activities despite the continued challenges caused by the COVID-19 pandemic.

At the beginning of 2021, the CHPB membership included a total of 13 companies with a mix of equipment manufacturers and utilities, which supported 10 regular projects and 2 seed-funded projects. Following the 2021 CHPB Spring meeting activities, three additional companies, i.e. Honeywell, Rheem and GE Appliances/ Haier, decided to join the center and broaden the membership. As part of the 2021 CHPB Fall meeting (hosted virtually), 11 regular projects were selected along with 4 seed-funded projects. A total of 14 faculty PI/Co-PIs and 25 students were involved in CHPB-related activities.

After 2 years of virtual meetings, the 2022 CHPB Spring meeting was hosted with a hybrid format and welcomed 11 CHPB members in-person and more than 80 members online. During the center meeting, faculty pitched 8 new concept proposals that will be evaluated during the 2022 CHPB Fall meeting, which is planned on October 19-20 followed by the Herrick IAC. During Spring 2022, a Center Leadership Council was formed to coordinate research and educational efforts with other centers such as CEEE at the University of Maryland, ACRC at the University of Urbana-Champaign, and CIBS at Oklahoma State University.

In Spring 2022, CHPB and Herrick Labs expanded the faculty list by adding two new hires in the area of Smart Building Systems: Kevin Kircher (starting date August, 2022) and Riley Barta (former Herrick PhD student, starting date August, 2023).

Since 2021, the CHPB has expanded efforts in promoting/supporting undergraduate research and educational activities. Notably, Profs. Horton, Qu and Ziviani were selected as faculty members as part of the "jump into STEM" program supported by the U.S. DOE BTO, and three national labs (ORNL, NREL and PNNL).

HERRICK CENTER UPDATES

RESILIENT EXTRA-TERRESTRIAL HABITAT INSTITUTE

After two years of virtual meetings, the RETH institute held their annual review in-person on June 13-14, 2022. NASA and industry visitors viewed demonstrations of the robotic modular end-effector system and of the cyber-physical space habitat testbed (CPT), both being developed at Herrick Labs. The CPT, currently being designed and assembled, aims to couple realizable physical habitat subsystems with computer modeled subsystems, where necessary, in order to validate the institute's resilience approach with real-world uncertainties. Vanessa Wyche, director of the Johnson Space Center, also took time to meet with the CPT development team in July while on-site for Herrick Conferences. Learn more on the institute's website (https://www.purdue.edu/rethi/).

On October 13-14, the institute co-hosted an interdisciplinary workshop in San Antonio, Texas to establish a "cross-disciplinary academic, government, and industry community dedicated to identifying, developing, and evaluating applications of advanced technologies to support deep space exploration missions." To learn more (https:// smarthabworkshop.org/).







INTERNET OF THINGS 4 PRECISION AGRICULTURE

IoT4Ag was established on September 1, 2020. In Year 2, the Center has had excellent growth and execution of its programs and activities that deliver on the IoT4Ag strategic plan across the four pillars: convergent research, engineering workforce development, diversity and culture of inclusion, and innovation ecosystem. To-date participants in IoT4Ag Research include: 16 Postdoctoral Associates, 59 Ph.D. students, 17 M.S. students, and 51 undergraduate students.

This June 15-17, 125 IoT4Ag members, including students, REUs, faculty, staff, and advisory board members were able to come together, in-person, at Purdue University for the IoT4Ag Annual Meeting. A "boot camp" organized by and for the students was held in advance on June 14-15. The



guiding principle for the agenda was to hold activities across all four ERC pillars that could only be done in-person. The IoT4Ag team members were able to tour Purdue's campus and impressive facilities, featuring those at the Herrick Laboratories.



HERRICK CENTER UPDATES

PURDUE ENERGETICS RESEARCH CENTER

In August, Purdue and the Army Research Laboratory forged a cooperative agreement focused on the development of new energetic materials, manufacturing processes, and modeling



and diagnostic tools. The 3-year, \$24.7M project is one of the largest research contracts in Purdue history, and will be completed primarily at the Maurice J. Zucrow and Ray W. Herrick Laboratories.

During the summer of 2021, as part of the Advancing Army Modernization Priorities through Collaborative Energetic Materials Research (AAMP-EM) project, Purdue hosted the first summer undergraduate program called AAMP-UP!'21 This program included 25 students from Purdue and other universities during a 10-week student-centered, experiential, research program for undergraduates to help further their academic and professional goals. The program was a tremendous success with year 2 of the program already in the works.







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ANNUAL REPORT supplemental information

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. Three pairs of psychometric chambers: each 7,000 cubic feet, with 5-ton testing capacity and precise temperature and humidity control. Designed to accommodate ASHRAE/ARI test procedures. Sixteen geothermal bores: 300 feet deep, with variable flow rates and numerous temperature sensors. A 90-ton centrifugal chiller and ice storage test facility; computer-controlled compressor load stands; psychometric wind tunnel with dust injection system. 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.

THE LIVING LABORATORY & SUSTAINABLE BUILDINGS

Herrick Laboratories is a living laboratory where the built environment is being studied. It includes a 16 bore geothermal field and plug-andplay heat rejection for experiments in the engines and thermal sciences laboratories. Four, almost-identical $34' \times 37'$ office spaces for humanbuilding interaction and building technology studies; completely customizable temperature, humidity, airflow patterns, and acoustic treatments; reconfigurable indoor lighting, daylighting/shading controls, mechanical cooling and ventilation controls, and more; thermal delivery by ceiling, floor or side walls, including radiant-floor heating and radiantchilled beam cooling; replaceable south-facing building envelopes. The normal temperature range is 65° F to 75° F but this can be extended to 55° F to 85° F. Relative humidity can be varied from 20% to 80%. 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

There are four test cells that 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. The four test cells support 670, 350, 150 and 150 HP engine testing respectively. A hydraulic variable valve actuation system capable of controlling 12 valves, a single cylinder rig for testing piezoelectric valve actuation, and 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 spaces house electro-mechanical systems, additive manufacturing, and vibrations research. This is comprised of two parts: an open 36 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 700 sq. ft. small-scale laboratory includes apparatus for the 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, these facilities 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, laser vibrometers, 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 43 ft. by 28 ft. laboratory houses a TEAM 6 degree-of-freedom shaker, which can be covered when not in use. Lighting, temperature (55° F - 85° F), 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 simulating various types of environments.





ANDRES ARRIETA

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING PH.D., UNIVERSITY OF BRISTOL, UNITED KINGDOM, '10

RESEARCH INTERESTS:

Adaptive structures • Mechanical metamaterials • Robotic materials • Programmable structures • Multistable structures • Structural nonlinearity • Elastic instabilities • Structural dynamics

Nonlinear vibrations



ANIL K. BAJAJ

ALPHA P. JAMISON PROFESSOR OF MECHANICAL ENGINEERING PH.D., UNIVERSITY OF MINNESOTA, '81

RESEARCH INTERESTS:

Modeling of nonlinear systems • Structural dynamics and localization • Flow-induced vibrations • Impacting systems • Bifurcations and chaos



ANTONIO BOBET

EDGAR B. AND HEDWIG M. OLSON PROFESSOR OF CIVIL ENGINEERING PH.D., MASSACHUSETTS INSTITUTE OF TECHNOLOGY, '97

RESEARCH INTERESTS:

Engineering geology - Underground construction - Rock mechanics - Fracture mechanics



J. STUART BOLTON

PROFESSOR OF MECHANICAL ENGINEERING PH.D. SOUTHAMPTON, '84

RESEARCH INTERESTS:

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

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING PH.D., THE UNIVERSITY OF TEXAS AT AUSTIN, '15

RESEARCH INTERESTS:

Indoor air quality (IAQ) • HVAC filtration • Human exposure assessment • Airborne nanoparticles • Bioaerosols (fungi, bacteria, pollen, allergens) • Air quality in occupational workplaces • Particle adhesion & resuspension • Early-life/infant exposures • Combustion aerosols & wood smoke • New particle formation • Urban air pollution • Low-cost air quality monitoring • Health effects of air pollution • Fate & transport of VOCs/SVOCs.



JAMES E. BRAUN

HERRICK PROFESSOR OF ENGINEERING DIRECTOR OF THE CENTER FOR HIGH PERFORMANCE BUILDINGS PH.D., UNIVERSITY OF WISCONSIN, '88

RESEARCH INTERESTS:

Modeling, analysis, and control of thermal systems



DAVID CAPPELLERI

PROFESSOR OF MECHANICAL ENGINEERING PH.D., UNIVERSITY OF PENNSYLVANIA, '08

RESEARCH INTERESTS:

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

ASSISTANT HEAD FOR FACILITIES AND OPERATIONS ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING PH.D., JOHNS HOPKINS UNIVERSITY, '04

RESEARCH INTERESTS:

Experimental fluid dynamics - Development of flow diagnostic techniques - Flow dynamics in stratified environment - Turbulent flow measurements and modeling



GEORGE T. C. CHIU

ASSISTANT DEAN FOR GLOBAL ENGINEERING PROGRAMS PROFESSOR OF MECHANICAL ENGINEERING PH.D., UNIVERSITY OF CALIFORNIA-BERKELEY, '94

RESEARCH INTERESTS:

Dynamic systems and control • Mechatronics • Digital and functional printing and fabrication • Motion and vibration control and perception • Embedded systems and real-time control



REBECCA CIEZ

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING PH.D., CARNEGIE MELLON UNIVERSITY, '18

RESEARCH INTERESTS:

Energy technologies • Economics • Decision-making processes • Decarbonized energy systems





PATRICIA DAVIES

PROFESSOR OF MECHANICAL ENGINEERING PH.D., SOUTHAMPTON, '85

RESEARCH INTERESTS:

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., UNIVERSITY OF NOTRE DAME, '96

RESEARCH INTERESTS:

Structural dynamics and control • Cyber-physical systems • Machine vision • Real-time hybrid simulation • Damage detection and structural condition monitoring • Cyberinfrastructure development



JAMES GIBERT

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING PH.D., CLEMSON UNIVERSITY, '09

RESEARCH INTERESTS:

Vibrations and nonlinear dynamics • Smart material systems • Non-pneumatic tires • Optimization of mechanical systems • Additive manufacturing



MARCIAL GONZALEZ

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING PH.D., CALIFORNIA INSTITUTE OF TECHNOLOGY, '11

RESEARCH INTERESTS:

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 • Particulate products and processes • Continuous manufacturing • Performance of pharmaceutical solid products



ECKHARD A. GROLL

WILLIAM E. AND FLORENCE E. PERRY HEAD OF MECHANICAL ENGINEERING REILLY PROFESSOR OF MECHANICAL ENGINEERING "DOKTOR-INGENIEUR" (DOCTOR OF ENGINEERING), UNIVERSITY OF HANNOVER, '94

RESEARCH INTERESTS:

Thermal sciences as applied to HVAC&R systems and equipment



W. TRAVIS HORTON

PROFESSOR OF CIVIL ENGINEERING PH.D., PURDUE UNIVERSITY, '02

RESEARCH INTERESTS:

Advanced thermal energy conversion systems • Energy utilization in buildings, and the interactions between a building and its environment • Development of advanced, highly integrated, heating, ventilating, air conditioning, and refrigeration systems



MOHAMMAD REZA JAHANSHAHI

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING PH.D., UNIVERSITY OF SOUTHERN CALIFORNIA, '11

RESEARCH INTERESTS:

Autonomous sensing • Data interpretation • Intelligent condition assessment of structures



NEERA JAIN

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING PH.D., UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN, '13

RESEARCH INTERESTS:

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 PROFESSOR OF CIVIL ENGINEERING PH.D., CONCORDIA UNIVERSITY, '08

RESEARCH INTERESTS:

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



KEVIN KIRCHER

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING PH.D., CORNELL UNIVERSITY, '19

RESEARCH INTERESTS:

Control, optimization, and machine learning methods for energy systems in buildings, focusing on their interactions with the power grid • New technologies for efficient electric heating • Validation methods through field experiments • Collaboration with campus building operators.





CHARLES M. KROUSGRILL

150TH ANNIVERSARY PROFESSOR OF MECHANICAL ENGINEERING PH.D., CALIFORNIA INSTITUTE OF TECHNOLOGY, '80

RESEARCH INTERESTS:

Dynamics • Nonlinear vibration of continuous systems • Stability analysis



TIAN LI

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING PH.D. UNIVERSITY OF MARYLAND, '15

RESEARCH INTERESTS:

Naturally nanostructured materials • Energy, water, and wearable technology • Manufacturing



YANGFAN LIU

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING PH.D., PURDUE UNIVERSITY, '16

RESEARCH INTERESTS:

Acoustic Source Modeling and sound field reconstruction • Active noise control • Room acoustics simulation and auralization • Noise control treatments • Human perception of noise



AMIN MAGHAREH

RESEARCH ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING PH.D., PURDUE UNIVERSITY, '17

RESEARCH INTERESTS: Design • High-performance buildings



MONIQUE MCCLAIN

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING PH.D., PURDUE UNIVERSITY

RESEARCH INTERESTS:

Dissimilar material 3D printing • Additive manufacturing of energetic materials • Additive manufacturing of materials for high temperature applications • Quality control in additive manufacturing



PETER H. MECKL

PROFESSOR OF MECHANICAL ENGINEERING PH.D., MASSACHUSETTS INSTITUTE OF TECHNOLOGY, '88

RESEARCH INTERESTS:

Motion and vibration control • Adaptive control • Intelligent control using fuzzy logic and neural networks • Engine and emissions diagnostics • Robotics



MING QU

PROFESSOR OF CIVIL ENGINEERING PH.D., CARNEGIE MELLON UNIVERSITY, '08

RESEARCH INTERESTS:

Solar cooling and heating systems • Building heat transfer • Building energy supply systems • Building controls and operations • Building and building system modeling & simulation • Sustainable building design and analysis • Building system integration dedicated to sustainable and healthy built environments



JULIO A RAMIREZ

KARL H. KETTELHUT PROFESSOR OF CIVIL ENGINEERING NHERI-NCO CENTER DIRECTOR PH.D., UNIVERSITY OF TEXAS AT AUSTIN, '83

RESEARCH INTERESTS:

Structural analysis and design of reinforced and prestressed concrete structures, with emphasis on seismic performance of concrete buildings and infrastructure • Structural models and experimental methods • Design codes for structural concrete



JEFFREY RHOADS

DIRECTOR OF HERRICK LABS AND PROFESSOR OF MECHANICAL ENGINEERING PH.D., MICHIGAN STATE UNIVERSITY, '07

RESEARCH INTERESTS:

Nonlinear dynamics and vibration • Resonant micro/nanosystems • Microscale sensors and actuators • Solid mechanics • Energetic materials • Additive manufacturing



FABIO SEMPERLOTTI

ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING PH.D., THE PENNSYLVANIA STATE UNIVERSITY, '09

RESEARCH INTERESTS:

Structural health monitoring • Wave propagation • Structural dynamics and vibration control • Adaptive structures • Periodic structures and acoustic metamaterials • Energy harvesting • Thermoacoustics





GREGORY M. SHAVER

PROFESSOR OF MECHANICAL ENGINEERING PH.D., STANFORD UNIVERSITY, '05

RESEARCH INTERESTS:

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 CIVIL ENGINEERING PH.D., CONCORDIA UNIVERSITY, '05

RESEARCH INTERESTS:

Design, operation and optimization of high performance buildings • Daylighting, design and control of dynamic facade and shading systems • Indoor environmental (thermal and visual) quality and comfort • Occupant preferences and interaction with building systems • Radiant building systems • Solar energy applications in buildings • Building energy modeling and simulation



BIN YAO

PROFESSOR OF MECHANICAL ENGINEERING PH.D., UNIVERSITY OF CALIFORNIA-BERKELEY, '96

RESEARCH INTERESTS:

Adaptive and robust control • Nonlinear control • Precision control of mechanical systems • Vehicle control • Robotics



DAVIDE ZIVIANI

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING ASSOCIATE DIRECTOR OF THE CENTER FOR HIGH PERFORMANCE BUILDINGS PH.D., GHENT UNIVERSITY (BELGIUM), '17

RESEARCH INTERESTS:

Advanced heat pumping/heat engine technologies and their equipment • Positive displacement compressors and expanders • High performance buildings • Thermal management systems

FACULTY PUBLICATIONS

Recent Herrick faculty publications can be found on the Herrick website.



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2021 - 2022 HERRICK STAFF



ASHLEY ANCIL SAFETY OFFICER



BRIAN BARRETT MARKETING AND COMMUNICATIONS SPECIALIST



DIANE COLLARD RESEARCH SCIENTIST



HEMANTH DEVARAPALLI CHPB RESEARCH SUPPORT ANALYST



AMANDA ELDRIDGE ADMINISTRATIVE ASSISTANT



BRYCE GEESEY RESEARCH ENGINEER



MARALEE HAYWORTH MANAGING DIRECTOR, RAY W. HERRICK LABORATORIES



ERIC HOLLOWAY DIRECTOR, INDUSTRY RESEARCH



KWOK (FRANK) LEE ENGINEERING TECHNICIAN



2021 - 2022 HERRICK STAFF



JOSE LOPEZ ROMERO ENGINEERING TECHNICIAN



LINDSEY MACDONALD WRITER/EDITOR



DEAN SMOLL ENGINEERING TECHNICIAN



RYAN THAYER RESEARCH TECHNICIAN



ALEX VAN ALLEN TECHNICAL SERVICES PROJECT MANAGER



SARAH WILLIAMS ADMINISTRATIVE ASSISTANT



VICKY DEARDRUFF CUSTODIAL SERVICES

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2021 - 2022 HERRICK POST DOC RESEARCH ASSOCIATES



FRANCESCO DANZI POST DOC RESEARCH ASSOCIATE



ZAMZAM GOLMOHAMMADI POST DOC RESEARCH ASSOCIATE



ALANA LUND POST DOC RESEARCH ASSOCIATE



CHUNJIAN PAN POST DOC RESEARCH ASSOCIATE



YIMING WANG POST DOC RESEARCH ASSOCIATE



HONGFEI ZHU POST DOC RESEARCH ASSOCIATE



2021 - 2022 HERRICK LAB GRADUATES



SHUBHAM AGNIHOTRI

DEGREE: M.S., 2021 PROFESSOR: GREGORY M. SHAVER

THESIS: EFFICIENCY IMPROVEMENT ANALYSIS FOR COMMERCIAL VEHICLES BY (I) POWERTRAIN HYBRIDIZATION AND (II) CYLINDER DEACTIVATION FOR NATURAL GAS ENGINES

MICHAEL ANTHONY

DEGREE: M.S., 2022 PROFESSOR: GREGORY M. SHAVER

THESIS: NOVEL THREE-WAY-CATALYST EMISSIONS REDUCTION AND GT-POWER ENGINE MODELING



SAI SWAPNEEL ARANKEDEGREE: M.S., 2021PROFESSOR: TIAN LI

THESIS: CELLULOSE BASED THERMOCHROMIC SMART WINDOW SYSTEM



MEGAN ARMSTRONG

PROFESSORS: JEFFREY RHOADS / STEVEN F. SON

THESIS: NON-THESIS

DEGREE: M.S., 2022



BRENNEN BOWEN

DEGREE: M.S., 2022 PROFESSORS: JEFFREY RHOADS / BRYAN W. BOUDOURIS

THESIS: FIRST STEP TOWARD A RADICAL POLYMER-BASED CONDUCTIVE ENERGETIC MATERIAL



JOHN BREHM

DEGREE: M.S., 2022 PROFESSOR: ECKHARD A. GROLL / DAVIDE ZIVIANI

THESIS: IMPACT OF HIGH-EFFICIENCY AND VARIABLE-SPEED MOTORS ON THE PERFORMANCE OF A RESIDENTIAL SPLIT-SYSTEM HEAT PUMP



LEON BRENDEL

 DEGREE: PH.D., 2021
 PROFESSOR: ECKHARD A. GROLL / JAMES E. BRAUN

 THESIS:
 VAPOR COMPRESSION REFRIGERATION IN MICROGRAVITY

2021 - 2022 HERRICK LAB GRADUATES



NIKHIL CARNEIRO

DEGREE: M.S., 2021

PROFESSOR: JEFFREY RHOADS

THESIS: THE DEVELOPMENT OF CHEMI-SELECTIVE SENSORS TO DETECT VOLATILE ORGANIC COMPOUNDS AND FLAMMABLE REFRIGERANTS



DANIEL CARR

DEGREE: PH.D., 2021 PROFESSOR: PATRICIA DAVIES

THESIS: PERCEPTION OF WIND NOISE IN VEHICLES



WAN KYN CHAN

DEGREE: M.S., 2021

PROFESSOR: ANDRES ARRIETA

THESIS: MECHXELS: LEVERAGING BISTABLE STRUCTURES FOR COLOR CHANGE, CHARACTER, AND IMAGE DISPLAY



ZHIPENG (STEVEN) DENG

DEGREE: PH.D., 2021 PROFESSOR: QINGYAN (YAN) CHEN

THESIS: RECOGNITION OF BUILDING OCCUPANT BEHAVIORS FROM INDOOR ENVIRONMENT PARAMETERS BY DATA MINING APPROACH



VRUSHALI DESHMUKH

DEGREE: M.S., 2021 PROFESSOR: GREGORY M. SHAVER

THESIS: ALTERNATE FUELS FOR ON-ROAD ENGINES AND IMPACT ON REDUCING CARBON FOOTPRINT



MILES DROEGE

DEGREE: M.S., 2021 **PROFESSOR:** GREGORY M. SHAVER

THESIS: HEAVY-DUTY TRUCK PLATOONING ON HILLY TERRAIN: METHODS FOR ASSESSMENT AND IMPROVEMENT



CHISOM EMEGOAKOR

DEGREE: M.S., 2021

THESIS: NON-THESIS

PROFESSOR: GREGORY M. SHAVER





ANDREW HAGEN

DEGREE: M.S., 2021 PROFESSORS: JEFFREY RHOADS / J. STUART BOLTON

THESIS: HIGH-FREQUENCY SOUND ABSORPTION CHARACTERIZATION OF MOCK ENERGETIC MATERIALS



SANG WOO HAM

DEGREE: PH.D., 2021 PROFESSOR: PANAGIOTA KARAVA

THESIS: ENERGY ANALYTICS FOR ECO-FEEDBACK DESIGN IN MULTI-FAMILY RESIDENTIAL BUILDINGS



JOHN HODUL

DEGREE: PH.D., 2022 PROFESSORS: JEFFREY RHOADS / BRYAN W. BOUDOURIS

THESIS: DEVELOPMENT OF SELECTIVELY INTERACTING SOFT MATERIALS FOR GAS SENSOR APPLICATIONS



YU-WEI HUNG

DEGREE: PH.D., 2021 PROFESSOR: TRAVIS HORTON

THESIS: SIMULATION AND OPTIMIZATION OF DESICCANT-BASED WHEEL INTEGRATED HVAC SYSTEMS



MYUNGWON HWANG

DEGREE: M.S., 2021 PROFESSOR: ANDRES ARRIETA

THESIS: NONLINEAR DYNAMICS IN LATTICES OF BISTABLE ELEMENTS



SUYASH JADHAV

DEGREE: M.S., 2021 PROFESSOR: PETER H. MECKL

THESIS: TRANSIENT MODELING OF TURBOCHARGER TURBINE USING PHYSICS AND MACHINE LEARNING TECHNIQUES



CHUFAN JIANG

DEGREE: PH.D., 2022 PROFESSOR: GREGORY M. SHAVER

THESIS: PERCEPTION SYSTEM DEVELOPMENT FOR AUTOMATED COMBINE-TO-CART UN-LOADING DURING HARVEST OF GRAIN CROPS





JUN HO KIM

DEGREE: M.S., 2021

PROFESSOR: BRANDON E. BOOR

THESIS: THE EFFECT OF FACEMASK TYPES ON THE INHALED DEPOSITED DOSE RATE OF PATHOGENIC BIOAEROSOLS IN MEDICAL FACILITIES



MICHAEL KIM

DEGREE: PH.D., 2021 PROFESSOR: ATHANASIOS (THANOS) TZEMPELIKOS

THESIS: LUMINANCE MONITORING AND DAYLIGHTING CONTROL IN BUILDINGS USING LOW-COST CAMERAS



PATRICK KRANE DEGREE: PH.D., 2022

PROFESSORS: NEERA JAIN / AMY M. MARCONNET

THESIS: AN EXAMINATION OF METAL HYDRIDES AND PHASE-CHANGE MATERIALS FOR YEAR-ROUND VARIABLE-TEMPERATURE ENERGY STORAGE IN BUILDING HEATING AND COOLING SYSTEMS



ZILIN LI DEGREE: M.S., 2021

PROFESSOR: NICOLE L. KEY

THESIS: NON-THESIS



ZIPING LIUDEGREE: PH.D., 2021PROFESSORS: GREGORY M. SHAVER / JOHN T. EVANSTHESIS: AUTOMATIC GRAIN UNLOADING FOR CROP HARVEST MACHINE



ALANA LUND

DEGREE: PH.D., 2021 **PROFESSORS:** SHIRLEY J. DYKE / ILIAS BILIONIS

THESIS: BAYESIAN IDENTIFICATION OF NONLINEAR STRUCTURAL SYSTEMS: INNOVATIONS TO ADDRESS PRACTICAL UNCERTAINTY



JOE MESEKE DEGREE: M.S., 2022

PROFESSOR: JEFFREY RHOADS / GEORGE CHIU

THESIS: INTEGRATED ELECTRONIC INTERFACE DESIGN FOR CHEMIRESISTIVE AND RESONANT GAS SENSORS





VANESSA RESTREPO PEREZ

DEGREE: PH.D., 2021 PROFESSORS: ECKHARD A. GROLL / RAMSES MARTINEZ

THESIS: BIOINSPIRED DESIGN AND FABRICATION OF SUSTAINABLE CONSTRUCTION MATERIALS WITH ENHANCED MECHANICAL PERFORMANCE AND SELF-HEALING PROPERTIES



TREVOR PETRI

DEGREE: M.S., 2021 PROFESSOR: JEFFREY RHOADS

THESIS: CHARACTERIZATION OF MOCK PLASTIC-BONDED ENERGETIC MATERIALS UNDER CYCLIC COMPRESSION AT LOW STRAIN RATES



AKSHAY RAO DEGREE: M.S., 2021

PROFESSOR: DAVID WARSINGER

THESIS: UNCOVERING THE EFFICIENCY LIMITS TO OBTAINING WATER: ON EARTH AND BEYOND



SREE HARSHA RAYASAM

DEGREE: PH.D., 2021 PROFESSOR: GREGORY M. SHAVER

THESIS: ROBUST MULTIPLE-INPUT MULTIPLE-OUTPUT CONTROL OF GAS EXCHANGE PROCESSES IN ADVANCED INTERNAL COMBUSTION ENGINES



VATSAL SHAH

DEGREE: PH.D., 2021 PROFESSORS: ECKHARD A. GROLL / JAMES E. BRAUN

THESIS: OIL MANAGEMENT IN SYSTEMS RUNNING VAPOR COMPRESSION CYCLE



ALAN SHEA DEGREE: M.S., 2021 PROFESS THESIS: NON-THESIS

PROFESSOR: WENBIN YU



ZACHARY SIEFKER

DEGREE: PH.D., 2022

PROFESSORS: JEFFREY RHOADS / JAMES E. BRAUN

THESIS: DEVELOPMENT AND EVALUATION OF CARBON DIOXIDE SENSORS FOR BUILDING APPLICATIONS



TYLER SWEDES

DEGREE: M.S., 2021PROFESSOR: GREGORY M. SHAVERTHESIS:ELECTRIFICATION OF DIESEL-BASED POWERTRAINS FOR HEAVY VEHICLES



JAROD THROCKMORTON DEGREE: M.S., 2021 PRO THESIS: NON-THESIS

PROFESSOR: DAVID CAPPELLERI



PRATIK WALIMBE DEGREE: M.S., 2022 THESIS: NON-THESIS

PROFESSOR: NICOLE L. KEY



ZHIYANG WEN DEGREE: M.S., 2021 PROFE

PROFESSOR: J. STUART BOLTON

THESIS: NON-THESIS



DEGREE: M.S., 2021 PROFESSOR: NEERA JAIN

THESIS: COGNITIVE MODELING FOR HUMAN-AUTOMATION INTERACTION: A COMPUTATIONAL MODEL OF HUMAN TRUST AND SELF-CONFIDENCE



SOURABH DEEPAK YADAV

DEGREE: M.S., 2022 **PROFESSOR:** DAVIDE ZIVIANI / JAMES E. BRAUN

THESIS: DEVELOPMENT, DESIGN, AND CONSTRUCTION OF A HUMAN-BUILDING INTERACTIONS LABORATORY

