Ray W. Herrick Laboratories

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Herrick Newsletter

Herrick Laboratories PURDUE UNIVERSITY

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Upcoming Events:

July 10, 2016	Short Courses
July 11-14, 2016	Compressor, Refrigeration & Buildings Conferences
Oct. 26-27, 2016	Center for High Performance Buildings Meetings
Oct. 27-29, 2016	Industrial Advisory Committee Meeting

*Herrick Laboratories Building, 1912**
**From the J.C. Allen Collection, courtesy of Purdue University Libraries, Archives & Special Collections*

New Ray W. Herrick Laboratories Building, opened November 2013

2016 Purdue Conferences, July 11-14

It has been a tradition since 1972 for the Ray W. Herrick Laboratories at Purdue University to sponsor the venue for the opportunity to exchange ideas, information and cutting-edge research in the area of refrigeration technology, compressors, high performance buildings and closely related fields. In today's economy, it is important to maintain your professional contacts and to keep current on the latest research. Thus, plan to join us in July, 2016!

The conferences are hosted by the Purdue Center for High Performance Buildings at the Ray W. Herrick Laboratories. They run from July 11-14 and consist of the 23rd Compressor Engineering Conference; the 16th Refrigeration and Air Conditioning Conference; and the 4th High Performance Buildings Conference. This is an excellent opportunity for practitioners and researchers in industry, government, consulting offices, laboratories and universities to reach an audience of over 800 participants from over 30 countries. It also provides opportunities to present compressor and refrigeration/AC system research results and state-of-the-art technology. The conferences technical sessions run simultaneously enabling attendees to attend sessions of interest from any of the three conferences. Conference registration includes online access to the conference schedule, presented papers and all social networking events. There will be tours of the research facilities available.

The Keynote and Plenary speakers will address current, world-wide issues of interest facing society today. **Viraj Vithoontien** (Program Leader, Montreal Protocol Program, World Bank), will deliver the keynote address on "Climate Action Driving our Future Forward, Key Perspectives on Climate Change and Refrigeration and Air Conditioning Linkages from the World Bank Montreal Protocol Program". The three Plenary Speakers are:

Ian Beausoleil-Morrison (Professor, Faculty of Engineering & Design, Carleton University) will present "Maximizing the Uses of Solar Energy to Radically Reduce the Energy Needs of Housing";

Drusilla Hufford (Environmental Protection Agency) will discuss her work on cutting U.S. production of ozone depleting substances by 99%, alternatives for use in major industrial and consumer sectors, and encouraging responsibile refrigerant management through regulations and in vibrant partnerships with supermarkets and groceries, appliance retailers, equipment manufactureers, States and utilites; and

Gene Fields (VP of Global Compressor Technolgies, Johnson Controls) will speak about "The Past, Present, and Future of Scroll Compresosrs".

The Short Courses and Workshop will be held on July 10. The topics to be discussed are: Oil Management Compressors and their Systems; Final Frontiers in Vapor Compression Cycle Efficiency; and 2016 Intelligent Building Operations Workshop.

More information on the 2016 conferences can be found at engineering.purdue.edu/herrickconf

2016 Purdue Conferences
Compressor Engineering
Refrigeration and Air Conditioning
High Performance Buildings

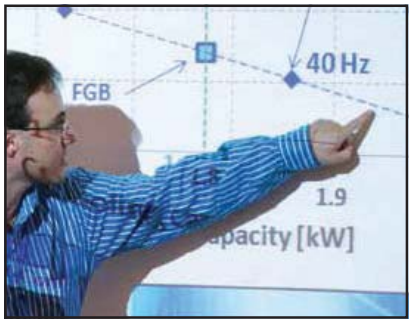
2016 Purdue Conferences (continued)

SHORT COURSE WORKSHOPS • SUNDAY, JULY 10 • 8AM – 5PM • STEWART CENTER

OIL MANAGEMENT IN COMPRESSORS AND THEIR SYSTEMS SHORT COURSE

The short course focuses on oil management in hermetic, positive displacement compressors, such as scroll, rotary and reciprocating compressors, and their systems. It consists of eight 50-minute lectures and will provide ample time for discussion. In particular, the following topics will be part of the short course:

- Impact of lubricants on compressor and system performance and reliability.
- Thermodynamic and transport properties of lubricant and HFC/HFO/CO2/NH3/HC refrigerant mixtures, including miscibility, solubility, and viscosity.
- Impact of oil on heat transfer and pressure drop, and oil retention in heat exchangers.
- Review of components used for oil management in vapor compression systems, such as oil separators, accumulators, and filters.
- Oil management in simple and complex vapor compression systems, including supermarket applications using multiple compressors on a rack, air-source heat pump systems, VRF systems, systems with vapor injection, industrial CO2 and NH3 refrigeration systems.
- Performance of liquid-flooded compression with regeneration systems.



Organizers: *Eckhard A. Groll, W. Travis Horton, and Orkan Kurtulus all of Purdue University*

FINAL FRONTIERS IN VAPOR COMPRESSION CYCLE EFFICIENCY

The efficiency of vapor compression cycles used for refrigeration and comfort cooling/heating has steadily increased since the US Department of Energy initiated minimum efficiency requirements in the early 1980s. Some current offerings have SEER values that are more than double the initial DOE minimum SEER of 10.0. These efficiency improvements have been the result of better compressor designs, larger and more efficient heat exchangers, better expansion devices, and more efficient motor technology. While efficiencies have risen substantially, they are still just a fraction of the theoretical Carnot efficiency.

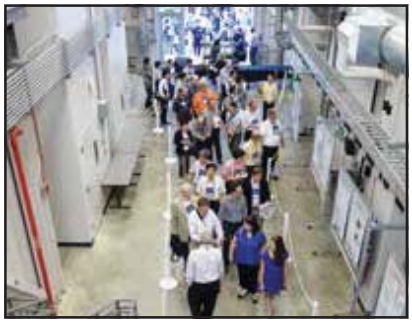
The short course speakers will evaluate the various components of the vapor compression cycle to identify all areas that still offer economic opportunities for even higher system efficiencies. Case studies using optimization methods will show how to "invent" new heat exchanger shapes that go beyond tube-fin and micro-channel designs, as well as overall system optimization while considering system level performance metrics. In addition, an overview will be provided for other thermodynamic cycles that may hold promise to compete with, or even surpass, the traditional vapor compression cycle that is used in the majority of refrigeration or comfort cooling/heating applications.

Organized by: *U. S. National Committee of the IIR, Ray W. Herrick Laboratories*

2016 INTELLIGENT BUILDING OPERATIONS (IBO) WORKSHOP

This will be the third (previously held in 2011 and 2013) in a series of workshops that brings together researchers and developers of intelligent building features and systems. The main goals of this one-day workshop are to

1. Review fundamentals of optimal control and automated diagnostics in intelligent buildings,
2. Understand the state-of-the-art in commercialized intelligent building technologies,
3. Identify existing gaps that should be addressed in future research and development.



The format of the workshop will include a review of relevant fundamentals, followed by brief case studies that highlight recent developments and demonstrations of model-predictive controls and automated diagnostics. Ample time will be allotted for open discussion to address what is necessary to move from research to widespread adoption of intelligent building technologies.

A single registration fee will cover participation in both the IBO Workshop and the 2016 Purdue Conferences. Participants in the IBO Workshop are strongly encouraged to participate in and attend the High Performance Buildings Conference where current research critical for achieving scalable and cost effective intelligent building operations will be presented.

Organizers: *Gregor Henze (University of Colorado), Jim Braun (Purdue University), and Neera Jain (Purdue University)*

2016 Purdue Conferences (continued)

2016 Purdue Conferences
Compressor Engineering
Refrigeration and Air Conditioning
High Performance Buildings

Hosted by
Purdue Center for High Performance Buildings
Ray W. Herrick Laboratories

MONDAY, JULY 11, 2016, 10 A.M. TO THURSDAY, JULY 14, 2016, 5 P.M.

Stewart Center, Purdue University, West Lafayette, Indiana, USA

The conferences technical sessions run simultaneously enabling attendees to attend sessions of interest from any conference. Conference registration includes online access to the conference schedule, presented papers and all social networking events. The conferences will be conducted in English.

REGISTRATION INFORMATION AND IMPORTANT DATES

- Conference Registration will be available online starting in March 1, 2016 at www.conf.purdue.edu/Compressor2016.
- Early Registration ends on May 27, 2016! Rates will increase after this date.
- Students attending receive a special discounted price.
- Bring 5 attendees from any one organization, get the 6th attendee free! See website for details.
- Continuing Education Credits (CEU's) may be available.

2014 STATISTICS

755 ATTENDEES REPRESENTING **31** COUNTRIES
352 PRESENTED PAPERS

KEYNOTE SPEAKERS

Monday Plenary – VIRAJ VITHOONTIEN, *Program Leader, Montreal Protocol Program, World Bank*
Climate Action driving our future forward, key perspectives on Climate Change and Refrigeration and Air Conditioning linkages from the World Bank Montreal Protocol Program

Tuesday Plenary – IAN BEAUSOLEIL-MORRISON, *Carleton University*
Maximizing the use of solar energy to radically reduce the energy needs of housing?

Tuesday All Conference Lunch – MANPREET SINGH, *Purdue University Food Science Department*

Wednesday Plenary – DRUSILLA HUFFORD, *Environmental Protection Agency*

Thursday Plenary – GENE FIELDS, *Johnson Controls*
The Past, Present & Future of Scroll Compressors

SPONSORS

Welcome Reception
Carrier – turn to the experts

Steak BBQ Dinner
EMERSON Climate Technologies

Tuesday All-Conference Luncheon
ENGINEERING TOMORROW
Danfoss

Refreshment Breaks
HIGHLY
KAWNEER AN ALCOA COMPANY
Tecumseh
Parker

Alumni Reflections - Tim Roggenkamp, Ph.D. 1992

In 1987, I was working as a Noise and Vibration Engineer for DELCO Products, div GM in Dayton, Ohio. I was engaged to my wife, Terri, who was in her senior year at Purdue. Terri was studying mechanical engineering and was interested in attending law school. I had told her she should pick a law school, and I would find a job nearby. One evening, Terri told me she wanted to give engineering a try and postpone a decision about law school. Immediately I replied, "Can I get a PhD?" She thought for a moment and said "I have to say yes, don't I?" I was accepted to graduate school at Purdue, and Terri worked for R.R. Donnelley and Sons in Crawfordsville, Indiana.

I learned so much in so many ways while at Herrick; from academic to practical lessons. I was fortunate to work with Prof. Bernhard and Murty Kompella on a project sponsored by The Goodyear Tire & Rubber Co. My primary research challenge was to indirectly determine in-situ broadband spindle forces using the pseudo-inverse of the system Frequency Response Function matrix and in-situ responses. I was given the chance to immerse myself in my research, write proposals for funding, and balance family with work. One special task Murty and I were given was to turn a 16 channel MassComp data acquisition front end into a multi-channel analyzer (no better way to learn Digital Signal Processing). I was fortunate to be surrounded by other mentors including Professors Bolton, Davies and Krousgrill. I also enjoyed the comradery while at the lab. I fondly remember picnics, ultimate Frisbee, softball games, and trying to become proficient at speed chess.

2005 Cumberland Lake Vacation

After graduating in 1992, I took a job at the General Motors Noise and Vibration Center at the Milford Proving Ground in Milford, Michigan. One of my first tasks at GM directly applied my PhD research. Because there was no commercially available software, I wrote Matlab code to implement Transfer Path Analysis using matrix inversion to indirectly identify forces. I have stayed on the technical side at GM, working on many different aspects of automotive noise control. I am currently a GM Technical Fellow working as the Vehicle Performance Owner for the Total Vehicle N&V. My job allows me to work with Global N&V teams tasked with developing future products. Our job is to ensure the N&V performance of our future vehicles meets customer expectations while considering the cost and mass implications.

2013 Hawaii Vacation

Terri and I have been married 27 years and have been blessed with a wonderful family. We have three children: Zach, Luke and Kenzie. Zach, now 23 and a Michigan State University alum, was born while in Indiana four months before I graduated. Zach is working as a chemical engineer for Proctor and Gamble in Iowa City, Iowa. Luke is 20 and a junior at the University of Michigan studying chemical engineering. Kenzie is 18 and a freshman at the University of Michigan studying nursing. Our family enjoys sports, family game nights, vacations, and the holidays when we can all be together.

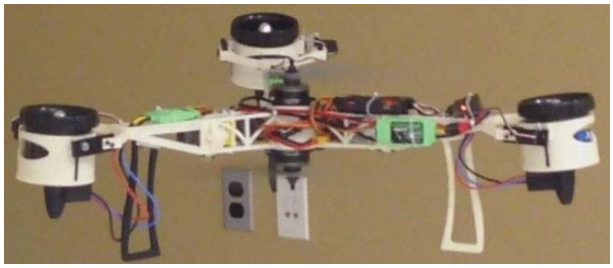
In Oct, 2015, I had the opportunity to attend the Herrick Lab IAC meeting. Being on the other side of the posters brought back many memories. Even though there is a new Herrick Lab building, it was comforting to know that Herrick still provides an innovative and challenging learning environment for so many students. In 24 years, I hope the current students will fondly look back at Herrick and smile as I do.

Multi-Scale Robotics and Automation Laboratory (MSRAL): Mobile Robot Research - Prof. David Cappelleri and Daniel McArthur

The Multi-Scale Robotics and Automation Laboratory (MSRAL) at Purdue is led by Dr. David Cappelleri, Assistant Professor of Mechanical Engineering. At Herrick, the MSRAL has been working on developing robotic platforms with enhanced manipulation capabilities. The MSRAL makes use of a state-of-the-art Vicon motion capture system located in the Perception Based Engineering (PBE) Lab at Herrick, in addition to a workspace in the High-Bay Area for building new robots.

Quadcopter (fitted with reflective spheres for Vicon motion capture system) flying in PBE Lab

In aerial robotics, the MSRAL is interested in the design and control of autonomous micro aerial vehicles (MAVs) with enhanced manipulation capabilities. There are many applications for such MAVs, including: search-and-rescue, security, surveillance, remote sensing, maintenance and agriculture. In order to overcome the limitations of conventional MAVs and realize fully controllable MAVs, the MSRAL is investigating new fully and over-actuated MAV configurations and actuation techniques, and has introduced two new MAV configurations: the Omnicopter, and the BoomCopter.

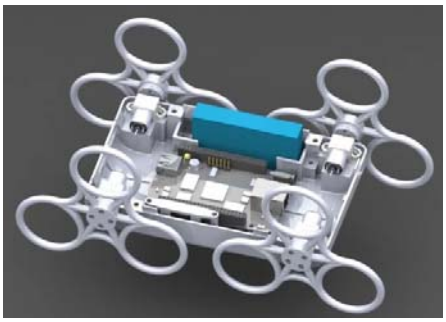


Omnicopter MAV in flight

Different from traditional underactuated MAVs, the Omnicopter employs a tilt-rotor mechanism (composed of three ducted fans and three servo motors) and is over-actuated. The characteristic of over-actuation enables the Omnicopter's position dynamics to be decoupled from its attitude dynamics. This allows the Omnicopter to perform maneuvers that traditional multicopters are unable to perform. Similarly, the BoomCopter, which is based on a standard three-rotor frame, makes use of an additional 3D-printed propeller mechanism (the BoomProp), which rotates around the rear boom. This propeller provides transverse thrust, allowing the BoomCopter to travel at high speeds, or to apply horizontal forces on an object such as a door. These two new MAV configurations show great promise in advancing the field of aerial manipulation research.

BoomCopter MAV fitted with 3D-printed Propeller Mechanism for Transverse Thrust (vehicle radius = 12.5" from center to each motor/ propeller, BoomProp diameter = 13")

On the ground, TurtleBots (from Clearpath Robotics) and the AgBug (an original centimeter scale robot) are being combined with custom and open-source hardware and software to enable collaboration among heterogeneous teams of ground and aerial robots. The software developed in the lab builds on the Robot Operating System (ROS) framework, and allows multiple robots to share information and work together in both indoor and outdoor wireless networks.



CAD rendering of Agbug centimeter scale robot (chassis dimensions: 3.75" wide x 6.5" long, wheel diameter 4.5")

Acknowledgements:
Initial work was performed at Stevens Institute of Technology. These projects have been supported by: The Journey for 9/11 Foundation via CACI, Stevens Institute of Technology, and Purdue University. This material is also based upon work supported by the National Science Foundation Graduate Research Fellowship Program under Grant No. 1333468. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation. Please visit the MSRAL website (http://multiscalerobotics.org) if you would like more information about the lab's current activities.

Multi-Scale Robotics and Automation Lab
Purdue Robotics

Past Herrick Labs Party Pictures - Fun at the Labs

2003

2006

1969

1989

Past Herrick Labs Party Pictures - Fun at the Labs

1983

Ginny Freeman's Retirement Party - 2012

Herrick Group and IAC Members' Photo - 2015

People News

Faculty Honors

Peter Meckl

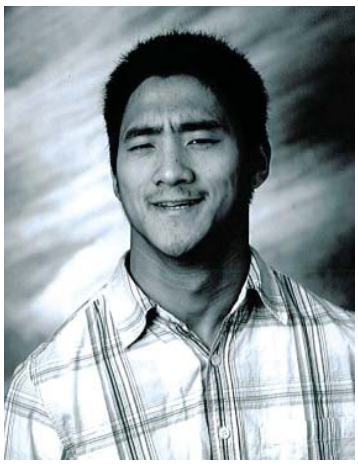
Peter Meckl, Assistant Head and Professor of Mechanical Engineering, received the Undergraduate Advising Award from the College of Engineering on April 8, 2016 for his steadfast commitment as lead faculty advisor to the EcoCAR2 Student Vehicle Competition team. the EcoCAR2 competition provided hands-on, real-world engineering experience through successful design, fabrication and demonstration of advanced automotive technologies. The Purdue EcoCAR2 team, calling themselves the Purdue EcoMakers, managed to place 4th in the final competition out of 15 North American teams. His nomination for the Advising Award was prepared by Professor Greg Shaver.

Staff Awards

Kim Stockment, Herrick Labs'' Conference Coordinator, was recently awarded one of the ME Staff Recognition Awards. She was nominated by Donna Cackley, who wrote: Kim worked in the Conferences Division before coming to Herrick Labs and we have benefitted from all the knowledge she brought with her. She has helped with InDesign, Photoshop, reservations, and assists with main office duties when Donna is out. Kim volunteers to help other Professors (non-Herrick) who are conducting conferences. Much of Kim's training has been self-taught. Kim takes the initiative to learn and use the skills she has acquired. She has become a valued employee and the Labs are lucky to have her.

Kim Stockment

Student Honors & Awards



Yangfan Liu

Yangfan Liu, (Ph.D. student working with Prof. Stuart Bolton) recently received the Purdue Teaching Academy Graduate Teaching Award for 2015-2016. This award honors graduate students with teaching responsibilities for their dedication to Purdue students and their outstanding teaching contributions. Recipients are selected by each academic department for their commitment to undergraduate education. Departments may select one recipient for every 50 graduate teaching assistants they support. The Graduate Teaching Award is sponsored by the Teaching Academy and the Office of the Provost. Here is the link to find a complete list of the 2015-16 recipients: http://www.purdue.edu/cie/documents/CelebrationGraduateTeaching16.pdf.

People News (continued)

Graduations

Carr, Daniel (MSME, 2015), Two Laboratory Studies of People's Responses to Sonic Booms and Other Transient Sounds as Heard Indoors. Daniel is staying to pursue his Ph.D. degree.

Shi, Tongyang, (MSME 2015) Equivalent Source Methods for Noise Source Visualization. Tongyang is staying to pursue his Ph.D. degree.

Wang, Xiaoshen (MSME 2015), Performance Evaluation of Different Valve Control Strategis for Building HVAC Systems. Xiaoshen's employment is not known at this time.

Balasubramanian, Shambhavi (MSME 2016), Fuel Type Estimation Using Fuel System Parameters. Shambhavi is working for Cummins Inc. in Columbus, IN.

Deshpande, Ameya (MSME 2016), Exhaust Temperature Management. Ameya's employment is not known at this time.

Gao, **Mengqi** (MSME 2016), Toner Usage Prediction for Laser Electro-Photographic Printers. Mengqi's employment is not known at this time.

Graban, Allison (MSME 2016), Heat Pump Dryer. Allison is working for Whirlpool Corp. in St. Joseph, MI.

Graham, Todd (MSME 2016), TIRA-Thermally Integrated Residential Appliances. Todd is working for Whirlpool Corp. in St. Joseph, MI.

Kesto, Nathan (MSME 2016) Dryer End-of-Cycle Detection. Nate is working for Whirlpool Corp. in St. Joseph, MI.

Nayyar, Soumya (MSME 2016), Implementation and Analysis of Reverse Breathing, Rebreathing and Cylinder Deactivation for Aftertreatment Thermal Management and Overall Efficiency Benefit on Diesel Engines. Soumya took a position with Cummins Inc. in Columbus, IN.

Births

Liuxian Zhao (Ph.D. student) and wife Siyao welcomed their first child, a son named Ethan on June 2, 2016. He weighed 6 lbs at birth.

Weonchan Sung (Ph.D. student) and his wife Jieun Han welcomed their first child, a son named Joseph Han Sung. His Korean name is Leehan. He was born on March 1, 2016. Joseph weighed 6 lbs. and is 19 inches long.

Daniel McArthur (Ph.D. student) and his wife, Sondra welcomed their third daughter named Kate. she was born on December 8, 2015 weighing 6 lbs 14 oz. and 19.75 inches long. Big sisters Madilyn (4 yrs.) and Emma (2 yrs.) love their baby sister!

Weddings

Jake Miller (Ph.D. student) and Anna-Elodie Kerlo were married on May 13, 2016 in Lafayette, IN. Jake is a Ph.D. student working with Prof. Jeff Rhoads and Anna is a research scientist in the Department of Chemistry.

Jie Cai (Ph.D. 2015, current Post Doc) and Hao Zhang were married March 8, 2016 in Denver, CO. Jie is working part time at NREL in Denver and Hao is a ME Ph.D. student. They will have a ceremony in China at a later date. Congratulations Jie and Hao!

Engagements

Domenique Lumpkin (Ph.D. student) and Sheldon Anderson got engaged on May 26, 2016, in Florence, Italy. No wedding date has been set.

Congratulations to all the couples!

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News about You and Address Changes

We are always interested in hearing your news, like weddings, births, and job promotions, and we want to be kept up-to-date on current addresses. Please send notes to Donna Cackley or to the e-mail address below. Don't hesitate to let us know of other alums that have moved or changed jobs. Photos are always welcomed and encouraged.

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