HERRICK LABORATORIES
PURDUE UNIVERSITY™

Annual Report
2004-2005

Ray W. Herrick Laboratories
School of Mechanical Engineering

The Ray W. Herrick Laboratories

THE RAY W. HERRICK LABORATORIES

The Ray W. Herrick Laboratories were founded in the mid-1950's as a research laboratory for studying the effects of climate control and for the design of improved climate control equipment. The Labs have grown and evolved into a center where graduate education and engineering research are combined in close partnership with industry in order to develop people and results of great importance. The Herrick Labs goal is to sustain a culture of excellence in an environment of partnership and shared resources.

The research programs of the Herrick Labs can be described in four general areas; electro-mechanical systems, noise and vibration control, perception based engineering, and thermal systems. The community at the Herrick Labs, which includes the faculty, staff, students, and sponsors, is focused on results that are both fundamental research discoveries and of practical importance to sponsors.

The educational experience at the Herrick Labs combines the traditional training of aspiring researchers with exposure to industrial needs and culture. Students study in a strong peer education environment with active mentoring from faculty and sponsors. Almost 700 Masters and PhD candidates have graduated from the Herrick Labs.

The engagement/service programs are highlighted by the well established conference and short course activity sponsored by the Herrick Labs. In addition, technology transfer to sponsors is an integral part of a majority of the research programs. The researchers at the Herrick Labs are also widely published across the spectrum of publications from academic journals to the popular press.

MISSION

An institution dedicated to graduate education and engineering research with emphasis on technology transfer to industry.

VISION

To overcome the barriers between knowledge creation, transfer, and utilization and to become leaders of how graduate education and engineering research are done in partnership with industry.

GOALS

1. To build upon the research excellence of the *Noise and Vibration Control Research Area* and the *Heating, Ventilation, Air-Conditioning, and Refrigeration Research Area* and grow the reputations of these areas as the top such research programs in the world.
2. Support the emerging research area of *Electro-Mechanical Systems* to enhance its national and international visibility.
3. To develop a proactive evolutionary strategy for the Laboratories to ensure its long-term stability and growth.
4. To improve the educational environment at the Labs so that its graduate students are multi-functional engineers who rate as the top engineering graduates in the country.
5. To continually monitor the technology transfer process by which research results are transferred to sponsors and the engineering community such that the labs will be recognized as *the* premier source of practical cutting edge research in our areas of expertise.
6. To continually grow the research environment at the Labs for the benefit of the students and faculty at the Labs.

2004-2005 HIGHLIGHTS

Research	*Last year*	*This year*
Research expenditures (academic year)	$3,851,000	$4,017,831
Number of sponsors as of September	48	40
Research assistants as of September	53	57
Archival papers published (calendar year)	34	32
Contracts in force for next academic year (July 1st)	$544,000	$ 630,757
Proposals pending in September (HL share)	$3,181,814	$2,912,064
Proposed funding for Center-Type Activities	$9,106,186	*$11,869,169
*Herrick Share		

Education		
Graduate students as of September	68	74
MS	21	20
Ph.D.	47	54
Students graduated (calendar year)	19	17
MS	14	11
Ph.D.	5	6
Undergraduate/graduate "research experience" students	17	21
Visiting scholars (academic year)	7	7
Summer interns	2	0
Fellowships	10	10
Grant-in-Aid	1	1
Student Paper Awards	3	1

Technology Transfer		
Conferences/Workshops held	3	2
Conferences planned in the next 2 years	3	2
Short Courses	2	2
Herrick Labs reports to sponsors	26	23
Conference and journal papers	87	61

Americas Editor and Americas Editorial Office, **Journal of Sound and Vibration** (Werner Soedel)

Associate Editors of the **International Journal of HVAC&R Research** (Jim Braun)

Advisory Board Member, **International Journal of HVAC&R Research** (Eckhard Groll)

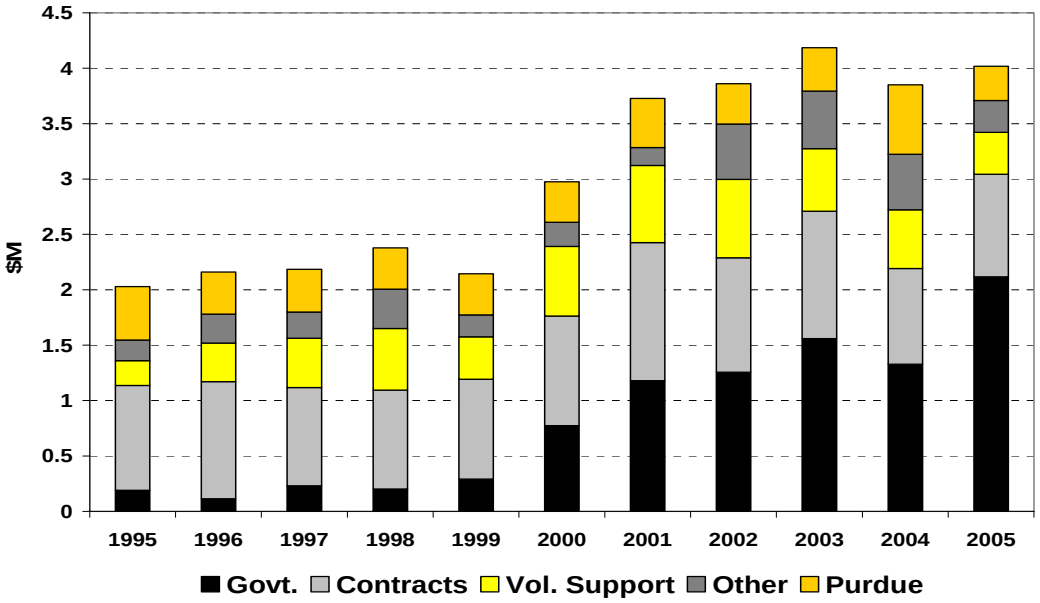
Administrative and Support Staff

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

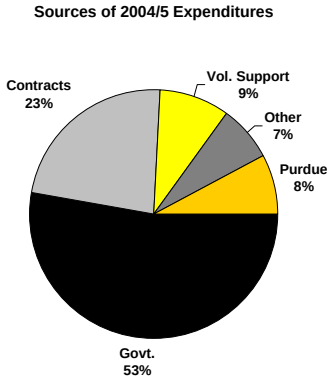
The Ray W. Herrick Laboratories

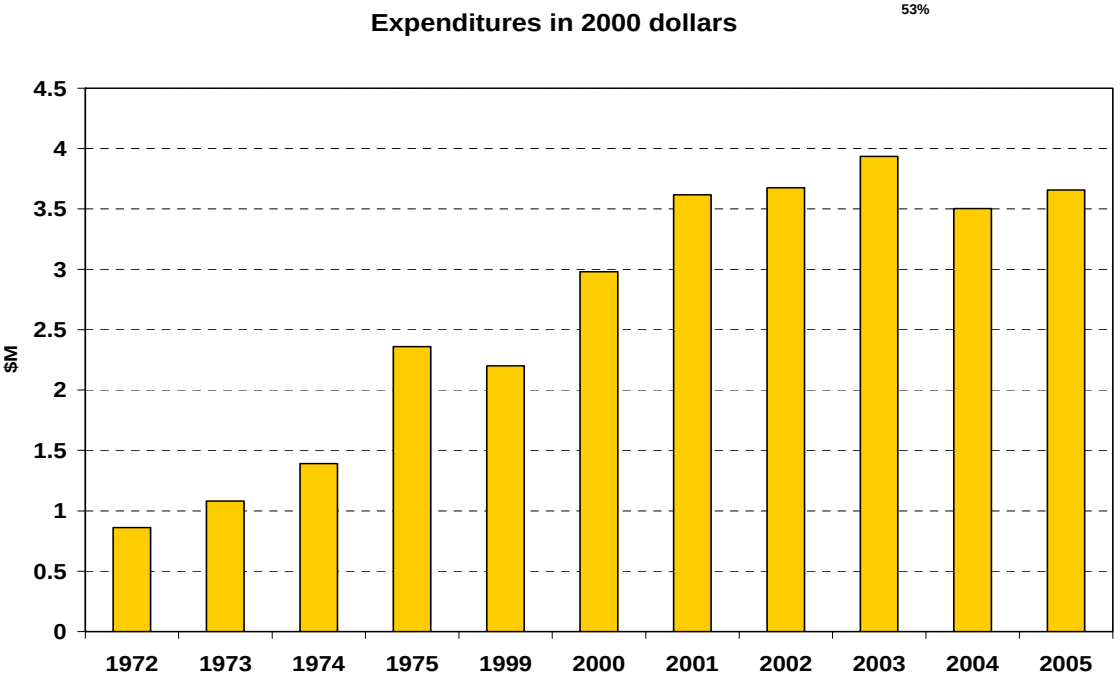
Ray W. Herrick Laboratories

2004-2005 EXPENDITURES



Expenditures for the 2004-2005 academic year were again down from last year to the level of the previous year. (University expenditures are also showing a drop.) Significant time and energy this past year have been spent on new initiatives for centers and institutes. Contracts in force for 2005-2006 appear to be increasing.

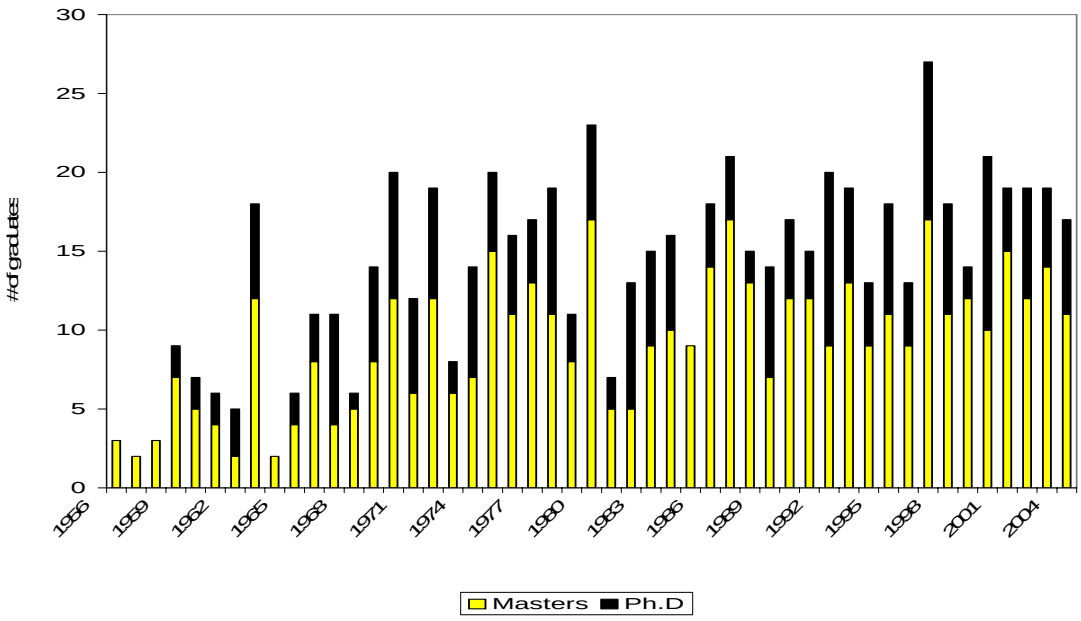




Research Expenditures: Actual Dollars $4,017,831; 2000 Dollars: $3,656,226;

HERRICK LABS EDUCATION PROGRAMS

The primary educational program at the Herrick Labs is thesis based graduate education. We believe that the experiential learning, the open-ended and integrative nature of thesis based research is outstanding preparation for both academic and industrial careers. To complement the student/advisor relationship, the Labs offer a learning community to the student. This community includes an outstanding cohort of graduate students as well as a staff prepared to support and teach. In many cases, the student's research is sponsored. Sponsor representatives also participate in educational activities with the student. We also have programs where graduate students do internships in industry or government laboratories. In total we believe this is an outstanding educational opportunity for our graduate students.



Fellowships, Scholarships and Student Awards

Fellowships:

Spencer Ackers received the Chapelle Fellowship
Li-Jen Chen received an Andrews Assistantship
Rudy Chervil received a Purdue Postdoctoral Fellowship
Jennifer Gosselin received a three-year NSF Fellowship
Derek Hengeveld received a Carrier ASHRAE
Margaret Mathison received the Lozar Fellowship
Sagnik Mazumdar received the Ross Fellowship
Joshua McKinsey received the Knox Fellowship
Rick Meyer received a National Defense Science & Engineering Graduate Fellowship
James Mynderse received the Laura Winkelman Fellowship

Awards:

Song Liu received the Best Student Paper Award from the 2005 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM'05)

The Ray W. Herrick

Herrick Labs Faculty Research Interests

Ray W. Herrick Laboratories

Douglas E. Adams, assistant professor of mechanical engineering. Experimental nonlinear structural dynamics and system identification, diagnostics and prognostics for mechanical systems, integrated vehicle/structural health monitoring, system-level modeling of vehicle systems (compressors, suspensions, exhausts, mounts), nonlinear dynamics in mechanical design, signal processing and data interrogation and novel experimental techniques.

Anil K. Bajaj, professor of mechanical engineering. Nonlinear oscillations in structures, chaotic dynamics, stability analysis, flow-induced vibrations, perturbation techniques, mistuned structures, and localization of modes, drum and disk brake squeal-friction induced vibrations, modeling of carseat-occupant dynamics, and modeling and identification of polyurethane foam properties.

Robert J. Bernhard, professor of mechanical engineering, director of Ray W. Herrick Laboratories, and co-director of The Institute for Safe, Quiet, and Durable Highways. Acoustics, noise and vibration control, and numerical methods.

J. Stuart Bolton, professor of mechanical engineering. Acoustics, numerical models of porous noise control materials, optimal design of noise control materials and treatments (barrier and sound absorption), measurement of physical properties of noise control materials, smart materials, theoretical and experimental analysis of tire vibration and sound radiation, multi-reference nearfield acoustical holography, outdoor sound propagation, visualization of motor vehicle passby sound radiation, and machinery noise source identification.

James E. Braun, professor of mechanical engineering. Thermal systems measurements, modeling, analysis, design optimization, and control optimization with applications to air conditioning and refrigeration equipment and systems.

Qingyan (Yan) Chen, professor of mechanical engineering. Indoor and outdoor airflow modeling by computational fluid dynamics and measurements, protection of buildings from chemical/biological warfare agent attacks, building ventilation systems, indoor air quality, airline cabin environment.

George T.-C. Chiu, associate professor of mechanical engineering. Dynamic systems, measurements and control, modeling and control of digital printing and imaging systems, mechatronics, network/wireless remote control, noise and vibration control, electro-hydraulic control, human-machine interface, and MEMS.

Patricia Davies, professor of mechanical engineering, director of Ray W. Herrick Laboratories. Signal processing and data analysis applied to mechanical systems, condition monitoring, vibration measurement, sound quality and perception-based engineering, nonlinear system identification, modeling of car seat-occupant dynamics and modeling and identification of polyurethane foam properties.

Eckhard A. Groll, professor of mechanical engineering.. Thermal sciences as applied to advanced HVAC&R systems, components, and their working fluids: alternative refrigeration technologies, vapor compression systems performance evaluations, natural refrigerants, analysis and optimization of individual components, such as compressors and heat exchangers.

Monika Ivantysynova, MAHA Professor of Fluid Power Systems. Fluid power systems and components measurements, modeling, analysis, design optimization, and control optimization with applications to off-road vehicles, airplanes, cars, robots and other drive systems.

Charles M. Krousgrill, professor of mechanical engineering. Non-linear oscillation, elastic stability, dynamics, vibrations, rotor dynamics, chaos, automotive brake squeal/vibration, and vibration in gearing systems.

Kai Ming Li, associate professor of mechanical engineering. Environmental acoustics, sound propagation outdoors, policy on the control of environmental noise, road/tire noise, design of innovative barriers in an urban environment, prediction and reduction of train/transit noise, reduction of noise in ducts for air conditioning and tunnels for road and rail traffic, room acoustics, speech intelligibility in built environment, monitoring of natural and human produced sounds in the environment, computational acoustics, physical acoustics and wave propagation in a complex medium.

Peter H. Meckl, associate professor of mechanical engineering. Motion and vibration control of high-performance machines, adaptive control, virtual sensing, and diagnostics. Applications to manufacturing devices, robotics, and automotive engines.

Luc G. Mongeau, professor of mechanical engineering. Flow-induced sound and vibration, thermo-acoustics, turbomachinery noise, aerodynamic noise of road vehicles, highway noise, and voice production.

Katherine Peterson, assistant professor of mechanical engineering. Experimental implementation of nonlinear control theory, control of mechatronic systems, control of biological systems, modeling and control of automotive systems, and robotic balancing.

Werner Soedel, professor of mechanical engineering and Herrick Professor of Engineering. Vibrations and dynamics of elastic systems, plate and shell vibrations, including gases and fluids, stress analysis, acoustics, simulation of machinery dynamics, and fluid machinery. Examples of applications: compressors, tires, valve flutter, suspensions, and mufflers.

David R. Tree, professor of mechanical engineering. Applied aspects of thermodynamics, fluid mechanics, and heat transfer to thermal systems and fundamental nature of heat transfer in heat exchangers.

Bin Yao, associate professor of mechanical engineering. Design and coordinated control of intelligent and high performance electro-mechanical/hydraulic systems; mechatronics; robotics; automotive control; optimal adaptive and robust controls; nonlinear observer design and neural networks for virtual sensing, modeling, fault detection, diagnostics, and adaptive fault-tolerant control; data fusion.

MAJOR RESEARCH FACILITIES

Ray W. Herrick Laboratories

Thermal Systems Research Area

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

Noise and Vibration Research Area

- 25 by 20 by 18 ft reverberation room
- Anechoic room with useful volume 12 by 12 by 12 ft
- Hemi anechoic room with useful volume 41 by 27 by 18 ft
- 8 by 8 ft audiometric room
- Acoustical materials laboratory
- Two wheel chassis dynamometer with 67 in. rollers
- Anechoic wind tunnel with 18 by 24 in. test section and flow velocity up 120 mph
- Three 1000 lb_f hydraulic shakers with 6 in. stroke
- Two 4000 lb_f electromagnetic shakers
- 64 microphone acoustical holography array and 80 channel data acquisition system

Perception Based Engineering

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

Electro-mechanical Systems Research Area

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

Ray W. Herrick Laboratories

HERRICK LABS STUDENTS

Student	Major Professor	Thesis Subject
Spencer Ackers	Adams	Damage detection and health monitoring
Gazi Naser Ali	Allebach/Chiu	Banding characterization and reduction for laser printers
Stefan Bertsch	Groll	Electro-pump for residential heating and cooling applications
Nasir Bilal	Adams	Prediction uncertainty in compressor modeling and simulation
Arthur Blanc	Bernhard	Numerical model validation
Li-Jen Chen	Mongeau	Fluid structure interactions within the human larynx
Xi Chen	Chen	Airliner cabin environment decontamination
Hung-Ming Cheng	Chiu	Finite word length controller implementation limitation on sampling rate
Rudy Chervil	Groll	Modeling of carbon dioxide compressors
Yong Cho Thung	Bolton	Acoustic holography
Douglas Cook	Mongeau/Frankel	Fluid structure interactions
Patrick Cunningham	Meckl	Diagnostics of diesel particulate filters
Paul Deignan	Meckl/King	Virtual sensor development for automotive engines
Phanindra Garimella	Yao	Model based fault detection, isolation and fault tolerant control of uncertain nonlinear systems using adaptive robust observers
Shreekant Gayaka	Peterson	EGR and VGT diesel engine flow control
Jennifer Gosselin	Chen	Building energy conservation
Kamran Ahmed Gul	Adams	Real time optimization of diagnostic algorithms
Muhammad Haroon	Adams	Durability and prognosis of ground vehicle systems
Derek Hengeveld	Braun/Groll	FDD analysis tools
Kwan Woo Hong	Bolton	Acoustics
Jason Hugenroth	Groll/Braun/King	Erickson cycle technology
Grant Ingram	Chiu/Franchek	Engine emissions
Scott James	Meckl	Engine diagnostics
Janette Jaques	Adams	Rattle vibrations in car seats
Hao Jiang	Adams	Acoustics and vibrations
Tim Johnson	Adams	Diagnostics and prognostics for rolling tires
Alok Joshi	Meckl	Diagnostics of engines
Raymond Joshua	Adams	Nonlinear methods for material damage identification
Miguel Jované	Braun/Groll	Modeling of rotary compressors
Harold Kess	Adams	Vibration-based structural health monitoring
Jun Hyeung Kim	Groll	Capacity control of positive displacement compressors
Uije Kim	Mongeau/Krousgrill	Friction-generated sound and vibration
Yan Fu Kuo	Chiu	Remote print defect diagnostics
Kyoung Ho Lee	Braun	Control of building thermal storage
Kyoung Hoon Lee	Davies	Perception of tones in large machinery noise
Phoi Tack Lew	Mongeau	Flow over vehicle sunroofs
Daqing Li	Groll	Transcritical CO2 cycles with ejectors
Ji Min Lim	Bolton	SEA modeling of compressors
Feng Liu	Chiu	Xerographic process control

HERRICK LABS STUDENTS (Cont.)

Song Liu	Yao	Automated modeling and energy-saving adaptive robust control of electro-hydraulic systems with novel programmable valves
Vishal Mahulkar	Adams	Modeling and simulation of complex dynamic systems with an emphasis on prognosis
Sravan Mantha	Mongeau/Siegmund	Fluid structure interactions in the human larynx
Andrew Marshall	Davies	Human response to supersonic aircraft noise
Margaret Mathison	Braun/Groll	Modeling of twin rotary compressors
Sagnik Mazumdar	Chen	Airliner cabin environment
Joshua McKinsey	Chiu	Force feedback of the Purdue electro-hydraulic manipulator
Paloma Mejia	Mongeau	Flow induced cavity resonance of road vehicles
Rick Meyer	Yao	Optimal control of fuel cell systems for transportation
Amit Mohanty	Yao	Practical and performance oriented nonlinear adaptive robust control
Jackie Mohrfeld	Meckl/Franchek	Practically zero emissions vehicles
Shashi More	Davies	Metrics for aircraft noise
James Mynderse	Chiu	Vibration quality
Insu Paek	Mongeau/Braun	Thermoacoustic refrigeration
Jong Beom Park	Mongeau	Voice production
Jeffrey Peters	Mongeau	Aerodynamic noise of compressor mufflers
Daniel Robinson	Bernhard	Low frequency noise
Abhijit Sathe	Groll/Garimella	Miniature-scale diaphragm compressors for electronics cooling
Bo Shen	Groll/Braun	Improving accuracy and capabilities to model unitary equipment
Yoon Shik Shin	Bolton/Mongeau	Electronic cooling fan noise
Mychal Spencer	Mongeau	Fluid-structure interactions within the human larynx
Nick Stites	Adams	Sensing and diagnostics for fault detection in gas turbine engine wire harnesses
Shankar Sundararaman	Adams	Damage identification using wave propagation
Will Thornton	Bernhard	Tire/pavement interaction noise
Suwat Trutassanawin	Groll	Miniature vapor compression systems for electronic cooling applications
Liangzhu Wang	Chen	Detailed multi-zone air flow simulation
Jonathan White	Adams	Structural diagnostics in thermal protection systems
Adam Wichman	Braun/Groll	Analysis of FDD tools for heat pump systems
Taewook Yoo	Bolton	Numerical acoustics
Kiho Yum	Bolton	Sound radiation from tires
Matias Zanartu	Mongeau	Fluid-structure interactions within the human larynx
Florence Zhang	Peterson	Robotic balancing
Tengfei Zhang	Chen	Air quality in aircraft cabins
Zhao Zhang	Chen	Particle dispersion indoor environment
Zhipeng Zhong	Braun	Modeling of heat and mass transfer in building materials
Xiaotang, Zhou	Braun	Transient modeling of cooling coils

Ray W. Herrick Laboratories

Ray W. Herrick Laboratories

HERRICK LABS TECHNOLOGY TRANSFER PROGRAMS

March 8 & 9, 2005, Herrick Labs organized and hosted **the Workshop for Industrial Participation in the NSF Engineering Research Center for Advanced Buildings**. Approximately 35 representatives from industry and universities from around the country attended the workshop. The Lead Team of the ERC Proposal Team from Purdue University are Qingyan Chen, James Braun, Leah Jamison, Heidi Diefes-Dux and Eckhard Groll. The primary goals of the workshop were to understand the opportunities associated with involvement in the Center for Advanced Buildings (CAB) and to understand industrial needs focusing on the technologies needed to establish college programs that integrate research results into curricula for pre-college and college students, practitioners, and teams of undergraduate and graduate students in research and education. It also addressed the long-term strategic vision to strengthen the diversity of the U.S. engineering and scientific workforce and to encourage committed, cross-disciplinary teams to integrate fundamental science and engineering research with research focused on the advancement of technology through test beds designed to test theory and functionality in proof-of-concept systems.

July 25-27, 2005, Doug Adams organized and presented a 2-1/2 day short course **Diagnosis & Prognosis in Mechanical System.** The short course focused on three aspects of mechanical health management: (1) loads identification, (2) diagnosis, and (3) prognosis. The state-of-the-art was reviewed in modeling, sensing, data interrogation and predictive analysis for characterizing mechanical systems over their life-cycles. Live and simulated demonstrations were provided to reinforce concepts. The goals of the course were to encourage interactions among participants and address common challenges and solutions in diagnostics & prognostics for health management in mechanical and structural systems. The course was attended by outside participants as well as about 30 students from various engineering backgrounds at Purdue.

October 17-19, 2005, Stuart Bolton and Patricia Davies are serving as Co-Chairs of **Noise-Con 2005** which will be **held jointly with the 150th Meeting of the ASA** in Minneapolis, Minnesota. Nearly two hundred papers will be published in the Noise-Con 2005 Proceedings covering a broad range of topics related to noise control. Plenary sessions at the start of each day are focused on Environmental Noise, Tire-Pavement Noise, and Hospital Noise. Two workshops will be held: one on Noise Policy and one on Power Plant Noise. A series of sessions focused on product noise measurement, case studies in noise and vibration control, products for noise control, sound quality, community noise, local and state noise policy, and speech issues in buildings will take place. The Noise Structural Acoustics and Architectural Acoustics Technical Committees have also organized interesting sessions on, e.g. transit system noise and vibration, safety of acoustic products, plumbing noise and sessions honoring the contributions of Bill Lang and Cyril Harris. More information can be found at http://www.noisecon2005.com.

November 1-3, 2005, the Quiet Asphalt 2005 A Tire/Pavement Noise Symposium sponsored by the Asphalt Pavement Alliance and Purdue University will be held at the Holiday Inn Select, City Centre, Lafayette. Robert Bernhard, Donald Johnson, and Will Thornton from Herrick Laboratories are organizing the majority of the symposium. 20 hours of lectures, displays, tours of the Institute for Safe, Quiet and Durable Highways and the North Central Superpave Center at Purdue will occur. Demonstrations are planned for realistic listening experiences comparing pavement, synthesizing some combination cases and acoustical perception concepts. There will be listening booth displays on highway noise measurement methods and perception of sound and noise as well as on quiet asphalt pavement topics including European scanning tour results, quiet asphalt mix design and construction techniques. The Labs are developing demonstration material that will be an integral part of the symposium. The expected attendance is around 160 people.

2006

April, 2006, the Volpe Workshop sponsored by the U.S. DOT/RITA/Volpe Center and organized by Robert Bernhard and Donald Johnson of Purdue University will be held in Indianapolis, Indiana.

July 15-16, 2006, the **Compressor Short Course and Refrigeration Short Course** (topics and titles to be determined) will be held at Purdue University. These courses will start on Saturday afternoon and end on Sunday around 5 p.m.

July 17-20, 2006, the **18th International Compressor Engineering Conference at Purdue** and **11th International Refrigeration and Air Conditioning Conference at Purdue** will be held at Purdue University. They will start on Monday at 10 a.m. and continue throughout the week and end on Thursday, July 20th around 3:30 p.m. At least one plenary session will be a panel discussion highlighting the latest breakthroughs in technology or alternative technologies in research and industry and invited keynote speakers who will address current, world-wide issues of interest. The popular reception, steak dinner at The Trails and a great banquet are still included in the conference registration fee. Interesting activities have been organized for family members who wish to participate in the Accompanying Person Program. **Deadlines:** December 15th – abstract submission deadline; January 23, 2006 – notification to authors of acceptance/rejection of abstracts; April 10, 2006 – manuscripts due to Conference Organizers; July 15-17, 2006 – short courses take place and July 17-20, 2006 – conferences occur. Check the Conference/Events' website at http://www.ecn.purdue.edu/Herrick/Events/2006 Conferences for updated information.

2004 HERRICK LABS GRADUATES

Satyam Bendapudi	PhD	*Development and Evaluation of Modeling Approaches for Transients in Centrifugal Chillers*
Rong Deng	PhD	*Modeling and Characterization of Flexible Polyurethane Foam*
Tim Freeman	MSME	*Reduction of Vehicle Chassis Vibrations Using the Powertrain System as a Multi Degree-of-Freedom Dynamic Absorber*
Aaron Hastings	PhD	*Sound Quality of Diesel Engines*
R. Jason Hundhausen	MSME	*Mechanical Loads Identification and Diagnosis for a Standoff Metallic Thermal Protection System Panel in a Semi Realistic Thermo-Acoustic Operating Environment*
Tom Lawrence	PhD	*Methodologies for Evaluating Demand-Controlled Ventilation Retrofits in HVAC Applications*
Moohyung Lee	PhD	*Acoustical Visualization of Aeroacoustic Sources*
Haorong Li	PhD	*A Decoupling-Based Unified Fault Detection and Diagnosis Approach for Packaged Air Conditioners*
Yaoyu Li	PhD	*Active and Adaptive Passive Control of Acoustic Impedance Matching and Thermoacoustic Cooling Applications*
Rex Mennem	PhD	*Parametrically Excited Vibrations in Spiral Bevel Geared Systems*
James Mynderse	MSME	*Design and Control of a Steering Wheel Vibration Simulator for Human Perception Testing*
Jeong-il Park	PhD	*Mathematical Modeling and Simulation of a Multi-Cylinder Automotive Compressor*
Tarun Puri	MSME	*Integration of Polyurethane Foam and Seat-Occupant Models to Predict the Settling Point of a Seat Occupant*
Scott Thomson	PhD	*Fluid Structure Interactions Within the Human Larynx*
William Thornton	MSME	*Non Thesis: Tire/Pavement Noise*
Chulho Yang	PhD	*Experimental Embedded Sensitivity Functions For Use in Mechanical System Identification*
Li Yang	MSME	*The Impact of Fouling on the Performance of Filter-Evaporator Combinations and Rooftop Air Conditioners*

Ray W. Herrick Laboratories