

# ERC NEWSLETTER

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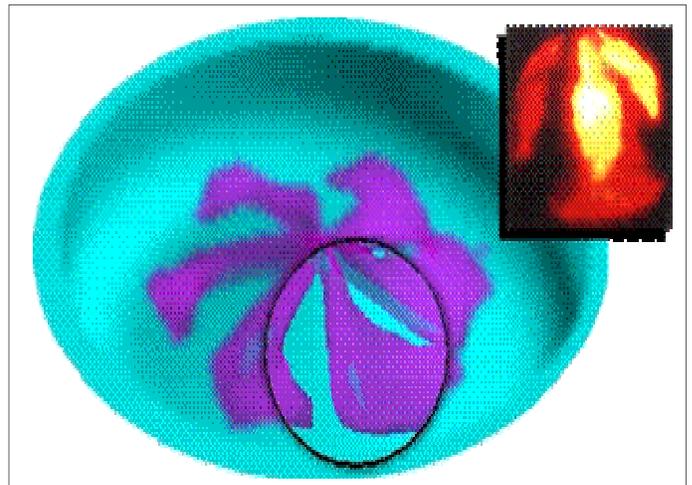
**Points of Interest:**

- ERC initiates a new consortium
- Reitz wins the ASME Honda Medal
- Chris Rutland elected as the new ERC Director
- Shedd and Arias win best paper award

## DIESEL EMISSIONS REDUCTION CONSORTIUM INITIATED

The Engine Research Center is launching a new, international consortium to assist diesel engine manufacturing and supplier industries in meeting future diesel engine emissions regulations. The Diesel Emissions Reduction Consortium's (DERC) mission is to provide members with access to current university research results and practices to achieve emissions mandates. For example, the 2010 EPA mandates for heavy-duty engines are: oxides of nitrogen (NOx) levels of 0.2 grams per horsepower-hour (g/HP-hr) and particulate matter (PM) levels of 0.01 g/HP-hr. Similar stringent emissions mandates are in place, or have been proposed for all classes of diesel engines, including automotive and marine engines.

The consortium encourages broad membership from all segments of the diesel engine manufacturing industry, including OEM producers, suppliers of engine components,



Comparison of diesel multi-dimensional simulation and an experimental image. The larger image shows the combustion simulation of a six hole nozzle. The smaller image shows soot luminosity taken using an endoscope in a fired engine corresponding to the location of the circled

manufacturers and designers of air handling, after-treatment, and engine controls systems, and manufacturers of instrumentation and measurement systems for emissions analysis. Consortium membership fees are modest to encourage participation from all tiers of the industry. An annual member-

ship meeting will take place in Madison in June, held in conjunction with the bi-annual Engine Research Center Symposium on odd years, and held independently on even years. Student and staff researchers from the ERC will present and demonstrate current projects and results at

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Engine Research Center  
University of Wisconsin - Madison



## ROLF REITZ AWARDED ASME HONDA MEDAL

The 2004 Soichiro Honda Medal is awarded to Rolf D. Reitz, former director of the Engine Research Center and Wisconsin distinguished professor of mechanical engineering, University of Wisconsin-Madison, for seminal contributions to the understanding and modeling of turbulence, sprays and combustion

chemistry relative to the performance and emissions from diesel, spark-ignition and HCCI engines; for technological innovations in fuel injection systems; and for computation methods defining future diesel combustion systems and advanced engine controls for low emissions.

The award will be made at the President's Luncheon, 2004 ASME International Mechanical Engineering Congress and Exposition in Anaheim, CA, 11/15/04. The SOICHIRO HONDA MEDAL recognizes an individual for an outstanding achievement or a series of significant engineering contri-

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## CHRIS RUTLAND IS NEW DIRECTOR OF ERC

Professor Chris Rutland was elected to be the new director of the ERC starting September 1, 2004. This follows a tradition at the ERC of rotating the position of director on a three year cycle. The principle investigators at the ERC decided to pursue this rotation procedure for several reasons. First, we generally view ourselves as a group of equals that work together very successfully. We all maintain strong research programs with our individual emphasis and interest areas that support the common themes of the ERC. The role of the director at the ERC is not to guide

the group, but to promote and support the mission and individuals of the ERC. Thus, each of us is qualified to be director.

The second reason for the rotation procedure is to take advantage of the unique talents that each of us can contribute to the group as director. There are many opportunities to advance the goals of the ERC through the director's position. There are also many responsibilities and obligations that are required to keep the ERC operating efficiently. It is advantageous to the group to have each of us contribute our

skills in turn. And it is advantageous to us as individuals to take on new responsibilities and expand our competencies.

The rotating directorship was initiated after Gary Borman's retirement in 1994. The previous succession of directors has been Dave Foster, Jay Martin, Pat Farrell, and Rolf Reitz. The outgoing director, Rolf Reitz, continues as a full participant in the ERC, and takes on new duties as the director of the new Diesel Emissions Reduction Consortium described on page 1.

*"...we generally view ourselves as a group of equals that work together very successfully."*

## MANUEL GONZALEZ JOINS THE ERC

Manuel A. Gonzalez D. joined the Engine Research Center in October 2004 as associate researcher. He will support operations for the recently initiated Diesel Emissions Reduction Consortium (DERC). Manuel will also work with students and sponsors on a variety of low temperature combustion research projects.

Manuel comes from a 19 year career in the Research Center of PDVSA, an international energy company, where ini-

tially he was responsible for the setup and operation of their internal combustion engine laboratory. He performed multidisciplinary projects involving petroleum products technical assistance, research and development and strategic planning. In recent years one of those studies resulted in product development for new water in diesel fuel micro emulsion. Also, Manuel acted as technical liaison with US DOE, international energy companies and major OEMs, studying the

effects of oxygenated diesel fuels combined with engine control strategies for reduced emissions. He also performed competitive technological intelligence projects, resulting in directions for corporate strategy.

Manuel received his BS in 1983 from Universidad Central de Venezuela, and his MS in 1990 from the University of Wisconsin-Madison working in the Engine Research Center.

## DIESEL EMISSIONS REDUCTION CONSORTIUM INITIATED

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the meetings. Members will have an opportunity to interact with ERC faculty and students, and with one another to discuss the future of diesel emissions research. Annual meetings will be recorded and made available for Internet

and DVD distribution to the members.

An organizational "kick-off" meeting of the DERC was held on September 21, 2004 with 14 member companies in attendance. More information about joining the Consor-

tium and details of member benefits is available on the ERC web page at: [www.erc.wisc.edu](http://www.erc.wisc.edu) or by contacting the consortium organizers, Rolf Reitz ([Reitz@engr.wisc.edu](mailto:Reitz@engr.wisc.edu)) and Manuel Gonzalez D. ([mgonzalez@erc.wisc.edu](mailto:mgonzalez@erc.wisc.edu)).

# ARIAS AND SHEDD WIN BEST PAPER AWARD

Assistant Professor Tim Shedd and Ph.D. candidate Diego Arias received the Best Paper Award at the 2004 Small Engine Technology Conference (SETC) held September 28-30 in Graz, Austria. Their paper, "Numerical and Experimental Study of Fuel and Air Flow in Carburetors for Small Engines" (2004-32-0053) explores the two-phase flow in the main jet of a carburetor. The study involved experimental visualization of the flow for a range of air-fuel mass ratios, pressure drop measurements of the two-phase flow, and the development of a comprehensive model to predict fuel flow from carburetors. Over one

hundred papers were presented at the SETC, an annual meeting that is sponsored by SAE and JSAE in alternating years.

Professor Shedd oversees the Multiphase Flow Visualization and Analysis Laboratory, which has been focused on flow problems in refrigeration systems and evaporative spray cooling of computer circuits. Professor Shedd's research on carburetor flows stems from the interests of the Wisconsin Small Engine Consortium, which supported this work. Tim is also affiliated with the Solar Energy



Diego Arias (left) and Professor Tim Shedd with their Best Paper Award from the SETC

Laboratory and the Computational Mechanics Center in the Mechanical Engineering department. Diego Arias is a native of Columbia and expects to complete his Ph.D. in 2005.

### ABSTRACT

This work presents a complete model of the carburetor for small engines. It extends the previously published models by incorporating a detailed review of two-phase flow pressure drop, the effect of the fuel well on the control of airbled flow, and unsteady flow. The homogenous two-phase flow model, which is commonly used in carburetor modeling, was compared with an empirical correlation derived from experiments in small pipes and found to be in poor agreement. In order to assess unsteady flow conditions, the model was extended by solving instantaneous one-dimensional Navier-Stokes equations in single-phase pipes. This strategy proved successful in explaining the mixture enrichment seen under pulsating flow conditions. The model was also used to derive a sensitivity analysis of geometries and physical properties of air and fuel.

*"This work presents a complete model of the carburetor for small engines."*

## ROLF REITZ AWARDED ASME HONDA MEDAL

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contributions in developing improvements in the field of personal transportation. This medal was established in 1983 in recognition of Soichiro Honda's exemplary achievements in the field of personal transportation. The

guidelines for awarding the medal state that attention shall be concentrated on the brilliance of the achievement or on the overall effect of a series of contributions – not on the individual. The achievement should be of such public importance as to be worthy of the gratitude of

society and to call forth the admiration of engineers.

Previous ASME Soichiro Honda medalists include ERC faculty Prof. Phil Myers (1993), and former ERC student Prof. John Johnson (2002).

### SOICHIRO HONDA MEDALISTS

- 1984 John P. Stapp
- 1985 Shoichi Furuhashi
- 1986 Lloyd L. Withrow
- 1987 Felix Wankel
- 1988 Arthur F. McLean
- 1989 Shunichi Ohigashi
- 1990 Charles M. Heinen

- 1991 Hans C. List
- 1992 Hiroyuki Hiroyasu
- 1993 Phillip S. Myers
- 1994 James Ellis Hall
- 1995 Joseph M. Juran
- 1996 Karl J. Springer
- 1997 Jack D. Benson

- 1999 John B. Heywood
- 2000 Franz F. Pischinger
- 2001 Robert C. Stempel
- 2002 John H. Johnson
- 2003 Robert F. Sawyer
- 2004 Rolf D. Reitz

## NEW STUDENTS AT THE ERC

Student	Project	Professor	Degree	Sponsor
Neerav Abani	Spray model development for advanced diesel engines	Reitz	PhD	Caterpillar
Angelo Chialva	Investigating Air Fuel and EGR Unmixedness Impacts on Gasoline HCCI	Foster / Ghandhi	MS	GM
Ben Drueclse	Second Law Analysis of Engine Combustion	Foster	MS	ORNL
Stephen England	Diesel Aftertreatment Modeling Steve will continue our development of aftertreatment DPF and DPNR models for cycle simulation system applications.	Rutland / Foster	MS	GM CRL
Nathan Haugle	Residual Gas Effects on Combustion in a Utility Engine: The objective of this project is to investigate the contribution of residual gas level, and its degree of mixedness on the combustion and emission performance of a utility engine.	Ghandhi	MS	WSEC
Mark Lemke	Use of Variable Valve Technology (VVT) for emissions control in HSDI diesel Engines	Reitz	MS	DOE
Ryan Nevin	HCCI control using Variable Valve Actuation (VVA) in a heavy-duty diesel engine	Reitz	MS	DOE
Richard Opat	Fundamental Limits to Diesel HCCI	Foster	MS	GM
Tim Pfeifer	Non-contact Piston Temperature Measurement: Recently we have developed and demonstrated a metal-embedded fiber Bragg grating technique for non-contact, minimally intrusive piston temperature measurements. In this study the technique will be refined further and applied to a variety of engine experiments.	Ghandhi	MS	WSEC
Victor Salazar	Investigation of Hydrocarbon Emission Mechanisms in SI Engines: Air-cooled engines have some unique operating characteristics relatively to automotive engines, and the purpose of this project is to investigate how these characteristics affect the hydrocarbon emissions.	Ghandhi	PhD	WSEC
Jason Schmidt	Optical Sensors for Rocket Engines Jason is developing laser-based sensors for rocket engines. He will apply the sensors to monitor LOX in rocket feed lines and gas properties in rocket plumes.	Sanders	MS	NASA / Orbitec
Laine Stager	Modeling HSDI engine combustion using detailed chemistry models	Reitz	MS	DOE
Bo Yang	Diesel Fuel Impingement Studies Measurements of fuel film thickness from diesel spray impingement will be made using the refractive index matching technique.	Ghandhi	Post- doc	Caterpillar

## NEW VISITORS AT THE ERC

Bjarke Dam	Spray model development for large diesel engines – MAN B&W and Technical University
Chulhwa Jung	Modeling of Homogeneous Charge Compression Ignition (HCCI) combustion processes – Hyundai
Dr. Teruano Kawai	Detailed measurement of diesel particulate chemical composition and particle size – National Traffic Safety and Environmental Laboratory, Japan
Denmark Hoojoong Kim	Implementation and testing of flamelet combustion models – Seoul National University
Kanji Namimatsu	Modeling of heavy-duty diesel combustion and emissions – Komatsu

## RECENT ERC GRADUATES

Mike Liechty, MS 8/20/04 - Exploring use of multiple injections and EGR to reduce emissions of heavy-duty truck engines

Hanho Yun, PhD 8/27/04 - An Experimental Study on Emissions Optimization using Genetic Algorithms in a HSDI Diesel Engine

Amar Patel, MS 6/11/04 -

Genetic Algorithm optimization of HSDI diesel engine combustion chamber geometries with improved combustions chemistry models

Jim von der Ehe, MS 8/25/04 - Assessment of engine performance sensors for incorporation in HCCI engine control algorithms

Bret RempelEwert, MS. 8/23/04 - Use of multi-dimensional models to analyze and improve the performance of High-Speed Direct Injection (HSDI) diesel engines

Mark Beckman, PhD 2004—Quantitative Vapor Phase Imaging in In-Cylinder Diesel Fuel Sprays

## RECENT ERC PUBLICATIONS

Albert, B.P. and Ghandhi, J.B., "Residual Gas Effects on Combustion in a Utility Engine," SAE Paper 2004-32-0029, 2004.

Bevan, K.E. and Ghandhi, J.B., "PIV measurements of in-cylinder flow in a four-stroke utility engine and correlation with combustion measurements," Proceedings of ICEF2004: ASME-ICED 2004 Fall Technical Conference October 24-27, 2004 Long Beach, CA

Bevan, K.E. and Ghandhi, J.B., "PIV Measurements of In-Cylinder Flow in a Four-Stroke Utility Engine and Correlation with Steady Flow Results," SAE Paper 2004-32-0005, 2004.

Canakci, M., and Reitz, R.D., "Experimental Optimization of a DI-HCCI-Gasoline Engine's Performance and Emissions Using Split Injections with Fully-Automated Micro-Genetic Algorithms," ASME Journal of Gas Turbines and Power, Vol. 126, No. 1, pp. 167-177, 2004.

Cromas, J. and Ghandhi, J.B., "Lubricating Oil Contribution to Direct-Injection Two Stroke Engine Particulate Emissions," SAE Paper 2004-32-0012, 2004.

Kim, T. and Ghandhi, J.B., "Investigation of Light Load

HCCI Combustion using Formaldehyde Planar Laser-Induced Fluorescence," to appear in Proc. Combust. Inst. (30), 2004.

Kim, T. and Ghandhi, J.B., "Optimization of Finpack Design for Finned Cylinder with Nonuniform Heat Flux Applied to the Inner Surface," SAE Paper 2004-32-0082, 2004.

Lee, K., and Reitz, R.D., "Investigation of Spray Characteristics from a Low-Pressure Common Rail Injection System for use in a HCCI Engine," Measurement Science and Technology, Vol. 15, No. 3, pp. 509-519, 2004.

Narayanaswamy, K. and C. J. Rutland, "Cycle Simulation Diesel HCCI Modeling Studies and Control," SAE Paper 2004-01-9337, SAE Powertrain & Fluid Systems Conference, Tampa, FL. Oct. 25-28.

Ra, Y., and Reitz, R.D., "A Model for Droplet Vaporization for use in Gasoline and HCCI Engine Applications," ASME Journal of Engineering for Gas Turbines and Power, Vol. 126, pp. 1-7, 2004.

Ra, Y., Kong, S.-C., Reitz, R.D., Rutland, C.J., and Han, Z., 2004, "Numerical simulation of transient injection of high speed hydrogen jet using coarse computational grids," ASME IC Engine Division Fall

Technical Meeting.

Reitz, R.D., Book Review: "Combustion of Two-phase Reactive Media," by Yarin, L.P., and Hetsroni, G., Springer: Heat and Mass Transfer Series, Mewes, D., and Mayinger, F. (Eds.) 2004, 249 figures, 558 pages, International Journal of Multiphase Flow, Vol. 30, Issue 9, pp. 1171-1173, 2004.

Walewski, J. W., Borden, M. R. and Sanders, S. T. Wave-length-agile laser system based on soliton self-shift and its application for broadband spectroscopy. Appl. Phys. B, 2004. Accepted for publication.

Walewski, J. W. and Sanders, S. T. High-resolution wave-length-agile laser source based on pulsed supercontinua. Appl. Phys. B, 79 (4):415-418, 2004.

Wang, Y. and C. J. Rutland, 2004, "Effects of temperature and equivalence ratio on the ignition of n-heptane fuel droplets in turbulent flow." Proceedings of the 30th International Symposium on Combustion, Chicago, July 26-29.

Yi, Y., and Reitz, R.D., "Modeling the Primary Breakup of High-speed Jets," Atomization and Sprays, Vol. 14, No. 1, pp. 53-80, 2004.

*ERC publications cover a full range of technical topics related to diesel sprays, combustion, and emissions*

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## MESSAGE FROM THE DIRECTOR

As I consider my new role as director of the ERC, I recall what Dave Foster used to say when he was director. And that is that I am honored to be in this role helping to represent truly talented researchers and outstanding individuals.

As I start my service in this position, I am considering the current and future situation of the ERC. As always, these are exciting times at the ERC. We have always had a three fold mission: maintaining a core competency in research, providing educational opportunities for students and engineers, and supplying a knowledge base for industry. Each of these activities are growing and rapidly evolving.

The ERC has always worked hard to maintain a top notch university research institute for the study of internal combustion engines. This means constantly growing and evol-

ing strong, coordinated programs in both laboratory research and modeling. These programs span a healthy range of applications from engine combustion optimization, to in-cylinder, emissions, and aftertreatment studies, to fundamental investigations that support advancing technologies. The ERC continues to receive strong financial support from government and industry in all of these areas.

More recently, the other two components of the ERC mission have been growing. Our educational mission has recently expanded through the development of a Masters of Engineering in Engine Systems degree that is offered completely online through a variety of mechanisms. This MEES program is spearheaded by Kevin Hoag in the ERC and expands on his continually growing program of continuing education courses

in engine topics. More information about this program, now in its second year, can be found through our webpage [www.erc.wisc.edu](http://www.erc.wisc.edu).

Our involvement with industry has always been highly valued at the ERC. It helps keep our work relevant and provides a market for our products. Our activities in providing a knowledge base for industry have recently taken a large step forward through the development of the Diesel Emissions Reduction Consortium (DERC). The cover article in this newsletter provides more details of this exciting activity.

Our strong continuing growth in core research and our recent spurt of growth in providing resources for education and industry help to make the ERC stronger, more adaptable, and able to continue making relevant contributions.

