Sustainable Transportation Update

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Intelligent transportation

Vehicles that are designed to "think" could be the answer to some of the automotive industry's most baffling challenges. ORNL researchers are currently studying how biological systems, such as the human brain, are able to function in complex situations and make decisions with very little detailed information. If a similar capability could be built into vehicles of the future, significant leaps in safety, efficiency, and emission reductions look achievable.

Andreas Malikopoulos, Alvin M. Weinberg Fellow, and Stuart Daw, UT-Battelle Corporate Fellow, are looking beyond traditional automotive engineering and borrowing from other scientific disciplines – neuroscience, physics, and even economics – to study how they have been able to understand and control systems with very high complexity. Andreas and Stuart hope that such cross-fertilization can lead to revolutionary approaches for addressing the multi-scale complexities in transportation systems.

While the idea of mimicking biology has been suggested in other contexts, utilizing this approach for transportation systems controls is relatively new. Andreas and Stuart propose that applying biological "reverse engineering" to transportation systems offers promising new research opportunities in the field of Information and Decision Science (IDS).

Andreas and Stuart bring unique ideas on how IDS research will impact vehicle technology as it relates to on-board vehicle control systems and the practicality of inter-vehicle communication.

According to Andreas, on-board vehicle control systems currently used have very limited computational power and storage capacity.

"Trying to globally optimize the fuel and emissions performance of modern vehicles head-on with traditional engineering approaches would require upgrading the on-board control systems to the level of supercomputers, which is of course impractical," he explained.

As the need for greater fuel efficiency and safer operation increases, the computational overhead required to maintain optimal performance of all vehicle subsystems will continue to grow exponentially, Andreas added.

ORNL researchers Andreas Malikopoulos (right) and Stuart Daw

Developing control systems that are able to mimic the efficient learning and decision-making processes of biological organisms without resorting to on-board supercomputers could revolutionize transportation, he said.

Stuart suggested, in the long-term, that "smart" vehicles need to mimic the ability of humans to efficiently perceive, filter, and rapidly respond to the flood of information available from the local environment, as well as from their own internal parts. He added that the idea of "intelligence" can also be extended to groups of vehicles.

"As inter-vehicle communication becomes practical, it should be possible to form vehicle networks that act like decentralized brains – much like groups of cells that synchronize their activity in the body – guiding individual vehicles to act in ways that optimize their collective performance," Stuart said.

IDS Research has been supported through a Weinberg Fellowship and sponsored by ORNL and the Department of Energy's (DOE) Vehicle Technologies Office (VTO).

References used in this article can be found at http://www-cta.ornl.gov/cta/staff_AndreasM.shtml.

ORNL garners technical awards at DOE Annual Merit Review

ORNL staff provided strong representation with 57 first-author podium and poster presentations at the DOE Hydrogen and Fuel Cells Program and Vehicle Technologies Office Annual Merit Review and Peer Evaluation Meeting. Congratulations to our four researchers who were honored with R&D Technology Awards.

Ron Graves, Sustainable Transportation Program Director, was recognized for his exemplary achievements on the Advanced Engine Cross-Cut Team, US DRIVE Engine Tech Team, and 21st Century Truck Partnership.

Scott Curran received the award for his leadership in transitioning reactivity controlled compression ignition combustion from a single cylinder to a multi-cylinder engine using bio-renewable fuels. Scott is a fuels, engines, and emissions researcher.

Janet Hopson was honored for management of the www.fueleconomy.gov website, one of the most visited federal sites. Janet works in transportation analysis.

Scott Curran, Janet Hopson, Karren More, and Ron Graves

Karren More was distinguished for her outstanding achievements in microstructural characterization of fuel cell materials. Karren is a materials science and technology researcher.

ORNL expresses its thanks to the DOE leadership for these recognitions.

In the PEEM Lab, ORNL's Madhu Chinthavali (right) explains the benefits of wide bandgap devices to Green Car Congress editor Mike Millikin.

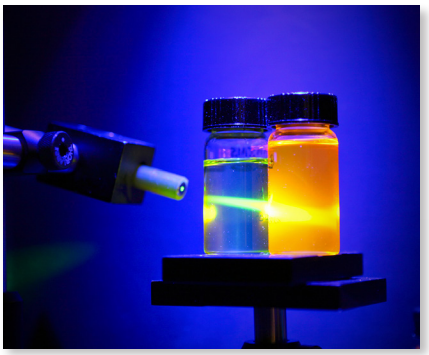
ORNL hosts Green Car Congress editor

ORNL hosted a visit with Mike Millikin, editor of Green Car Congress (www.greencarcongress.com), a publication that reports on a full spectrum of energy options, technologies, products, issues, and policies related to sustainable mobility. Starting at EVEREST, Ron Graves gave an overview of the Sustainable Transportation Program, and other researchers presented more specific transportation-related highlights throughout the day. Tour stops included the Fuels, Engines, and Emissions Research Center (FEERC) labs, the Power Electronics and Electric Machinery (PEEM) Lab, the Transportation Analysis and Visualization Lab, the Vehicle Systems Integration (VSI) Lab, the Battery Manufacturing Facility (BMF), the Manufacturing Demonstration Facility (MDF), and the Spallation Neutron Source.

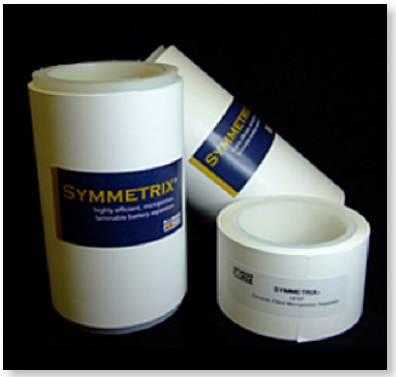
Congratulations to our R&D 100 Award winners

Two of the six R&D 100 awards presented to ORNL this year included research projects associated with the Sustainable Transportation Program. R&D Magazine bestows the Awards in recognition of the year's most significant technological innovations.

Da Vinci Fuel-in-Oil, or DAFIO™, Measurement System was developed and jointly submitted by Da Vinci Emissions Services, Cummins, and an ORNL team that includes Jim Parks and Bill Partridge, and Technology Transfer's David Sims. The DAFIO technology provides fast, real-time, on-engine assessment of oil contamination by fuel and enables combustion engineers to rapidly assess fuel dilution of oil during development of efficient, clean, and reliable engines. This technology, originally developed in a DOE-VTO-sponsored CRADA between ORNL and Cummins, also received a 2011 Federal Laboratory Consortium Award and has been licensed to Da Vinci Emissions Services.



Fuel-in-Oil technology

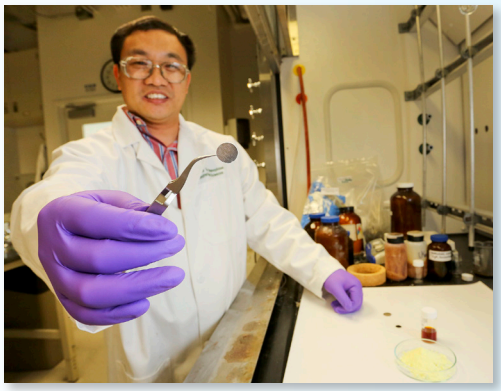


Lithium-ion battery separators

SYMMETRIX® HPX-F Nanocomposite Separator for Improved-Lithium Ion Battery was jointly developed by Porous Power Technologies and ORNL. This technology addresses market demands by lowering lithium-ion battery costs and improving safety through the replacement of polymer separators. ORNL's team includes David Wood III, Claus Daniel, Wallace Porter, Amit Shyam, Cristian Contescu, Rosa Trejo, Edgar Lara-Curzio, Harry Meyer III, Ralph Dinwiddie, Hsin Wang, Jane Howe, Beth Armstrong, Curt Maxey, and Jianlin Li. This research was co-sponsored by DOE's VTO and Advanced Manufacturing Office (AMO).

New all-solid sulfur-based battery outperforms Li-ion technology

A new all-solid lithium-sulfur battery developed by ORNL's team led by Chengdu Liang has the potential to reduce cost, increase performance, and improve safety compared with existing designs. The new battery design uses abundant low-cost elemental sulfur and has approximately four times the energy density of conventional lithium-ion technologies used today. It also addresses flammability concerns experienced by other chemistries. "Our approach is a complete change from the current battery concept of two electrodes joined by a liquid electrolyte, which has been used over the last 150 to 200 years," said Chengdu, lead author on the ORNL study. The research was sponsored by DOE's VTO. The investigation of the ionic conductivity of the new compounds was supported by DOE's Office of Science.



Chengdu Liang

New transportation seminar series kicks off

On August 6, Ron Graves began a new seminar series focused on the major challenges in transportation, the significant impacts and breadth of research at ORNL, and new directions to achieve efficient, clean, and sustainable mobility. The seminar series will include presentations on a quarterly basis by ORNL transportation technology leaders as well as external experts. The series' objective is to inform and foster new collaborations across ORNL that will support DOE's mission, ultimately reducing US energy consumption for transportation.

ORNL to lead biofuels R&D project

ORNL will lead a DOE research and development project to help bring next generation biofuels online faster and drive down the cost of producing gasoline, diesel, and jet fuels from biomass. ORNL will use a microbial electrolysis process to efficiently generate hydrogen from the aqueous phase associated with bio-oil. This technology will help reduce the corrosivity of bio-oil and improve the efficiency of converting hydrogen and biomass to biofuels while reducing greenhouse gas emissions. The effort will be directed by ORNL biosciences researcher Abhijeet Borole. University of Tennessee-Knoxville, Georgia Institute of Technology, Pall Corporation, OmniTech International, and FuelCellsEtc will also participate in this project and provide a cost-share.

Wireless charging team advances toward interoperability

ORNL's wireless power transfer (WPT) team completed studies on selecting a common frequency, bringing them closer to finding a standard for wireless charging of vehicles that currently use a plug-in charging method. The team experimented with two power inverters, each set at different frequencies using the latest technology found in commercial, silicon-based inverters. With all other WPT components the same, the team discovered little difference in overall efficiencies with the results remaining within about 1% of each other. ORNL plans to investigate further using wide bandgap (WBG) devices in this research to evaluate what benefits WBG may have.

VSI Lab delivers complete, heavy-duty Class 8 powertrain implementation

The VSI Lab team successfully implemented a complete conventional Class 8 powertrain in the powertrain test cell. The current Cummins engine has been mated to an Eaton automated manual transmission and coupled to the full powertrain dynamometer setup (twin 500 kilowatt dynamometers and summing gearbox). The full emissions aftertreatment system has been installed and verified to work with the Cummins engine control module. Once the powertrain dynamometers and battery emulator have been commissioned, the entire test cell will be fully operational and able to handle evaluation and analysis of vehicles from light-duty up to Class 8 hybrid electric Drivetrains. The VSI Lab is located at NTRC Building 2.

ORNL co-organizes, participates in Vehicle Data Jam

ORNL reseachers lent their collective knowledge spanning advanced engines, advanced vehicle systems, big data, and data security for a Vehicle Data Jam held in Detroit during the week of the SAE World Congress. Fuels, engines, and emissions researcher Robert Wagner co-organized the event. Ron Graves, David Smith, Wade McNair, and Stacy Prowell rounded out the expert ORNL team during the Jam that was hosted by the White House Council on Environmental Quality, DOE, and the Department of Transportation (DOT) – in partnership with SAE International.

PBS interviews fuels researchers about ethanol blends program

ORNL researchers Brian West and Scott Sluder spent a day with a film crew from PBS NewsHour discussing the lab's research on the effect of intermediate ethanol blends (blends greater than 10% ethanol) on vehicles, non-automotive engines, and infrastructure materials. They focused mostly on the results of the $20 million catalyst durability project – completed in 2011 and published in 2012 – that involved aging more than 80 vehicles with dedicated fuel blends while driving over six million miles. PBS has not yet determined when their ethanol story will air.

Local news profiles VSI Lab research

David Smith and Paul Chambon with the VSI Lab team were featured in a news story titled, "ORNL research helps fuel savings, lower truck emissions," that aired on WBIR TV-10 and was posted to WBIR.com on July 16. The report focused on tractor trailer emissions and fuel costs. To view the video online, visit http://oakridge.wbir.com/news/news/615112-ornl-research-helps-fuel-savings-lower-truck-emissions.

Fuel cell research featured in Chemical Communications

ORNL's fuel cell R&D was featured on the April 25, 2013, cover of Chemical Communications, the leading journal on important developments in the chemical sciences. ORNL designed the cover to accompany an article based on collaborative research among Los Alamos National Laboratory, Argonne National Laboratory, and ORNL titled, "A carbon-nanotube-supported, graphene-rich, non-precious metal oxygen reduction catalyst with enhanced performance durability."

OESA members tour ORNL

ORNL's Burak Ozpineci (pictured right) guides members of the Original Equipment Suppliers Association (OESA) through the PEEM Lab as part of the group's day-long tour of ORNL's transportation-related research labs. Ron Graves hosted the OESA group – including (pictured from left) Mike Shapiro, OESA Executive Director; Chris Blair and Paul Nahra with BorgWarner, JD Kehoe with Mahle Industries, and Aaron Wisniewski with Faurecia North America – who also visited the FEERC Lab, the VSI Lab, the BMF, and the MDF.

New report describes EV transition model

ORNL's David Greene released a report that describes an effort to model the transition to electric drive vehicles in California, including measuring the costs and benefits, quantifying the transition barriers and network external benefits, and estimating the effects of public policies on the transition process. ORNL's Changzheng Liu and University of Tennessee's Sangsoo Park assisted David with the report, which was funded by the International Council on Clean Transportation (ICCT).

National Public Radio visits NTRC

NPR Science Reporter Geoff Brumfiel visited the National Transportation Research Center (NTRC) as part of a larger ORNL tour to get an update on laboratory highlights for possible future story ideas. He toured the FEERC Lab, watched the first-ever demonstration of in-motion wireless charging in the PEEM Lab, visited the BMF, and toured the MDF.

Spotlight on: *Bill Partridge*

Bill Partridge has focused his career on developing transportable diagnostics for understanding and optimization of automotive technologies. His contributions to ORNL's SpaciMS and Fuel-in-Oil (FiO) projects have led to R&D 100 award recognition, as well as National Federal Laboratory Consortium Excellence in Technology Transfer awards for positively impacting partners, industry, and consumers.

Bill works in fuels, engines, and emissions at ORNL and leads a research team who frequently brings diagnostic equipment and expertise to partners' facilities for on-site support of developing technologies.

"These are very exciting, challenging, high-stress opportunities to make major impressions on industry partners," he said. "Because of our extreme attention to detail, preparation, hard work, and organization, we have a track record of hitting home runs on these campaigns, which has been a big part of our long-term programmatic success."

His team's latest project is an Exhaust Gas Recirculation (EGR) Probe, a patent-pending invention that Bill thinks may yield fruits similar to SpaciMS and FiO. "We've applied this new diagnostic to understand the physics of mixing in EGR systems, the performance of specific EGR architectures, and the performance of the numerical design tools used to design specific hardware and systems. We are working to extend the diagnostic for applications to study advanced combustion methodologies," he explained.

Bill holds an MS from the University of Tennessee (UT) where he first developed an interest in optical diagnostic techniques, and later obtained his PhD from Purdue University. He teaches and encourages future generations of engineers as an adjunct associate professor with the Department of Mechanical, Aerospace, and Biomedical Engineering at UT and through numerous ongoing partnerships with University of Central Florida, Institute of Chemical Technology Prague (Czech Republic), Politecnico di Milano (Italy), Chalmers University of Technology (Sweden), and Queen's University Belfast (Ireland).

He was recognized for these efforts in 2010 when he received the Outstanding Mentor Award from DOE's Office of Science. Bill also won ORNL's Distinguished Engineer award in 2008.

Employee Excellence

- Congratulations to Scott Curran for receiving second prize for the 2013 ASME Old Guard Early Career Award for helping the global engineering community develop solutions to benefit lives and livelihoods through advances in energy efficiency and alternative fuel research, as evidenced by involvement with ASME conferences; science, technology, engineering, and mathematics recruiting; and public outreach and education. Scott also received the 2013 ORNL Earth Day Community Sustainability Award because of his personal commitment and valuable contributions to ensuring the promotion of efficient technologies and biofuel use in the community, at home, and in his research.

- PEEM reseachers Tim Burress and Curt Ayers were awarded the third paper prize by the IEEE Industry Applications Society Transportation Systems Committee for their paper titled, "Development and Experimental Characterization of a Multiple Isolated Flux Path Reluctance Machine." The paper was published for the 2012 IEEE Energy Conversion Congress and Exposition.

- Hua-Tay Lin, materials science and technology researcher, has been selected to receive the 2013 Honor Medal of Aurel Stodola by the Slovak Academy of Sciences. Lin is being recognized for his research activities and significant contributions in sciences on high temperature mechanical behavior of ceramics and composites.

- Environmental sciences researcher Virginia Dale participated in the White House Women's Leadership Summit on Climate and Energy as one of only a select group of 100 women leaders brought together for a dialogue on the President's climate and energy agenda. The gathering provided an opportunity for interaction among women who are leading the nation in outreach, education, and research.

- The American Society of Agricultural and Biological Engineers has awarded Shahab Sokhansanj, ORNL environmental sciences researcher, the 2013 Standards Developer Award. This award recognizes his exemplary leadership and work in the revision to S269 to incorporate modifications and corrections within the standard and to include the use of biomass pellets and cubes.

- ORNL researchers Brian West, Jim Szybist, and Scott Curran received Outstanding Oral Presentation Awards for their presentations at the 2013 SAE World Congress and Exposition held in Detroit in April. The awards were based on high scores given by other attendees at the conference.

- Jonathan Mielenz, ORNL biosciences researcher, was elected to serve a three-year term on the Board of Directors of the Society of Industrial Microbiology and Biotechnology (SIMB). Mielenz also serves as a co-chairman of SIMB's annual Symposium on Biotechnology for Fuels and Chemicals.

- Stuart Daw was selected as a Fellow of the American Institute of Chemical Engineers (AIChE). Stuart is an active leader for the local chapter of AIChE, and this honor recognizes him an elite member.

Congratulations to ORNL's research teams on recent patent activity

- Chaitanya K. Narula and Claus Daniel, "Solid Lithium Ion Conducting Electrolytes and Methods of Preparation."

- Jianlin Li, Beth Armstrong, Claus Daniel, and David L. Wood III, "Aqueous processing of composite lithium ion electrode material."

- Jim Parks and Bill Partridge, "Optical backscatter probe for sensing particulate in a combustion gas stream."

- Jy-An Wang, Zhili Feng, Lawrence Anovitz, and Ken Liu (retired), "Apparatus and method for fatigue testing of a material specimen in a high-pressure fluid environment."

Visits & Events

- ORNL researchers Mark Downing, and Cliff Eberle presented the "State of Technology of Lignin to Carbon Fiber" at the DOE Renewable Low-Cost Carbon Fiber for Lightweight Vehicles Workshop in Detroit in June. This plenary presentation outlined the basis for utilizing lignin for both structural and non-structural carbon fiber production. Hosted by both the DOE Bioenergy Technologies Office and Advanced Manufacturing Office, the workshop was held in anticipation of continued discussions about bio-derived materials.

- ORNL's transportation analysis staff participated in a protocol visit from the Commissioner of Transportation for the State of Tennessee and key members of his staff. The Tennessee Department of Transportation (TDOT) research manager followed up to request ideas for freight studies that might be performed for TDOT.

- DOT executives Gregory Winfree, Research and Innovative Technology Administration Acting Administrator, and Kevin Womack, Office of Research, Development, and Technology, visited NTRC on April 25. DOT provided excellent feedback regarding potential collaborations with the University Transportation Centers for future technology projects.

- The VSI Lab team hosted EPA, Cummins, Eaton, and ICCT who toured the new lab and discussed its impact on the development of new evaluation (and possibly future certification) procedures for Phase 2 of greenhouse gas rulemaking. The group focused on medium- and heavy-duty vehicle powertrain and component analysis and witnessed some of the lab's development activities.

- President and CEO Fred Smith and other executives from FedEx visited ORNL and were given a tour and overview of the VSI Lab, the BMF, and the MDF.

- Representatives from Delphi visited NTRC to discuss power electronics. The group also toured several ORNL sites including the MDF, materials processing facilities, and the Carbon Fiber Technology Facility.

- ORNL hosted Marcello Moreira, a representative from Instituto de Estudos do Comércio e Negociações Internacionais (ICONE, Institute for International Trade Negotiations), Brazil, to compare parameters of the ORNL Global Trade and Analysis Project for Dynamic Energy Policy Simulations and ICONE's Brazilian Land Use Model. This is a first step in linking these two models for improved land use change modeling and analysis.

- ORNL's Robert Wagner presented a keynote lecture titled, "Accelerating the Development of High Efficiency Engines" at the 5th International Symposium on Clean and High Efficiency Combustion in Engines during a meeting at the State Key Laboratory for Engines in Tianjin, China. He also gave a plenary lecture titled, "Pushing the Limits of Stability of Clean High Efficiency Engines" at the 12th International Present and Future Engines Conference in Delphi, Greece.

Do you have news or information you would like to share?

Please submit to Sara Shoemaker,
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The Sustainable Transportation Update newsletter aims to cover news and technical highlights associated with transportation and transportation-related research activities and projects. This publication is produced and distributed by the Oak Ridge National Laboratory's Sustainable Transportation Program Office.