# engineering laboratory

Newsletter • August 2011

## What's inside



What kinds of impacts does EL have on the lives of taxpayers? A complete answer to this question would fill up many newsletters. Let me give you a few examples to show you the breadth of our contribution to the economic prosperity and quality of life in the U.S.

EL is committed to establishing a critical national role for EL in manufacturing R&D, building on our success in this area. Our work in industrial robot and vehicle safety standards has enabled improved safety of industrial robotics and automated guided vehicles. EL research into industrial control network security has enhanced the protection of industrial control systems against cyber attacks by developing security guidelines that have been downloaded over a million times. The Standard for the Exchange of Product Model Data (STEP) saves manufacturers time and money through standards for the exchange of product model data.

EL catalyzed industry to action on addressing the lack of interoperability in the U.S. construction industry by providing an authoritative analysis of its $18.2 billion annual cost to industry and the country. Our integrating sphere-based weathering device enables precise estimates of the lifetime of polymeric materials (plastics, coatings, adhesives, sealants…) through accelerated service life data and models, leading to dramatic reductions in time-to-market and long-term performance of new products. Our energy-related work enables energy savings, reduced operating costs, and consumer awareness via standard DOE testing and rating procedures for HVAC, water heaters, and appliances.

Our fire research has reduced smoking related fires and unsafe mattresses through widely adopted standards and regulations for reduced-ignition-propensity cigarettes and mattress flammability. Changes to the U.S. model codes resulting from the World Trade Center investigation have enhanced nationwide safety of buildings, occupants, and emergency responders though better fireproofing strength, installation, and inspection; structural integrity and fire-resistance rating; occupant evacuation and fire service access; active fire protection systems; and emergency responder communications.

I hope these EL success stories have whetted your appetite to learn more about the work we do in EL. As always, we encourage you to visit our website for more information about ongoing activities in the Laboratory: http://www.nist.gov/el/

Sincerely,

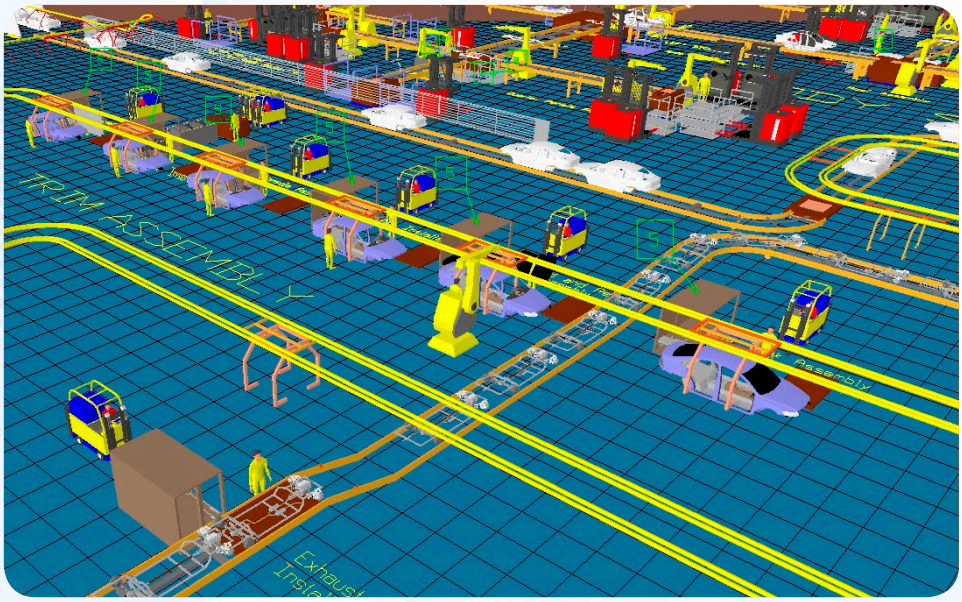
Dr. S. Shyam Sunder

Director, NIST Engineering Laboratory


NIST
National Institute of Standards and Technology
U.S. Department of Commerce

# NIST Spearheads Publication of First Standard for Manufacturing Simulation Data

The Simulation Interoperability Standards Organization (SISO) announced the release of the Core Manufacturing Simulation Data Standard, SISO-STD-008-2010. CMSD helps to resolve long-standing interoperability issues that make integrating manufacturing applications and simulation difficult and expensive. Standards like CMSD help to reduce the systems integration costs incurred by manufacturers due to the lack of systems interoperability across the supply chain, estimated in excess of $5B/year for the automotive industry and almost $3.9B/year for the electronics industry. * CMSD defines a data interface specification for efficient exchange of manufacturing life cycle data in a simulation environment. The specification provides neutral data interfaces for integrating manufacturing software applications with simulation systems. The recent SISO press release quotes Bill Waite, Chairman and CTO at the AEGIS Technologies Group, "This standard will facilitate data exchange between simulation systems, other software applications, and databases, and will speed the construction of manufacturing simulators. Ultimately, increased use of modeling and simulation technology in all phases of the manufacturing life-cycle will significantly accelerate productivity and thereby improve economic well-being so strongly dependent on that economic sector."




**Automobile assembly simulation enabled using CMSD**

The Engineering Laboratory's Manufacturing Systems Integration Division developed the initial draft, validated the evolving specification with industrial partners, and led the SISO effort to standardize the CMSD specification. Swee Leong, Frank Riddick, and Tina Lee have held the elected positions of Chair, Vice-Chair, and Secretary respectively. Riddick and Lee have also served as the official editors for the SISO standards-related documents. A beta version of a CMSD application has been adopted in the development of a potentially lucrative commercial product, tentatively named "eVSM to QUEST," by the Connecticut Center for Advanced Technology, Inc.

SISO is an international organization dedicated to the promotion of modeling and simulation interoperability and reuse for the benefit of a broad range of M&S communities. It is dedicated to the promotion of modeling and simulation interoperability and reuse for the benefit of diverse M&S communities, including developers, procurers, and users world-wide.

* Source: 2004 Economic Impact of Inadequate Infrastructure for Supply Chain Integration Final Report (http://www.nist.gov/director/planning/upload/report04-2.pdf)

# High-Tech Concrete Technology Has a Famous Past

In the business of concrete making, what's old -- even ancient -- is new again.

Almost 1,900 years ago, the Romans built what continues to be the world's largest unreinforced solid concrete dome in the world -- the Pantheon. The secret, probably unknown to the Emperor Hadrian's engineers at the time, was that the lightweight concrete used to build the dome had set and hardened from the inside out. This internal curing process enhanced the material's strength, durability, resistance to cracking, and other properties so that the Pantheon continues to be used for special events to this day.

But it is only within the last decade or so that internally cured concrete has begun to have an impact on modern world infrastructure. Increasingly, internally cured concrete is being used in the construction of bridge decks, pavements, parking structures, water tanks, and railway yards, according to a review of the current status of the new (or old) concrete technology just published by the National Institute of Standards and Technology (NIST).

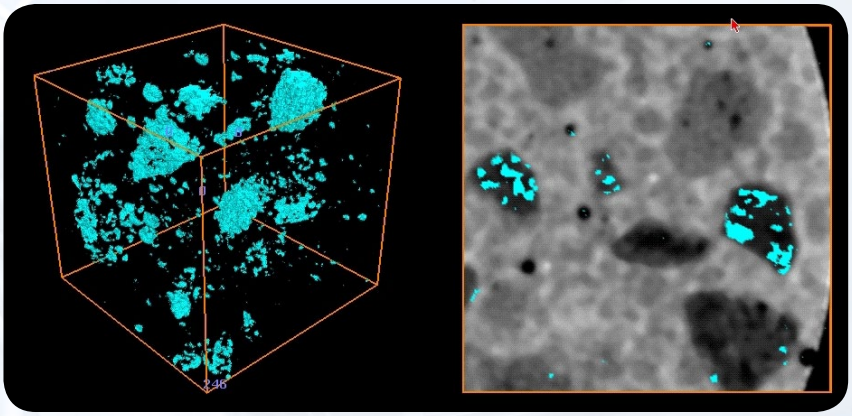
The virtues of internally cured concrete stem from substituting light-weight, pre-wetted absorbent materials for some of the sand and/or coarse aggregates (stones) that are mixed with cement to make conventional concrete. Dispersed throughout the mixture, the water-filled lightweight aggregates serve as reservoirs that release water on an as-needed basis to nearby hydrating cement particles.

According to one study cited in the review, bridge decks made with internally cured, high-performance concrete were estimated to have a service life of 63 years, as compared with 22 years for conventional concrete and 40 years for high-performance concrete without internal curing.

"As with many new technologies, the path from research to practice has been a slow one, but as of 2010, hundreds of thousands of cubic meters" of the lighter and more durable material have been successfully used in U.S. construction, write the report's co-authors, NIST chemical engineer Dale Bentz and Jason Weiss, Purdue University civil engineering professor.

Compared with conventional varieties, internally cured concrete increases the cost of the concrete for a project by 10 to 12 percent, Bentz and Weiss estimate on the basis of bridge-building projects in New York and Indiana. The increased front-end cost, they write, must be evaluated against the reduced risk of cracking, better protection against salt damage, and other improved properties that "should contribute to a more durable structure that has a longer life and lower life-cycle costs," they write. "Further, this could have substantial benefits in a reduced disruption to the traveling public, generally producing a more sustainable solution."

The 82-page report summarizes the current practice and theory of internal curing, reviews project experiences and material performance in the field, and describes opportunities for research that could lead to enhancements in the material.



**X-ray microtomograph (left) shows pores (blue) that remain within lightweight aggregates (LWAs) after water has migrated from the pre-wetted materials during the first day of hydration. In the two-dimensional image (right), the emptied pores are superimposed over the original microstructure (hydrating cement paste is white, sand is light grey, and LWA is dark grey), illustrating the detailed pore structure of LWA particles.**

# Researchers Share Useful Lessons Learned in Evaluating Emerging Technologies

Most industry executives, military planners, research managers or venture capitalists charged with assessing the potential of an R&D project probably are familiar with the wry twist on Arthur C. Clarke's third law*: "Any sufficiently advanced technology is indistinguishable from a rigged demo."

After serving for five years as independent evaluators of emerging military technologies nurtured by the Defense Advanced Research Projects Agency (DARPA), a team from the National Institute of Standards and Technology (NIST) shares critical "lessons learned" that can help businesses and others negotiate the promises and pitfalls encountered when pushing the technology envelope to enable new capabilities.

Writing in the International Journal of Intelligent Control and Systems,** the NIST researchers also describe the evaluative framework they devised for judging the performance of a system and its components as well as the utility of the technology for the intended user. Called SCORE (System, Component, and Operationally Relevant Evaluations), the framework is a unified set of criteria and software tools for evaluating emerging technologies from different perspectives and levels of detail and at various stages of development.

SCORE was developed for evaluating so-called intelligent systems—a fast growing category of technologies ranging from robots and unmanned vehicles to sensor networks, natural language processing devices and "smart" appliances. By definition, explains Craig Schlenoff, acting head of NIST's Systems Integration Group, "Intelligent systems can respond to conditions in an uncertain environment—be it a battlefield, a factory floor, or an urban highway system—in ways that help the technology accomplish its intended purpose."

Schlenoff and his colleagues used their SCORE approach to evaluate technologies as they progressed under two DARPA programs: ASSIST and TRANSTAC. In ASSIST, DARPA is funding efforts to instrument soldiers with wearable sensors—video cameras, microphones, global positioning devices and more—to continuously record activities while they are on a mission. TRANSTAC is driving the development of two-way speech-translation systems that enable speakers of different languages to communicate with each other in real-world situations, without an interpreter. By providing constructive feedback on system capabilities, the SCORE evaluative framework helps to drive innovation and performance improvements.

**A U.S. Marine and a native Pashto speaker converse using a smart phone voice translation system as part of an evaluation of the technology recently conducted by NIST for the Defense Department.** (Photo Credit: NIST)

Several lessons learned recounted by the NIST team are aimed at maximizing the contributions of test subjects and the developers of technologies without biasing test results. "There is often a balancing act," they write,

* "Any sufficiently advanced technology is indistinguishable from magic."

**C. Schlenoff, B. Weiss and M. Steves. A detailed discussion of lessons learned in evaluating emerging and advanced military technologies. International Journal of Intelligent Control and Systems. Forthcoming. To learn more about SCORE, go to: http://www.nist.gov/el/isd/ks/score.cfm.

"between creating the evaluation environment in a way that shows the system in the best possible light vs. having an environment that is as realistic as possible."

They also discuss unavoidable trade-offs due to costs, logistics, or other factors. While evaluators and technology developers should never lose sight of their ultimate objective, the NIST researchers also advise the need for flexibility over time. As more is learned about the system and about user requirements, features may change and project goals may be modified, necessitating adjustments to the evaluation approach.

"The main lesson," Schlenoff explains, "is that the extra effort devoted to evaluation planning can have a huge effect on how successful the evaluation will be. Bad decisions made during the design can be difficult and costly to fix later on."

# Improved Thermal Performance of Self-Contained Breathing Apparatus Face Pieces

The National Institute of Standards and Technology (NIST) in collaboration with the U.S. Fire Administration (USFA), the National Institute for Occupational Safety and Health (NIOSH) and their National Personal Protective Technology Laboratory (NPPTL) along with the Fire Protection Research Foundation held a workshop in July 2010 to identify performance needs and establish research priorities to address the thermal characteristics of respiratory equipment used by emergency first responders. The workshop provided a forum for representatives from the first responder community, self contained breathing apparatus (SCBA) and component manufacturers, as well as research and testing experts to discuss issues, technologies, and research associated with SCBA high temperature performance. The goals of the workshop were defined in two parts: 1) Clarify baseline information, including the current state-of-the-art, applicable fire service events, and current related research, and 2) Research planning, including identification of performance needs and short and long term research priorities.

**An SCBA face piece, shown with other components of fire fighter protective equipment mounted on a instrumented mannequin, after a full scale fire experiment in the Large Fire Research Facility**

The results of the workshop discussions focused on thermal performance needs of the SCBA face piece, the objective being to improve thermal resistance of the face piece to equal or better than the rest of the fire fighter ensemble. The areas identified as priorities for further research included improving SCBA face piece design, characterizing the fire environment, developing more representative and realistic testing, and defining best practices for use and behavior. Further details can be found in the report, NIST Special Publication 1123, Emergency First Responder Respirator Thermal Characteristics:

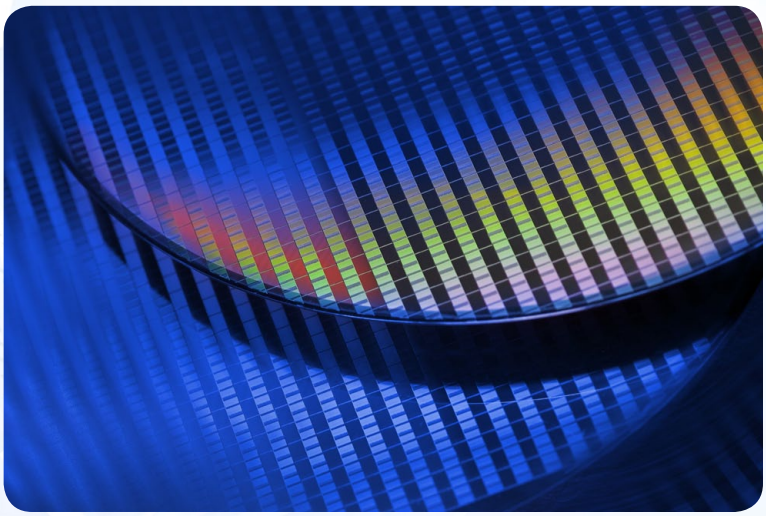
http://www.nist.gov/manuscript-publication-search.cfm?pub_id=908782

Workshop Proceedings: http://www.nfpa.org/assets/files//PDF/Research/RFSCBAFacepiecesWorkshopProceedings.pdf

The EL Fire Research Division is continuing research to improve the thermal performance of SCBA face pieces and is working with the National Fire Protection Association's Technical Committee on Fire and Emergency Services Protective Clothing and Equipment to improve test standards for the SCBA.

# NIST and the Open Applications Group Mark 10 Years of Collaboration

NIST hosted the 2011 spring meeting of the Open Application Group Inc. (OAGi) Consortium April 19-21. This was the 10th consecutive year that NIST has hosted this annual spring meeting of OAGi. The organization, which develops Open Applications Group Integration Specification (OAGIS) a supply chain integration standard, continues to grow and expand into new industries including metals, chemicals, and trade compliance. OAGi now has a total of 50 members with over 3500 standards users from 89 different countries. Those members are very interested in standards for trade compliance, materials declaration, and cloud computing services. The main theme of this year's meeting was cloud computing. The major issue was the role that OAGi can play in developing standards to enable cloud computing for the industries it serves.



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KC Morris, from NIST, presented an overview of the new testing tools NIST has developed to facilitate the testing of OAGIS 9.5, the latest standards release. Severin Tixier, also from NIST, summarized the results of that testing, which was based on the NDR (naming and design rules) test suite used in the previous release, OAGIS 9. Those results were submitted to the OAGi working group preparing the OAGIS 9.5. That group will use those results to make changes to the new release, which is a significant extension of previous releases. That extension was necessary to address new requirements from the chemical and metals industries, as well as, broader requirements for the auto industry and their supply chains. Morris also presented an overview of proposed FY12 projects of interest to OAGi members.

OAGi board members including representatives from Cisco Systems, Microsoft, Intel, SAP, and ORACLE met with Mary Saunders, Director of NIST's Standards Coordination Office. The group discussed NIST's recent reorganization, its emphasis on improving the standards development process, and its role in cross-domain standards convergence.


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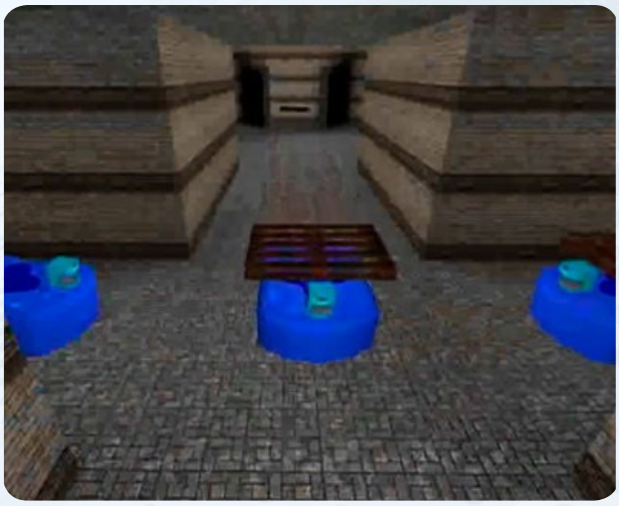
## New Video Showcases NIST-Hosted Robotics Competitions

As reported in a prior EL Newsletter, NIST Engineering Laboratory researchers hosted three of the four robotics competitions at the IEEE International Conference on Robotics and Automation (ICRA) in Shanghai, China in May of 2011. The trio of contests was designed to prove the viability of advanced robotics and micro-robotics technologies. Several EL Intelligent Systems Division staff and associates contributed to ensure the success of these robotic competitions, including Stephen Balakirsky, Tsai Hong, Tommy Chang, Jeremy Marvel, Elena Messina, Joe Falco, Mili Shah, and Charles Hagwood. Stephen Balakirsky served as General Chair of Competitions for the ICRA event.

A new video highlights the best of two of the competitions: the Mobile Microrobotics Challenge (MMC), where microscopic automatons navigate a maze about the size of a sesame seed and perform miniature manufacturing tasks; and the Virtual Manufacturing Automation Competition (VMAC), in which virtual robots pick up pallets, navigate around each other and load trucks in a simulated warehouse environment.

To view the video go to: www.nist.gov/pml/semiconductor/mmc/upload/microrobotsfinal2.mov



**Virtual robots move pallets while maneuvering around each other in a simulation of a busy warehouse.**

Credit: Laboratory for Robotics and Intelligent Control Systems (LARICS), University of Zagreb, Croatia

## NIST Seeks Comments on Structure for Proposed Advanced Manufacturing Consortia (AMTech) Program

A notice published by the National Institute of Standards and Technology (NIST) in the Federal Register requests opinions from the public about the best ways to structure a proposed new Advanced Manufacturing Consortia (AMTech) Program.

First described in the President's fiscal year 2012 budget request for NIST, the AMTech Program is a new public-private partnership initiative that would provide federal grants to leverage existing consortia or establish new ones focused on long-term industrial research needs. The grants would fund development of research road maps and projects in advanced manufacturing and enhance the research productivity of consortia members through improved coordination and efficiencies. The program's goal is to accelerate the innovation process—discovery to invention to development of new manufacturing process technologies—that creates skilled, high-wage manufacturing jobs.

The Request for Information (RFI) asks interested parties to answer 26 questions about eligibility for consortia membership, selection criteria for research funds, best practices for maximizing small business participation or disseminating results, and a number of other topics.

Comments will be accepted by email only to AMtechRFC@nist.gov through Sept. 20, 2011. All comments will be made publicly available.

For further information, see the full Federal Register notice at http://www.gpo.gov/fdsys/pkg/FR-2011-07-22/pdf/2011-18580.pdf and the description of the AMTech Program in NIST's fiscal year 2012 budget request (pages 250 to 254) at: http://www.osec.doc.gov/bmi/budget/12CJ/2012_NIST_&_NTIS_Cong_Budget.pdf

Contact: Barbara Lambis
301 975 4447

Additional Contact: Michael Walsh,
301 975 5545

# Steve McCabe Named Deputy Director of NEHRP

Steven McCabe recently joined the National Earthquake Hazards Reduction Program (NEHRP) as Deputy Director. He manages NEHRP research that is conducted or supported by NIST through its Earthquake Risk Mitigation R&D Program, which combines in-house and extramural expertise to address key research and knowledge-transfer issues in earthquake engineering. He also assists in cooperative work involving the NEHRP agencies and other federal, state, and public domains.

Prior to joining NIST, McCabe was Chief Executive Officer of NEES Consortium, Inc. from 2007 to 2010. There he was responsible for management and operation of the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), which was funded by the National Science Foundation (NSF) with an annual budget of $22 million. He managed the day-to-day operations of NEES headquarters and the network's information technology (IT) development, and worked with NSF, the 15 NEES experimental sites, and the earthquake engineering research community to increase use of network facilities.

From 1985 to 2007, McCabe was a professor of structural engineering in the Department of Civil, Environmental, and Architectural Engineering at the University of Kansas. He taught a variety of courses from beginning analysis through steel, concrete, and masonry structural design, and served as department chair from July 1998 through September 2002. His research interests include earthquake engineering and structural dynamics as well as the application of computer-based nonlinear analysis techniques to static and dynamic analysis problems. A particular interest is the identification of damage levels and reserve capacity in structures under dynamic loads. He researched mechanical splice performance issues under extreme loading and developed criteria and design rules for headed reinforcing bars and other new reinforcing systems for concrete structures.

During 2002–2005 McCabe served as program manager for the Structural Systems and Hazard Mitigation of Structures Program in the Division of Civil and Mechanical Systems at NSF. He managed research funding for structural performance under extreme loading, both natural and manmade, as well as supporting work in structural health monitoring. He was active in the construction and initial operational phases of NEES and managed the first two NEES research competitions.

Before beginning his academic career, McCabe worked at several engineering firms as a design and resident engineer primarily in the nuclear- and fossil-power industries. He is a registered professional engineer and has been active in many national and international professional societies.

## Recent Publications

- Measured CO Concentrations at NIST IAQ Test House from Operation of Portable Electric Generators in Attached Garage – Interim Report, 07/08/11 (Publication 907771)
- MBE Standardization and Validation, 7/06/2011 (Publication 908106)
- Embedded Capacitive Displacement Sensor for Nanopositioning Applications, 7/2011 (Publication 907248)
- Emergency First Responder Respirator Thermal Characteristics: Workshop Proceedings Special Publication (NIST SP) 1123, 6/29/11 (Publication 908782)
- Tool Temperatures in Orthogonal Cutting of Alloyed Titanium, 06/17/2011 (Publication 908259)
- Proposed UNIFORMAT II Classification of Bridge Elements, 06/10/11(Publication 908293)
- Guide to Industrial Control Systems (ICS) Security - Supervisory Control and Data Acquisition (SCADA) systems, Distributed Control Systems (DCS), and other control system configurations such as Programmable Logic Controllers (PLC), 06/07/2011 (Publication 907249)
- A Detailed Discussion of Lessons Learned in Evaluating Emerging and Advanced Military Technologies, 06/03/11 (Publication 907576)
- Performance Assessments of Two-Way, Free-Form, Speech-to-Speech Translation Systems for Tactical Use, 06/03/11 (Publication 908374)
- Characterizing Inward Leakage in a Pressure-Demand, Self-Contained Breathing Apparatus, 06/10/11 (Publication 906719)
- Sustainable Design of Reinforced Concrete Structures through Embodied Energy Optimization, 6/01/11 (Publication 906867)
- Mathematical Modeling of Wildland-Urban Interface Fires, 05/19/11 (Publication 908818)
- Sustainable Manufacturing Indicator Repository, 05/02/11 (Publication 908073)

To search for titles go to:
www.nist.gov/publication-portal.cfm

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For more information about EL, please visit our website at www.nist.gov/el/


**NIST Engineering Laboratory**

Dr. S. Shyam Sunder, Director

Gail Crum, Executive Assistant to the Director

100 Bureau Drive, M/S 8600
Gaithersburg, Maryland 20899-8600
301-975-5900 Telephone
301-975-4032 Facsimile

**www.nist.gov/el**

**el@nist.gov**