EI Annual Workshops

EI hosts an annual workshop with focus on the broad areas of predictive modeling, advanced sensing and information technology. The reports from these workshops are available on our website. We also work with other LANL organizations to co-host workshops. For more information, please contact Chuck Farrar at farrar@lanl.gov, 663-5330.

Events

Please contact Chuck Farrar (farrar@lanl.gov, 663-5335) for more information.

- **Spring 2010 UCSD courses (Instructor)**
  - **Finite Element Methods in Solid Mechanics III (SE 276 C, David Bension), Tu/Th 9:00-10:20 am**
  - **Seismic Hazard Analysis and Design Ground Motions (SE 207, Norm Abrahamson), W Noon-3:00 pm**
  - **Sensor Networks (SIO238, William Hodgkiss), Tu/Th 9:00-10:20 am**

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Engineering Institute

UCSD Jacobs School of Engineering | Los Alamos NATIONAL LABORATORY

this issue

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The Engineering Institute

The Engineering Institute (EI) is a collaboration between LANL and the University of California at San Diego (UCSD) Jacobs School of Engineering whose mission is to develop a comprehensive approach for 1) conducting mission-driven, multidisciplinary engineering research and 2) recruiting, revitalization and retention of the current and future staff necessary to support LANL's national security missions.

The components of the Engineering Institute are 1) the Los Alamos Dynamic Summer School 2) a joint LANL/UCSD degree program, 3) joint LANL/UCSD research projects, 4) annual workshops, and 5) industry short courses.

Contact:
Engineering Institute Leader
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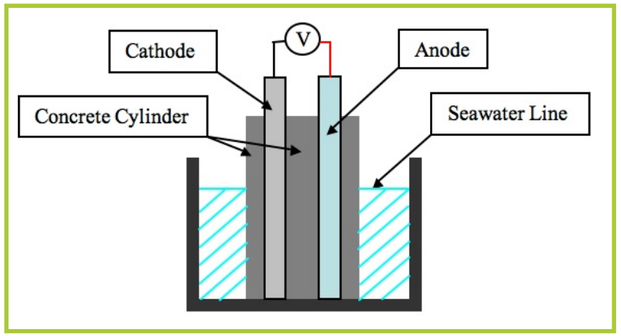
Concrete battery power for wireless sensor networks

Wireless sensor networks play a critical role in many engineering applications. However, power provision can become a limiting factor, as the conventional strategy for powering such wireless networks is a battery. Batteries require periodic retrieval and replacement, as their useful shelf lives often do not exceed the intended service life of their host applications.

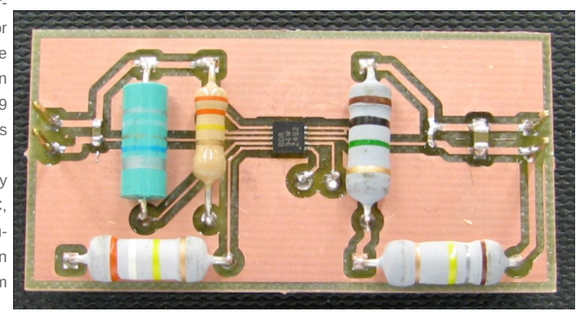
Energy harvesting has emerged as a class of potential network powering solutions whereby one form of energy available on the structure is harvested and converted to useful electrical energy. With this method, sensors can be placed in critical locations on structures which are not readily accessible and continue to make measurements without the need for replacement of a power supply/ battery.



UCSD M.S. student Scott Ouellette, who was from the 2009 Los Alamos Dynamic Summer School and now advised by Prof. Michael Todd (UCSD), is utilizing an innovative energy harvesting method where galvanic corrosion between two dissimilar metals embedded in concrete are immersed in an electrolyte (seawater) creating a battery used for powering wireless sensors on marine structures. This initiative has three phases of deliverables: 1) develop a working power source from corrosion, 2) develop and power a wireless sensor node & determine service life of the corrosion-based power source, 3) develop sensor network & optimize power output. The first phase of the initiative was completed by Scott as an undergraduate, and a manuscript from the 2009 SPIE Smart Structures & NDE conference is available online.

The results from phase 1 have preliminary measurements of output voltage of 1.8 VDC, 5mW of power, and 1V of charge on a 0.1F super capacitor. The concrete battery configuration consists of a carbon cathode, a magnesium anode, and a carbon-fiber admixture used to reduce the electrical resistivity of the concrete, shown in the figure. The investigation from phase 1 concluded that the voltage levels achieved may be naturally integrated with a booster circuit to provide CMOS voltage levels suitable for sensor network powering in some applications.

The project is currently in phase 2 with the development of a 96% efficient booster circuit (pictured below) having just been completed. The prototype circuit board was produced using an in-house LPKF Protomat S62 high precision milling machine. The next step in this phase is to test the voltage boosting circuit with the concrete batteries, and to perform a demonstration of simple measurements and wireless data transmission. Additionally, a power conditioning circuit will need to be developed to optimize the amount of energy stored for discrete measurements for a given duty cycle. With the summer fast approaching, phase 2 will need to be complete with a working demonstration in order to give way to the networking challenges incorporated with phase 3. The goal of phase 3 will be to take measurements of the wave loads on the concrete pilings of the research pier at Scripps Institution of Oceanography (SIO) over an extended period of time using the concrete battery as the power source.



Los Alamos NATIONAL LABORATORY

UCSD Jacobs School of Engineering

UCSD Course Sequences

Signal Processing
Digital Signal Processing
Array Processing
Detection Theory
Parameter Estimation
Stochastic Processes
Sensor Networks
Random Processes

Embedded Systems
Introduction to Embedded Systems
Software for Embedded Systems
Validation and Testing of Embedded Systems
Design Automation and Prototyping for Embedded Systems

Parallel Computing
Large Scale Computing
Parallel Computation

Controls
Linear Systems Theory
Nonlinear Control Systems
Approx Identification and Control
Applied Structural Control

NDE/SHM
Experimental Mechanics and NDE
Structural Health Monitoring

Structural Dynamics
Structural Dynamics
Advanced Structural Dynamics
Nonlinear Mechanical Vibration
Random Vibrations
Wave Propagation in Elastic Media
Wave Propagation in Continuous Structural Elements

Applied Mechanics
Theory of Elasticity
Theory of Plasticity/ Viscoelasticity
Structural Stability
Solid Mechanics for Structural and Aerospace Engineering
Mechanics of Laminated Composite Structures

Computational Mechanics
Numerical Methods
Finite Element Analysis I & II
Computational Fluid Dynamics
Model Verification and Validation

If you are interested in having any of these classes or a class sequences offered at LANL, please contact Kathie Womack (Womack@lanl.gov, 663-5206)

Chatter suppression in single-point boring using smart fluid

Sandra Ward (WCM-2) has recently received her MS degree from UCSD through EI

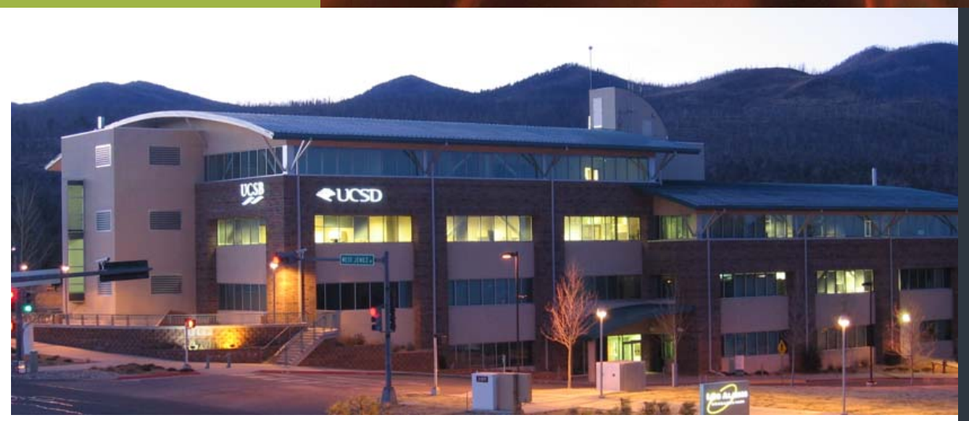
After being with the laboratory for a few years with a BS in Mechanical Engineering, I began looking for a graduate program in engineering that would fit my work schedule. My group leader at the time told me about the Engineering Institute; a joint education initiative between LANL and UCSD that offers comprehensive graduate degrees in engineering. He recommended I contact Dr. Chuck Farrar, leader of the Institute , to inquire about the program. Accordingly, I opted to attend an introductory course on structural health monitoring taught by Dr. Farrar and see how the program lined up with my interests and research needs at the Lab. After completing his course, I enrolled in the engineering program at UCSD the following quarter. With an interest in machining R&D, I was able to choose three focus sequences that provided a complimentary skill-set for a master's degree: signal processing, advanced structural dynamics, and sensor and measurement methodologies. Finding inspiration from my LANL mentor, Dr Gyuhae Park, I chose to do research on chatter suppression in a boring bar using semi-active control and smart fluid. With simultaneous guidance from my UCSD advisor Prof. Michael Todd, I graduated with a MS degree in engineering in Dec 2009.

I found my experience at the Institute akin to being on campus; live courses broadcast on-site during the work day, local mentoring from LANL Staff at the Institute, a UCSD advisor who frequented the laboratory, and access to research space when needed. Furthermore, staff members at the Institute and UCSD provided continuous support in coordinating, facilitating, and broadcasting courses between UCSD and LANL.

Obtaining my degree through the Engineering Institute was a challenging endeavor. However, I recommend the program to anyone seriously considering an advanced technical degree. It's a great opportunity to stay employed with the laboratory while attending graduate school. It also provides means to obtaining a graduate degree via the work you may already be doing. I wish to acknowledge my group leader Doug Kautz in WCM-2 along with my LANL colleagues for their unfeigned support, and the WCM division office for providing tuition assistance.

a. Server Chatter

a. No Chatter



François Hemez received the DeMichele award

EI Staff, François Hemez (XCP-1) received the prestigious D.J. DeMichele award from the Society of Experimental Mechanics (SEM) in January 2010. This award, established in 1990 in honor of Dominick J. DeMichele (1916-2000), recognizes an individual who has demonstrated "exemplary service and support of promoting the science and educational aspects of modal analysis technology." This award is presented annually at the International Modal Analysis Conference (IMAC).

François is currently with XCP-division, manages the code verification project of the ASC program and contributes LANL's effort on the development and application of Verification and Validation (V&V), uncertainty quantification, and decision-making for engineering, nuclear energy, and weapon physics projects. Francois chaired the SEM's Technical Division on V&V from 2005-2009; has served on the advisory board of the IMAC Conference since 2006; and served on the SEM Executive Board from 2007-2009. François received the Junior Research Award of the European Association of Structural Dynamics (2005); and two U.S. Department of Energy Defense Program Awards of Excellence for applying V&V to programmatic work at Los Alamos (2006). François has authored over 285 publications and reports (including 23 peer-reviewed papers) since 1994.

A new director-funded postdoc at EI—David Mascarenas

David Mascarenas recently joined the institute as a director-funded postdoctoral fellow. David received his Ph.D. in Structural engineering from UCSD, advised by professor Michael Todd. David has been an integral part of the Engineering Institute's research in structural health monitoring and wireless hardware development. His Ph.D. dissertation involved the development of a novel "mobile host" wireless sensor network, where a small-scale helicopter platform was used as a mobile host to wirelessly deliver energy to sensor nodes on as-needed basis. Once a sensor node was energized, it would make a measurement and wirelessly transmit the data back to the helicopter for storage and further analysis. His work was highlighted in the April 2008 issue of Sound and Vibration Magazine. For his postdoctoral research, David is planning to do work on using Partially Observable Markov Decision Processes for high-speed, autonomous unmanned ground vehicle escape and evasion. This work is vital to developing tamper-resistant unmanned ground vehicles that are robust when confronted by hostile agents.

Advisory Board for EI

The EI has formed an internal advisory board to help guide its educational and research activities. The purpose of this Board is to maximize the positive impact the EI's recruiting, training and retention activities have on LANL engineers and maximize the number of line organizations impacted by these activities.

The roles and responsibilities of the EI Advisory Board include

- Represent their respective line organization's needs in terms of recruiting, training and retention to the EI staff.
- Guide the collaborative research projects and educational activities of the EI
- Help to define other EI activities such as workshops and development of proposal writing teams
- Bridge a gap between line organization and EI for summer internships, for post-doctoral research appointments, or for staff hiring.

The following members will serve on this advisory board for a two-year period,

Frank Addessio (T-3)
Don Hush (ISR-2)
Doug Kautz (WCM-2)
Thomas Mason (W-6)
Evelyn Mullen (IAT-DO)
R. Alan Patterson (MST-DO)
Ray Guffee (AET-1)
Daniel Rees (AOT-RFE)
Angela Mielke (ISR-3)