Smart Vehicle Concepts Center (SVC)

National Science Foundation - Industry/University Cooperative Research Center

Annual Newsletter **December 2008 Issue**

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Membership (Year 1)

Members and affiliates for the lead intuition (OSU) are:

Industrial Members (2007-08)

Advanced Numerical Solutions
American Axle & Manufacturing
Army Research Laboratory
The Boeing Company
Edison Welding Institute
Ford Motor Company
Goodyear Tire and Rubber Co.
Honda R&D Americas Inc.
Honda Research Institute
Moog Inc.
NASA Glenn Research Center
Solidica
Tokai Rubber
Transportation Research Center, Inc.

Affiliate (2007-08)

BorgWarner, Inc.

Mission

The mission of the Smart Vehicle Concepts Center (SVC) is as follows: (1) Conduct basic and applied research on the characterization of smart materials, and the development of adaptive sensors, actuators and devices (based on active materials and control methods) for application to vehicle sub-systems and components; (2) Build an unmatched base of research, engineering education, and technology transfer with emphasis on improved vehicle performance; and (3) Develop well-trained engineers and researchers (at the MS and PhD levels) with both experimental and theoretical viewpoints.

SVC Website

Please visit us online at:
http://smartvehiclecenter.org

You will find the latest project proposals on the Projects page, reports on the IAB page, and frequent updates on the News page. Please contact Prof. Singh for the latest log-ins on the protected (members only) pages.

For the NSF Fact Sheet on the SVC, please visit:
www.nsf.gov/eng/iip/iucrc/directory/svc.jsp

History

In October 2005, the National Science Foundation awarded a planning grant to The Ohio State University for the purpose of developing the Smart Vehicle Concepts Center. The Ohio State University held a planning conference in October 2006, after which it began accepting proposal submissions and membership sign-ups. The Smart Vehicle Concepts Center was officially launched in July 2007 with support from

www.SmartVehicleCenter.org

National Science Foundation and industrial members. Since February 2007, projects have been initiated by founding members at The Ohio State University. Preliminary discussions with Texas A&M University began in October 2007. Texas A&M University submitted a proposal to the National Science Foundation in early 2008. The First Semi-Annual Project Review and Industrial Advisory Board (IAB) Meeting was held at The Ohio State University in February 2008. In July 2008 the SVC announced the academic partnership between The Ohio State University and Texas A&M University. The First Annual Project Review and Industrial Advisory Board Meeting was held at The Ohio State University August 13-14, 2008.

Academic Partner – Texas A&M University

In July 2008, Texas A&M University (TAMU) was welcomed as the first Academic Partner in the Smart Vehicles Concept Center (SVC). Professor Dimitris Lagoudas of the Aerospace Engineering Department serves as the SVC-TAMU Site Director, with Prof. Ibrahim Karaman (from Mechanical Engineering) and Prof. James Boyd (from Aerospace Engineering), joining him as project leaders.

The Texas A&M University team focuses on scientific and technological solutions for applications where shape memory alloys (SMAs) have an advantage or they are the only feasible solution. Specifically, R&D is focused on overcoming impediments to the commercialization of SMAs.

First Annual (Summer 2008) Meeting Report

On August 13-14, 2008, the Smart Vehicle Concept Center held its First Annual Summer Meeting at OSU. The open session on August 13 opened with a boxed lunch and an overview of the Center. A list of sponsored projects was presented, followed by a short course on Shape Memory Alloys, presented by Prof. Boyd. This was followed by presentations from Texas A&M University and from Wayne State University.

The closed session for SVC sponsors was held August 14, 2008, and technical sessions covering each sponsored project were presented. The Industrial Advisory Board meeting was held after the technical sessions. Members may check out the project presentations and IAB meeting minutes on our website at www.smartvehiclecenter.org. Please note these items are password protected. Contact Prof. Raj Singh for the password.

Winter 2009 Meeting

A meeting for the members
and guests of the SVC

February 5, 2009, 7:30 am to
February 6, 2009, 12:00pm
Texas A&M University
College Station, TX 77843-3141

Tentative Events:

- Introductory Session
- Overview of the Center
- Reception
- Review of Projects (Members Only)
- IAB Meeting

The second semi-annual meeting will be held at the Annenberg Presidential Conference Center in the George Bush Presidential Library and Museum. A block of hotel rooms has been reserved at the Courtyard by Marriott located at 3939 SH-6 Frontage Road E, College Station, TX 77843. The room rate is $85.

Contacts for the Winter 2009 SVC meeting

Texas A&M University
Host: Prof. Jim Boyd
E-mail: boyd@aero.tamu.edu
Tel: 979-458-0419

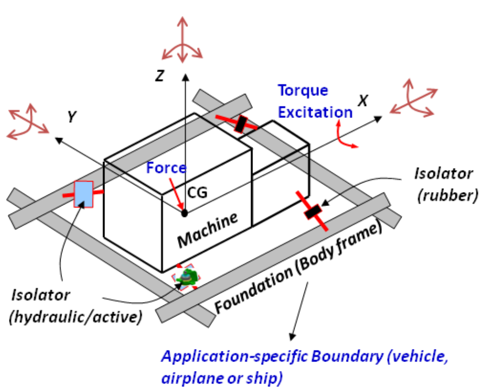
Administrative Assistant: Pam McConal
E-mail: pam@aero.tamu.edu
Tel: 979- 845-9409

The Ohio State University
SVC Center Director: Prof. Rajendra Singh
E-mail: singh.3@osu.edu
Tel: 614-292-9044

Administrative Assistant: Caterina Runyon-Spears
E-mail: runyon-spears.1@osu.edu
Tel: 614-292-9044

Summer 2009 Meeting
A meeting for members of the Industry/University Cooperative Research Center (I/UCRC)

August 12, 2009, 12:00 pm to
August 13, 2009, 5:00pm
Ohio State University (Scott Laboratory)
Columbus, OH 43210



From Project 3: 3 or 4 powertrain mounts must satisfy stringent motion control and NVH requirements, including torque roll axis decoupling

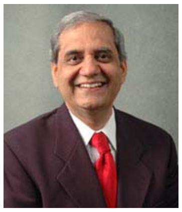
Current Projects – OSU

- **Project 1**: Electro-Hydrostatic Actuation and Sensing (E-HAS)
- **Project 3**: Comparative Design Tool for Examining the Feasibility and Performance of Smart Engine Mounts
- **Project 7**: Multifunctional Composites with Embedded Sensing and Stiffness Control
- **Project 20**: Development of Interfacial Force Sensing Systems using Experimental and Computational Methods
- **Project 22**: Smart Material Database Compilation and Material Selection Tool Development (with Focus on Elastomers)
- **Project 29**: Silent Gearbox Concepts
- **Project 30**: Development of Smart Engine Mount Actuation Mechanism and Active Elastomers
- **Project 31**: Adaptive Seat Belt System Using Smart Material Technologies
- **Project 32**: Critical Assessment of Passive and Active Noise and Vibration Technology for Rotorcraft Gearboxes and Airframes
- **Project 33**: Micro-Sensors for Sound Measurement
- **Project 35**: Development of Contactless Torque Sensor
- **Project 36**: Joining of Shape Memory Alloys and Structural Materials

Current Projects – TAMU

- **Project 1.1**: Processing and Characterization of NiTiPd and NiTiPd-X Shape Memory Alloys for Aerospace and Space Exploration
- **Project 2.1:** Ni-Rich Shape Memory Alloy Fatigue Testing and Modeling

Key Project Leaders



Raj Singh
(Donald D. Glower Chair in Engineering and Professor, Director of SVC)
Expertise: Noise & vibration control, geared systems, nonlinear dynamics, DSP

Marcelo Dapino
(Assoc. Professor, OSU)
Expertise: Smart materials, nonlinear coupled systems, design, control

Gregory Washington
(Interim Dean of Eng and Professor, OSU)
Expertise: Active material systems, vibration control, mechatronics

Dimitris Lagoudas
(John and Bea Slattery Chair of Aerospace Engineering and Professor, TAMU Site Director)
Expertise: Micromechanics of active materials and smart structures; shape memory alloys (SMA)

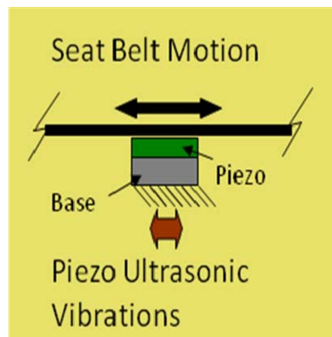
Ibrahim Karaman
(Professor, TAMU)
Expertise: Micromechanical constitutive modeling; Twinning and martensitic phase transformation in metallic materials

Jim Boyd
(Assoc. Professor, TAMU)
Expertise: Structural applications of multi-functional materials; nano and micro electromechanical systems; micro and nano scale electro-mechanics

Illustrative Project – OSU

Adaptive Seat Belt System Using Smart Material Technologies (Project 31)
Project Leader: Prof. Marcelo Dapino

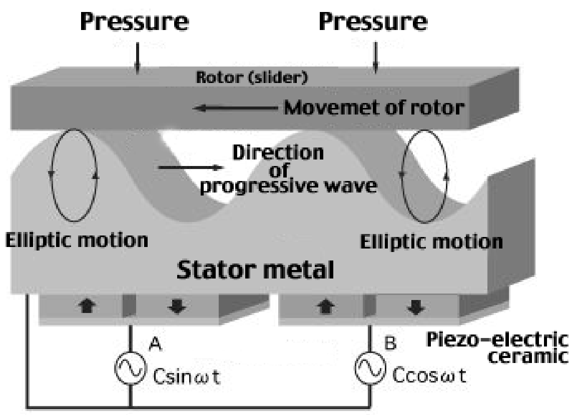
Researchers at the Smart Vehicle Concepts Center are conducting fundamental research that could change the manner in which seat belts are designed and operate. Utilizing the key benefits of smart materials, the new seat belts would be adaptive and would offer unprecedented levels of safety and comfort over existing designs, while also featuring a reduced mass and simpler operation.



"Right now, seat belts are not adaptive and must be designed as compromise for various occupants and loading conditions," says Marcelo Dapino, associate professor of mechanical engineering at Ohio State University and lead investigator on the project. Further, "current seat belts use a pretensioner and load limiter which are bulky, heavy, and complex," adds Dapino. Ideally, a load limiter would ensure that the force applied to the occupant's chest is constant during a crash event. Dapino and his team are looking for ways to precisely control this force by actively varying the effective friction coefficient between the seat belt's D-ring and webbing. Force-sensing yarns based on electroactive polymers reinforced with carbon nanotubes would be woven in the seat belt webbing to facilitate closed-loop control of the seat belt forces. If successful, this approach would allow the seat belt to create optimal restraint regardless of the occupant's size, using compact mechanisms.

"Crash data suggests that small changes in friction forces at the D-ring has a large effect on the chest force," says Dapino, adding that "our recent studies show that ultrasonic vibrations created by piezoelectric materials could provide an effective way of modulating the friction force between a nominal friction coefficient and a much lower friction coefficient when the piezoelectric material is energized." Because the piezoelectric material operates at frequencies in the 40 kHz to 60 kHz range, the system response is much faster than the crash events.

The friction control technology and smart sensing fabrics being investigated could be used in many applications outside of seat belts. Funding for this research is provided by the Honda Research Institute through a 2007 Honda Initiation Grant awarded to Professor Dapino. For further details, contact Marcelo Dapino at dapino.1@osu.edu.



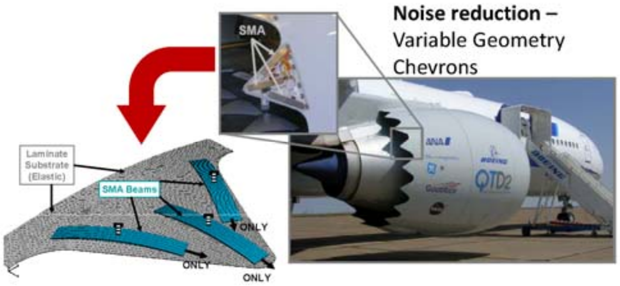
Illustrative Project – TAMU

Thermo-Mechanical Processing and Modeling of High Temperature Shape Memory Alloys for Multifunctional Engine Components (Project 1)

Project Leader: Prof. Ibrahim Karaman

Shape memory alloys (SMAs) can produce high recoverable shape changes as a result of reversible martensitic phase transformation which can be triggered by changes in temperature, stress, and magnetic field. Thus, they have permeated into the biomedical, energy, and aerospace fields for applications involving actuation, pseudoelasticity (PE), vibration damping, and noise reduction. Current use of SMAs is, however, limited to temperatures below 100°C. This is the transformation temperature limit of the two commercial SMA systems: NiTi and some Cu-based alloys. There are several potential applications in automotive and aerospace as well as manufacturing and energy exploration industries in which SMAs with an operating temperature range of 100 to 300°C can enable simplifications and improvements in efficiency of many mechanical components. Few existing high temperature SMAs show distinct dimensional instability and low temperature creep behavior observed at high stress levels without sufficient understanding of the materials behavior. The lack of knowledge on the materials' mechanical and functional response and life makes the development of predictive models challenging and designing with these materials is deemed difficult.

Thus, the present work aims at developing new and improved high temperature SMAs by examining the variations of NiTiX alloy compositions and using new processing techniques and different thermo-mechanical treatments to improve dimensional stability and creep resistance under high stress and temperatures. In order to achieve this goal, microstructural characterization and the influence of the processing on the functional behavior is analyzed. A viscoplastic material model is being developed to provide improved methods for predicting the life of components made of these high temperature SMAs that experience nonlinear, time-dependent behavior such as creep.



Students Graduated in 2008

Song He, PhD, currently with GM
Jae-Yeol Park, PhD, currently with Samsung
Neelesh Sarawate, PhD, currently with GE
Thomas Walters, MS, currently with Moog

Miscellaneous Information

IAB Chair: Duane Detwiler of Honda R&D is the current IAB chair. For questions about the IAB, he can be reached at: <DDetwiler@oh.hra.com>.

NSF I/UCRC: Dr. Rathindra DasGupta is the Program Director of the NSF I/UCRC. He can be reached at: rdasgupt@nsf.gov.

NSF Evaluator: Dr. Eric Sundstrom is the NSF Evaluator. He can be reached at: <sundstrom.eric@gmail.com>.

The Smart Vehicle Concepts Center would like to wish everyone safe and happy Holidays!