Adaptive Structures & Material Systems

ASME & AIAA Adaptive Structures & Material Systems Newsletter Spring 2010

Message from the Chair

Don Leo, Virginia Tech ■ Welcome to the Spring 2010 edition of the AIAA and ASME Adaptive Structures and Materials Systems Newsletter. As you can see from our newsletter, the last year has been a good one for our research community at large. The Smart Structures and Materials meeting organized by SPIE in San Diego had good attendance during a time of financial difficulty for many of our participants, and the 2010 meeting is doing quite well with a measurable increase in participants. I hope that we will see you there in San Diego March 8-11, 2010. The SMASIS meeting, in its second year, was held in Oxnard, CA and included a number of sessions on topics in our community that are bringing a new group of researchers to our field. Thanks to Diann Brei and Chris Lynch for their substantial efforts in making the meeting a technical and financial success. The ICAST 2009 meeting was held in Hong Kong from October 20-22 and, as always, was a great showcase of the international collaborations that exist in our community. Thanks to all of the organizing committee and especially to Dr. W. H. Liao for his leadership in chairing the meeting.

Inside our newsletter you'll find an overview of the awardees from the past year. Congratulations go out to Dr. Henry Sodano and Dr. Amr Baz for their awards for early career success and for a lifetime of work in the smart materials community. Congratulations also go to Dr. Mary Frecker, Dr. Zoubeida Ounaies, and their colleagues for winning the best paper awards for structures and materials, respectively.

You'll also find articles on the evolution of our field and its impact on technology. Xin Xiang Jiang discusses how shape memory allows are impacting the field of space systems, and Dr. Henry Sodano provides an overview of recent advances in the field of energy harvesting. The newsletter also highlights some important advances that have been made in the transitioning of technology - in this case piezoelectric actuation - to the commercial sector. The work by Kinetic Ceramics on the development of piezohydraulic actuation is also noteworthy since it received the Smart Materials Product Implementation Award in 2009.

I would be remiss if I didn't thank all of the people who worked hard to make this Newsletter a success. Thanks to Diann Brei for her persistence and leadership and thanks to Sergio L. dos Santos e Lucato for his excellent work in laying out the newsletter. Thanks also goes to all of those who contributed articles for this edition.

Finally, as chair of the ASME Adaptive Structures and Materials Systems Technical Committee, I would like to extend an invitation to everyone to get involved with the programs that support our research community. Our technical committee meetings are held twice a year; the first is at the SPIE meeting in March and the second is now being held at the fall SMASIS meeting. We would welcome you to join us at one or both of the meetings to see how you can get involved with the organization of our conferences, assistances with our awards, and the consumption of our delicious buffet dinner that is usually served at the meetings. If you have any questions about how to get involved (or the meeting menu) please don't hesitate to contact me.

Don Leo

Chair, ASME Adaptive Structures and Material Systems Technical Committee ■

Diann Brei ■ EDITOR

Table of Contents	Spring 2010

AIAA/ASME TC Officers

AIAA Adaptive Structures TC

Chair: Vit Babuska, *vitbabuska1@msn.com*
Vice Chair: Greg Agnes, *gregory.s.agnes@jpl.nasa.gov*
Secretary: Tim Hindle, *timothy.hindle@honeywell.com*

ASME Adaptive Structures & Material Systems TC

Chair: Don Leo, *donleo@vt.edu*
Vice Chair: Marcelo Dapino, *dapino.1@osu.edu*
Secretary: Zoubeida Ounaies, *zounaies@tamu.edu*
Treasurer: Sergio Lucato, *treasurer@asms-tc.org*

Feature Article

Current Trends and Hurdles in Piezoelectric Energy Harvesting

Henry Sodano, Arizona State ■

With a renewed focus on alternative sources of energy, the concept of harvesting the low-level energy surrounding us has gained significant traction. This energy exists in many forms including solar, thermal, electromagnetic waves, vibration etc. Each of these areas, with the exception of vibration has received significant interest for many years. However, the recent demonstration that piezoelectric materials could be used to convert vibration energy directly into electricity has made this a viable solution for low power wireless sensors and implanted biomedical devices. Evidence of the interest in this emerging field can be found in the publication growth rate in piezoelectric energy harvesting as shown in Figure 1.

Early research into this field was primarily concerned with the characterization of materials, formulation of models and development of methods to quantify the conversion efficiency, see for instance Sodano et al. 2004. Notable studies have been performed by Kymssis et al. (1998) on the incorporation of piezoelectric energy harvesters into shoes for self-powered electronics, Sodano et al. (2004) on the modeling of piezoelectric energy harvesters and Lesieutre et al. (2004) on switched circuits for improved energy conversion efficiency. The results of these early studies made major strides in cementing the technology as a viable source of power. However, as time has passed, one clear issue has arisen from the existing literature base: namely, the lack of a standard method for testing or reporting data, which has led to discrepancies in technologies developed and has complicated the commercial acceptance of the results. This problem has not gone unnoticed, and several groups have begun to formulate standards in reporting. For instance, Liao and Sodano (2009) recently published an article on the evaluation of the efficiency of an energy harvesting device and the shortcomings of a conservation of energy approach when dealing with vibration based harvesting. The articles points out that under conservation of energy the only important parameter is the damping, and the efficiency is independent of the coupling of the piezoelectric material.

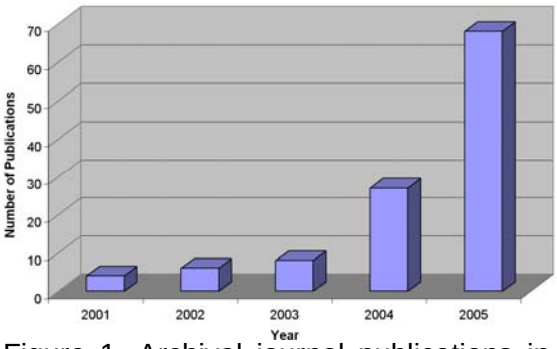


Figure 1. Archival journal publications in piezoelectric energy harvesting per year.

Even with the current lack of a standard process for the reporting of data from an energy harvesting system, the future for electrical energy generation from vibration is bright. Many industries can benefit from the technology, and the significant investments are being made. Current focus is directed at the conservation of energy from humans, such as the energy harvesting backpack developed by Granstrom et al. (2007) or prosthetics developed by Platt et al. (2005) and micro-harvesters for on chip energy conversion, see for instance Jeon et al. (2005). However, like many modern technologies, vibration based energy harvesting requires a multidisciplinary approach with equal emphasis on materials development, vibration analysis and electronics design. The advances in nanotechnology hold many potential methods for efficiency enhancement, such as the use of the flexoelectric effect in ultra thin films or nanostructures. For instance, HARP Engineering LLC is currently investigating nanocomposites for energy harvesting by utilizing morphology control of the filler to increase the conversion efficiency. However, the current roadblock for commercial acceptance of energy harvesting lies in the electronics field – the lack of circuits compatible with the stochastic, periodic and low power output from a piezoelectric energy harvester.

The field of energy harvesting has significant merit and is the key to self-powered electronics, however many technical challenges lie ahead for the progress of the technology into widespread use. An emphasis on multidisciplinary research will ultimately allow the field to progress to commercial fruition.

References

Granstrom, J. et al., 2007, "Energy Harvesting from a Backpack Instrumented with Piezoelectric Shoulder Straps", Smart Materials and Structures, 16(5): 1810-1820.

Hofmann, H. et al., 2002, "Optimized Piezoelectric Energy Circuit Using Step-Down Converter in Discontinuous Conduction Mode," IEEE Transactions on Power Electronics, 18(2): 696-703.

Jeon Y. B. et al., 2005, "MEMS power generator with transverse mode thin film PZT," Sensors Actuators A 122 16-22

Kymissis, J. et al., 1998, "Parasitic Power Harvesting in Shoes," Second IEEE International Symposium on wearable Computers, October 19-20th, Pittsburg, PA, pp. 132-139.

Liao, Y. and Sodano, H.A., 2009, "On Structural Effects and Energy Conversion Efficiency of Power Harvesting,"

World News

R & D Activities at the Canadian Space Agency (CSA) in Shape Memory Alloy Actuator Technology and Potential Space Applications

Xin Xiang Jiang, Canadian Space Agency ■ Future space missions require spacecraft and subsystems with higher performance and functionality and with lower mass and cost than current technologies provide. Smart materials promise to meet these requirements and have, thus, become of greatest interest for future space technology development. The Shape Memory Alloy (SMA) actuator in space systems has been demonstrated to be an enabling factor in many innovative devices where there is a need for high force to mass ratio and design simplicity at the same time. Recognizing the potential for space systems with this technology, the Advanced Materials and Thermal Group of the Spacecraft Engineering Directorate of the CSA initiated R & D on SMA actuator technology in 1999, with a focus on several targeted space applications. One of the major challenges in the design and use of SMA actuators in space, particularly for robotic systems, is precision position control without the benefit of a dedicated position sensor. To address this, research was conducted to establish a 3 dimensional correlation between strain, stress and electrical resistance of SMA (Fig.1), upon which the precision position control of SMA actuators can be based. Reliability and stability of SMA

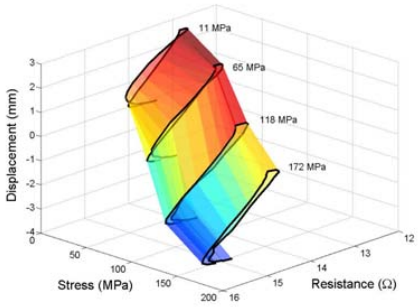


Fig.1 SMA strain, stress and electrical resistance correlation.

actuators is another concern for space applications. xtensive studies were conducted on the fatigue and degradation behaviour of SMA actuators in both ambient and simulated space environments, along with modeling, prediction and in-situ monitoring for high cycle applications. SMA actuators for active flatness control of membrane structures for potential future Synthetic Aperture Radar (SAR) antenna applications (Fig.2) have been successfully demonstrated in a simulated space thermal environment. Work has also been conducted on the design, prototype development and preliminary test of an SMA space structure deployment mechanism and dust cover for space optical instruments, through collaborative R & D with Canadian universities and industry. ■

Fig. 2 Setup of membrane structure flatness control experiment using SMA actuator

Feature Article, cnt'd

Journal of Intelligent Material Systems and Structures, 20: 505-514.

Sodano, H.A et al., 2004, "Estimation of Electric Charge Output for Piezoelectric Energy Harvesting," Strain, 40: 49-58.

Sodano, H.A. et al., 2004, "A Review of Power Harvesting Using Piezoelectric Materials," Shock and Vibration Digest, 36(3): 197-206. ■

Thank You!

To all those that contributed and helped in the preparation of this newsletter!

Julianna Abel	*University of Michigan*	Christopher Lynch	*UCLA*
Diann Brei	*University of Michigan*	Poorna Mane	*University of Michigan*
Marcelo Dapino	*Ohio State*	Greg Reich	*AFRL*
Xin Xiang Jiang	*Canadian Space Agency*	Janet Sater	*IDA*
Don Leo	*Virginia Tech*	Henry Sodano	*Arizona State*
Sergio L. dos Santos e Lucato	*Teledyne Scientific*	Norman Wereley	*University of Maryland*
		Andrei Zagrai	*New Mexico Tech*

Honors and Awards

2009 Gary Anderson Early Achievement Award

Marcelo Dapino, Ohio State University ■ Dr. Henry Sodano has been awarded the Gary Anderson Early Achievement Award by the ASME Adaptive Structures and Material Systems Technical Committee. The award, consisting of an ASME certificate and honorarium of $1,000, was presented at the 2009 Smart Structures and Materials meeting in San Diego, California.

Dr. Henry A. Sodano received his Ph.D. in Mechanical Engineering from Virginia Tech in 2005, his M.S. in 2003 and his B.S in 2002 also from Virginia Tech. He is currently an Assistant Professor in the School of Mechanical, Aerospace, Chemical and Materials Engineering at Arizona State University and was an Assistant professor at Michigan Technological University from 2005-2007. He has published 90 technical articles since 2002 (5 book chapters, 40 refereed journals and 45 proceedings) and currently serves as an associate editor of *Smart Materials and Structures* and the *Journal of Intelligent Material Systems and Structures*. Dr. Sodano is the recipient of the National Science Foundation CAREER award, Arizona State University's 2009 Faculty Achievement Award for Defining Research, and Virginia Tech's 2010 Outstanding Recent Alumni Award. He received the NASA Graduate Student Research Program Fellowship in 2003, was awarded the prestigious Directors Funded Post Doctoral Fellowship at Los Alamos National Laboratories and the best paper at SAMPE's 2008 fall technical conference, received the Paul E. Torgersen Research award at Virginia Tech in 2004 and 2005 and was selected in 2007 for the Air Force Research Laboratory's Air Vehicles Directorate Summer Faculty Program. His current research interests are in the areas of nanotechnology, power harvesting, smart and multifunctional materials, multiscale composites, structural health monitoring, and autonomous structures. His work in energy harvesting led to his selection to give a presentation at the National Academy's 2008 German-American Frontiers of Engineering Symposium for outstanding early-career German and American engineers and an invitation to give the keynote address at the 2008 Power MEMS conference. He is a member of ASME, ASME's Adaptive Structures Technical Committee, AIAA, MRS, SEM, SPIE and SAMPE.

The Gary Anderson Early Achievement Award is conferred to a researcher in his or her ascendancy whose work has already had an impact in his/her field within Adaptive Structures and Material Systems. The winner of the award must be within 7 years of terminal degree at the time of nomination. Nominations may be received at large from any source and should be sent to Dr. Marcelo Dapino at *dapino.1@osu.edu*. ■

2009 ASME Adaptive Structures and Materials Systems Prize

Marcelo Dapino, Ohio State University ■ Dr. Amr Baz received the 2009 ASME Adaptive Structures and Materials Systems Prize. The prize was awarded at the AIAA Adaptive Structures Conference in 2009.

Amr Baz earned his Ph.D. in Mechanical Engineering from University of Wisconsin at Madison in 1973. Currently, he is Professor of Mechanical Engineering at the University of Maryland in College Park, MD. He is also serving as the Director of the Smart Materials & Structures Research Center. Between 2001-2006, he served as the Director of the Small Smart Systems Center. His research interests include active and passive control of vibration and noise and virtual reality design of smart structures. He has published more than 140 papers in referred journals and holds 6 US patents. He is Fellow of the American Society of Mechanical Engineers,

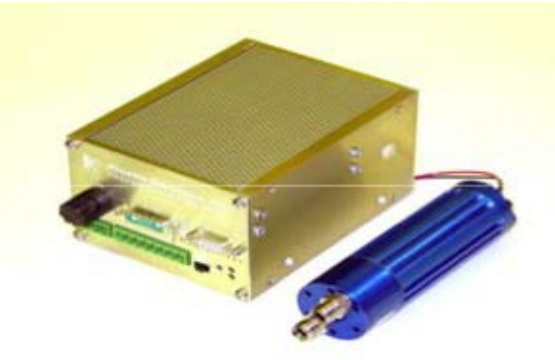
listed in Who's Who of American Inventors, and is a recipient of Engineering Alumni Association Outstanding Faculty Research Achievement Award. Dr. Baz received the 2009 ASME Adaptive Structures and Material Systems award and the Pi-Tau-Sigma Purple Cam-Shaft Teaching Award in 2009. Dr. Baz serves on the editorial boards of journals of *Vibration and Control*, *Smart Structures & Systems*, and *Mechanics of Advanced Materials and Structures*.

The ASME Adaptive Structures and Materials System Prize is presented to a member of the technical community who has made significant contributions to the advancement of the sciences and technologies associated with adaptive structures and/or material systems. The $1,000 cash award and certificate are meant to recognize scientific contributions as measured by leadership, technical publications, and advances made. The award also includes a special evening lecture given by the recipient on Wednesday after the last session of the AIAA Adaptive Structures Conference. Nominations for the 2010 prize can be sent to Dan Inman at *dinman@vt.edu* by November 2010. ■

Honors and Awards, Continued

2008 Smart Structures Product Implementation Award

Janet Sater, IDA ■ The 2009 Smart Structures Product Implementation Award was presented to Kinetic Ceramics, Inc., for their innovative PHP3 Piezo Hydraulic Pump. Conal O'Neill, company president, accepted this award.This miniature, high power density piezoelectric hydraulic pump consists of a piezoelectric actuator that pressurizes a chamber and forces fluid through an outlet valve. Once the fluid packet is pushed through the outlet



valve, the piezoelectric actuator returns to a neutral position, thereby allowing fluid to refill the main chamber. This pumping process continues in a cyclic fashion, allowing fluid to flow through the outlet valve. In fact, the actuator itself can be operated a high frequencies while the output frequency is relatively small. For example, if the piezo actuator operates at 1 kHz, 1000 fluid packets are pushed through the outlet valve, which leads to increased fluid velocity, but doesn't necessarily increase the operating frequency of the piston the fluid is driving. The current spec sheet shows a pump weight of 480 gm; dimensions of 1.5 in diameter and 7.5 in long; a peak flow rate of >40 cc/sec; and a peak pressure of >2000 psi. Power densities of 400 W/kg have been achieved with this device – some other piezo motors have been measured at about 90 W/kg – and further design improvements could push that up to >1 kW/kg.Competing products include electromagnetic motors and piezoelectric motors. For these hybrid pump devices the power density remains constant as the PHP gets smaller. For electromagnetic motors, the smaller the motor, the smaller the power density; this behavior is due to increased resistance in coil windings as size decreases. Most piezoelectric motors rely on friction mechanisms to transfer forces and, with limited force, such motors cannot achieve high power density. These pumps are useful in a number of applications including hydraulic power for aircraft primary flight controls; automotive fluid pumping for lubrication, power steering, antilock brakes, and fuel injection; medical devices; and deep well oil and gas production. ■

For more information visit the Technical Committee Websites:

ASME: http://asms-tc.org

and

AIAA: http://www.aiaa.org/tc/as

AIAA National Capital Section Engineer of the Year Award

Dr. Norman M. Wereley, the Techno-Sciences Inc. Professor of Aerospace Engineering at the University of Maryland, was awarded the American Institute of Aeronautics and Astronautics (AIAA) National Capital Section Engineer of the Year Award. The award is presented to a local AIAA member who has made a recent (within the past two years) individual contribution to the application of scientific and mathematical principles leading to a significant accomplishment or event worthy of AIAA's national or international recognition. Dr. Wereley was recognized at the AIAA-NCS Annual Honors and Awards Banquet, hosted by The Council of the National Capital Section of the AIAA on June 18, 2009. He was honored for his, "revolutionary contributions to the development of adaptive occupant protection systems employing magnetorheological energy absorbers, as well as leadership in education, mentoring, and professional service." Dr. Wereley is a key member of the Alfred Gessow Rotorcraft Center, and is an internationally recognized leader in the field of Smart Structures and Materials in the specialties of magnetorheological (MR) fluids and MR devices. He has developed highly innovative applications of MR technology to adaptive crashworthiness systems for automotive and aerospace applications, such as air bag systems, crashworthy helicopter crew seats, semi-active vibration damping, and shock absorption systems. Most recently, Dr. Wereley led the development of an adaptive seat vibration system for the SH-60 Seahawk helicopter that will soon be entering its flight testing phase. ■

Honors and Awards, continued

ASMS TC Best Paper Awards

2009 Best Paper in Materials

Zoubeida Ounaies, Texas A&M

"Evidence of Piezoelectricity in SWNT-Polyimide and SWNT-PZT-Polyimide Composites" by Zoubeida Ounaies, Texas A&M University, College Station, TX 77843, USA Cheol Park, National Institute of Aerospace, Hampton, VA 23681, USA

Joycelyn Harrison and Peter Lillehei, NASA Langley Research Center, Hampton, VA 23681, USA

Zoubeida Ounaies received her M.S. in Mechanical Engineering and her Ph.D. in Engineering Science and Mechanics from The Pennsylvania State University in 1991 and 1996 respectively. She joined the Advanced Materials and Processing Branch at NASA Langley Research Center in 1997. Since 2005, she is an assistant professor in the Aerospace Engineering Department and the Materials Science and Engineering Program at TAMU. Her research focuses on the processing and characterization of smart polymers and composites. She has been awarded the Texas Space Grant New Investigators Program Award (2006) and the NSF CAREER Award (2007). She is currently the secretary of the ASMS TC.

2009 Best Paper in Structures

Mary Frecker, Penn State

"Stress Relief in Contact-aided Cellular Compliant Mechanisms" by V. Mehta, M. Frecker, and G. Lesieutre October 28-30, 2008, Ellicott City, Maryland, USA

Mary Frecker is a Professor of Mechanical Engineering at the Pennsylvania State University. She has a B.S. from the University of Dayton, and an M.S. and Ph.D. in Mechanical Engineering from the University of Michigan. When she joined Penn State in 1997, she was awarded the Pearce Endowed Development Professorship in Mechanical Engineering. Dr. Frecker has also been awarded the GM/Freudenstein Young Investigator Award by the ASME Mechanisms Committee (2002), the Outstanding Advising Award by the Penn State Engineering Society (2002), the Outstanding Research Award by the Penn State Engineering Society (2005), and Fellow of the ASME (2008). Dr. Frecker is an Associate Editor of the ASME Journal of Mechanical Design, and has served as Chair of the ASME Adaptive Structures Technical Committee. She is also a member of the ASME Mechanisms and Robotics Committee. ■

Historical Note

Greg Reich, Air Force Research Laboratory and Janet Sater, IDA ■

Dr. Michael Obal was another of the founding fathers of the field of Adaptive Structures. In 1990, then-Maj. Obal joined the Strategic Defense Initiative Organization (later Ballistic Missile Defense Organization), where, as program manager for materials and structures, he was instrumental in funding many early space-based adaptive structures projects. Some of these projects include the ACTEX I and II (Active Control Technology EXperiments) to demonstrate adaptive vibration control using smart materials; shape memory alloy release devices; modular control electronics; and the joint U.S./U.K. STRV (Space Test Research Vehicle) experiments to demonstrate cryocooler vibration suppression and sensor platform vibration isolation. Additionally, Dr. Obal provided financial support to the first big conference in the area - the ADPA/AIAA/ASME/SPIE Active Materials and Adaptive Structures conference held in November 1991 in Alexandria, VA. This conference developed into the SPIE Smart Structures and Materials Symposium. Dr. Obal, a now-retired Lt. Col., joined DARPA as a program manager in 2003, where he continued his support for adaptive structure applications in space, including space tethers, flexible electronics, and deployable structures.

Dr. Obal's interest in the field stemmed from his work as a young Air Force officer working with Robert Forward on vibration suppression of laser-based optical systems at Wright-Patterson AFB in the late 1970's. As a PhD student, he studied piezo-based vibration control with Satya Hanagud at Georgia Tech. The pair were among the first to introduce the adaptive structures concept to Gary Anderson at the Army Research Office (ARO). Along with

Industrial News

Engine Exhaust to Energy: Smart Idea for Smart Materials

The day is coming when the heat from your engine exhaust is captured and converted to mechanical energy capable of powering your vehicle's stereo, power seats and air conditioning. General Motors R&D received a $2.7 million federal award that will help build a prototype using Shape Memory Alloy, or SMA, that would generate electricity from the heat in automotive exhaust. "When you heat up a stretched SMA wire, it shrinks back to its pre-stretched length, and when it cools back down it becomes less stiff and can revert to the original shape" said Jan Aase, director of GM's Vehicle Development Research Laboratory in Warren, MI. "A loop of this wire could be used to drive an electric generator to charge a battery."It is too soon to identify a vehicle where this technology could work, but hybrid or conventionally powered vehicles are possible applications."No one else anywhere in the world is doing this work as far as we know," Aase said. "In a hybrid system, the electrical energy could be used to charge the battery. In a conventional engine, this could perhaps even replace the alternator without any load on the engine."The award from the Department of Energy's Advanced Research Program Agency - Energy, or ARPA-E, was the only grant to an automaker among $151 million distributed by the DOE. GM will work with HRL Laboratories, Dynalloy, Inc., a Tustin, CA manufacturer of shape memory alloys specially made to be used as actuators, and the Smart Materials and Structures Collaborative Research Lab at the University of Michigan."This award is significant for the gains in energy efficiency it could bring, and because it signifies how GM is doing business through collaboration and partnership," said Alan Taub, GM vice president of global R&D. "The days are gone when we could do this kind of groundbreaking work on our own. We need to continue to find ways to combine our deep technical knowledge with those who can help keep it on track to commercialization."The idea of an SMA heat engine "has been around for 30 years," Aase said, "but only a few devices have been built that actually work and none of those have been shown to produce enough energy, to last long enough, and to be too massive to make it worthwhile." Even now, it is in the very early stages. A technical concept is not yet validated, but over the next two years, GM and its partners will work to create a working prototype. "We're taking advantage of a network of people that we've been working with for a number of years on shape memory alloys," Aase said. "and we have some novel approaches to make this high-risk, high return project successful." ■

Historical Note, Continued

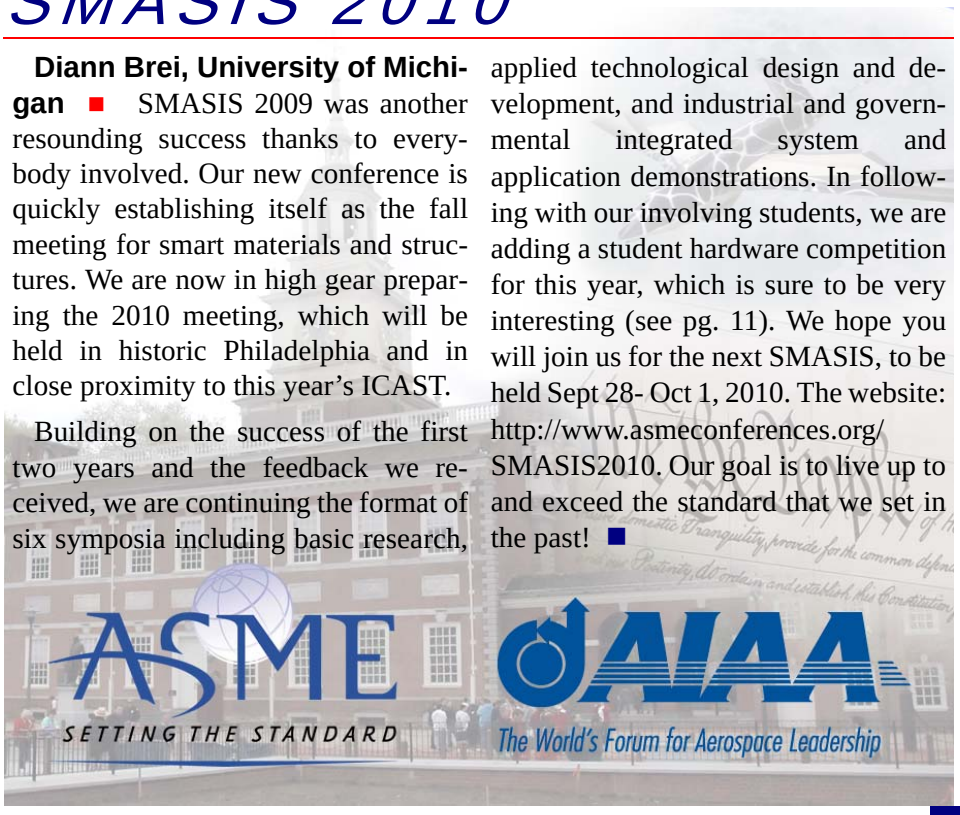
Janet Sater, he published a number of program papers at SDM and the early ICAST meetings presenting the SDIO case for adaptive structures, and laid out the military's planned programmatic response to develop the required technologies.

Dr. Obal's influence on the field of adaptive structures cannot be overstated. As an early researcher, he and Prof. Hanagud laid many of the foundations for later work on vibration suppression. In his positions at SDIO and DARPA, he championed the field as an organizer of meetings, a funding source, and a communicator of the requirements, the challenges, and the potential of adaptive structures to solve real-world problems in space systems. ■

SMASIS 2010

Diann Brei, University of Michigan ■ SMASIS 2009 was another resounding success thanks to everybody involved. Our new conference is quickly establishing itself as the fall meeting for smart materials and structures. We are now in high gear preparing the 2010 meeting, which will be held in historic Philadelphia and in close proximity to this year's ICAST.

Building on the success of the first two years and the feedback we received, we are continuing the format of six symposia including basic research, applied technological design and development, and industrial and governmental integrated system and application demonstrations. In following with our involving students, we are adding a student hardware competition for this year, which is sure to be very interesting (see pg. 11). We hope you will join us for the next SMASIS, to be held Sept 28- Oct 1, 2010. The website: http://www.asmeconferences.org/SMASIS2010. Our goal is to live up to and exceed the standard that we set in the past! ■



THE DEVELOPING SMASIS STUDENT COMMUNITY

Julianna Abel and Dr. Poorna Mane, University of Michigan ■ Smart Materials and Structures students are establishing a vibrant community facilitated by activities at the ASME Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS) conference. The number, type and quality of social and career networking events for students make it the premier conference for up and coming researchers in the smart materials and structures field.

Each year SMASIS has been packed with career networking opportunities that have helped us (the students) to better connect with the leaders in our fields. The Best Student Paper Competition provided a forum for highlighting some of the most exciting and impactful research being conducted in the smart materials and structures field. Finalists of the competition shared their discoveries with professionals and other students during the student competition sessions of the conference. In recognition of their accomplishments, the finalists were acknowledged at the Pioneer Banquet, attended by industry bigwigs, academic leaders and students alike. We also took advantage of other networking events like the Student Mentoring Luncheon, which paired students with professionals from academia, industry, and the government. The poolside luncheon allowed us to engage in one-on-one discussions about developing and achieving our career objectives.

Career networking activities are always appreciated, but social networking activities set the conference apart from others. The unique format of SMASIS allowed all of us to participate in the Pioneer Banquet. Tables were filled with a combination of students, professionals, and family members (even children), advancing the conversation beyond current research results into discussions about the long term implications of our work, our professional aspirations, and our personal goals. Collegial relationships between the students and professionals were further strengthened by the lunchtime volleyball challenge, when we battled the professionals for athletic superiority (but we tied). The highlight was the student dinner cruise. The Pacific Ocean provided the perfect backdrop for us to socialize together building the next generation network.

SMASIS 2010 promises to build upon its success by keeping the tradition of social and career networking events while adding new experiences. We will have a new opportunity to showcase our talents in a Student Best Hardware Competition, which will highlight novel device development, measurement techniques, and prototyping capabilities at the leading educational institutions in the country. In addition, we want to give back by hosting an outreach opportunity which we hope will unite students and professionals through the introduction of hands on smart materials and structures activities to Philadelphia high school students, inspiring the next generation of scientists and engineers. We have developed an enthusiastic student community, and we will take a lead role in organizing student events for SMASIS 2010. We promise it will be exciting. If you are interested in planning student events (or if you just want to let us know your favorites from last year) please contact Julianna Abel (jmariee@umich.edu). ■

SMASIS STUDENT AWARDS

The SMASIS student paper competition was a huge success this year - over 50 students submitted papers spanning topics from all six symposia. One finalist from each symposium was chosen to present their results during the student competition session. Congratulations to the Best Student Paper Finalists - Steven Anton (Multifunctional Materials), Shaofan Qi (Active Materials, Mechanics and Behavior), Su Zhao (Enabling Technologies and Integrated System Design), Israel Lopez (Structural Health Monitoring/NDE), Harinder Singh (Nonlinear Dynamics and Passive/Adaptive Controls), and Shuguang Li (Bio-inspired Smart Materials and Structures). A special congratulations to Steven Anton, who was awarded the Best Student Paper for his presentation, "Self-Charging Structures Using Piezoceramics and Thin-Film Batteries." Also, thanks to Dr. Christopher Niziecki, Dr. Leann Faidley and Dr. Nakhiah Goulbourne for organizing the student paper competition and to all the professionals who dedicated their invaluable time to review papers for the competition. ■

Steven Anton receives Best Student Paper Award presented by Dr. Nakhiah Goulbourne

Education Corner

Student Spotlight

Chaitanya Mudivarthi, a native of Hyderabad, India, joined Prof. Alison Flatau at University of Maryland for his MS in Aerospace Engineering. During this time, he developed a finite element-based bidirectionally coupled magnetoelastic model (BCMEM) that is capable of predicting the macroscopic 3-D behavior of magnetostrictive materials such as Galfenol. His work to understand the sensing behavior of Galfenol nanowires using BCMEM received an honorable mention at 2007 SPIE conference held in San Diego. Further work on the BCMEM was presented at ASME SMASIS 2008 conference in Ellicott City, MD. His work on Galfenol fascinated him immensely, leading to his wish to understand the mechanism of magnetostriction in this alloy at the atomic/lattice level. He is currently pursuing a doctoral study in materials science and engineering to fulfill this wish. His dissertation work involves probing Galfenol at micro- and nanoscale using neutrons, x-ray's, and optical light to unravel the magnetostriction mechanism. His work showing the existence of nanoscale heterogeneities, thought to be responsible for the large magnetostriction in this alloy, by using small-angle neutron scattering was one of the finalists at the "best student paper" competition held at Intermag 2009 conference, Sacremento. His work at microscale studying the magnetic domains of Galfenol under magnetic- and elastic fields was recently invited to be presented at 2009 MRS fall conference in Boston, MA. His collaborative research piecing together the macro-, micro-, and nanoscale magnetostriction processes earned him a patent application, number of journal publications, and conference presentations, including two that are invited. The outcome of his dissertation will lead us one step closer to our understanding of magnetostriction processes in this fascinating alloy and aid in our quest to discover better performing magnetostriction materials. ■

John Redmond is a doctoral candidate at the University of Michigan in Mechanical Engineering, conducting research in the Smart Materials and Structures Design Laboratory. While SMA wires are frequently cited for their great potential to enable energy-dense, low-cost actuation, difficulties in packaging long lengths of wire required for large deflections have hindered their large-scale deployment in industry. In John's research, he has developed a spooled-packaging strategy to overcome this critical obstacle by wrapping SMA wires around mandrels. Based on this technique, John designed an ultrafast SMA-based latch for a pedestrian protection application in his Master's research. For his Ph.D., he derived and validated a predictive model for spool-packaged SMA actuators, and developed a design methodology providing the framework for the synthesis of low-cost, compact, customizable actuators for industrial applications. This work has led to three patents and six conference and journal papers with several more under review. John is an original student in the GM/UM Smart Materials and Structures Collaborative Research Laboratory. His work adds rigor and confidence for industry to adopt SMA actuation, and has helped GM transition to a major focus on smart materials technologies for improved cost and functionality across its vehicle fleet. John's contributions to the field and his leadership at the University have been recognized with numerous awards including the UM Deans/ Named Fellowship, an honorable mention for the NSF Graduate Student Research Fellowship, the UM Distinguished Leadership Award, a Best Poster Award at Michigan's Engineering Graduate Symposium, and a Best Student Paper Award at ICAST2009. When not in the lab, you'll find John practicing aerial yoga or collaborating on interactive set designs for Bang! Productions and the Ann Arbor Film Festival. John will defend his dissertation this spring and is seeking opportunities to design and develop active structures with applications in sustainable buildings and technologies. ■

Majid Tabesh is currently perusing his Master's degree in Mechanical Engineering at the University of Toledo in Toledo, Ohio. He holds a bachelor's degree from Isfahan University of Technology in Isfahan, Iran. Majid joined the Dynamic and Smart Systems laboratory in Mechanical, Industrial, and Manufacturing Engineering Department in January of 2008 and embarked on his research under the advisement of Dr. Mohammad Elahinia during the first semester.

Majid's research focuses on the design and development of medical devices from shape memory alloys, especially Nitinol, aiming at utilizing the unique properties of this type of smart material in negotiating the functionality barriers of conventional materials. As part of this research, devices such as smart pedicle screw, esophagus displacer, thrombectomy catheter, etc are under development. The smart pedicle screw enhances the effectiveness of the spinal surgical treatments against the osteoporosis risks. The screw is implanted in the spinal vertebrae in a collapsed form and expands when body tempera-

Continued on page 10

Calendar of Events

SPIE Smart Structures & Materials Symposium,
San Diego, CA
Dates: March 7–11, 2010
http://spie.org/smart-structures-nde.xml

AIAA/ASME/AHS Adaptive Structures Conference,
Orlando, FL
Dates: April 12-15, 2010
http://www.aiaa.org/events/sdm

2010 U.S. Navy Workshop on Acoustic Transduction Materials and Devices
State College, PA
Dates: May 11-13, 2010
https://www.mri.psu.edu/conferences/usnavy/index.asp

12th International Ceramics Congress, CIMTEC 2010
Montecatini Terme, Italy
Dates: June 6-11, 2010
http://www.cimtec-congress.org/2010/ceramic_congress.asp

International Exhibition on Smart Actuators and Drive Systems
Bremen, Germany
Dates: June 14-16, 2010
http://www.actuator.de

21st International Conference on Adaptive Structures and Technologies
College Station, PA
Dates: October 4-6, 2010
Abstracts Due: May 3, 2010
www.icast2010.net

ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems
Philadelphia, PA
Dates: September 28 - October 1, 2010
Abstracts Due: March 19, 2010
http://www.asmeconferences.org/smasis2010/

International Workshop on Smart Materials and Structures
Montreal, Canada
Dates: October 21 - October 22, 2010
Abstracts Due: June 15, 2010
http://www.cansmart.com/workshop2010.htm

Education Corner, continued

ture is reached. Thus, as the bone goes through osteoporosis and degradation, the screw maintains its purchase and prevents loosening. The collaborative proposal submitted to the Ohio Third Frontier Commission, incorporating these ideas, was awarded $3 million to develop and commercialize products made from Nitinol.

Another component of Majid's research work is modeling the thermomechanical performance of shape memory alloys. He successfully developed a code in the frame work of COMSOL Multiphysics, software which can be used to simulate the behavior of designed components and devices from Nitinol. His work appears in five conference papers, three soon-to-be published journal papers, and two provisional patents.

In addition to his strong academic background and dedication to scientific research, Majid has been involved in numerous extracurricular activities. These include volunteering in various seminars, judging in conferences on campus, assuming leadership roles in several campus activities, and participating in multicultural programs. He served as the acting president for the University of Toledo's Engineering Graduate Student Association dedicated to providing a development springboard for graduate students. Majid will defend his thesis this spring semester graduating with a GPA of 3.93 and will be seeking a PhD post graduate research position as of May 2010. ■

Vipul Mehta is a PhD candidate in Mechanical Engineering at Penn State University. Vipul has presented his work on cellular structures at three conferences (2009 SMASIS, 2008 SMASIS, 2008 SPIE SMS). His 2008 SMASIS paper received the ASME Adaptive Structures and Material Systems best paper award in adaptive structures. He has published two journal articles in ASME Journal of Mechanical Design and IEEE Transactions on Robotics. Prior to at-

tending Penn State, Vipul obtained his B.Tech. and M.Tech. degrees from Indian Institute of Technology, Bombay, where he was recipient of Institute Silver Medal for academically best student in his program of study.

Vipul is currently working on design and analysis of contact-aided cellular compliant mechanisms for high-strain and high-strength applications such as morphing aircraft skin. He introduced the concept of incorporating contact mechanisms into cellular structures, thereby increasing their stretching capacity. The contact mechanism reduces the maximum stress in the cellular structures by redistributing the loads – a phenomenon termed as 'stress relief'. He has designed cellular mechanisms using this concept that can be stretched elastically as high as about 30 times the core material allowable strain, resulting in a 100% improvement over the cellular structures without contact. He showed that such cellular structures with contact can be used in morphing aircraft skin and that the resulting skin mass is decreased by about 13%. He has also developed an accurate analytical model to predict the stretching capacity knowing the cellular geometry. The model was used to maximize the stretching capacity as well as the stress relief using genetic algorithms. He has conducted experiments on aluminum prototypes to validate some of the results. His research group is collaborating with another research group at Penn State to fabricate meso-scaled cellular structures using nano-particulate zirconia and stainless steel. Presently, he is developing a topology optimization algorithm to synthesize contact-aided cellular mechanisms. The synthesis yields new designs that can be used for high-strain applications. Apart from current research, Vipul also hold interests in mechatronics, control systems, and robotics. ■

Andrei Zagrai, New Mexico Tech

■ Student activities at SMASIS 2008 and 2009 attracted a notable number of participants. To make an upcoming SMASIS 2010 conference even more interesting and exciting event, the scope of student activities is broadened to include a hardware competition. New best student hardware paper competition is aimed at inspiring interest in adaptive structures, promoting practical engineering skills, and encouraging student participation in hardware development. The event will give students (and their advisors) an opportunity to demonstrate adaptive/intelligent structures hardware or experiment developed as a part of educational and research projects or university design courses.

Eligibility for the contest

• While other authors may be listed on the paper, the student must have contributed the majority of the hardware efforts presented, writing of the paper and poster presentation.

• Student participants are required to submit via web a regular technical paper based upon their hardware, which will undergo the normal conference review process and deadlines.

• Authors of accepted papers must e-mail by July 12th , 2010 a paper PDF file to the contest chairperson, Prof. Andrei Zagrai at azagrai@nmt.edu. Please include the paper tracking number in the subject line of the e-mail.

• The student author must commit to attending the conference and presenting his or her paper at the special hardware exhibit session in addition to their regular assigned session.

Entrees in the competition will be judged by a committee of smart materials and structures experts and a list of finalists will be determined based upon the technical paper. Finalists are required to present their papers at a regular conference session and must participate in a special exhibit session to demonstrate hardware operation and a present a poster explaining the nature of the project. The papers and presentations submitted to the contest will each need to explicitly demonstrate a connection to smart materials, adaptive structures, and/or integrated systems, and represent advancement to the state-of-the-art. Evaluation criteria include relevance to conference topic, significance of work, creativity and innovation, completeness and quality of work presented. The overall SMASIS conference best student hardware will be selected from the finalist based on the project presentation in the hardware demonstration session. The finalists will be honored during the Pioneer Banquet. It is expected that several monetary awards will be presented to the selected finalists and overall conference winner.

Questions on the student hardware paper competition may be addressed to Prof. Andrei Zagrai, *azagrai@nmt.edu* or voice 575-835-5636. ■

Key Dates:

Abstracts Due:	03/19/2010
Final Full Papers:	06/11/2010
Competition Submission:	07/12/2010
Finalist Notification:	08/23/2010
Student Hardware Competition:	09/29/2010

SMASIS Conference Synopsis

Adaptive Structures and Materials Systems by definition are intelligent, flexible systems that have sentience and responsiveness to ever changing environments. The field has rapidly matured due to synergistic interdisciplinary efforts across sectors of universities, government and industry. To continue the high impact growth of this field and lead it into the future, the purpose of this conference is to assemble world experts across engineering and scientific disciplines (mechanical, aerospace, electrical, materials, and civil engineering, biology, physics chemistry, etc) to actively discuss the latest breakthroughs in smart materials, the cutting edge in adaptive structure applications and the recent advances in both new device technologies and basic engineering research exploration. The conference is divided into six symposia broadly ranging from basic research to applied technological design and development to industrial and governmental integrated system and application demonstrations.

Schedule

March 19, 2010: 400 word abstract due
April 26, 2010: Authors informed of abstract acceptance
June 11, 2010: Copyright form due
June 11, 2010: Final full-length paper due

Full paper will appear in an archival ASME Conference Proceedings. Selected papers will be published in archival Journals.

Participation

Authors should submit a 400 word abstract to the conference web site www.asmeconferences.org/SMASIS10. Questions can be directed to:

Diann Brei, General Chair
dibrei@umich.edu

Mary Frecker, Technical Chair
mxf36@psu.edu

Executive Committee

Dan Inman, Jay Kudva, Greg Carman, Kon-Well Wang, Ephrahim Garcia, Dimitris Lagoudas, Nancy Johnson, Alison Flatau, Anna McGowan, Roger Ohayon, Janet Sater, Inderjit Chopra

Image courtesy of Dan Smith

Call for Papers

ASME Conference on

SMART MATERIALS, ADAPTIVE STRUCTURES AND INTELLIGENT SYSTEMS

September 28 - October 1, 2010
Philadelphia, PA, USA

Sponsored by the Adaptive Structures & Materials Systems Technical Committee, Aerospace Division
Participating society: AIAA Technical Committee on Adaptive Structures

The conference is divided into six symposia broadly ranging from basic research to applied technological design and development to industrial and governmental integrated system and application demonstrations. The six symposia specifically are:

Multifunctional Materials: ***focuses on the development of materials (polymers, oxide single crystals and ceramics, metals, multiferroics, new materials systems)***
Chair: Pavel Chaplya, *Sandia National Labs*
Co-Chair: Zoubeida Ounaies, *Texas A&M*
Topical areas: Material formulations, evaluation, synthesis, and processing; multifunctional composites and hybrid materials; bio-inspired and nano-composites; self-healing materials; novel triggering approaches, including optical, chemical, electrical, and mechanical; material property enhancement; interface and interaction science.

Active Materials, Mechanics and Behavior: ***focuses on characterization and mechanics based modeling of field coupled materials***
Chair: Stefan Seelecke, *North Carolina State*
Co-Chair: Marc Kamlah, *Karlsruhe Inst. Tech.*
Topical areas: Advanced constitutive measurements, micro- and nano-mechanics of actuator & sensor materials, phase field modeling, multi-scale and multi-physics material models, finite element implementations, reliability issues: aging, fatigue, and fracture, materials for energy storage

Modeling, Simulation and Control: ***focuses on the dynamic modeling, simulation, and control aspects of smart material systems and structures***
Chair: Mohammad Elahinia*, Univ. of Toledo*
Co-Chair: Chris Rahn, *Penn State*
Topical areas: Micro and macro level modeling, vibration and acoustic control, passive/semi-active/active damping and stiffness variation, actuation and motion control, intelligent and adaptive control, nonlinear control, hysteresis control, modeling simulation and control of micro/nano systems, nonlinear dynamics, and nonlinear vibration

Enabling Technologies and Integrated System Design: ***focuses on the design processes and development of smart devices, active technologies and intelligent systems***
Chair: Nancy Johnson, *GM R&D*
Co-Chair: Norman Wereley, *Univ. of Maryland*
Topical areas: Sensors and actuators, power and control electronics, smart devices and technologies, compliant mechanism design, adaptive / intelligent /integrated systems design, smart structures design processes and tools, Industrial and Government smart products and system applications, smart electronics and devices, MEMS

Structural Health Monitoring / NDE: ***focuses on the application of distributed sensor networks to damage detection***
Chair: Andrei Zagrai, *New Mexico Tech*
Co-Chairs: Oliver Meyers, *Mississippi State*
Ken Loh, *UC Davis*
Topical areas: Damage identification & mitigation, sensor networks, data fusion, data mining and management, damage diagnostic and prognostic modeling software, system integration, and applications.

Bio-Inspired Smart Materials and Structures: ***focuses on application of biological understanding to inspire novel biomimetic smart materials, devices and structures***
Chair: Lisa Weiland, *University of Pittsburgh*
Co-Chair: Mike Philen, *VirginiaTech*
Topical areas: Modeling of biological systems, understanding physical phenomena in biological systems, biomimetic and bio-inspired devices, machines and robotics, utilizing biological systems, smart prosthetic systems and intelligent implant materials and structures

ASME SETTING THE STANDARD

AIAA The World's Forum for Aerospace Leadership