ASME & AIAA Adaptive Structures & Material Systems Newsletter Spring 2011

Adaptive Structures & Material Systems

Diann Brei ■ EDITOR

Table of Contents — Spring 2011

MESSAGE FROM THE CHAIR

Greg Agnes, JPL ■ Welcome to another edition of the newsletter. I became chair of the AIAA Adaptive Structures TC last April approximately twenty years after a fellow graduate student (Ron Barrett) introduced me to these cool little piezoelectric wafers that could make structures move. Over that time, I have watched the field evolve from one dominated by cantilever beams and university demonstrations, to a mature field with products in aerospace, automotive, medical, and sporting goods (just to name a few).

On a regular basis at JPL, I run into applications of Adaptive Structures technology. From the next generation of lightweight optics and reflectors that will gather the light from the far reaches of the universe, to ultrasonic drills bound for Venus and Mars, Adaptive Structures have left the laboratory bench-top and are making their way into real-world applications. In fact, these are not seen by most as an application of adaptive structures, but as a way to make things. Their performance, not the glamour of being the newest technology on the block, is what is getting the technology funded.

This is not only true in NASA. The automotive applications demonstrated by the University of Michigan, the Morphing Wing UAVs funded by DARPA, and many others similarly embody this transition. The philosophy of adaptive structures design (that objects can sense their environment and change their shape or load-path to respond in an appropriate way) is approaching the mainstream. As our field evolves, the challenges we face change with it. For the next decade in Adaptive Structures three major challenges will face us.

Our first challenge will be to bring together the "Rules and Tools" of adaptive structures component technologies to mainstream design. The ability to analyze and simulate not only the performance of multi-physics, often nonlinear mechanics, must be available for the design engineers in industry. We as a community must work to establish the benchmark problems, the standards, and the datasets needed to enable design.

Second, as specific large government Adaptive Structures research programs becomes rarer, keeping the critical mass of the adaptive structures conferences going will be critical. We must, as a community, strive to bring the best university, government, and industrial research and development together. The interaction of the three invigorating for the field and without a critical mass of the three, advancement will be slowed. Communication is critical so please thank Diann and her staff for the difficult job of pulling together this newsletter each year.

Finally, we must encourage and inspire the next generation of adaptive structures researchers. Work within our committee to put together Education Kits (contact Ron Barret for information) and to publish a new book (Norm Werely, editor) has recently been completed. At SMASIS, a young professionals forum was held along with the high school outreach and hardware competition. The first Adaptive Structures Shootout was held two years ago to bring a hardware competition to the Adaptive Structures Conference. I am hoping to reinvigorate this effort this year, with a competition similar to Science Olympiad's Mission Possible, a Rube-Goldberg challenge with points awarded for using different Adaptive Structures technologies. Contact me if you're interested in helping.

By inspiring the next generation of students, keeping the critical mass needed to interact and grow at conferences, and providing the rules and tools needed for product development; we all can help keep this technical community healthy. I look forward to working on these challenges with you over the coming months. ■

For more information visit the Technical Committee Websites:

ASME: http://asms-tc.org

and

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

Feature Article

SMASIS 2011 - Symposium on Sustainability

Lisa Mauck Weiland, University of Pittsburgh ■ Is it green? Is it sustainable? Is it just another research fad? I for one don't think sustainability is any more a fad than smart materials research was a few decades ago. But even if you're not yet convinced, it may be fruitful to entertain the issues.

To begin, despite the fact that the words 'green' and 'sustainable' are often used interchangeably, they are in fact not synonyms. 'Green' is unclearly defined and sometimes embodies political connotations. On the other hand, sincere thought has been invested in defining 'Sustainable.' Here the intent is to extend the classic dictionary definition, 'capable of being sustained,' to the specific case of *sustaining human life*. One of the often quoted definitions is, "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." – Brundtland Commission of the United Nations, 1987.

It is generally accepted that there are three key, intertwined areas of sustainability: economic, social, and environmental. Per the above definition these three pillars should be respected as having equal importance. However, early-entry for most of our research community will likely lie with environmental sustainability.

With the specific case of environmental sustainability in mind, let's return to that dictionary definition, 'capable of being sustained.' How does that phrase translate into the lingo of a person classically trained in engineering and science? The answer is Introductory Thermodynamics.

As students, when we were first introduced to the idea of drawing a boundary around some control volume, we were offered a range of thought experiments to consider the implications of energy and mass crossing that boundary. For cases where *sustaining* equilibrium was desirable, we came to understand that an arrow pointing in must be balanced by an arrow pointing out over time – though not necessarily balanced at a specific moment in time. In fact, for equilibrium studies it is imperative that the conservation laws be considered in their rate forms. Put in that context it is

interesting to note that oil is in fact a renewable resource – we're just extracting it at a rate that far exceeds the rate at which nature replenishes it.

But sustainability reaches well beyond energy issues. It addresses the consumption or, in some cases, corruption of any natural resource on which we humans depend, either directly or indirectly. To consider environmental sustainability in its broadest form, an interesting exercise is to draw boundaries first around the entire ecosystem that supports us (a hollow sphere bounded below by the earth's crust and bounded above by the outer rim of the atmosphere) in comparison to specific ecosystems within. Among other things, this exercise enables consideration of some second law implications. For instance, once we make '*it*' – whether from once-naturally-sequestered substances extracted from the earth's crust or from substances found in the biosphere – *it* will ultimately be distributed. In some cases the interaction of the things we make with the biosphere are unexpected – such as fertilizer runoff leading to the formation of massive deadzones in most US coastal regions, and subsequently contributing to a degenerating condition of our (food) fish stocks.

How does all of this relate back to the smart materials community? Well, frankly sustainability is a topic of importance to all, but we do bring a unique skill set to the table. We are especially adept at exploring and utilizing the tenets of transduction – of manipulating the flow of energy and matter (sometimes already in structural form) from one domain toward another. In fact we are so skilled at creating boundary-crossing arrows that it is often implicitly taken as granted in our programs. And since our programs are routinely ideated in response to societal needs, adding sustainability to our repertoire is also a natural extension.

And with that I will close with a challenge of sorts. If you are currently considering sustainability from a professional perspective for the first time, when you do your literature searches and have those conference hallway conversations, engage them with the intent of seeding one new project with a sustainability thrust. Collectively we are already poised for sustainability high impact; I look forward to learning from the creative and varied ways in which our community will demonstrate that predisposition. ■

WORLD NEWS

MORPHING IN EUROPE, 2010

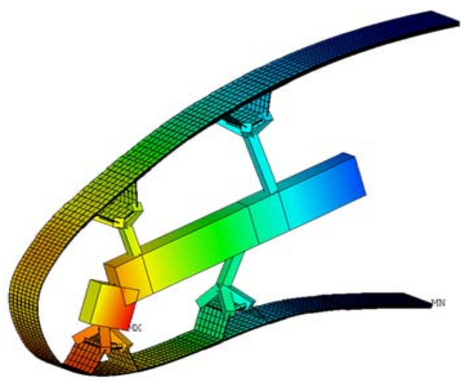
Johannes Riemenschneider, German Aerospace Center and Grzegorz Kawiecki, Boeing ■ An important portion of European morphing research is done within the framework of three European Commission - sponsored projects. Project activities range from feasibility testing of innovative airframe and lifting surfaces morphing concepts to the development of more efficient optimization methods.

Work on the Swansea University (UK) - led, 7th Framework Program sponsored project "Optimization of multiscale structures with applications to morphing aircraft" - **OMSAMA**, has begun in 2010 and is oriented towards the development of multi-physics and multi-scale modeling methods with application to aircraft shape changes.

"Smart High Lift Devices for Next Generation Wings" - **SADE** is another FP 7 sponsored project, which began in 2008 and is lead by HP Monner (DLR). This project is targeting to the evaluation of promising morphing high lift devices and has already contributed significantly to this field [http://www.smr.ch/sade]. The devices investigated within SADE are the seamless 'smart leading edge device', which is an indispensable enabler for laminar wings and offers a great benefit for reduction of acoustic emissions, and the 'smart single slotted flap' with active camber capability, which permits a further increased lift.

Several concepts to design such high lift devices are being investigated. Cranfield University (UK) is contributing numerical studies towards the use of a rotating eccentric beam which supports the skin of a leading or trailing edge. CIRA (Italy) developed a leading edge concept with a morphable metal skin, and TsAGI (Russia) designed a morphing trailing edge based on SDS material. Several small demonstrators have been built to validate numerical models. One approach, which is based on a kinematic chain and a flexible skin, is being designed and will be tested in a wind tunnel in 2011 (see picture).

The wind tunnel model is a five meter constant airfoil section of a FNG wing with a chord of 3 meters. It is equipped with a flexible nose part and a flap, which can be placed into cruise, takeoff and landing positions. As the flaps and wing box are rather conventional in their design, the seamless smart leading edge is designed to be flexible enough to be morphed into the take off and



landing shape, but strong enough to carry the aerodynamic loads into the substructure and to bear the strains of morphing. In order to do so, a skin design process is established, which allows us to tailor the skin thickness. The displacements introduced by the kinematics morph the skin into the desired shape, which introduces loads into the GFRP skin. In the end, omega stringers were designed to distribute the load of morphing deflections into the skin, taking into account stringer stability and strength. The difference between the aerodynamically wanted target shape and the achieved shape is within tolerable limits. Besides the skin design it is an important task to design the kinematics to deploy to a position of approx. 18 degrees down. The kinematics have to follow the trajectories given from structural investigations of the skin with minimum deviations, allow continuous movement (no raster or holding / breaking mechanisms); and it has to keep driving moments low for fully retracted and fully deflected position. Another requirement is to keep only one actuation per kinematic mechanism. The next step towards the wind tunnel experiment is the manufacturing of the hardware, which will be done by different partners: DLR will provide the leading edge skin, EADS (Germany) will provide the kinematic mechanism, the trailing edge with the flaps and the mounting plates will be manufactured by Piaggio (Italy), and the wing box and side plates as well as the connections to the wind tunnel will be manufactured by TsAGI. The wind tunnel model will be equipped with pressure sensors to compare the experimental results with CFD predictions, but also with strain and displacement measurements. That way the drooped shape of the nose under aerodynamic loads can be measured.

To top the project off, an evaluation of these concepts on an aircraft level will be carried out. The RWTH Aachen (Germany) and Airbus will introduce the different devices into their tools and predict the impact on weight, fuel and, of course, DOC on a conventional A 320 type transport aircraft.

The project titled "Smart Morphing Technologies" - **SMorph** has been partially sponsored by the EC Eurocores S3T program and was started in 2006. The program was initiated jointly by European Science Foundation and the US National Science Foundation. Among its objectives are to improve links and to create new synergy among efforts of American scientists and their European colleagues. The SMorph project has been focused principally on wing structure morphing and on development of a comprehensive design tool to help in efficient morphing concepts

Continued on page 7

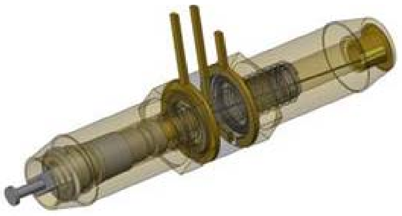
FLEXINOL® ACTUATOR WIRE SHAPE MEMORY ALLOY APPLICATIONS: SPANNING INDUSTRIES OF ALL TYPES

Jeff Brown, Dynalloy ■ Dynalloy, Inc has been in business for over 20 years manufacturing and selling its NiTi based shape memory alloy, trade named Flexinol® actuator wire, and is a leader in the field of Shape Memory Alloys.

In addition to manufacturing, Dynalloy, Inc strongly focuses on research and development, aiding companies and students in finding new and interesting ways to use Flexinol® in place of traditional actuators. By utilizing years of experience with our product, state of the art materials, techniques, and analytical tools, Dynalloy, Inc guides its customers to viable design solutions. In some cases, customers are trying to create less expensive and more efficient versions of already available products, and in some cases, customers are utilizing Flexinol® to create previously unheard of products and solutions. Flexinol® has found use in the automotive, appliance, aerospace, toy, and medical industries, just to name a few. The possibilities are endless with this exciting product. Some examples of Dynalloy, Inc. breakthroughs are:

ELECTROSTEM™ II: A New Generation of Valve

Lightweight, acoustically silent, and with no electrically noise, the Electrostem™ II is the vanguard of proportional air control valves. Equilibrium in the airflow is automatically maintained by the electrical input level, allowing the user to know what the airflow is through electrical current control. This automatic feedback creates a pressure independent flow control. This revolutionary valve uses Flexinol® to run with built-in overheat protection that serves as an electrical safety cutoff. Its small diameter (~ 0.25 inches) makes it ideal for inline and high-density applications and its pin connectors provide for easy PCB integration and simple user interface. The cost savings are enormous with the Electrostem™ II compared to traditional valves and it comes with standalone electronics, making this high quality valve an excellent choice. Please learn more at: *www.dynalloy.com/Kits.html*



Computer Compatible FLEXINOL® actuator wire moving butterflies!

Dynalloy, Inc. first produced butterflies as a demonstration piece to show

the effectiveness of Flexinol® actuator wire, but the beautiful creatures have grown into a market all their own. In addition to Dynalloy's traditional ac/dc adapter butterflies, which are available to U.S. customers only, Dynalloy, Inc. now has butterflies that are powered by USB! This makes it possible for anyone around the world with a computer to enjoy a beautiful computer companion simply by plugging in a USB into the USB port on his or her computer. These colorful butterflies bring a little bit of nature into a workspace and brighten up a person's day. They are capable of continuous cycles, and many have been cycling for years. The butterflies first became popular with a less technical, more novelty item audience, but now these butterflies also help prove the technology, showcasing not only life-like motion, which is natural with SMAs, but also the functionality and repeatability of Flexinol® wire. Please learn more at: *www.holbrookandcompany.com*

DYNAFUSERS: The HVAC of the Future!

Titus and Dynalloy, Inc. have developed a new line of industrial HVAC equipment called the Dynafuser, intelligent air control products using Dynalloy's Flexinol® Actuator Wire. The ability to intelligently control airflow without costly electronic controls requires specially made alloys that operate under specific temperatures. This is one of Dynalloy's areas of special expertise and forms the basis for Dynalloy's contribution to Titus' products. Titus is the nation's largest manufacturer of products that move, direct, and diffuse air on non-residential buildings. Titus products can be found in many high profile applications such as the Inner Harbor in Baltimore, Mayo Clinic in Minnesota, The Guggenheim Museum in Spain, Bank of China in Beijing, and the International Space Station, just to name a few. Dynalloy, Inc. is excited to assist in new innovations through our strategic alliance with Titus, and find new and exciting ways to utilize Flexinol®. Please learn more at: *www.titus-energysolutions.com/green/ecat/model.aspx?prodid=444&catid=186.* ■

Honors and Awards

2010 Gary Anderson Early Achievement Award

Marcelo Dapino, Ohio State University ■ The recipient of the 2010 Gary Anderson Early Achievement Award is Dr. Mohammad H. Elahinia. The award, consisting of an ASME certificate and honorarium of $1,000, was presented at the 2010 SMASIS meeting in Philadelphia.

Dr. Elahinia is an Associate Professor of Mechanical, Industrial and Manufacturing Engineering (MIME) at the University of Toledo. He serves as Director of the Dynamic and Smart Systems Laboratory at UT, where he has been on the faculty since 2004. He graduated from Villanova University with an M.S. degree and from Virginia Tech with a Ph.D. in Mechanical Engineering in 2001 and 2004, respectively. Dr. Elahinia's research interests are in developing dynamic models and designing control systems for smart and active materials. His current research is focused on biomedical applications of shape memory alloys. During the first five years of his appointment at UT he has served as investigator on 17 funded projects with a total budget of more than $5 million. Dr. Elahinia is author of more than 100 technical papers and 2 book chapters.

Dr. Elahinia is the recipient of several awards, including the Outstanding Young Faculty Research Award from University of Toledo in 2006 and the Torgersen Graduate Research Excellence Award from Virginia Tech in 2004.

Dr. Elahinia dedicates his Gary Anderson Early Achievement Award to his mentors: Professors Ashrafiuon, Ahmadian, Inman, and Leo, to his graduate students who never let him forget how poorly he sometimes treated his advisors in graduate school, and to his wonderful wife and two daughters who put up with his grumpiness when endlessly working on research proposals!

The Gary Anderson Early Achievement Award is conferred by the ASME Adaptive Structures and Material Systems Technical Committee. The award is given 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 for the 2011 Gary Anderson Early Achievement Award may be submitted at large by any source by December 31, 2011, and should be sent to Dr. Marcelo Dapino at *dapino.1@osu.edu*. ■

■ ■ ■

2010 ASME Adaptive Structures and Materials Systems Prize

Marcelo Dapino, Ohio State University ■ Dr. Jay Kudva is the recipient of the 2010 ASME Adaptive Structures and Materials Systems Prize. The prize was awarded at the 2010 AIAA/ASME/AHS Adaptive Structures Conference held in Orlando in 2010.

Dr. Kudva received his BS in Aeronautical Engineering from the Indian Institute of Technology in 1973 and his M.S. and Ph.D. degrees in Aerospace Engineering from Virginia Tech in 1976 and 1979, respectively.

Dr. Kudva worked at Northrop Grumman Corporation from 1980 to 2002 where he managed a structures R&D group and led division activities on smart materials and adaptive aircraft. In 2003, Dr. Kudva founded NextGen Aeronautics with the explicit purpose of developing revolutionary technologies and designs for the next century of flight. He is an Associate Fellow of AIAA. He received the SPIE Smart Structures and Materials Lifetime Achievement Award in 2007.

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/ASME/AHS Adaptive Structures Conference. Nominations for the 2011 prize can be sent to D. Lagoudas, *lagoudas@aero.tamu.edu*, by 11/2011.■

Honors and Awards, continued

ASMS TC Best Paper Awards

The ASME Adaptive Structures and Material Systems (ASMS) Technical Committee confers two best-paper awards, one in Materials and Systems and another in Structures and Structural Dynamics. Papers published in journal publications relevant to smart materials and structures and conference proceedings sponsored by the ASMS Technical Committee are eligible for the best-paper competition. The winning papers are selected among the nominations through a peer-review process. The winners of the 2010 beat-paper awards were recognized at the SMASIS conference in Philadelphia, and are listed below.

2010 Best Paper in Materials

"A finite element model for shape memory alloys considering thermomechanical couplings at large strains," by Daniel Christ and Stefanie Reese in International Journal of Solids and Structures.

Since 2009 Daniel Juhre is head of the department "Simulation and Continuum Mechanics" at the German Institute of Rubber Technology in Hannover (Germany). He has a Ph.D. in Mechanical Engineering from the Technische Universität Braunschweig (Germany). The title of his Ph.D. thesis is "Thermomechanical modelling of shape memory alloy structures in medical applications". It was designated as best Ph.D. thesis in 2008 at the TU Braunschweig. His current field of research includes the experimental characterization and the multiscale modelling of filled elastomers.

Since 2009, Stefanie Reese is professor for applied mechanics at the RWTH Aachen (Germany). Before 2009, she held professorships at the Ruhr University Bochum and at the Technische Universität Braunschweig (Germany). She did postdoctoral research in Hannover, Darmstadt, Berkeley (USA) and Capetown (South Africa). Her main research fields are material modelling of innovative materials as shape memory alloys, fibre-reinforced polymers and biomaterials as well as efficient and robust finite element technologies. One goal of her research is always to apply the new methods to interesting applications, e.g. in the field of medical technology, biomechanics, and production technology. Stefanie has won several prizes for academic achievements from scientific academies and is member of the senate of the German Science Foundation, a high-ranking committee in German science. She further serves on different boards and commissions in the international mechanics community.

2010 Best Paper in Structures

"Variable Stiffness Structures Utilizing Fluidic Flexible Matrix Composites," by Ying Shan, Michael Philen, Amir Lotfi, Suyi Li, Charles E. Bakis, Christopher D. Rahn and K. W. Wang, Journal of Intelligent Material Systems and Structures.

Ying Shan was a Postdoc Fellow in Engineering Science and Mechanics at Penn State. He is currently a Composite Design Engineer at Beacon Power Corporation. Michael Philen is a Assistant Professor of Aerospace and Ocean Engineering at Virginia Tech. Amir Lotfi was a Graduate Assistant at the Mechanical Engineering at Penn State. He is currently a Senior Mechanical Engineer at Otis Elevator Company. Suyi Li is a Graduate Assistant in Mechanical Engineering at Univ. of Michigan. Charles E. Bakis is a Distinguished Professor of Engineering Science and Mechanics at Penn State. Christopher D. Rahn is a Professor of Mechanical Engineering at Penn State. Kon-Well Wang is the Stephen P. Timoshenko Collegiate Professor and Chair of Department of Mechanical Engineering at the Univ. of Michigan. ■

Thank You!

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

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Lisa Mauck Weiland — *University of Pittsburgh*

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Greg Reich — *Air Force Research Laboratory*

Johannes Riemenschneider — *German Aerospace Center*

Janet Sater — *IDA*

Andrei Zagrai — *New Mexico M&T*

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Historical Note

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

Welcome back to the history corner! This time, we will look at a series of major programs initiated by Gary Anderson of the Army Research Office (ARO) that provided significant impetus for the application of adaptive structures in helicopters.

Long a key player in rotorcraft technology development, ARO recognized that there were opportunities for improving rotorcraft performance via application of smart structures. ARO had a particular interest in noise and vibration control that could be achieved by applying smart actuators to rotor blades. In the early 1990's, ARO sponsored a number of small and large university research initiatives (URIs). Three universities – the University of Maryland, Virginia Polytechnic Institute and State University (VPI), and Rensselaer Polytechnic Institute (RPI)-were each awarded 5 – year grants for interdisciplinary URI programs to address "smart rotor" systems using smart materials and structures to reduce vibratory loads and improve rotor performance.

Maryland's URI, led by Dr. Inderjit Chopra, was entitled "Smart Structures Technology: Applications to Rotorcraft". The primary research objectives were to reduce rotorcraft vibrations, increase blade fatigue life, reduce acoustic levels, minimize blade dynamic stresses, and refine smart structure elements in rotorcraft. The goal was to build a rotor with reduced vibration amplitudes utilizing a controllable twist and camber model or a piezoelectrically -actuated trailing edge flap.

VPI's URI, led by Dr. Craig Rogers, was entitled "Smart Structures for Active Damage Control". This effort focused on active strain alleviation, damage identification, and delamination growth control. These objectives were to be achieved through optimization of induced strain fields for active damage control, development of a design methodology for selecting, locating, and sizing of actuators and sensors, and development of coupled field theories for actuator/sensor/control structure interaction.

RPI's URI, led by Dr. Iraj Tadjbaksh[1], was entitled "Interdisciplinary Basic Research in Smart Materials and Structures". The effort initially focused on development of constitutive models for non-linear coupled-field interactions. Specifically, they were interested in non-linear electromechanical field equations for viscous dissipation, thermodynamic descriptions of phase transformations, micromechanical slip mechanisms, and phase transformations in electro-rheological fluids. Later additions to the project included work on piezoelectrics, mechatronics, adaptive control, and flow control.

In these objectives and goals, one can see many of the themes and key technology challenges common to many adaptive structures applications: shape and vibration control, actuator/sensor placement and interaction, damping, and non-linear modeling of combined-field behavior. ■

[1]Dr. Tadjbaksh unexpectedly passed away after the program started. He developed the basic program approach that was implemented by Dr. Kevin Craig, who succeeded him as the PI.

World News, continued

implementation. Several very promising concepts have been developed within the framework of this project. In particular, a passive, wingtip installed gust alleviation device is under development at the University of Liverpool, UK. Another important achievement related to the wingtip technology was a significant performance improvement of an adaptive wingtip device based on the application of multi-stable composites properties. Another application of a blended bi-stable laminate, for a morphing flap application, has been studied at the University of Bristol by Panesar and Weaver (2010). An implementation of the telescoping wing concept to improve selected UAV performance is being developed at the Instituto Superior Técnico of Lisbon, Portugal. A very ambitious component of the SMorph project is the development of a conceptual design framework for the evaluation of morphing concepts. That tool addresses a recurrent conclusion of several previous projects: "the full benefit of morphing solutions may be achieved only if morphing is implemented at aircraft design stage." That is why the core of this framework is a system of advanced modules for aero-structural analysis to be used at the design stage. One of the most interesting implementation of this tool is a MDO analysis of a wing with active camber mechanism based on a DLR - developed concept. A model of the resulting wing will be tested in a 3' x 10' wind tunnel. Portions of this technique have been described by Miller et al, 2010, and De Gaspari and Rici, 2010. A competing optimization approach has been proposed by Rhodes and Santer (2010) of Imperial College of London, UK. They have developed a fast geometric optimization algorithm and applied the resulting tool to a morphing wing leading edge and a flow control device, among others. One of the advantages of this method is that it helps to predict the effect of actuation locations on the deflected shape. An alternative approach has been presented by Panesar and Weaver (2010) who used an ant colony technique to improve performance of a blended bi-stable laminate for a morphing flap application. ■

Education Corner

Student Spotlight

Minal Bhadane is a doctoral student in the University of Toledo Biomedical Engineering program conducting her research in Dynamic and Smart Systems Lab. She received her bachelor's degree from University of Pune, India. Her Bachelor's thesis focused on developing programmable motorless magnetic stirrer. This project received Forbes Marshal outstanding project award along with first place in M-Pulse 07 project competition organized in Modern college of engineering, Pune, India.

The research topic of her dissertation is focused on development of active ankle foot orthosis by using shape memory alloys. This work is supported by National Science Foundation. She has conducted experiments for controlling stiffness of the shape memory actuator. Using COMSOL she has modeled stiffness of shape memory alloy wires for different combinations. She is currently working on the test apparatus for evaluating stiffness characteristics of passive ankle foot orthosis. In addition to her work on shape memory alloys, Minal has also studies human motion and kinematics to establish ankle stiffness profiles. Using gait analysis techniques such as 3D videography, EMG and force platform, she has evaluated effect of walking speeds on ankle stiffness characteristics. During her doctoral program Minal has presented four conference papers. She is quite interested in business side of the research. She has developed and proposed a business plan on her research in the University of Toledo Innovation Challenge Competition and received the first place award with the prize of $10,000.

Minal has actively participated in campus activities as a volunteer in various seminars and conferences. She has served as a secretary for the University of Toledo Graduate Student Association. She has also served as a judge for the research presentations of Sigma Xi Student Research Symposium at University of Toledo in 2009. Minal is advised by Dr. Mohammad Elahinia and will graduate with a Ph.D. in Biomedical engineering in May 2012. ■

Brent Volk is working on his PhD in the Materials Science and Engineering Program at Texas A&M University, from which he previously received his Bachelor of Science and Master of Science degrees in Aerospace Engineering. He has been a member of our research team on active materials and smart structures since January 2005.

An active researcher in the field of smart materials, Brent has focused his research efforts on the thermomechanical characterization and constitutive modeling of shape memory polymers. He participated in the summer Undergraduate Student Research Grant (USRG) program at Texas A&M and spent two summers performing research at NASA Langley Research Center. Coadvised by Dimitris Lagoudas and Dr. Duncan Maitland of Biomedical Engineering, Brent's research contributions have been featured in two peer-reviewed journal publications, five papers in conference proceedings, and thirteen conference presentations.

Currently a National Defense Science and Engineering Graduate (NDSEG) Fellow, Brent has received numerous awards. Academically, he was a recipient of the NSF Integrative Graduate Education and Research Traineeship (IGERT) Fellowship for his pursuit of a degree that combines mathematics and materials science, and received Honorable Mention for the National Science Foundation (NSF) Graduate Research Fellowship Program. His research has been recognized through a 'Best Student Contribution' award for his paper presented at the International Conference on Adaptive Structures and Technologies (ICAST) in Ascona, Switzerland in 2008, two first place presentations in Materials Science at the Texas A&M University Student Research Week, and two travel grants to attend professional conferences.

Brent was recently selected, based on his academic and research performance, as one of 80 students representing the United States to attend the 61st Meeting of Nobel Laureates in Lindau, Germany this summer. With an affinity for teaching and mentoring others, Brent is pursuing a career in academia. His teaching activities have included volunteering as a teaching assistant for two undergraduate courses and serving as a guest lecturer.

Outside the classroom, Brent has been an active member in student organizations and professional activities. As a graduate student, he has held the role of Assistant Director for the 2010 Student Research Week at Texas A&M University as well as the Treasurer of the Society of Engineering Sciences. As an undergraduate, Brent was a member, counselor, and director of a freshman leadership organization at Texas A&M. He is a member of the American Society of Mechanical Engineers and the Biomedical Engineering Society and reviews manuscripts for four peer-reviewed journals. ■

Surya Chakrabarti is a doctoral candidate at the Ohio State University, working under the supervision of Professor Marcelo Dapino. He completed

Education Corner, continued

his bachelor's degree (2007) in manufacturing science and engineering from the Indian Institute of Technology, Kharargpur, as a recipient of a Tata Steel Millennium Scholarship. His academic achievements as an undergraduate student earned him the Ohio State University Fellowship for his first year of education.

Surya's research focuses on design and modeling of magnetostrictive transducers. His first project dealt with the development of an actuator for active powertrain mounts. Surya designed a hydraulic amplification mechanism coupled with a Terfenol-D actuator; the device satisfies the large stroke requirement (on the order of 2 millimeters at engine idling frequency) while simultaneously achieving a gain-bandwidth product twice as large as that of a commercial mount actuator used for benchmarking. He developed a model combining nonlinear constitutive laws, Maxwell's equations, and structural dynamics to accurately describe the dynamic performance of the actuator. This work led to two journal papers, one of which is in review, and four conference papers, including an honorable mention at the 2010 SPIE Smart Structures/NDE Conference. Surya's work was recognized with a 2-year Graduate Fellowship from the Smart Vehicle Concepts Center, a National Science Foundation Industry/Collaborative Research Center at Ohio State and Texas A&M University.

During the current year (and last of his Ph.D.), Surya has been working on developing an advanced finite element tool to describe the full nonlinear coupling between electrical, magnetic and mechanical domains in 3-D Galfenol systems. The framework couples Max-

SMASIS 2010 Best Hardware Competition

Andrei Zagrai, New Mexico Institute of Mining and Technology

■ The SMASIS 2010 conference has drawn notable attention of scientist and engineers working in a field of smart materials and intelligent systems. Young professionals attending the conference were given opportunities to participate in a number of special events. One of them, the Best Student Hardware Paper Competition, was aimed at inspiring interest in adaptive structures, promoting practical engineering skills, and encouraging student participation in hardware development. As a part of the competition, students were asked to submit regular technical papers based upon their hardware. These papers were subject to normal conference review process and were subsequently evaluated by a team of experts to determine 6 hardware competition finalists. The finalists traveled to SMASIS 2010 with their hardware and demonstrated hardware projects during a special conference session. Best Student Hardware Paper Competition finalists included students from University of Maryland, North Carolina State University, University of Michigan, and Korea Advanced Institute of Science and Technology (KAIST). The experts, and general public alike, were truly amazed with outstanding level of hardware development and system integration presented in all onsite demonstrations. The project entitled "Design of an SMA Actuated Mechanotransductive Implant for Correcting Short Bowel Syndrome" received the largest number of expert votes and the student author, Brent Utter, was announced as the Conference winner of the SMASIS 2010 Best Student Hardware Paper Competition. All teams of finalists were honored with award certificates and honorarium at the Pioneer Banquet held in National Constitution Center. We encourage all

students interested in hardware development to participate in the SMASIS 2011 Best Student Hardware Paper Competition. Competition organizers are thankful to the support of the following sponsors: NSF, J. of Intelligent Materials Systems and Structures, NextGen Aeronautics, IOP/Smart Materials and Structures Journal, ASME Journal of Mechanical Design, Air Force Office of Scientific Research. ■

Student Spotlight, continued

well's equations for electromagnetics and Navier's equations for mechanical systems through nonlinear constitutive laws for Galfenol derived from thermodynamic principles. Three journal papers dealing with this modeling and its implementation in finite element system models are currently in preparation. Working within the Galfenol ONR MURI that supports this work has allowed Surya to give presentations in review meetings and closely collaborate with members of the MURI team. In combination with the strong industry exposure he received working in the NSF I/UCRC, Surya is a well-rounded researcher who is ready to step into the workforce. ■

Calendar of Events

SPIE Smart Structures & Materials Symposium,
San Diego, CA
Dates: March 6–10, 2011
http://spie.org/smart-structures-nde.xml

22nd International Conference on Adaptive Structures and Technologies
Corfu, Greece
Dates: October 10-12, 2011
Abstracts Due: May 5, 2011
www.icast2011.eu

2011 International Workshop on Acoustic Transduction Materials and Devices
State College, PA
Dates: May 10-12, 2011
Abstracts Due: February 11, 2011
https://www.mri.psu.edu/conferences/usnavy/index.asp

AIAA/ASME/AHS Adaptive Structures Conference,
Denver, CO
Dates: April 4-7, 2011
http://www.aiaa.org/events/sdm

ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems
Scottsdale, AZ
Dates: September 18 - 21, 2011
Abstracts Due: March 18, 2011
http://www.asmeconferences.org/smasis2011/

IWPMA 2011 and 6th Annual Energy Harvesting Workshop
Roanoke, VA
Dates: August 7-11, 2011
Abstracts Due: February 28, 2011
http://www.cpe.vt.edu/ehw/abstract.html

Education Corner, continued

SMASIS High School Outreach Event

Julianna Abel, University of Michigan ■ The creation of the Student and Young Professional Development Symposium in the ASME Smart Materials, Adaptive Structures, and Intelligent Systems (SMASIS) Conference has given students the ability to introduce new student events at the conference. One new event that graduate students introduced at SMASIS 2010 in Philadelphia, PA was an outreach event for high school students.

The high school outreach event was completely organized by graduate students - from idea conception to execution. A graduate student organizing committee determined the type of outreach event they wanted to host, contacted math and science teachers at public schools in Philadelphia to find a teacher, scheduled the event with conference organizers to create the best experience, and recruited students from numerous universities to help with the outreach event. All of the graduate student volunteers encouraged the high school students to pursue careers in engineering by introducing them to the exciting field of smart materials and structures.

The nine high school students who attended the outreach event (juniors from the Science Leadership Academy in Philadelphia) had a morning packed with smart materials and structures. The high school students played with smart material demos, conducted several hands-on experiments (including shape setting SMA, measuring the displacement of a piezo bender, and creating a speaker using a PVDF strip), attended a technical talk by a graduate student, and explored the conference's Best Student Hardware Competition. In addition to these planned activities, the high school students had the opportunity to participate in an impromptu Q&A session with mechanical and aerospace engineering professors. The high school students were amazed by the technologies they experimented with, enjoyed seeing the real life applications in the hardware competition, and appreciated the opportunity to speak with professors.

The high school outreach event at SMASIS was a huge success. The graduate students gained invaluable knowledge in planning and executing an activity at a conference while the high school students got to experience an interesting field they would not have been exposed to in their traditional science courses. Because the event was so successful we plan on incorporating another outreach event into the SMASIS 2011 conference. Please contact Julianna Abel (jmariee@umich.edu) if you have suggestions or want to volunteer for the next outreach activity. ■

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 symposia broadly ranging from basic research to applied technological design and development to industrial and governmental integrated system and application demonstrations.

Schedule

March 18, 2011: 400 word abstract due
April 25, 2011: Authors informed of abstract acceptance
May 30, 2011: Final full-length paper due
June 13, 2011: Copyright form 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/SMASIS2011. Questions can be directed to:

Diann Brei, General Chair
dibrei@umich.edu

Stefan Seelecke, Technical Chair
seelecke@mx.uni-saarland.de

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, Chris Lynch

Images courtesy of Sergio Lucato and Wing-Chi Poon

Call for Papers

ASME Conference on

SMART MATERIALS, ADAPTIVE STRUCTURES AND INTELLIGENT SYSTEMS

September 18 - 21, 2011
FireSky Resort, Scottsdale, AZ, 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 symposia broadly ranging from basic research to applied technological design and development to industrial and governmental integrated system and application demonstrations. The symposia specifically are:

Multifunctional Materials

***Chair: Zoubeida Ounaies,** Penn State*
***Co-Chair: Hani E. Naguib,** Univ. of Toronto*
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.

Enabling Technologies and Integrated System Design

***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.

Active Materials, Mechanics and Behavior

***Chair: John Huber,** Univ. of Oxford*
***Co-Chairs: Marc Kamlah,** Karlsruhe Inst. Tech.*
***Travis Turner,** NASA*
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.

Structural Health Monitoring / NDE

***Chair: Andrei Zagrai,** New Mexico Tech*
***Co-Chairs: Oliver Myers,** 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.

Modeling, Simulation and Control

***Chair: Mohammad Elahinia,** Univ. of Toledo*
***Co-Chair: Ralph Smith,** North Carolina 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.

Bio-Inspired Smart Materials and Structures

***Chair: Mike Philen,** VirginiaTech*
***Co-Chair: Vishnu Baba Sundaresan,** VCU*
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.

Guest Symposium on Sustainability

***Chair: Lisa Weiland,** University of Pittsburgh* ***Co-Chair: Sergio Lucato,** Teledyne Scientific*
Topical areas: Modeling of, device & technology development for, and illumination of the engineering challenges embodied in sustainability. Specific areas of interest include but are not limited to novel approaches to renewable energy; distributed power systems; water management; transportation systems; and greening the residential, commercial, and industrial environments.

ASME SETTING THE STANDARD

AIAA The World's Forum for Aerospace Leadership

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