ASME

Adaptive Structures & Material Systems

AIAA 75

ASME & AIAA Adaptive Structures & Material Systems Newsletter Summer 2006

MESSAGE FROM THE CHAIR

Diann Brei ■ EDITOR

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Diann Brei, AIAA ASTC ■ Welcome to the first AIAA/ASME semi-annual newsletter for the Adaptive Structures and Material Systems field! While our field is too large and active for exhaustive coverage, this newsletter aims to highlight interesting aspects of efforts being pursued around the world. Each newsletter will have sections devoted to the latest research, education initiatives, industrial perspectives, international highlights, awards and honors, brief historical notes, a student spotlight, and a calendar of events.*

From this first newsletter, it is clear that our field has progressed from a new area of study (1980's) to *a bona fide,* full-fledged field with achievable benefits in terms of weight, power, size and cost for many applications. More mature materials such as shape memory alloys and piezoelectric ceramics are transitioning into the marketplace, with applications ranging from high end components for aerospace and medicine to commercial parts for use in appliances and automobiles. An information pipeline — with important feedback from users to researchers and developers — is developing as we move from basic research to fielded commercial products. As technologies enter the marketplace relevant research issues that must be addressed for successful transition — e.g., reliability, quality, and processing for mass production — are being uncovered. In addition, new advances are being made continually in the area of basic research, some recent examples of which include carbon nano-tubes, self-healing materials and electro-active polymers. These new advances provide fresh opportunities for us, in terms of education initiatives and potential technology transition paths, and lead to a plethora of enabling capabilities and functions limited only by our imaginations.

Clearly, our field is robust and multi-faceted with development at all levels, which we have tried to capture in this newsletter.

We hope you enjoy it!

Please note that this newsletter was prepared as a team effort by members of both the AIAA Adaptive Structures Technical Committee and the ASME Adaptive Structures and Material System Technical Committee. Members of the two committees represent all sectors of the field including academia, government agencies, and industries – both large and small.‡ These two committees have a long history of collaboration and are responsible for organizing conferences and sessions for the four primary meetings addressing smart materials and structures:

- SPIE Smart Structures and Materials Symposium (SPIE)
- AIAA Adaptive Structures Conference (ASC)
- ASME International Mechanical Engineering Congress and Exposition (IMECE)
- International Conference on Adaptive Structures and Technologies (ICAST)

These committees also offer major awards and honors, handle editorial responsibilities for special articles, books and journals, and developed a national adaptive structures database for dissemination of field-relevant information. This newsletter provides additional testimony of the service of these technical committees to the community.

*If you would like to submit an article for the next newsletter, please contact Don Leo, *donleo@vt.edu*.

‡If you are proactive in the field, regularly attend at least one of the identified meetings, and are interested in joining either of the committees, please contact Diann Brei, *dibrei@engin.umich.edu* (AIAA Adaptive Structures TC) or Chris Lynch, *clynch@me.gatech.edu* (ASME Adaptive Structures and Material Systems TC). ■

Aerospace Applications of Adaptive or Reconfigurable Structures at DARPA

Darryll Pines, DARPA DSO

The field of adaptive structures has evolved significantly over the past 20 years. In the past 5 years at DARPA, we have seen the developments of adaptive rotors, morphing engines, and morphing airplanes. The key to their use is to find applications where they are relevant in terms of stroke, power, weight, cost and performance. This article reviews a few ongoing DARPA activities that attempt to integrate adaptive structure technology into aerospace systems. Three applications and technologies are discussed below:

- Morphing Munitions Using Shape Memory Alloys
- Multifunctional Inflatable Air Vehicle
- Adaptive Shape Changing Aircraft for Perching Maneuvers

Morphing Munitions Using Shape Memory Alloys

Under a DARPA Small Business Innovative Research Phase I contract, Midé Technology Corporation is developing novel flight control and range expansion devices for gun-launched munitions. Efficacy and operational capability of gun-launched munitions can be substantially improved through in-flight aerodynamic control and range extension. In-flight control capability allows for in-flight course corrections, end-of-game maneuvers to improve the strike rate, and dynamic re-targeting during flight. Munition range extension increases the operational envelope of artillery systems. Existing aerodynamic flight control technologies are complex, add considerable mass, and are expensive. In comparison, the devices under development are relatively cheap, simple, easy to integrate into existing designs and require a minimal amount of volume and power. The baseline materials for the morphing actuator development are thermally activated and pseudoelastic shape memory alloys (SMAs). Through gun and aero-dynamic heating the materials are morphed into pre-memorized shapes. Two ideas have been considered (i) bi-stable SMA dimples and (ii) an SMA activated conformal delta wing. Figure 1 (a) shows a single dimple in the two stable geometrical configurations. Four dimples are mounted on the projectile nose cone to provide normal control forces in the pitch and yaw planes. A CFD analysis was used to evaluate the control authority of the concept on a 105 mm baseline munition (also shown in Figure 1). Results showed that that dimple actuators have sufficient control authority without adversely increasing drag.

A model of the delta wing concept is shown in Figure 2 (a). Also shown in this figure is the flow field predicted by a CFD code using a prototype that was tested in MIT's low speed wind tunnel. Extrapolating the wind tunnel results showed that the delta wing would increase the range by as much as 100% (Figure 2).

Multifunctional Inflatable Air Vehicle systems

Under a DARPA-funded seedling effort, ILC Dover has been working on adding actuation capability to inflatable/deployable wings for UAVs. Inflatable wing structures are advantageous for packaging reasons when deploying systems from guns. It is often difficult to interface actuation technologies to such wings for flight control. The ILC Dover team has investigated the use of thin wire SMA to provide additional functionality to their robust wing structural systems.

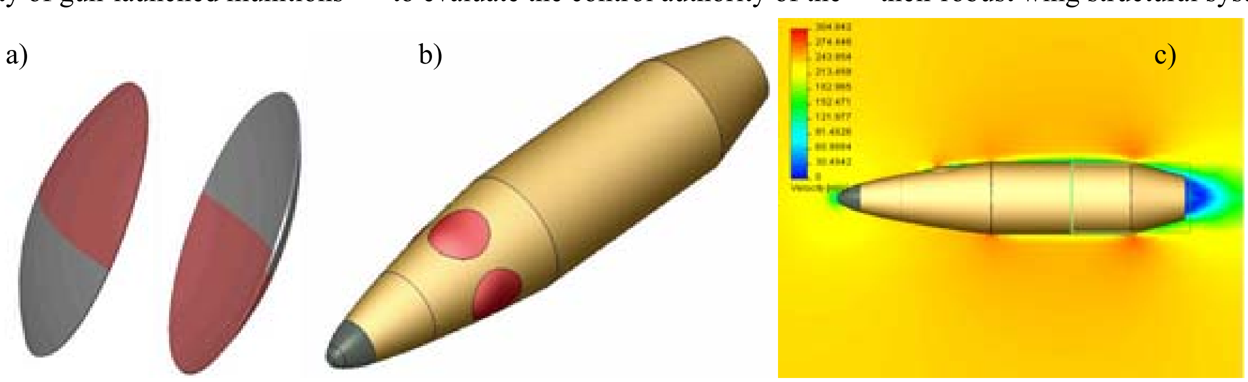

Figure 1: a) States of the Bi-stable SMA Dimple, b) 105 mm projectile with Dimple Actuators, c) CFD Flow Field.

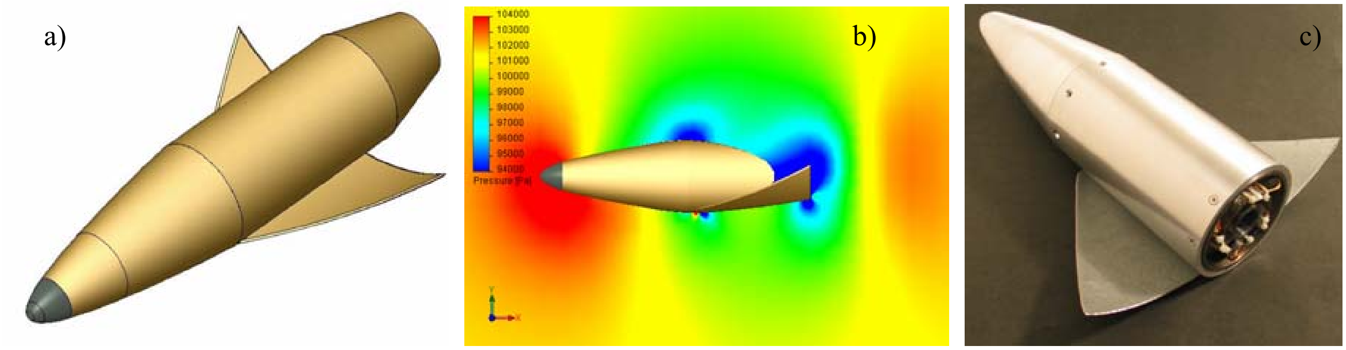

Figure 2: Delta Wing – a) SolidWorks model, b) CFD Flow Field, c) Prototype tested in wind tunnel.

Inflatable wings have also demonstrated two aspects of morphing for UAVs or other flight platforms (such as airships). These are high aspect ratio changes achieved via the deployment of inflatable tip extension and camber morphing for aerodynamic control. Inflatable wings with embedded actuation systems that are deployable and can easily be morphed in shape to provide the required aerodynamic control for small UAVs have been developed.

The flexible composite materials used in inflatable wings also allow for the inclusion of multi-functional elements to augment performance.

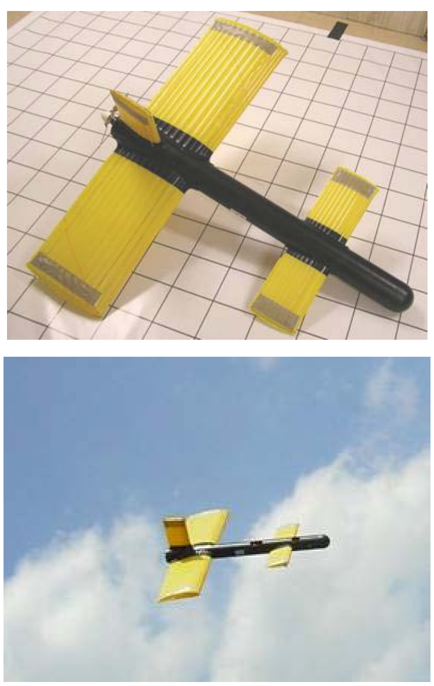

Figure 3: Morphing Inflatable Air Vehicle: (i) with adaptive SMA actuators, (ii) In flight

Multi-functional elements for deployable wings include those that perform structural or aerodynamic functions, but are also used for aerodynamic control, power generation, power storage, and communication.

Key tests conducted during this research include rapid simultaneous wing deployment, gust and impact loading survivability tests, and wing shape vs. inflation pressure (characterized through wind tunnel testing). The program culminated in the design, fabrication, and test of a small UAV with embedded shape memory alloy wire and/or servo motor actuation technology on the inflatable components (see Figure 3).

Adaptive Shape Changing Aircraft for Perching Maneuvers

Under a DARPA seedling contract, Cornell University is working on adaptive, reconfigurable aircraft configurations, with appropriate flight control to perform perching maneuvers for urban operations. Reconfigurable aircraft enable new degrees of freedom for aircraft flight maneuvers. These mechanical concepts coupled with bioinspired flight maneuvers may enable short landing maneuvers similar to those exhibited by birds during descent, in which the concept of dynamic stall is employed near landing.

The perching trajectory optimization problem has been formulated as a search for the optimum landing trajectory that will bring an aircraft from a known position and velocity relative to the landing site to a near zero speed at the site. The aircraft configuration with a translating/rotating tailboom is shown in Figure 4, and some common trajectories achieved using this configuration are shown in Figure 5. ■

Figure 4: Perching Aircraft Configuration

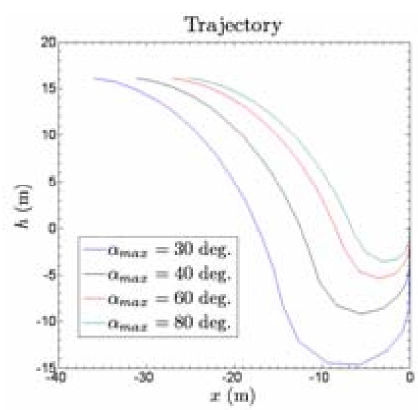

Figure 5: Optimal Point Mass Perching Trajectories.

Honors and Awards

Gary Anderson Early Achievement Award

Mary Frecker, Penn State and Janet Sater, IDA

The ASME Adaptive Structures and Material Systems Technical Committee has instituted the Gary Anderson Early Achievement Award. The award is given for notable contribution(s) to the field of Adaptive Structures and Material Systems. The prize is awarded to a young researcher in his or her ascendancy whose work has already had an impact in the field.

The award has been named in honor of Dr. Gary L. Anderson, now retired (November 2005); he was a Program Director in the Army Research Office's Structures and Dynamics Program, Mechanical Sciences Division, Engineering Sciences Directorate for 20 years. Dr. Anderson's contributions to the field of adaptive structures and material systems are significant: he was the first government sponsor to recognize the performance advantages of active smart materials and structures in military systems and the first to fund relatively large projects such as the University Research Initiative (URI) programs at Virginia Tech, the University of Maryland, and Rensselaer Polytechnic Institute and, later, several Multidisciplinary University Research Initiative (MURI) programs. He also strongly supported smaller, individual projects at many universities. He was a particularly strong supporter of young faculty. Most of the early and current leaders in the field of smart materials and structures have been supported through Dr. Anderson's long standing efforts. It seems obvious to state, but the field would not be where it is today without his strong support and commitment over the past 15 or so years. That Dr. Anderson was – and is – a consummate gentleman only further reinforced the Technical Committee's desire to name an award for him.

The winner of the Gary Anderson Early Achievement Award must be within 7 years of terminal degree at the time of nomination. The award decision is based on the extent of the nominee's contribution(s) to the field of Adaptive Structures and Material Systems. The prize consists of an ASME certificate and $1,000, and the award will be announced each year at the SPIE meeting. Nominations may be received at large from any source. Please send nominations to Dr. Mary Frecker at *mxf36@psu.edu*.

2006 ASME Adaptive Structures and Materials Systems Prize

Marcelo Dapino, Ohio State University

Professor Dimitris C. Lagoudas, the John and Bea Slattery Chair of Aerospace Engineering at Texas A&M University, College Station, Texas, received the 2006 ASME Adaptive Structures and Materials Systems Prize. The prize was awarded at the AIAA 47th SDM conference held 1-4 May 2006. Professor Lagoudas is currently serving as Director for the Texas Institute for Intelligent Bio-Nano Materials and Structures for Aerospace Vehicles (TiiMS), and has served as Chair of the Executive Committee of the Faculty of Materials Science and Engineering and as an Associate Vice President for Research at Texas A&M.

Professor Lagoudas was honored for his seminal and often referenced work in Shape Memory Alloys. He has authored or co-authored about 270 scientific publications (110 in archival journals). His work has received several awards and recognitions, including among others, the 2005 ASME Adaptive Structures and Material Systems Best Paper Award, 2003 TEES Charles W. Crawford Service Award, 2000-2005 Texas A&M University Faculty Fellow and 1998 Neely '52 Dow Chemical Faculty Fellow Award. Professor Lagoudas is a Fellow of ASME and an Associate Fellow of AIAA.

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 lecture given by the recipient on Tuesday evening at the SDM conference. Prof. Lagoudas delivered the Adaptive Structures Award Keynote Lecture titled "Modeling and Characterization of SMA and Magnetic SMA Actuators" to an audience of several hundred. Nominations for the 2007 prize can be sent to Dan Inman at *dinman@vt.edu* by November, 2006.

Industrial News

NextGen successfully finishes morphing wing wind tunnel testing at NASA Langley Research Center

Shiv Joshi, NextGen Aeronautics ■ NextGen Aeronautics has successfully completed morphing concept and structural integrity testing of a morphing wing structure in the Transonic Dynamics Wind Tunnel at NASA Langley Research Center.

DARPA initiated an ambitious program in morphing aircraft structures in 2003 and awarded NextGen Aeronautics, a newly formed company at that time, one of the three contracts. Each team was expected to create a morphing wing concept, show its benefits, address risky technologies, demonstrate structural integrity of the morphing wing, and conduct flight-traceable wind tunnel tests in thirty months. The NextGen team came up with very innovative technologies that bring us closer to building bird-like aircraft. The wind tunnel tests demonstrated that NextGen's morphing wing concept is capable of sustaining loads and achieving speeds needed for realistic flight missions.

The wind tunnel morphing wing model was tested at sea level to 50,000 ft altitude conditions and speeds corresponding to 0.92 of the speed of sound at higher altitudes. The model was morphed among various configurations while subjected to aerodynamic lift and corresponding drag, bending and torsional loads.

NextGen is encouraged by successful demonstration of the feasibility of the morphing wing concept. They are now designing and building a 200 lb morphing flight demonstrator aircraft in the next 12 months. ■

GM/UM Smart Materials and Structures — Collaborative Research Lab

Nancy Johnson, GM R&D ■ General Motors (GM) has teamed with the College of Engineering at the University of Michigan (UM) to establish a $2.9 Million Collaborative Research Laboratory (CRL) in Smart Materials and Structures, directed by Nancy Johnson (GM) and Diann Brei (UM). GM is becoming a world leader in Mechamatronics, the integration of **mecha**nical systems, smart **ma**terials and elec**tronics,** relative to automotive applications with 35+ patents, 70+ published patent applications, and competitive products already in production such as MSRC (Magnetic Selective Ride Control). Researchers at both GM and UM are working closely together to create leap-frog technologies, starting from conceptualization and proceeding all the way through demonstration and handoff to product teams. This approach bridges the traditional technology gap between industry and academia. In addition to *Smart Device Technology Innovation*, other thrust areas in the CRL include *Smart Material Maturity,* with a basic research focus on overcoming material issues that form roadblocks to commercialism, and *Mechamatronic System Design Methodology,* with an applied focus on development tools (synthesis and analysis) to aid the engineer in application of smart materials to system engineering. To establish the necessary workforce to support this effort, UM is offering several graduate courses in Smart Materials and Structures. This CRL is a global effort with partners across the

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Historical Note

Greg Reich, AFRL ■ Welcome to the Adaptive Structures History Corner, where we will briefly look at a significant event in Adaptive Structures history, as well as the impact it has had on the field in general.

As a first installment, let's go back and look at perhaps THE seminal paper in adaptive structures. The year was 1987. That October, in the *AIAA Journal*, Ed Crawley and his student Javier de Luis published "Use of piezoelectric actuators as elements of intelligent structures". The paper addresses many of the issues that would become central to the field: it defined (although not for the first time) intelligent structures as a highly distributed network of sensors, actuators, and processors; it developed an analytic model for the behavior of the coupled structure/actuator system, and verified that model experimentally; it created a scaling parameter, ψ, to help determine the effectiveness of an actuator in relation to the substructure; it addressed actuator placement in terms of the expected behavior of the system; and it addressed manufacturing issues for implementation of adaptive structures.

The impact that this paper has had on the field can't be overstated. According to Norm Augustine in his book *Augustine's Laws* (used to demonstrate Law V, for those of you who want to look it up), one measure of the worth of a piece of work is the number of times it is referenced by other works. According to the Scopus Citation Tracker, this paper has been cited an amazing 804 times since its publication (as of 7/27/06; yesterday it was only 802!) No other paper in the field of adaptive structures comes close. ■

INTERNATIONAL HIGHLIGHTS

Chris Lynch, Georgia Tech ■ Each newsletter, we hope to bring highlights of international activities in adaptive structures. Because of the diversity and breadth abroad, it is impossible to be complete, but we hope that this will give a small and interesting glimpse into the world of smart structures. Those interested in having their work, conferences, or laboratories highlighted in the next newsletter are requested to submit a paragraph (and graphic) to Don Leo, *donleo@vt.edu*.

For this first column, we are focusing the highlights on Europe. Over the past year, several adaptive structures/materials research programs were launched in Europe. These include an integrated project termed UPWIND, launched in Spring 2006, aimed at the development of greater than 5 MW wind-turbines. This is a 5 year research program funded by the European Union with a budget of 14 Million Euros. Part of this project will address the design of a smart wind turbine blade with active aeroelastic and flow control capabilities. During the "Aeronautics Days 2006" in Vienna, the concept of the "Clean Sky" Joint Technology Initiative was presented by a large group of members of the European Aeronautical Industry. This initiative aims to mobilize a massive effort towards the development of more environmentally friendly aircraft with reduced emissions and noise. The project includes three aircraft platforms: large fixed-wing aircraft, regional aircraft, and rotorcraft. It is highly likely that, if approved, all three platforms will need to support various applications of active and smart materials/structures technologies to attain the ambitious environmental objectives. Another adaptive rotor developed by Eurocopter in Germany was demonstrated at full scale on a real helicopter during flight. It is based on a piezoelectrically actuated flap that can be slotted into the rotor. There is also a major EU-funded programme called SMART-COPTER that addresses similar issues. Airbus is also very active in structural health monitoring (SHM). TATEM, a major EU-funded program coordinated by Smiths Industries, deals with the complete aircraft maintenance process, and thus, includes SHM.

Several international conferences on adaptive materials and structures took place in Europe last year. These include the ICAST conference hosted in Paris during October 2005 and the European Workshop on Structural Health Monitoring hosted in Granada, Spain during July 2006. The latter meeting was attended by over 300 people, from Europe, US and Asia, and included many interesting papers on various ideas and concepts regarding the use of piezoelectric actuators/ sensors and fiber optic sensors for damage detection and identification. The EACPD conference on polar dielectric materials will be held in Metz, France in September, 2006. ■

For more information visit the Technical Committee Websites:

ASME: http://divisions.asme.org/aerospace/committees/asms.html

and

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

THE NEW AIAA INTERNATIONAL SUBCOMMITTEE

Victor Giurgiutiu, University of South Carolina ■ An international subcommittee of the AIAA Adaptive Structures Technical Committee has been formed with the purpose of promoting international activities related to adaptive structures. The main objective of the subcommittee is to reach out to all corners of the world and let the AIAA Adaptive Structures Technical Committee activities be known to interested individual and professional societies. Through this outreach, we hope to create a two-way synergistic effect facilitating the flow of scientific information and establishing joint activities in areas of common interest. The subcommittee plans a number of new initiatives in the future including an international best paper exchange, keynotes, liaisons, international co-op exchange, newsletter highlights and much more.

At present, the international subcommittee of the AIAA Adaptive Structures Technical Committee comprises six members, with a diverse international background. To facilitate outreach, informal coverage of the globe's main geographical areas has been agreed to as follows:

- Victor Giurgiutiu and Dimitris Saravanos: *The Americas and Europe*
- Anindya Ghoshal and Akilesh Jha: *Indian subcontinent and Australia*
- Usik Lee and Yuji Matsuzaki: *Pacific Rim area*

If you would like to suggest further outreach activities, help or join the committee, please contact Victor Giurgiutiu, *giurgiut@engr.sc.edu*. ■

Education Corner

An Abundance of Continuing Education Options

Ron Barrett, University of Kansas ■ The dynamic and growing field of Adaptive Materials and Structures is currently revolutionizing several corners of technology. New capabilities and improved performance have been concretely demonstrated in the human body, cars, and aircraft from the size of a baseball to widebodies. Although these materials and structures are currently on production lines of many industries, in the air, in the field and in combat today, the area still faces a profound challenge in that too few practicing technologists have been trained to properly exploit the capabilities of these unique materials and structures.

Although a daunting challenge, there are several tools to combat it, among the most formidable is Education. Currently there are more than a dozen major universities worldwide that offer graduate coursework and training in the area. While this produces a very important flow of educated technologists into the workforce, it is but a trickle. More information and engineering skill are needed to allow the technical workforce to more completely exploit the new capabilities afforded by these materials and structures. Practicing engineers are in need of a large quantities of information delivered quickly so as to allow them to "get back on the job." Thankfully, a host of excellent short courses on "Smart" "Adaptive" and "Active" structures and materials have sprung up over the past decade.

A sampling of the excellent short courses that have been developed and offered through the years gives an idea of the range of topics covered:

- Active Structures[1]
- Active Structures for Vibration and Shape Control[2]
- Adaptive Aerostructures[3]
- Adaptive Aerostructures for Missiles, Munitions and UAVs[3]
- Adaptive Structures: Practice and Promise[4]
- Electroactive Polymers as Emerging Actuators and Sensors[2]
- Fiber Optic Sensors for Smart Structures: Basics and Applications[5]
- GPR & Ultrasonic Techniques for Bridges, Pavements, & Building Components
- Magnetostrictive Materials Technology[1]
- Microsensors, MEMS and Their Applications[2]
- Smart Materials Short Course[6]
- Smart Structures and Nanotechnologies[7]
- Smart Structures Theory and Applications[2]

The reader will see that courses range from depth in materials through breadth of applications for specific industries and vehicle/mechanism types. Although not universal, most courses begin by laying a foundation explaining material behavior and fundamental modeling techniques. Many then extend these basic behaviors to gross structural characteristics and methods of integration into higher order systems. Applications from automotive through biomedical through aerospace show that for many applications, these materials can certainly enhance product lines. In several instances, adaptive materials and structures are even enabling. Although some courses are regularly offered and others are available by special arrangement, there remains a wide array of options for technologists, managers and decision makers to gain a significant bulk of information on these new material, structures and systems with minimal investment in time and resources. ■

Sources:

1 www.spie.org/web/meetings/programs/ss98/scindex.html
2 www.spie.org/web/meetings/programs/ss00/scindex.html
3 www.continuinged.ku.edu/aero/course.php?aid=24
4 www.aiaa.org/content.cfm?pageid=161&lumeetingid=1221
5 www.spie.org/web/meetings/programs/ss99/scindex.html
6 www.mide.com/serv_smart_materials_course.html
7 www.esm.vt.edu/~rbatra/short.html

XQ-138 Adaptive Structures Enabled UAV at Ft. Benning, Georgia Firing Range

Industrial News

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nation and world from GM's Global Research Network such as HRL Laboratories in California and GM's India Science Lab in Bangalore, India.

For more information on GM's Research Labs visit: *http://www.gm.com/company/careers/career_paths/rnd/* ■

Education Corner, continued

Student Spotlight

Our first Student Spotlight is on Paul Alexander, who just recently graduated with his PhD in mechanical engineering from University of Michigan (MS from UM and BS from Texas A&M). At Michigan, Paul worked in the Smart Materials and Structures Design Laboratory (SMSDL) where his research focused on piezoceramic materials and actuation architectures, culminating in his dissertation on Dual Electro-Piezo Property (DEPP) Functionally Graded Piezoceramics (FGP). This work sought to improve the functionality and reliability of piezoceramic actuators by controlled variation of material properties within a monolithic piezoceramic specimen, eliminating bonding layers that result in failure-inducing stress concentrations. Using the DEPP gradient technique, Paul was able produce novel multi-dimensionally graded piezoceramics which yield complex, higher-order deformation capabilities. During his studies, Paul also served as a visiting researcher within the South Africa Tertiary Education Linkages Project (TELP) at Peninsula Technikon in Cape Town. Because of his exemplary research, Paul was awarded the University of Michigan DeVlieg Award for outstanding research in manufacturing. In addition to research, Paul is a talented instructor, serving as a graduate student instructor for multiple semesters for the senior and junior level capstone design courses. During his last semester he was given the rare opportunity to serve as lead instructor for the core machine design course. He was honored for his teaching with the University's highest graduate-level teaching award - Outstanding Graduate Student Instructor. He has actively participated in recruiting new graduate students into the mechanical engineering department and in mentoring programs for promising, scientifically inclined high school students in Ann Arbor, MI. Paul recently accepted a position in the Mechamatronics group in General Motor's Research and Development department conducting product design in smart materials and structures.

To nominate an exceptional graduate student for the next AIAA Adaptive Structures Student Spotlight, submit recommendations to Don Leo, *donleo@vt.edu*. ■

Thank You!

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

Ron Barrett	*University of Kansas*
Christian Boller	*Sheffield*
Ian Bond	*University of Bristol*
Marcelo Dapino	*Ohio State*
Mary Frecker	*Penn State*
Victor Giurgiutiu	*University of South Carolina*
Betty Gullie	*AIAA*
Nancy Johnson	*GM R&D*
Shiv Joshi	*NextGen Aeronautics*
Don Leo	*Virginia Tech*
Sergio L. Dos Santos e Lucato	*Rockwell Scientific*
Chris Lynch	*Georgia Tech*
David McGowan	*NASA*
Daryll Pines	*DARPA DSO*
Greg Reich	*AFRL*
Dimitris A. Saravanos	*University of Patras*
Janet Sater	*IDA*

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Call for Articles

We hope you enjoyed the first issue of the AIAA Adaptive Strucutres / ASME Adaptive Structures & Material Systems TC joint newsletter. We would like to invite you to participate in making these newsletters a full success. If you would like to volunteer or contribute an article to a future newsletter, please contact the editors: Don Leo at *donleo@vt.edu* (Winter newsletter) or Diann Brei at *dibrei@umich.edu* (Summer newsletter). ■

Calendar of Events

AFOSR Program Review for Mechanics of Multifunctional Materials and Microsystems and Structural Mechanics, *Seattle, WA*
Dates: August 28-September 1, 2006
Contact: Dr. Les Lee (*les.lee@afosr.af.mil*)
Dr. Victor Giurgiutiu (*victor.giurgiutiu@afosr.af.mil*)
https://conference.epeerless.com/MeetingMain.asp?uid={339DC6C0-B478-40B6-A0C1-C25F343EA54A}

CANSMART International Workshop on Smart Materials and Structures, *Toronto*
Dates: October 12-13, 2006
Abstract due: June 16, 2006
http://www.cansmart.com

International Conference on Adaptive Structures and Technologies (ICAST), *Taipei, Taiwan*
Dates: October 16-19, 2006
Abstract due: May 31, 2006
http://www.icast2006.org

US-European Competition and Workshop on Micro Air Vehicles, *Sandestin, FL*
Dates: October 30-November 2, 2006
Contact: Dr. Gregg Abate (*gregg.abate@eglin.af.mil*)
http://www.us-euro-mav.com

ASME International Mechanical Engineering Congress & Exposition (IMECE), *Chicago, IL*
Dates: November 5-10, 2006
Abstract due: March 13, 2006
http://www.asmeconferences.org/congress06/

SPIE Smart Materials, Nano-, and Micro-Smart Systems 2006, *Adelaide, Australia*
Dates: December 10-13, 2006
Abstract due: June 5, 2006
http://spie.org/conferences/calls/06/au/

SPIE Smart Structures & Materials Symposium, *San Diego, CA*
Dates: March 18–22, 2007
Abstract due: September 4, 2006
ASME ASMS TC Meeting: TBD
http://spie.org/Conferences/calls/07/ss/

AIAA Adaptive Structures Conference, *Waikiki, HI*
Dates: April 23-26, 2007
Abstract due: August 11, 2006
http://www.aiaa.org/content.cfm?pageid=230&lumeetingid=1473

World>>Forum on Smart Materials and Smart Structures>>Technology (SMSST '07), *Chongqing & Nanjing, China*
Dates: May 22-27, 2007
Abstract due: September 10, 2006
http://smsst07.cee.uiuc.edu

International Workshop on Structural Health Monitoring (IWSHM), *Stanford, CA*
Dates: September 11-13, 2007
Abstract due: February 1, 2007
http://structure.stanford.edu/workshop/workshop/homepage1.htm