

Workshop, “New Concepts for Active Materials, Actuators and Bioinspired Sensing-Actuation Control ”

University of Washington Tower,
April 19-20, 2012.

Organizers:

Minoru Taya, Director of the Center for Intelligent Materials and Systems, Department of Mechanical Engineering and Boeing-Pennell Professor of Engineering

Per Reinhall, Professor and Chair, Department of Mechanical Engineering, University of Washington

Makoto Saito, Fellow and General Manager, Nabtesco Corp, UW ME Affiliated Professor



Mt Rainer as seen from the UW Campus

Sponsors:

Nabtesco Corporation

University of Washington

Background and aim of the workshop

Examples of shape changes (morphing) seen in the action plants are abundant, with actuation speed ranging from very fast to modest. Large shape changes are often observed in animals, which are associated with three mechanisms: (1) body fluid motions similar to the ionic fluid motions inherent in plasmodial slime, (2) metamorphosis of insects and (3) muscle-bone linkages as in the case of bat wings. The first two cases provide large shape change but at slower speed with lower energy consumption, while the third case exhibits rapid shape change with large volume and shape change at cost of larger energy consumption. This rapid folding and unfolding ability of bat wings stems from the microstructure of the wings, which are composed of several bones and flexible membranes. The membranes are composed of a set of reinforcing fibers (elastin and collagen) and muscles.

Actuations of insects are time-serial events of sensing, diagnosis and actuation. Thus, studying these sequential events will provide us rich knowledge for designing fast-response synthetic actuator systems that require sensing, diagnosis and actuation with smart control system.

When the above knowledge is transferred to synthetic design of morphing structures, we note that there exists a strong need to establish a set of new design methodologies by which future morphing structures and actuators can be designed and processed, where existing and modified active materials with least energy expenditure will be used.

The aim of this workshop is to examine mechanisms of large shape changes and bearing force in active materials and cohesive sensing-diagnosis-actuation algorithm associated in biological species. We can then transform them into human-made active materials and actuators with possible applications to future airborne actuators, energy-harvesting structures and other applications while identifying the technical challenges and possible method for solutions.

Workshop Program

Organizers: Minoru Taya and Per Reinhall, University of Washington
Makoto Saito, Nabtesco Corporation

Meeting room : Auditorium at Mezzanine of UW Tower, which is located directly across the street from the Hotel Deca at the intersection of Brooklyn Ave. and the 45th Street.

Thursday, April 19

8:00 am Welcome speech,
Matt O'Donnell, Dean, College of Engineering, UW

Session 1: Bioinspired new concepts on sensing-diagnosis-actuation (8:10 am – 9:40 am)

Session Chair: Per Reinhall, UW

Shimozawa, Hokkaido University, “Why nerves are bundles of fibers? -What Insects tell us for future technology?”

Kristi Morgansen, University of Washington, AA department: Bioinspiration in sensing and control for agile autonomous vehicles

Masatugu Shimomura, Tohoku University, “Biomimetic Water Transport Materials Inspired by Wharf Roach, *Ligia exotica*”

Coffee Break (9:40 – 10:00 am)

Session 2: Active materials and systems-1, (10:00 am – 11:30 noon)

Session Chair: Dimitris Lagoudas, Texas A & M

Alison Fatau, University of Maryland, “Structural Magnetostrictive alloys”

Toshihiro Omori, Tohoku University, “Fe- and Ni-based magnetic shape memory alloys”

Hiroyuki Kato, Hokkaido University, “Disclination modeling of variant structure in shape memory alloy martensite; application to the tetragonal martensite in Fe-Pd polycrystal”

Lunch Break (11:30 noon – 12:40 pm)

Session 3: New Active materials and systems-2 (12:40 – 2:10 pm)

Session Chair: Martin Dunn, NSF

Per Reinhall, University of Washington, “Sensor and Actuator Development for Below Knee Prosthetics”

Tomohiro Tachi, University of Tokyo, “Freeform Kinetic Origami Structure”

Minoru Taya, UW, “Force-displacement relation of Tachi-Miura origami bellow actuator”,

Short Coffee Break (2:10-2:20pm)

Session 4: Active materials- modeling (2:20 – 3:50 pm)

Session Chair: Alison Fatau, University of Maryland

Dimitris Lagoudas, Texas A&M University, “Advanced Multi-physical Analysis and Optimization of SMA-Based Morphing Structures”

Tadashige Ikeda, Nagoya University, “Constitutive Model of Shape Memory Alloys and Ferroelectric Materials”

Shinji Muraishi, UW, “Nanoparticles of FePd”

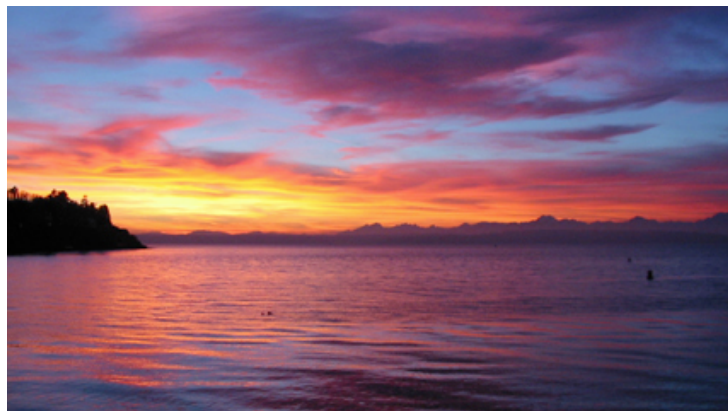
All participants must to leave the auditorium upon the conclusion of session 4, as the room will be used by another group at 4 pm.

Spring Cherry Blossoms on the UW Quadrangle



Dinner at Ray's Boathouse
(<http://www.rays.com/boathouse>)
6:00 – 8:30 PM

At 5:30 pm, after the close of the workshop on Thursday afternoon, an executive motorcoach will transport guests from the Hotel Deca to Ray's Boathouse. Combined with the spectacular bayside view of the Olympic Mountains over Puget Sound, Ray's Boathouse is the quintessential Northwest seafood experience.



Sunset view from Ray's Boathouse

Friday, April 20

Session 5: Polymer based active materials (8:20 am – 9:50 am)
Session Chair: Christine Luscombe, UW

Zoubaida Ounaies: Nano-Enabled Functional Polymers for Electrical Applications.

Yosi Bar-Cohen, NASA, "EAP materials as actuators of biologically inspired mechanisms"

Martin Dunn, University of Colorado, "Light activated polymers"

Coffee break (9:50 – 10:10 am)

Session 6: Active/sensing/energy-harvesting integrated structures (10:10 am – 11:40 noon)
Session Chair: Tad Caukins, Boeing

Dan Inman, University of Michigan: Integrating Energy Harvesting and Structural Health Monitoring

Marcelo Dapino, Ohio State University: Ultrasonic Additive Manufacturing of Smart Structures

Hans Lilholt, Risø National Laboratory, "Optimum design of composite structure for wind turbine rotor blades"

Lunch break (11:40 noon – 1:00 pm)

Session 7: Actuator design-1 (1:00 pm – 2:30 pm)
Session Chair: Dan Inman, University of Michigan

Shiv Yoshi: Active Materials for MAV applications - challenges and solutions

Kyorou Miura, University of Tokyo, “Volumetric Actuation Mechanism of Tachi-Miura Polyhedra”

Robert Liang, University of Washington, “Design of inchworm actuators based on FSMA composite”

Coffee Break (2:30-2:50 pm)

Session 8: Actuator design-2 (2:50 – 4:20 pm)

Session Chair: Makoto Saito, Nabtesco

Tad Caukins, Boeing, “The future of smart materials actuators for aerospace”

Sayit O Ural, Penn State, “New era in high power actuators, unexpected behavior of non-lead Piezoelectrics”

Taishi Wada, Yokohama National Univ., “Designs of actuators based on low-cost FSMA and ferroelectric polymer”

Short Break (4:20-4:30)

Special Session, Martin Dunn, NSF program manager, “NSF program on Mechanics and Materials at NSF” (4:30-5:00pm)

Session Chair: Albert S. Kobayashi, UW

Closing Remarks by Minoru Taya

Luxury Dinner Cruise Aboard the Emerald Star (6:00 - 9:00 pm):

At 5:30 pm, after the close of the workshop on Friday afternoon, an executive motorcoach will transport guests from the Hotel Deca to the Waterways Pier on Lake Union where the sleek and luxurious Emerald Star yacht awaits.



On this Lake Washington Dinner Cruise, the meal is equaled only by the views and vistas from Lake Washington. Guests will experience the majesty of Mount Rainier’s 14,000-foot summit, a peek into Seattle’s remarkable waterfront estates, the spectacular sunset of the Pacific Northwest reflected by downtown skyscrapers, and beautiful live music.

The Emerald Star Cruise Ship, the site of the Dinner event on Friday, April 20.

The following photos were taken during the workshop.



(left) Dean O'Donnell talking to Prof. Morgansen. (right) Prof. Reinhall, Caroline Hansen, Prof. Taya, and Prof. Shimozawa at the podium (L to R).



(left) Prof. Inman asked a question. (right) Ms. Pasztor, Drs. Matsumoto and Saito (L to R).



(left) During a coffee break: Prof. Inman, Ms. Yamashiro, Dr. Hancock, Prof. Taya, and Dr. Bar-Cohen (L to R). (right) Enjoying coffee and conversation: Dr. Ural, Mr. Namli, and Prof. Qunaies (L to R).

During the dinner at Ray's Boat House, April 19, 2012



Prof. Dunn, Dr. and Mrs. Bar-cohen, Profs. Inman and Qunaies (L to R) at the reception before the



Profs. Lagoudas and Dapino (L to R) chatting at the reception



Profs. Hartle and Dunn and Dr. Yoshi at the reception before the dinner (L to R)



Prof. and Mrs. Kobayashi and Prof Liang (L to R) at the reception before the dinner

Cruise Ship Dinner, April 20, Lake Washington



(left) Profs. Chung and Kim, Ms.C. Xu and Ms. P. Xu (L to R) before boarding. (right) Mrs. Lilholt, Dr. Lilholt, and Prof. Taya (L to R) on the upper deck.





(left) Profs. Reinhall and Luscombe, Drs. Matsumoto and Saito (L to R). (right) Dr. Ural, Dr. and Mrs. Bar-cohen and Prof. Qunaies (L to R) chat before dinner.



(left) Mr. Balasu, Mr. Takagi and Mr. Standley. (right) guests enjoying dinner.



(left) and (right): dinner conversations