



# Newsletter

No. **13**<sup>E</sup>  
September 1, 2007

The 21st Century COE Program  
Mechanical Systems Innovation, The University of Tokyo

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## The 3rd International Symposium Series on Mechanical Systems Innovation was held

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An International Symposium Series was held for a period totaling to 7 days, consisting of 22, 24-25, and 27-28, of November 2006 and 1-2 of March 2007, at Ichijo Hall in Yayoi Auditorium and Takeda Hall in the Takeda Frontier Science Building. This symposium series, which is the third in a line of such series, consisted of two international symposiums in the energy innovation field, an imperative research area for the 21COE Program, entitled, "International Symposium on Structural Reliability in Energy Systems Innovation," and, "International Symposium on Innovative Aerial/Space Flyer Systems," one international symposium pertaining to the biomedical innovation field entitled, "International Symposium on Biomedical Systems Innovation," and one pertaining to the hyper modeling / simulation field entitled, "International Symposium on Computational Challenges in Thermal, Fluids and Energy Systems." It was held with the purpose of communicating activities in this program worldwide.

The series launched with the opening address by program leader, Nobuhide Kasagi, and went on to introduce recent activity content and future activity plans in the 21st Century COE Program "Mechanical Systems Innovation." At the each of the four international symposiums, prominent researchers both from within Japan and abroad were invited, and active exchange of information and opinions was conducted regarding cutting edge research in each field. Also, poster sessions and mini oral presentations by young researchers, including Ph.D. students participating in the COE Program were held in their respective symposiums, and the active participation of young researchers was impressive.



Opening address by Prof. Kasagi, the 21COE program leader

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## *International Symposium on Structural Reliability in Energy Systems Innovation*

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An international symposium on mechanical systems innovation entitled “International Symposium on Structural Reliability in Energy Systems Innovation, -Mastering Reliability-” was held on November 22, 2006 (Wed) in Yayoi Auditorium Ichijo Hall of the Agriculture Department on the Hongo Campus of the University of Tokyo. Aiming for improving structural reliability in energy systems, this symposium featured lectures and discussion revolving around issues pertaining to (1) Operation & Maintenance for Structures, (2) Advanced Simulation for Nano-, Micro-, and Macro-Structural Reliability, and (3) Structural Reliability of Innovative Aerospace Composite Systems. Along with the presentation of research results by project promoters pertaining to the energy innovation field, an imperative research area for the COE Program, Mr. Charles Becht IV, Professor Seyoung Im, Professor Takano, and Dr. Iwahori and associates were invited to give lectures about cutting edge research results. Furthermore, the 26 poster presentations and discussions as well as demonstration experiments given by ph.D. students were lively thanks to active participation of the guests. Cutting edge research was shared in a wide range of fields, making this an incredibly meaningful workshop.



Mr. Becht's lecture

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## *The 3rd International Symposium on Innovative Aerial/Space Flyer Systems*

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An international symposium on mechanical systems innovation entitled “The 3rd International Symposium on Innovative Aerial/Space Flyer Systems -Mastering Flight-” was held on November 24 (Fri) and 25 (Sat), 2006 at Takeda Hall in the Takeda Frontier Science Building on Asano Campus. This symposium featured two sessions in each of the following areas, with the goal of making innovative aerial systems possible: (1) MAV (Micro Aerial Vehicle) and UAV (Unmanned Aerial Vehicle) research and development, (2) space energy usage, and (3) basic research. It was developed centering around researchers and students participating in the COE Program innovative aerial robot project, the space energy sub-project of the energy innovation project, and in basic research. Research findings from the COE Program from both fields were presented. H. Jin Kim (Seoul National University, Korea), Cees Bil (RMIT University, Australia), Eric N. Johnson (Georgia Institute of Technology, U.S.A.), Agnès Luc Bouhali (ONERA, France), Sang H. Choi (NASA Langley Research Center, U.S.A.), Yves Ribaud (ONERA, France), and Norbert Mueller (Michigan State University, USA) were invited to give lectures about state of the art research results. Furthermore, the 27 poster lectures and discussions as well as demonstration experiments given by students were lively thanks to active participation of the guests.



Discussion at a poster session

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## *The 3rd International Symposium on Biomedical Systems Innovation*

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An international symposium on mechanical systems innovation entitled “The 3rd International Symposium on Biomedical Systems Innovation” was held over the two day period of November 27 (Mon) and 28 (Tues) at Takeda Hall in the Takeda Frontier Science Building on Asano Campus. This symposium featured five sessions: Cellular Biomechanics, Cell/Tissue Culture Technologies, Computer-integrated Robotics Surgery, Computational Biomechanics, and Engineering Synthesis with Medicine. The latest information in this field was provided by Prof. Zhu (Georgia Inst. of Tech.), Prof. Matsumoto (Nagoya Inst. of Tech.), Dr. Eric Leclerc (Univ. of Compiègne), Prof. Naruse (Okayama Univ.), Prof. Fujie (Waseda Univ.), Dr. Kamiyama (Toshiba Medical Systems), Dr Xu (Imperial College of London), Prof. Tamagawa (Kyushu Inst. of Tech.), and Prof. Sugimori (New York Univ.). The audience was active in asking questions and inspiring vibrant discussion. Furthermore, Ph.D. students participating in the COE Program gave short presentations and poster sessions, and lively discussions with the guests unfolded.



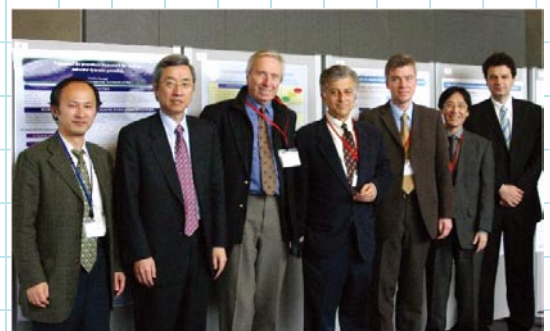
Professor Matsumoto's lecture

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## *International Symposium on Computational Challenges in Thermal, Fluids and Energy Systems*

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An international symposium on state of the art computational science pertaining to thermal, fluid, and energy systems was held on March 1-2, 2007 in the Takeda Hall of the Takeda Frontier Science Building. This two day symposium consisted of four sessions pertaining to moving boundary flow, micro systems, design and optimization, and flow within energy systems as well as short oral / poster sessions by 20 doctorate students. 21COE Project promoters and project promotion supporters presented internationally the latest research findings, and frontline researchers Prof. S. Hardt (Technical Univ. of Darmstadt), Prof. B. Launder (Univ. of Manchester), Prof. P. Koumoutsakos (ETH), Prof. P. Moin (Stanford Univ.), Prof. S. Obayashi (Tohoku Univ.), and Dr. K. Takase (JAEA) lectured on the latest research trends. Ph.D. students took advantage of the opportunity to present their individual research results via short oral / poster sessions, and garnered high praise from the guests regarding 21COE activities and the student research level.



Lecturing professors

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## *Domestic Symposium in FY2006*

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The 21st Century COE Program's domestic symposium entitled "Mechanical Systems Innovation" was held on March 7 (Wed), 2007 in Building No. 8 of school of engineering on the Hongo Campus of the University of Tokyo. The domestic symposium is held at the end of each year as an arena for research assistants (RA) in this program to report on their research activities for that year and for RAs to deepen mutual exchange. In 2006, it was held in three parallel sessions corresponding to the major research areas.

A total of 15 sessions were held, with five sessions in the energy innovation field on monitoring / sensing, global material circulation, combustion, clarification systems, and observation / control, five sessions in the bio-medical field on tissue engineering, dynamic modeling, micro processing I, micro processing II, and robot control and oscillation, and five sessions in the hyper modeling / simulation field on multiphase flow, electromagnetic fluids, numerical fluids I, numerical fluids II, and multi-scale analysis. Each session was composed of voluntarily gathering RAs whose research themes were relevant to the session. Also, the RAs conducted operation tasks, such as MC responsibilities, etc. Each session was attended by project promoters related to the session theme, who gave evaluations. Discussion was incredibly vibrant, and along with a reaffirmation of the importance of these types of machinery, as evidenced by sessions that repeatedly lasted longer than their planned time frames, it also offered areas of reflection in terms of operation.

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## *The 3rd 21<sup>st</sup> Century COE Seven Universities Joint Symposium*

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The 3rd 21st Century COE Seven Universities Joint Symposium was held on March 8 (Thurs), 2007 at the Hiroshima University Higashi Hiroshima Campus and Hiroshima University Satake Memorial Hall. With the purpose of promoting research exchange between universities and the communication to society of the research activities of each program, young researchers from the COE programs in seven universities including this program take the lead in planning and operating this symposium. Continuing from the previous symposium held at Nagoya University 2005, this symposium was headed by Hiroshima University. At the symposium, introduction to activity content at each office, guest lectures, poster presentations, and panel discussions were



At the symposium

conducted. 11 RAs from this program participated, and latest findings in chief research areas, cross-major lectures, and introductions of educational programs such as the ETH-UT exchange program were presented. Interest was high from other universities as well regarding these research and educational activities, and many questions were asked. Also, panel discussions after the introduction of the activities of each office were entitled "Which is more important, practical research or academic one?" and "Should we work in college / university or research centers?" The audience participation format panel discussion using chat was incredibly successful, making this an extremely valuable arena for exchange between schools.

## Towards reliability engineering based in material fracture mechanics

Professor: **Shinsuke Sakai**, Graduate Engineering Program, Mechanical Engineering Major

### ●Pursuing scientific maintenance methods for chemistry plants and nuclear plants

I have continued to research in the field of reliability engineering ever since I chose it as my graduate dissertation theme. Within this field, I focus on fracture mechanics and risk based engineering. Risk based engineering incorporates the concept of risk management into the maintenance of machines and structures, defines and evaluates risk as "a product of the failure probability and consequence," and is a theory for surveying and maintenance.

In general, long-term continuous operation for machines and atomic power plant facilities provides better efficiency and lower maintenance costs. However, in Japan particularly frequent and routine inspections are common, resulting in low efficiency and a large difference in the inspection program and the amount of deterioration actually found. Also, increasing inspection frequency in nuclear plants, for example, means an increase in the danger of radiation exposure for plant inspectors. Conducting the same inspection each time also has the demerit of creating a situation where those in charge stop thinking actively. It is necessary to make judgments based on evaluations of permissible and impermissible defects and conduct flexible maintenance. The academic field of fulfilling the social responsibility of guaranteeing safety while conducting scientific and economic maintenance as well as evaluations of continual usability is called risk based engineering.

Currently, maintenance guidelines are being developed via risk based engineering by The Japanese Society of Mechanical Engineers in the field of nuclear power and the RBM (risk based maintenance) research group of the High Pressure Institute of Japan in the field of non-nuclear energy sources. Also, the Industry-Academia Joint Manufacturing Human Resource Training Project of the Ministry of Economy, Trade and Industry is involved in the cultivation of a workforce to execute risk management and the construction of a failure probability database which compiles example cases of symptoms of breakage in pipes of nuclear power plants and chemical plants. Via these sorts of actions, it is my hope that research findings are used to contribute to society and that reliability engineering will be taken root in Japanese soil.

Via the Hyper Modeling / Simulation Project, 21st Century COE Program is overseeing material strength and interfacial multi scale analysis such as MEMS (Micro Electro Mechanical Systems). The components that make up the analysis base are the finite element method, molecular dynamics, and electron density analysis.

The non-loosening bolt nut developed last year via joint research with a manufacturer is one achievement of simulation. First, the state of the bolt and bolt nut loosening was simulated via a computer. Then, based on the results of that simulation, the method was developed in which after inputting an incision in the nut face, it was curved using air pressure from the top. By doing this, because the screw thread contact surface ceases to be uniform, loosening becomes difficult. This bolt nut did not loosen even after 100 oscillation experiments following NASA standards, and can be removed with a spanner and reused.

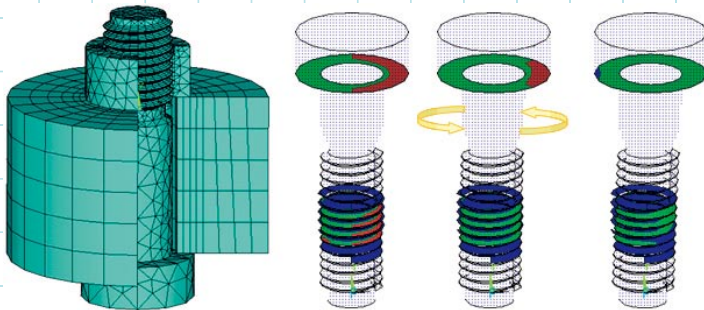
### ●Research that constantly keeps in mind links to society

I have liked machines since childhood. In high school I frequented Akibahara and made radios and amps.

When I was given the theme of reliability engineering and risk based engineering by my former teacher in graduate school, Professor Hiroyuki Okamura (former Tokyo University of Science Dean), there were very few researchers in this field and the importance was difficult to see. However, in continuing my research, I began to understand the necessity, the depth of the theme, and the strain of society connected to risk. I began to feel a definite calling towards research in that area. Thinking of the increasing need for this area of study in today's society, I am grateful to the foresight of my professor.

As a risk based engineering specialist, I feel that I must perform risk management in my own life as well. By revolving through the PDCA (Plan, Do, Check, Action) cycle, which is the foundation of safety management, in the morning I create and execute the plan for that day, and aim to improve through performing checks.

From the time young researchers are in college, I wish for them to develop the habit of constantly considering links to society. When conducting high level theoretical research at college, there are many cases of difficulties due to the industry not existing at that level. It is necessary for researchers as well to work towards diminishing this gap. I feel that being aware of how one's own research can benefit society is the cornerstone of being an engineer.



The mechanism that prevents bolts from loosening was simulated via computer using the finite element method. The finite element method minutely segments the calculation target range, calculates using functions common to the sub-ranges, and finds the overall sum. It is a method used for targets which cannot be analyzed simply. The findings of this research led to the development of non-loosening bolts with uneven contact surfaces for the screw threads.



#### < Career Summary >

After graduating from the Mechanical Engineering Department in the College of Engineering of The University of Tokyo in 1975, Mr. Sakai completed doctorate work in the Engineering Graduate Program (Marine Mechanical Engineering Major) of The University of Tokyo in 1980 and became a Doctor of Engineering. From that year he became a lecturer in the College of Engineering at The University of Tokyo, and became an assistant professor in 1981. In 1995 he became an assistant professor in the Engineering Graduate Program, and has worked in his current position since 1997.

## Program Executive Organization

### Program leader

Nobuhide Kasagi  
Professor, Department of Mechanical Engineering, School of Engineering

### Project Promoters

#### Energy innovation

Toshio Nagashima  
Professor, Department of Advanced Energy, School of Frontier Sciences  
Chisachi Kato  
Professor, Department of Mechanical Engineering, Institute of Industrial Science  
Takayuki Terai  
Professor, Department of Nuclear Engineering and Management, School of Engineering  
Kazuro Kageyama  
Professor, Department of Technology Management for Innovation, School of Engineering  
Nobuo Takeda  
Professor, Department of Advanced Energy, School of Frontier Sciences  
Tamaki Ura  
Professor, Department of Environmental and Ocean Engineering, Institute of Industrial Science  
Shinichi Nakasuka  
Professor, Department of Aeronautics and Astronautics, School of Engineering  
Toyoshisa Fujita  
Professor, Department of Geosystem Engineering, School of Engineering  
Shigehiko Kaneko  
Professor, Department of Mechanical Engineering, School of Engineering  
Shinji Suzuki  
Professor, Department of Aeronautics and Astronautics, School of Engineering

#### Project members

Tomonori Yamada Project Lecturer, International Research and Education Center for Mechanical Systems Innovation, School of Engineering  
Yoshiaki Akematsu Project Research Associate, International Research and Education Center for Mechanical Systems Innovation, School of Engineering

### Advisory Committee

#### Advisory Committeemen

Koutaro Inoue Senior Fellow, Japan Science and Technology Agency  
Noboru Kikuchi Professor, The University of Michigan  
Yoshitsugu Kimura Professor Emeritus, The University of Tokyo  
Tetsuya Tateishi Fellow, National Institute for Material Science

#### Biomedical innovation

Mamoru Mitsuishi  
Professor, Department of Engineering Synthesis, School of Engineering  
Masao Washizu  
Professor, Department of Mechanical Engineering, School of Engineering  
Masayuki Nakao  
Professor, Department of Engineering Synthesis, School of Engineering  
Teruo Fujii  
Professor, Department of Environmental and Ocean Engineering, Institute of Industrial Science  
Takashi Ushida  
Professor, Center for Disease Biology and Integrative Medicine, School of Faculty of Medicine

#### Hyper modeling / simulation

Yoichihiro Matsumoto  
Professor, Department of Mechanical Engineering, School of Engineering  
Takafumi Fujita  
Professor, Department of Engineering Synthesis, Institute of Industrial Science  
Hideaki Miyata  
Professor, Department of Environmental and Ocean Engineering, School of Engineering  
Shinsuke Sakai  
Professor, Department of Mechanical Engineering, School of Engineering  
Shinobu Yoshimura  
Professor, Department of Quantum Engineering and Systems Science, School of Engineering

## Activities of Mechanical Systems Innovation Program

#### <Open Seminars>

##### ◎FY2006-11th Seminar

Date : December 14, 2006 16:30pm-  
Venue : Conference room 31A1, Faculty of Engineering bldg.2, Hongo campus  
Subject : Modeling of Fluid-Structure Interactions with the Space-Time Techniques  
Speaker : Professor Tayfun E. Tezduyar (Rice University)

##### ◎FY2006-12th Seminar

Date : January 17, 2007 15:00pm-  
Venue : Conference room 31A1, Faculty of Engineering bldg.2, Hongo campus  
Subject : Transient Convective Heat Transfer  
Speaker : Professor Jacques PADET (University of Reims, France)

##### ◎FY2006-13th Seminar

Date : January 22, 2007 1:00pm-2:30pm  
Venue : Seminar room 1, Faculty of Engineering bldg.2, Hongo campus  
Subject : Real-time ab initio calculations of excited-state dynamics in carbon nanostructures  
Speaker : Professor David Tomanek (Physics and Astronomy Department, Michigan State University)

##### ◎FY2006-14th Seminar

Date : January 26, 2007 11:00am-12:00am  
Venue : Lecture room 232(2-301), Faculty of Engineering bldg.2, Hongo campus  
Subject : Observations of the motion of heavy particles in a viscous fluid.  
Speaker : Professor Tom Mullin (Manchester Centre for Nonlinear Dynamics, Department of Physics and Astronomy, Manchester University)

##### ◎FY2006-15th Seminar

Date : March 22, 2007 4:00pm-  
Venue : Conference room 422B, Faculty of Engineering bldg.4, Hongo campus  
Subject : Research, Innovation and Trends in Development of Physical Methods of Material Manipulation  
Speaker : Professor Jan Svoboda

##### ◎FY2006-16th Seminar

Date : March 23, 2007 1:00pm-2:30pm  
Venue : Lecture room 232, Faculty of Engineering bldg.2, Hongo campus  
Subject : Atomic mechanics of nanotubes: Elasticity, yield, superplasticity  
Speaker : Professor Boris I. Yakobson, Departments of Mechanical Engineering and Materials Science, Smalley Institute for Nanoscale Science and Technology, Rice University

#### <International Symposium>

##### ◎International Symposium on Computational Challenges in Thermal, Fluids and Energy Systems

Date : March 1~2, 2007  
Venue : Takeda Hall, Takeda Bldg., Asano campus

#### <Domestic Symposium>

##### ◎21st Century COE Mechanical Systems Innovation

Date : March 7, 2007  
Venue : Lecture room 83, 84, 85, Faculty of Engineering Bldg.8, Hongo campus

#### <Industry-Faculty Council for Human Resource Development>

##### ◎5th Industry-Faculty Council for Human Resource Development

Date : March 9, 2007  
Venue : Faculty of Engineering Bldg.2, Hongo Campus

#### <Cross-Department Doctoral Course>

##### ◎Research Assistant Final Debrief Session, "Mechanical Systems Innovation I,II"

Date : January 26, 2007  
Venue : Takeda Hall, Takeda Building, Asano campus

#### <Workshops>

##### ◎BK21 - 21COE Student Workshop

Date : February 14, 2007  
Venue : Room 402, Takeda Bldg., Asano campus

### The 21st Century COE Program Mechanical Systems Innovation, Newsletter No.13E

September 1, 2007

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