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

Newsletter

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

Final Issue : Research & Educational Achievements in "Mechanical Systems Innovation"

25th January, 2008. Cross Department Doctoral Course Final Results Debriefing Session

Reflection at the End of the 21st Century COE Program "Mechanical Systems Innovation"

Nobuhide Kasagi, Program Leader

In the five-year program started in 2003 for establishing a center of excellence for research and education, we have been developing activities aiming at restructuring engineering discipline based on mechanics by creating visions and aims appropriate for the new century. That is to say, we have been exploring how mechanical engineering and technology could help in converting the exceedingly expanded human sphere into a sustainable system that can co-exist with the earth, and also in materializing sound and comfort lives as well as a safe and secure society for people with diverse senses of value. We focused mainly on the energy and biomedical fields in addition to the modeling/simulation technology, which supports leading design of future mechanical systems. In an open international environment, more than a hundred people, including faculties and Ph.D. candidates, have been involved in this program to establish a base where transdisciplinary research activities can be created beyond generations and departments. Such base has also enabled us to engage in various attempts to cultivate able young people.

In the field of energy innovation, we worked with related major industrial companies as a part of industry-academia collaboration toward the energy security of our country, and publicly issued "Triple Fifties: Japan's Energy Vision for 2030." We extracted technological issues based on the vision and promoted some fundamental research projects. Concerning highly value-added energy utilization, which would sustain future ubiquitous environment and aging society, we promoted R&D studies on micro energy conversion technologies. We also launched a project named "Innovative Aerial Robots" for natural resource search and security monitoring, and expanded its activity outside the University in such ways as presentation at EXPO Aichi 2005 and organizing annual student competitions.

In the field of biomedical innovation, an outstanding progress was made in the basic study on human-friendly medical processes, i.e., noninvasive/minimally invasive treatments or remote diagnosis/treatment. Development of a new diagnostic treatment system was advanced by fusion of ultrasound technology and medical robotics. For regenerative medicine, we studied dynamical effects on cell differentiation and also developed a micro cell processing system for extracting rare stem cells from peripheral blood. These activities have greatly contributed to establishing a new postgraduate course of bioengineering at the School of Engineering.

A distinct progress has also been made in hyper-modeling/simulation, which supports designing innovative and advanced mechanical systems. We continuously advanced the numerical methodology for multi-scale analysis covering molecular to continuum scales, and for multi-physics analysis dealing with coupled dynamical, electrical/electronic and chemical phenomena, while developing the methods for whole system simulation and system optimization with extra-large scale computation. Several examples of our achievement are microscopic analysis of semiconductor structures and capillary vessel systems, design simulation of micro engines and fuel cells, and simulation of large-scale structures and thermal/fluids systems.

Concerning human resource development, continuous exchange of ideas and opinions between industry and academia with voluntary participation of postgraduates has made an unprecedented mutual understanding possible. We have reached a shared recognition that, as the world is increasingly globalized, an internationally competitive industry is indispensible for establishing a knowledge-oriented society and assuring sustainable development. So, we should pursue postgraduate education with a distinct target of nurturing people who can lead innovation in a diversely developing society. Some of the new programs are the group-PBL style "Inter-departmental Lectures" for acquiring project management skills and comprehensive understanding of the trend in technological development; the doctoral internship program at companies and national laboratories for developing problem-setting/resolving capacity; and annual international exchange program with Eidgenössische Technische Hochschule (ETH) Zürich.

Reflecting on all the above achievements, major outcomes of this COE program can be summarized into the following three items:
Promotion of research projects beyond the frames of specialties and/or departments, and vision-driven research projects,
Innovation of postgraduate education programs, clear definition of the aims, and awareness raising of the teaching staff and students,
Sharing of visions and aims between industry and academia towards attainment of research and education goals.
Especially, concerning the postgraduate education, I feel it is a unique achievement of our COE program that both teaching staff and students have realized that, in order to achieve human resource development based on the visions and aims in the new century, it should be necessary to rebuild education programs as concrete means to nurture basic grounding, professional knowledge, literacy, and competency, and introduce an effective monitoring system to check the degree of achievement. We have actually promoted an organized and systematic reformation.

Although there are still remaining issues, I have had a sure feeling about the progress in the new system of research and education each time I saw confident smile of postgraduates and young researchers. I would like to take pride in establishing and bringing up a center of excellence not only with the project promoters and teaching staffs involved but also with postgraduates who will sustain the future.

This program is closed in this fiscal year, but we will make even more efforts in maintaining our activities as an international education and research center. On behalf of the 21COE program members, I would like to sincerely acknowledge supports from many people in industries, other universities and government offices in a variety of forms, and express our deepest gratitude to them.

Energy Innovation Project

Chisachi Kato: Institute of Industrial Science
(Mechanical Engineering Department)

In addition to reducing environmental load and stabilizing energy supply, the ability to select a variety of energy delivery modes will become a requirement of future society. This capability will support our everyday lives such as through mobile power supplies for information appliances and nursing equipment. The Mechanical Systems Innovation program has been promoting the research and development of elemental and system technologies and simulation technologies as the key to achieving this future society. This R&D has been centered on high-efficiency energy conversion system, compact and distributed energy sources, energy-harvesting and heat-recovery technologies, and recycling technology. This report introduces several key research achievements from among these projects.

High-efficiency Energy Conversion System

To raise the efficiency of gas-turbine combustors and make their emissions clean, the atomization process of fuel film in the combustor's fuel injection valve must be understood in detail and the process must be optimized. As a first step in that direction, visualization experiments conducted by the Watanabe Laboratory have enabled this atomization process to be observed. They have also led to the formulation of a numerical calculation method that can handle free surfaces and the separation and unification of liquid film. Computational results by this technique show good agreement with experimental results. This work should lead to a greater understanding of the atomization process (Figure 1).

At present, combustion gas at the inlet of gas turbines used for generating electricity reaches temperatures up to 1500˚C. To increase the efficiency of gas-turbine power-generating plants and combined-cycle power-generating plants, it is essential that temperature at the turbine inlet be made even higher. This will require accurate prediction of the heat transfer coefficient of high-pressure-stage blade cascades and the optimization of blade cooling design. However, the conventional Reynolds-Averaged Navier-Stokes Simulation (RANS) technique is limited in its ability to make high-precision predictions of the heat transfer coefficient in a flow field that includes transitions. At the Kato Chisachi Laboratory, Large Eddy Simulation (LES) is being used to predict the heat transfer coefficient for the surface of a blade in a gas turbine. Results so far indicate the possibility of making quantitative predictions of transition points and heat transfer coefficients (Figure 2) that should contribute to the development of advanced cooling designs for gas turbine blades.

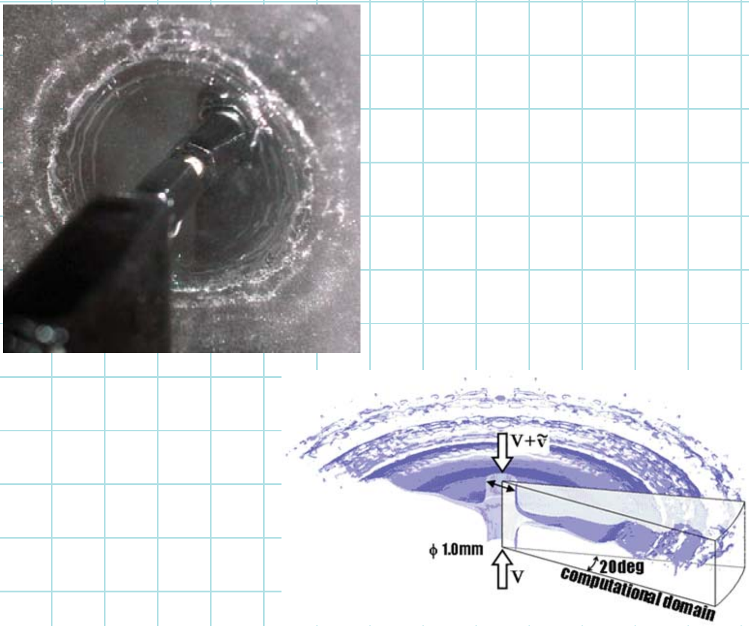


Figure 1: Experimental visualization (above) and numerical simulation (below) of the atomization process of liquid film (Watanabe Laboratory)

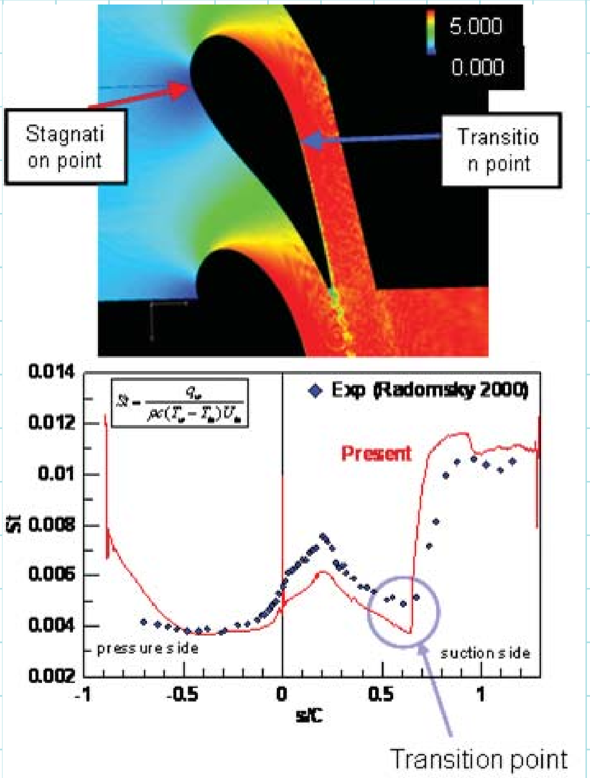


Figure 2: Prediction of heat transfer coefficient for blade surfaces in a gas turbine using LES (Kato Chisachi Laboratory)

Energy Innovation Project

Compact and Distributed Energy Sources

Fuel cells have been attracting much attention as small-sized and distributed energy sources, but the optimal design of its electrode structure is indispensible for raising fuel-cell performance. So far, the implementation of such design improvements based mainly on empirical results has had limited effects. In response to this situation, the Kasagi-Shikazono Laboratories have constructed a prototype microchip-type Solid Oxide Fuel Cell (SOFC) system and measured power-generating characteristics. They also formulated a numerical simulation model for a fuel-electrode porous structure, and applied the lattice Boltzman method to the prediction of overpotential characteristics that essentially indicate conversion loss in these electrodes (Figure 3).

Gas engines supporting various types of biomass gases have also been attracting attention as a future source of energy. The Kaneko Laboratory has calculated heat production and estimated fuel calorie load in such an engine by detecting intra-cylinder pressure, and its research team has constructed a prototype biogas engine that can control ignition timing and the air-fuel ratio in an optimal manner. Figure 4 shows the prototype engine and engine test results when varying fuel load. When changing the type of fuel gas (top graph), the engine automatically performs optimal control of the air-fuel ratio (middle graph) and ignition timing (bottom graph) thereby demonstrating that stable operation can be achieved for a variety of biogas fuels.

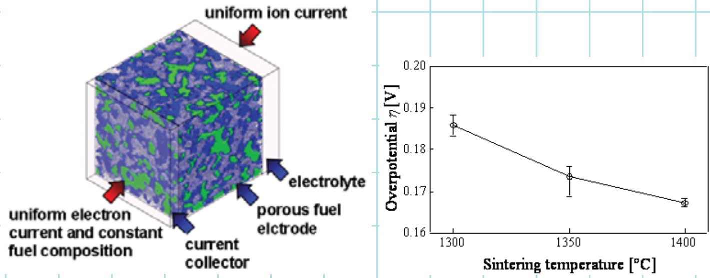


Figure 3: Model of SOFC fuel-electrode structure and results of characteristics prediction by the lattice Boltzman method (Kasagi-Shikazono Laboratories)

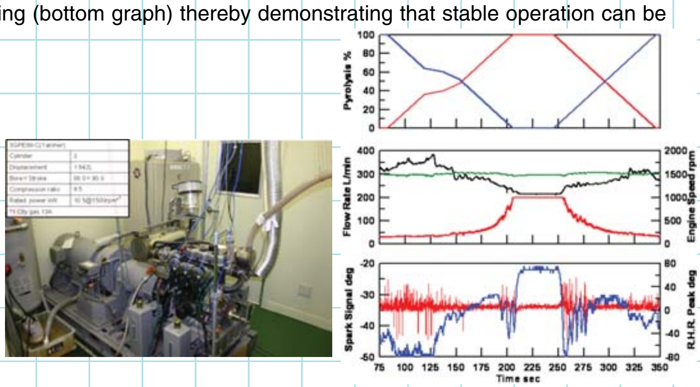


Figure 4: Prototype biomass gas engine supporting various fuel calorie loads (Kaneko Laboratory)

Energy Harvesting and Heat-recovery Technology

Figure 5: Prototype microvibration-type electret power generator (Kasagi-Suzuki Laboratories)

The movement of people, automobiles, and other things in society gives rise to microvibrations (environmental vibrations). If a means can be found to use such vibrations to generate electricity, it should be possible to develop ultra-long-life power supplies without the need for fuel. A wide array of applications can be envisioned such as power supplies for radio devices in unmanned locations and power supplies for sensors in locations inappropriate for other types of power supplies. The Kasagi-Suzuki Laboratories have undertaken the research and development of static-induction power generation using electrets and have constructed a prototype microvibration-type electret power generator using a micro-electromechanical system (MEMS). Although power generation by such a device was limited to the microwatt level in the past, the research conducted here is helping to make devices on the milliwatt level promising (Figure 5).

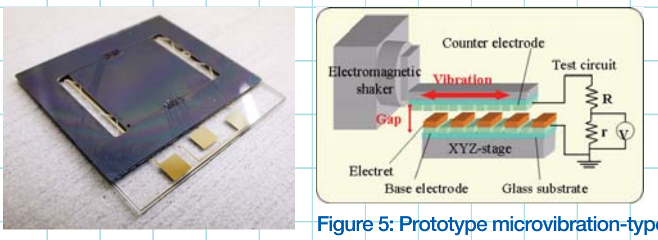


Figure 5: Prototype microvibration-type electret power generator (Kasagi-Suzuki Laboratories)

Environmental Recycling Technology

This Center of Excellence (COE) supports the R&D of environmental recycling technology in addition to research on high-efficiency energy systems, distributed power supplies, and energy harvesting as described above. To give an example, Figure 6 shows the results of an experiment conducted at the Fujita Laboratory on explosive fragmentation in water. These results demonstrate that energy in the form of a 1.7-GPa high-pressure shockwave can be used to separate electrical appliances like cell phones with an amount of energy much lower than that used by conventional methods.

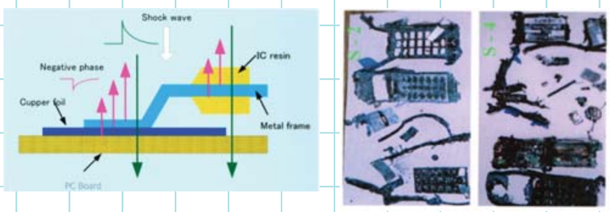


Figure 6: Energy-saving separation experiment using explosive fragmentation in water (Fujita Laboratory)

Innovative Aerial Robot Project

Shinji Suzuki：Department of Aeronautics and Astronautics

Flying Robot

Field Flight Experiment

Goal and Scope of the Project

As a cross-sectional research project in the COE program, the Innovative Aerial Robot Project (IARP) was organized to promote collaborative activities between COE members and students. The target of IARP is to develop unmanned aerial vehicles (UAVs). UAVs with autonomous flight systems and aerial photography equipment are expected to be of considerable use in missions such as early reconnaissance of disaster areas and environment monitoring. From concept designs to its applications become a focus of collaborative research and educational activities throughout the COE program.

Developed Technology

Mini UAVs were developed for EXPO 2005 through by entrustment by NEDO (New Energy and Industrial Technology Development organization). These mini UAVs electric powered weight less then 2.0 kg are automatically guided by GPS signals and have a data link system using cellular phone communication lines. This size was selected to enable operators to carry and the launch a flying robot with ease.

We have explored the feasibility of aerial monitoring of disaster areas and natural environments. We participated in a general emergency drills in Nagata Ward, Kobe City in 2005 and 2006 and in aerial monitoring at Yamakoshi Village which was struck by a big earthquake in 2005. These projects were carried out in close cooperation with Mitsubishi Electric Company. For environment monitoring, aerial photography has been practiced periodically since 2005 with the Hiroshima Prefectural Forestry Research Center. These activities were utilized to acquire flight testing skill and to improve the flight system.

Feedback on Education

A new design class in the graduate course of the department of Aeronautics and Astronautics was created by Professor Kennichi Rinoie. In the class, UAVs are designed, constructed and flight-tested by groups of students. Additionally, in the inter-department class in our COE program, an innovative MAV design was developed by one group and its prototype was created in IARP. In order to expand our activities over Japan, we held an indoor-flying robot contest for students under the auspices of JSASS (Japan Society of Aeronautical and Space Sciences). Self-made model planes of less than 150 gram weight with a small wireless camera were used for a target identification mission in a large exhibition hall. For this year's 3rd annual competition, some foreign teams will be invited as well. The department of aeronautics and astronautics received the Ministry of Education and Science Award from the Japan Society for Engineering Education for organizing these activates.

Feedback on Research

Following upon the launch of IARP, joint meetings have been held periodically and several research activities started. These include individual projects as well as projects managed by joint research groups with different organization including industries. Research areas cover a wide range of fields such as Low Reynolds Number Aerodynamics, Insect Flight Control Analysis, GPS/INS Avio-units, Microwave Energy Transmission, Flapping Wing Flight, Solar Powered Planes, VTOL UAVs, Automatic Flight Helicopter Flight, CFRP materials. At several international conferences best paper awards were obtained by our research groups.

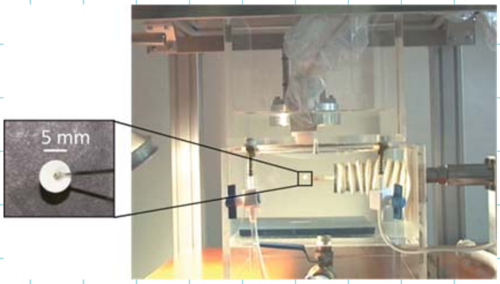
Conclusion

Our projects have been reported by the media and we have organized an international symposium annually. IARP is now internationally recognized as a center of expertise for research and education on flight systems. IARP shows great potential and we look forward to further evolve our activities in the future.

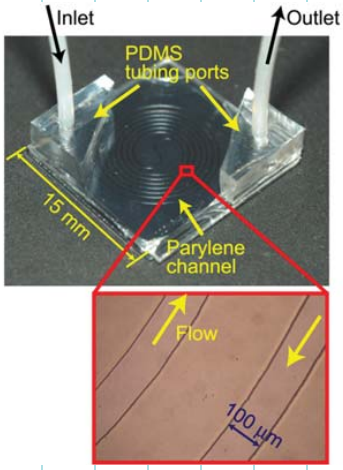
Biomedical Innovation Project

Mamoru Mitsuishi : Department of Engineering Synthesis

Development of biomedical systems in the next generation



The integrated system for non-invasive ultrasound diagnosis and treatment



Micro cell sorter prototype with antibody-coated affinity chromatography micro column

M.Mitsuishi and Y.Matsumoto's group developed the integrated system, for noninvasive ultrasound diagnosis and treatment, by utilizing visual tracking technology, based on the stereo diagnostic images(Fig.1).The concept behind our proposal focuses on destroying tumors and stones. Using focused ultrasound directly without damaging healthy tissue while tracking and following the affected area -- kidney stones in this case -- during movement due, for example to the patient's respiration.The prototype system has been constructed, which tracks and follows model stones. Some experiments have been conducted to destroy the model stones so far. Average tracking error: 1mm is realized, so far. The model stones move in accordance with the input motion pattern of the real human kidney by respiration. The robust visual tracking method for the change in the shape of the stone is newly proposed and implemented in the present study. A controller, considering the quasi-periodical respiratory motion, is also proposed and implemented. The realization of the system is expected which tracks, follows, and destroys stones within the real body precisely.

M.Nakao and H.Takahashi's group investigated how neural circuits are developed in dissociated cultured neurons. Hypothesizing that organized external stimuli and definition of the input-output relationship of neural circuits have great impacts on the development, this study developed a light-addressable electrode and culture dish with 3-dimensional microstructures. The light-addressable electrode employed a hydrogenated amorphous silicon (a-Si:H) as a photo-sensitive conductive layer and zinc antimonate-dispersed epoxy (ZADE) as a passivation layer, which prevented penetration of culture medium and thus avoiding deterioration of a-Si:H layer. Also the experimental setup we developed allowed simultaneous calcium imaging in conjunction with the light-addressable stimulation. These setups demonstrated that the spatial resolution of the light-addressable stimulation was approximately 10 μm. The cultured dishes with 3-dimensional microstructure consisted of a micro-slope and wall with a 20 μm height, which was designed to induce asymmetry in the signal transfer; neurite growth rate from the wall to slope side would be suppressed. Calcium imaging of stimulation-induced activities demonstrated the directional property of signal transfer, by which neural activities by slope-side stimulation can propagate better to the other side than those by wall-side stimulation, confirming our hypothesis. We believe these two novel techniques will open a new avenue to investigate the development of the neural circuit of dissociated cultured neurons.

N. Kasagi, T. Ushida, Y. Suzuki, K. Furukawa and N. Shikazono's group developed Micro Cell Sorting Systems. Stem cell therapy is a rapidly evolving biomedical technology, in which multipotent stem cells are cultured in vitro and transplanted to regenerate damaged or deficit tissue. One of the key issues in tissue engineering is efficient detection and extraction of rare primary cell sources such as stem cells. Therefore, it is very important to develop devices for rapid separation of rare cell samples with high purity and accuracy. In the present study, we are developing cell sorting systems for rapid detection and separation of cells with specific antigens from biofluids such as peripheral blood. Accomplishments so far are as follows; 1) development of cone-plate-driven rotational flow chamber for trapping target cells on antibody-coated surface of temperature-sensitive gel, 2) development of on-chip cell labeling mixer and magnetic separator as components of micro immunomagnetic cell sorting system, for stem cell extraction from small amount of concentrated blood sample such as white blood cell fraction, and 3) design and microfabrication of novel antibody-coated affinity chromatography micro column for surface-marker-based separation of cells without the need of labeling particles (Fig. 2). Through quantitative evaluation of the performance of these devices, we have shown that the cell sorting principles are promising for use in tissue engineering, and have established concrete design methodologies of these systems for future clinical use.

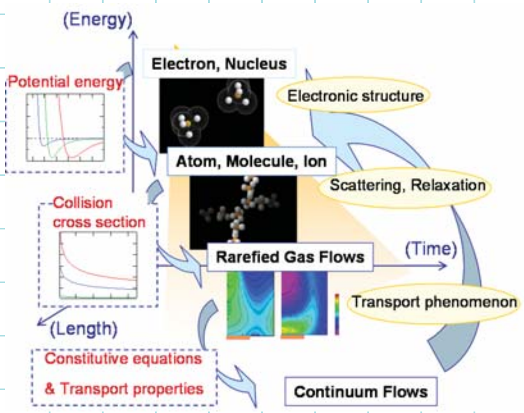
M.Washizu's group investigated methodologies for bio-manipulation of cells and DNA using the electric field constriction created by a microfabricated orifice whose diameter is smaller than that of the cells, the reversible breakdown of biological membrane can be induced at a targetted position on the cell in a controlled manner, thus leading to high-yield and less-invasive electroporation and electrofusion. More than 90% yield is achieved both for the poration and the fusion with the method. Other research topics include the modulation of enzymatic activities by the use of periodical micro-structures, single molecular manipulation of chromosomal DNA based on optically-driven micro-hooks and micro-bobbins, by which DNA can be picked and wound at will.

Hyper Modeling and Simulation Project

Yoichiro Matsumoto : Department of Mechanical Engineering

Establishment and enhancement of multi-physics and multi-scale analysis methods

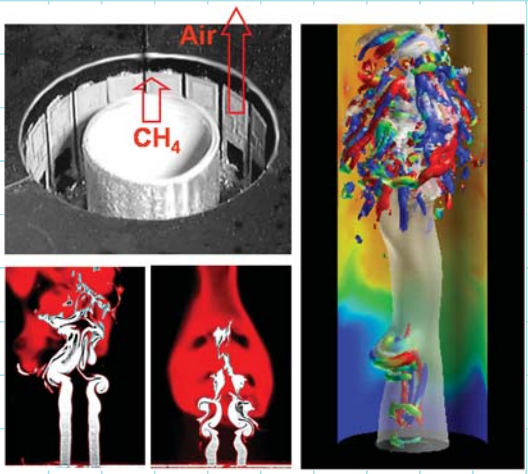
To cultivate and create various kinds of future technologies to better human life, it is indispensable to establish powerful design methodologies incorporating high performance simulations that accurately model the complex multi-scale and multi-physics phenomena that occur internal and external to real mechanical systems. In order to develop such engineering methodologies based on a hierarchy from quantum to continuum mechanics, we have been tackling advanced modeling for micro and nano scale fundamental processes, physics and chemistry at interfaces between different phases, nonlinear multi-scale and biochemical phenomena, and so forth. We also have been investigating ultra high-speed computational algorithms to achieve large-scale and complex simulations coupled with the new models.



Construction of a hierarchical dynamical system from quantum mechanics to continuum mechanics

The analysis of mechanical properties of materials is one of the typical targets that highly require multi-scale and multi-physics modeling. In order to simulate material properties, we developed methodologies such as generic developing method of interatomic potentials, multi-scale modeling of surface reactions, hybrid simulations employing first principles calculations and classical molecular dynamics (MD), coupling of MD and finite element mothod, and so on. Our simulations based on these methodologies accurately predict material properties.

We developed simulation tools for the circulation of blood in the human body since it is getting more important for the achievement of advanced medical care for cardiovascular disease, cerebrovascular disease, and others, which are becoming increasingly serious problems in the aging society. Our multi-scale analysis covered from molecular-level transportations into cells through biomembrane to continuum level fluid-structure coupling between blood flow and dispersed bodies. The transportation and mechanical properties of membrane were evaluated with molecular simulation methods.



Control of lean premixed turbulent combustion

We also employed MD - continuum hybrid simulation which couples atomistic simulation and continuum simulation and enables us to investigate meso- or macro-scale phenomena while retaining molecular-scale resolution near membrane. At a continuum scale, a coupled fluid-structure analysis between blood flow and dispersed bodies was conducted using immersed-boundary method. Our simulation successfully reproduced the dispersed bodies passing through a microchannel with their shapes largely deformed. In addition, with geometric models reconstructed from CT and MRI images of individual patients, we conducted coupled fluid-structure analysis between blood flow and blood vessel wall to unravel the cause of blood vessel impairment.

As a part of our turbulence modeling project, we constructed a hybrid simulation method which couples direct numerical simulation (DNS) and large eddy simulation (LES). Our numerical scheme successfully predicted heat and matter transport phenomena in concentration field with high Schmidt number. DNS simulations were also employed to evaluate and optimize the control algorithm of turbulent drag reduction system using MEMS devices. We also investigated unsteady turbulent flows of turbomachinery and noise production mechanism around high speed trains using LES simulations, which enable accurate predictions of flows with large separation, transitional flows and flow-induced noise.

We believe that the fruitful outcome of wide-ranging research topics during the five years of our COE project expands and deepens fundamental academic knowledge, which must be incorporated in ongoing schematization of mechanical engineering, including theory of modeling and high-performance simulations by interdisciplinary collaboration.

Cross-Department Education Project

Shinsuke Sakai : Department of Mechanical Engineering

As a vision of cross-department doctoral program education, this department aims to develop people with well-established fundamental education and high level technical knowledge, as well as with a sense of responsibility and mission with creative ability, a pioneering force for unexplored fields, an international view, project planning, and management ability.

One of the three pillars of the doctoral program education is Mechanical Systems Innovation I which is held as a cross-department PBL lecture. With Nobuhide Kasagi as a program leader, although 1. fundamental education, 2. technical knowledge, 3. literacy, and 4. competency are given as abilities which must be cultivated by graduate school education, of these abilities, the primary aim in this education project is to cultivate competency

Old doctorate graduates in industry often have been criticized because although they are good at delving deeper into particular specialized areas, their research is too "sectional." In response to this, with the recognition that it is important to bring doctorate graduates, as human resources, not only into academic fields such as colleges and national research organizations into industry, as well as holding the cross-department lecture, the Council for Human Resource Development Meeting was also established for information exchange with industry. From industry, doctorate graduates were strongly sought for the granting of an overlook view, power of teamwork, and the improvement of research management ability, so these were set as one of the key challenges of the cross-department lecture.

This lecture is held for one year. Projects are set as lecture activities, and after students are placed in each project group, lectures and exercises are carried out. In each group the future technology research development topics are set in the introductory lectures, that is to say deepen the debate concerning the meaning of this technology in society, the research development roadmap, market introduction process, etc. An accomplishment report meeting is held as a conclusion, and presentations are made by students in English and by poster sessions. The final accomplishment report meeting is shown in Fig.1.

Fig.1 Final Accomplishment Report Meeting

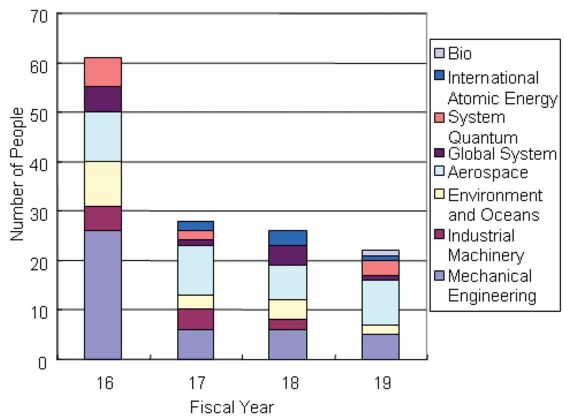


Fig.2 Student Participant Details

With the student participant accomplishment reports, related teachers and participants from industry take part and have a lively debate. Fig. 2 shows the number of participants over the four years that participated in the lecture and the details of the majors. Like this, this lecture was performed with the participation of students of fields with a wide scope of related majors. With the purpose of surveying the evaluations from student participants, a questionnaire was given two times, at the middle and after the end of the lecture course. The result was that 90% of students answered, "I understand the meaning of the course." In addition, high evaluations were received from industry such as "the importance of the study of project management among several fields," and, "a valuable opportunity to study the targeting process by focusing on the theme."

This type of lecture form goes beyond the scopes of traditional college education. Therefore, it is important to accumulate the methodology to cultivate the power of teamwork and project management ability from acquired experience in this trial. Moreover, to develop these abilities by the cooperation of such as business project management specialists are thought to be important.

PhD Internship Program

Shigehiko Kaneko :
Department of Mechanical Engineering

Unmanned vehicle navigation

Final meeting

Background

The idea of starting internship program of PhD level was brought from a discussion in one of the working group dealing with the collaboration of university and industries belonging a committee for breeding PhD course students of 21COE. After the discussion of this working group, the contents which PhD course students are recommended to acquire was summarized as the ability for management, application and communication especially in English.

According to the recent survey by the committee on engineering education program at graduate course level (2003.9.19) summarizing the opinion on the achievement level of the students before entering PhD course and after finishing PhD course from university professors and industry people, small difference was found on the items of ability of forecasting their research goal and logical thinking, the level of knowledge and application of their specialties, writing technical papers in Japanese and English and interests in international activities. However, large difference was found on the items of deep understanding and diversity of basic subjects, the ability for innovation, planning and execution, diverse way of thinking and problem definition.

Under such a background, internship in PhD level meant for fostering the ability difficult to acquire by the university education was started in 2007.4. This program is named Mechanical System Innovation II with two credits all through one year. Registered students in 2006 and 2007 were 8 and 5, respectively.

Schedule of internship

Internship starts with the guidance in mid April and after matching meeting with industries in mid May, students start their activities in mid June. Period of internship varies from one to six months depending on the theme and the style of their activities.
Students are obliged to submit intermediate report in mid November, make presentations on their achievement at a meeting in late January and submit final report by the end of January. In some exceptional cases, the starting date of internship shifts down to late November due to the special reason on student or industry side.

Style of internship

Three types of internship are prepared such that (1) to select topic from the list proposed by companies and research institutes (6 students); (2) to pursuit the collaborating topic already operated between the university and the companies and research institutes (7 students); (3) to contact companies and arrange new topic by the students themselves (0 students). Numbers inside parentheses are the number of students participated this program in 2006-2007. Internship activities are widely spread from flow analysis, flow measurement, utilization of air bubbles, evaluation on the fracture of pipes due to the wall thickness deterioration by probabilistic approach, consulting support, flight test utilizing a commercial aircraft, and flight test of unmanned small scale airplanes, etc.

Outcomes assessment

Comments from the registered students are summarized as follows; helpful experiences on deep physical understanding, acquiring new knowledge on numerical calculation method, schedule management technique and problem solution technique etc. In addition, some students rendered internship as a good opportunity to understand the difference on the standpoint of industries and university on the research and could acquire the knowledge and information helpful for them to think about their future career. Most of the comments from the industry people who acted as a tutor are positive saying that such internship program brings a chance for students to have a look at the activities of the researcher who finished PhD course and a opportunity for stimulating young industry researchers as well. However, some of the industry people sent a comment that the period of internship is too short. Therefore, to reflect such a comment properly, the second internship program was designed to start earlier compared with the first one.

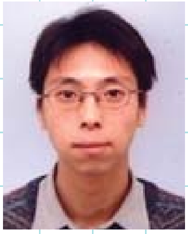
Summary

Internship program of 2006 and 2007 brought the following valuable experience helpful to the future career for the students;
(1) Importance of the idea from the standpoint of needs
(2) View from a connection between their current research topic and society demand
(3) Importance of time management and project management
(4) Importance of the activities towards safety and security
(5) Importance of information exchange by the people with different research background
In order to improve outcomes brought from this internship program of PhD level, university professors have to make the students completely understand the aim and give them a good motivation before sending them to companies and research institutes.
Investigating the outcomes after finishing internship by university professors is also important.

Acknowledgement

At the end, I appreciate all the people of companies and research institutes who collaborated our first internship program of PhD level.

International Exchange Program



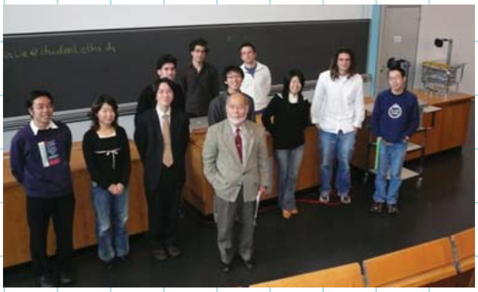
Tomonori Yamada : Department of Quantum Engineering and Systems Science
Yosuke Hasegawa : Department of Mechanical Engineering

We have been running ETH-UT Exchange Programs aiming at promotion of young researchers' cultivation through international research experience between other oversea bases since 2005. The purpose of this program is not only to offer opportunities to improve their communication skill in English but also to nurture able young researchers who can exert leadership by fully expressing themselves without hesitation. The program sent out five RAs and a project research assistant in 2005, four Research Assistants (RAs) in 2006 and three RAs in 2007. We ,too, have taken one professor and four young researchers (post doctorates) from ETH Zürich.

RAs are sent to ETH Zürich for about two months (October and November) on this program. Those who wish to be appointed as a member of this program must contact one of the host professors in advance and submit their research proposals to obtain an preliminary acceptance of their stay. This process can help candidates improve their English skills and develop their planning ability, after which they must submit permission letters of their visit from their supervisors' in UT, the host professors' letters of consent to accept them and their written proposals of research activities during the time they are dispatched. Three to five RAs are finally selected after their papers and results of interviews in English.

ETH-UT Exchange Program 2005

During the time they are dispatched, RAs must carry out reserach exchange/joint reserach according to their own research plans. Project management skills and leadership as well as fluency in English are required in the collaborative work with oversea researchers. They are also expected to obtain overall knowledge in engineering by developing and expanding their field of specialty taking such opportunities as a variety of research presentations, visit to companies and so on. In the final week of their two month stay, RAs must participate in joint workshop with young researchers in ETH to conclude their activities. After coming back to Japan, they must submit reports and present their achievements in the "Cross-Department Doctoral Course".



ETH-UT Joint Workshop 2006

We admit that two months is not long enough to expect extremely outstanding achievemnts in their research fileds. However, what we rather expect is that their experience will lead to further development in exchange among research groups and joint researches. Oversea study is normally programmed for six months to one year, which often makes it too difficult for potential candidates to consider application, because they also have to think about completing their doctorate theses, financial and security aspects and it may seem too much of a risk for them. Our short-term exchange program makes it possible for students to consider oversea research experience at a smaller risk. Also we arrange project teaching staff to stay with students in the first and the final weeks of the two months so that they can cope with their new life abroad.

ETH-UT Joint Workshop 2007

As winter term starts at the end of October in the Switzerland, not so many students will be found around for a while just after their arrival. However, there will be international conferences, workshops and seminars taking place in the premises around that time, so dispatched students can obtain broad knowledge in engineering by taking part in them. From November, students can experience the Western style lectures by taking lectures relevant to them. Circle reading which emphasizes on discussion, in addition to writing on boards, is found fresh by some RAs. In the final week, as a conclusion to what they have achieved in the research, students hold a joint workshop inviting young reserachers they have worked with and the host professors. Despite the short term, dispatched RAs each year come back with considerable achievements. It is not rare that such achievements lead to research collaboration between UTand ETH.

Thus it seems fair to say this short-term oversea exchange program is an effective way of offering postgraduate students opportunities to acquire management skills and leadership which is difficult to foster in Japan. Development of collaboration at a faculty level preliminary promoted by such students' achievements is also a big benefit of this program. The most significant achievement of postgraduate students is an acquisition of confidence that they can work equally with oversea researchers and of stronger motivation for research activities, but not simply improvement in communication skill. We recognize such confidence and motivation in RAs' sparkling eyes when they come back home.

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Department/Institute

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Department of Mechanical Engineering
Department of Engineering Synthesis
Department of Environmental and Ocean Engineering
Department of Aeronautics and Astronautics
Department of Geosystem Engineering
Department of Quantum Engineering and Systems Science
Department of Nuclear Engineering and Management

Institute of Industrial Science
Center for Disease Biology and Integrative Medicine, Graduate School of Medicine

Program Executive Organization

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Hyper modeling / simulation

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Yoshitsugu Kimura Professor Emeritus, The University of Tokyo
Tetsuya Tateishi Fellow, National Institute for Material Science

Activities of Mechanical Systems Innovation Program

〈Open Seminars〉

◎**FY2007-8th Seminar**

Date : January 30, 2008 (Wednesday) 11:00-12:30
Venue : Lecture room 232(2-301), Faculty of Engineering bldg.2, Hongo campus
Subjec : The Novel Nanostructures of Carbon
Speaker : Professor Mildred S. Dresselhaus (Department of Electrical Engineering and Computer Science, and Department of Physics, Massachusetts Institute of Technology)

◎**FY2007-9th Seminar**

Date : January 25, 2008 (Friday) 16:00-18:00
Venue : Lecture room 73, Faculty of Engineering bldg.7, Hongo campus
Subject : Innovative UAV Control Research at RMIT University
Speaker : Associate Professor Cees Bil (Department of Aerospace Engineering, RMIT University, Melbourne, Australia)

◎**FY2007-10th Seminar**

Date : February 18, 2008 (Monday) 14:00-15:30
Venue : Seminar room 2-31B, Faculty of Engineering bldg.2, Hongo campus
Subject : Colorful Carbon: Photophysics of Carbon Nanotubes
Speaker : Professor Tobias Hertel (Department of Physics and Astronomy & Vanderbilt, Institute of Nanoscale Science and Engineering (VINSE), Vanderbilt University)

◎**FY2007-11th Seminar**

Date : February 19, 2008 (Tuesday) 15:00-16:30
Venue : Seminar room 2-31B, Faculty of Engineering bldg.2, Hongo campus
Subject : Floating Catalyst CVD Method for Controllable Synthesis of Carbon Nanotubes
Speaker : Professor Hui-Ming Cheng (Shenyang National Laboratory for Materials Science, Institute of Metal Research, Chinese Academy of Sciences)

◎**FY2007-12th Seminar**

Date : March 12, 2008 (Wednesday) 10:30-12:00
Venue : Lecture Room 232 (2-301), Faculty of Engineering bldg.2, Hongo campus
Subject : Pressure-Induced Single-Walled Carbon Nanotube (n, m) Selectivity on Co-Mo Catalysts
Speaker : Professor Yuan Chen (School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore)

〈International Symposium〉

◎**The 4th International Symposium on Innovative Aerial/Space Flyer Systems**

Dates : January 14~15, 2008
Venue : Yayoi Auditorium Ichijo Hall, The University of Tokyo

◎**The 4th International Symposium on Biomedical Systems Innovation**

Date : February 18, 2008
Venue : Conference room 213, Faculty of Engineering bldg.2, Hongo campus

〈Domestic Symposium〉

◎**The 3rd symposium on Holonic Energy Systems**

Date : January 9, 2008 (Wednesday) 13:00-17:10
Venue : Takeda conference hall, Takeda bldg., Asano campus

◎**21st Century COE symposium Mechanical Systems Innovation**

Date : February 27, 2008 (Wednesday) 9:20-19:00
Venue : Conference room 221,222,223 Faculty of Engineering bldg.2, Hongo campus

〈Special Invited Lecture〉

Date : March 18, 2008
Venue : Yasuda Conference Hall, The University of Tokyo, Hongo Campus
Subject : INNOVATION AND THE SUSTAINABILITY CHALLENGE, Rethinking the Role of Higher Education Institutions
Speaker : Professor Calestous Juma (Director, Science, Technology and Globalization Project Belfer Center for Science and International Affairs John F. Kennedy School of Government, Harvard University)

〈Cross-Department Doctoral Course〉

◎**Reserch Assistant Final Debrief Session, "Mechanical Systems Innovation I, II"**

Date : January 25, 2008 (Friday) 13:00-20:30
Venue : Takeda conference hall, Takeda bldg., Asano campus

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March 20th, 2008

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