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

Newsletter

No. 14E
March 1, 2008

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Mechanical Systems Innovation, The University of Tokyo

Special Issue on Scientific Writer

Introduction

The COE Program has been dedicating to doctor course students the cross-department education programs on the basis of the main three researches of energy, bio-medical and hyper-modeling/simulation; and planning international symposia as well. Also the newsletters have been introducing those activities and the education programs, while introducing the project promoters' activities vividly touched through the columns provided by interview style. For this newsletter no. 14, we plan to have a special edition; the articles about the project promoters who have not yet be introduced.

The COE Program has been promoted by such many people as promoters, special appointed members and secretaries. We could not have covered all of such members as mentioned, however, we would be exalted if you have further understanding of the activities of this COE Program through the columns presented.

"Mechanical system Innovation". Prof. **Ushida Takashi**, promoter, School of Medicine (concurrent with Department of Mechanical Engineering)

Advanced Composite Materials and Fiber-Optic Structural Health Monitoring

Kageyama Kazuro, Prof., Department of Environmental and Ocean Engineering, School of Engineering

●Optical fiber/ acoustic sensor born with accidental discovery.

My study theme is about advanced composite materials, smart material and structure systems, structural health monitoring and non-destructive inspection.

After finishing the graduate school, I entered a study about carbon fiber reinforced plastics (CFRP) in Mechanical Engineering Laboratory, Agency of Industrial Science and Technology, Ministry of International Trade and Industry. After my service of research official, I move to Department of Naval Architecture, The University of Tokyo. Before I joined to the department, I didn't study ship, so I got boat license so that I had my own ship, coming to enjoy it as a hobby.

We installed optical fiber sensors to the yacht structure to collect data of safety or reliability in 1999, when "Nippon Challenge" participated in the race (Luis Vinton cup), pre-champion series for the famous "America's cup".

Presently I'm working for CFRP(Carbon fiber reinforced plastic) that is available for re-cycle or re-use; also is friendly to the surroundings. CFRP has a bottle-neck in processability and cost compared with metal available in the automobile industry, However I hope you could get your car lighter and less energy- consumed if we overcome bottle-neck of composite materials in the future.

I'm engaged in developing optical fiber as a study of structural monitoring. It was an accident. One of my students found a fact that displacement rate normal to the small segment of bent optical fiber effects on the frequency shift of light transmitted through the optical fiber and that the intensity of the frequency shift is proportional to the curvature of the bent fiber. It came from a principle "Doppler effect in flexible and expandable light-waveguide. We developed it to vibration and acoustics sensor of optical fiber. It took 4 years to get to the mechanism but in the mean time we applied the patents to set up a venture. Now we're managing cooperative researches.

Optical fiber is extremely durable, heat and corrosion-resistant as well as flexible and fine. It's good for sensor. We used it and developed a sensor with numbers of functions for vibration, noise, sound, ultrasonic on it. The sensor is highly sensitive and immune to microwave. If you set it on structures or machines you can measure tens kilometers away or monitor in a long term. Its application may expand to civil engineering, aerospace, railroad, road, chemical and energy plant or security. We're making it forward that we impart these sensors into structures as a neuronic network so that the structures themselves sense damages happening within.

●Education of researchers who will be trained to handle the process to business

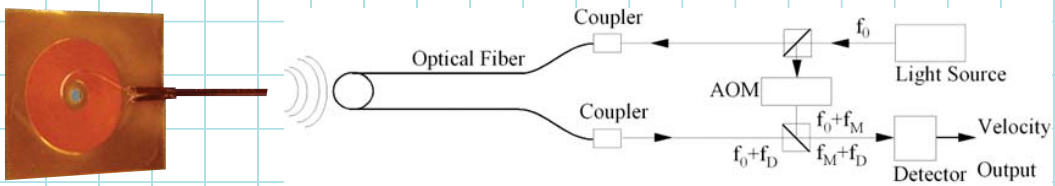
Department of Technology Management for Innovation (TMI) was launched in the Graduate School of Engineering in April 2006. Since its preparation stage, I've been associated with it. Now that science technology and social system is being complicated, more people in the engineering field are needed to be not just with the knowledge of scientific technology but also management ability. That's why students should learn business-modeling strategy, R&D management or system theory in the course. The course has such program based on inter-academics for selected members; and helps more students become not single-majored but multi-majored. Some will graduate from the course next March. I want to see how they will play their roles. I also want to put my work into making the net-work of the graduates.

●Idea is coming up while exercising

When I look back, I think my study has been made forward naturally while enjoying the subject given by senior professors or even by the management, rather than I have been trying to look for theme myself.

I think I can get my brain activated while exercising like cycling or walking with a dog, and sometimes get good ideas to come up with me. I can calculate 5 to 6 lines of formulas and often plot sentences while walking. As a resident of Ushiku City, I sometimes go to the mountains or go hiking if things permitted. I've been attending the aerobics class in the city since last year. It is pleasant for me to use my muscles that I don't use usually. I used to do astronomical observation as my childhood, and now I enjoy it for relaxation sometimes.

Optical fiber- vibration and sound sensor and its system



The sensor is based on a new finding that frequency of light wave transmitted through a bent optical fiber is shifted by vibration at the bent region. The phenomenon can be explained as Doppler's effect in flexible and expandable light-waveguide.

＜Profile＞

1981:Doctor of Engineering of Marine Mechanics Dep. of Tokyo Univ. Employed at National Institute of Advanced Industrial Science and Technology, researches the value of advanced compound materials. 1985:Guest researcher of US Delaware Univ. 1988:Evaluates structural design and materials of ultra-light ships as assistant prof. of Dep. of Eng. of Tokyo Univ. 94～95:Guest researcher of US Stanford Univ. 97:Prof. of Dep. of eng. research of postgraduate course of Tokyo Univ. Majored in structure of intellectual materials and structural health monitoring.

Development of Super-small Satellite Making Familiar to Space

Nakasuga Shinichi, Prof., Department of Aeronautics and Astronautics, School of Engineering

●Possible for functioning as large-scale satellite in a tens of formation

Speaking of space utilization, there may be a public's image; (1)big satellite,(2)requiring huge money, (3)long development time. The image may be deterring companies from entering. We desire to strip away such image, so that we would like to help people feel familiar to space.

Our main study is the development of super small satellites, not heavier than 0.5 to 10kg. These satellites swell the possibility for space if they could play a role kept by large satellites, in the way they work in a formation by tens of pieces. We also engaged in "furoshiki satellite", meaning that the satellite party has a sheet unfold to generate solar power or collect debris. The small satellite is useful for deploying the membrane.

We have launched a satellite "CubeSat" (1kg,10 cm3), the smallest of the world, respectively one in 2003 and the other in 2005. Usually it would cost more than 1 billion yen for a usual large satellite, while it cost just 2 million yen for each satellite's parts of our case. The both of them keep sending the vivid image of the earth taken by a tiny inside camera, which are distributed to more than 2000 people for free to please them.

●Launch waiting huddled close together, Good for education

Launch is close together in line. One of the next models is "PRISM" (approximate 8 kg weight), equipped with a 30m-resolution camera, higher than that of "CubeSat".; another is "Nano-JASMINE" that is expected to measure stellar 3-D positions precisely in corroboration with National Astronomical Observatory.; one more is "PETSAT" whose mission is assemble panels with various functions.

Japan is really a pioneer in this field and has been good at packing a variety of functions into a limited space, as is seen in traditional work of bonsai or hakoniwa. That may mean that super small satellite is the thing we can serve to the world. For the future, we desire to work for structuring a new aerospace system based on satellites loaded with artificial intelligence.

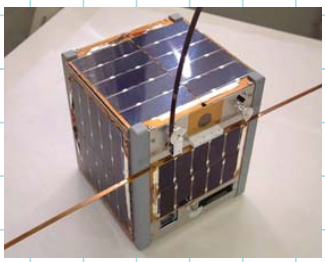
Small satellite program is truly useful for education. Through the program, at least once, students could experience basic technology, manufacturing, launch testing, operation and so on. It would be a fantastic opportunity for realistic world is a better teacher than any other things. Doctor course students are to manage the program. I wish them to be good leaders as well as good researchers.

●Consider balancing, thinking through

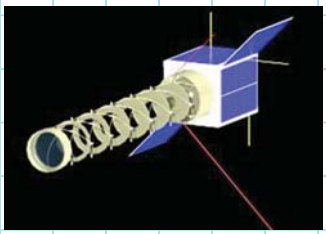
I used to be crazy about airplane and enjoy copying drawings of fighters at my home. I found myself fascinated by the fact that the more I pursue the function the more beautiful the design turns. Eventually Apollo 11 brought me to my present work. I originally came from theory work like the application of artificial intelligence. I moved from a private company to University of Tokyo and I had a chance to visit Stanford University in 1999, when I was surprisingly impressed with the fact satellites could be produced in that dirty room. That experience charmed me, which led to my first work of 1999, the can-made model "CanSat". Idea wells up while sticking to idea. I like that. I come up with ideas, sometimes with integrated one while enjoying drinking, relaxing on sleeping, So I put a scratch pad under my pillow. My hobby is playing sports like tennis or baseball. I can recover myself from deadlock through exercises. My class enjoys a two-days camp every summer, doing only exercises with football or swimming. It seems like an athletic meeting.

Here in COE, I'm keeping study work for obtaining spacious energy by the "Furoshiki Satellite". I think it a good stimulation to get associated with people from different fields. Ideas generated through such association may make me feel close to the universe.

Launched super small -size satellite, "CubeSat" in 2003 and 2005



Super small -size satellite, "PRISM".
Equipped with 30m resolution camera. Weight is about 8kg.



＜Profile＞

1988:Doctor of Eng. of Tokyo Univ. Employed at Japan IBM Tokyo Basic Research.1990: Lecturer and assistant prof. of Tokyo Univ. 2004:Prof . of Aeronautics and Astronautics. Engaged in design, production and management of ultra-small satellite, intelligence and autonomy for space system , research and education of innovative space system and navigation guidance control of space machines. Member of Aerospace Society of Japan, IAA, AIAA、SICE. IFAC Aerospace TC Japanese Branch Chairman, Related-Member of the Science Council of Japan.

Study for Energy and Bio-system; Realization of peaceful safe Society

Kaneko Shigehiko, Prof., Department of Mechanical Engineering, School of Engineering

●Research on mechanism on doze and development of doze preventive seat

The motto is “Study to contribute safety and peace to society”.

The practical study theme is about control of motion and dynamic problems occurred from vibration , noise or some other mechanical systems. I’ve been focusing on small size distributed energy system. I’m especially studying the elements of micro-gas turbine and gas engine control system that I believe will be the core for the distributed energy society in the future.

Here in COE, my study is about biomass energy conversion system. I study the way how biomass energy with lower calories and unstableness, could be applied to small size energy conversion system.

Also I work for development of technology for sensing phenomena occurring in bio-system.

My study class was successful to develop a doze preventive seat in a joint project in 2007. As a driver gets seated, measurement begins on heart rate and respiratory rate through magnetic circuit sensor and pressure sensor. The sensor functions as alarming for some time before the driver falls into doze. The corroboration work brought us a fruit in medical aspect that we found out that a sign was appeared about 10 minutes before driver’s doze by measuring pulse and breathing; that the more the driver exercised the shorter time to doze became; that 33 degree is the position for keeping the driver awaken with less fatigue physical and mental. Now pulse/pressure monitoring system with high precision and other function is under development.

I’m emphasizing on a new industrial education method(PBL: Problem based learning). The method provides programs for the participants. In the programs they get grouped and given the problems that are taken from the real world; and eventually helps them promote solution ability. Through the programs, they can acquire knowledge and skill of “judgment for technology” in the process to goal, while top-viewing studies of their class mates as well as himself with sensitive feeling. The “close communication” with various kinds of people like the people from foreign countries or companies could be precious experiences. I like seeing students growing with successful experiences piled through PBL.

●Cultivating study themes from a view point of people at work

I was born at a smith in Yuda Spring of Yamaguchi Prefecture, which is also the birthplace of Dr. Yamao Youzou, founder of the Imperial College of Engineering leading to the School of Engineering, the University of Tokyo, called “Father of engineering”. So I was close to engineering and manufacturing. I belonged to Astronomy club in Yamaguchi High School, where I was interested in phototube devices while studying relation between sparkling of stars and passing of low pressure. I entered the engineering department of the University of Tokyo, where I met Prof. Fujii Sumiji. He was giving classes by only chalk. It was fun to me. Then I entered studies of vibration, or its measurement and control.

As I was in work places for research on vibration or noise, I found few researchers were caring the standpoints of the working people there. So I decided to make use of my expertise from their stand points, for solving problems they were facing. For examples, it was a truck driver. They had time pressed and sometimes are to blame for the accidents. I wish the doze preventive seat could work for them well. It could be interesting to simulate the phenomena that could happen if last trains could be set earlier by 30 minutes.

When I find myself nearly pressed with work, I try to read again “Techniques to leave work at regular time ,Laura Stack” to ensure time controlled. I always keep time for gardening and dripping morning coffee because I think it is precious time for relaxation for me. I’d like young people to have curiosity rising, sense polished, simple questions and simple feeling cherished to keep trying to review problems possibly to be the needs of the coming future. In time, I will set up web-site where I present used devices for young people. I think I will help them not with money but things.

Magnetic circuit sensor and pressure sensor are programmed in the seat. Posture, heart rate and respiratory rate of a driver can be measured upon his sitting on the seat. Alarm is raised with some signs, such as decline of respiratory rate, unique to drivers right before falling asleep. Co-research with the Univ. Tokyo., Oita Univ., Shimane Institute of Health Science , Deltatooling , Japan Railway Construction, Transport and Technology Agency.

＜Biographical outline＞

1981 PhD, The University of Tokyo, Lecture, The University of Tokyo, 1982 Associate Professor, The University of Tokyo, 1985-1986 Visiting Associate Professor, McGill University, Canada,

2003-present Professor, The University of Tokyo, Academic interest:Small Size Distributed Energy Systems, Biomass Gas Turbine and Engines, Dynamics and Control of Energy Systems, Flow Induced Vibration, Noise and Vibration Control

Resource Processing Engineering: Technology for Recycling & Better Environment

Fujita Toyohisa, Prof., Department of Geosystem Engineering, School of Engineering

For sustainable society, it is required that we should recycle the resources, which their amount is limited, and use them efficiently. Within this frame, based on my area of expertise that is the resource processing engineering, I have been involved in developing technology in order to recycle the resource, saving the energy, and in turn contributing for a better environment. There are a number of method for better environment that can be pointed out.

Removal of insoluble chlorine from bottom ash for recycling. In other words, the method that is able to remove chlorine from ashes generated by thermal processing of industrial wastes. Here in Japan, over 6 million tons of ashes are generated every year and most of them are landfilled. There is a growing movement for recycling ashes by using them for cement production. However, the relatively high concentration of chlorine in ashes, can cause corrosion of iron frames when the cement that was manufactured by using such materials, is used in preparing construction materials. Moreover, we considered that calcium chloride in fluid can be taken from the ashes by blowing in micro-bubble of carbon dioxide. We therefore developed a cost-effective technology for removing chlorine from ash.

In abandoned sites of some semiconductor or glass manufacturing factories, the soil is contaminated by fluorine and boron. We found out that the contamination level can be reduced under the level of environmental standard, by adding some chemicals like sulfuric acid into the soil. In addition, we also tried other methods in order to dissolve dioxin in soil by employing microbes. Besides, we are engaged in a research focused in removing hazardous ion from water.

Generally speaking, the recovery and recycling of rare metals like nickel, platinum, niobium or lithium from used products is considered difficult. Nevertheless, we succeeded in collecting gold or indium from LED of discarded mobile phones by exploding it in the water. It is also important to recover lithium or cobalt.

Actually, we are developing a new recycle system by attaching IC tag to various products and their parts.

Nowadays that world annual oil production is reaching the peak, energy saving is another issue that demands break-through for balancing between nuclear energy, fossil energy, and environment. Here, I would like to stress that it is important in developing technologies for reusing elements, found in spend fuel in order to promote the nuclear energy as well as improving processing biomass for energy production.

In my days of middle and high school, I loved chemistry and making things. I chose Tohoku University as I wanted to be apart from my parents and enjoy skiing. At that time, atomic engineering was popular, however, I moved into a better environment, i.e. magnetic fluid, smart material that I felt are instrumental in areas such as energy and resource. I feel that environmental problems and world-wide energy saving can bringing about new research areas such as resource engineering, shifting our view point to that of saving energy and recovering more and more materials from wastes. Our research filed is indispensable for concentration of wide range of knowledge. In that sense, the COE net-work is working very effectively. Moreover, our course has many students from China or other Asian nations. They give presentation and exchange experience and opinions by participating in various seminars.

I would like that young people being able to point out which way or source they should take through experiencing many situations, discussing or participating in the flood of information. Speaking of my field, it is hard to know which is right or which way to go. I want them to enjoy what's seen through try and error. When I'm stacked, I try to share discussion with company's people and I've got new direction, however, experimentation often works for break-through. I enjoy playing mandolin beside golf and walking for relaxation. In geopolitics aspect, there is an increasing demand for researchers of this field, that is the field where they can work for the entire world and I sincerely wish that more and more people get their interest in it.

Collecting useful material from used mobile phone
Explosion in water with powder. Materials are taken apart according to their density by using shock wave and bubbles generated.

Processing of ashes to material available
Removal of Chlorine and fixing of CO_2 as CaCO3 by blowing CO_2 micro-bubble

＜Profile＞
1983:Doctor of Eng. of Dep. of resource eng. of Tohoku Univ. Lecturer of Dep. of mining of Akita Univ. 95: Prof. of Akita Univ. (98～2003:Prof. of Dep. of resource) 98:guest Prof. of dep. Of fluid science of Tohoku Univ. and US Saint Cloud Univ. 2000:Head of Akita Satellite Venture Business Laboratory, 2002: Prof. of Eng. Research Dep. of postgraduate course of Tokyo Univ., 2005:Prof. of Research Dep. of Earth System of the same Univ. President of the Society of environment resource engineering.

Simulating for the Whole Society Organized by the Human, Artifacts and the Natural

Yoshimura Shinobu, Prof., Dept. of Quantum Engineering and System Science , School of Engineering (with Dept. of Human Environment Studies, Graduate School of Frontier Sciences)

●Study themes covering from nuclear reactor to mobile phone and traffic net-work

Computational mechanics and intellectual data processing for predicting structural deformation and fluid, thermo, electromagnetic fields; Intelligent simulation combined with high-performance computer; Virtual demonstration testing and virtual social experiment; These are my study themes. My computer simulation treats gigantic or artificial structures that are not appropriate for real experimental verification, and phenomena associated with human actions or senses as well. So far I have been engaged in simulation and numerical analysis works on damages caused by earthquakes upon historical structures like Pantheon of Rome and nuclear reactors; I also have been simulating the process of cracks resulted from damages on natural gas pipe-lines; and modeling of environmental pollution as well. We went to the final nomination of IEEE/ACM Gordon Bell Award, awarded on projects for application of parallel computing for the study on how mobile phones hit the ground. It was a collaboration work with a industrial companies.

Presently I am doing simulation for the case that the rails of LRT (Light Rail Transit) in Okayama City are extended. It is such a problem concerning to NPOs, city government, police or other stake-holders. I have never seen such big-scaled simulation used for social consensus in other than ours. If it is successful, I hope the experiences can be applied to other LRT system that some local governments are thinking abut.

The essence of computational mechanics is “approximation”. We give big effort to predict the truth by appropriate parameters and newly proposed equations. However, I think I would not want to depend too much on “approximation”, but I will simulate it by many elements computed thoroughly . For that purpose, I make degrees of freedom for mesh in FEM, to 0.2 billion though formally it was tens of thousand or hundreds of thousands. Then it comes for analysis with need of fast computers like an earth simulator.

My research group has released free simulation software “ADVENTURE system” and its commercial version as well, which was developed mainly by my project in “Development of Computational Mechanics System for Large Scale Analysis and Design ” sponsored by Japan Society for Promotion of Science. I want many people to use it. For such purpose, we have been developing the codes for a decade.

●Always I get back to “actual matters” to solve

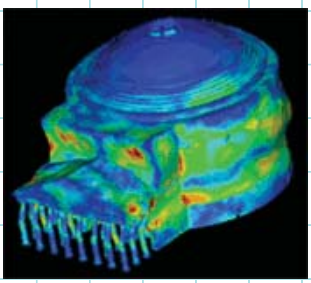
I majored in safety of nuclear reactor in my university because I experienced the” oil shock” in my childhood and came interested in energy to study something beneficial to the world. At first I was engaged in the both of computation and experiment, and I found those results unconfirmed. Also I found out that the accidents are also affected by actions of persons, so eventually I started to think the necessity of combined/coupled simulation in the designing stage. That is when I came to the concept of the intellectual simulation.

While staying in Germany, 1994, I was impressed to know that the recycling process is taken into account in the designing stage of artifacts. Considering relations between environmental issues and artifacts, I found the world was essentially made of combinations of human beings, artifacts and nature, and I became convinced that I could serve as solving some of social problems by modeling the combination including their interactions.

At home, I share house work with my wife. I have new ideas coming while doing it, maybe because I had the memory of discussions at classes. I well think about the relation of the growth of my children to intellectual data processing. Life is the treasure box of vital matters.

Usually I try to see things from sense or feeling rather than from expertise. I am imagine how I would do it even someone else had formed studies or modeling. I always think there is not only one study or method, and I get back to actual matters to solve.

These days I have been giving some time on simulating flapping of insects. It requires coupled method, which involves lots of factors. It is also referred to a grand challenge of simulation, however, I want to develop it to modeling that could be applied to trials of small-sized flying robots that would be working in the disaster area and also be working as environmental monitoring.



Earthquake proof simulation in the case of Pantheon of Rome

The sample of the simulation how a great earthquake damages the Pantheon of Rome, computed by the world fastest parallel computer.
The simulation provides indication of points where to be fixed or reinforced.

＜Profile＞

1983: Graduated from Master Course of Dep. of Nuclear Engineering, Graduate School of Engineering, Univ. of Tokyo. (Master of Engineering). 1985: Visiting Prof. of Computational Mechanical Center of US Georgia Tech. Univ. 1987: Graduated from Doctoral Course. (Dr. of Engineering) Lecturer, Assistant Prof. of Univ. of Tokyo. 1992: Assistant Prof. of Research into Artifacts, Center of Engineering. 1994: Visiting Researcher of Material Testing Institute of Stuttgart Univ. (Germany). 95: Assistant Prof. of Graduate School of Engineering, Univ. of Tokyo. 1999: Prof. of Institute of Environmental Studies of Graduate School of Frontier Sciences and Dep. of Quantum Engineering and Systems Science of Graduate School of Engineering, Univ. of Tokyo(additional). Specialty in computational mechanics and intelligent simulation.

Micro Fluid Device for Bio and Environment

Fujii Teruo, Prof., Production Technology Institute,
Micromechatronics International Research Center

●Development of card-size bio-sensor for DNA of the deep sea microbes

We finished developing micro fluid device using semi-conductor technology, moving it forward to study of application of the device to environments or bio-field. The card-size device has micro space on its surface where chemical and biological reaction is analyzed. Such devices will be customized at any rate. I'm getting to provide basic technology on which its applied study can be practical with a wide scope.

For that application, I can mention local measurement system at deep see investigation. There is a chip on the some square cm of the board. On the board, there's a graved ditch, 0.1mm in width, extending to 4m in length. The deep sea water is absorbed into the ditch where the water is chemically processed so that microbes' DNA can be taken. Then the taken DNA is processed for reproduction(PCR) using heat. Consequently the taken microbes or some objects are identified. Such research has been usually done on the ship with the deep sea water taken by diving vessels. They've got no deep sea sensor devices so far. If something like the fungi with methane oxidase in its DNA is identified, it could help methane hydrate called fire water be tracked down.

It's in good use in cultivation of sells or tissue. It's normal to do it with plates as scharle, however, we use chips to providing the condition similar to the bio tissue where cells are cultivated. That method can be used in reproduction medical like growth of organs or tissues or outside artificial organ(bioreactor) for the weaken organs as liver. It's applied to cultivating cells for testing efficacy of medicine and toxin.

We've succeeded to grow in vitro fertilized eggs of mouse in use of the microchips efficiently. To begin it, we cultivated uterine membrane on the multi-layered chip. The chip became the environment as same as uterine. Then we placed fertilized eggs on the chip, where the eggs became in shape to grow up in not more than 72 hours. With help of clinics dealing with sterility, we think we can utilize this method for this field. If we could verify the safety, we will help suffering women reduce their burden. Another application could be for breeding beef cattle.

With this method, it is possible to measure how taken matters are absorbed in the small intestine. The toxin or medicine taken into doesn't go directly to organs but through intestines. For the two-layered chip, we take the upper as the wall of intestine, the lower as normal tissue. We pour chemical matter on the upper and see how it goes.

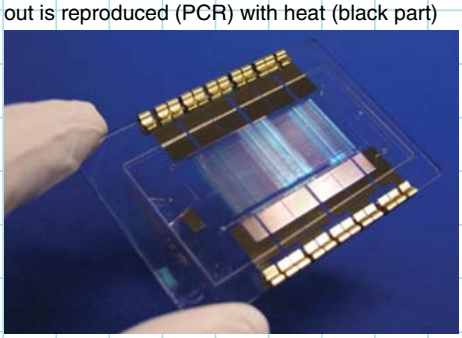
The fact is that development competition of such devices began in Europe in '90s. The competition is fierce, but it's a home field to Japan. The devices is available not just on the earth but in space. It might be useful to probe extraterrestrial life. It's promising.

●Take up the study as my theme leading to practical use in broader fields.

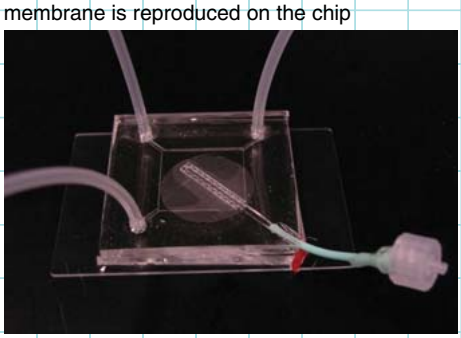
I thought science and technology have something to move people as I watched Apollo's moon landing on TV. As I loved physics and chemistry, I went up to vessel engineering to study the under-sea. I was once engaged in development of self-auto prove robot for submerging. Then I challenged a new field and entered chemical and biological fields where I thought micro technology is fully applied and that such small thing could give rather big impact.

In COE, bio-medical being a major, I'm responsible for developing such devices that can apply to medical treatment through tissue engineering(cyto engineering) and Protein/DNA analysis. I have many to do. I want to request the students love the story of his study and to tell us if it is practical or not. It's not necessary to go further. That's a job of companies. They should make the most of their time available and focus on things they want to do the most. I believe they have plenty of chances including study of overseas.

Card-size chip useful to probe microbes in the deep sea. Its ditch is 4m in length. DNA taken out is reproduced (PCR) with heat (black part)



Fertilized eggs is cultivated efficiently on the chip. The environment similar to uterine membrane is reproduced on the chip



＜Profile＞

1993:Doctor of Eng. of Ship marine eng. of postgraduate course of Tokyo Univ. Guest prof. of production and technological institute of Tokyo Univ. 95:Employed at Institute of Physics and chemistry. 99:assistant of research center of undersea of production and technological institute of Tokyo Univ. 2006:assistant prof. of Micromechatronics international institute center of production and technological institute of Tokyo Univ. 2007:prof . of the institute.

New Energy System based on Material Engineering

Terai Takayuki, Prof., System quantum engineering, Graduate School Engineering course

●Developed new macromolecule electrolyte film for fuel cell

It was when I was in the third grade of elementary school. My class teacher told us we could take back home books that are supposed to be disposed from the library. So I read many books and met biology of scientists like Madame Curie, which helped me be expelled to science. Though I loved Physics, Chemistry and Astronomy, I entered Tokyo University and chose engineering course as I thought it connected to the real world.

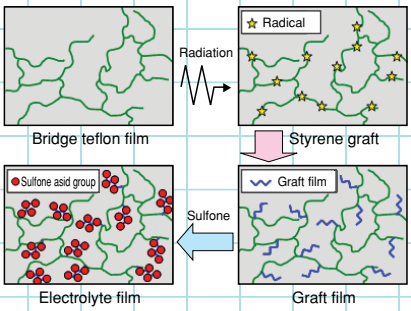
In 1975, when I entered into atomic engineering in the third grade of university, atomic power plants treating nuclear fission had been commercialized for about 10 years. Troubles at the power plant were on the issue. Nuclear fusion that two atomic nucleuses with less proton and neutron are fused into stable one, which I thought is not more realistic than nuclear fission that one with more proton and neutron fissions into two atomic nucleus. However thinking of futures 30 to 50 years ahead, I thought it might be interesting for my graduation essay. Since then, I've been studying atomic power system, fusion reactor engineering, hydrogen energy system, and fuel cell from hydrogen system. For the theme that hydrogen energy use safe, secured and good for comfortable life, I was working for composition and its application of macromolecule electrolyte film for solid macromolecule fuel cell that works at room temperature, in the "The 21st Century COE Program, Mechanical System Innovation", I succeeded to compose the electrolyte film that has proton conductivity three time as much as available products. Through simulating work for mechanism of the conductivity, I came to find out that cluster of H2O molecule is formed within electrolyte film. Presently, I'm in testing stage of prototype of the fuel cell. My goal for this cell is to overcome disadvantage in cost and durability, and to supply power for mobile phone or PC and even for space or remote areas. Another theme is about development of new catalyst because platinum used as catalyst for fuel cell is limited resource and expensive. I have study that platinum particle gets its diameter to be small to broaden its surface so that reaction efficiency can be improved, I'm also trying to make compound metal from platinum and other metal.

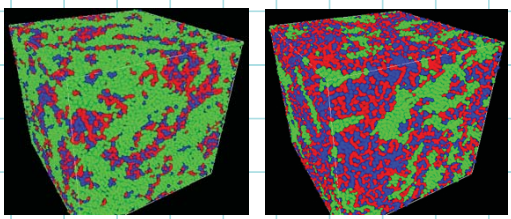
I'm engaged in another project that we realize innovation using high energy particles like radiation or plasma. As is known, diamond in nature is formed deep inside of the earth with high pressure and enormous time, If we use plasma, we can make diamond film in a short time. It will be interesting to apply this film to energy system of atomic and hydrogen energy. These two years, I've been stressing on bio suitable material that would help affinity to bio systems of artificial blood tube or catheter or stent improve with high energy particle processing.

Speaking of nuclear fusion, I've been keeping it as my study since my university, and I see the possibility of realization of international thermal nuclear fusion reactor(ITER).

●Project management essential to study and life

I came up with hints when I was attending meetings or conference, or when I was reading. I take memos on the piece of paper inserted in my pocket notebook. When I'm stuck, for refreshment, I get more sleep, read history of western or Japanese, or renew the web-site of my study room My dream is to contribute to the world through education and study. Material engineering is not so attracting but is one of key technologies. I feel romantic with nurturing people at work as well as my expertise. I want them dressed in sense of management. They should be consciously concerned with the world around. They should set goals and tasks and put it to practice and check and review it, It should be cycled. I want them to produce essay and some things resulting from studies. For that, they should learn how they can produce and control it. It's just life itself. Because life is the piles of projects.





High polymer electrolyte film for solid high polymer fuel cell developed in the study class. When simulated by computer, it was proved that the newly developed High polymer electrolyte film (right side)has more H2O clusters formed inside and proton conductivity more increased than current one (left side).

＜Profile＞

1983:Doctor of eng. of Tokyo Univ. (majored in atomic energy) Researcher of the Japan Society for the promotion of Science. 84:assistant of dep. of eng. of Tokyo Univ. 87:assistant prof. of dep. eng. of Tokyo Univ. Guest researcher of Laurence Livermore Institute from Nov. 86 to Feb. 87 and of Karlsruhe (Germany) atomic institute from May 92 to Feb.93. 99:Prof. of dep. of eng. of Tokyo Univ. (majored in system quantum-engineering). 2000:prof. of dep. of system frontier of eng. (environment and energy system course) 2005:present position.

Development of Robots Safe for Surgery with Minimal Invasion

Mitsuishi Mamoru, Prof., Industrial mechanical engineering, Graduate School Engineering course

●Under researches on robots supporting medical operation of brain, abdomen and joint

What I'm stressing on is the development of medical robots. As their merits, there are minimal invasion, germfree operation, low infection risk, stability and remote operation. There are some robots for use in minimally invasion laparoscopy operation, depth cerebral nerve surgery or artificial knee joint replacement operation. Besides we have robots to work for positioning legs precisely at thigh bone operation and recovering broken complicated scaphoideum bones. We've already build up those robots to be improved. Minimally invasion laparoscopy operation robot has three arms, two for forceps and one for laparoscopy. Operators give operations while viewing the monitors from laparoscopy. Presently the second robot is in production. Robots working for depth cerebral nerve surgery has a camera shooting affected area. When operators move manipulators while viewing displays, then slave manipulators move. The second model can put 0.1mm thick needle through 1mm thick blood tube, or can extract brain tumor(2X2cm) 8cm deep in the brain. Now we are redesigning it so that it can tighten forceps more. Those robots are hand-made by the students. We developing image transference for remote use, optical measurement and high speed precise processing system. My idea is that we commercialize those robot models within two years. To do it, we have documents approved by the health, labor and welfare ministry. Now Ministry of economy and industry and Ministry of health, labor and welfare are proceeding the guideline for examining of navigation operation(operation robot) . When those steps are set, then I hope we will be taking one step ahead.

There is some proposals coming up from Washington University and some researchers for cooperation. For medical robots, the market is world-wide, so there must be standards needed for robots and their materials.

●Conversation with a friend led me to choose medical robot as a study theme

Originally I went up to the department of science to study semi-conductor or chip, resulting in being kept from practical level. So I entered the engineering department. In fact I was interested in designing and assembling and found I was good for the field. At first I was studying machine tools when I happened to meet an old class mate from middle school. That happening had me change my study theme. He was an orthopedic surgeon at the hospital attached to Okayama University. He told me that he found it harder to connect blood tubes than nerves. His words hit me, thinking that there must be needs of robots working as precise and sensitive handlings. However, the field was totally new to me and there was less relationship between medical and engineering, so I had hard time with materials and designing. Eventually, I was successful of remote controlled operation to connect blood tubes 1mm in diameter. It was done between Tokyo University and Okayama University. I have begun giving presentations to some of medical societies.

From my experiences I had, it's important to share discussions with people from various back grounds as well as from the same field of mine in order to choose theme for study and to further it. I learned many things from people from different fields when I attended the study circle supported by Professor Hatamura Yotaro famous for " Shippai-gagu (learning from failure)" whose room was next to mine. The topics we shared were not only variety of knowledge but something that inspired me later on. I always comes up with ideas how to proceed my studies while taking a bath or standing on a train, or even right before getting up. I'm afraid to say, but I sometimes think about another thing and come up with an idea while talking with another person. I'd like to tell young students to move their hands rather than feel worried, Trial and error is never a waste as long as you keep building up something as an engineering researcher.

Figure: Master manipulators for internal organs of minimally invasion laparoscopy

Master manipulators of the robot for minimally invasion laparoscopy operation. Operator handles arms to operate forceps and laparoscopy while viewing images from laparoscopy. The operator can not keep forceps still for some time but the robot can. With this equipment they succeeded extraction operation of a pig's gallbladder four times.

＜Profile＞

1956:Born in Okayama. 86:Doctor of Eng. of Tokyo Univ. Lecturer and assistant prof. of eng. of Tokyo Univ. prof. of dep. of industry and mechanics. Researches computer integrated operation support system (long-distance operation system, long-distance diagnosis system), intellectualized productive system (censor information merged system), IT productive system, feeling transmittance long-distance education system.

Ocean Floor Probe with Automatic and Remote-controlled Operation

Ura Tamaki, Chief of Institute of Industrial Science, the University of Tokyo

●Achievement report for discovery of hot water activity, including a hot water chimney, by underwater robots for the first time in the world.

I am working on the development of a robotic probe to explore natural resource on the seafloor. The exploration of natural resources on the seafloor typically involves the following steps; (1) highlight promising areas with on a map of the seafloor, (2) obtain core samples (column core) over several kilometers and analyze for volcanic sediment to focus the investigation area, (3) survey a 100m order grid using self-controlled robot (AUV; Autonomous Underwater Vehicle) to pinpoint spots likely to contain mineral deposits, (4) identify the deposits directly using images or pictures sent from a tethered remotely controlled submersible (ROV; Remotely Operated Vehicle) or a manned submersible. Thus, to date, seafloor exploration required the deployment of several robots, including both AUVs and ROVs. In order to achieve these tasks with just a single robot, we developed the robotic ocean probe “TUNA-SAND; Terrain base Underwater Navigable AUV for Seafloor And Natural resources Development”

TUNA-SAND can function as an AUV, or as a ROV since it is equipped with a removable fiber optic cable so that it can be remote-controlled if required. While viewing images transmitted during fully automatic controlled operation, the operator can override and switch to remote-control operation depending on the situation at hand, in order to perform more detailed investigations. This innovation makes it possible to overcome the major disadvantage of AUVs, making it possible make real-time decisions to focus investigations on specific target areas as required.

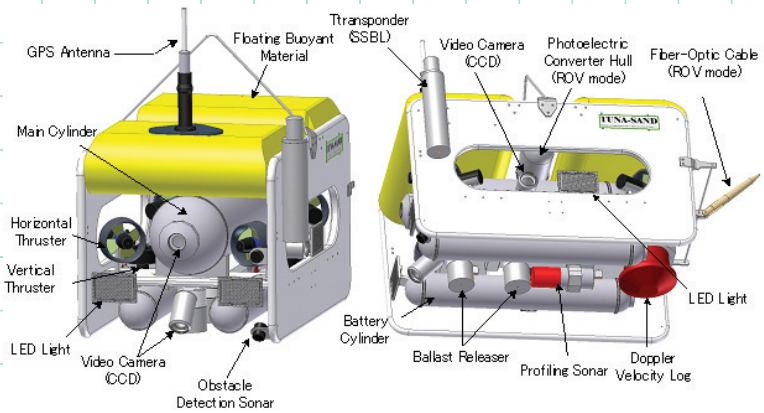
TUNA-SAND performed excellently during its seafloor inspections between 16th-26th August 2007. It discovered vigorous spring s of hot water at 200m depth on the seafloor of Kagoshima bay. Of particular significance was the discovery of a 3m high volcanic chimney. These dives were the first time video images of the hot water activity had been taken by a AUV/ROV hybrid.

● New robot adventures!

My ideal is to develop robots that can go on exciting adventures, like Astro Boy hanging on the wall of my laboratory. The robots should go to places where people cannot go and do things that people cannot do. Once a particular challenge has been cleared, the robots should move on to the next, more difficult, challenge. I want our young students to also take risks and challenges, just like the robots, as I believe that only by struggling together with the robots, can they also truly share and enjoy the success of their achievements.

There are two types of challenges facing underwater robots. The first is how to cover larger areas, and the other is how to pinpoint specific targets. For survey of broad area, the AUV is unrivalled in its capabilities and is ideally suited to the challenge. On the other hand, for pinpoint observations, ROVs and manned submersibles are better suited. TUNA-SAND can combine the advantages of both.

The next mission for TUNA-SAND is to explore Myojinsho caldera in March 2008. Myojinsho symbolizes both the beauty and the terrifying nature of our seas, on the one hand it’s seafloor deposit contains a wealth of natural resources and on the other hand, it is a highly active underwater volcano that has clamed several lives. TUNA-SAND will go on a new adventure to explore the mineral deposits of Myojinsho. Here, TUNA-SAND will reach its maximum depth rating of 1500m, which was designed specifically for exploration of Myojinsho. In time the aim is to equip TUNA-SAND with manipulators for sampling, so that it can independently handle any situation. I am excited to see our robots take on new adventures.



TUNA-SAND; Terrain base Underwater Navigable AUV for Seafloor And Natural resources Development
Functioning as AUV and ROV
1.1m (length)×0.7m (width)×0.71m（height, except antenna) 240kg (in the air), 1500m(maximum submerge),
2.5knots (Maximum speed)

＜Profile＞

1977:Doctor of Eng. of naval architecture of postgraduate course of Univ. of Tokyo 1978: associate prof. of institute of industrial science of Univ. of Tokyo 1992: prof. of the institute. 1999: director of underwater technology res. center . Prize of the society of naval architects of Japan(1979, 1994, 1997) Prize of technology of the Society of mechanical engineers of Japan (1999) and others.

Aiming for Regenerating Articular Cartilage with Hydrostatic Pressure

Ushida Takashi, Prof., School of Medicine (concurrent with Department of Mechanical Engineering)

●Enhanced regeneration of articular cartilage by 50 atm of hydrostatic pressure loading

As the great age society is going, osteoarthritis, disease of joint cartilage getting worn out, is increasing. Cartilage plays an important role on joint movement. When cartilage gets worn out bones hit each other to get inside nerves stimulated, causing severe pains. Eventually the patients are getting difficult to walk, resulting in low quality of life (QOL). Among the people who have past middle age, osteoarthritis is detected frequently. As one of the treatments in regenerative medicine, transplantation of chondrocytes, cells in cartilage has been tried. However, its efficiency is still low. We have been trying to regenerate cartilage tissue itself for transplanting it to damaged portion of articular joints.

How to proliferate cultured chondrocytes efficiently. How to regenerate articular cartilage tissue. (1) biochemical methods by using growth factors such as fibroblast growth factor (FGF), (2) methods in material engineering by using bio-degradable polymers such as poly-L-lactic acid (PLLA). We have adopted a third method, method in mechanics, by using physical stimulations, which are thought to be physiologically loaded with.

Articular cartilage is thought to be physiologically loaded with hydrostatic pressure up to 50 atm, corresponding to water pressure at 500 m in depth, by weight and exercise. Cartilage is composed of 10 % in matrices and 90 % in water, then compressive stress is transiently transformed to hydrostatic pressure inside cartilage tissue. We think such a physical condition controls cellular functions and promotes tissue regeneration. Actually we have achieved to make cartilage tissue elements under hydrostatic pressure loading. However, there still remains much work to seek for adequate loading conditions of hydrostatic pressure. How does chondrocyte sense hydrostatic pressure? We have studying its sensing mechanism by detecting intracellular signals evoked by hydrostatic pressure. In the future, we hope that articular cartilage can be regenerated in a tailor-made manner, so that the shape of regenerated cartilage can be regulated by using a mould made by rapid prototyping method, based on X-CT 3D data.

●Who is required in the field of medical engineering is the person with basement of the both engineering and medical in themselves.

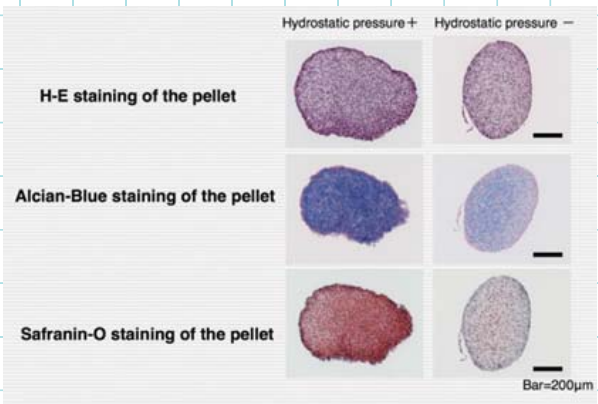
I was brought up in a region where a huge automobile company reigned. I had relative some of whom founded companies relating to automobile. So I was thinking I would also do so. However when I met a research theme on artificial kidney at the graduate school, I clearly understood that medical engineering was that I sought for, though it was a little late. So when I entered Agency of Industrial Science & Technology (present National Institute Of Advanced Industrial Science & Technology), I started culturing mammalian cells in the laboratory. It was a turning point for me that I started the cell culture and made biomedical researches under Professor Tateishi, who is one of the founders of biomechanics in Japan.

Collaboration between medicine and engineering, has been defined to collaboration between medical doctors and engineers. I think that this definition is already out of date. I think that researchers with basement of the both engineering and medical in themselves are required for future progress in medical engineering field. In that sense, I want that the students should have wishes to exploit new fields on the base of their disciplines.

My hobby is listening to classical music at outdoor, using a iPod with a noise-cancelled headphone. I remember that I have played trombone at a citizen orchestra. I like looking outside from the train windows. Away from the daily works, ideas or hint to solve difficult problems might unexpectedly come up to me. I don't hesitate to take a train, although the destination may be at a flight distance. I highly value such precious time.

Effect of physiological hydrostatic pressure on regeneration of cartilage tissue elements

The images show histochemical staining of cartilage tissue elements under hydrostatic pressure loading or not. Haematoxylin-Eosin staining shows cell viability and distribution. On the other hand, both Alcian-Blue staining and Safranin- O staining show the matrices of cartilage, such as chondroitin sulfate, heparan sulfate. The images show that hydrostatic pressure loading promoted the regeneration of cartilage tissue elements.



＜Profile＞

1979:graduated from Faculty of Eng., Univ. of Tokyo, 1980:studied at School of Med, Nancy Univ., France, 85: graduated from Graduate School of Eng. Univ. of Tokyo. Ph.D. 1985: researcher at Agency of Industrial Science and Technology. 1992:conjugated associate prof., School of Med., Tsukuba Univ. 2000:associate prof., Faculty of Eng., Univ. of Tokyo. 2003:prof., Center for disease biology and Integrative Medicine, School of Med., Univ. of Tokyo, concurrent to Dep of Mech Eng., Faculty of Eng., Univ. of Tokyo.

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Advisory Committee

Advisory Committee

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

Activities of Mechanical Systems Innovation Program

〈Open Seminars〉

◎FY2007-1st Seminar
Date : May 30, 2007 4:00pm-6:00pm
Venue : Conference room 2-31A, Faculty of Engineering bldg.2, Hongo campus
Subject : The challenge of modelling and simulating flow separation from curved surfaces
Speaker : Prof. M. A. Leschziner(Imperial College London)

◎FY2007-2nd Seminar
Date : June 20, 2007 4:00pm-6:00pm
Venue : Conference room 2-31A, Faculty of Engineering bldg.2, Hongo campus
Subject : Addressing the near-wall problem in large eddy simulation at high Reynolds numbers
Speaker : Prof. M. A. Leschziner(Imperial College London)

◎FY2007-3rd Seminar
Date : July 2, 2007 2:45pm-4:15pm
Venue : Lecture room 72, Faculty of Engineering bldg.7, Hongo campus
Subject : Smart composite materials and structures
Speaker : Prof. Alexander L. Kalamkarov(Dalhousie University in Halifax, Canada)

◎FY2007-4th Seminar
Date : September 26, 2007 3:00pm-4:30pm
Venue : Conference room 2-31A, Faculty of Engineering bldg.2, Hongo campus
Subject : New thermal mechanisms in sub-10nm structures
Speaker : Dr. Sebastian Volz (Ecole Centrale Paris)

◎FY2007-5th Seminar
Date : October 22, 2007 2:00pm-3:30pm
Venue : EEIC Conference room 4 (112C1), Faculty of Engineering bldg.2, Hongo campus
Subject : The Growth of DWCNTs from the Precursor Route
Speaker : Professor Hans Kuzmany (Department of Physics, University of Vienna, Austria)

◎FY2007-6th Seminar
Date : December 11, 2007 1:30pm-3:00pm
Venue : Conference room 2-31A, Faculty of Engineering bldg.2, Hongo campus
Subject : Are interfaces good or bad for thermal management?
—Mediocre carbon nanotube composites and ultra-low thermal conductivity solids—
Speaker : Professor Pawel Keblinski (Materials Science and Engineering Department, Rensselaer Polytechnic Institute)
(Currently Sabbatical Leave to Department of Physics, National University of Singapore)

◎FY2007-7th Seminar
Date : December 26, 2007 (Wednesday) 14:00-15:30
Venue : Conference room 2-31A, Faculty of Engineering bldg.2, Hongo campus
(Department of Electrical and Computer Engineering, University of Missouri-Columbia)
Subject : Science and Technology of Advanced Multifunctional Nanocarbons for Vacuum Microelectronics
Speaker : Professor Sanju Gupta

〈Domestic Symposium〉

◎Final Symposium on the 21st Century COE Program : Mechanical Systems Innovation
Date : 9:40-17:50 , November 30, 2007
Venue : Faculty Meeting Room, Faculty of Engineering bldg.8, Hongo campus

〈Workshops〉

◎Workshop on Research and Development in Simulation-based Engineering and Science
Date : December 7, 2007
Venue : Conference room 2-31A, Faculty of Engineering bldg.2, Hongo campus

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March 1, 2008
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