Asia Science Letter

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The Asia Science Letter is a bi-monthly publication of the Asian Office of Aerospace Research and Development (AOARD), Detachment 2 of the US Air Force Office of Scientific Research (AFOSR), the basic research manager of the Air Force Research Laboratory (AFRL). Its purpose is to inform the Air Force S&T community on the research and development activities in Asia and Pacific Rim countries including India and Australia. The assessments in this periodical are solely those of the authors and do not necessarily reflect official US Government, US Air Force, or AFOSR positions.

Highlights

Happy New Year!

A record number of people from the Air Force S&T community came to Asia recently to deliver invited talks at international conferences. Many of them visited AOARD or traveled with AOARD program managers. Visitors were in Asia to review a wide variety of technologies. They included:

- Small satellite technology -- LtC David Parris and Capt Scott Haskett from SMC/TEL (article on page 3)
- Electric propulsion – Dr. Ron Spores and several other researchers from AFRL/PRR (article on page 4)
- Computational fluid dynamics, guidance, and control - Dr. Joe Shang from AFRL/VAA and Dr. Bradley Liebst from AFIT (article on page 6)
- Chemical Oxygen-Iodine Laser (COIL) for practical application to manufacturing -- Drs. William Latham, Kip Kendrick, Arthur Guenther, and Maj. William Cooley from AFRL/DE (article on page 12)
- Solar terrestrial physics and space weather --Dr. Edward Cliver from AFRL/VSB
- Data Mining -- Dr. Len Popyack from AFRL/IFG
- Electronic prototyping -- Dr. Steven LeClair from AFRL/MLM
- High temperature super conductors -- Dr. Charles Oberly from AFRL/PR
- Structural material science -- Dr. Kumer Jata from AFRL/MLL
- Dielectric thin film science -- Dr. Arthur Edwards from AFRL/VSS
- Computational molecular chemistry for photonics and electronics – Dr. Shashi Karna from AFRL/VSS

In this reporting period, there were also a number of outstanding conferences. AOARD Program Managers have been extremely busy in covering as many of them as possible. As a result, we had more articles than we can list in this issue. Look for reports on “Power MEMS”, “Laser Machining at Toyota”, “New Graduate School of Frontier Sciences at University of Tokyo” in the Mar/Apr ASL. (White)

TABLE OF CONTENTS

Feature Article

Anthropometry in Asia

In the Pacific Rim, researchers are showing an increased interest in exchanging both anthropometry data and application methodology research. AOARD is supporting this trend.

AFRL Visit: Mr. Kazushige Suzuki, Executive Director, and Mr. Kazuo Tsuchida, Manager of the Technical Planning Division, of HQL visited AFRL/HE, Computerized Anthropometric Research and Design (CARD) Laboratories at Wright Patterson Air Force Base, Ohio, 1 November 1999:
Mr. Suzuki and Mr. Tsuchida brought HQL data sets and gave a presentation on the HQL anthropometry project. AFRL/HECP is processing the HQL data and considering options for future cooperation. (POC: Kathleen Robinette, AFRL/HECP)

Site Visit: Department of Clothing (Professor Yoshiko Taya), Japan Women's University, Tokyo, Japan; 22 October 1999:
In Japan significant anthropometry research is conducted in support of the clothing industry both in industrial laboratories and also in departments of Clothing Science at Japanese Universities. At the Department of Clothing, Japan Women's University, research includes clothing fit as well as the design and functionality of clothing in different environments. Dr. Taya has developed a humidity/temperature measurement capsule to isolate temperature probes from the environment and get rapid, repeatable, and reliable measurements of perspiration. Ongoing research includes differentiation of insensible, heat induced, and anxiety-induced perspiration rates.

Site Visit: Wacoal Corp. (Mr. Akio Shinozaki, Manager), Human Science Research Center, Kyoto, Japan; 21 October 1999:
Wacoal anthropometry data includes a data set of over 30,000 individuals. For some subjects, 30 years of longitudinal data has been collected. Since the introduction of 3-D laser scanning technology, 5,000 subject data sets have been obtained. Research is ongoing in anthropometry measurement and human comfort/ sensibility including studies of clothing pressure, blood flow, and venous return. Also participating in the visit and scientific discussion were Prof. Yoko Matsuyama and Prof. Hiroko Takabu, Otsuma Women's University; Prof. Takako Hayashi, Hiroshima University; and Dr. Young-Suk Lee, Chonnam National University, Korea. The repository of anthropometry data and expertise in Wacoal is significant. Wacoal was requested, for example, to contribute Japanese anthropometry data for the design of the U.S. Space Shuttle.

Site Visit: Technical Planning Division, Mr. Kazuo Tsuchida, Manager, HQL, Osaka, Japan; 6 Oct 1999:
From 1992 to 1994 the MITI-funded HQL conducted an anthropometric survey of 34,000 Japanese males and females ranging in age from 7 to over 90. Data included 178 measurements as well as 3-D image data. This data is available to Universities for research and to commercial companies for product development. For more information on HQL see AOARD's Asia Science Letter Vol 18, January 1999, p11.

Meeting: Professor Young-Suk Lee, Department of Clothing, Chonnam National University, Korea; 17 September 1999:
Dr. Lyons and Mr. Kim of AOARD met with Professor Young-Suk Lee, the leading researcher in Korea in the field of anthropometry. including thermal comfort. She is the International Standards Organization (ISO) Liaison representative for Korea. At an upcoming Window-on-Science visit to AFRL in January 2000, she will give a seminar on "Korean Anthopometry Data and the Development of Innerware for Human Sensibility."

Current research (supported by a series of grants) covers:

1. The 4th Korean National Anthropometric Survey in 1997 (National Institute TQ Standards, completed 1997) This survey of 12,000 Korean males and females ranging in age from 0 to 70 included measurement of 120 body dimensions.
2. Development of a Korean anthropometric dummy was granted by the Ministry of Industry and Commerce, 1999-2002.
3. Human sensibility ergonomics for innerware was funded by the G7 project of the Ministry of Scinence and Technology (1998/12 – 2000/11).
4. Somatological studies in Korean Women for the establishment of the standard garment sizing system 1997 (National Institute TQ Standards, completed 1998).
5. Shoe sizing system 1997 (National Institute TQ Standards, 1999).
6. Head gear/sizing system 1997 (National Institute TQ Standards, 2000).

Site Visit: Research Institute of Human Engineering for Quality Life (HQL), Osaka, Japan: 16 Nov 1999:
Ms. Robinette of the Air Force Research Laboratory, Human Effectiveness Directorate (AFRL/HE) accompanied by Mr. Marc Rioux of the National Research Council of Canada, Institute for Information Technology,

and Dr. Lyons of AOARD visited the. In the past two months several additional visits have taken place.

Furture AOARD plans in anthropometry include:

1. Window on Science Visit: Dr. Young-Suk Lee, Department of Clothing, Chonnam National University to visit AFRL/HE CARD Laboratories on 18-19 January 2000. Dr. Lee will present a seminar on "Korea Anthropometry Data and the Development of Innerware for Human Sensibility".

2. Window on Science Visit: Dr. Koo Hyoung Lee, LG Electronics Corporate Design Center to visit AFRL/HE CARD Laboratories on 15 February 2000. Dr. Lee will present a seminar on "Human Centered Technology and Human Sensibility".

3. Anthropometry Workshop, organized by Dr. Halimahtun Khalid of the University of Malaysia in Sarawak, 27-31 March 2000, at Merdeka Palace Hotel, Kuching, Sarawak, Malaysia. Speakers will include Professor Martin G. Helander (Nanyang Technological University, Singapore), Dr. Ravindra Goonetilleke (Hong Kong University of Science and Technology), Mr. Marc Rioux (National Research Council of Canada), and Ms. Kathleen Robinette (Air Force Research Laboratory). Workshop: http://www.unimas.my/idea or contact Professor Halimahtun Mohd Khalid, Ph.D., Director Institute of Design and Ergonomics Application (IDEA), University Malaysia Sarawak, 94300 Kota Samarahan Sarawak, MALAYSIA Tel +6082 671790; Fax +6082672094 Email: mkmahtun@idea.unimas.my (Lyons)

Aerospace

Site Visits: Space Test Program (SMC/TEL) Team Visits Japan and Korea; 11-15 November 1999:

A team from Space Test Program (STP), accompanied by AOARD, visited space institutes in Japan and Korea from 11-15 November for a fact finding mission. The STP team consisted of LtCol David L. Parris, and mission flight designers Capt Scott A. Haskett, and US Navy LT Demian A. Bailey. STP is a multi-user space program whose role is to be the primary provider of spaceflight for the US Department of Defense (DoD) Space Research community. It provides low-cost access to space through various means such as Freeflyer Spacecraft, Space Shuttle, and Piggybacks. International cooperation is possible where there is mutual interest in the scientific outcome of the mission. STP is currently searching for these opportunities in the small satellite technology. Various ministries and government agencies support Japanese space activities but all are coordinated by Space Activities Commission (SAC). The following sites were visited:

The Institute of Space and Astronautical Sciences (ISAS), Japan: ISAS is an institute dedicated to space and astronautical sciences funded by the Ministry of Education, Science, Sport and Culture. [The National Space Development Agency (NASDA) is in charge of development of satellites and launchers - similar to NASA]. ISAS (annual budget $110 million) has 300 researchers and 170 graduate students.

- The US visitors observed final checkout of the X-ray astronomy satellite called Astro-E. This satellite will be launched by the ISAS developed M-V launch vehicle (1,800 kg max payload) scheduled for January 2000. Astro-E is a 1680 kg spacecraft designed to study evolution of clusters of galaxies by measuring motion and chemical abundance of the hot gas. This observation might lead to better understanding of the hidden mass (dark matter). Astro-E will carry an X-ray telescope, a Hard X-ray detector, an X-ray CCD camera, and a X-ray spectrometer.
- The MUSES-C spacecraft, scheduled to retrieve sample from an asteroid Nereus, is another on-going scientific project at ISAS. This 350 kg autonomous spacecraft controls itself through optical sensing, LIDAR, and fan beam sensors. MUSES-C will be launched in 2002 and return back to earth in 2006. Prof. Hiroshi Hatta, Prof. Hirobumi Saito, and Prof. Yoshifumi Inatani hosted the US delegates.

The National Aerospace Laboratory (NAL), Japan: Started in 1955 for the development of Japan's aerospace technology, NAL is Japan's only national laboratory that conducts research and development in areas related to aircraft, spacecraft, and rockets. NAL's budget ($130 million FY 1998) is fully supported by the Science and Technology Agency and is). NAL employs 425 personnel, 327 associated with research engineering. Most of the research funding (~90%) is spent on in-house research activities.

- Dr. Takashi Ishikawa, who is involved in the advanced material development for next generation of high-speed civil transport plane project, presented an overview of NAL. He described ALFLEX, the automatic landing flight experiment which demonstrated that unmanned automatic landing systems are feasible. The ALFLEX is one of a series of completed flight experiments supporting Japanese unmanned orbital vehicle (HOPE).
- Prof. Tomonao Hayashi of Chiba Institute of Technology presented the current status of the Whale

Ecology Observation Satellite (WEOS) program. By monitoring the movement of whales and their ecology data, environmental information on the ocean may be determined. Onboard sensors include GPS, pressure, temperature, magnetometers, and microphones.

- Dr. Kojiro Shoda of Toshiba Corporation (contract with NASDA) gave a presentation on the μ-Labsat design and development. The μ-Labsat is a three-axis attitude control piggyback satellite planned to be launched by an H-IIA launch vehicle in 2000. The main objective of μ-Labsat is to demonstrate small low-cost bus technology and the separator for the relay satellite.

Korea Advanced Institute of Science and Technology (KAIST), Satellite Technology Research Center (SaTReC), Korea: The SaTReC is a KAIST university based research center for satellite technology and applications research (See ASL 22). Currently, SaTreC is developing a fourth micro-satellite (KAISTSAT-4) to test and demonstrate their three-axis attitude control system and the satellite bus structure. This satellite will perform space science experiments using payoads and instruments such as UV Imaging Spectrograph, Solid State Telescope, and Narrow Angle Star Sensor developed in-house. This project is schedule to be completed by August 2002. (Kim)

Conference: The 26th International Electric Propulsion Conference (IEPC), Kitakyushu, Japan; 17-21 October 1999:

Approximately 200 researchers attended the IEPC from various countries such as the U.S., Japan, China, Germany, Israel, Argentina, Russia, France and Austria. The electric propulsion (EP) technology is rapidly moving from early generation reistojet thruster to arcjet to current ion, hall, and laser thrusters. The pulse-plasma thruster and the magnetoplasmadynamic thruster that are capable of producing ≥50 kilowatts of power are being developed for spacecraft propulsion systems. The ion thruster was recently successfully demonstrated on NASA's Deep Space 1 spacecraft and similar engines will be used on the Japanese MUSES-C spacecraft scheduled to be launched on 2002 for an asteroid sample return mission. In the ion engine, the Xenon propellant is ionized in the discharge chamber and is accelerated through electrodes with high voltage to generate the thrust. The ion thruster generates less than 0.5 Newtons but a high exhaust velocity with long-term operation will result in a lower consumption of propellants. Propellantless propulsion systems are also being explored such as a tethered satellite system that will deploy a long positive charge string to collect electrons and convert spacecraft kinetic energy to electrical power. As mentioned, most of the EP systems produce low thrust at milli-Newton (mN) levels. This technology has gained acceptance in spacecraft communities due to compact size, high specific impulse (Isp), and high efficiency. EP systems offers significant mass-savings and convert energy to thrust at much higher efficiency values (> 60%) when compared to chemical propulsion systems. These high efficiencies give the option to down-select to smaller launch vehicles. Besides launch cost savings, if used in conjunction with gravity assisted maneuvers, overall interplanetary mission objectives can be achieved in significantly less time.

In current commercial satellites EP is used as a secondary propulsion system to maintain north-south or east-west station keeping. In order for EP to be used as a primary propulsion system, some of the technical challenges, such as power conversion efficiency, thrust, reliability, and the problem of surface erosion at thruster chambers and grids, need to be addressed. Furthermore, the EP system must be reliable for up to 15 years or more lifetime operation and provide greater thrust levels (>100 Newton) for the orbital transfer and planetary mission considerations. Researchers from AFRL/PRRS were present and gave an overview of their work including results from the Electric Propulsion Space Experiment (ESEX)—a 30kW arcjet demonstration which was flown on the ARGOS satellite earlier this year. (Kim)

Conference: Workshop on Observation Satellite Systems and Sensing Technologies, Institute of Electronics, Information and Communication Engineers (IEICE), Tokyo; 15 Oct 1999:

The progress of Japanese earth observation satellite systems was reviewed. Various related technologies, especially key sensor technologies were selected and summarized by specialists in those fields. The total of 60 attended, most from Japanese aerospace corporations. The following were presented:

1. Observation Satellite Systems in Japan by T. Sakata, Tokai University. The focus was on clear and continuous observation of the earth and atmosphere. The main tasks are to collect and analyze information on natural and man-made disasters. The key requirement is to improve spatial resolution (< 1 m).
2. NASDA Earth Observation Satellite Issues by S. Sobue, NASDA. The missions of NASDA satellites were summarized. They included ADEOS series (global earth observation), GCOM-B1 (energy and material cycles), GCOM-A1 (ozone and greenhouse gases), JEM (system engineering demonstration platform for earth observation with long term availability) and MDS-2 (satellite for LIDAR experiment called ELISE).

3. Progress in Japanese Observation Satellites by O. Kakuichi, Mitsubishi Electric Corp. Two key objectives are observation of the earth environment (international collaboration) and observation with high spatial resolution (extending to commercial applications).
4. Synthetic Aperture Radar (SAR) by H. Wakabayashi, NASDA.
5. Optical Sensor Technology by H. Shimoda, Tokai University. Remote sensing technologies with microwave and optical methods were outlined, respectively.
6. Analysis of Satellite Observation Data by R. Kouda, Agency of Industrial Science and Technology.
7. Utilization of Satellite Observation Data by M. Ono, Remote sensing center. Data analysis methods were outlined.

Overall this workshop found that for both SAR and optical sensor technologies spatial and spectra resolution must be improve tenfold and data analysis techniques should keep pace. (Miyazaki)

Conference: International Conference on Intelligent Robots and Systems (IROS '99), Kyongju, Korea; 17-21 October 1999:

IROS '99 hosted 77 session with 308 papers presented. Japan and Korea contributed over half of the papers with the PacRim contributing 65% - Japan (115), Korea (71), Australia (3), China (2), Hong Kong (6), Singapore (1), and Taiwan (2).

- Plenary speaker Prof. Thomas Ray from Univ. of Oklahoma presented a project he worked on while at Advanced Telecommunications Research (ATR) Human Information Processing Research Laboratories, located in Kyoto, Japan (Web page: http://www.hip.atr.co.jp/~ray/). The project dealt with artificial life - machine code programs that reproduce themselves, but have an evolutionary nature.
- Plenary speaker Kazuo Tanie, Director of Mechanical Engineering Laboratory (MEL), Agency of Industrial Science and Technology (AIST), Ministry of International Trade and Industry (MITI) gave a presentation on Human Friendly Robotics (HFR). Dr. Tanie defined HFR as a robot that works in human environments and provides various services in a safe and efficient manner. Typically, the operator and user will be non-professional persons, so the technology for HFRs must include a safe body structure and a safely controlled architecture. MEL is considering two types of new applications; task execution and communication (e.g., Sony's Aibo and Tiger Electronics' Furby). A Cat Robot is in the works for the latter application. Over the next three years, MITI will develop the technologies for a humanoid HFR. The humanoid shape was chosen because the shape works well in environments designed for humans, will aid with human friendly feeling, and is challenging. The first step is a Virtual Robot platform simulator for design. The initial budget was 914 million yen (~US $9M) for '98, and 881 million yen (~US $8.5M) for '99. Applications are being sought that can be achieved with foreseeable technologies. (MEL homepage: http://www.mel.go.jp/enghome.html)

During the Industrial Forum,

- Dr. Sukhan Lee of Samsung Advanced Institute of Technology (SAIT), Korea, discussed trends in industry robots, especially service and embedded robots. Japan has more robot installations per year than the rest of the world combined and is nearing saturation. Japan also dominates in the world robotics market. The world robot market is becoming healthier due to continued demand by the automotive industry and the spread of robots to other industries such as nuclear power plants and medical/surgical. There is a new market emerging -- the embedded robot used in intelligent transportation systems and micro-electromechanical systems (MEMS) applications.
- Dr Tatsuno from Toshiba proposed an Open Robot controller. Unlike current research trends focusing on components, the Open PC controller is concerned with the development of systems. Like a PC, the Open PC controller is easy to use and should make many jobs possible.
- Mr. Fujita from Sony discussed the market for robot entertainment. The development of these robots is designed to create a market for robots now and not for mission critical tasks. He showed a video on Aibo, the integration of robotics and artificial intelligence.
- Dr. Harry Stephanou of Rochester Polytechnic Institute (RPI) presented the university's new role in industrial research. The challenge in a research center is to provide client companies with a quick return on their investment while providing students and faculty with opportunities for longer term research. Projects are industry driven, with clear deliverables, tighter tolerances, and a shorter product lifecycle. One opportunity is micro systems packaging.

IROS '99 was sponsored by IEEE, Robotics Society of Japan, Society of Instrument and Control Engineers, New Technology Foundation, and Institute of Control, Automation, and Systems Engineers. The IROS '99 website is http://iros99.kaist.ac.kr/. (Gaudreault)

Conference: 37th Japan Society of Aeronautical and Space Sciences Symposium (JSASS), Tokyo, Japan; Oct. 13-15, 1999:
This year, JSASS's annual symposium was supported in part by AOARD. The majority of papers were presented in Japanese. Research areas covered helicopter technology, aerospace materials, flight simulation, flight control, aerodynamics, and navigation. English titles can be found at AOARD website http://www.nmjc.org/aoard/. English papers from the International Sessions covered computational fluid dynamics, aerodynamics and focussed on guidance and control (over half the papers presented). This reflected the desire of Asian researchers to present their work internationally. One of the three special lectures, Dr. Brad Liebst of the Department of Aeronautics and Astronautics, Air Force Institute of Technology spoke on Pilot-Induced Oscillations. The Air Force also had the honor of providing one of the plenary speakers, Dr. Joe Shang of the Air Vehicles Directorate, Air Force Research Laboratory who gave an Assessment of Aeronautical Science for the 21st Century.

Next year's conference will be held in Sendai. This symposium would be a very valuable experience for all researchers, especially those in guidance and control, contemplating cooperative research with their Japanese peers. Contact Maj. Gaudreault for more information: gaudream@aoard.af.mil (Gaudreault)

Final Technical Report: The Observation of Cometary Dust Trails by Using a Cooled Charged Coupled Device (CCD) Camera, Dr. Ryosuke Nakamura, Information Processing Center, Kobe University:
Dr. Nakamura and his team from Kobe University have suggested that the dust clouds inside the tube can be seen easily from the Earth due to an increase in optical depth of grains along a line of sight, when the meteor shower occurs. The meteor storm, consisting of tiny particles traveling at 140,000 mph, can cause serious damage (mechanical and electrical) to spacecraft in the storm vicinity and early detection may prevent such a threat.

In November 1998, his team observed the dust tube associated with the comet P/Tempel-Tuttle, using a cooled CCD camera with a wide-angle lens. They made observations from an aircraft provided from NASA's Leonid Multi-Instrument Aircraft Campaign and from the ground-based observatory on Mauna Kea in Hawaii. The target was a faint glow resulting from the scattered sunlight off such small dust grains. Most of the interplanetary dust grains come from asteroids and comets. It is believed that the dust grains produced by collisions between asteroids yielded the "dust bands" discovered by IRAS (Infrared Astronomy Satellite). On the other hand, the larger dust grains blown out from the cometary nucleus are seen as the "dust trail", which has a tube-like structure along the parent comet's orbit. Meteor storms occur when the Earth enters into such a dust tube. The favorable conditions provided by meteor storms consist of the high spatial density of meteoroids and the configuration between the Earth and the meteoroid tube.

With a predicted time of the storm maximum of 19:00 UT, East Asia was preferred for the Leonid observation. These platforms left from Kadena Air Base, Okinawa (USAF) and made it possible to observe above the clouds in a clear and transparent sky. In December 1998, Dr. Nakamura and his team observed the same region of the sky from Mauna Kea to estimate the background flux. The model calculations for the expected brightness from such dust tube have been done to assess the possibility of its being observed. The apparent brightness on the sky is sum of the scattered sunlight from all the meteoroids along the line of sight. The analysis of their image data showed that in the data obtained on Mauna Kea, significant features like a dust cloud associated with the position expected for the dust tube appears on the smooth background component. AFRL/VSBC and NASA-Ames Research Center supported this research. The Kobe team is also scheduled to observe this year's Leonid Meteor Storm scheduled to arrive on November 17. (Kim)

Conference: The 6th Japan International SAMPE Symposium & Exhibition (JISSE-6), Tokyo, Japan; 26-29 October 1999:
The Japan Society for the Advancement of Materials and Process Engineering (SAMPE) chapter organized successful symposium that focused on metallic (alloys) and non-metallic (composite) materials. There were 400 conference attendees from around the world and more than 300 technical papers were presented. 45 booths in the exhibition area displayed the latest products from the advanced materials development companies and research centers such as Mitsubishi, Toray, Hitachi, and Fuji Heavy Industries.

Dr. Steven LeClair from the Materials Directorate, Air Force Research Laboratory, gave a keynote lecture titled: "Innovations in Materials Design (Problems and Issues)." The paper presented more efficient methods of organizing materials data using both supervised and unsupervised artificial neural networks. (Kim)

Site Visit: Department of Materials Science and Technology, Science University of Tokyo, Japan; 7 October 1999:
Prof. Hiroshi Fukuda has investigated various experimental methods to improve testing standards such as the simplified compression-bending (SCB) test and

loop test method for advanced composite materials. In order to examine the SCB method, a new mechanical loading device was designed to minimize the stress concentration buildup at the loading point. The material properties values of bending strength and modulus of elasticity can be efficiently obtained by knowing only applied load and displacement of crosshead. The test specimen does not require installment of strain gauges or midpoint deflection readings. Similarly, the strength of carbon monofilament was obtained using a combination of a loop test and the theory of elasticity. The standard mechanical tensile test on a single filament (~ 7 μm diameter) is tedious. Handling is difficult because the filaments are easily broken. The loop test eliminates the need for attaching grip tabs at each end that cause premature breaks reducing handling problems. Such simple but accurate test methods are needed to determine strength of composite materials at micromechanical level. The effects of fiber/matrix interface are important in understanding the failure mechanism in loading situations.

Prof. Fukuda is also the Chairman for the 9th US-Japan Conference on Composite Materials. This conference will be held at the Toray Human Resources Development Center in Shizuoka, Japan from 2-5 July 2000. The conference papers are being accepted in the area of Low Cost Composite Structures, Composite for Infrastructures, and Smart & Intelligent Composites. Website: http://www.rs.noda.sut.ac.jp/~kogo/us-j/index.html (Kim)

Comment: "Computer Environment for Computational Mechanics Research in the U.S. and Japan" by Professor Kozo Fujii, The Institute of Space and Astronautical Science Sagamihara, Japan:
Prof. Fujii has been engaged in CFD (Computational Fluid Dynamics) research for the past 25 years. He has observed the trend of HPC (High Performance Computing) hardware from a user's viewpoint and occasionally evaluated its performance in terms of CFD requirements. Last summer, he participated in the WOS program and gave a seminar at Air Force Research Laboratory at Wright-Patterson AFB, Ohio. The below article is his impression on the difference in the computer environments at the leading-edge research centers in the U. S. and Japan.

"All of the Japanese computer companies announced their new supercomputer products last year. Two of them are still vector supercomputers. A single processing element (PE) has a peak speed of 8 GFLOPS with 8 or 16 GB memory. Users can carry out large-scale CFD simulations using almost 100 million grid points without the effort of parallel coding. The price of recent supercomputers, including these two, has come down for the last five years with the use of CMOS chips and DRAM memory. As a result, quite a few of the national universities have (or will have this year) supercomputers of 500 GFLOPS to 1TFLOPS performance (which means that they are composed of many strong vectors). At the same time, even a single department of a university or research laboratory is able to buy one or two processors within their budget. Aerospace researchers and students can easily access very capable supercomputers that do not require parallel programming for most of their work. In the U. S., all of the vector supercomputers are gone. Therefore, while AFRL are doing very good work, they must parallelize their computer codes on a scalar CPU of several hundreds of MFLOPS. It is true that the HPCs are moving toward parallel computations, but at the same time, it is also true that the coding itself is not the purpose of the CFD research. Therefore, it may be necessary to give them good coding support on the parallelization using MPI and let them concentrate on fluid dynamics research itself."

Window on Science: Prof. Ichiro Okura, Tokyo Institute of Technology, AFRL Air Vehicles Directorate; 11-15 October 1999:
At the Paint Sensitive Workshop held at Purdue University, 11-13 October, Prof. Okura gave a seminar on his recent work entitled "Optical Oxygen Sensing based on the Change of Triplet-Triplet Absorption of Organic Dyes Using Laser Flash Photolysis". He proposed using non-phosphorescent compounds to improve oxygen sensing by measuring the triplet-triplet absorption. His area of research was not familiar to the Pressure Sensitive Paint community and his presentation was well received and stimulated interesting discussion. Prof. Okura also gave a seminar at Wright-Patterson AFB on 14 Oct 99. POC: Gary Dale, (Gary.Dale@va.wpafb.af.mil). (Gaudreault)

Micro and Nano Systems

Conference: The 5th International Micromachine Symposium, Tokyo, Japan; 28-29 October 1999:
The Micromachine Center (MMC) of Japan held the fifth symposium (tenth exhibition) presenting the technical advances of the National Micromachine Research and Development Project to over 200 scientists on October 28-29. Over 80 companies, laboratories, and universities presented micromachine related work at the exhibition. Six speakers from Japanese Universities and 18 from industry & MMC funded laboratories addressed recent micromachine research during the symposium. The status of microsystem technology development worldwide was also partially addressed through six invited speakers from outside of Japan.

The Ministry of International Trade and Industry's (MITI) Agency of Industrial Science and Technology (AIST) sponsors the New Energy Development Organization (NEDO) which has delegated management of the national project to MMC. The 10 year, 25 billion yen (~$185 million) MMC project was the first large long-term national commitment to microsystem technology (MST) development. The Japanese commitment influenced other nations to increase their MST investment. MITI selected a project membership of 22 Japanese companies, 3 MITI laboratories, 2 public Japanese institutions, 1 U.S. company, and 1 Australian university in 1991 and has not significantly altered membership. Defined and funded at project start in 1991, the three research focus areas are micro-factory development, micro-technologies for medical application, and maintenance systems for power plants. The Japanese national project is characterized by (1) the development of small precision machine systems (other nations, e.g. U.S.A., are focusing more on lithographic based systems) and the belief that machine tool precision is the most important factor in determining machine system size and complexity. As the 2001 project completion date approaches discussion on commercial viability and the social benefit of the investment, management structure, and the project's vision of MST is ongoing. The Japanese research effort, although experiencing an overall increase in research expenditures, is forced to react to the economic climate in Japan. This has caused a decrease in industrial research funding and an increase in government sponsored research. The result of this shift in funding is a more serious project review process and a planned change in the national university sponsorship system.

The symposium's opening speakers included Mr. Shinichrou Oota, Director-General, Machinery and Information Industries Bureau of MITI, Dr. Koji Kajimura, Director-General of AIST, and Mr. Hideyuki Matsui, the Chairman of NEDO. Mr. Oota indicated it was vital to pursue micromachine technology and that downsizing maintenance, industrial, medical and information systems were key technologies for the future. Dr. Kajima expressed a feeling that micromachining could become a core future technology. Mr. Matsui called micromachine development a promising technology. The exact measure of the opening speakers' support should be apparent in the spring of 2000 when a decision to renew or extend the project will most likely occur.

Speakers from academic institutions from outside and inside Japan examined the topic of micro-technology commercialism during the symposium. AIST estimates the current size of the Japanese micromachine market is 400-billion yen. The rapid economic impact of scaled systems was illustrated by the success of NTT Mobile Communications Network, Inc. They added over 25 million subscribers in the last 6 years to their mobile phone unit service partially as a result of advances in phone micro-technology. The 25 billion-dollar a year inkjet printer industry is another example of a micro-technology market success. In both cases micro-technology is the enabling technology. A trend was suggested that micromachine manufactures in the future might primarily supply product core technology vs. finished consumer products. The role of micro-technology as an enabling technology has influenced the realization that standardization of micro-technology will be required.

Three national research laboratories are members of the MMC managed MST project. The Mechanical Engineering Laboratory is pursuing the development of micro-processing and testing methods, and the development of the micro-factory. The micro-factory is a Japanese micromachine concept to improve machining tolerances and lower machine tool infrastructure costs. The Electromechanical Laboratory is developing cooperative robotic control systems and a miniature electron gun system for an electron-beam-induced 3-dimentional-fabrication process. The National Research Laboratory of Metrology is tasked to perform and develop dynamic testing of microstructures, and the examination micro-material properties.

Cooperation between industrial members has been fostered by assigning system component development to different companies. The resulting inter-company network and basic technology may provide a foundation for future complex micro-device development. The micro-pipe inspection project (part of the MITI maintenance systems for power plants initiative) is an example of industrial cooperative research. Denso Corporation is developing a wireless micro-pipe inspection device consisting of a low-voltage piezoelectric locomotion system with a driving voltage of 15 and containing a 3-dimensional high-density LSI system control unit. Sanyo Electric Company, Limited is developing a power supply unit and micro-wiring methods for the inspection unit. Toshiba Corporation is constructing a micro-CCD camera 10-mm in diameter that requires 300mW for operation. The final phase of the project requires the three companies to integrate the components and form a visual micro-pipe inspection system. The development of such complex microsystems forces researchers to address specific component integration challenges such as thermal & power management and the development of reliable wiring/connection methods. Other devices developed by Japanese companies supported by the MMC include: a flexible 5 mA-4.14 V-90mAh Lithium ion battery, a

chain-type cooperative robot system, a catheter type inspection and assembly system with an integrated 8 mm diameter micro-YAG welding laser, an optical scanning system, a 10-mm diameter micro-servo, a micro-gyroscope, and a micro-factory.

Sixty-one corporations, nineteen universities, three national Japanese Laboratories, and one independent organization exhibited at Exhibition Micromachine'99. The exhibitions showed an expected technical maturity after 9 years of development. Working prototypes of many of the systems funded by MMC could be viewed. The devices on display included pipe inspection units, optical scanning systems, active material actuators, material and structural analysis systems, and micro-fabrication apparatus. Micro-factories demonstrated their material handling and process abilities. The final step in these devices is the integration of system components with power management, physical interconnection, and power supply methods the main unresolved issues. (Pokines)

Site Visit: Taste Sensors Help to Determine Flavors of the Future: Kyushu University, Fukuoka, Japan; 8 October 1999:

Research to develop artificial tasting methods is being performed in Dr. Kiyoshi Toko's laboratory in the Department of Electronic Device Engineering, Graduate School of Information Science and Electrical Engineering. The taste technology is based on lipid-polymer membranes that produce an electrical potential when immersed in chemical substances. A number of lipid-membranes have been developed that respond to different substances. Eight lipid/polymer taste sensors are bundled to form the Kyushu University tasting probe and the data from these eight sensors are combined to form a taste profile of a liquid substance. Combining the sensor data in this manner is conceptually different than other taste sensors systems that detect specific taste producing chemicals. The taste profile corresponds to the overall taste perceived by humans. Specific patterns correspond to different tastes (e.g. salty or sour). Several foods have been tested with the system including Japanese sake, beer, coffee, tomatoes, Worcester sauce, rice, soy sauce, milk, and green tea. The research has seen commercial application with beer companies striving to improve the taste consistency and quality of beer. The taste of different beer brands has been quantified and beer tastes plotted relative to each other. The information can be correlated to market share and product development can be directed from this information. The Anritsu Corporation has successfully commercialized the system and several factories and laborites are currently using the systems. The taste-sensing scheme has application beyond the development of new food flavors. Researchers are investigating the potential to use the lipid-membrane electrical potential response pattern to detect the presence of contaminants in fluids such as CN^-, Fe^{3+}, and cyanide. Dr. Kenshi Hayashi is extending the taste research by investigating other tastes such as the spiciness of a food, odors, and endocrine disrupting chemicals using electro-chemical impedance changes. (Pokines)

Site Visit: Gas Sensor Research Aims to Improve the Environment: Kyushu University, Fukuoka, Japan; 8 October 1999:

Sensors to detect harmful pollutants and combustion products are under development in Dr. Noboru Yamazoe's laboratory in the Department of Molecular and Materials Sciences, Interdisciplinary Graduate School of Engineering Sciences. The focus of the sensor work is to develop accurate gas sensors with improved response time for use at low and high temperatures. The sensors have application in pollutant monitoring and feedback control systems to regulate harmful gases.

A NO sensor that operates at 500°C has been developed at Kyushu University. The sensor overcomes the limitation of low sensitivity to NO vs. NO_2. The sensing approach is based on the use of amperometric effects and has a response time of 30 seconds. A low temperature (150°C) NO_2 sensor with a 60-second response time capable of detecting a change of .1 PPM of NO or NO_2 has also been developed. This amperometric sensor uses a catalyst layer to convert NO to NO_2, which can then be detected. Dr. Kengo Shimanoe of the laboratory is developing potentiometric and amperometric CO_2 gas sensors. The laboratory is actively examining methods to reduce sensor fabrication complexity, and increase reliability and uniformity though the development of planar (vs. stacked) sensor configurations.

The laboratory is also involved in the development of rechargeable metal-air batteries. The researchers have increased the power output of metal-air batteries through the use of an electrode loaded with $Pr_{0.2}Ca_{0.8}\ Mn_{0.1}F_{0.9}O_3$. This lightweight battery has a maximum power density of $142mW/cm^2$ at $290mA/cm^2$ with excellent charge-discharge properties. (Pokines)

Site Visit: The Australian Membrane and Biotechnology Research Institute (AMBRI), Chatswood, NSW, Australia: 24 September 1999:

Using an approach that mimics biology, over the last 10 years AMBRI has developed a robust, generic and sensitive bio-sensor that uses simple electrical measurements. The work has been published in Nature, Cornell et al, "A Bio-sensor that uses Ion Channel Switches", 5th June 1997, Dr. Peter Osman, Dr. Bruce Cornell, and Mr. R.H. Joseph Shaw, Managing Director.

Using self-assembly based on organic chemistry, ion channels obtained from Bacillus Brevis are incorporated into a membrane structure tethered to a gold electrode. The goal is to develop a bio-sensor to detect airborne bacteria or bacteria in blood, serum or saliva samples. Using specific antibodies linked to the ion channels, this nano-scale device can detect sub-pico-molar concentrations of specific antigens. Reproducibility of the sensor, shelf-life, sensitivity, and resistance to matrix effects are continuing challenges in the development of this technology.

AMBRI is a consortium, part of a Cooperative Research Center Program (CRC), involving collaboration between CSIRO, Pacific Dunlop, and the University of Sydney. DARPA is also funding AMBRI to develop a biological warfare agent sensor under a 3 year, $2.3 million contract. This project is expanding to become a collaborative effort between the Australian Defense Science and Technology Organization (DSTO) and DARPA. It will include:

- One aspect is going to be a joint research effort with the US Army Research Institute in Infectious Diseases (USAMRIID) at Ft. Detrick in Frederick, MD to compare and evaluate this detection method.
- The design of the multi-electrode array of the Ion Channel Sensor transducers to optimize sensitivity and stability is being carried out at AMBRI's Laboratory in Chatswood by Dr Peter Osman.
- The production, selection, and optimization of antibodies to B.anthracis (anthrax), Y.pestis (plague), & C.burnetii (Q-fever)is being conducted at DSTO (Dr Mick Alderton), St Vincent's Hospital, Sydney (Dr Robyn Ward), Melbourne University, and the University of Adelaide.

This innovative technology promises to introduce a new class of detector. Near term applications could include clinical diagnosis, environmental monitoring, process control, and drug screening. In addition, an electrical switch with biologic components assembled chemically has broad implications for 3-D electronics. For detailed information see the web site http://www.ambri.com.au/. (Lyons)

Site Visit: Department of Intelligent Machinery and Systems, Graduate School of Engineering, Kyushu University, Fukuoka, Japan; 8 Oct 1999:

Dr. Yoichi Kanemitsu's laboratory is conducting several experimental vibration control projects aimed at improving vibration isolation of high precision machinery for the semiconductor industry and atomic force microscopes. The main emphasis is to replace or update conventional bearing systems with actively controlled magnetic bearings.

The vibration control projects, conducted jointly with industry, involve the retrofitting of conventional bearings with an active magnetic bearing in a Si waffer handling system. The active control system will increase quality control during Si processing. In support of this project an active control system to mitigate vibrations in a magnetically supported platform is being developed. Robust control techniques will be applied to the closed loop system of the platform. Dr. Koichi Matsuda is improving the resolution of scanning electron microscope (SEM) through a novel feedforward approach. Using the SEM video signal to form a feedforward sensor signal, Dr. Matsuda has developed a method to correlate the video signal with the relative motion of the specimen and electron beam of the SEM. Using this sensor signal eliminates the need to install additional sensing hardware. Vibrations of the SEM base will be mitigated initially with the existing base control system. Implementation of this systems has the substantial payoff of increased SEM resolution at the cost of only a signal analysis and software upgrade. (Pokines)

Window on Science: Microsystems in Harsh Environments Workshop, Cleveland and Wright-Patterson AFB, Ohio; 22-22 October 1999:

Over sixty researchers attended Glennan Microsystems Initiative, Microsystems in Harsh Environments Workshop. AOARD and EOARD provided U.S. microsystem technology (MST) researchers with access to 6 of the 7 workshop speakers through the Window-On-Science program. This workshop illustrates a research paradigm shift from developing new MST process to integrating MST into military and industrial systems. The harsh environment workshop speakers assisted U.S. researchers to identify applications and specify standards of high performance microsystems by focusing on MST harsh environment applications and current research in Asia and Europe. Professor Masayoshi Esashi from Tohoku University in Sendai, Professor Hiroyuki Fujita from the University of Tokyo, Professor Susumu Sugiyama from Ritsumeikan University in Kyoto, and Miwako Waga from the Asian Technology Information Program Tokyo office participated in the conference from Japan.

The European research group NEXUS predicts the market for MST will reach 34-37 billion U.S. dollars worldwide by 2002. These markets are difficult to study since MST touches many fields and the definition of MST drastically changes the prediction. One speaker demonstrated this difficulty by comparing three market studies varying by billions of dollars. The same speaker inferred that Japan is in a prime position to capture a large segment of the MST market because of its position in the consumer and

industrial electronics markets. Japan currently supplies 60% of the consumer electronics and 40% of the industrial electronics market worldwide. The Japanese infrastructure could be leveraged to allow companies to rapidly expand into emerging MST markets.

Harsh MST environments are varied and include temperature, pressure, corrosiveness, vibration, power consumption, reliability and tribology issues. Harsh environments exist in the biomedical, aerospace, and manufacturing industries. But the development of MST for harsh environments is not a new area. An early example was Toyota's development of Si pressure sensors for automobile engine use in 1971. This early research is the foundation of a production-model cylinder pressure sensor to increase engine efficiency. European MST end-user representatives presented current harsh environment application examples and parameters including natural resource metrology and automobile component engineering. Vast oil well and natural gas monitoring, analysis, distribution, transportation, and storage networks create a need for compact, low-cost, precise sensors that can withstand temperatures of over 300◦C, pressures of 1400 bar, and last for ten years. The sensors also must withstand corrosion and wear. Efficient metrology systems improve management of nonrenewable energy sources, and provide accurate customer billing. These two factors provide a bottom-line (profit) motive to implement and develop harsh environment MST. Automobile manufacturing is often sighted as an industry where MST is a success with commercial viability illustrated by the production of 9 million MST based airbag triggering systems units per year by one European company. MST is spreading to other automobile components such as inertial sensing systems, emission control units, engine pressure sensors, and fuel injector valves as automobile engineers and managers become aware of the benefits of incorporating MST into new designs. MST devices integrated into a combustion engine may face temperatures between 200-400◦C, and diesel engine operating requirements raise the mark to 450◦C. Brake systems may require an MST device to withstand temperatures of between 150-175◦C during normal operation. Pressures parameters also are high, i.e. injection systems where pressures vary between 1500-2000 bar. These systems must not only survive these environments but must operate reliability from 4,000 to 10,000 hours. The pay-off of further implementation of MST into the automobile industry is two-fold: component cost reduction (e.g. airbag system) and system performance improvement (e.g. pressure sensor).

Innovation is required to further integrate MST into harsh environments. Speakers agreed that thermal masking and signal compensation methods are only partial design integration answers. Sensors and actuators must interact with their environment and electronic signal compensation methods are limited. Conventionally fabricated and packaged MST Si pressure sensors have been demonstrated to operate at 150◦C. Silicon on an isolator (e.g. Si bonded to SiC) and Si surface treatments can raise MST environmental resistance. Solutions presented at the workshop to the harsh environment integration challenge seem to be leading toward the development of completely SiC based MST systems that can withstand temperatures greater than 500◦C. Micro-turbine researchers in Japan are fabricating components from SiC. Si_3N_4 was presented as another possible MST harsh environment material. Another challenge researchers must overcome is the cost of MST for harsh environments. High environmental performance requirements raise the costs of assembly and packaging above device fabrication and testing costs.

Several WOS participants gave a seminar at the Materials Directorate, WPAFB on 22 October. Dr. Robert Crane hosted the seminar. (Pokines)

Electronics & Physics

Site Visit: Kanto Technical Institute of Kawasaki Heavy Industries Ltd. (KHI), Noda, Chiba; 28 Oct 99: Scientists from AFRL/DE and AFOSR visited KHI to discuss recent progress in Chemical Oxygen-Iodine Laser (COIL) and possible future collaboration. The group consisted of Dr. William P. Latham (AFRL/DELC, Chief of Cooperative Development Branch), Dr. Kip R. Kendrick (AFRL/DELC, Gas and Chemical Lasers Branch), Prof. Arthur H. Guenther (The University of New Mexico and Visiting Scientist at AFOSR), Ms. Joanne H. Maurice and Dr. T. Miyazaki (AOARD).

The KHI was established in 1896 and has 16,000 employees. Sales revenues in 1997 were 1.1 trillion yen with sales breakdown of Aerospace (25%), Machinery (23%), Plant Engineering (17%), Environment & Power Plants (15%), Ships (14%) and others. KHI is also one of the top five military defense contractors in Japan. The superiority of COIL laser among high-power gas lasers was illustrated from various standpoints. As an example of its application, laser material processing was described. Mr. Nakabayashi of KHI outlined the development of COIL welding. KHI has combined COIL laser with Nd:YAG laser to increase the power density and has obtained more than 30 kW output. A penetration depth of 0.5 m/min has been realized for steel plate of 15 mm

thickness. Their final target is the experimental confirmation of welding speed above 1 m/min for steel and aluminum plates. The 10 kW COIL system and several laser welding systems were demonstrated during the laboratory tour. The KHI has been collaborating with Boeing Corp. on developing a reusable system of chemical resources. (Miyazaki)

Conference: Chitose International Forum on Photonic Sciences, Chitose City, Hokkaido, Japan; 12-13 Oct 1999:

Participants including 111 international researchers and over 100 students took part in the forum. Presenters at the Forum included Drs. George Stegeman (the CREOL Center for Research and Education in Optics and Lasers, University of Central Florida), Nassar Peyghambarian (Optical Sciences Center, University of Arizona), Yasuhiro Koike (Keio University), and Paras Prasad (SUNY Buffalo).

The Forum focussed on the design, synthesis and characterization of passive and active element materials and devices, especially those based on organic and photorefractive materials. Recent research on passive element materials such as plastic optical fiber (for optical links, sensors and diagnostics) and active element materials such as and liquid crystal films and fluorescent polymers (including DNA-based) was presented. Of particular interest was applications work in biophotonics with topics ranging from medical diagnostics/imaging to novel drugs. These included a "nanoclinic" cancer-therapy concept , a cancer-cell probing and targeting tool - one billionth of a meter in size, from Dr. Prasad. A multifunction silicon "bubble" containing a two-photon dye (flourophore) immersed in an aqueous solution, it exhibits specific and selective responses toward outside stimuli. That is, it's an externally activated chemotherapy, passing safely through cells other than its target!

This meeting was in memory of Professor Keisuke Sasaki, founding president of the new Chitose Institute of Science and Technology whose objective is to foster pioneering work in biophotonics. (Maurice)

Conference: International Forum on Advanced High-Power Lasers and Applications (AHPLA'99), Osaka, Japan; 1-5 November 1999:

About 400 laser researchers from around the world participated in the first AHPLA Forum held at Osaka University, Osaka, Japan. The conference was sponsored by the Laser Society of Japan (LSJ) and the International Society for Optical Engineering (SPIE) with AOARD and ONRIFO as contributing sponsors. AHPLA'99 consisted of 5 individual conferences with focuses on (1) advanced high-power lasers and applications in (2) ablation, (3) energy engineering, (4) civil engineering, and (5) manufacturing. AHPLA'99 also featured a public forum day and laboratory tours of Japan's leading laser facilities. These included the Institutes of Laser Engineering of Osaka University (focus on fusion), the Institutes of Joining and Welding Research of Osaka University (laser material processing), Toyota Motor Corp., Denso Corp., Yamazaki Mazak, and Mitsubishi Electric Corp. (Details on these will be provided in a future ASL.)

AHPLA'99 featured renowned laser researchers and had a particularly strong AFRL presence. Several exciting plenary sessions were delivered by the field's founders, including Nobel Laureate Dr. C.H. Townes (University of CA, Berkeley) and William F. Krupke (Lawrence Livermore National Laboratory). Dr. William P. Latham (AFRL/DELC) was program committee member, chair of several sessions, and co-author of many submissions. Further, Dr. Arthur H. Guenther (University of NM and AFRL/AFOSR), Dr. Kip R. Kendrick (AFRL/DELC), and Major William T. Cooley (AFRL/DELS) chaired and presented.

Laser processing of materials is highly versatile because of its controlled functionality. Lasers with short pulse and short wavelength beams enable precision microfabrication of electronics, optoelectronics, and medical devices. In manufacturing and microstructuring, novel applications of pulsed lasers included the ablation and deposition of many materials for microelectronic thin films and laser-shock processing for the tempering of surfaces. In manufacturing output powers of 2.2 kW and power densities of 200kW/cm^2 were reported, with material processing speeds of 1m/min.

Highlights included:

- Dr. Yamanaka of the Institutes of Laser Engineering at Osaka University reviewed the progress and barriers to achieving laser fusion at his plenary session. The institute has achieved a focused irradiance exceeding 10^{21} W/cm^2.
- Hoya Corporation reported a novel high-power laser (10.8 W) with embedded tube and disk fiber configuration.
- Tokai University reported development of a prototype COIL laser system based on high-pressure subsonic modes. Combined with a novel resonator, the new system attains continuous 2-hr operation under 1kW output power and 23% efficiency.
- Hamamatsu Photonics demonstrated high-power 2D laser diode arrays, successfully made by the 'Funryu heat sink" method of low thermal resistance.

Also key at AHPLA'99 was the thermal management of gradients that lead to birefringence, bifocusing, and fracture. Parasitics remain a problem for storing and

switching power. Given the innovating breakthroughs, of semiconductor wafer based processing (such as MOCVD crystal growth technology) which led to the diode-pumped solid-state laser (DPSSL), diode prices have decreased steadily. With the DPSSL's excellent beam quality, compactness, high power and brightness, it is currently the economic engine in laser technology. And with $1/Watt projected by 2005, the era of large-scale deployment has begun. (Maurice & Miyazaki)

Conference: 6th International Workshop on Femtosecond Technology (FST'99), Chiba, Japan; 13-15 July 1999:

For 500 researchers interested in fast phenomena, the 6th FST met this summer at the Nippon Convention Center. Co-located with InterOpto'99 (the largest mercantile exhibition of its kind in Asia) and the MOC'99 & ICPOF conferences (see ASL 22), the FST Workshop is sponsored by several Japanese national laboratories and academic societies. In sponsorship, organization and participation, the Workshop is closely associated with Japan's national research program in Femtosecond Technology. International participation is quite large with 45% of its contributions coming from Europe and the US.

The scope of FST'99 was
(1) ultrafast electronics & optoelectronics,
(2) femtosecond pulse generation, measurement, and THz radiation,
(3) ultrafast phenomena & material science, and
(4) nano and photonic structures for femtosecond devices.

A recent revolution (last 10 years) in ultrashort pulse lasers has made very compact laser sources of short, intense pulses, of durations less than 10 fs and fast repetition rates possible. The advances are having an impact on industrial applications in telecommunication and measurement systems and in the development of novel materials for ultrafast functions. These diverse applications range from electronics and materials science to precision surgery and material processing (e.g., thin-film deposition). They include imaging, scanning, coherency control in terabit-per-second transmission technologies (e.g, telecom), and the generation and detection of electrical currents. In each case, light from femtosecond technology is used as the measuring stick! For example:

- University of Tsukuba reports the formation and coherent control of optical phonons in graphite -- a standard material in solid-state physics -- and thus, *control* of crystalline *lattice dynamics* in a solid-state system. This has vast industrial applications.
- The Femtosecond Technology Research Association (FESTA) and Hitachi report successful femtosecond-pulse generation from laser diodes and 4-fold pulse compression by way of simple semiconductor (InGaAsP/InP-based) waveguide structures. In nonlinear (soliton-based) telecom-compatible fiber lasers for fiber-optic integrated components.
- Osaka University reports THz radiation from superconducting thin films (80 nm). The films are first prepared using pulsed laser deposition, then patterned into antenna structures using standard techniques, and finally, femtosecond 800 nm wavelength laser pulses are used to excite and detect the radiation. THz pulses in imaging have become a tool in neuroscience and cellular biology, where latency (delay-time measurement), plays as a time-resolved imaging technology, offering an interesting, perhaps, co-alternatives to spatial-resolution methods.

Finally, so far as convenient generation of such pulses, Professor Joe Haus (an AFRL-sponsored researcher at University of Dayton, formerly of RPI) in a standing-room-only invited talk described the propagation of ultrashort light pulses in photonic crystals - "photonic bandgap," structures, easily fabricated of layered dielectrics. (Maurice)

Conference: 1999 International Conference on Solid State Devices and Materials (SSDM'99) Tokyo, Japan; 21-24 September 1999:

Now in its 31st year SSDM, an annual conference sponsored by the Japan Society of Applied Physics, had 700 researchers participate this fall in Tokyo. Besides Japanese and European participation in SSDM'99, there was also a large Taiwanese and Korean presence, especially in sessions related to Si materials processes, process integration, and memories. This year's SSDM had a distinctly wide coverage of rapid progresses in the mutually connected technology fields of fabrication, characterization, and materials technologies for solid-state integrated circuit (IC) devices and process technologies. Research was reported in parallel sessions that covered:

- Group-III nitride devices and materials.
- Photonic crystals and devices.
- New materials and characterization.
- Advanced silicon devices and modeling, circuits and systems.
- Silicon process materials technologies for devices and integration.
- Quantum computing and single-electron devices.
- Quantum dots and other nanostructures and devices.
- Non-volatile memories.
- Semiconductor lasers for telecommunications.
- Compound semiconductors materials and device processes.

- High-speed/high frequency Ics.
- Low-power circuits and devices.
- Photonic devices, integration, and packaging.
- System-level packaging technologies.

Rump session topics were photonic integration and sub-0.1 micron metal-oxide-semiconductor field-effect-transistors (MOSFETs) and the role of new gate dielectrics.

Notable papers in the GaN sessions were: 1) NEC's Optoelectronics and High Frequency Device Research Labs reported successful fabrication of the first high-gain AlGaN/GaN heterojunction field-effect-transistor (HJFET) with an air-bridge interconnection. The reduced parasitics allowed by the bridge (air has an extremely low capacitance!) make it perfect for high-frequency, high-power microwave application. It operates with a high, stable power gain and 60% efficiency. (The best efficiencies in the US for such devices are about 40%.) NEC fabricates the device on a sapphire substrate. 2) Though sapphire substrates are widely used by the GaN community, the large sapphire-to-GaN lattice mismatch incurred is problematic. GaN substrates are thus urgently sought. To this end, Japan Energy Corporation's Central R&D Lab (Dr. Osamu Oda), world premier in bulk crystal technologies, reported two successful methods.

In the first, GaN nodule-like wafers are grown from side facets of a cleaved $NdGaO_3$ substrate, which quasi-lattice matches the GaN, and simply peeled off during cooling. The free-standing, 2-inch diameter, 50-300 micron thick wafers grown by this method resemble fungi along a bulk $NdGaO_3$ substrate "tree trunk". Further scaling up in size is possible given increased size of the $NdGaO_3$ substrate. In another paper, bulk GaN is obtained by modified application of the conventional high-pressure solution crystal growth (SG) method. In the method the group developed, a pressure-controlled Ga solution is held at constant temperature, overcoming the usual SG-method problems of supercooling, decreased growth rates, and unused solvent (in this method, more of the Ga solvent is converted to crystals). 3) Dr. Shuji Nakamura, in an invited talk packed with participants, described the latest super bright nitride-based laser diode (LD) from Nichia. The InGaN violet-emitting (420 nm) LD is fabricated on a lateral-epitaxial-overgrown (LEO) GaN metal-organic-chemical-vapor-deposition (MOCVD)-grown substrate and operates at ambient temperatures, under a mere 4-6 volts, with continuous output power of 30 mW for 10,000 hours. Full papers will be available in a special (green) volume of the Japan Journal of Applied Physics (JJAP) in March 2000. (Maurice)

Conference: 3rd Symposium on Photon Processing and Measurement Technologies, Tokyo, Japan; 8 Nov 99:
The "Advanced Photon Processing and Measurement Technologies" national project was started in 1997 as part of the frame work of the Industrial Science and Technology Frontier Program of Ministry of Industrial Trade and Industry (MITI). In this project, 13 private companies, 1 university, and 4 national research institutes are developing three technology fields; Photon Beam Generation, Photon-Applied Processing and Photon-Applied Measurement Technology. The symposium covered this year's results for all the themes from the members of R&D Institute for Photonics Engineering (RIPE).

- In the *"High-Power All-solid-state Laser Technology"*, RIPE is developing two kinds of high-power lasers using both rod type and slab type laser oscillation media of Nd:YAG crystals. The rod type laser achieved 3.3 kW output continuously by arranging 4 pumping modules in series. An efficiency of 19 % has been achieved with a 1 kW class resonator using a pumping module. The slab type also achieved an average power of 3.3 kW (peak power of 13 kW) and an efficiency of 13%.
- In the *"tightly-focusing all-solid-state laser technology"*, the structure type fiber laser has achieved an output power of 10 W for the first time ever in the world. As for the high-brightness and high-repetition rate UV all-solid-state laser with $CsLiB_6O_{10}$ (CLBO) crystal, a new diode pumping configuration achieved high efficiency and uniform pumping distribution. This Nd:YAG laser showed an output power of 270 W and an electrical-optical conversion efficiency of 18.4 %. In addition, a UV laser output (Fourth Harmonic Generation: 266 nm) of 20 W was obtained by using CLBO crystals. Welding tests were conducted using a Chemical Oxygen-Iodine Laser (COIL laser). High quality and full penetrative welding of a 10 mm thick stainless steel plate in nitrogen gas atmosphere was achieved. The welding rate was above 1.2 m/min. Other research themes of the projects were also progressing according to the original plans. For info contact: http://www.photon.mstc.or.jp). (Miyazaki)

Liaison Report Abstract: Laser radar and atmospheric turbulence research in Japan:
Laser radar, known as Lidar, is a very useful method to detect trace gas contamination, global concentration of ozone, ocean wind vectors and global atmospheric concentration of aerosol. Japan is now making an effort to play a key role in establishing a global earth observation system in collaboration with other countries. The report summarizes present Japanese progress in this field. (Miyazaki)

Conference: International Symposium on the Electron and Electromagnetic Field in the Nanometer-scale Structures, Tsukuba, 27 Oct 1999:
The National Research Institute for Metals has conducted research activities on interactions between electrons in nanometer-scale localized fields and electromagnetic fields. The objectives are to study novel quantum mechanical effects (especially photon emission phenomena induced by tunneling electron) and transport mechanisms. These phenomena have been considered to be developed by interaction between local electro-magnetic fields and complex nanometer-scale molecular structure.

The Kansai Advanced Research Center of Communication Research Laboratory has done research on molecular harmonic structure formed by molecular ensemble. In realizing nanometer-scale molecular devices, molecules with different characteristics are synthesized like building blocks and transformed to a hyper-functional molecular structure which is called a molecular ensemble. The main research programs are in the design and synthesis of these molecular structures. In 1999, these two activities were merged and a new corporative experimental facility was set up. The laboratory (Super-Molecular Photonics Joint Research Laboratories) will conduct research work on multidimensional photonic statistical analysis through 2005. A new measurement technique of a single photon and a single tunnel electron will be developed for investigating energy relaxation dynamics of a single molecule and molecular clusters. The result will be applied to functional devices composed of a novel molecular cluster.

The 1st conference was held to clarify the fundamental research approach of the new laboratory and organization, inviting well-known scientists throughout the world and having lectures on recent notable scientific research topics and future perspective. Dr. L. Esaki (Nobel Prize Laureate) was the chairman of the organizing committee. Contents of the conference included (Japanese proceedings only);

(1) Modern alchemy by L. Esaki, Director of the Society for the Promotion of Science and Technology in Ibaraki.
(2) Control of electrons using semiconductor nano-structure and its application to novel functionality by H. Sakaki, Univ. of Tokyo.
(3) Progress of 10 year study of a single molecule using optical spectroscopy by M. Orrit, CNRS et Universite Bordeaux.
(4) Challenge of a single molecule to science by J. Gimzewski, IBM Lab. Zurich.
(5) Interaction of photons with material at nanometer-scale by H.Hori, Yamanashi Univ.
(6) Quantum entanglement in a mesoscopic device by Y. Yamamoto, Stanford Univ.
(7) Multifunctinal optical microscope with nanometer resolution by A. Lewis, Hebrew Univ.
(8) STM image of adsorbed fullerene and its tunnel spectroscopy by J. Hou, Univ. of S&T in China.
(9) Microfabrication by nanotechnology and scanning probe microscope by F. Ohnesorge, GSI, Germany.

An International meeting will be held next year based on results of the projects. (Miyazaki)

Human Systems

Conference: 1st Japan-Korea-EU Workshop on EMF Human Hazard Issue, Tokyo, Japan; 26 Oct 1999:
Hosted by the Japan Ministry of Posts and Telecommunications, (MPT) this is the third annual meeting of Japanese and Korean EMF biological effects experts. This Korea-Japan collaboration followed a bilateral ministerial meeting in 1996. Subsequent meetings were held in Tokyo, 1997, and Seoul, 1998. For this 3rd meeting European Union (EU) experts were also invited making this the first Japan-Korea-EU Workshop on EMF Human Hazard Issues.

The Opening Address from Japan was given by Professor Shoogo Ueno University of Tokyo, Department of Biomedical Engineering, Graduate School of Medicine, and Chairman of the Japanese Committee responsible for RFR/EMF Guidelines in Japan. Active research in Japan is ongoing in government laboratories (MPT Communications Research Laboratory), in industry laboratories (NTT), and at many academic institutions. Current possible concerns outlined by Dr. Ueno included effects on the blood brain barrier, CNS effects, and carcinogenesis. Professor Masao Taki of Tokyo Metropolitan University, member of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Japanese Committee responsible for RFR/EMF Guidelines in Japan (recent WOS visitor to AFRL/HEDR) summarized Japanese research efforts including studies on dosimetry, carcinogenesis, blood brain barrier permeability, neurological effects, and genetic effects. Dr. Taki also presented recent work in his laboratory on the microwave auditory effect.
Dr. Nak Sam Chung, President Emeritus of the Korea Electromagnetic Engineering Society (KESS) gave the Opening Address from Korea. A new but growing research area in Korea, the KESS Study Group was formed in 1996 and drafted Human Exposure Guidelines

in 1999. Other Korean scientific presentations from Chungbuk University and from the Radio Research Laboratory of the Ministry of Information and Communication included a study of specific absorption rates (SARs) in the head and the development of a new millimeter resolution model of the Korean human head. Mr. Hiroshi Asami, Director of the Electromagnetic Environment Division of MPT concluded that although no definite hazards have been confirmed, there is need for further studies as well as ongoing international collaboration. (Lyons)

Final Report: Bioassay for Effects of Radiofrequency Radiation, Dr. Stanley Barnett, CSIRO, Telecommunications and Industrial Physics Division Lindfield, NSW, Australia:
Dr. Barnett, Prof. John Lett, (Colorado State University) and Dr. Ann Cox (AFRL/HECP) completed their final report for their AOARD sponsored research project on the "Comet" bioassay. The project examined the suitability of a synchronized radio-sensitive leukemic cell line as a sensitive indicator of biological effects at the DNA level and its suitability as a biologic test model/indicator of DNA damage caused by non-ionizing radiation. They were able to confirm the cell synchrony technique utilizing the Beckman Elutriator System to obtain G1 phase populations of the radiosensitive L5178Y S/S murine lymphoma cell line. Dr. Barnett discovered some subtle problems with the single-cell gel electrophoresis ("comet") assay. Application of the "comet" assay to single-strand DNA breaks resulted in inconsistencies which raised questions concerning technique-dependent artifacts and the limitations of this commonly used assay. This international collaborative project and the effective international scientific partnership that developed laid the essential groundwork for a continuing research program. The ultimate goal is to develop and characterize a sensitive bioassay for the purpose of subsequent research into the effects of various physical stressors. (POC: Dr. Ann Cox AFRL/HECP). (Lyons)

Site Visit: Hokkaido Institute of Technology, Sapporo, Japan; 7 October 1999, Dr. Koichi Shimizu, Professor Hokkaido University and Dr. Hisae Shimizu, Research Associate, Hokkaido Institute of Technology:
A variety of research efforts are underway in this laboratory to study the biological effects of ELF electric fields. Human perception thresholds of ELF electric fields, both local exposure and whole body, have been extensively studied. Human perception is largely based on the sensation of hair movement. Methods have been developed to obtain EEG recordings even in the presence of strong 50-60 Hz fields. Effects on alertness and the autonomic nervous system are also being studied. Measurements to date suggest an increase in vigilance of human subjects exposed to ELF electric fields is warrented. Animal experiments are also being conducted to differentiate the effects of magnetic effects and electric fields. Applications in bacteriology are being studied including bactericidal effects, effects on bacterial growth, cell adhesion, the release of interferon. Biological effects of ELF fields may include possibly beneficial effects such as effects on sleep/alertness and bactericidal properties. (Lyons)

Site Visit: Mega-Float, Yokosuka Shipyard (Sumitomo Heavy Industries Co.), Yokosuka, Japan; 15 Oct 1999:
Very Large Floating Structure research also known as Mega-Float is currently being conducted offshore in Eastern Japan (Tokyo Bay). Japan, having limited land resources has already utilized about 50% of shallow seawater areas. To alleviate the land problem, the Japanese government (Ministry of Transport) in 1995, funded a research project to develop a mega-floating marine structure capable of withstanding hurricane force wind or earthquake. This project involves seventeen different Japanese shipbuilders and steel companies to build a 1,000 meter (length) by 60 meter (width) experimental platform designed to last over 100 years at any sea depth. Applications for which Mega-Float is being considered include offshore airports, power plant, and leisure-facilities.

Phase I was successfully completed (1995-1997) and tested several technological challenges such as at-sea joining technology, anti-corrosion technology, and impact on the ocean environment. To assess the technology, nine separate model units (100 m x 20 m) were manufactured and joined (welded) to form a floating platform of 300 meters in length at a cost of ~$75 million. In this phase, it was verified that the mega-floating structures can be easily constructed in a short time and can be easily moved to different locations when required.

In Phase II of the project (1998-2000), the Phase I model platform was extended to 1,000 meters in length. The goal of this phase is to construct an "airport" facility able to handle medium-size airplanes. The floating structure uses a mooring system that doesn't obstruct the takeoff/landing of aircraft and provides stability against wakes and vibrations. This pontoon-like structure's middle section can accommodate sleeping quarters and storage areas. The construction and research budget for Phase II, which also includes a control tower and approach lighting system, is expected to be about $100 million. This kind of platform could be used as an offshore military air base. Like an aircraft carrier it could move close to a conflict area to handle military logistics and is big enough to handle the C-5 transport aircraft. (Kim)

Upcoming Conferences In Asia

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Date	Name	Place
Feb 22-27, 00	Asian Aerospace 2000	Singapore
Mar 13-17, 00	**An Introduction to Using Anthropometry for Effective Solutions**	**Sarawak, Malaysia**
Mar 22-26, 00	Tokyo Aerospace 2000	Tokyo, Japan
Mar 27-30, 00	International Conference on Physiological and Cognitive Performance in Extreme Environments	Canberra, Australia
Mar 27-31, 00	12th International Conference on Ternary & Multinary Compounds (ICTMC-12)	Taiwan
Apr 12-13, 00	Photomask Japan 2000	Yokohama, Japan
May 7-12, 00	USARPAC Asia-Pacific Military Medicine Conference X (APMMC X)	Singapore
May 14-17, 00	The Fourth International Conference/Exhibition on High Performance Computing in Asia-Pacific Region (HPC-Asia 2000)	Beijing, China
May 22-25, 00	Fourth International Commission on Non-ionizing Radiation Protection (ICNIRP) workshop	Kyoto, Japan
May 23-26, 00	Advanced Underwater Technologies for the 21st Century	Tokyo, Japan
May 22-25, 00	Fourth International Commission on Non-ionizing Radiation Protection (ICNIRP) workshop	Kyoto, Japan
May 23-26, 00	Advanced Underwater Technologies for the 21st Century	Tokyo, Japan
May 30-Jun 15, 00	International Conference on Role of Mesomechanics for Development of S&T Mini-Symposia on Use of Intelligent Material Computational Mechanics Composite Technologies	Xi'an, Beijing, Dalian, Shanghai, China
Jun 5-9, 00	The 10th International Conference on Metal Organic Vapor Phase Epitaxy (ICMOVPE-X)	Hokkaido, Japan
Jul 2-6 00	**9th US-Japan Conference on Composite Materials**	**Shizuoka, Japan**
Jul 9-14, 00	**22nd International Symposium on Rarefied Gas Dynamics (RGD22)**	**Sydney, Australia**
Jul 11-13, 00	2000 International Microprocesses & Nanotechnology Conference	Tokyo, Japan
Jul 11-14, 00	Fifth Optoelectronics and Communications Conference	Chiba, Japan
Jul 12-14, 00	The International Workshop on Activematrix Liquid-Crystal Displays-TFT Technologies & Related Materials	Tokyo, Japan
Jul 26-28, 00	**Photonic Taiwan 2000**	**Taipei, Taiwan**
Aug 6-11, 00	7th International Symposium on Polymer Electrolytes (ISPE7)	Queensland, Australia
Aug 16-18, 00	**4th International Conference on Fracture and Strength of Solids**	**Pohang, Korea**
Aug 18-20, 00	**2nd Asian-Australasian Conference on Composite Materials (ACCM-2000)**	**Kyongju, Korea**
Aug 20-23, 00	**Topical Workshop in Heterostructure Materials (TWHM'00)**	**Japan**
Aug 24, 00	**3rd Composite Durability Workshop (CDW 2000)**	**Kanazawa, Japan**
Aug 27-Sep 1, 00	26th International Congress on Occupational Health	Singapore
Sep 10-15, 00	The 11th International Conference on Molecular Beam Epitaxy	Beijing, China
Sep 13-15, 00	The International Conference on the Physics and Application of Spin-Related Phenomena in Semiconductors	Sendai, Japan
Sep 17-22, 00	25th International Conference on the Physics of Semiconductors (ICPS25)	Osaka, Japan
Sep 24-27, 00	The 9th International Conference on Shallow-Level Centers in Semiconductors	Hyogo, Japan
Sep 24-27, 00	International Workshop on Nitride Semiconductors	Nagoya, Japan
Sep 24-28, 00	The 9th International Conference on High Pressure Semiconductor Physics	Hokkaido, Japan
Sep 25-29, 00	The 14th Int'l Conference on High Magnetic Fields in Semiconductor Physics	Shimane, Japan
Sep 27-29, 00	9th International Symposium on Semiconductor Manufacturing (ISSM2000)	Tokyo, Japan
Nov 14-18, 00	**7th Int'l Conference on Neural Information Processing (ICONIP 2000)**	**Taejon, Korea**
Nov 19-23, 00	**International Conference on Communication Systems (ICCS'00)**	**Singapore**
Nov 20-23, 00	3rd International Hydrology and Water Resources Symposium	Perth, Australia
	Continued	

Nov 28-1 Dec, 00	**4th Asia Pacific Conference on Computer Human Interaction (APCHI)** **6th S.E. Asian Ergonomics Society Conference (ASEAN Ergonomics)**	**Singapore**
Nov 29-1 Dec, 00	2nd International Conference on Experimental Mechanics	Singapore
May 14-18, 01	**Indium Phosphide and Related Materials, 2001 (IPRM'01)**	**Nara, Japan**
June, 01	**International Light Materials Conference (LiMat 2001)**	**Pusan, Korea**
Jul 7-11, 03	**5th International Congress on Industrial and Applied Mathematics**	**Sydney, Australia**

Upcoming Window-on-Science Visitors

Contact us for more details if you are interested in the following WOS visitors.

Dates	Visitor Name	Affiliation and Country	Topic	Visit Location
15 Feb 00	Dr. Koo-Hyoung Lee	LGE Corporate Design Center, South Korea	Human Centered Technology and Human Sensibility. LG Electronic Corporate Design Center	AFRL/HE (WPAFB)
17 Mar 00	Prof. Soon-Hyun Hong	Korea Institute of Advanced S&T (KAIST)	Functional Graded Material Develop	AFRL/ MNMW
17 Mar 00	Prof. Sung-Hak Lee	Pohang Univ. of S&T, Korea	Deform Behavior of Intermetallics	AFRL/MNMW
9-10 Mar (TBD)	Prof. Jun-Ichi Koike	Tohoku University, Japan	Develop of 62222 Titanium Alloy	AFRL/MLLM
24-28 Apr 00	Dr. Yuriko Aoki	Hiroshima Univ, Japan	Multiscale Modeling of Organic Materials	AFRL/MLBP
24-28 Apr 00	Dr. Koji Tashiro	Osaka Univ	Multiscale Modeling of Organic Materials	AFRL/MLBP
15-19 May (TBD)	Prof. Hiroshi Hatta	Institute of Space and Astro Sciences, Japan	High Temp Oxidation Behavior of SiC-coated carbon	AFRL/MLLM
22-24 May	Prof. Kigook Song	Kyung Hee Univ., Korea	Development of Liquid Crystal Polymers	AFRL/MLBP
3o May 00	Prof. Yusuke Kawakami	Japan Advanced Institute of S&T	Synthesis and characterization of new organosilicon polymers	AFRL/MLBP
10-13 Aug	Prof. Wan Soo Huh	Soonsil University, Korea	Develop of Polycrystalline Materials	AFRL/MLBP
20-23 Aug 00	Prof. Greg Walker	Univ. of Tasmania, Australia	Boundary Layer Transition and Unsteady Aspects of Turbonachinery Flows	WOS in conjunction with Conference at Syracuse Univ, NY

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