MMC

2004 8

MICROMACHINE

MMC Activities

Activities of the Micromachine Center in Fiscal 2003

I. Investigation and Research on Micromachines

Research activities were aimed at gaining a clear understanding of the trends in micromachine technologies and industries and conducting investigations of and research on new technological issues regarding the fusion of micro- and nanotechnologies, as well as making adjustments appropriate for the multidirectional expansion of micromachine technology.

1. Microanalysis/production system project (recommissioned by New Energy and Industrial Technology Development Organization [NEDO])

A mostly "*Namazu*" full-text search system was completed in accordance with the specification, and data was input. In addition, investigations into technological trends in microchemical devices were conducted at "Transducers'03" in June and "MEMS 2004" in January.

2. Studies on the future prospects of micromachine technology.

The long-term vision subcommittee (chairman: Prof. Isao Shimoyama, Graduate School, the University of Tokyo) met three times, and decided on the orientation of book content.

3. Studies on R & D trends for micromachine technology in Japan and abroad

Subcommittee of trends in R&D for micromachine technology in Japan and abroad (chairman: Prof. Shuichi Shoji, Waseda University)met three times, and conducted exploratory analysis of the latest situation regarding the rapid expansion, both domestically and internationally, of micromachine technology and research trends; and of basic technological data that contributes to the advancement of micromachine technology; and compiled the results of investigations on technological trends into the 2003 report of investigation into trends by category.

4. Studies on the micromachine market

The 2002 investigation into the domestic market scale for micromachine technology put forward preparations for the compilation of relevant statistical data, etc.

5. Development of new functional materials for MEMS (commissioned by the Japan Machinery Federation)

Recommendations were made for the promotion of the development of new functional materials for MEMS, and compiled into a report. Recommendations included exchange between researchers from different fields, a top-down and bottom-up fusion area approach, and the necessity of meeting the needs of society.

6. Investigative research into the current state of the MEMS related market and an analysis of Japan's competitive power (commissioned by Japan Industrial Policy Research Institute)

With a view to building up an economically consistent database of micromachine-related market statistics, and investigating the current state of MEMS development and strategy in the U.S., as well as making recommendations in order to maintain and improve Japan's competitive power, an investigative research committee to study the current state of the MEMS related market and to conduct an analysis of Japan's competitive power; a subcommittee to consider issues related to the creation of a market-estimation system (chairman: Prof. Isao Shimoyama, Graduate School, the University of Tokyo) met and compiled a report of their findings of this fiscal year.

7. Joint survey research activities concerning the industrialization of MEMS

Foundry manufacturer Olympus Corporation, Omron Corporation, and Matsushita Electric Works, Ltd. took part in the business activity promotion committee (chairman: Ryo Ohta, Olympus Corporation), which carried out joint survey research into identifying issues that needed to be addressed in order to facilitate the early industrialization of MEMS, together with measures to achieve this goal. This fiscal year in Japan public hearings were held in MEMS related universities and national research institutions, MEMS foundries, MEMS users, and venture companies, and fact-finding was carried out in the U.S. and in Europe.

II. Collection and Provision of Micromachine Information

Information and documents on micromachines in universities, industries, and public organizations both in Japan and overseas have been collected and combined with survey results compiled and documents produced by MMC, and made freely available in the MMC library.

1. Maintenance and expansion of the MMC library

Information and documents such as periodicals and books on micromachines in universities, industries, and public organizations both in Japan and overseas have been collected and combined with survey results compiled and documents produced by MMC and made available in the MMC library. (49 books collected in FY 2003, making a total of 1,037 books as of March 31.)

2. Publication of a micromachine periodical ("*Micromachine Index*")

The above-mentioned collected documents were made freely available in the MMC library for perusal by interested parties. Moreover, a micromachine periodical entitled Micromachine Index gathering together abstracts of important documents was published and distributed to interested parties, as well as being incorporated into the database. (FY 2003: Nos. 84-91 issued [8 volumes])

3. Publication of a newsletter

Information concerning research and governmental trends related to micromachines was distributed monthly to supporting members. This was posted on the Internet homepage for the first time from January, resulting in a substantially higher hit count.

MICROMACHINE CENTER
Internet Home Page : http://www.mmc.or.jp/

No.48

4. Database construction and data management system operations

Along with revisions of its Internet homepage, a new page for supporting members was opened, and the content of the database was transferred.

III. Exchange and Cooperation with Worldwide Organizations Involved with Micromachines

To promote affiliation, exchange and cooperation with related organizations in and outside Japan, MMC involved itself in such activities as participating in the Micromachine Summit, holding international symposiums, inviting to Japan and sending overseas researchers and experts in the field.

1. Participation in the 9th Micromachine Summit

The 9th Micromachine Summit was to have been held for three days from April 28-30, but was cancelled due to the spread of SARS to Beijing.

2. Held the 9th International Micromachine/Nanotech Symposium

The 9th International Micromachine/Nanotech Symposium was held on November 13 at the Science Museum in Kitanomaru Park, Tokyo, with the aim of promoting micromachine technology and educating a wider public audience. The event was well attended, with a total of 297 participants including speakers and media representatives.

3. International exchange and dispatch of researchers

For four days from June 9 to 12, 2003, Etsuro Shimizu, manager of the Research Department attended "Transducers'04" held in Boston, U.S.A., where he carried out an investigation into trends. For five days from July 7 to 11, 2003, Takayuki Hirano, Executive Director, and Yoichi Toguchi, manager of the Research Department made official trips to Switzerland, France, and the U.K. to carry out surveys into research institutions, foundry companies, design houses, and marketing companies in Europe. For 5 days from January 25 to 29, 2004, Yoichi Toguchi, manager of the Research Department attended "MEMS 2004" held in Maastricht, the Netherlands, where he carried out an investigation into trends.

4. Constructing a foundry network system

In order to further the industrialization of micromachines, particularly MEMS, MMC organized the foundry service industry committee (chairman: Takashi Mihara, Senior Researcher, Olympus Corporation) six times to organize businesses providing foundry services, to set up a network system to improve services and to consider ways such a system could be developed. As a means of disseminating information, the MMC also upgraded its own Internet homepage and held two MEMS lectures.

5. Establishing a forum for the exchange of micromachine technology

A demand study in respect of the themes of forums for exchange was carried out, and a forum for the exchange of cutting-edge micro-nano technology was held for supporting members.

IV. Standardization of Micromachines

In micromachine technology and other newly established fields of systemized techniques as well, there is an urgent need for the standardization of terminology, measurement, and evaluation methods. The MMC worked toward this, taking international initiatives into perspective.

1. Standardization of fatigue testing methods for micro-nano materials (commissioned by Ministry of Economy, Trade and Industry)

In order to achieve this goal, a committee for the promotion of standardization was formed in 2003, which conducted a comprehensive investigation into investigation into trends in technological development in Japan and overseas, and the formulation of recommendations and guiding principles, appropriate areas for standardization, requisite conditions, and so forth. In addition, an investigative research committee was formed, which carried out improvements and optimization of strain measurement methods and test specimen equipment methods, for the standardization of fatigue testing.

2. Standardization of tensile testing methods for thin film materials

Japanese standard proposals in respect of tensile testing for thin film materials and test specimens were collected together, and a NP (New Project) proposal was submitted to IEC/TC47/WG4 based on the results.

3. Support for standardization of IEC terminology

In respect of the terminology approved as CD (Committee Draft) proposals by IEC/TC47, the terminology subcommittee met and carried out the task of adding terminology as well as handling comments for the CDV (Committee Draft for Vote).

4. Investigation and research on micromachine standardization

The results of this research have been transmitted worldwide, encouraging international standardization while exercising initiative in establishing international standards. This fiscal year, the standardization committee met three times. (chairman: Prof. Emeritus Hiroyoshi Sato, the University of Tokyo). Activities were consolidated in respect of "standardization regarding fatigue testing for micro-nano materials" scheduled for implementation for 3 years from 2003. International standardization activities regarding IEC terminology presented the CDV in March, 2004, and subsequently supported this international proposal activity. As for the standardization of material properties, a test specimen NP and a tensile testing method NP proposals were submitted to IEC, and were recommended to the CD stage. In addition, activities for JIS were carried out.

V. Dissemination and Education about Micromachines

By issuing and distributing quarterly magazines and by holding exhibitions, we intended to disseminate information on micromachines extensively in order to educate as many people as possible.

1. Publication of public relations quarterly magazine "*MICROMACHINE*"

Vols. 43 to 46 were published in Japanese only. English versions are available on the MMC website: http://www.mmc.or.jp/

2. The 14th Micromachine Exhibition

The 14th Micromachine Exhibition was held from November 12 to 14 at the Science Museum in Kitanomaru Park, Tokyo. 238 companies, organizations, etc. participated (the total number of booths was 323), and the total number of visitors was 8,793, making it the largest scale event to date.

3. Administration of the Federation of Micromachine Technology

Served as secretariat for the Federation of Micromachine Technology to link and strengthen micromachine-related organizations.

4. Workshop presenting the results of grant recipient projects for the 9th Micromachine Technology Research Grants (FY 2001)

A Workshop presenting the results of grant recipient projects completed in March, 2003 was held on Friday, September 12, 2003, with 6 themes from applicants in FY 2000 and 3 themes from applicants in FY 2001, a total of 9 themes being presented.

Omron's MEMS Foundry Service

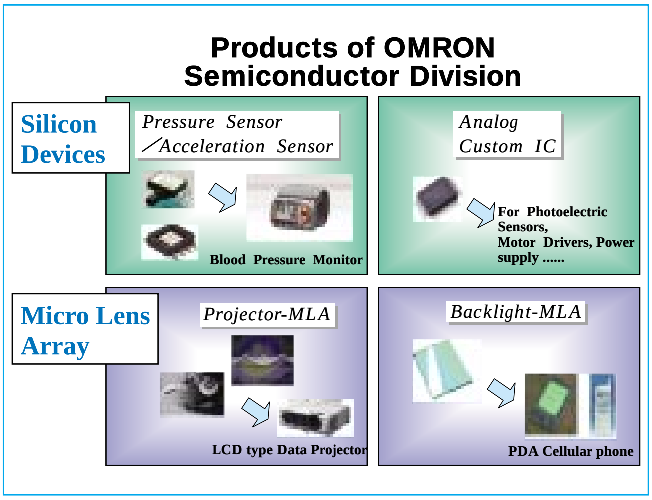
Masayuki Maeda
MEMS Division, Semiconductor Division H.Q.
Electronic Components Company
Omron Corporation

1. Outline

The Semiconductor Division and MEMS Division at the Omron Corporation ECB Company officially began a MEMS foundry service in 2001 due to the rising demand for the MEMS foundry. In 1988 Omron began producing bipolar ICs and in 1999 began MEMS research at the Central R&D Laboratory in Tsukuba, Ibaraki Prefecture. Through achievements made in this research, Omron began mass-producing ultrasmall capacitance-type pressure sensors and accelerometers at its Minakuchi factory in Shiga Prefecture in 1996. In 1998 Omron added a microlens array project that combines the use of semiconductor micromachining and electroforming, and has been mass-producing microlens arrays for LCD type data projectors and LCD backlights for cellular phones and PDAs. Omron has amassed a production of more than 18 million ultrasmall capacitance sensors and more than 50 million microlens-related devices.

In addition to the mass-produced products described above, Omron has undertaken the development of numerous MEMS devices when participating in the national Micromachine Project in the 1990s. These MEMS devices include optical scanners, micromachine relays (MMR) currently under development, 3-axis accelerometers, and flow sensors that are now being mass-produced.

With the increasing need for a MEMS foundry, Omron has been encouraged to develop such a foundry by many people seeking the participation of a manufacturer with mass-production experience. Accordingly, we have officially established a MEMS foundry that is founded on such strengths as our technological know-how, production experience, and infrastructure.



2. Features of Omron's foundry service

Processes provided by the foundry service focus on bulk micromachining techniques such as anodic bonding (including bonding in vacuum) and electrochemical etchstop (ECE) that are base technologies for mass-produced sensors. The foundry performs on commission such silicon processes as thin-film formation, wet and dry etching, impurity layer formation, and electrode formation; and such glass wafer processes as metal formation on special lines and etching. The foundry also accepts commissions for processes based on the microlens array technology, including an electroforming technique using substrates produced through semiconductor micromachining, and ultraprecision formation using photopolymerization (a curing method using ultraviolet rays). The electroforming foundry has garnered very high praise from the market for its production of substrates that can be formed in any shape by the foundry's unique methods and for electroforming in its clean room. The merging of electroforming or machining techniques with semiconductor fabricating techniques has expanded the possibilities not only in the field of sensors, but also for a variety of devices and structures, such as labs-on-a-chip and microneedles.

Omron accepts orders ranging from a small number of prototypes to mass-production and can delivery wafers or chips or only perform partial processing, depending on the user's wishes.

Procduction is carried out at our Minakuchi factory in Shiga Prefecture using production lines and a clean room for bipolar ICs and a clean room dedicated to MEMS. Another of our strengths lies in our foundry members, who have a wealth of experience from R&D to mass-production.

3. Conclusion

Last year we combined the two laboratories at Tsukuba City and Nagaokakyo City in Kyoto and established a new base for MEMS research in the Kyoto-Osaka-Nara area. At this base, we are also conducting research on RF switch manufacturing techniques in the "MEMS project" adopted by NEDO.

In addition to sophisticating more about the techniques accumulated thus far, we hope to introduce new technologies and continue to expand the foundry service.

For further details, refer to the URL:

http://www.omron.co.jp/ecb/products/sc/index.html

Column

Butterflies, MEMS, and Displays

Isao Shimoyama, Professor, Department of Mechano-Informatics,
Graduate School of Information Science and Technology, the University of Tokyo

It seems that printed materials and computer displays have become very colorful these days. In my school days and when I join the faculty, I remember that the computer displays were monochrome CRT monitors that displayed green text on a black background, and the more expensive displays depicted green graphics with electron beams. Then before I knew it, these monitors had been replaced by LCD monitors in high-resolution color. In the days leading up to this years Olympics, electronic shops in Akihabara and Shinjuku have been overflowing with large displays projecting beautiful pictures. I believe displays will further evolve toward three-dimensional stereoscopic images in more realistic colors.

It should be possible to produce devices with high added value using MEMS to implement functions expressed in nanoregions. While carbon nanotubes and quantum dots have attracted much attention as devices used on a nanoscale, light interference is a phenomenon that involves wavelengths of light, which are on the order of submicrons. Accordingly, we could call light interference a function manifested on a nanoscale. While carbon nanotubes and quantum dots have recently been created artificially, objects in which the phenomenon of light interference can be observed have existed in the natural world since long ago.

These photos taken by Eiji Iwase depict a Morpho butterfly and its scales. A Morpho butterfly does not produce colors through pigmentation in its wings. Rather, light is reflected and diffracted by minute three-dimensional structures in the surfaces of the scales and appears to our eyes as beautiful colors through light interference. The wavelengths of light that can be seen through interference depend on the surface structure. Hence, the colors can be changed by changing the structure of the surface. Changing microstructures of a surface is a specialty of MEMS to achieve an effect considerably different from the fixed light wavelengths produced from LED illumination and pigments.

Humans have photoreceptor cells corresponding to the RGB (red, green, and blue) colors. When light enters the human eye, these photoreceptor cells read wavelengths of the RGB components and see combinations of the component magnitudes as colors. However, the photoreceptor cells of insects are different from those of humans, possessing a sensitivity to light having wavelengths different from the RGB wavelengths. In other words, insects apparently receive different visual stimuli from that received by human photoreceptor cells when humans view nature. In previous discussions with researchers who observe the behavior of insects while shining lights on their visual systems, they asked me if it would be impossible to create an LCD panel that could be used to visually stimulate insects. Certainly our liquid crystal displays use only RGB components, which cannot stimulate photoreceptor cells sensitive to UV rays.

While LCD monitors depict colors by combining illumination and intensities of the three primary colors of light, the colors obtained from this display represent only a portion of the colors in nature. In other words, these representations are missing data for light of wavelengths other than the three primary colors and data of light spectrums dependent on the direction of light reflection. Therefore, while light produced by these displays appears somewhat natural to humans, it cannot be said to reproduce nature.

Enter MEMS. If MEMS can be used to freely adjust the spectrum of light rays emitted into space at each point of the display, it should be possible to reproduce sensations of light dependent on the positions of the light sources, objects, and the eye, such as a silver-like metallic luster. MEMS are also effective for incorporating light-emitting elements having wavelengths other than RGB in displays.

So how, specifically, can we implement these ideas? I heard that a mathematician once said, "I have proved it, but there is not enough space to write it down." In the same way, I would like to say that I have an idea, but there is not enough space in this paper to explain.

Photo 1 The Morpho butterfly

Photo 2 An enlarged view of the wing scales

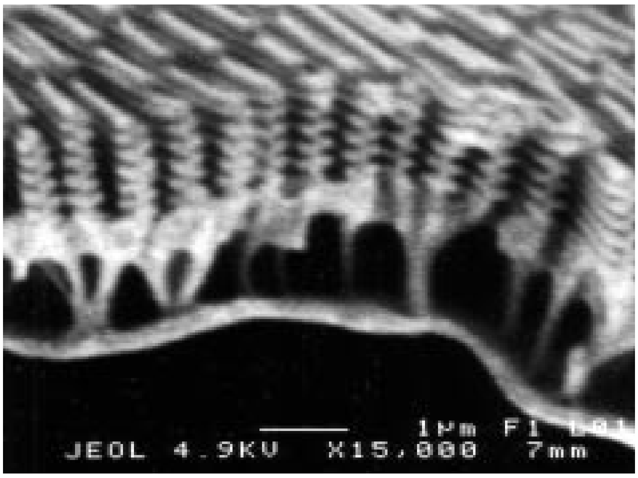


Photo 3 A cross-sectional view of the scales further enlarged; the microstructure of the scales produces beautiful colors through light reflection, diffraction, and interference

Overseas Trends

Hannover Messe (Germany), April 21 - 26

The Hannover Messe international trade fair for industrial technologies was held in Hannover of Lower Saxony, Germany April 19 - 24. This event simultaneously presents eight trade fairs, including (1) INTERKAMA (a leading international trade fair for process automation), (2) Factory Automation (a leading international trade fair for production automation), (3) Energy (a leading international trade fair for energy technology, renewable energy, and energy management), (4) Surface Technology plus Powder Coating Europe (a leading international trade fair for surface technology), (5) Subcontracting (a world trade fair on industrial parts and materials for vehicles, machinery, and plant assembly), (6) Digital Factory (a special trade fair for integrated processes and IT solutions), (7) MicroTechnology (a leading international trade fair for applied microsystems technology and nanotechnology), and (8) Research & Technology (an innovations market for research and technology).

Among these trade fairs, our investigations were focused on two related to the Micromachine Center: (7) MicroTechnology and (8) Research & Technology. The following is an outline of our findings and impressions based on this investigation.

1) A total of 5,040 exhibitors took part in the trade fairs. The country having the most exhibitors other than Germany was Italy with 218 companies, followed by China (People's Republic of China) with 190, Switzerland with 160, and Japan (including local subsidiaries) with 70. It was clear that China had an aggressive policy aimed at the European market.
2) Total visitors numbered about 180,000, with about 50,000 from overseas. About 40% (20,000) of the participants from overseas were from non-European countries. It was obvious that the Hannover fair had established its reputation as an international trade fair.
3) In Europe the giant of research and development was the Fraunhofer Institutes, while the giant of industry was Siemens. The presence of these companies overshadowed the others.
4) Exhibition planning on the part of the Eastern European countries due to the expansion of the EU economic sphere on April 1 was notable (particularly in the Research & Technology trade fair).
5) A total of 210 companies provided exhibits at the MicroTechnology trade fair. Among these, the network group IVAM (Germany) enjoys the participation of 40 related companies. In the open forum, presentation of the EMINENT project, a virtual network involving eight European countries has served as a reference for network development in Japan's MEMS industry. Incidentally, connections have been had with IVAN and American's MEMS Industry Group for initiating alliances in future project expansions at the Micromachine Center.
6) The Research & Technology trade fair enjoyed 420 exhibits in Life Sciences, Optics, Biotechnology, and other fields. For activating technology transfer, presentations by universities and research institutes were prepared for the open forum in an effort to gain the interest of the visitors. Another feature of this trade fair was the striking exhibits by Eastern European countries in the field of material processing. Some exhibits drew many families and women to this trade fair, even on weekdays, where the exhibitors used numerous gimmicks in their displays and descriptions to draw interest. Activities for popularizing and generating interest and expectations in science and technology seem to have become more commonplace.
7) Having met some of the exhibitors related to MEMS and nanotechnology, including those who have studied as exchange students in Japanese universities or participated in internships at Japanese companies, we sensed a remarkable advance in human exchange with Japan.
8) Our overall impression of the trade fairs was that both the exhibitors and the visitors believed strongly that everything begins with "communication and an exchange of information."

The Research & Technology trade fair makes science and technology accessible. Here, an exhibitor at the nanotechnology booth explains his exhibit to a visiting family.

The 10th Micromachine Summit

The 10th Micromachine Summit was held in Grenoble, France May 3-5. The Summit was co-sponsored by NEXUS, CEA Léti, MINATEC, and FEMTO-ST and was presided by Gaëtan Menozzi, the chairman of NEXUS.

This year, 108 people—the highest ever—participated from twenty-three countries and regions. A total of seven participants came from Japan, including four delegates and three observers. Of particular note was the participation of Israel, which is facing severe conditions in the international community, India, which is earning foreign capital in the software industry, and Poland and Romania who have become independent from the former Soviet Union and recently have begun participating in the EU. In addition, a professor from the University of Ho Chi Minh in Vietnam was present as an observer from France. Hence, research and development on micromachines and MEMS has now spread to these countries.

The objective of this Summit has been to provide an annual forum for the free exchange of ideas among people of high standing in the field regarding initiatives and the future outlook toward the policies, education, and industrialization of micromachines. The forum has become increasingly more highly regarded as the development of MEMS and MST advances toward industrialization. As an organizer of this international Micromachine Summit, Japan received high praise in Chairman Menozzi's opening speech.

The program for this year's Summit was configured of three sections, beginning with a reception on the first day to provide participants with a chance to meet one another, two days of conferences, and a technical tour on the final day providing a look at the achievements of development and companies involved in the field. In addition to the traditional country review, the two days of conferences on May 3 and 4 also included sessions on government policy, national programs, and infrastructures; education; industrial developments in micro- and nanotechnologies (MNT) and the future outlook of advanced research in MNT, and featured a total of fifty-six presentations.

This year's Summit revealed the following information.

(1) Most research projects are dependent on governmental budgets in general, and the prefix "nano" is more frequently being used with "micro." The term MST (microsystems technology) that has conventionally been used in the EU in particular is now being replaced with MNT (micro-nanotechnology).

(2) Although MEMS and MST products are now being developed, these developments are insufficient to generate a large market.

(3) Foundries have rebounded since the burst of the communication bubble, and business conditions have improved.

(4) Countries that were latecomers to the field have taken up research activities in such specialized fields as optics.

(5) There has been many activities aimed at putting together international networks, such as NEXUS based in Europe or MANCIF based in America, with the networks competing to attract new members. Limitations in development and commercialization with the traditional individual organizations have apparently led to an increase in membership in these networks.

(6) We are now seeing research conducted on sensors designed for social issues, such as the detection of SARS and soil contamination. Other participants introduced studies aimed at dream-like applications for the long term. Also, an EU project has initiated basic research involving infrastructure, including a study on precision combining the efforts of universities and research institutes in various countries.

The 11th Micromachine Summit will be held on May 2-4 in Dallas, Texas (America). Further, in a meeting of the Chief Delegates, it was determined that Beijing, China would host the 12th Summit in 2006.

The technical tour on May 5 included a visit to the wafer manufacturer SOITEC. SOITEC imports its silicon from Japan's Shin-Etsu Chemical Co., Ltd., fabricates silicon wafers, further modifies these wafers into SOI wafers according to its own patented "Smart Cut" process, and exports 80% of these wafers to America as IC materials. SOI wafers are employed by IBM for their high performance and low power consumption, and are also being marketed in Japan.

Nihon Unisys Excelutions, Ltd.

Toshiro Yamamoto
President

1. Research and Development on Software for Design and Analysis

The Nihon Unisys Group has been conducting research and development on CAD /CAM systems for more than thirty years and today is actively conducting development, support, and sales for CADCEUS, which has the NO1 market share in the metallic mold industry, and is supporting manufacture technology of Japan.

Our company is part of the Japan Unisys Group specializing in CAD/CAM solutions. We are performing positively product development and sale business, such as CADCEUS and DigiD.

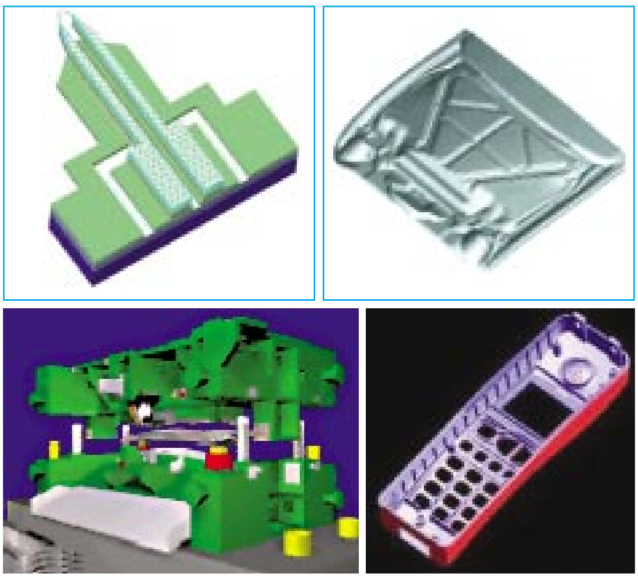
In recent years, we have witnessed rapid developments in MEMS parts design and manufacturing technology. MEMS product is increasing the range of applications, such as acceleration sensors for automobiles and inkjet print heads. This technology is expected to become a base technology supporting Japan's manufacturing industry in the 21st century.

In the design and manufacturing of normal-sized parts, simulation softwares play a major role in reducing cost of trial products, decreasing the delivery time, and improving precision. However, there is no inexpensive software that is simple and effective to use for supporting design and manufacturing in the field of MEMS products.

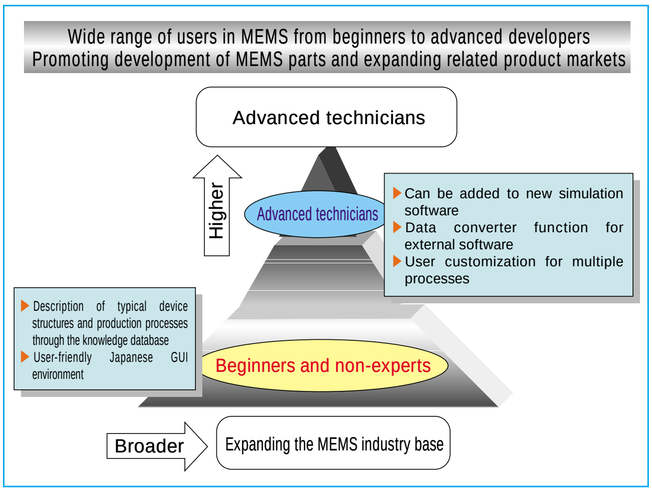
By using our knowledge and assets cultivated over the years in the development of CAD/CAM and CAE systems, we are going to work toward the development of design and analysis software for micromachines such as MEMS.

2. The present activity in MEMS and Micromachine Technology

As part of our endeavors, we will deal with software development entitled "Simulation Software for MEMS Design and Analysis", primarily in framework functions, which was offered publicly by NEDO and adopted in early June. This simulation software for MEMS design and analysis will be developed in close cooperation with the Micromachine Center, the Fuji Research Institute Corporation, AIST(National Institute of Advanced Industrial Science and Technology) and 10 universities. Compared to existing MEMS simulation software produced overseas, our system will possess features, including (1) low price, (2) being used effectively by beginners and experts alike, (3) containing material&process database and knowledge database, and (4) facilities to add new simulation software.



3-dimensional modeling examples using CADCEUS



Use of simulation software for MEMS design and analysis

Worldwide R&D

Area of Intelligent Systems, Division of Systems Science, Department of Systems Innovation, Graduate School of Engineering Science, Osaka University

Tatsuo Arai, Professor

When the laboratory was first established in 1997, we conducted research on micro-hands and mobile manipulation robots focusing on parallel mechanisms and the mechanisms and control of arms, as well as their industrial applications. After later getting more personnel in the laboratory, we expanded our studies on mobile manipulation of humanoid robots, human interface, and information processing. Beginning in 2001, our laboratory was selected to head the Grant-in-Aid for Creative Scientific Research Project entitled "Initiative of Systems and Human Science for a Safe, Secure, and Reliable Society," and we are now engaged in research aimed at establishing a new academic field for engineering and humanities. In addition, we have been working on many R&D projects, primarily within a large national project framework involving close cooperation with participating businesses. We have received research aid from the Micromachine Center for a study on micro-hands, which has greatly advanced research on automated handling. Currently, we are participating in METI's IMS Project, the Project for Destruction of Abandoned Chemical Weapons under the Prime Minister's Office, and the NEDO Project for Developing Next-Generation Robots and are implementing commissioned and joint research with related businesses.

The current organization of the laboratory includes one each of a professor, associate professor, research associate, post-doctoral fellow, and technical official; two secretaries; four doctor course students (three of whom work for a living); thirteen master course students; and eight bachelor course students with whom we are conducting research and development focusing on robot hardware. We are implementing a robot system by studying the mechanisms and processing functions of humans and other organisms in order to coordinate information processing and the functions of these mechanisms in robots through studies of new sensors, mechanisms, and control techniques. We are also establishing a basic policy for education and research in an effort to propose a system to achieve the coexistence of humans and robots in order to build a safe and secure society. Through these educational studies, we hope to contribute to society with robotics by addressing the difficult problems facing the world today.

Fig. 1 Two-finger micro-hand still under development

Our current research focuses on nano- and micro-robotics and monitoring and support systems for assuring safety and security. The former field of research involves manipulation of micro-objects using a two-finger micro-hand developed together with the National Institute of Advanced Industrial Science and Technology, automated focusing and handling of objects in motion using visual information, evaluating operability of interface devices in the manipulation of micro-objects, handling and processing cells and tissue, measuring micro-forces, and the like. In the area of safety and security, a basic concept of merging system science with human science is employed in tracking humans with a moving camera to understand human behavior, providing humanoid robots to assist wheelchair users in movement and manipulation, evaluating humans' sense of security in response to robots, and conducting research on applications for humanoid robots.

In addition, we are working on a haptic interface for reproducing soft objects, integrated control of information and objects using RFID, improvements in the accuracy of a parallel mechanism, development of a limb mechanism for a robot having arms and legs, and applications for these robots in rescue operations. The limb mechanism was selected as one theme in NEDO's Project for Achieving a Practical Next-Generation Robot (Project to Support Prototype Development). We plan to perform a demonstration at next year's World Expo in Aichi.

In the future, we hope to continue concentrating our efforts on education about and research on robots that can be integrated into society. Since we apply great importance to our collaboration with the Micromachine Center and everyone in the industry, we hope that you will continue to provide us with this support.

Arai Laboratory Homepage:
http://www-arailab.sys.es.osaka-u.ac.jp

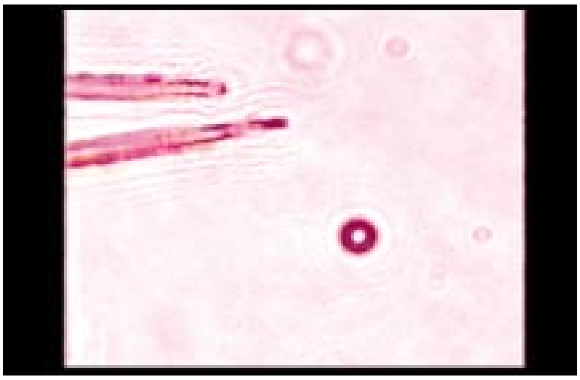


Fig. 2 Automated handling using automated focusing and object recognition functions (the object is a glass particle 2 μm in diameter)

MICROMACHINE is published quarterly by Micromachine Center (MMC) to promote the international exchange of information related to micromachines, R&D and other technical topics, and is circulated free of change. Please send your comments about **MICROMACHINE** to the publisher :

Keiichi Aoyagi, Executive Director, Micromachine Center (MMC)
MBR99 Bldg., 6F., 67 Kanda Sakumagashi, Chiyoda-ku, Tokyo 101-0026, Japan
Tel : +81-3-5835-1870, Fax : +81-3-5835-1873
Internet Home Page http://www.mmc.or.jp/
Date of Issue : August 23, 2004