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行政院國家科學委員會
補助國內專家學者出席國際學術會議報告

89 年 4 月 17 日

報告人姓名	李世光	服務機關及職稱	國立臺灣大學應用力學研究所 教授
會議時間地點	2000 年 4 月 10 日 ~ 4 月 14 日 日本 Hiroshima	本會核定補助文號	NSC 89-2217-E-002-006
會議名稱	（中文）2000 年第六屆世界微機電高峰會議 （英文）2000 World Micromachine Summit		
發表論文題目	（中文） (See Attached) （英文）		

報告內容包括下列各項：

一、參加會議經過

二、與會心得

三、考察參觀活動（無是項活動者省略）

四、建議

五、攜回資料名稱及內容

六、其它

List of Paper Published

1. M. S. Lin, and C. K. Lee, "MEMS in Taiwan: Year 2000 Status," The 6th World Micromachine Summit, Section 1: Country Review, Hiroshima, Japan (April 10-14, 2000).
2. M. S. Lin, and C. K. Lee, "Taiwan's Approach to MEMS Technology Transfer," The 6th World Micromachine Summit, Section 5: Technology Transfer, Hiroshima, Japan (April 10-14, 2000).
3. M. S. Lin, and C. K. Lee, "MEMS Commercialization: Taiwan's Foundry Role," The 6th World Micromachine Summit, Section 6: Industrial Infrastructure, Hiroshima, Japan (April 10-14, 2000).

2000 年第六屆世界微機電高峰會議

(2000 World Micromachine Summit)

報告人：李世光

國立臺灣大學應用力學研究所

一. 參加會議經過

會議於 4 月 10 日報到，4 月 11 日開始論文報告。共計 15 個國家(地區)代表參加，各國代表及觀察員分別為：

Australia:	Prof. Ian Bates, Mr. Jason Chaffey, Prof. Clive Davenport, Prof. Erol Harvey
觀察員:	Mr. Egon Vetter
Benelux (Belgium, The Netherlands):	Prof. Albert Van den Berg, Dr. KrisBaert, Dr. Kees Kykel,
Canada:	Mr. Dan Gale, Mr. Chris Lumb, Dr. Marc Nantel
China:	Prof. Zhaoying Zhou, Prof. Henggao Ding, Prof. Yog Qin, Prof. Zhenging Zhao
觀察員:	Mr. Yong Huang, Dr. Yong Li, Dr. Zuwu Yuan, Prof. Wendong Zhang
France:	Prof. Daniel Hauden, Dr. Jean-Christophe Eloy
Germany:	Prof. Wolfgang Menz, Dr. Robert Bauer, Dr. Ralf Voss, Prof. Engelbert Westkaemper
觀察員:	Mr. Patric Salmon
Japan:	Prof. Naomasa Nakajima, Mr. Takayuki Hirano, Dr. Tsuneo Ishimaru, Mr. Toshiro Shimoyama
觀察員:	Mr. Tatsuaki Ataka, Dr. Kunihiko Hara, Mr. Masami Inada, Mr. Takao ishizaka, Dr. Hirotaka Itoh, Dr. Hideto Iwaoka, Mr. Akihiro Kaahara, Mr. Mitsuhiko Kawamura, Mr. Takashi Kurahashi, Dr. Takashi Mihara, Dr. Koji Namura, Mr. Yoshihiro Naruse, Dr. Kuniki Ohwad, Mr. Toshiyoshi Okazaki, Mr. Hideaki Oku, Mr. Ryo Ota, Dr. Toshihiko Sakuhara, Mr. Akinobu Satoh, Dr. Kiyoshi Sawada, Dr. Tadashi Sugihara, Dr. Hisaki Tarui, Dr. Osamu Tohyama
Korea:	Prof. Young-Ho Cho, Dr. Joong Won Lee, Dr. Suk-Han Lee, Dr. Sangmo Shin

觀察員: Dr. Jong-Uk Bu, Dr. Ci Moo Song

Mediterranean (Spain, Greece, Italy,):
Prof. Paolo Dario, Dr. Carles Cane, Prof. Dr. Androula Nassiopoulou, Dr. Mario Zen

觀察員: Eng. Giancarlo Alessandretti, Dr. Giouse Iseni

Nordic (Denmark, Finland, Norway, Sweden):
Prof. Jan-Ake Schweitz, Dr. Sami Franssila, Dr. Francois Grey, Dr. Stein-Ivar Hansen

觀察員: Prof. Klas Hjort

Singapore: Dr. Loke Chong Lee, Prof. Siaw Kiang Chou, Prof. Mong King Lim, Dr. Siak Lim

觀察員: Kwok Hong Lee

Switzerland: Prof. Nico de Rooij, Mr. Philippe Fischer,

Taiwan: Dr. Min-Shyong Lin, Prof. Yen-Hwei Chang, Prof. Chia-Lung Kuo, Prof. Chih-Kung Lee

UK: Prof. Geoff Beardmore, Prof. Richard Gentle, Dr. Malcolm Gower, Prof. Ronald Lawes

觀察員: Dr. Ayman El-Fatatry, Mr. Russell Noble, Kr. Katharina Otani

USA: Dr. Albert Pisano, Dr. Long-Sheng Fan, Dr. Nadim Maluf, Dr. William Tang

會議論文題目及重點為：

1. Review of Microtechnology Activities in Australia
   - MEMS Research Development Paradigm Changed.
     - Knowledge Development →Product Development
     - Device Development →System Development
     - Examples of the current micro-technology actives were:

       Sensors: Oxygen and Ozone sensors for high temperature applications, Light sensor for defect detection in wire cable, Pathogen recognition sensor, Environmental sensing arrays, Sensors for food condition monitoring and certification, etc..

       Micro-systems: Drug delivery system, Multiplex array

Bio-devices, etc.

- MEMS Resources
  - Academic Researchers →Researchers with Industry Experience
  - Silicon Chip Manufacturing Technologies →Double Sided UV Mask Aligner, Synchrotron, Micro embossing and micro injection molding
- MEMS Education
  - Ph.D. Univ. Research →Ph.D. Industry Projects
  - Specialist Microtechnology Course Modules →Microtechnology Coursework Degrees
- MEMS Commercialization
  - One-off Customer Projects →Product Targeted for Mass Production, Spin-off Companies and Joint Ventures

2. Region Review of Benelux (Belgium, The Netherlands, Luxembourg)
   - No dedicated program to promote MST R&D in Belgium.
     - Research: joint force between university and industry
     - Application Driven
     - Avantium Company: Target Lab on a Chip, high-throughput experimentation for chemical and pharmaceutical industry and with US$5Million investment from the incubating university
   - Dutch government stimulated MST R&D since the beginning of 80's.
     - Activities are to increase the assimilation of MST in university into industry
     - Avantium Company: Target Lab on a Chip, high-throughput experimentation for chemical and pharmaceutical industry and with US$5Million investment from the incubating university

   Typical application field were: Micro optics, RF-MEMS, X-ray detector and inspection, Micro displays etc..
3. Overview of Micromachining Activity in Canada
   - Rapid expanding national research infrastructure
   - Increased university research → more university-industry collaborations→boost in the supply of MEMS/micromachining graduates
   - The field was emphasized in optical micro-systems, Leadar Cronos etc.

4. Recent Status of MEMS Development in China
    - Extended and new programs for MEMS research in succession
        - Ministry of Science and Technology (MSTC) started a key fundamental research plan: "Integrated Micro Opto-electro-mechanical Systems" as one of the "10th Five-year Plan"
        - The MEMS project includes 9 topics: (1) micro-scale mechanical dynamics, (2) calorifics for micro systems, (3) mechanical properties of materials for micro machines, (4) vector optics for micro optical devices, (5) theoretical problems of RF MEMS, (6) micro fluids, (7) inter-disciplines for micro systems, (8) 3D fabrication, materials, packaging and reliability for MEMS, (9) design, modeling, database and simulation of MEMS.

5. The Five Last Year Period in Micro-Nano-technologies in French
    - Academic Education
        - 2 Engineering schools proposed a complete course→At least 8 universities and engineering schools proposed diplomas now
        - 300-400 new engineers per year in MEMS/MST, all of them are employed in Industry or in Res. Centers or Ph.D. Doctorants (50 per year)
    - Academic Research
        - 1997, the laboratories of le Centre National de la Recherche Scientifique (CNRS) created a four year MST research programs. Seventy-six research teams are working on 28 selected projects and the 5 demonstrators devoted to micro-robots, micro-airplane, micro-system for drug delivery, microlab on a chip. The main themes are (1) 8 projects in integrated sensors, (2) 5 projects in specific micro-technologies and nano-technologies, (3) 5 projects in micro-motors and micro-actuators, (4) 3 projects in MOEM, (5) 5 projects in Lab on a chip, (6) 2 projects in nano-instruments
        - 1999, Ministry of Research sponsored a new nano-structure program. Eight of the 25 proposals were selected, which are (1) new materials obtained from self assembly, (2) nano-optics, (3) nano-electronics (one electron transistor), (4) photonic band

gaps, (5) nano-biology, (6) near field micro-scopies.

- Cooperative Academic/Industry Research and Development
  - National Program I started in April 1999 with code name RMNT (Reseau en Microtechnologies et Nanotechnologies) and with budget larger than US$1.3 millions. Funded by Ministry of Research and many ministries. Initiated by consortia and Academic institutes. Scientific and technical goals include: (1) nano-technologies, nano-materials, nano-structures, nano-electronics; (2) advanced microelectronics and high-powered integrated electronics, opto-electronics; (3) micro-technologies, microsystems, micro-devices; (4) micro-connectors, micro-energetics, micro-packaging, (5) biotechnologies, lab on a chip; (6) ultra accurate milling, (7) CAD for microelectronics, nano-technologies, and microsystems.
  - Application fields include automotive, space, communications, life science, and environment.
- Main Industry Players
  - Automotive; aeronautic sensors; space applications; biotechnologies; micro-optics; electronic sensors; medical microsystems; domestic appliance systems; micro-fluids and micro-aerodynamics; DNA, Proteomic chips, Lab on a chip.
  - Start-ups such as Tronics, Teem Photonics, Osmoze, etc. are being created recently.

6. Micromachine Development in Germany
   - MEMS Programs are US$800Millions/10 years.
     - 50% Federal Ministry of R&D, 25% Industry, 12% University, 12% Fraunhaufer Institute of Technology, 1% others.
   - Collaborative Projects include: (1) intelligent cutting tools, (2) intelligent power outlet, (3) distributed intelligent micro-systems for home applications, (4) Microsystems technology for outlet, (5) wafer analysis, (6) environmental sensing. Typical examples were the online water analysis device.
   - New MEMS Program: MST 2000+
     - Goal: MST for high-tech products made in Germany
     - Funding Period: Jan. 1, 2000 – December 31, 2003

- Funding: EU$50M/year
- Perspectives: fostering the use of MST/MEMS in important fields of application, MST manufacturing – building up of a broad industrial infrastructure (modular MST), improving basic conditions for innovation with MST.
- The distribution of application areas was primarily focused in environment, machinery, medical, communication and automotive.

7. Country Review of Micromachine in Japan
   - Japanese Future Market

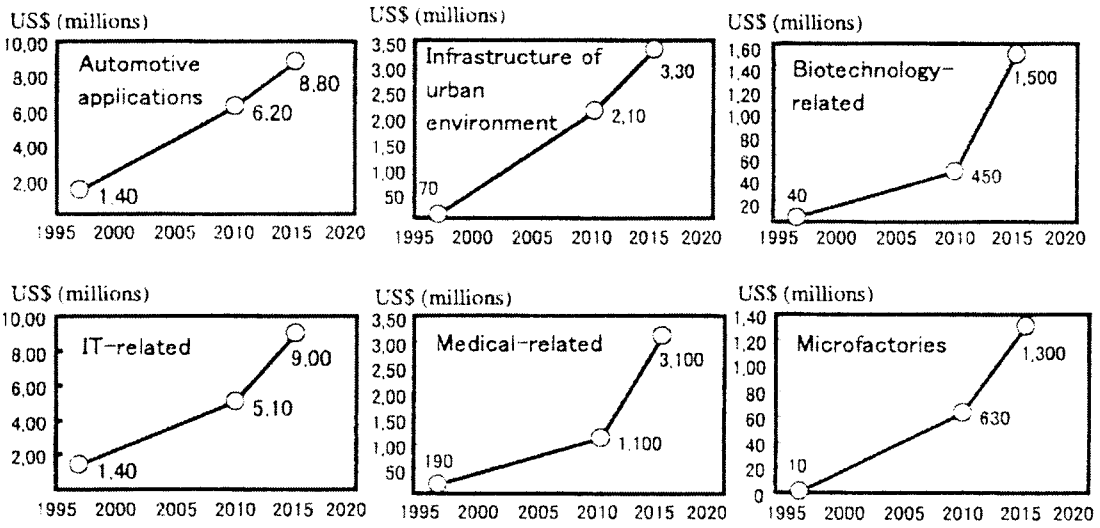
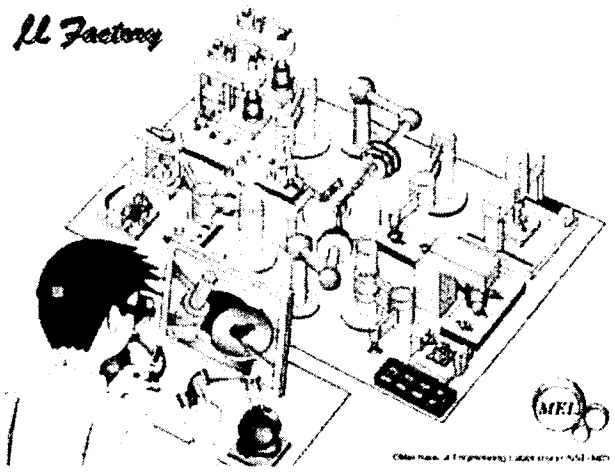


Figure 1. Japanese Market for Typical Application Area

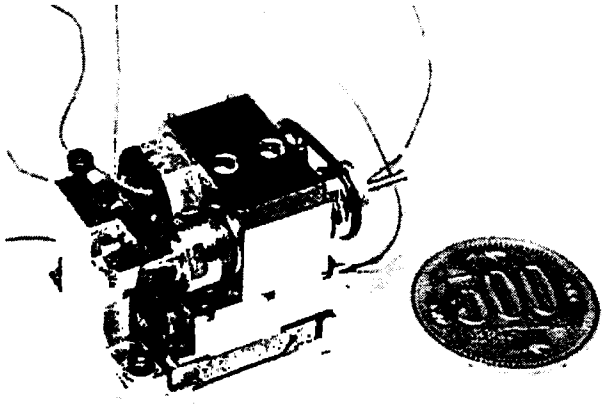
- MEMS National R&D Project: "Micromachine Technology"
  - 2nd Phase since 1996
  - Part of the Industrial Science and Technology Frontier (ISTF) program sponsored by the Agency of Industrial Science and Technology (AIST) of the Ministry of International Trade and Industry (MITI)
  - Goal: establish a technological paradigm for micro-machines
  - Main focus currently: (1) systematization technologies: fabrication of four experimental micromachine systems; (2) functional device technologies: actuators, micro-joints,

batteries, etc.; (3) common basic technologies: control, evaluations, etc.; (4) study of micromachine technology and systems.

- Demonstrations: (1) wireless micromachine, (2) chain-type micromachine, (3) catheter-type micromachine, (4) micro-factory, (5) laser catheter for medical applications.



機械加工によるマイクロファクトリ
Conceptual drawing of microfactory



マイクロ旋盤
Photograph showing microlathe

- A newly designed portable micro-factory (www.mel.go.jp) that includes micro-lathe, micro milling machine, micro press machine, micro transfer arm, micro two-fingered hand, etc. was constructed and fabricated. (See drawing/photo above.)

8. MEMS Summit Country Report of Korea
   - Launched a National Micro-system Project
     - Long-term basic research that uses micro-robots as the focal

point.

- Installed a National Level MEMS Lab

9. MEMS Regional Report of Mediterranean
   - Spain launched a New National Framework Program of Research, Development and innovation 2000-2004
     - 8 areas of interest
     - Total Budge: US$40 millions
     - Six new projects on the applications of MST on home appliance, agroalimentary industry, industrial control and biomedical applications.
   - Greece micromachine activities can be examined from 3 areas:
     - Institute of Microelectronics, National Center for Science Research "Demokritos" with an emphasis in silicon micromachining for microsystems and sensors such as bulk/ surface micromachining, wafer bonding and thinning techniques
     - Institute of Electronic Structure and Laser/Foundation for Research and Technology-Hellas with capabilities in excimer laser micromachining, materials processing, surface treatment and cleaning, and micro-structures of materials by laser etching.
     - CERECO (Company for Research and Development Ceramic and Refractory Materials) can perform excimer laser micromachining and laser processing.
   - Italy's Main National Microsystems Projects
     - Microsystems Project of US$ 3.5 millions.
     - Project on Special Materials and Advanced Technologies of US$1.0 millions.
   - Micromachining activity at IRST of Italy
     - Micro-calorimeters for high energy physics: beta-ray detector for neutrino mass experiment
     - Medical and biomedical micro-devices based on ISFET technology for cell activity measurement, and 3D microelectrodes array for neurological applications
     - Micro-heaters acts as low power sensors for methane detection,

fire protections, etc.

- Experimental devices such as quantum wires for gas detection
- Medical and biomedical micro-devices involves integrated pressure-flow sensor for urodynamic diagnostics
- Microphones based on capacitive silicon microphones for low cost/high volume applications
- Microshutter-micromirror array and micro-actuator array.

10.Nordic MEMS Region Review

- Several new MST initiatives were launched in Denmark.
  - Reorganize Microelectronics Center (MIC) at Danish University of Technology (DTU).
  - COM (Communication, Optics and Materials): combine MIC's photonics research program and telecommunication programs at other DTU institutes
  - CAT (Center for Advanced Technology): established as an industrial research center in 1998 with an emphasis in Microsystems and photonics packaging.
  - Sensor Initiative: initiated by the Council for Advancement of Industry (Erhversfremmestyrelsen), started at the summer of 1999 and will last for 4 years. Format is center-contract collaborations between service centers and industry, as well as industrial Ph.D. education.
  - Start-up companies: 4 start-up companies established at MIC between the summer of 1999 and the summer of 2000.
  - Major activities were focused on optoelectronic.
- Tekes (the National Technology Agency) of Finland has launched a new MEMS program called Presto.
  - Goals include: (1) create new components and solutions based on MEMS, (2) facilitate the large scale use of micromechanical components, (3) develop Finnish research in companies, research institutes and universities, (4) facilitate the implementation of micromechanical products in existing products, (5) create new business in the manufacturing, assembly and design of micromechanical products, (6) create an international network of partners to supplement the national know-how, to educate industrial/research personnel, and to