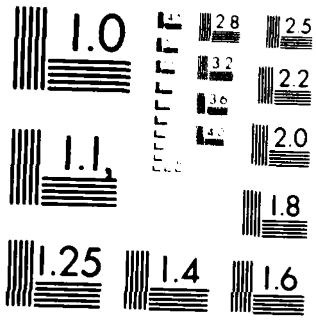
AD-A130 670 ONR FAR EAST SCIENTIFIC BULLETIN VOLUME 8 NUMBER 2 1/1
APRIL TO JUNE 1983(U) OFFICE OF NAVAL RESEARCH LIAISON
OFFICE FAR EAST APO SAN FRANCISCO 96503
UNCLASSIFIED S YAMAMOTO ET AL. JUN 83 F/G 5/2 NL

END
DATE
FILMED
8-83
DTIC

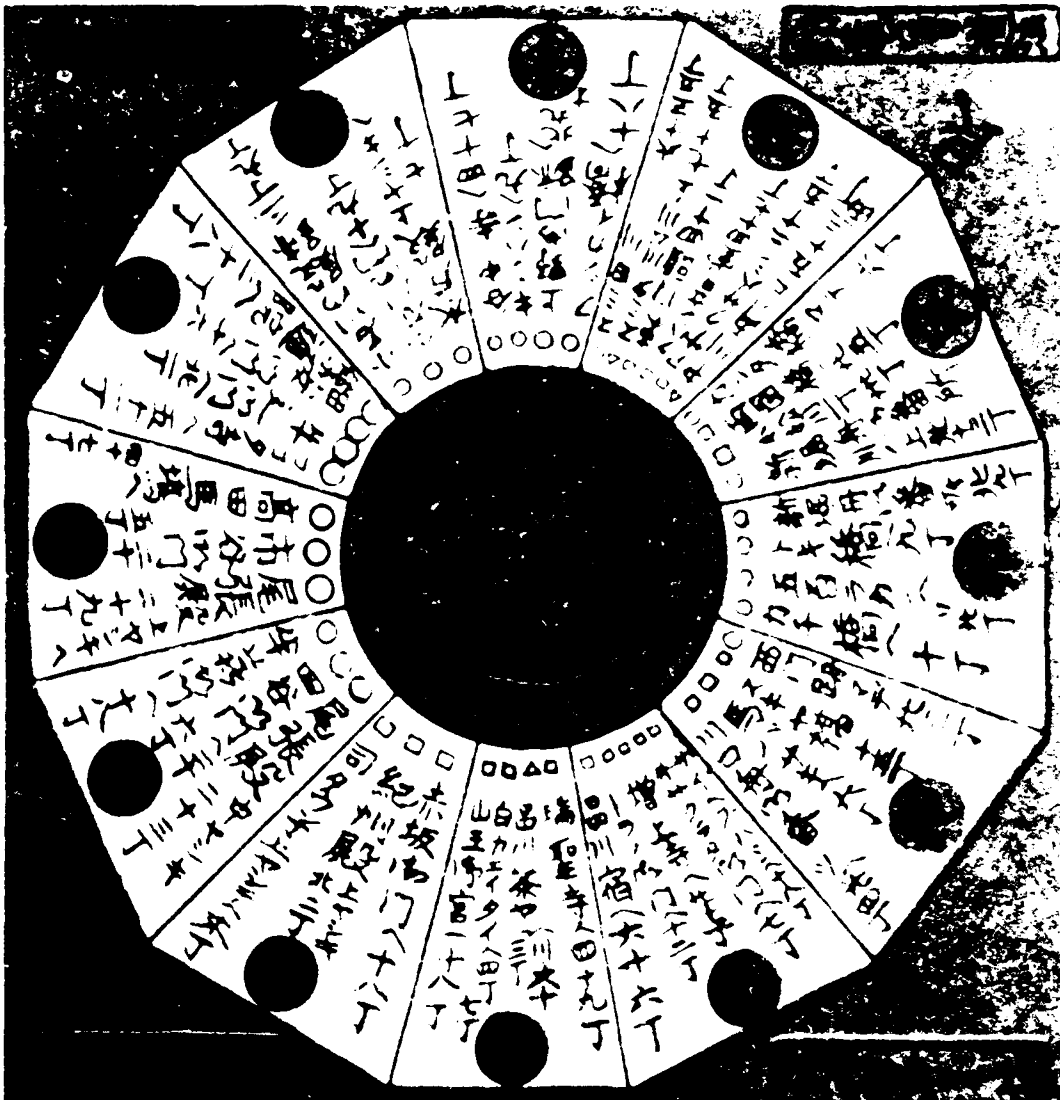


MICROCOPY RESOLUTION TEST CHART

APRIL TO JUNE 1983 VOL. 8, NO. 2

SCIENTIFIC BULLETIN

DEPARTMENT OF THE NAVY OFFICE OF NAVAL RESEARCH FAR EAST



NAVSO P-3580

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ONR/FE Vol 8, No 2	2. GOVT ACCESSION NO. AD-A135 670	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ONR FAR EAST SCIENTIFIC BULLETIN		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Sachio Yamamoto, Director Mary Lou Moore, Assistant Editor		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Office of Naval Research Liaison Office, Far East APO San Francisco 96503		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE April-June 1983 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Korea Institute of Machinery and Metals (KIMM)
Metallurgy
Calibration
Ship hydrodynamics
Technology
Engineering programs
Education
Applied research
Software Development Center

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is a quarterly publication presenting articles covering recent developments in Far Eastern (particularly Japanese) scientific research. It is hoped that these reports (which do not constitute part of the scientific literature) will prove to be of value to scientists by providing items of interest well in advance of the usual scientific publications. The articles are written primarily by members of the staff of ONR Far East,

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

19. Key Words (continued)

Ocean Research and Development Institute
Seoul National University
Admission quotas
National universities
Education Ministry
Sri Lanka
Institute of Fundamental Studies (IFS)
Modern science
Astronomy
Magnetic field effects (MFE)
Gaseous molecules
Singlets
Triplets
Institute for Molecular Science (IMS)
Okazaki
Yonsei University
Solid state physics
Nuclear physics
NSF-KOSEF research grant
Collaborative research
Solid state electrochemical research
China
Japan
Corrosion chemistry
Electrolyte
Osaka
Light measurement
Radio frequency studies
Silicon on sapphire (SOS)
Solid state devices
Royal Australian Institute of Chemistry (RACI)
Chemists
Coordination and metal organic chemistry
Organic chemistry
Polymer chemistry
Australia
Computers
Kuala Lumpur
Southeast Asia Regional Computer Conference (SEARCC)
Malaysian science and technology
Electronics
Hong Kong
Institute of Electrical and Electronics Engineers (IEEE)
TENCON
Singapore
Software engineering
Japan
Information industry
International Conference of Software Engineering (ICSE)
Information Processing Society of Japan (IPSJ)
Japanese Diet
Software development
Human sensing
Environmental pollutants
Silicon crystal growth
Gallium arsenide crystal growth
Electronic devices
Tetradoxin
Korean Chemical Society
Solar energy
Magnetic field effects
Chemical Society of Japan
Samurai
Chemistry

20. Abstract (continued)

with certain reports also being contributed by visiting stateside scientists. Occasionally a regional scientist will be invited to submit an article covering his own work, considered to be of special interest.

CONTRIBUTORS

James (Jim) E. Butler is a research chemist at the Naval Research Laboratory at Washington, D.C. He is currently a visiting scientist at the Institute for Molecular Science located at Okazaki, Japan. Dr. Butler's research interests include photochemistry, chemical kinetics, and energy transfer and chemiluminescence.

Leslie C. Hale was born in New Mexico and educated at Carnegie-Mellon University, the Carnegie Institute of Technology (CIT). He spent five years at the Los Alamos National Laboratory and was involved in work in the early U.S. space program. He has had two assignments in London and one in Brussels. Since 1962, he has been on the faculty of Pennsylvania State University where he is engaged in sounding rocket, balloon, and ground-based research in the "middle atmosphere." In 1979, he was appointed A. Robert Noll Distinguished Professor of Electrical Engineering.

Michael J. Koczak is Professor of Materials Engineering at Drexel University, Philadelphia, Pennsylvania. Dr. Koczak is currently on the scientific staff of ONR Far East. His specialties include physical and powder metallurgy, composite materials, and ceramics.

George E. Lindamood is a liaison scientist with ONR Far East. Previously he taught at the Johns Hopkins University, the American University, and the University of Maryland (College Park), and held research positions at the IBM Corporation, the Westinghouse Electric Corporation, Johns Hopkins Applied Physics Laboratory, and the U.S. National Bureau of Standards. Prior to joining ONR, he was a visiting scholar in the Center for International Studies at MIT. His interests include computer architecture, computer networking, computer performance, evaluation, office automation, and the social implications of computers.

Sung M. Lee is Professor of Physics and also Director of the Keweenaw Research Center of the Michigan Technological University in Houghton, Michigan. Dr. Lee received his Ph.D. from Ohio State University in 1965. De Lee was a NATO Senior Fellow in 1974 and his research interests include infrared optics, acoustics, and applied physics.

Dr. David W. Mizell has held the position of computer scientist at the Office of Naval Research Detachment in Pasadena, California, since January 1981. He manages basic research programs in the areas of computer architecture, distributed processing, VLSI tools, distributed artificial intelligence, and man-machine interfaces. He was previously employed as a computer systems designer at Bell Telephone Laboratories, Naperville, Illinois, and the Jet Propulsion Laboratory, Pasadena, California. He earned a Ph.D. in computer science from USC in 1977.

Melvin C. Ohmer is currently in the Electromagnetic Materials Division of the Materials Laboratory located with the Air Force Wright Aeronautical Laboratories at Wright-Patterson Air Force Base, Ohio.

Seikoh Sakiyama, Science Advisor of ONR Far East, has had considerable industrial experience in laboratory chemistry, electronic instrumentation, and quality control methodology. His interests include computer science, linguistics, and energy technology.

Wayne L. Worrell is Professor of Materials Science and Engineering at the University of Pennsylvania. He received his undergraduate and graduate education (Ph.D., 1963) at the Massachusetts Institute of Technology. His major research interests include corrosion chemistry and solid state electrochemistry at elevated temperatures. His recent studies in the corrosion chemistry area have focused on the structural and kinetic aspects of SO -metal reactions. He is editor of *Progress in Solid State Chemistry*. As a past Chairman of the National Research Council Committee on High Temperature Science and Technology, he was responsible for initiating a study of the future needs and anticipated developments in high temperature science. Dr. Worrell is Chairman of the 1982 Gordon Research Conference on High Temperature Chemistry and is an elected member of the IUPAC Commission on High Temperatures and Refractory Materials.

Sachio Yamamoto, a marine chemist, is currently the Director of ONR Far East. He is on leave from his position as head of the Marine Sciences Division at the Naval Ocean Systems Center in San Diego where, since 1969, he has served as a research chemist. Dr. Yamamoto received his Ph.D. in physical chemistry from Iowa State University in 1959, and his research interests are primarily in environmental sciences, trace metal analysis, gas solubility, and x-ray fluorescence analysis. Dr. Yamamoto is a member of the American Chemical Society.

CONTENTS

Cover: The Japanese compass and navigation aid is taken from a map of Edo (Tokyo) during the Tokugawa era. It was used as an aid to travelers in the city. The center of the compass is Edo Castle; the inner square indicates north, east, south, and west. The immediate circle outside the square shows the specific gates of the city such as Hirakawa, Ote, Sakurada, and Kojimachi. The circles, squares, and triangles tell the traveler which gate to take; for example, Ote: circle, Sakurada: square. The remaining "Kanji" are specific instructions to travelers to reach a part of the city, i.e., the road for Shinagawa is through the Kojimachi Gate. Each point on the compass is a symbol of the Chinese zodiac. Starting at the top, or north, is the rat, ox, tiger, rabbit, dragon, snake, horse, sheep, monkey, bird, dog, and wild boar. Edo Castle is now the Emperor's Palace in downtown Tokyo.

KOREA INSTITUTE OF MACHINERY AND METALS (KIMM)

Michael J. Koczak

INTRODUCTION

The Korea Institute of Machinery and Metals is a consolidation and reorganization of the Fine Instruments Center (FIC), the Korea Research Institute of Ships (KRIS), and the Korea Institute of Machinery and Metals as detailed in Table I. The functions of the institute are manifold, (Figure 1) since it must play a role in research, testing, and calibration as well as provide technical support to small manufacturing concerns. The facilities are divided into three stations, i.e., Seoul, Changwon, and Daeduk. The Seoul Station provides for administration and technical coordination coupled with research functions (Table II). The Changwon Station encompasses the metallurgical, industrial, and mechanical engineering aspects. In addition, it maintains a standards laboratory to assess and provide secondary standards for calibration and testing for industry, institutes, and universities. The Ship Research Station at Daeduk is involved in ship hydrodynamics, structural design, and ship building technology. In these areas KIMM is providing research assistance to the industrial activities in Korea. Apart from the internal research programs, the function of KIMM is to also provide technical guidance and training for small and medium industries to promote productivity, quality, and a better understanding of the production process.

For background, in terms of a world economic performance as measured by gross national product (GNP), consumer price inflation rates, currency strength, and strength of exports, the International Monetary Fund (IMF) ranked Korea third behind Saudi Arabia and Singapore in terms of World Economic Performance between 1981 and 1982. Between 1962 and 1980, the Korean economy has maintained a growth rate of 8.8% and a 17-fold increase in per capita GNP from US $87 to US $1503 in 1982. In addition, trade has diversified with approximately 60% of exports to Asia, 20% to North America, and the balance to Europe and others. Also a greater percentage of manufactured goods are being produced. A summary of the rapid growth of the Korean export and import markets are provided in Tables III and IV respectively. The nonferrous minerals are moderately abundant and it is hoped they will meet domestic demands. In contrast, Korea is hindered by a lack of coal and iron; nevertheless, Pohang Iron and Steel Company (POSCO) has been a remarkable success. Despite these glowing reports, the industries in Korea are facing obstacles to development which involve dependence on foreign raw materials, heavy loan-related burdens, insufficient development, and unclear business prospects. Of particular note is growth of steel, automotive, shipbuilding, and textiles.

Given these assets and liabilities, scientists at KIMM are striving to provide guidance and training for the promotion and enhancement of metals and machinery industries with the clear goal of becoming more competitive in the export market.

CHANGWON STATION OF KIMM

The Changwon Station of KIMM, located near Pusan, is housed in an excellent physical facility in an 80-company developing industrial park. The major activities involve mechanical, metallurgical, and industrial engineering coupled with inspection and standardization activities. In the mechanical engineering field, the major efforts are related to manufacturing machinery, transportation with regard to development of automotive and agricultural parts, automatic control devices, aeronautical, thermal, and hydraulic machinery as well as structural mechanics. In manufacturing technology, the study of machine tools and development of domestic prototypes is pursued. In addition, production processes, i.e., grinding, die making as well as the mechanics of machinery structure are being evaluated.

The Changwon facility is staffed by 220 members; 150 being engineers. It is interesting to note that the KIMM Changwon facility was initiated by funds of US $6.9 million from the Asian Development Bank and DM 7.4 million from West Germany. A close relation exists between West German industrialists and academics and their Korean counterparts. KIMM operates on a budget of US $20 million per year not including capital equipment. In this regard, the Changwon facilities plans to purchase an ASEA hot isostatic press, sintering furnaces, a 150-ton Kotaki compaction press, a 300-ton hydraulic press, a vacuum induction melting facility, and a scanning electron microscope.

The metallurgical engineering group aims at the improvement of domestic manufacturing through the improvement of metallic materials and fabrication processes. The major aspects involve material developments, metal forming, surface treatment, and corrosion and chemical analysis. The metals forming laboratory, under the supervision of Dr. Sang-kee Suh, a Ph.D. from Drexel University, has been involved in the development of powder metallurgy and cold forming industries in Korea. To stimulate the growth of newly developing companies, typically, engineers from KIMM discuss material and processing developments with their industrial counterparts to improve productivity. Such discussions occur at plant facilities where KIMM engineers and scientists work jointly with industrial engineers to solve production difficulties.

Apart from manufacturing studies in metal forming and powder metallurgy, alloy research programs are underway in aluminum, titanium, and magnesium systems. Additional studies in the metallurgical department of KIMM involve studies of stress corrosion and surface coatings, hard chromium platings, and nickel-free stainless steels. In the composites area, Dr. Eir-jin Jun, a Ph.D. from the University of Hanover in West Germany, is examining SiC and Al_2O_3 reinforced aluminum alloys produced by Nippon Carbon and Sumitomo Chemical Company. Additional studies in the nondestructive evaluation and mechanics of composite structures are being conducted at KAIST by Professors Ho-chun Kim and Chang-shun Hong respectively. Also, impact studies of reinforced materials are being evaluated by Professor Hyang J. Lee of the Korean Military Academy. There appears to be several domestic sources of fibers in Korea, i.e., the Han Kuk Fiber Company produces on E glass as well as a 99% SiO_2 fiber, the Kolon International Corporation, a textile company, manufactures an aramid fiber for tire cord applications. In addition, Jae-il and the Lucky Company are involved in polymer reinforced composites. The Sunkyong Company, a company strongly involved in video tapes and synthethic fibers, also has application interests in reinforced composite structures.

DAEDUK SHIP RESEARCH STATION

In the Daejon region, an industrial, academic, and scientific park is established. Apart from the KIMM Ship Research Center, major facilities include government institutes in energy, natural resources, the National Standardization Laboratory, and the Chemical Institute. An industrial research center for the petrochemical industry is established as well as the Lucky Central Chemical Research Institute and the Sanyong Cement Institute. Chung Nam National University is also located in Daejon.

The Korean shipbuilding and steelmaking capacity has grown remarkably (Table III). Hyundai shipyard is one of the largest shipyards in the world and the construction of Daewoo Chukdo yards on Koje island place Korea in a strong position as a major shipbuilder. In light of this growth, the KIMM Daeduk Ship Research Center is involved in ship hydrodynamics, ship building technology, ship structure and design, model testing, shipboard machinery and materials. The major facilities involve a 216 m length, 16 m width, 7 m depth towing tank, and a towing carriage capable of speeds of 6 m/sec. Major test projects are conducted in the following areas:

Ship Hydrodynamics

- Theoretical and experimental analysis of ship resistance
- Potential and viscous flow calculation around ship hull forms
- Hull form development by using wave pattern analysis and wake surveys
- Power performance prediction of ships
- Interactions between hull and propeller
- Design and performance prediction of propellers
- Theoretical and experimental research on cavitation, noise, and erosion
- Theoretical and experimental research on seakeeping, maneuverability, and stability
- Research on system identification and maneuvering simulation
- Data filing of ocean waves for application to ship design

Ship Structure

- Numerical analysis of static and dynamic response of structures
- Development of computer programs
- Experimental stress analysis, structural model testing, measurement and evaluation of noise and vibration
- Rigid vinyl model testing

Ship Building Technology

- Shipbuilding methods
- Shipyard layout
- Welding technology
- Computerization of shipbuilding technical information systems
- Ship production planning and control
- Shipyard operation systems

Ship Design

- R&D of economical ship design based on optimization technology
- R&D of computerization in design process
- R&D of energy-saving ship design
- Technical advice in ship design (basic design, structure design, hull outfitting, machinery outfitting, electric outfitting, etc.)
- Collection, standardization, and supply of ship design data

Shipboard Machineries and Materials

- Development of alternative energy and engines
- Testing, analysis, and evaluation of outfittings
- Development of elemental technology for shipboard machinery and technical support for its localization
- Support of elemental technology and policy projects to foster the shipboard machinery and material industry and its localization

- Establishment of evaluation standard and performance tests in accordance with the Facilitation Law of Shipping Promotion
- Type approval projects to meet international regulations including IMCO, SOLAS, etc.

Model Testing

- Resistance test
- Propeller open water test
- Self-propulsion test
- Flow visualization test
- Wake survey test
- Wave form measuring test
- Resistance and propulsion test in the waves
- Seakeeping tests of ships and ocean structures
- Cavitation test of propellers
- Horizontal P.M.M. test (By 1985)
- Maneuvering test (By 1986)

In general, the facility has an excellent physical facility with good equipment in the areas of nondestructive evaluation and welding. An area of concern involves the staff support and maintenance of the facility and the equipment which was purchased from Japan, West Germany, and the United States. Because of the briefness of the visit, it was not clear of the level and magnitude of interaction between the Ship Research Center and the major Korean shipbuilding concerns.

SEOUL STATION

The Seoul Station of KIMM provides the administrative support as well as having departments in machinery, electrical appliances, precision machinery, standards, testing and inspection. Apart from the product testing and evaluation functions, KIMM also administers two year technical training colleges in tool design, electronic and industrial instrumentation, and precision machinery. By 1980, nearly 2000 students have graduated with technical training and have entered the labor market. The clear purpose is to fill the needs of primary and secondary industries with a trained pool of technician-level manpower capable of operating and maintaining equipment and instrumentation for the manufacturing sectors. Technical assistance at Seoul Station is also given in terms of feasibility studies for pilot plants, product development, dissemination of technology to prevent duplication of efforts, quality promotion, technical assistance, and materials selection.

SUMMARY

The activities of the Korea Institute of Machinery and Metals involve research and development, testing and inspection, technical supervision and training, cooperative research activities, and technology transfer. The goals of promoting Korean industry's quality and productivity is achieved at several levels, e.g., engineer consultations with industries, technician training, prototype design, and pilot plant studies. Further information can be obtained from these New York or San Francisco offices:

Suite 636
460 Park Avenue
New York, NY 10022
Phone: (212) 935-1223/5
Telex: 23679 KEIIO UR NY

Suite 215
355 W. Olive Avenue
Sunnyvale, CA 94086
Phone: (408) 733-5733/5
Telex: 346336 FIC KEIPO
SUNNYVALE

KIMM also publishes at monthly magazine, *Machinery Korea,* which provides technical and trade information for the promotion of the metal, machinery, and shipbuilding industry. An informative profile of Korea's remarkable growth in manufacturing, textile, electronics and fishing sectors over the last ten years as monitored by the export and imports by major commodity is shown in Table III and IV respectively. The growth of the export market in the areas of steel, automotive, seafood and consumer products is quite impressive and demonstrates the strong growth of Korean industry into the manufacturing sectors.

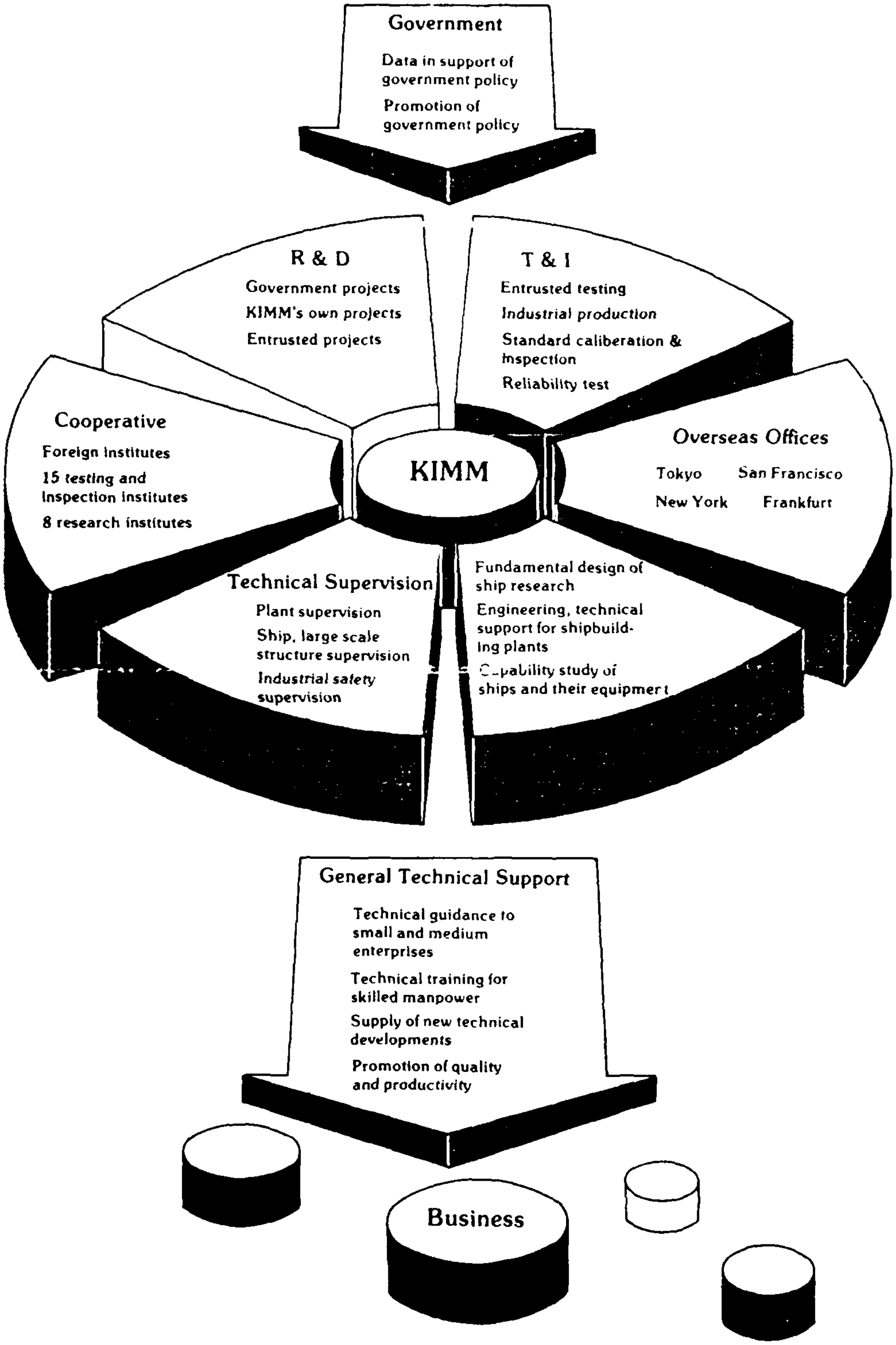


Figure 1. The Functions and Roles of KIMM

TABLE I

HISTORICAL DEVELOPMENT OF KIMM (+)

13 April 1966	Establishment of Fine Instruments Center (FIC)
4 November 1976	Establishment of Korea Research Institute of Ships (KRIS)
30 December 1976	Establishment of Korea Institute of Machinery and Metals (KIMM)
21 November 1980	Government plan implemented for the consolidation of Korea Institute of Machinery and Metals (KIMM) and Korea Research Institute of Ships (KRIS)
5 January 1981	Korea Institute of Machinery and Metals renamed after its consolidation with KRIS

(+) Data Courtesy of KIMM

TABLE II

RESEARCH LOCATIONS AND DEPARTMENTS OF KIMM

SEOUL STATION

222-13, Guro-dong, Guro-ku, Seoul 140, Korea
P.O. Box: Guro Danji, P.O. Box 27
Cable: FINCEN SEOUL
Telex: FINCEN K28456
Telephone: 855-0611/5, 854-1061/5

.Departments

Machinery Testing and Inspection
Electrical Appliance Testing and Inspection
Standards Department
Precision Machinery
Technical Support

CHANGWON STATION

Changwon Industrial Complex 720, Oi-Dong
Changwon, Kyungsangnam-Do, Korea
P.O. Box: Changwon, P.O. Box 41
Cable: KIMMROK
Telex: KIMMROK K3835
Telephone: Changwon 6-0721/30

.Departments

Mechanical Engineering
Metallurgical Engineering
Technical Supervision
Industrial Engineering
Standard Laboratory
Machine Shop

SHIP RESEARCH STATION

171, Jangdong-ri, Tandong-myeon, Daeduk-kun, Chungnam
P.O. Box: Daeduk Science Town, P.O. Box 1
Cable: KRISROK DAEJEON
Telex: KRISROK K5504
Telephone: Daejeon 44-7401/11

.Departments

Ship Research
Ship Technology
Project Development Group
Towing Tank Operation Group

Table III

Korean Exports by Commodity (in thousands of US dollars)
(Courtesy of KIMM)

During	Total	Fish, fresh, chilled or frozen	Crustacea & molluses	Canned button mushrooms	Tobacco, unmanufactured	Raw silk, not thrown	Tungsten ore	Ginseng	Petroleum & petroleum products	Chemical elements & compound
1973	3,225,025	56,756	45,438	23,078	22,111	72,844	10,283	13 035	31,136	20,126
1974	4,460,370	74,183	49,696	19,381	46,711	59,828	16,326	11,291	101,427	62 520
1975	5,081,016	242,376	65,438	22,314	66,258	20,988	20,547	15,971	95,356	41,216
1976	7,715,108	164 632	89 580	35,210	77,076	11,656	19,450	24,187	132,449	69,098
1977	10,046,457	482,581	127,733	52,139	105,656	37,416	24,010	31,450	100,450	105,258
1978	12,710,642	420,262	123,326	25,274	111,464	61,003	22,727	46,701	30,0[illegible]	103,049
1979	15,055,453	548,676	173,828	46,075	91,327	40,122	18,276	38,516	15,333	185,669
1980	17,504,862	434,957	161,194	27,687	83,978	19 010	17,045	34,777	29 425	210 075
1981. 1	1,400,770	28 073	12,775	1,828	14,638	--	872	255	1 513	17,117
2	1,524,149	58 786	26 341	1 372	20,184	106	1,420	264	15 860	20 478
3	1,697,519	39 471	17,480	1,279	20,444	187	1,510	1,009	17 440	23,623
4	1,783,714	39 164	18,191	2,554	17,947	–	1,160	1 994	17,349	19 947
5	1,767,112	44,159	17,023	3,968	4,335	–	1,109	696	3 182	13 628
6	1,943 092	34 805	13 300	2,678	4 225	–	1,265	4 133	9 446	17 690
7	1,931 850	37 963	11,903	1,365	4 982	–	1,140	2,245	19 457	18 271
8	1,771,553	31,819	9,774	474	[illegible]459	-	1,029	1,365	5,151	15 679
9	1,878,715	39,184	9,360	232	907	–	1,331	3,020	9 445	18,708
10	2,060,519	39,633	11,352	304	812	–	914	10,216	22,892	18,975
11	1,564 490	54 982	14 677	2,631	2,736	--	1,045	1,105	21 911	16 121
12	1,940,830	79 669	34,760	1,982	9 145	–	1,686	2,492	13 02[illegible]	23 696
1982. 1	1,478,249	34 703	13 701	[illegible],072	18,326	-	260	512	867	18 [illegible]0

During	Sheets of iron or steel	Finished structural parts & structures	Cutlery	Power generating machinery	Office machines	TV receivers	Radio	Telecommunication equipment	Thermionic valves	Railway vehicles
1973	129,526	5,280	21,948	2,597	32,750	23 894	32,754	23 073	179 697	3 585
1974	233,281	5,464	28 320	3,120	40,666	37,406	49,597	51 085	242 681	10,474
1975	74,300	3,717	33,962	2,438	44,133	31,362	50 374	56 432	206 613	20 452
1976	158,224	17,260	56,796	15,412	57,794	72,597	91,613	140 986	319 402	7 060
1977	165,819	261,511	84,692	19,722	57,899	100,295	125,968	172,732	331 748	41 724
1978	298,196	113,323	78,769	24,313	70,164	229 659	182,361	207 812	371 686	89 939
1979	447,117	101,192	87,347	43,518	87,638	299,450	282,356	273 936	490 794	183,527
1980	557,922	147,405	110,755	72,810	87,382	417,056	286,664	248 438	517 311	261,663
1981 1	43,655	11,460	10,572	3,648	6 608	26,226	21,005	16 161	38 739	20 847
2	54 680	11 662	8,867	5,186	5 489	27 292	21 948	16 679	36 953	21 656
3	55,040	19,441	9,717	4,856	6,486	39,595	26,421	23,232	43 252	20,788
4	42,295	16 651	10,387	5,247	6,826	43,745	29,841	23,920	42 096	28 696
5	49,701	21,778	10,462	6,068	7,173	44,492	31,522	22 074	44 661	18 952
6	63 872	34 409	11,836	6,432	7,581	52,982	31,550	24 254	42 740	21 589
7	47 594	30,098	10 447	9,926	8,773	47,309	32 970	25,921	45 955	24 888
8	39,002	23,391	9,830	8,009	7,901	48,131	30 855	24 333	43 509	20 252
9	45,012	33,649	8 841	4,928	8,121	44,701	34,195	25 669	45 231	30 810
10	46,778	87,033	9,708	8,093	8,703	41,522	34,633	27,740	44 775	44 828
11	31,793	14,842	8,500	6,420	8,587	39,477	27 853	23,054	44 284	28 312
12	44,385	24,566	11,478	12,354	9,451	44,490	23,809	29 059	52 998	38 034
1982. 1	46,106	20,347	7,931	4,154	8,043	26,071	19,417	20,306	42 611	18,658

Table III

Korean Exports by Major Commodity (continued)

In thousand U.S. dollars

Medicinal & pharma-ceutical products	Fertilizers, manu-factured	Rubber tires & tubes	Plywood	Textile yarn & thread	Cotton fabrics, woven	Textile fabrics	Cement	Ingots of iron or steel	Rod and angles of iron or steel	During
4,648	5,064	18,500	273,188	85 813	55 489	[illegible]	19 619	9 928	8 240	1973
6,278		59,797	163,409	117 851	54 661	[illegible]	48 946	45 916	52,186	1975
9,692	30	82,158	206,407	204 986	50 496	[illegible]	68 922	34,603	46 512	1975
9,109	11,533	128,937	333,091	254 785	81 399	[illegible]	109 933	48,760	56 262	1976
11,299	71,214	148,044	319,104	250 411	[illegible]	[illegible] 828	154 990	65 797	28 906	1977
13,034	162,110	213,808	346,102	337 669	104 782	[illegible]	142 265	26 369	43 531	1978
17,878	222,592	325,036	388,218	443 697	[illegible]	[illegible]	113 982	206 012	153 702	1979
19 671	344,361	477,372	303 976	623 608	148 858	[illegible]	234 668	302,101	347 803	1980
1,831	34 275	39 247	31 481	64 015	14 996	[illegible]	24 428	10 562	33 430	J 1981
1 895	10 864	45 484	26 468	50 081	13 899	[illegible]	27 991	15 682	31 706	F
2,172	28,147	44 390	27 152	60 801	14 378	135 048	34 114	30 703	37 294	M
2,353	25 373	47 370	31 096	52 923	[illegible]	[illegible]	34 462	24 359	24 603	A
2,142	7,885	34 463	28 036	[illegible]	12 378	133 852	25 789	28 772	25 209	M
1 684	14 322	30 408	32 315	41 324	11 769	138 180	36 356	38 590	13 125	J
1,993	19,455	32 114	28 698	69 269	10 666	136 985	25 621	52 025	17 886	J
1,764	22 474	59 451	34 161	39 416	8 314	128 768	39 076	32 059	15 140	A
2,160	7,270	32 999	19 748	45 050	7 606	117 261	24 298	37 638	24 872	S
2,744	7,205	34 967	23 159	41 113	9 441	130 280	16 381	46 160	31 614	O
1,919	4 002	27 205	17,625	45 621	[illegible]	116 049	[illegible]	42 785	13 961	N
3,512	7,928	35 559	23,304	47 719	14,857	136 819	28 696	56 717	23 360	D
2,982	22,059	23,967	15,006	42 093	14 984	106 213	31 120	39 816	18 118	J 1982

passenger motor cars	Lorries & trucks	Ship & boats other than warship	Travel goods	Clothing of textile fabrics	Outer garments knitted	Footwear	Gramo-phone & reproducers	Articles of artificial plastics	Wigs & false beards	During
140	206	5,478	17,867	314,636	118,516	106 371	42 344	20,926	81,536	1973
70	132	74,013	32,753	414,235	108,512	179 547	53 977	39,352	72,907	1974
116	612	137,804	61,274	484 030	106 851	191 213	64 223	88 264	75 262	1975
2 333	3,519	276,745	49,225	898,071	418,894	398,524	119 385	36 149	69 535	1976
12 860	5,363	526,252	67,345	992,248	445,796	487,626	120 211	52,884	58,765	1977
42,322	22,292	801,415	114,856	1,249,029	522 866	686 171	133 995	62 294	60,174	1978
53,739	41,493	514,948	107,267	1,501,516	451,440	728 911	154,381	85 075	54 344	1979
50,060	39,022	617,625	106,158	1,588,038	498,697	874,397	131,836	104,565	55,547	1980
2,005	2,053	27,043	10,036	127 155	34 928	78,280	8 677	9 637	3 448	J 1981
2,393	1 977	27,876	8,790	119 198	31 978	68 415	7 987	8 941	3,466	F
3,967	1,880	54,690	13,311	141 599	46 029	84,741	8 683	10 663	4,753	M
8 325	1,333	81,386	10 921	160 840	58 142	87,470	11 203	9,445	4,616	A
11,005	3 151	135,222	11,739	71 659	91 433	11,807	11 009	4 705		M
3,790	3,062	180,127	12 827	199 292	81 028	105 161	13 250	8,985	4 384	J
8,257	756	172,524	14,335	211 719	82 598	96,190	16 792	9 373	4,937	J
5,509	1,842	83,821	12,054	198 568	75,265	81 691	17,148	9,218	4 541	A
7,686	7 146	214,726	13,504	197 461	72 314	75,283	16,008	9,445	4,074	S
6,852	6,117	255,580	10,699	189 058	57,154	88,992	14 764	11,270	4,623	O
2,206	7,217	58,707	10,567	146 791	35,245	78,453	14,107	10,259	4,072	N
7,710	4,606	119,699	13,345	196 779	42,582	94,171	14,536	12,106	5 473	D
1,591	287	118,017	9,656	139 668	36,205	75,492	11 207	7,308	3 682	J 1982

Table IV

Korean Imports by Major Commodity (in thousands of US dollars)
(Courtesy of KIMM)

During	Total	SITC Code 0410 Wheat & meslin unmilled	042 Rice	0440 Maize	0611 Raw sugar beet & cane	08 Feeding stuff for animals	231 Crude rubber	242 – 3 Wood	2512 – 9 Pulp	262 Wool & other animal hair	2631 Raw cotton
1973	4.240.277	256.621	83.965	41,272	63,015	3,166	46,700	311,641	64,935	54,349	112,426
1974	6 851.848	297.562	153,112	66,545	131,490	2,542	75,475	343,523	111,097	36,767	189,450
1975	7.274.434	293.651	195,118	87,104	185,387	1,511	57,908	268,733	74,831	42,745	248,992
1976	8.773 632	276.030	46,954	124,155	93,683	984	90,297	418,228	88,200	62,937	307,692
1977	10.810.538	273.227	14,205	151,614	102,694	10,210	117,793	533,649	100,883	76,796	373,611
1978	14 971.930	235.354	610	230,752	143,172	16,151	163,068	668,751	121,156	93,685	447,454
1979	20.338.611	299.077	69,367	364,594	165,163	57,310	235,364	975,075	175,490	117,493	461,623
1980	22 291.663	366.617	328 428	376,218	491,907	5,787	276,825	876,810	225,802	136,731	604,066
1981 1	1.832.210	30 427	21.780	38.430	42.964	111	17,726	43.830	11,377	13.717	44.617
2	2.013.863	38.034	12.382	29.480	54.544	3,172	23.198	51,254	19.991	12.493	45.940
3	2.180 529	34 577	67.163	35.087	40.654	1.529	17,993	61.081	21,652	14.802	56.269
4	2.328 137	37.719	79.845	38.186	46,070	1,646	19,554	72.795	21,501	20.045	67.848
5	2 220.338	40.302	76.809	37.775	46.042	746	19,521	58.283	18,261	18.259	63.375
6	2.197.208	40.245	104.238	35.161	33.653	293	17,093	63.671	21,399	17.408	66.674
7	2.406 759	22.553	239.759	37.355	48.869	3,156	25,614	59,854	34,184	13.902	60.477
8	2.116.719	28.336	17,699	36.859	33.587	5,111	21,847	51.540	16,662	14.067	43.849
9	1 993 742	36.914	1.015	36.993	22.826	1,064	17.558	63.682	15.763	13.735	48.714
10	2.014 099	36.783	64	37.764	18,163	1,140	17.752	47,658	16,744	14.025	39.278
11	1.993 870	29.192	21	32.198	18.592	3,834	15.739	46.040	16,781	13.570	36.285
12	2.833.947	30.009	464.713	43,204	21,278	320	28,183	56,624	33.186	13.193	50.294
1982 1	1.864.994	25.526	26.310	22.578	20.057	5.582	14,1[illegible]	36 115	13,025	15,244	43.787

During	SITC Code 672 Ingots of iron or steel	674 Plates & sheets of iron or steel	678 Tubes & pipes of iron or steel	682 Copper	691 Finished structural parts & structures	711 Power generating machinery	714 Office machines	715 Metal working machinery	7171 Textile machinery	7184 Construction & mining machinery	7191 Heating & cooling equipment
1973	197.039	43.491	10.359	16,936	9.659	35.007	34.821	46,914	147,38	9.682	44,639
1974	236.473	81.505	23.605	37,869	6,602	81.830	33,649	62,988	108.547	21,316	70,026
1975	128,190	85.898	30.044	20,588	7,187	113.709	39,864	93,810	167,145	33,131	66.943
1976	189 198	84.631	31.521	33,525	13,001	122.458	51,835	160,221	125,805	34,570	124,325
1977	271.979	123.276	63,931	39,908	19,242	246.356	68,815	237.795	180,247	49,127	57,724
1978	416,541	205.713	77,500	58,253	15.466	373.702	103,039	390,990	248,954	107,561	308,106
1979	503,170	194.944	105,482	110,911	23,033	648,453	138.372	418,881	336,010	56,530	313,341
1980	487,013	185,049	78.531	86,435	16,967	451,151	156,964	356,593	162,302	31,675	184,534
1981 1	17.266	14,052	3,784	5,540	889	28,740	10,094	4,650	11,916	1,907	96,217
2	34.278	18,015	5,979	5,210	2,717	40,287	15,190	30,587	13,680	1,780	40,549
3	27.162	13,154	6.162	6,860	1,475	44,881	9.577	24,169	10,787	3,874	9.850
4	41.361	20,519	6,260	4,563	1.501	37,287	16,051	51,576	27,080	3,657	33.948
5	37.629	16.878	4,945	4,480	1,933	42.299	11,739	14,381	13,001	4,284	9.109
6	35.750	23,085	6,543	9.114	2,335	27.772	10,169	28,818	12,830	6,381	9,404
7	35 874	19.570	6.992	11.201	956	57,053	13,963	8,813	15,063	3,116	6,542
8	41.327	19.003	7.194	16,276	3,160	29.962	12,963	10,658	13,602	1,934	6,356
9	29.016	27.789	18,266	8.432	7,844	85,802	17,053	6,835	12,710	4,768	9,316
10	25.533	16.677	14.969	10,774	2,486	50,423	19,078	14,567	12,708	3,907	7,220
11	29.601	18.248	12,253	4,687	1,155	40,047	18,312	23,821	18,672	5,821	13,029
12	25,809	26,904	13,398	14,474	3,191	79,124	24,847	39,815	24,085	5,707	14.375
1982 1	23.582	16,797	10,091	9,148	4,517	35,965	12,070	10,025	23,894	4,409	8.933

Table IV

Korean Imports by Major Commodity (continued)

In thousand U S dollars

266 Artificial fibers	2820 Iron & steel scrap	33 Petroleum & petroleum products	411321 Beef tallow	512 Organic chemicals	513–4 Inorganic chemicals	541 Medicinal & pharmaceutical products	581 Plastic materials	64 Paper	651 Textile yarn & thread	653 Textile fabrics woven	During
83,457	74,323	296,217	27,258	137,248	36,105	17,869	60,686	17,489	108,069	152,274	1973
74,387	171,811	1,020,259	46,219	294,756	54,249	24,801	92,752	23,714	78,641	141,248	1974
38,868	102,793	1,339,274	40,209	339,066	51,270	27,483	91,578	23,244	50,418	148,211	1975
35,072	109,674	1,657,610	45,420	424,145	67,767	30,290	124,691	31,461	68,348	164,233	1976
29,018	147,724	2,064,805	69,734	477,736	71,064	35,177	186,600	35,157	97,096	159,677	1977
24,192	172,990	2,312,088	78,439	559,366	96,380	52,890	273,573	46,402	123,051	167,550	1978
43,003	221,238	3,415,571	104,916	960,015	137,609	78,628	422,969	56,807	121,808	198,369	1979
38,833	286,254	6,163,536	78,852	949,975	130,628	72,332	256,441	62,825	110,427	192,406	1980
2,959	17,478	648,317	4,904	77,859	7,623	3,730	20,651	4,438	9,556	11,550	J 1981
3,234	21,548	598,547	5,880	65,417	9,500	6,341	19,790	5,406	8,661	13,608	F
3,199	21,367	765,152	5,021	93,475	10,649	6,381	21,771	7,132	12,541	19,313	M
3,476	25,663	531,761	8,234	99,144	11,582	8,239	25,493	7,146	19,037	19,145	A
3,784	19,916	546,250	6,166	94,692	10,400	6,768	22,210	6,877	13,191	20,104	M
6,661	20,768	514,479	6,714	74,857	10,981	7,030	27,207	7,761	14,355	23,039	J
3,827	27,815	527,754	6,803	89,619	12,558	6,595	26,683	7,018	14,111	21,673	J
4,065	19,969	516,797	6,960	82,580	12,465	6,289	26,370	6,115	14,600	16,805	A
4,591	16,429	257,215	7,111	75,636	10,716	5,301	26,735	6,234	13,289	18,553	S
4,221	16,580	559,863	6,469	82,422	10,865	5,840	28,419	6,638	13,699	15,939	O
4,456	11,308	623,175	6,067	67,009	9,597	5,894	24,122	7,223	15,657	16,393	N
5,179	10,795	628,469	10,356	94,133	13,505	6,233	27,592	8,190	18,143	16,653	D
2,920	10,150	608,292	5,016	72,061	14,875	6,732	[illegible]	[illegible]	14,555	13,933	J 1982

7193 Machanical handling equipment	722 Electric power machinery	724 Tele-Communications apparatus	7293 Thermionic valves	7295 Electrical measuring & controlling instruments	731 Railway vehicles	7321 Passenger motor cars	7323 Lorries & trucks	734 Aircraft	7353 9 Ship & boats other than warship	86 Professional, scientific instruments	During
71,046	52,464	76,739	162,005	16,099	18,756	20,653	22,521	106,693	51,023	40,656	1973
36,081	93,065	102,424	218,489	22,721	57,747	6,840	40,155	72,785	392,239	69,381	1974
77,111	107,629	105,372	187,193	26,748	35,991	7,646	39,651	169,706	245,629	85,323	1975
93,229	172,809	161,765	286,764	42,426	20,084	5,843	18,319	28,698	396,569	138,607	1976
123,860	216,487	141,686	293,978	50,171	70,918	4,742	16,522	90,203	193,231	181,938	1977
240,866	356,957	213,880	385,720	65,675	68,618	18,002	108,015	206,100	401,849	273,598	1978
183,549	492,689	256,157	468,023	111,991	40,606	15,502	18,832	395,346	315,795	367,387	1979
129,896	357,090	317,922	527,006	102,314	45,336	5,966	9,187	356,943	472,029	367,343	1980
19,480	24,571	63,494	37,444	5,539	14,395	821	6	1,051	10,920	27,085	J 1981
16,102	46,499	48,190	44,242	8,231	15,004	967	--	1,650	68,747	31,692	F
4,285	30,919	30,194	48,238	9,312	5,067	1,070	600	57,710	39,179	32,780	M
40,218	39,328	27,178	74,514	9,548	7,357	727	21	105,967	40,027	36,644	A
4,381	35,112	30,907	50,187	8,247	1,797	618	1,221	145,544	38,017	35,854	M
26,242	34,000	32,791	51,319	8,660	4,897	846	84	3,053	100,711	34,301	J
8,619	31,102	59,149	49,769	10,373	469	1,216	-	5,575	56,019	33,403	J
11,680	25,274	45,097	47,913	9,330	643	1,530		26,464	162,093	31,710	A
8,112	57,482	32,406	53,495	9,130	524	537	268	19,905	76,542	30,788	S
18,169	33,073	30,668	55,602	8,027	3,123	1,396	15	27,212	75,415	34,077	O
10,994	30,537	29,613	48,554	9,829	1,562	1,081	392	4,395	96,483	31,126	N
14,009	50,407	32,226	50,360	13,199	610	1,108	1,021	21,144	108,825	36,217	D
5,661	74,217	28,473	38,444	8,605	109	462	1,085	7,991	64,410	23,816	J 1982

KOREA ADVANCED INSTITUTE FOR SCIENCE AND TECHNOLOGY

Michael J. Koczak

INTRODUCTION

On 1 December 1980, the reorganization and consolidation of the Korean Institute of Science and Technology (KIST) and the Korea Advanced Institute of Science (KAIS) occurred and the two independent, but physically adjacent, laboratories formed the Korea Advanced Institute for Science and Technology (KAIST). The objectives of KAIST are:

- to educate and develop competence in science and technology,
- conduct basic and applied research activities in medium and long-term research programs in order to develop and improve the nation's technology base, and
- to assist the industrial community as well as other research and professional organizations.

The organization structure, as shown in Figure 1, is divided into academic and research groups, and presents a clear reminder of the two formerly independent facilities. KAIS, the former academic and educational component, is shown under the Deans of Science and Engineering with four departments in the science group and ten departments in the engineering group. The former research branch of the organization KIST is under the Director of Research with seven engineering oriented divisions as well as a product development group. In addition, two institutes are under KAIST; an Ocean Research and Development Institute as well as a Software Development Center. Details of the facilities are provided in Table 1. As a result of the organizational structure, KAIST is composed of a graduate school and a technical research institute. The graduate school has produced 2000 students with master's degrees since 1971, and since February 1982 more than 70 Ph.D. degrees have been granted. A national goal of the Koreans is to dramatically increase the number of Ph.D.s in Koreans universities, research institutes, and industries, i.e., over a ten year period more than 2000 Ph.D.s will enter the Korean scientific community. The source of the scientific talent will be American-educated Koreans as well as Korean university Ph.D.s, e.g., KAIST as well as national university graduates. Since the undergraduate student to faculty ratios at the national universities is high, i.e., 40 to 1, consequently, the major sources of the technical talent will be American-educated Koreans as well as KAIST graduates. In 1985, it is anticipated that 250 Ph.D.s will enter the Korean scientific community with approximately 150 coming from abroad and 100 from KAIST.

FACULTY OF ENGINEERING

The Faculty of Engineering provides degrees in ten traditional disciplines (Figure 1) as well as three professional engineering programs, i.e., production engineering, industrial electronics, and chemical process engineering. Students typically receive full scholarships or are supported by their employers. The staff in the College of Engineering numbers 105 with a total of 1075 students.

The Department of Materials Science has a twofold responsibility of graduate education and research. Research topics include electrobcronizing and ion nitriding of steels, directionally solidified superalloys, dual phase steels, hydrogen embrittlement, liquid phase sintering, sintering of carbides and nitrides, bonding in ceramic metallic systems and recrystallization of silicon steels. The research activities in powder metallurgy of Dr. Yoon have involved the kinetics of coarsening during sintering in Co-Cu and Fe-Cu, sintering in W-Ni as well as pore formation studies in W-Ni-Fe alloys. In addition, previous studies by Dr. Nam have involved hydrogen embrittlement, creep in aluminium alloys under varying stress conditions as well as wear resistance in cast iron.

The Production Engineering program is involved in cost effective production processing and is composed of four areas:

- materials processing,
- production management and process design,
- machine tools, and
- production automation.

In the materials processing area, current research topics include extrusion, ring rolling, and cold forging processes. The remaining three areas involve production processes, plant design, and production automation.

The graduate research and education of KAIST represents a long-term research commitment to improve the research level of universities, research institutes, and industries. The joining of KAIS and KIST has been accomplished in theory, however, they remain somewhat divided although the driving forces for exchange have been initiated. The educational arm and research arm remain apart, but greater coordination and cooperation is anticipated.

THE RESEARCH AND DEVELOPMENT DIVISION

Formerly KIST, the Research and Development Division includes groups in:

- materials science and metallurgical engineering,
- applied chemistry,
- mechanical and electrical engineering,
- chemical engineering and polymer technology,
- food and biotechnology, and
- technoeconomics as well as a technology support center.

In ferrous metallurgy, studies are in the area of controlled rolling, silicon steels, and dual phase steels. In magnetic materials, efforts are aimed to develop a variety of domestic production goals to include permalloys, $SmCo_5$ magnets, and Co-Cr-Fe magnets. The ceramic materials laboratory has efforts in domestic industrialization of high voltage electrical insulators, integrated circuit (IC) package materials, ferrite piezoelectric and dielectric materials.

SUMMARY

KAIST has two divisions, the Faculty of Engineering and the Research and Development Division which respectively represent the graduate academic and research programs. The KAIST programs also allows for sponsored research, technical assistance, and technical service. Tax subsidies are provided to research sponsors and is used to encourage research support of technical innovations by private industry. Upon successful completion of a project, the research can be utilized by industry through the Korea Technology Advancement Corporation (KTAC) which provides technical and economic feasibility studies, venture capital, and management for companies. As a result, KAIST has an integrated research program which has the capability of conducting basic and applied research and the mechanism available for end product commercialization and manufacture. The program is ambitious in terms of fostering manpower and technology.

Dr. Lee Sang-soo, Dean of Science at KAIST, convincingly argues, "We are very confident about Korea's future. We can build science and technology in Korea."

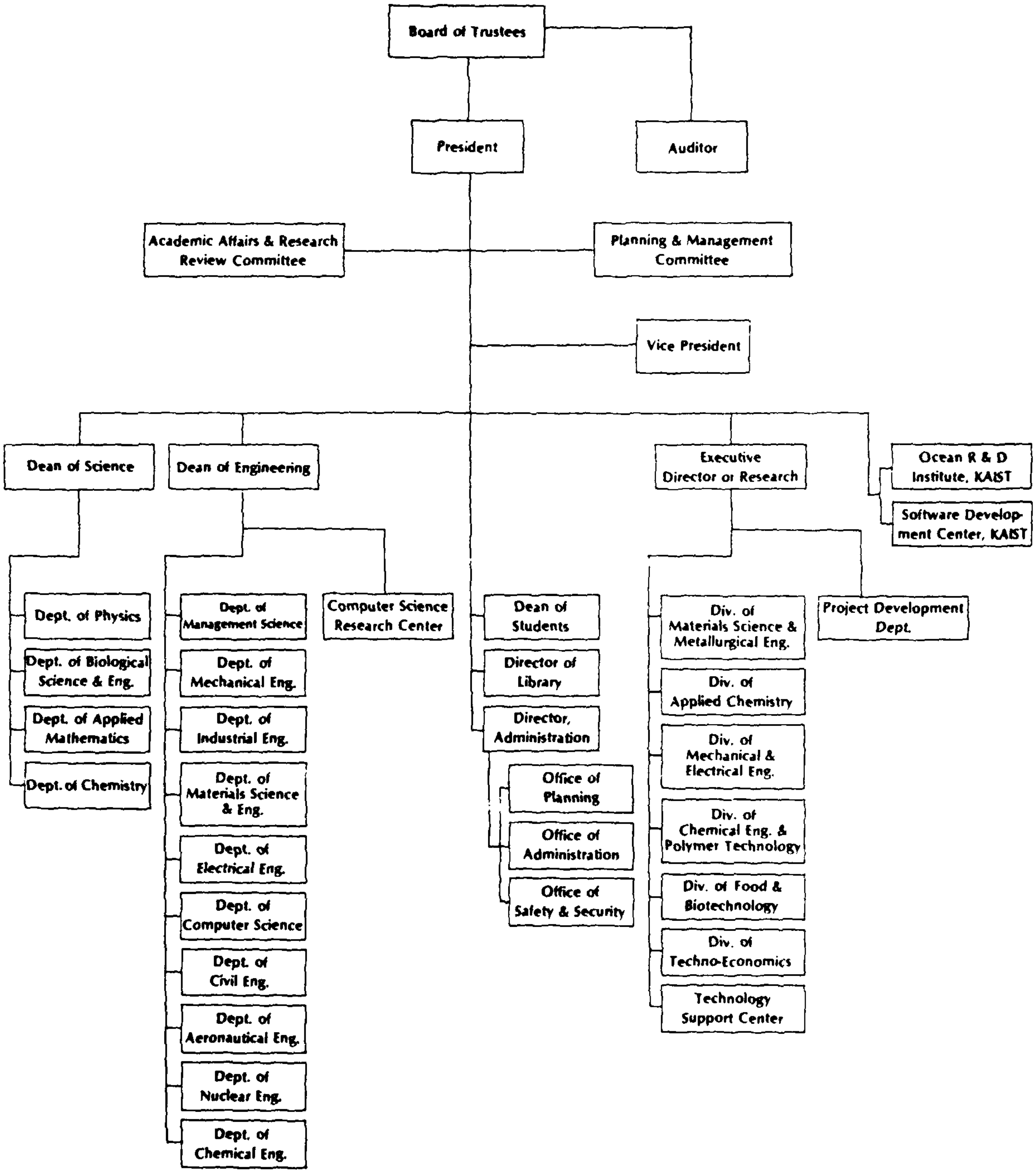


Figure 1. The Organization of the Korean Advanced Institute for Science and Technology (Courtesy of KAIST)

TABLE I

KAIST OUTLINE (+)

Location

- Faculty of Science and Engineering
  207-43, Cheongryangri-dong, Dongdaemoon-gu
  Seoul, Korea

- Research and Development Division
  39-1, Haweolgog-dong, Seongbug-gu
  Seoul, Korea

Buildings

Main and Laboratory Buildings	62,726 m
Subsidiary Facility	24,918 m
Residence	33,383 m
Incheon Annex	4,924 m
Total	125,951 m

Staff

Executive	2
Faculty	107
Research staff	446
Other personnel	690
Total	1,245

- Affiliated Software Development Center

Location	39-1, Haweolgog-dong, Seongbug-gu, Seoul, Korea
Staff	231 (research staff: 103)

- Affiliated Korea Ocean Research and Development Institute

Location	215-1, Seocho-dong, Gangnam-gu, Seoul, Korea
Staff	105 (research staff: 57)

(+) Provided Through the Courtesy of KAIST

SEOUL NATIONAL UNIVERSITY

Michael J. Koczak

OVERVIEW: EDUCATIONAL SYSTEM IN KOREA

The Korean educational system is based on traditional lines, as shown in Table I, i.e., primary, middle, high schools, and universities. In 1980, there were 224 universities or colleges with 85 having four year curricula. In 1982, this number was increased to 98. The Education Ministry administers quotas for the four year colleges for admission as well as for graduating seniors, e.g., 202,460 entering freshmen are permitted in 1983, and a graduation quota of 155,840 in 1987 has also been set. By varying quotas for different universities, different academic areas may be emphasized, e.g., languages, basic sciences, engineering while other disciplines can be diminished. Admission to the university is a two-step process. An initial qualifying examination is administered by the state followed by a second examination at the university where students seek admission. Although these restrictive undergraduate admission quotas are imposed on the national and university levels; at the graduate level, in the next three years they will be increasing the number of Ph.D.s in engineering and science from 2000 to 2500. The sources of the Ph.D. graduates will be national universities, KAIST, and foreign-educated Koreans. In 1982, 100 Ph.D.s joined the university, industrial, and research staffs in Korea. In 1985, it is anticipated that 500 will join the teaching and research ranks. Naturally, viable employment positions for these individuals must also be generated so that their contributions can be fully utilized. Clearly, this is an area of concern for the graduate students as well as the faculty. Notwithstanding the concerns of future employment prospects, the Korean government's Education Ministry is providing a stimulus to the universities for the promotion of technically trained Ph.D.s for future roles in research institutes, industries, and universities.

SEOUL NATIONAL UNIVERSITY

Seoul National University, located 16 km east of Seoul, is the top-ranked Korean engineering and science university. The College of Engineering was established in 1946, (Figure 1) and is a fully supported university with eighteen academic departments. In addition, three basic science divisions, Applied Chemistry, Applied Mathematics, and Applied Physics, are located in the College of Natural Science. The graduate and undergraduate enrollments for the various departments are shown in Table II.

The total number of undergraduates in the College of Engineering numbers 2400 with 1000 master's students and 600 doctoral students. The faculty in the college numbers 193 with nearly all the faculty involved in research, teaching, and as advisors to the government research efforts. Within the College of Engineering is the Institute for Industrial Science which supports four common facilities: the Material Testing Center, the Fine Instrumentation Center, the Instrumental Analysis Center, and a machine shop.

The Department of Metallurgical Engineering has an associated materials testing laboratory which was constructed in 1975. The Department of Metallurgy has 11 faculty members with research areas in physical metallurgy, extractive metallurgy, and production processes. Dr. Son Joe Kim is the Department Head, and also President of the Korean Institute for Metals. The university has an elite student body coupled with a well-educated staff. Nearly half of the faculty have doctorate degrees from foreign universities. The combination, a good faculty and motivated students, provides a fine formula for educational success.

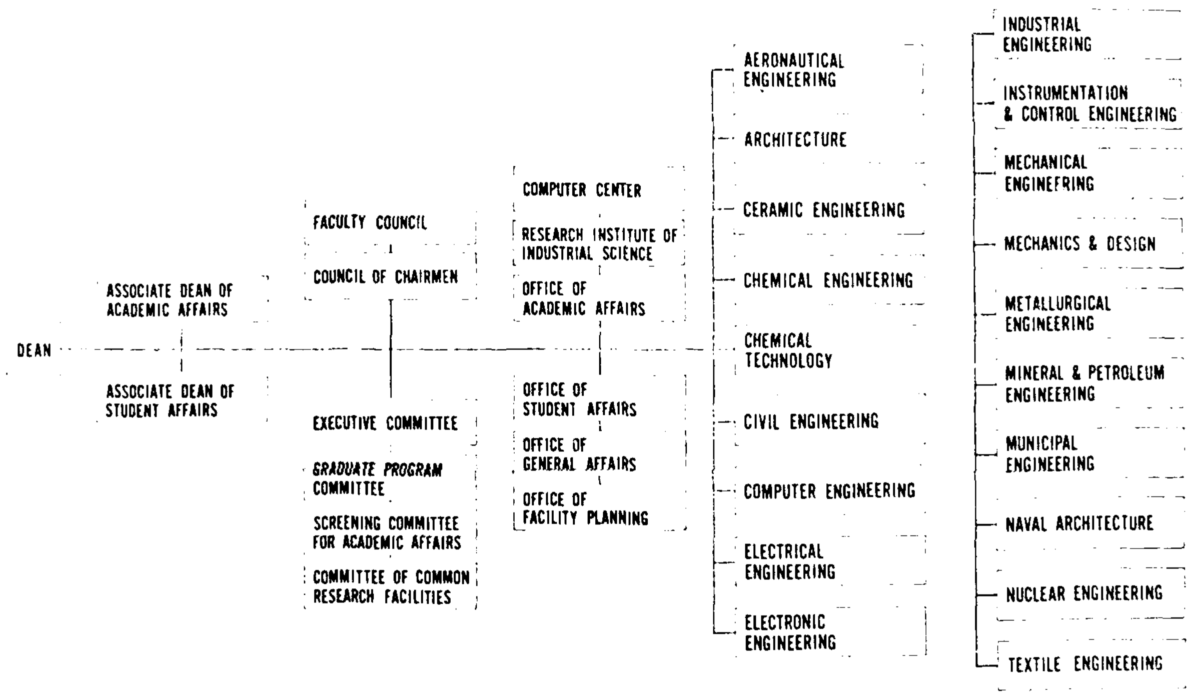


Figure 1. Organization of the College of Engineering of Seoul National University

TABLE I

1980 KOREAN EDUCATION PROFILE

	Number of Schools	Number of Students
Graduate Schools	121	33,939
Universities/Colleges	224	577,109
High Schools	1,354	1,696,792
Middle Schools	2,100	2,471,997
Primary Schools	6,487	5,658,002

TABLE II

Enrollment at Seoul National University's College of Engineering

Department	Undergraduate (Sophomore-Senior)	Graduate (Master)	Graduate (Doctorate)
Aeronautical Engineering	90	40	30
Architecture	120	60	45
Ceramic Engineering	90	40	30
Chemical Engineering	150	60	45
Chemical Technology	105	50	30
Civil Engineering	120	70	45
Computer Engineering	120	30	10
Electrical Engineering	180	60	30
Electronic Engineering	150	60	30
Industrial Engineering	90	50	45
Instrumentation & Control Engineering	120	20	10
Mechanical Engineering	150	50	30
Mechanics & Design	210	80	45
Metallurgical Engineering	150	70	45
Mineral & Petroleum Engineering	120	40	18
Municipal Engineering	60	40	30
Naval Architecture	150	50	45
Nuclear Engineering	90	40	21
Textile Engineering	120	[illegible]	[illegible]
Total	2,385	1,000	602

A SEMINAR IN SRI LANKA
FUNDAMENTAL STUDIES: PRESENT ATTITUDES AND FUTURE PROSPECTS

Leslie C. Hale

An Inaugural Seminar on the theme, Fundamental Studies: Present Attitudes and Future Prospects, was held at the imposing Bandaranaike Memorial International Conference Hall, Colombo, Sri Lanka, in the period 1-11 December 1982. The seminar was organized by the Institute of Fundamental Studies (IFS) of Sri Lanka, (formerly Ceylon) with support from the United Nations Industrial Development Organization (UNIDO), United Nations Educational, Scientific, and Cultural Organization (UNESCO), United Nations Development Program (UNDP), ICTP (Trieste) and the Government of Sri Lanka. The purpose of the seminar was to find a rationale for the recently formed Institute which is envisioned as a center of excellence possibly inspired by the Tata Institute of India, but in search of a more specifically Sri Lankan character. One of the problems faced by the Institute is typified by the able young director, N. Chandra Wickramasinghe, who holds a professorship at Cardiff which he would probably be unwise to relinquish to spend more time in Sri Lanka. There are many able Sri Lankan scientists, but those who have chosen to remain in the country have been consigned to relative isolation and obscurity largely through lack of facilities.

Although some lip service was paid to industrial development, it became clear at the outset that food for the mind was more to the liking of most of the participants. In the opening address, J. R. Jayawardene, the President of Sri Lanka, conceded that Eastern religious tenets contribute to slow and uneven technological development in South Asia. Nevertheless, he came out strongly for the "pursuit of Truth for Truth's sake." Mr. Ronnie De Mel, the Minister for Finance, took a different view pleading for science to provide research and development geared to specific needs, but he and Cyril Ponnamperuma (a well-known Sri Lankan who directs the Laboratory of Chemical Evolution at the University of Maryland) who spoke on "Chemistry in the Conquest of Hunger" were in the minority.

Within hours of landing in Sri Lanka, I was startled to hear a Hindu physicist describing himself as a Cavendish student of Lord Rutherford, wax enthusiastic about the contemplative science of Plato and Aristotle, and condemn Galileo for "opening Pandora's box" contending that experimental science has not given us a moment's peace since. The opening Buddhist statement was relatively sympathetic toward science--as long as we concede that science is a second-rate activity compared to the contemplation of Nirvana then if one does it one should do it well. Both the Hindu and the Buddhist implied that many of the ideas of modern science, such as an oscillating universe, were a part of their ancient lore.

About a quarter of the fifty-odd lectures were in the area of religion, politics, and philosophy, but fully half were in the combined areas of astronomy, astrophysics, and those areas of biology and geophysics possibly relevant to cosmology and exobiology. This reflects the interests of the Director who is widely known for his collaboration with Sir Fred Hoyle on some very unconventional ideas about the biological nature of interstellar dust and the evolution of life to the virus and bacteria stage on comets, and the continuing interaction of this genetic material with terrestrial life. This did not imply the assemblage of a group of synchophants, however, as many of the participants were quite critical of the Hoyle-Wickramasinghe theories. In particular, Professor Gustaf Arrenhius of the University of California at San Diego (UCSD), the grandson of the Swedish scientist most generally associated with the "panspermia" idea of populating the universe politely, but meticulously, raised detailed objections to much of the H-W work. In private, however, most of the participants were quite willing to consider the H-W theories as serious scientific work in contrast to much of the scientific press which has tended to lump H-W with Velikovsky and von Danniken. The consensus was that they had raised some very serious and important questions which may eventually lead to major advances.

Interesting new material on microfossils in meteorites was presented by H. Pflug from West Germany, and some older work was discussed by Bart and Lois Nagy from the University of Arizona. The strong suggestions of extraterrestrial origins is still faced with some scepticism voiced by Cyril Ponnamperuma in terms of the difficulties in being sufficiently prompt and careful in analyzing samples. A suggestion was made by Professor Arrenhius of the need for a group on alert with a "kit" for the rapid analysis of carbonaceous meteorite falls.

Several more conventional areas of science, particularly astronomy, received awe-inspiring treatment. Professor S. Hayakawa of Nagoya University talked about infrared measurements and Professor Arnold Wolfendale of the University of Durham and Professor Larry Peterson of the University of California at San Diego (UCSD) discussed gamma ray observations. I learned that the question of the mass of the neutrino is by no means settled and that the whereabouts of much of the mass of the universe is in any case still under dispute since molecular hydrogen is inaccessible to direct observations.

Professor Phil Solomon of the State University of New York (SUNY) at Stony Brook discussed millimeter observations of molecular clouds and inferred very different H_2 densities than those inferred from gamma ray astronomy. Professor David Walton of the University of Essex discussed the microwave observations of complex molecules. Professor Walton is living in Sri Lanka as a consultant on higher education and was considerably exasperated about attempts to publish scientific textbooks in Sinhalese in a country where English is widely spoken.

Professor Hoyle, who had given a interesting talk on "From Virus to Cosmology" on the opening day, also gave an interesting talk on straight astrophysics, "The Origin of Chemical Elements in Stars," describing the highly successful current status of computation in this field.

Lectures in biology and ecology were given by Dr. G. Fryer and Dr. J. N. R. Jeffers of the United Kingdom. Dr. Fryer talked of the importance of the simple observation of organisms to environmental and food supply problems and Dr. Jeffers emphasized the use of computers in modelling complex ecosystems, particularly for checking options. An example was the English Lake District, one of the few instances of inefficient agriculture in England, with sheep used primarily as lawn mowers to keep the region in what is certainly not a "natural" state. But clearly overriding social reasons for keeping the area as it was in the time of Wordsworth dominate all other considerations in this case.

Three local Sri Lankans gave lectures on biological topics. Professor Hilary Crusz of the University of Peradeniya made an impassioned plea not to abandon Darwinism; Professor R. Ramaswany of the University of Jaffna lectured on genetic information and engineering; and Dr. L. B. DeSilva of the Medical Research Institute talked on medicinal plants.

Other Sri Lankan lecturers included Mr. Roland Silva on "Engineering Principles Behind the Largest Brick Monuments in the World," an appropriate topic since some of the "stupas" of Sri Lanka, in classic Buddhist shape, are among the largest such structures in the world. Ionospheric research in Sri Lanka was discussed by Dr. S. Gnanalingam of the Ceylon Institute of Scientific Research who has surmounted the difficulties of isolation to become world-renowned in his field despite working under less than ideal circumstances. The location between the geographic and geomagnetic equator apparently leads to strong effects in shortwave radio absorption which are only weakly suggested by data from other locations.

Three talks were presented on atmospheric science topics, including a review of atmospheric research in the Antarctic by Dr. Michael Rycroft of the British Antarctic Survey and lectures on aerosol particles in the atmosphere by myself and by Dr. E. K. Bigg of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO).

Fritjof Capra from the University of California at Berkeley presented an entertaining lecture extolling the wisdom of the East and seamlessly stringing together words such as ecological, holistic, mystic, and spiritual. Professor Z. Kopal from the University of Manchester asserted that we have not recently seen intellects of the quality of Newton, Gauss, and Poincaré and contended that this was statistically anomalous, but his methods of analysis were challenged by several participants.

Inputs from sponsors were provided by Dr.(Mrs.) M. Vanucci of UNESCO and Professor Nayudamma of UNIDO. A common theme was for third world countries to do their own work and "leapfrog" into new areas. One idea that seemed to recur during the conference was that the advent of cheap computers could be a boom to developing countries, particularly because of their need to organize data from observational science rather than to conduct expensive active experiments. Perhaps this approach will facilitate a natural Asian tendency not to disturb the universe while still producing worthwhile and challenging intellectual activity. The rationale for the IFS might well focus on some aspects of good indigenous Sri Lankan science in the biological (possibly oceanographic) or geophysical (possible atmospheric) sciences.

There was some conflict between the bustling in and out of Northern Hemisphere westerners well into winter commitments and the relatively leisurely pace of the conference which afterward included a tour of this beautiful country. Unfortunately, I had to leave after seven days of meetings and thus missed not only the tour but many undoubtedly fascinating lectures by people like Arrenhius and Alfven, Asoka Mendis (a Sir Lankan planetary scientist at UCSD), Sreekantan and Narlikar of the Tata Institute, a third paper (on cosmic dust) by Fred Hoyle, and a talk by Arthur C. Clarke, Chancellor of the nearby University of Moratuwa, who displayed recent radar maps of the subsurface Sahara which indicate previously undiscovered ancient civilizations.

All in all it was a most stimulating week, and for this observer produced at least some consciousness-raising on Asian problems in a U.S.-European oriented person (albeit with some South American and African experience which seemed strangely inapplicable). Perhaps the most indelible experience was hearing Mr. De Mel and Mr. Jayawardene extol the needs for both effective action and for quiet contemplation with no little tension between the two. I felt a bit of guilt about complaining about perceived strictures in research funding after seeing some very fine work being done with really small resources such as the study of equatorial lightning by scientists at the University of Colombo.

At the conference rather free discussion was permitted. The two most persistent voices were an elderly man who continually insisted that all of what we were doing was unnecessary if we would only heed a certain religious leader and a young man who kept saying rather loudly that all problems could be reduced to a Cartesian grid and modelled on computers. If Sri Lankan science can steer into the Middle Way (a Buddhist concept) between extremes, it should find an important niche for its indigenous science in addition to supplying the world with a disproportionate share of first-rate scientists.

CONFERENCE REPORT ON THE MAGNETIC FIELD EFFECTS UPON DYNAMICAL BEHAVIOR OF MOLECULES

James E. Butler

INTRODUCTION

The 16th Okazaki conference entitled, Magnetic Field Effects (MFE) upon Dynamical Behavior of Molecules, was held at the Institute for Molecular Science (IMS), Okazaki, Japan, on 17-19 January 1983. The conference began with Professor Nagakura (Director, IMS) presenting a review of the history of MFE on the dynamics of chemical and physical events, and an overview of the theoretical interpretation of many of the observations. The two major classes of MFE discussed by Professor Nagakura were:

- changes in the chemical reaction pathways of radical pairs in solution, and
- the inter and intramolecular dynamics of excited states of gaseous molecules.

The theoretical interpretation focused on the mechanism and dynamics of the interconversion of singlet and triplet spin states of unsaturated molecules as in class two above, or derived from pairs of the doublet spin state of free radicals or ions as in class one. Very weak perturbations, such as nuclear hyperfine coupling, and/or differences in the Zeeman effect (Δg) of the two correlated doubles, e.g., class one above, can give dramatic changes in the chemistry because the differences in the rate of recombination (vs. diffusion apart) for the "single" vs. the "triplet" radical pair state. In gaseous molecules, the primary effect is the Zeeman tuning of the paramagnetic levels (e.g., triplets) of molecules into (Fermi) resonance with nonparamagnetic levels (singlets) and thus opening new channels for dynamical relaxation.

DISCUSSION

In consecutive lectures, Professors A. Tramer (University of Paris-Sud) and M. Lombardi (University of Science and Medicine, Grenoble) presented a "tour de force" on the MFE's in the glyoxal molecule. Professor Tramer began by discussing the collision induced intersystem crossing in glyoxal and use of the MFE to isolate "gate" levels where accidental "near" degeneracies exist between the molecular singlet and triplet states, and which exhibit enhanced cross-sections for the collision induced intersystem crossing. This confirms the spectroscopic observation that the singlet state is weak, and that the density of triplet states is low ($\sim 1/cm^{-1}$) in the region of the singlet. Professor Lombardi carried the discussion further by presenting the MFE detection of the spectroscopy of level anticrossings of glyoxal cooled in a supersonic nozzle beam. From the MFE on the level anticrossing of singlet and triplet states, and the detailed assignment of the singlet states, his group identified the perturbing triplet states and thus determined that the dominant mixing terms in the Hamiltonian were either the vibronic spin-orbit, or the spin-rotation-vibration-rotation interactions, not the direct spin-orbit. Finally, Professor Lombardi presented recent data on quantum beats observed in the fluorescence of C_2H_2 whose frequency implies a triplet state density 100 times larger than expected.

The application of the MFE to the study of bacterial photosynthetic centers was discussed by G. Closs (University of Chicago). The technique employed, reaction yield detected magnetic resonance, enabled the observation of transitions between the short-lived (~ 1 ns) radical pair states by the changes in a molecular triplet state EPR signal when a scanning microwave frequency was applied to the sample. He determined that the magnetic dipole-dipole interaction between the radical pairs was larger, by an order of magnitude, than the exchange interaction. Modeling of these results suggested that the chlorophyl molecules lie on top of one another separated by approximately a van der Waals radius, 4 Å. A major point stressed by Professor Closs was that the dipole-dipole interaction, which is averaged by rapid tumbling motion in most liquids and thus is usually ignored, will be important in constrained media, e.g., micelles, solids, membranes, etc.

Another study of electron paramagnetic resonance (EPR) of short-lived radical pairs states was presented by Y. N. Molin (Institute of Chemical Kinetics and Combustion, Novosibisrk) in which he studied liquid solutions of aromatic radical ion pairs in saturated hydrocarbon solvents. The EPR transitions between "singlet" and "triplet" radical ion pairs was observed by the decrease in fluorescence arising from the recombination of singlet radical pairs. The sensitivity of this technique was sufficient to observe concentrations as low as 20 pairs per cc. Amongst the many pairs reported was the durene cation-solvated electron anion. Geminate recombination of the tetramethyl ethylene cation and the perdeutero-triphenyl anion in liquid solution gave extremely large quantum beats in the fluorescence. The origin of the quantum beats is the interference between the singlet and the triplet hyperfine states, which are regularly spaced in high field, hence the large modulation amplitude of the quantum beats.

A theoretical interpretation of the MFE in emission from gaseous molecules was detailed by Y. Fujimura (Tohoku University), including a discussion about the effect of collisions on quantum beats. Experimental results on the MFE on level crossing, photodissociation, and predissociation of NaK were presented by H. Kato (Kobe University and IMS). Professor E. Hirota (IMS) discussed an interesting example of Zeeman effects in the singlet-singlet ($\tilde{A} \leftrightarrow \tilde{X}$) transition of bent carbenes, CHF and CHCl. These states are derived from the $^1\Delta$ state of the linear configuration, and are perturbed by singlet-triplet mixing in the case of CHCl, and also electron-corolis interactions in the case of CHF.

M. Iwasaki (Industrial Research Institute, Nagoya) reported EPR studies of radical pairs in low temperature materials induced by radiation chemistry (primarily x-rays). For example, the $CH_3\cdot$ + H• pair was observed only from CH_4 while larger hydrocarbons gave R• + R'•, with a separation between the radicals of typically 8-25 Å. In electron scavaging matrices, e.g., SF_6, RH^+ was observed indicating that ionic mechanisms also occur. The kinetic isotope effect on the reaction of hydrogen radicals with ethane and perdeutero-ethane in Xe matrices was observed to vary from 2 (at 30 K) to 60 (at 50 K). K. Itoh (Osaka City University) presented studies on attempts to make high spin states of organic substrates by exploiting the nonbonding molecular orbitals in alternate hydrocarbons, e.g., ϕ-Ċ-ϕ-Ċ-ϕ. He observed an S=4 state for ϕ-Ċ-ϕ-Ċ-ϕ-Ċ-ϕ-Ċ-ϕ which the temperature dependence indicated was the ground state.

Experimental results on the MFE on reaction pathways, e.g., recombination of singlet radical pairs *vs.* the diffusion apart of triplet radical pairs were reported by Y. Sakaguchi (Institute of Physical Chemical Research) for benzophenone +RH in micelles, and by Y. Tanimoto (Kanagawa University) for quinones in micelles. N. Hata (Aoyama University) used the MFE to show that the photochemical rearrangement of some aza-aromatic compounds occur via radical pair mechanisms involving the solvent alcohol with the singlet-triplet mixing caused by the hyperfine and exchange interactions.

A number of papers presented interesting, but as yet unexplained, observations of MFE's. The MFE on the OH (A → X) emission in flames (O_2 + H_2) was reported by H. Hayashi (Institute of Physical Chemical Research), on collision-induced D_2CO emission by H. Morita (Chiba University), and on methyl glyoxal and biacetyl emission by I. Nakamura (Institute of Physical Chemical Research). H. Kuroda (University of Tokyo) reported a MFE on the delayed fluorescence of tetramethyl p-phenylene diamine crystals which also exhibits a photocurrent and dichroic behavior when excited into the first singlet band.

CONCLUSION

In his closing remarks, Professor S. Nagakura stressed the resurgence of interest in the last ten years in using and exploiting magnetic field effects (MFE) for studying and altering molecular processes.

PHYSICS AT YONSEI UNIVERSITY, KOREA

Sung M. Lee

INTRODUCTION

In this report, I would like to introduce Yonsei University to the educational and research communities of the United States and to describe in some detail the research activities in its physics department. This is motivated by my recent observation that Yonsei has a substantial capability to contribute to physics research that is not being fully utilized by the educational communities at an international level. At the same time, Yonsei has much room to grow by learning to expand its horizons and by seeking collaborative working relationships with other research groups.

The report is based on my recent visit to the university, my alma mater. The school has changed and grown tremendously since the time of my graduation 28 years ago. The positive attitudes of the students and faculty and the overall healthy atmosphere of the university impressed me strongly. Writing this report is a pleasant task by means of which I can renew old friendships with my classmates and teachers.

YONSEI UNIVERSITY

Yonsei is probably the most prestigious private university in Korea. It is due to celebrate its centennial in 1985. The school can trace its origin to 1885 when the first hospital practicing western medicine was opened by royal decree under the auspices of the Korea Mission of the Presbyterian Church in the United States. In 1893, the hospital and the affiliated medical school went through a major expansion with funds made possible through a donation by L. H. Severance of Cleveland, Ohio; these facilities have been known by the name of Severance since that time.

Independently, from the emergence of the Severance Medical College, the Chosun Christian College, later renamed Chosun Christian University, was founded in 1915. Four mission boards pledged cooperation in the administration of the school:

- the Presbyterian Church in the U.S.A.,
- the Methodist Episcopal Church,
- the Methodist Church, South, and
- the United Church of Canada.

The Reverend Horace Grant Underwood, who had been chiefly responsible for the founding of the College, was elected as the first president and Dr. O. R. Avison of Severance Medical College as vice president.

In 1957, the Chosun Christian University and the Severance Medical College combined into one comprehensive university and adopted the name Yonsei. The university is under the leadership of its ninth president, Dr. Se Hee Ahn. Although the historical origin of the school is very evident from the administrative functions of the university, the casual observer of campus activities would not notice undue religious tone in the campus atmosphere other than, perhaps, the existence of an excellent College of Theology.

Yonsei University is located on 250 acres of wooded hills in the northwestern part of Seoul. Its 24,200 students, 5000 of which are graduate students, are enrolled in 60 academic departments, which are organized into seven graduate schools and 14 colleges.

Graduate students pursuing doctoral degrees number 731. There are 669 academic faculty members holding the ranks of instructor to professor. Lecturers, faculty assistants, and medical faculty members number a total of 994. These faculty members are complemented by 1600 support staff, such as medical technicians, nurses, clerical staff, etc.

One unusual feature of the university organization is its auxiliary organization. It is apparent that the underlying philosophy here is that any part of the university function which is not a traditionally academic program is to be identified as an auxiliary function. Thus, such teaching programs as the School of Medical Technology and the Korean and Foreign Language Institute are included in the Educational Institute as part of the auxiliary organization. The Severance Hospital, Central Library, the Audio-Visual Center, and the Computer Center, likewise belong to supportive organizations along with eight other less prominent university functions. There are 21 research institutes, none of which is autonomous in the administrative sense. Many faculty members are affiliated with these institutes, while maintaining their positions in the academic department, in accordance with their research interests.

Faculty research is supported by two methods: internal and external research grants. During the period from March 1981 through February 1982, internal research grants provided $213,000 to 100 projects, and $944,000 was obtained from external sources to support 142 projects. With an enrollment of 5000 graduate students, these figures seem very inadequate even if one takes into account the fact that these grant monies do not go into salary support of the personnel involved.

COLLEGE OF SCIENCE

The College of Science exists independently from the College of Engineering and the College of Liberal Arts. It consists of nine departments:

- mathematics,
- physics,
- chemistry,
- biology,
- geology,
- astronomy-meteorology,
- biochemistry,
- premedicine, and
- predentistry.

The first seven of these departments have 58 faculty members teaching 1357 undergraduate and 313 graduate students. It is remarkable that such a heavy burden on the faculty does not cause any sign of discouragement, but instead a healthy research activity seems to be coming out of it.

The university is currently constructing a large modern building to house the College of Science. Even though the present buildings appear to be adequate, this new facility will provide classroom and laboratory spaces which are equipped with more up-to-date equipment. One strong impression that I received during the tour of the laboratories was the extent of improvisation that the faculty members and the students exercise to make up for the lack of adequate research equipment. It is interesting to speculate on what changes the new building may bring about to this working habit which, from a pedagogical viewpoint, is a healthy one.

The following statistics should be a matter of interest to the research-minded readers: of the 313 graduate students, 82 are pursuing doctorate degrees. Mathematics leads the statistics with 32 doctorate students while physics and chemistry have 15 and 13, respectively. Throughout its existence, the College of Science has produced 267 Ph.D.s, 205 of whom received their degrees overseas. Physics and chemistry lead these statistics with 91 and 64 Ph.D.s respectively.

DEPARTMENT OF PHYSICS

The Department of Physics has 12 faculty members, eleven of whom hold doctorate degrees. Student enrollment consists of 268 undergraduate and 60 graduate students including the 15 doctorate students. A summary of current research activities is listed below:

- Solid State Physics

  Electrical property and luminescence of semi-insulating InP:Fe crystals,
  Deep impurity level recombination center of InP:Fe,
  Cathodoluminescence of semiconductors,
  IR detector, CMT($Cd_xHg_{1-x}Te$),
  Metal-nonmetal transition in doped semiconductors-theoretical study,
  Changes in elastic properties due to hydrogen impurities in metals (hydrogen embrittlement) - theoretical study.

- Nuclear Physics

  Nuclear structure study by means of beta ray and gamma ray spectroscopy,
  Angular correlation measurement of beta gamma and gamma gamma interaction; study of parity,
  Ionization energy by measurement of alpha ray and electron beam stopping power.

- Optics

  Properties of high power CO_2 and N_2 lasers,
  Absorptance and reflectance of materials by means of high power lasers,
  Application of high power lasers to material fabrication,
  Scattering of light by aerosols,
  Holography.

- Theoretical Physics

  Intermediate energy physics--photopion production, meson exchange currents,
  Lorentz transformation in indeterministic space-time,
  Quantization of fields,
  General properties of nonabelian gauge theories,
  Field theory at finite temperature,
  Quantum electrodynamics at finite temperature.

- Magnetic Properties

  Magnetism by means of Mössbauer spectroscopy,
  Magnetism by means of vibrating sample magnetometer,
  Ferromagnetism of amorphous ferromagnets and crystalline alloys,
  Conduction mechanism in the system $(Fe_{1-x}Zn_x)_3O_4$.

- Applied Physics

  Molecule-metal surface interactions,
  Development of experimental technique to analyze mass and energy of low energy ion,
  Amorphous semiconductor wafer by plasma deposition--solar cell application,
  Laser annealing of amorphous semiconductors,
  Ion Implantation--Li^+ and As^+ ions are injected onto the surface of crystalline semiconductors and the characteristics of subsequent ion distribution and PN junctions are investigated,
  Ionic conduction of semiconductors and insulators injected with ions,
  Design and construction of a 400 keV accelerator,
  Properties of liquid injected with ions - Li^+ ion is accelerated by a small 20-keV accelerator and injected into water or other liquid after passing through polymer film of thickness 1 ~ 2 micrometers. The electrical and chemical properties of the liquid enables one to investigate the concentration and transport phenomena of the ions in the liquid.

SOME OBSERVATIONS

The research described above is a testimony to an active physics department. I had to be impressed by the dedication of these twelve faculty members who teach all the service courses and have enough enthusiasm left to direct 60 graduate students enrolled in the department. Faculty and students together seem to form a closely knit department with a positive atmosphere which was pleasant to observe.

The funding level of research is very modest. Much of the equipment is fabricated in the laboratory. While this practice does give invaluable opportunities to the students to dig into many unexpected difficulties that often arise from experimental work and solve them, and thereby contribute to their learning process, it also prolongs the process of "pushing the frontiers of knowledge" when these students have only limited time available for graduate work. It should also be noted that some research, particularly in applied physics, requires the design and fabrication of special purpose equipment as part of research itself. Nevertheless, some compromise must be sought to maximize the educational process of these students.

Extramural research funding of some kind will be needed to improve this situation. Most of the Korean faculty members are not familiar with the type of entrepreneurial activities that their counterparts in the United States often play in order to secure research funds. Nor is it necessarily good to advise them to plunge into such a practice. My view is that there is much to gain mutually if the talent and enthusiasm existing in the Yonsei University physics department is brought into a collaborative research arrangement with other groups in the United States. There are some funding mechanisms that would facilitate such collaborative research activities, such as the National Science Foundation (NSF) and the Korea Science Engineering Foundation (KOSEF) joint funding being the most prominent example.

For further information on the Yonsei University Physics Department, contact:

- *Professor Youn-Kyu Koh*
  Chairman,
  Department of Physics

- Professor Won Mo Chung
  Director,
  Natural Science Research Institute

- Professor Chul Chu Lee
  Dean,
  College of Science,
  Yonsei University,
  Seoul, Korea

SOLID STATE ELECTROCHEMICAL RESEARCH IN THE PEOPLE'S REPUBLIC OF CHINA AND JAPAN

Wayne L. Worrell

INTRODUCTION

During the fall of 1982, I was invited to spend two weeks in the People's Republic of China (PRC) and five weeks in Japan. This was my second visit to China as a guest lecturer at the Beijing University of Iron and Steel Technology (BUIST), and my third visit to Japan. My Japanese visit was sponsored by the Japan Society for the Promotion of Science (JSPS). My impressions of the research activities in the PRC and Japan are summarized in this article. Since my research experience and interests are in solid state electrochemistry and corrosion chemistry at elevated temperatures, these areas are emphasized.

PEOPLE'S REPUBLIC OF CHINA

- Beijing University of Iron and Steelmaking

On October 13, I arrived at the Beijing (Peking) airport where I was met by a welcoming group from the Physical Chemistry Department of BUIST. Many physical improvements since my visit in the fall of 1980 were noticeable, particularly the renovated buildings and the new, modern laboratory facilities. While in Beijing, I gave three lectures, had numerous research discussions at the University, and visited two research institutions: the Central Iron and Steel Research Institute and the Institute of Physics, Academia Sinica. Because Chinese iron ore contains significant concentrations of the rare-earth elements, many of the research activities of the Physical Chemistry Department at BUIST are concerned with the effects of these elements. For example, Professor Zhu's group is investigating the use of rare-earth elements to desulfidize steel and to form nodular graphite in iron while Professor Han's group is using radioactive tracer techniques to determine the concentration and diffusivity of elements such as Ce and Nd in liquid iron and steel.

However, I was particularly interested in the solid electrolyte research group under the direction of Mr. Liu who had recently returned from a two-year research leave with my group at the University of Pennsylvania. For a number of years, this group has worked closely with the Central Iron and Steel Research Institute to develop useful zirconia electrolyte probes to measure the oxygen content of molten steel. Presently, they are collaborating with copper smelting factories to develop a zirconia probe which could continuously measure oxygen in molten copper. As part of their expanding interests in other solid electrolytes they are initiating studies with an oxysulfide electrolyte which Liu and I developed at the University of Pennsylvania.

- Other Research Institutes in Beijing

At the Central Iron and Steel Research Institute (CISRI), I spent most of my time with Mr. Song, the director of the Refractory Materials Research Department. This department is a vigorous and productive one which has several invention awards for their achievements in developing specialized ceramic materials. They gave me several samples of their small zirconia electrolyte tubes which are used by Lui's group at BUIST for their oxygen probe research. I was told that the zirconia electrolyte project is only one example of the active and continuous collaboration between the CISRI and BUIST. The close association appears beneficial to both organizations. The CISRI has excellent, up-to-date research facilities and equipment while the University has younger and more vigorous researchers.

While in Beijing, I also visited the Institute of Physics where Mr. Chen is leading a recently established group in solid state ionics. This group is mainly interested in fast lithium-ion conductors which could be useful in batteries. They are investigating two-phase systems where grain boundary or surface effects could significantly increase the lithium-ion conductivity. For example, they report that a mixture of amphorous and crystalline $Li_2B_2O_4$ and additions of Al_2O_3 to LiCl and LiI increased the lithium-ion conductivity by a factor of 100 over that observed for the single phase, crystalline lithium compounds.

- Some General Impressions of Chinese Research

Several general impressions were formed during my second visit to the People's Republic of China. The government is strongly committed to becoming an equal contributor in the international community of scientific research and development. They are purchasing the best, most modern equipment and are sending many of their researchers abroad for research training and experience. It also appears that the more innovative researchers, like Mr. Liu and Mr. Chen, are supported and encouraged to develop new, active research programs when they return. However, it will be interesting to observe the progress of these new research initiatives, particularly in an environment where changes and advances are usually very slow.

JAPAN

- Hokkaido and Tohoku Universities

After two weeks in the People's Republic of China, I went to Japan on October 27 to begin a five-week JSPS fellowship visit. My trip began in Sapporo where I visited the Metals Research Institute at Hokkaido University. Professor K. Nishida's high temperature corrosion research and Professor N. Sato's electrochemistry laboratory were of particular interest to me. For a number of years, Professor Nishida's group has been investigating the role of sulfide formation in the high temperature corrosion of iron alloys. Recently, they have clarified the importance of grain boundary segregation in the sulfidation of iron-chromium alloys. Professor Nishida has a well-deserved international reputation, and his retirement in 1983 will leave a significant void in Japan's high temperature corrosion research. Professor Sato's electrochemistry group is an extremely active and comprehensive one. I was particularly interested in their use of ellipsometry and Auger electron spectroscopy to study the selective surface oxidation of iron-nickel alloys. These two research groups establish Hokkaido University as the academic leader in Japanese corrosion research.

After Hokkaido, I went to Sendai where I visited several research institutes and the Department of Metallurgy at Tohoku University. At the Research Institute of Mineral Dressing, I had research discussions with the Ironmaking, Steelmaking, Pyrometallurgy, and Electrometallurgy Divisions. I also visited the Research Institute for Iron, Steel, and Other Metals, and various research groups in the Department of Metallurgy. The extensive and comprehensive research programs at Tohoku University are very impressive. The present organization of the metallurgical research activities are divided into two research institutes and one academic department which creates a highly competitive and productive environment. The various research groups are actively pursuing forefront research. However, I have the impression that even greater advances would result if there were closer communication and cooperation between the academic departments and the research institutes.

- Tokyo Institute of Technology

The next stop on my Japanese itinerary was the Tokyo Institute of Technology (TIT). In addition to presenting a series of four lectures on "Recent Advances and Applications of Solid State Ionics," I had extensive research discussions with five research groups.

Professor M. Taniguchi, who was my JSPS host scientist, and his research group in the Department of Chemical Engineering are well-known for their precise investigations of the structures, phase relationships, and nonstoichiometry in transition metal sulfides. Recently, they have shown the need for some kinetic studies including the sulfidation of vanadium and the oxidation of vanadium sulfides. They are also starting a sulfur sensor research project using a CaF_2 solid electrolyte.

Professor M. Kato also has an active and comprehensive research group in the Department of Inorganic Materials at TIT. His group is interested in a wide range of ceramic materials including zirconia, titanates, transition-metal nitrides, and ZnO varistors. During my visit to Professor K. Goto's research group in the Department of Metallurgical Engineering, we discussed their solid electrolyte research projects. They have used a beta alumina solid electrolyte to measure sodium oxide activities in silicate melts and are currently investigating the use on Al_2O_3-AlN solid solution as a nitrogen sensor in liquid steel.

During an interesting day at the Nagatsuta campus of TIT, I visited Professor Y. Saito's and Professor S. Somiya's research groups in the Research Laboratory of Engineering Materials. The research activities in Professor Saito's group include solid electrolyte studies, oxidation of alloys, and new thermal analysis techniques. I was particularly interested in their use of Na_2So_4 and NASICON electrolytes to measure SO_2 concentrations in air. They have had problems with porosity in their sintered Na_2SO_4 electrolytes. Thus, they are currently using high-density NASICON electrolytes which provide a reversible cell potential due to the formation of a thin film of Na_2SO_4 on the surface of the NASICON electrolyte in an SO_2 environment.

Professor Somiya's laboratory for hydrothermal synthesis is extremely well-equipped. I was particularly impressed with their two Xenon arc image furnaces which enable one to melt and rapidly quench materials at temperatures up to 3000°C. This active research group has established an international reputation in the use of hydrothermal techniques to prepare well-characterized powders of ceramic materials.

- Other Laboratories in the Tokyo Area

Professor K. Fueki of the Department of Industrial Chemistry at the University of Tokyo has a particularly active and comprehensive research group in high temperature solid state chemistry. Their current research activities include perovskite-type oxides, thermochemical cycles for hydrogen production, and the application of O^{17} nuclear magnetic resonance to determine the oxygen vacancy diffusion coefficient in CeO_2 doped with Y_2O_3. The perovskite-type oxides are particularly interesting materials because their high electronic conductivity suggests many useful electrode applications under oxidizing conditions. Professor Fueki's research group has been investigating the nonstoichiometry, defect chemistry and oxygen diffusivity in several of these oxides including $La_{0.9}LR_{0.1}CoO_{3-\delta}$ and $La_{0.9}Sr_{0.1}CrO_{3-\delta}$.

My three-week stay in Tokyo was interrupted by my participation in the Third Japan Institute of Metals International Symposium (JIMIS-3) on the High Temperature Corrosion of Metals and Alloys. There were 131 (44 foreign) attendees and 84 papers at this symposium which was held on 17-20 November 1982 at Hotel Mt. Fuji, Lake Yamanaka. The symposium has been reviewed by Dr. Michael J. Koczak in the ONR Far East *Scientific Bulletin 7* (4), 40 (1982).

While in the Tokyo area, I had the opportunity to visit two government research institutes and the Central Research Laboratory of Hitachi. At the National Research Institute for Metals, I met with Dr. K. Nii, director of the corrosion division. His group has been investigating the role of sulfur surface segregation on oxide-scale adhesion. Some of their very interesting results were presented at JIMIS-3. They are also interested in determining how extremely small amounts of yttrium improve oxide-scale adherence on high temperature alloys.

During a day at the National Institute for Research in Inorganic Materials in Tsukuba, I met with several research groups. The sulfide group under the direction of Dr. I. Kawada has completed studies of the phase relationship and nonstoichiometry in the TiS_x system and is initiating investigations of the double molybdenum sulfides, i.e., $M_xMo_4S_8$. Another research group under the direction of Dr. S. Shiraski has quite diverse research interests including the segregation of Li_2O in ZnO varistors, oxygen diffusion in oxides, and the phase relations and surface structure in the MgO-V_2O_3-VO_2 system.

At the Central Research Laboratory of Hitachi, I visited the Electrochemical Devices Group whose research is clearly directed toward the development of new products. This group recently developed a new lithium solid state primary battery using a Li_3N-LiI-LiOH electrolyte. Currently, they are attempting to develop a lithium rechargeable thin film battery using an amorphous $LiPO_4$-Li_4SiO_4 electrolyte and a TiS_2 cathode.

- Kyushu, Osaka, and Kyoto Universities

During my last week in Japan, I travelled to three universities in the southwest. At Kyushu University in Fukuoka, I first visited Professor Y. Oishi who is busy completing his current research projects before he reaches the mandatory retirement age this year. Professor Oishi's group in the Department of Nuclear Engineering is interested in the lattice and grain boundary diffusion in oxides. Using an improved method developed in their laboratory, they have investigated the effects of various dopent cations upon the zirconium diffusion coefficient in stabilized zirconia.

At the new campus of Kyushu University, I met with Professor T. Seiyama and N. Yamazoe in the Department of Materials Science and Engineering. Their new laboratory facilities are excellent. I was particularly interested in their chemical sensor research activities. One project is an investigation with palladium-modified SnO_2 semiconducting sensors. They are also interested in several types of hydrogen-ion conducting materials. Their moisture sensor activities include the use of porous alumina and doped $SrSnO_3$. This group appears to be the academic leader in Japanese chemical sensor research. Thus, it is appropriate that they are organizing an "International Meeting on Chemical Sensors" which will be held in Fukuoka next September.

At Osaka University, I spent one day with Professor Z. Kozuka in the Department of Metallurgical Engineering. His group has been active in using zirconia solid electrolytes to determine the thermodynamic properties of alloys and oxide solid solutions, and to measure the solubility and chemical activity of oxygen in liquid metals and alloys. Currently, they are also investigating the use of Na_2SO_4 and sodium beta alumina solid electrolytes as SO_2 sensors. The sodium beta alumina electrolyte appears to form a Na_2SO_4 surface layer in an SO_2 environment and to function in the same manner as described earlier for the NASICON cell in Professor Y. Saito's laboratory at the Tokyo Institute of Technology.

There appears to be an interest in developing SO_2 and sulfur sensors in Japan. Representatives from several Japanese industries attended my lecture at Osaka University. One company requested and received information from a recent patent application regarding some new SO_2 sensors developed in our laboratory at the University of Pennsylvania. I also met Dr. A. Egami of the Central Research Laboratory of Kobe Steel who has done extensive research to develop a solid electrolyte suitable for measuring sulfur contents in liquid steel.

My last laboratory visit was in the Department of Metallurgy at Kyoto University. I spent one day with Professor K. Ono's group who has studied the factors affecting the performance of zirconia-based oxygen probes in liquid copper. In their current investigations of the Cu-S-O and Cu-H-O systems, they are using the preferred magnesia stabilized zirconia electrolyte and a $LaCrO_3$ lead to provide electrical contact with the copper melts.

- Some General Comments Concerning Japanese Research

During my five weeks in Japan, I presented 15 lectures on four different topics, participated in two symposia, and visited seven universities, two government research institutes, and one industrial research laboratory. It was an obviously active and stimulating visit which enabled me to learn the direction and the diversity of current research activities. The Japanese researchers are very industrious; a six-day work week is quite common in the university laboratories. In general, the research projects appear to be adequately funded, and the research equipment is equal to, or better than, that in comparable U.S. universities. Many of the more active research programs involve the development of new techniques or materials for specific technological applications. My overall impression is that solid state electrochemical research in Japan is vigorous and quite competitive with similar activities in the U.S. and in Western Europe.

THE FOURTH SOUTHEAST ASIA REGIONAL COMPUTER CONFERENCE

George E. Lindamood

INTRODUCTION

The Fourth Southeast Asia Regional Computer Conference, SEARCC '82, was held 19-22 October 1982, at the Hilton Hotel, Kuala Lumpur, Malaysia, under the joint sponsorship of the Hong Kong Computer Society, the Computer Society of India, the Indonesian Computer Society, the Malaysian Computer Society, the Philippine Computer Society, the Singapore Computer Society, and the Computer Association of Thailand. The Malaysian Computer Society served as host and did a magnificent job. This was the best planned and executed conference this writer has had the pleasure of attending.

The conference was opened (a few minutes ahead of schedule) by Secretary-General, Mr. Robert Iau. In his remarks, he stated that the purpose of the biennial SEARCC conferences is to promote collegial relationships, cooperation, and mutual self-help among computer personnel in the region. He noted that it was the intent of conference organizers to stress relevance to the needs of the region and its computer professionals rather than focus upon the "highest" technologies.

Mr. Iau then introduced the Malaysian Minister of Science, Technology, and Environment, Y. B. Datuk Amar Stephen K. T. Yong, who gave a short opening address. Mr. Yong noted that Singapore, the site of the first SEARCC in 1976, was regarded by the southeast Asian nations as the regional leader in computerization. He affirmed his own country's goals in seeking to make wider use of computers in business and government and in promoting greater general public awareness of what computers can and cannot do. To strengthen Malaysian science and technology, he advocated the establishment of a central computer complex and a computerized scientific information center linked to other such centers throughout the world. He stated that the long-term goal was to bring about increased computer usage by focusing on younger people by encouraging them to learn about computers through hobby clubs in the public schools, and upgrading and expanding university facilities and programs in computing. Software, not hardware, should be the focus, he said.

After concluding his remarks, Mr. Yong officially opened the conference by striking a large brass gong. This was followed by what was apparently the local equivalent of a fanfare performed by native drummers at the rear of the auditorium. The conference then recessed for a welcoming reception.

THE CONFERENCE

The keynote address, on "Challenges of Information Systems Education in Industry," was given by Dr. Robert W. DeSio, Director of the IBM Systems Research Institute and Technical Education. Dr. DeSio began by describing what he called "the golden era of information." In this connection, he contrasted the past spontaneous growth of the information industry, driven by technology, with the future in which the growth and pervasiveness of computerization will be limited primarily by the ability of people to cope with system complexities and the explosion of information. He then suggested various ways of dealing with the "people problem" focusing on various approaches to education, especially continuing education. He concluded by describing in some detail the various formal education programs within IBM to exemplify what can (and should) be done.

Following Dr. DeSio's address, Dr. T. C. Chen, head of the United College and professor of computer science and electronics at the Chinese University of Hong Kong, presented a delightful lecture on "Computer Technology and the User." Using numerous slides, Dr. Chen first surveyed advances in semiconductor technology suggesting that we may now be approaching the point of "throwaway hardware." Turning next to software, he noted that "computers are the best mind sharpeners since geometry" because "people are forced to become precise, perceptive, and organized when they deal with dumb machines." He presented some fascinating data suggesting that the cost of programming a line of code is more than 10 million times the cost of executing the code and that that ratio is continuing to increase. He concluded with some observations on the societal implications of computers stating that, "there need be no unemployment if people are willing to be retrained."

Dr. Chen's presentation was the first of eleven invited lectures, all of which were presented by distinguished speakers who were brought to Kuala Lumpur--or "KL," as it is called hereabouts--specifically for that purpose. The other invited lectures were as follows:

- Mr. Charles Bachman Vice President Cullinane Database Systems, Inc.	Data management systems: past, present and future
- Dr. Michael W. Blasgen Manager of Advanced Systems Technology IBM Federal Systems Division	Recent advances in data base systems
- Mr. Werner L. Frank Executive Vice President Informatics, Inc.	Software strategies for the '80s
- Mr. John Imlay Chairman of the Board and Chief Executive Officer Management Science America, Inc.	Information technology
- Professor Yu-Huei Jea Chairperson of the Computer Science Department Telecommunication Training Institute Taipei	Advanced techniques for design automation
- Dr. Hisashi Kobayashi Director IBM Japan Science Institute	Performance evaluation of computers and communication systems--a survey
- Dr. C. L. A. Leakey	New approaches to agricultural information
- Professor Mamoru Maekawa Department of Information Science Tokyo University	Distributed processing for highly intelligent information processing

- Dr. Yukio Mizuno Associate Senior Vice President Nippon Electric Company, Ltd.	Technical trends of computer networks
- Mr. D. L. Moss Sperry Univac	Realizing the productivity expectations from office automation
- Dr. V. Sadagopan Manager of Technical Relations IBM T.J. Watson Research Center	A review of current research programs in computer science and engineering

Because these lectures were given in parallel sessions (and because a prior commitment forced this writer to leave KL before the end of the conference), it was not possible to cover them all. In most cases, the conference proceedings contained only a one-paragraph abstract for each of the invited papers.

In addition to the invited papers, more than 80 contributed papers were received by the conference organizers, and 30 of these were accepted for presentation and publication in the conference proceedings. The papers were grouped into three categories:

- Management and National Issues in Data Processing,
- Computer Applications in Developing Countries, and
- Technical and Current Issues.

Six papers were presented in the first category including a description of Singapore's Institute of System Science (ISS) by its director, Mr. R. C. Eikenberry. ISS was established (with considerable support from IBM) at the National University of Singapore in 1981 to provide continuing education for executives and computer professionals. It is playing a central role in Singapore's planned development as a computerized society and, as such, is regarded as a laudable example of how the public and private sectors can and should work together to encourage computerization in this region.

Other papers in the first category dealt with computer operations management in the Philippines; applications software development in India; computer education in Australia; and programming management in Malaysia and the United Kingdom. Among the nine papers in the second category were: two on computer-assisted instruction (CAI) in Malaysia and the Philippines; three--two from Malaysia and one from the U.S.--on data base systems; and single papers on a Malaysian land administration system, a Malaysian on-line bank teller system, computing techniques, and facilities at CERN (Geneva), and software for the U.S. space shuttle. The 15 papers in the third category included one on expert systems, two on data communications and networking, and several on various aspects of software: programmer productivity, data base systems, security, and applications. The authors were from Hong Kong, India, Indonesia, Japan, the Philippines, Singapore, the U.K., and the U.S.

The conference included two panel sessions, one on "The Training of Computer Professionals--When, Where, and How," and the other on "The Role of Computer Societies in Developing Countries." The panelists represented the various countries of the Southeast Asia region plus the United States. A one-day tutorial session on "Management of Systems Development Projects" was given on the day preceding the conference by Messrs. David S. S. Lee, David W. McComb, and David L. Bushman, all from the Singapore office of the Management Information Consulting Division, Arthur Andersen and Company.

A surprisingly extensive "Computer Expo" was also held in conjunction with the conference. Some 40 companies were represented, including (either directly or through distributors) such major firms as Burroughs, CDC, CPT, Data General, DEC, Hitachi, Honeywell, IBM, ICL, NEC, Northern Telecom, Philips, Prime, Racal, Telex, and Wang as well as several small local software firms and service bureaus. The equipment shown emphasized small business systems, terminals, and office automation equipment.

The conference was attended by more than 500 persons, most of them Malaysian. In keeping with the theme of relevance to the needs of the region, the vast majority of attendees (and presenters) were "computer practitioners" rather than "computer scientists." A surprising number were women, some of whose traditional Moslem garb contrasted sharply with the modern technologies and concepts being discussed. The next SEARCC will be held October 1984 in Hong Kong.

THE TRENDS IN ELECTRONICS CONFERENCE

George E. Lindamood

INTRODUCTION

The first Trends in ElectroNics CONference, TENCON '82, was held 6-8 December 1982, at the Furama Hotel, Victoria, Hong Kong, under the cosponsorship of the Institute of Electrical and Electronics Engineers (IEEE) and the IEEE Computer Society. The Hong Kong Section of the IEEE served as host. The TENCON series of conferences are aimed at promoting the development and application of electronics in the countries of the Western Pacific, the Indian Ocean, and Oceania which make up IEEE Region Ten. The theme of this conference was "VLSI and Microcomputers: Today and Tomorrow."

THE CONFERENCE

The conference was opened by Professor S. Y. King, Chairman of the TENCON Organizing Committee. King, an IEEE Fellow, was characterized to this writer as "the grand old man of electrical engineering in Hong Kong." After welcoming all those in attendance, he introduced the Honorable Mr. W. Dorward, O.B.E., J.P., Secretary for Trade and Commerce of the Kong Kong government. In his opening address, Mr. Dorward spoke of the speed of technological development and the consequent technological ignorance of the general population. He stated that he felt that the only limitation on what can be done with new technologies is that imposed by the imagination of the users. But much more than "just technology" is at stake in today's world, he said; there would be "unpredictable shifts" in the new societies being created, and these must be regarded by a certain amount of concern as well as optimism.

Mr. Dorward's remarks were followed by an address by Special Guest Speaker, Mr. Philip Yeo, Chairman of the National Computer Board of Singapore. In that address, Mr. Yeo described what is being done in Singapore's drive toward computerization which is serving as a model for many other developing countries. He characterized Singapore's only resource as people: "people who are adaptable and eager to learn, people who are willing to accept change." To support the more than 1400 computer installations now in that country, Singapore has established a three-part training program. The first part is aimed at augmenting the more than 1000 computer professionals, the second at educating computer users, and the third part at fostering an all-pervasive "Computer Culture" in Singapore.

Actions taken by the Singapore government to train computer professionals include:

- expanding the computer science department at the National University of Singapore (NUS) from the 1980 level of 70 graduates per year to a targeted level of 200 graduates per year in 1985,

- establishing an Institute of System Science at NUS under joint sponsorship with IBM in 1981,

- establishing a Japan-Singapore Institute of Software Technology in 1982 to facilitate transfer of Japanese information technology to Singapore, and

- establishing a Center for Computing Studies at the Polytechnic Institute in Singapore.

In addition, the National Computer Board will grant approximately 100 scholarships over the next five years for undergraduate and postgraduate study in computer science, computer engineering, and computer information systems at foreign universities. Through these actions, Singapore expects to close the gap between the supply of, and the demand for, computer professionals by 1990. To maintain standards, ties have been set up with the British Computer Society.

Computer users in Singapore are also expected to benefit from the programs of the Institute of System Science at NUS and the Center for Computing Studies at the Polytechnic Institute. To promote "Computer Culture," the government is setting up a loan system to enable individuals to purchase microcomputers, sponsoring "computer literacy" courses at local community centers, and developing "on-the-job" computer training programs.

Mr. Yeo's talk was followed by the conference Keynote Speech, given by Hong Kong's "other" IEEE Fellow, Professor T. C. Chen, Head of United College, Chinese University of Hong Kong. Professor Chen began with a brief survey of VLSI technology, noting that the principal dictum is "think small." He speculated that soon one would be able buy the operator's manual for a microcomputer chip for US $5.00 at a computer store and the chip itself would be included free of charge.

Turning to software, Dr. Chen discussed software costs and programmer productivity. Citing Knuth's finding that the most frequently occurring FORTRAN statement is "A = B," he suggested that programmers should not be measured by the number of lines of code produced, but rather by the number of instructions executed. Next, Dr. Chen talked about the impact of computers on society. He cited a fable about a man who spent three years learning to kill dragons and the rest of his life trying to find dragons to kill. He identified "mental preparedness" as perhaps the most important factor in attaining peace and prosperity, stating that, "As the microelectronics industry grows, the entire world must grow with it."

The entire afternoon of the first day of the conference was devoted to tutorial sessions. The tutorials were given by four invited speakers:

- Dr. H. N. Yu IBM Research Laboratory Yorktown Heights, NY	VLSI technology
- Professor C. L. Meador School of Engineering Massachusetts Institute of Technology Cambridge, MA	Decision support systems
- Professor Rein Turn California State University Northridge, CA	Distributed data bases and security
- Mr. Ben Lee Calma Company Santa Clara, CA.	Computer-aided design and manufacturing

A one and one-half hour session was devoted to "tutorial follow-up and discussion" the next morning.

In addition to the tutorials, two invited lectures were given: Mr. V. Leo Rideout of IBM's General Technology Division, Burlington, Vermont, spoke on "Limits to Improvements of Silicon Integrated Circuits," and Mr. Donald L. Tang of IBM's T. J. Watson Research Center spoke on "VLSI Circuit Testing Using Linear Codes." Mr. Larry Lieberman of IBM's T. J. Watson Research Center was also scheduled to present an invited lecture on "Computers in the Service of Society: Robots and Automatic Control," but he was unable to attend the conference.

The 26 technical papers given at the conference were presented in eight sessions:

- VLSI systems architecture,
- Chinese language processing,
- VLSI design methodologies,
- Computers and instrumentation,
- Distributed systems and networks,
- Computer applications in biology and medicine,
- Microprocessor systems development, and
- Computers in office automation.

All but three of these papers were published in the conference Proceedings as were the invited papers on VLSI techniques by Messrs. Rideout and Tang and three additional papers. The authors of the various papers were from Australia, China, France, Hong Kong, India, Indonesia, Korea, Malaysia, the Netherlands, Singapore, Taiwan, and the U.S.

There were also two Panel Discussion sessions at TENCON '82. The first, on "VLSI and Microcomputers in Regional Economic Development," was chaired by Professor Graham Mead of Hong Kong Polytechnic and included Professors R. J. Widodo of Indonesia, I. T. Hawryszkiewcz of Australia, Graham Pasco of Hong Kong, and J. W. Cho of Korea. The second, on "Technology and Society," was chaired by Dr. Ramon Barquin of IBM World Trade Asia (Hong Kong) and included Dr. H. N. Yu of IBM (Yorktown), Ms. Deborah M. Puretz of Office Automation Asia (Hong Kong), Mr. J. Martin Eades of Jardine Matheson (Hong Kong), and Mr. L. Collings, President of the Hong Kong Chapter of the Fédération Internationale des Echecs (FIDE) (chess federation).

CONFERENCE-RELATED EVENTS

An exhibition of "VLSI, microcomputers and related products" was held in conjunction with the conference but was located in Hong Kong City Hall so as to attract a wider audience. Among the 20 or so firms represented were British General Electric (G.E.C.), Ferranti Wheelock Microelectronics, Fluke, Hewlett Packard, Hitachi Semiconductor, IBM, Intel, Motorola Semiconductors, National Semiconductor, and Tektronix. The equipment shown emphasized microelectronic components and test equipment.

An interesting and unusual feature of the conference was a chess competition sponsored by a local manufacturer of microcomputer-based chess-playing computers. The competition pitted the SciSys "Mark V," which was characterized as the "1981 world microcomputer chess champion," against any and all persons attending the conference. Prizes, in the form of smaller, less sophisticated chess-playing microcomputers, were offered to every person who could defeat the Mark V, and a grand prize, consisting of a round trip ticket from Hong Kong to Bangkok, was offered to the person who defeated the machine in the least number of moves. (In the event of a tie in the number of moves, the shortest playing time was to determine the winner.)

Only two persons were able to defeat the Mark V. The machine won nine games outright, and several more through opponent's resignation. There was one game adjudged a draw after 50 moves. The winner of the grand prize was the first person to play the machine, Professor Rein Turn. Professor Turn, who defeated the machine in 28 moves (after six minutes, 48 seconds), said that his winning strategy consisted of "aggressive play so as to keep the machine on the defensive and not give it any chance to exploit its opponent's mistakes." The soundness of this strategy was confirmed by the experience of the many players who lost through cautious, but eventually erroneous, play as well as the other player who won. According to observers, the latter should have won in 24 moves, but made a mistake in his haste; he recovered to win in 30 moves.

CONCLUSION

This was the first IEEE conference ever held in the Far East, and it was certainly a success. Although the conference organizers were disappointed that only about 40 persons attended from abroad, this was offset by an unexpectedly strong local showing which brought the total attendance to more than 160. Notable by their presence (without advance notice) were some 15 computer engineers from the People's Republic of China, and notable by their total absence were the Japanese--which fact the conference organizers were at a loss to explain.

The next TENCON will be held December 1984 in Singapore. The theme will be "Consumer and Industrial Electronics and Applications." Further information on TENCON '84 can be obtained from:

Dr. J. Phang
TENCON '84 Conference Secretary
Electrical Engineering Department
National University of Singapore
Kent Ridge Campus
Singapore 0511.

THE SIXTH INTERNATIONAL CONFERENCE ON SOFTWARE ENGINEERING

George E. Lindamood and David W. Mizell

INTRODUCTION

The Sixth International Conference on Software Engineering (ICSE) was held 13-16 September 1982, at Gakushuin University, Tokyo, Japan, under the joint sponsorship of the Association for Computing Machinery, Special Interest Group for Software Engineering (ACM SIGSOFT), (U.S.) National Bureau of Standards, the IEEE Computer Society, and the Information Processing Society of Japan (IPSJ). The ICSE, which has been held about every eighteen months, has the reputation of being the best of the software engineering conferences.

Many significant research concepts and innovations were presented and discussed at the first few ICSE's. More recently, however, the content of the conference has tended to move away from research toward practical application issues. For most observers, this is perceived as a healthy trend, one which indicates that the software field is maturing into an engineering discipline. In the fifth ICSE, held in San Diego in early 1981, this trend was evident in the technical content of the presentations, but not in the makeup of the audience: the industry's software engineers and software development managers were still not aware that the ICSE had become a conference which would be valuable for them to attend.

That was not by any means the case in Tokyo last year. The 1000-plus Japanese attendees consisted mainly of software development managers from the computer companies plus some of their senior programmers. Furthermore, the content of the conference was geared even more toward practical issues. Parallel sessions at the conference were run on three tracks; practical experiences, advanced concepts, and software engineering tools with two out of the three of immediate relevance to practitioners. Also, the first day of the conference was devoted to an IPSJ-sponsored all-day tutorial (in Japanese) which introduced the concepts and terms of software engineering.

THE CONFERENCE

The conference was opened by the General Chairperson, Professor Yutaka Ohno of the Department of Information Science at Kyoto University. Brief "opening remarks" were made by Professor Ohno and by the Program Cochairperson, Professor Victor R. Basili of the Department of Computer Science, University of Maryland; the President of IPSJ, Professor Hiroshi Inose of the Department of Electronics Engineering, Tokyo University; and the two Honorary Cochairpersons, Professor Raymond T. Yeh of the Department of Computer Science, University of Maryland and Dr. Koji Kobayashi, Chairman of the Board, Nippon Electric Corporation (now NEC Corporation).

The Keynote Address was given by the Honorable Mr. Tadashi Kuranari, Member of the Japanese Diet. Mr. Kuranari is Chairperson of the Congressional Federation for the Promotion of the Information Industry, a group of some 100 Diet members who are concerned that Japan's evolution into a postindustrial society not entail undue meandering. Mr. Kuranari was also formerly the Director of Japan's Economic Planning Agency (a Cabinet-level post) and has recently been active as the deputy leader of the Diet's trade delegations to the European community and to the United States.

In his address entitled "Human Aspects of the Information Age," Mr. Kuranari displayed an admirable understanding of not only the current approaches to solving the major technological problems in computing, but also the broader social issues which are emerging because of the increasing encroachment of computers into all aspects of our lives. Beginning with a brief summarization of this latter phenomenon, Mr. Kuranari then described four facets of what he called "the technological response,"

- the increasing sophistication of computers themselves (as exemplified by Japan's current efforts to develop fifth generation computer technologies),
- increasingly sophisticated software technology, not only for the expert programmer but also for the unskilled computer user,
- increasingly sophisticated communications technology, which he characterized as "the hands and feet of all computers," encompassing satellite communications, local networks, and encryption technology, and
- the design of data base management systems.

Next, Mr. Kuranari identified areas of concern in "laying the groundwork for the Information Age,"

- computer security,
- legal protection for software,
- the improvement of communications networks and their efficient utilization--this is a broad reference to the fact that computer networking in Japan is still very much restricted by government-sanctioned telephone company regulations, and
- the education of computer specialists.

He characterized the social consequences of the information revolution as "immense," stating that "even in politics . . . the traditional definition of national sovereignty in geopolitical terms has begun to give way to considerations of information and culture in the face of the computer age."

In conclusion, Mr. Kuranari proposed four principles as possible guidelines for the man-machine interface:

- computers should contribute to the peace and welfare of the human race,
- computers are a joint asset of all humankind, and all people should have an opportunity to enjoy the benefits which they bring,
- respect for various peoples' unique cultures should be maintained throughout the international diffusion of computerization,
- human independence must be guaranteed by using computers "as a human tool to satisfy human needs."

In Mr. Kuranari's words:

> "We must never forget that systems for providing information have been constructed predicated upon our ability to select what we need, and that the education system was built predicated on our self-motivated desire for personal improvement. It is only when we possess a firm self-discipline that we will be able to use the free time provided us by the advent of computers to satisfy our creative and cultural hunger, to engage in heart-warming dialog with others, and to come into closer contact with nature."

After a short recess, the conference continued with an Invited Address by Dr. Gerald M. Weinberg, the prominent American software engineering management consultant and author of the ground-breaking book, *The Psychology of Computer Programming*. Speaking on the topic of "Overstructured Management of Software Engineering," Dr. Weinberg began by asserting that "poor management can increase software costs more rapidly than any other factor." In considering how such poor management manifests itself, Dr. Weinberg hypothesized that software engineers who have become managers often utilize in managing people those software techniques which have brought them success as programmers: sequence, choice, iteration, recursion, refinement, modularization, and data structures. The problem, he said, is that people do not behave the way programs do, so these strategies are inappropriate. The solution is not for software managers to "try harder," but rather to develop a broad perspective, to become generalists, to learn from psychology, biology, economics, and other diverse sources and disciplines, in order to (first) stop overmanaging themselves and (then) stop overmanaging others.

Dr. Weinberg's talk was the first of three invited lectures, the other two being given on successive days by Professor Friedrich L. Bauer, Institüt fur Informatik, Technische Universität München, and by Professor Hisao Yamada, Department of Information Science, Tokyo University. Speaking on "Program Construction Through Formal Reasoning: From Specifications to Machine Code," Professor Bauer claimed that it should be possible to make all aspects of program development, from specification to verification, into a formal, rigorous process. In the first stage of that process, the "purchaser" and the programmer would draft the formal specification in a language suitable for the "purchaser." As he put it:

> "Instead of trying in vain to teach vice-presidents, MPs and colonels our formalized symbol-ridden, mathematically corrupted language, we have to map specifications and translate programs into a language the customer thinks is his own, thus removing the language barrier. We can trust that the customer will then be able to understand even very complicated things, at least if he has the intellectual level that would allow him to pass law school."

In Bauer's second stage, the program would be "constructed" (as opposed to "produced") through a rigorous process of stepwise refinement. The final stage would be "certification of the software product," in which Bauer claimed that:

> "There is, of course no need to prove correctness of a (correctly) derived software product: such a product is automatically correct with respect to the original specification. And testing in the low moral sense of 'debugging' is pointless."

At this stage, the customer need only ascertain whether the product obeys the specification and evaluate the performance of the software product. If the latter is unacceptable, "return to stage two may be necessary until sufficient efficiency is reached."

Throughout this process, Bauer would have the emphasis be put on responsibility:

> "Professional morals require looking at programming as the fulfillment of a contract. The difficulties are less than most people would expect, provided the language barrier between customer and programmer can be lowered. The necessary theoretical background is available, but should not be used to frighten the customer. The responsible decisions should be made with common sense."

Professor Yamada's lecture, on "Human Factors Aspects in the Touch Typing of Japanese Text," presented the latest results of his extensive research into the best way to input written Japanese into a computer. He began with a fairly exhaustive survey of the various typing methods for Japanese writing, focusing on the problem of devising typewriters capable of representing the 2,000-3,000 Kanji--Chinese characters--necessary for modern Japanese. He characterized the problem of "touch typing" as "very easy on 30 keys, manageable on 40 keys, and virtually impossible on over 50 keys for average people." Therefore, to develop a touch typing system for Kanji input, he turned to the literature on learning theory, especially as it pertains to hemispheric specialization in the brain and the consequences of that for the design of codes. The results of his investigation, which is something of an interdisciplinary tour de force, are embodied in his "superwriter" system, in which a typist is trained to make two keyboard strokes to represent each Kanji character. The experimental results shown by Professor Yamada, although somewhat incomplete at the time of the conference, suggest that his system is indeed well "human engineered."

The balance of the conference was devoted to the presentation of contributed papers and to several panel sessions. The subjects of the latter were:

On Maintaining Software Quality,
Nonconventional Programming,
Can Formalization Do Any Good in Practice?
Software Engineering Education and Technology Transfer,
Knowledge-based Systems,
Impact of New Technologies on Software Engineering, and
Software Engineering: Challenges of Tomorrow.

An evening session was also held at which senior personnel from the Institute for New Generation Computer Technology (ICOT) presented an overview of Japan's Fifth Generation Computer Project for the benefit of the approximately 200 foreigners attending the conference.

The contributed papers were divided into two categories: "full" papers and "short" papers. Two hundred forty five of the former and 46 of the latter were submitted. Full papers were reviewed on the basis of quality and relevance to the conference; 39 were accepted. Short papers were reviewed according to "interesting ideas and valuable experiences," six were accepted. The conference organizers attempted to get six reviews for each paper: two each from U.S., Japanese, and "international" members of the Program Committee; no paper was reviewed by persons from just one country.

The contributed papers were presented in 14 sessions on the following subjects:

Software maintenance,
Language processing issues,
Configuration management,
Quantitative aspects of software,
Requirements techniques,
Programming environments,
Perspectives in software engineering,
Specification techniques,
Tools for program design and construction,
Testing and tools,
Software notations,

Interactive systems,
Case studies, and
Program analysis and synthesis.

Among these papers, several advanced projects to develop software engineering environments were described. Drs. Barry W. Boehm and Arthur B. Pyster talked about the environment they and their colleagues are putting on top of UNIX at TRW. Professor Leon J. Osterweil of the University of Colorado described the "Toolpack" project, which is to build a set of programming tools for FORTRAN for the sake of scientific programmers who use this language almost exclusively. Mr. LeRoy E. Nelson of Xerox Corporation (El Segundo) described the benefits of using a sophisticated software engineering environment to develop the software for the Xerox "Star" office automation work station. Messrs. K. Takahashi, T. Aso, and M. Kobayashi of Fujitsu, Ltd. presented an interactive, graphics-oriented system for debugging FORTRAN programs.

Ms. Sandra Rapps and Elaine J. Weyuker of New York University's Courant Institute presented an interesting set of criteria for test data selection derived from data flow analysis techniques similar to those used in compiler optimization. Messrs. Donald V. Buyansky and James W. Schatz of Bell Laboratories (Naperville) described a test coverage analyzer which is used in the Laboratory Support System to support software development for Bell's No. 1A Electronic Switching System (ESS). Mr. M. Ohba of IBM Japan's Product Assurance Laboratory (Fujisawa) proposed a Software Product Quality (SPQL) index which combines subindices for test accuracy and test coverage and presented some experimental results from attempts to use this index in practical situations.

Two important research papers presented could both be characterized in the same way: a professional statistician, having examined the data used by the authors of key works in the area of software metrics, completely demolished the claims of the software "metricians" using the very same data. M.J. Lawrence of the University of New South Wales (Australia) did this for L. A. Belady's and M. M. Lehman's "evolution dynamics," and Peter G. Hamer and Gillian D. Frewin of STL (Essex, England) did it for M. H. Halstead's "Software Science."

Because there were so many quality papers that could not fit into the regular program schedule, the Program Committee decided to organize "poster sessions" at the conference. Forty five papers were presented at these sessions and were published in a supplement to the conference proceedings. The topics of the poster sessions were:

Programming and programming languages,
Verification, validation, and test techniques,
Tools and support systems,
Software quality assurance,
Software structure,
Specification,
Application systems, and
Advanced topics.

CONFERENCE-RELATED EVENTS

A "Tools Fair" was held in conjunction with the conference to enable attendees to examine state-of-the-art software engineering tools using microcomputers and personal computers. Of the 23 exhibitors, all but two, one from the U.K. and one from the U.S., were Japanese. Most of the systems shown were for text processing or program development.

CONCLUSION

A few years ago the Japanese used to speak of a "software gap," referring to a perceived superiority in the state-of-the-art in Europe and the U.S. That expression is rarely heard any more, although the Japanese have not yet begun to point proudly to their software accomplishments as they do with their hardware. (Perhaps the lack of a suitable yardstick is part of the problem.) Nevertheless, the Japanese are serious about getting their industry people up to speed in software engineering. Holding the ICSE in Japan was one step in that process, and the fact that the conference was held there will, no doubt, be pointed to in the future as evidence that progress has been made. Given their track record in computer hardware and in other areas, there is little reason to doubt that the Japanese will eventually eliminate the "software gap." It is difficult to predict when. It is even more difficult to predict what will happen after that.

ELECTROTECHNICAL LABORATORY, OSAKA BRANCH

Sachio Yamamoto

INTRODUCTION

The Electrotechnical Laboratory (ETL) was established in 1891 and is currently one of sixteen research institutions belonging to the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry. It has a staff of 730 members and its budget in JFY 1982 was $39.5 million ($1 = Y220). ETL conducts basic and applied research in four broad areas:

- solid state physics and materials,
- information processing,
- energy, and
- standards and measurements.

Most of the staff and its laboratory facilities are located at the Tsukuba Research Center. ETL also has a branch laboratory located on the outskirts of Osaka where it is housed in old but spacious quarters. The Osaka Branch was established in 1914 and will be celebrating its 70th anniversary next year.

The head of the branch laboratory is Dr. Yasuyuki Moriuchi. The laboratory is divided into three sections:

- Industrial Measurement Section (Head, Dr. Motoi Nanjo),
- Standard Measurement Section (Head, Dr. Yutaka Kurioka), and
- General Affairs Section (Head, Ken-ichi Arai).

There are a total of 33 members on the staff.

RESEARCH ACTIVITIES OF ETL, OSAKA

The primary function of the Osaka Branch Laboratory is to conduct research and development of precise measurement techniques for light, color, high frequency voltages, and ionizing radiation and to apply these techniques in the establishment of national standards. These techniques are also being used in studies of the detection of environmental pollutants and of human sensing of colors and odors.

In the area of light measurement, the laboratory has developed a multichannel spectrometer for accurate spectral analysis. The system uses an image sensor consisting of an array of over 1000 silicon photodiodes arranged either in a linear or circular manner. The sensor has high linearity and can be used over a wide range of intensities. As part of a program to standardize fluorescent materials, a system was developed under the direction of Dr. Nanjo for very precise measurement of fluorescent light. A block diagram of the apparatus is shown in Figure 1. Although the system is cumbersome to use it allows for very precise measurements. It consists of two spectrometers--one as a variable monochromator for the exciter source and the other to analyze the fluorescent and reflected radiation. The system has features for subtracting reflected exciter radiation from the fluorescence spectrum and for correcting errors introduced by polarization. A third apparatus was developed by Dr. Kurioka and Dr. Toshio Yamanaka to accurately measure the spectral reflectance of materials used for traffic signs. It is designed to measure retroreflected light under nighttime conditions in accordance with international measurement standards, that is, at varying angles of incidence of the illuminating source (e.g., -4° to 50°) and a small observation angle between the illumination direction and the reflection direction (1°). The system is compactly arranged so that these measurements can be made in an ordinary laboratory.

The radio frequency group has developed precise measurement techniques for voltage, power, and quality factor Q in the high frequency ranges (10 - 1000 MHz). They have established the RF voltage standard in the low voltage range (100 μV - 0.1 V) with an accuracy of $\pm 1\%$. Deviation from the world average was -0.4%. A new technique was developed for measuring microwave power by use of the saturation effect of the resonant absorption spectrum of ammonia gas ($^{14}NH_3$) at 23.870 GHz. They have developed a method for measuring Q (100 - 300) at frequencies up to 20 MHz by a damped oscillation method as well as a standard Q coil (Q = 100 at 1 MHz) for use in Q meters.

This laboratory has an interesting bionics program in which research on the perception of colors and odors are being conducted. Dr. Kotaro Takahama and co-workers are studying chromatic adaptation experimentally by subjective estimation of hue, saturation, and brightness of colors under daylight and the white light from a tungsten lamp, and theoretically by taking into account the nonlinear processing of color by the primatial visual system. Measurements of color appearance by the magnitude estimation technique is being conducted by Dr. Hiroaki Sobagaki. He has devised a training plan and instructions for the observers (i.e., subjects) which has resulted in improved reliability of the estimates. Drs. Masamine Takebayashi, Mitsuo Tonoike, and Yutaka Kurioka have measured visually evoked potentials for stimuli of monochromatic light at various wavelengths at three positions of the visual pathway of the monkey brain: the optic tract, lateral geniculate body, and visual cortex. The waveforms of the potentials were analyzed by applying the principal component analysis combined with singular value decomposition. They derived opponent color responses of the yellow-blue and red-green components and found them to be very similar to the human brain which they studied ten years earlier at this laboratory.

Drs. Tonoike and Kurioka are also studying olfaction and making precise measurements of human olfactory evoked potentials from odorant stimuli for the purpose of clarifying how information of odors is processed and transformed in the brain. They studied the relationship between the waveforms of the olfactory evoked potentials and subject fatigue and found that the amplitudes of the accumulated waves for pleasant odors (amyl acetate, vanilline) increased almost linearly with the number of stimuli while with unpleasant odors (isovaleric acid, trimethylamine) they leveled off. They have also succeeded in measuring evoked potentials with stimuli synchronized with respiration and found that the frequency of odor perception by the subject was substantially greater than with stimulations at fixed time intervals. Hence, they were able to reduce the time of the experiments and thereby decrease subject fatigue. They correct latency values for the time lag of the odorant stimuli which they measure with a SnO_2 absorption effect transistor. Corrected latency values for the main positive and negative peaks ranged from 240-340 and 460-640 milliseconds respectively.

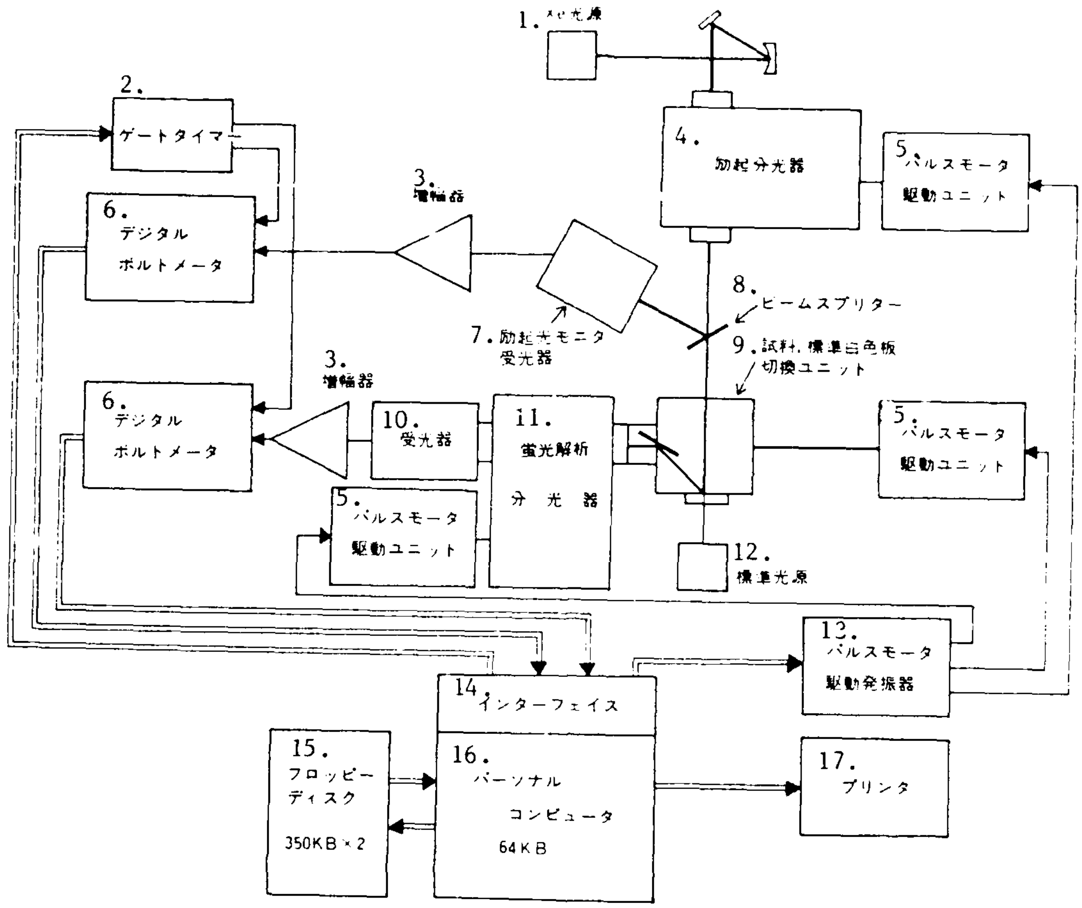
The measurement techniques developed by the Electrotechnical Laboratory are being applied to pollution studies. Dr. Motoi Nanjo and his associates have developed a system for *in situ* measurement of levels and particle size distributions of plankton in seawater. The shipboard portion consists of laser sources and spectrum analyzers which are connected by an optical fiber cable to an underwater towed body containing a flow through water channel and necessary optics (Figure 2). The particle size analyzer portion is shown in Figure 2b. The exciter source is a 1.5 W multimode argon laser. Fluorescent light pulses and scattered light pulses coincident with the former from individual particles are analyzed with the pulse height analyzers. Figure 2c is a diagram of the part of the system for measuring the fluorescent excitation spectra. The four dye lasers were selected to provide excitation wavelengths between 450 and 600 nm. Fluorescent, Rayleigh scattered and exciter source light are transmitted from the towed body to the signal processor from which chlorophyll a concentrations are obtained. The cross section of the optical fiber cable is shown in Figure 3. The 30-m cable uses quartz fibers and the transmision efficiency over this length is 70%. They were able to measure plankton at concentration levels down to 1 mg/m^3 (as chlorophyll a) in 100-300 seconds in the presence of other suspended particles. Members of the Standard Measurement Section are investigating the airborne detection of oil spills by microwave radiometry. Thermal microwave emissions and sea surface roughness are measured. They developed a passive microwave imager consisting of an x-band radiometer, an x-y antenna scanner, a scanner/driver controller and on- and off-line displays as a prototype marine oil surveillance system. The off-line display can show 512x320 pixels with 511 color grades.

OTHER ACTIVITIES OF THE OSAKA LABORATORY

This laboratory is in charge of the inspection, certification, and testing of standard instruments for measuring high frequencies, light, and radiation in Japan. The types of instruments calibrated and certified by ETL, Osaka, are presented in Table 1. In the case of radiation survey meters this laboratory is the only institution in Japan which can formally certify them.

For further information, address mail to:

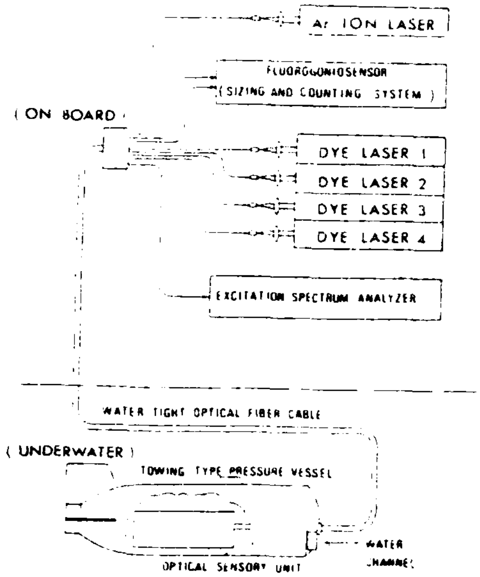
Electrotechnical Laboratory
Osaka Branch
3-11-46, Nakoji, Amagasaki-shi
Hyogo-ken 661
Japan



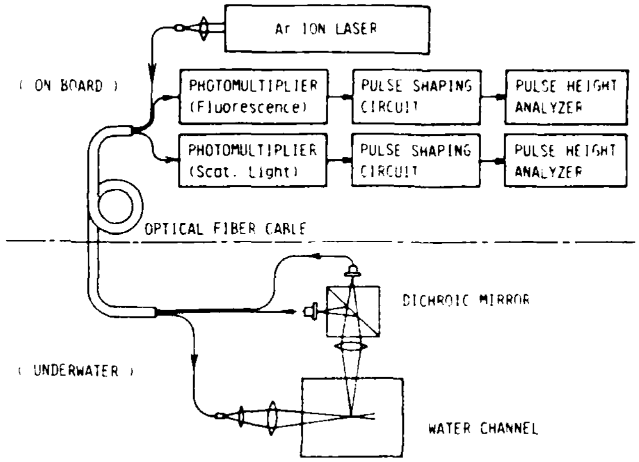
測定設備のブロック図
Block diagram of the apparatus.

1. Xenon Light Source
2. Gate timer
3. Amplifier
4. Monochrometer
5. Pulse monitor/drive unit
6. Digital voltmeter
7. Exciter light monitor
8. Beam splitter
9. Sample/standard white board
10. Light sensor
11. Fluorescent light spectrometer
12. Standard light source
13. Pulse monitor/drive oscillator
14. Interface
15. Floppy disk
16. Microcomputer
17. Printer

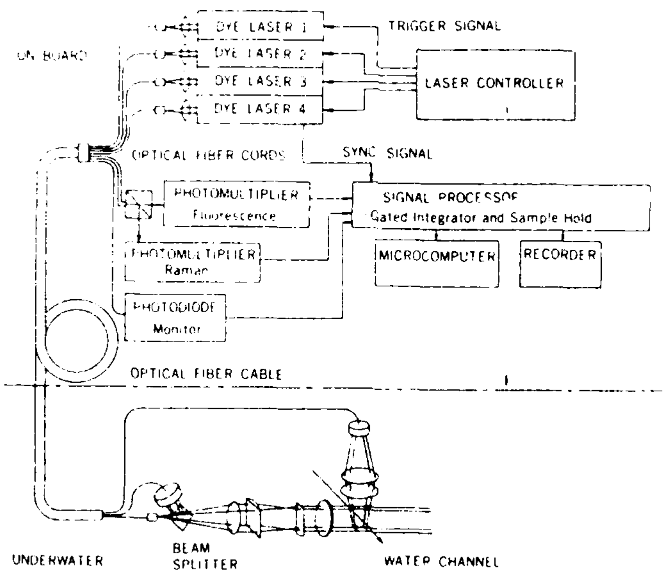
Figure 1. Block diagram of spectrometer for measuring fluorescent materials.



a. General block diagram



b. Particle size distribution analyzer



c. Fluorescent excitation spectrum analyzer

Figure 2. Block diagrams of the *in situ* fluorescence and particle size distribution analyzer system

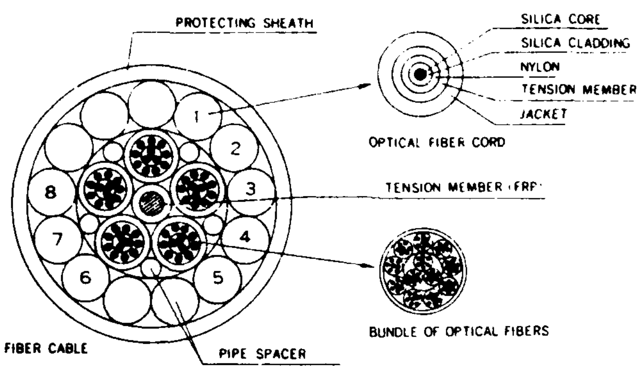


Figure 3. Cross section of the optical fiber cable used in the *in situ* fluorescence and particle size distribution analyzer

Table I

INSTRUMENT TESTING AND CERTIFICATION AT ELECTROTECHNICAL LABORATORY, OSAKA

Instruments	Type of Test	Comments
High Frequencies		
Wattmeters	Test and calibration	30,150, 400 MHz, 1-30 W
Voltmeters	Test and calibration	10 kHz-470 MHz, 0.2-1 V
HF attenuators	Test and calibration	50 kHz-470 MHz, 0-120 dB
Signal generators	Test and calibration	50 kHz-470 MHz, 0-120 dB
HF impedances	Test frequency characteristics	50 kHz-900 MHz, 10-1000 Ω
Light		
Standard light intensity lamp	Test light intensity	Measure light intensities at specified voltages, currents, and temperature distributions
	Test temperature distribution	Measure voltage at specified temperature distributions
Photometers	Test and calibration	
Ionizing Radiation		
Exposure meters (pocket chambers)	Certification	Ionization chamber type, 30-2000 keV, 5 mR-100 R
	Inspect reference meter	30-2000 keV, 5 mR-100 R
	Test and calibration, test characteristics	Characteristics for 15-120 keV x-ray and ^{137}Cs, ^{60}Co, ^{226}Ra γ energies, system efficiency, directionality
Dosimeters (survey meters)	Inspect reference meter	15-120 keV x-ray and ^{137}Cs, ^{60}CO, ^{226}Ra γ energies, 10 mR/hr - 500 R/hr
	Test and calibration, test characteristics	Characteristics for 15-120 keV x-ray and ^{137}Cs, ^{60}Co, ^{226}Ra γ energies, system efficiency, dose rate characteristics, directionality
Gamma sources	Inspect reference sources	^{137}Cs, ^{60}Co, ^{226}Ra; 10 mR/hr - 1000 R/hr
	Test intensity	10 μR/hr - 5000 R/hr at 1m
Detectors (films, solid state, etc.)	Standardization	Energy and dose rate characteristics, directionality

CHEMICAL SOCIETY MEETINGS IN EAST ASIA

Sachio Yamamoto

INTRODUCTION

Recently, three chemical society meetings were held in East Asia; in Australia in the summer of 1982, in Korea in the fall of 1982, and in Japan in the spring of 1983. The following is a brief description of the meetings as well as short sketches on the chemical societies.

CHEMICAL SOCIETY OF JAPAN

- 47th Spring Meeting, 1-4 April 1983

The Chemical Society of Japan (CSJ) was founded as the Chemical Society in 1878 just two years after the arrival of Commodore Matthew C. Perry and his Black Ships in Uraga at the entrance of Tokyo Bay. The rapid rate at which Japan modernized during that period can be appreciated from the fact that only two years earlier in 1876 the government issued a decree which banned the wearing of swords by samurai. The organization was renamed the Tokyo Chemical Society in 1879 and then to its present name in 1921. In 1948, it merged with the Society of Industrial Chemistry which was founded in 1898. Today the Society has 32,000 members and its annual budget is about $3 million. It publishes six periodicals:

- *Kagaku to Kogyo (Chemistry and Industry)*
  Monthly news magazine

- *Nippon Gagakkaishi (Journal of the Chemical Society of Japan)*
  Monthly

- *Bulletin of the Chemical Society of Japan*
  Monthly, articles in English, German, or French

- *Chemistry Letters*
  Monthly, articles in Japanese, English, German, or French

- *Kagaku Kyoiku (Chemical Education)*
  Bimonthly

- *Newsletter*
  Quarterly news magazine of colloid and surface chemistry

The 47th Spring Meeting of the Chemical Society of Japan (CSJ) was held on the campus of Doshisha University in Kyoto. There were 6200 registrants, and about 3000 papers were presented. There were very few foreign participants, undoubtedly because the meeting was held in Japanese. Approximately 100 of the papers were special one-hour presentations on the following themes:

Cells and Chemistry--the Role of Membranes
New Developments in Organometallic Chemistry
Frontiers in Organic Chemistry
Rare-earth Elements
The Ultimate Limits of Polymer Functions

New Developments in the Chemistry of Surfaces and Interfaces
The Life Sciences and the Frontiers of Chemistry
The Role and Chemistry of Biological Microconstituents
The Future of Chemistry
Chemistry and the New Artificial Transplant Organs
Status of Chemical Sensors and their Applications
The Traditional (Historical) Chemistry of Japan
Energy and Natural Resources
Technological and Business Strategies in the Chemical Industry--World-wide Trends
Effect of Technological Changes on Industrial Structures
New Techniques in Chromatography
New Advances in the Chemistry of Werner Complexes

These papers were presented in six concurrent sessions and were for the most part reviews of a particular topic or field in chemistry. They ranged from being quite general in scope to an in-depth coverage of a specific topic. The technical papers were divided into the following categories:

Chemical education
Physical chemistry (structures, physical properties, reactions)
Inorganic chemistry (general, synthesis, solid state, radiation and nuclear)
Coordination and organometallic chemistry
Analytical chemistry (general, spectrometry, gas chromatography, liquid chromatography, electroanalytic)
Polymer chemistry (synthesis, reactions, structures, functions)
Catalyst chemistry
Colloid and surface chemistry
Materials (synthesis and properties of amorphous materials, organic electronic materials, electronic materials, solid electroytes, ion exchange, porosity and surfaces, solid and liquid-solid reactions, carbonaceous materials)
Natural resources
Energy (hydrogen energy, photochemistry, energy storage, electrochemistry)
Environment and safety
Computers and chemical information

The papers were ten minutes long and were presented in 23 concurrent sessions which ran from 9:00 to 12:00 in the morning and from 1:30 to 6:00 in the afternoon. Session chairmen changed every hour but there were no breaks. The papers were kept on a schedule that would have made the Japanese National Railways proud. Usually a speaker completed his talk in about nine minutes which allowed time for one or two questions. Because of the time limitations, the papers were quite narrow in scope usually covering the results and conclusions from a few experiments. Also the tight schedule made it somewhat more difficult to have informal discussions than is the case at an American Chemical Society meeting.

An instrument and equipment exhibit was held in conjunction with this meeting. It was similar in scope but substantially smaller than those at ACS meetings. A number of well-known American companies were represented, however, there were fewer than I had expected.

For further information, contact the:

Chemical Society of Japan
1-5 Kanda-Surugadai
Chiyoda-ku, Tokyo 100
Japan

ROYAL AUSTRALIAN INSTITUTE OF CHEMISTRY (RACI)

- Seventh National Conference, 1982

The Seventh National Conference of the RACI was held during 22-27 August 1982 on the campus of the Australian National University in Canberra. The RACI was founded in 1917 and has a membership of about 7000 chemists, chemical engineers, biochemists, and chemical technologists and is comprised of twelve divisions:

Analytical Chemistry
Cereal Chemistry
Chemical Education
Colloid and Surface Chemistry
Coordination and Metal Organic Chemistry
Electrochemistry
Industrial Chemistry
Medicinal and Agricultural Chemistry (Group)
Organic Chemistry
Physical Chemistry
Polymer Chemistry
Solid State Chemistry

The national meeting, which is held quadrennially, had 1025 registrants including 93 from overseas. All the divisions participated and over 600 papers were presented. The meeting, however, was dominated by three divisions, Coordination and Metal Organic, Organic, and Polymer which accounted for approximately 50% of the attendees and papers.

The meeting maintained a comfortable schedule which allowed ample time for participants to meet and interact with each other. Each morning and afternoon sessions had two one-hour sessions with a 30-minute tea break in between. The oral presentations were 20 or 30 minutes long. A substantial number of the papers (circa 250) were presented in poster sessions, most of which were held in the evenings--some in conjunction with divisional mixers.

There were five special convention-wide lectures, Sir David Phillips of Oxford University reviewed the role of x-ray diffraction in the study of protein structures during the period following 1959 when the detailed structure of a globular protein molecule was first determined by crystal structure analysis. His talk was concluded by a four-minute film produced by computer graphics technique of an enzyme in thermal motion and featuring the loss of two water molecules during the brief period of stimulation. Dr. M. Stanley Whittingham of Exxon Research and Engineering reviewed the role of chemistry in energy production in general, and in catalysis, energy storage, and synthetic fuels in particular. Research on semiconducter-based photochemical cells for direct conversion of light to chemical energy was presented by Professor Mark S. Wrighton of the Massachusetts Institute of Technology. Professor Lewis N. Mander of the Australian National University (ANU) discussed the "art" of total synthesis of natural products as illustrated by the synthesis of gibberellin as carried out at ANU and Dr. Donald E. Weiss, Director of the Planning and Evaluation Advisory Unit of the Commonwealth Scientific and Industrial Research Organization (CSIRO) presented a lecture entitled "Chemistry-The Enabling Science." Professor Mander and Dr. Weiss were recipients of the Institute's senior awards, the H. G. Smith Medal (Mander) and the Applied Research Medal (Weiss).

There were several joint symposia involving two or more divisions:

Automation, techniques and consequences	Analytical Chemical Education Industrial
Polymers at the secondary and tertiary levels	Chemical Education Polymer
Protein structure and function: metalloenzymes	Coordination and Metal Organic Polymer
The teaching of chemical bonding at the secondary-tertiary levels in the 1980s	Chemical Education Physical Chemistry
The direction of analytical chemistry education for future employment	Analytical Chemical Education
Chemical rate processes	Colloid and Surface Electrochemistry Physical Polymer Solid State
Metals in organic chemistry	Coordination and Metal Organic Organic

Participation by chemists from the private sector was small compared to an American Chemical Society meeting. This reflects the fact that in Australia only 37% of scientific research and development is performed by industry; the remainder is conducted by government (53%) and universities and nonprofit institutions (10%). By contrast in the United States and Japan, industry performs about 65% of scientific R&D. Australian chemists have historically been very active in organometalic research. This was evidenced by the strong participation of the Coordination and Metal Organic Chemistry division which presented more papers than any other division. The meeting also featured an instrument and equipment exhibit in which 45 firms exhibited their products. A number of the major American instrument manufacturers (Beckman, Hewlett Packard, Perkin Elmer, Technicon, Varian) were represented.

For further information about the RACI or its Seventh National Meeting, contact:

Mr. Peter W. Woodhouse
Executive Secretary
Royal Australian Chemical Institute
Clunies Ross House
191 Royal Park Parade
Parkville, Victoria 3052
Australia

KOREAN CHEMICAL SOCIETY

- 1982 Fall Meeting

The Korean Chemical Society (KCS) was established in 1946 and currently has 2000 members. The organization is managed by the Secretary-Director who is selected by the Board of Trustees for a one-year term. The Secretary-Director in turn selects the Secretaries for General Affairs, Treasury, and Planning, who also serve for one year, as well as two or three assistant editors. The board also selects the president of the Society for a two-year term. The KCS issues four publications:

- *Bulletin of the Korean Chemical Society* (bimonthly),
- *Journal of the Korean Chemical Society* (bimonthly),
- *Progress in Chemistry and Industry* (monthly newsletter), and
- *Chemical Education* (semiannually).

The first meeting of the Society in 1946 drew only 53 attendants. By contrast, the 1982 Fall Meeting held on 22-23 October 1982 at the Ulsan Institute of Technology in Ulsan had 500 participants and 200 special and technical papers. Of the 16 special papers, three were presented by invited foreign speakers:

- Professor Harry S. Mosher Department of Chemistry Stanford University	Tetradoxin and derivatives, chemistry and activity
- Professor Kenichi Honda[1] Department of Synthetic Chemistry Faculty of Engineering Tokyo University	Chemical conversion and utilization of solar energy
- Professor Saburo Nagakura Director-General Institute of Molecular Science Okazaki, Japan	External magnetic field effects upon chemical reactions and fluorescence of excited molecules

The technical papers were 15-minutes long and were presented in seven concurrent sessions which ran from 9:30-12:00 in the morning and from 1:30 to 6:00 in the afternoon; there were no poster sessions. The proportion of theoretical papers was relatively high. The reason for this, I was told, is that Korea is still a developing nation and does not have the resources to support much experimental research. However, one can expect this picture to change since the nation is now undergoing rapid and impressive industrial growth with concomitant technological advances.

For further information, contact the:

Korean Chemical Society
5-35, Anandong, Sungbuk-ku
Seoul, Korea

[1] *Scientific Bulletin 4* (2), 58 (1979)

VISITS TO SEMICONDUCTOR MATERIALS RESEARCH GROUPS IN JAPAN, THE 1982 SYMPOSIUM ON VLSI TECHNOLOGY, AND THE INTERNATIONAL CONFERENCE ON SOLID STATE DEVICES

Melvin C. Ohmer

INTRODUCTION

This report covers a recent trip to Japan to attend the 1982 Symposium on VLSI Technology, the International Conference on Solid State Devices, and to visit key semiconductor materials research groups. The topics of the visits were selected to be improved silicon and gallium arsenide crystal growth, improved silicon films on dielectric substrates [i.e., silicon on sapphire (SOS)] and projected materials requirements for VLSI technology. The visits included:

- the Shin-etsu Handotai Company--suppliers of very high quality silicon wafers and innovative silicon materials developers,
- the Musashino Electrical Communications Laboratory of Nippon Telegraph and Telephone (NTT) Public Corporation--developers of crystal growth technology,
- Sony Research Laboratory--leaders in the development of magnetic field assisted crystal growth,
- Toshiba Semiconductor Device Engineering Laboratory--leaders in the development of improved SOS and its utilization, and
- the University of Osaka--well-known for semiconductor characterization and processing research.

I also took advantage of an opportunity to visit a modern robot factory, Fujitsu FANUC.

In conjunction with the VLSI conference, the Nippon Electric Corporation (NEC) announced a new process called, "Implant Through Metallization," which provides technology necessary to increase the level of integration of random access memories (RAMs) from 256 kilobits to 4 megabits. The Japanese initiative on three-dimensional integrated circuits is following parallel paths in amorphous and crystalline silicon films. Single crystal silicon growth technology is being directed toward producing wafers customized for specific integrated circuit device processes. Gallium arsenide crystal growth technology is receiving substantially increased emphasis. Toshiba is still optomistic regarding SOS technology and predicts that SOS advantages will scale to .5 micrometer design rules. A major national program in radiation hardened electronics is being initiated. A new robot factory with 101 robots producing motors for robots will be constructed in the shadow of Mt. Fuji by Fujitsu FANUC. The overall conclusion to be drawn from the conference presentations is that solid state technology will continue to advance dramatically in the level of integration via a projected scale reduction to .2 micrometer design rules.

INSTITUTIONS AND COMPANIES VISITED

Company/Institution	Host	Subject
Shin-etsu Handotai Company	T. Abe	Silicon crystal growth

Nippon Telegraph and Telephone Public Corporation (NTT)	K. Hoshikawa	Silicon and gallium arsenide crystal growth
University of Osaka	S. Namba	Characterization of Si and GaAs
Sony Corporation	K. Hoshi	Magnetic Czochralski growth of Si and GaAs
Toshiba Corporation	H. Tango	SOS recrystallization, CMOS/SOS and internal gettering

SUMMARY OF VISITS

- Shin-etsu Handotai (SEH) Company, Ltd.

Magnetic field assisted crystal growth was discussed. Shin-etsu Handotai has tried transverse and longitudinal magnetic fields in FZ crystal growth. Mr. Takao Abe showed me data on resistivity profiles for transverse fields which indicated the best results for P doped silicon for 4000G and no rotation. The resistivity uniformity was equal to that obtained by NTD. Shin-etsu Handotai has not been able to reproduce the Tosil result which claimed that 90G longitudinal improved the resistivity uniformity of FZ grown crystals substantially. Fields of up to 400G were tried with no apparent benefit. The Japan Silicon Company has close ties to the Sony Corporation. The Japan Silicon Company is offering silicon wafers grown by magnetic CZ at a cost of 1.5 times conventional wafer price to Japanese customers, but Mr. Abe claims there is no interest. He stated that a 20 ton electromagnet is required for the transverse field Sony process. Mr. Abe felt that double crucible was not a production process. However, he visited Dr. Bennett of Bell Laboratories, Allentown, PA, where three double crucible pullers are in production, but he was not allowed to view them. Long p-type crystals which have good resistivity uniformity are easy to grow because boron does not segregate. The n-doped crystal segments appeared to be 8"-11" in length. The length is limited in n-type because P segregates and resistivity varies with length. A good materials program would be growth of long uniform resistivity n-type CZ crystals for CMOS. In a new research facility, SEH has constructed a high bay area where they will attempt to grow crystals as long as telephone poles. The parent company, Shin-Etsu Chemical owns a quartz company, so Mr. Abe has access to interesting crucible materials. A crucible grown from SiH_4 of optical fiber quality was tried, but no difference was observed. Mr. Abe also said that carbonware in pullers does not add carbon to crystals, but poor sealing does (air or vacuum grease, possibly). A recharge process in which the crucible is used many times is in general use in Japan. Oxygen donor annihilation anneals are usual practice for the customer. That is, the thermal history of the crystal is important for gettering. NMOS does not need high p or sharp junction in epi. Epi of 10 Ω-cm on a .1 Ω-cm substrate is suitable. FZ crystals may be oxygen doped to 15 ppm. Shin-etsu Handotai may have the largest CZ production in the world at their sister plant.

Tsumoru Masui is doing the photoluminescence at SEH using a system designed by Dr. Tajima of the Electrotechnical Laboratory. His sample holder is a triangular block which holds eight samples per side (24 samples). For samples with lowest concentrations, a twenty minute scan is required. Mr. Abe offered to grow double-doped crystals to help sort out the quantitative nature of pl in complex samples. Mr. Masui said that measuring epi-layers 2 to 5 μm thick on substrates with resistivities above one Ω-cm is fairly easy, but calibration is different.

Oxygen is a very important topic at SEH. The SEH standard material has an oxygen concentration of 19±2 ppma wafer to wafer with radial oxygen uniformity exceeding sensitivity of measurement for a macroscope beam diameter. For converting absorption coefficient to ppma there are three calibration constants, 9.63 for old ASTM, 6.0 for SEH's recent calibration, and 4.9 for new ASTM. Mr. Abe is interested in controlling microscopic oxygen. Presently, wafers are scanned by a traveling slit (actually moving wafer) and the ratio of absorptions at 9 μm and 8 μm is recorded. Absorption at 8 μm is a baseline. Mr. Abe wants to go to a 400 μm spot scan. He asked me where one could buy Si:Ga detectors (8-14 μm). Actually, a laser source for each wavelength would be a good QC hardware development program for manufacturing technology.

Mr. Abe gave me two x-ray topographs of wafers upon which CCD's had been fabricated. One was high yield and one was low yield. The worst looking wafer had the highest yield. It had heavy striations and the center had a high dislocation density.

Shin-etsu Handotai has tried rf CZ with a rotating magnetic field to rotate the molten Si in the crucible. By rotating the seed, the crucible, and the molten Si in the same direction, low oxygen material can be obtained.

The SEH nitrogen doped FZ crystals are being used by three European companies to fabricate power/discrete devices.

- The Musashino Electrical Communication Laboratory of NTT

NTT is a public corporation which transfers technology to industry. The primary reason for the visit was to discuss magnetically assisted crystal growth with Keigo Hoshikawa who has published several interesting articles on the subject. Dr. Tatsuo Izawa, Chief of the Crystalline Memory Material Section also joined us. Dr. Izawa has developed large gradient Ge doped SiO_2 pre-formers for producing long lengths of optical fibers. He has been the head of the Memory Section since this spring. The Memory Section has a program in silicon, galium arsenide, and bubble materials (bubble research is on the way out). NTT uses 4 MRAM's based on bubble technology which are more reliable in earthquake environments than the American Telephone and Telegraph (ATT) disc approach. NTT will use 256K RAMS in systems beginning the end of this year. NTT has a large processing research capability. They developed an x-ray lithography machine, full wafer, and step and repeat, an area where Bell Laboratories is also developing corresponding equipment. Such machines are not available to other organizations. A good MT equipment program would be x-ray lithography. Mr. Hoshikawa has used rotating magnetic fields to stir the melt so that it rotates in the direction of the seed and crucible rotation to grow low oxygen silicon. This work was reported at Silicon 1981. Mr. Hoshikawa provided me with a preprint of new work which utilized a vertical magnetic field (1000-2000 Oe) which was also effective in eliminating turbulence in the melt, but should be much cheaper to incorporate into crystal pullers than the Sony approach. They have tried double crucible for silicon and find it very effective when the inner crucible is rotated (a reprint of an abstract in Japanese was provided).

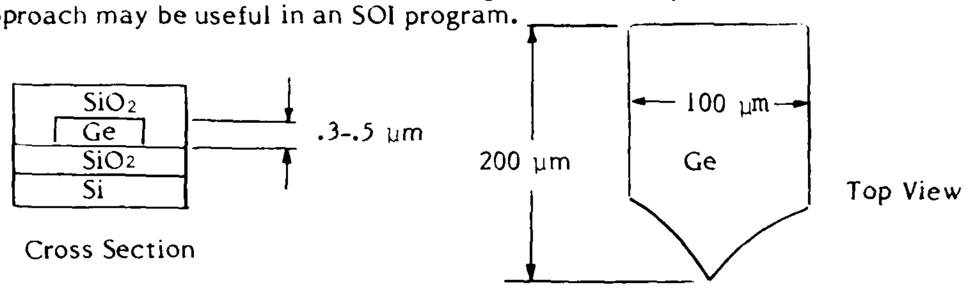
I was asked a number of questions about solution growth of thallium doped silicon. Their interest may be related to incorporation of high vapor pressure dopants in Si or to Tl specifically, or even GaAs.

A major GaAs effort is being initiated at NTT. They have a high pressure CZ system of their own design capable of growing 3" diameter crystals. Material of interest is all chrome doped (.1 or 2 ppm of Cr). They want to try double crucible growth of GaAs.

- University of Osaka

Professor Namba, who was my host, arranged many interesting discussions. I received an annual report from the Namba laboratory (1981), and an annual report from the semiconductor laboratory (1981). Professor Namba's Institute of Physical and Chemical Research is working on isotope separation of UF_6 and separation of tritium by laser chemistry. A number of reprints on photoluminescence and DLTS for GaAs were provided.

Kenichi Harakawa, a former captain in the Japanese Air Self-Defense Forces, gave me a laboratory tour. (He graduated from the National Defense Academy and knew a lot about our military academies because Japanese students at the National Defense Academy compete to attend them.) Mr. Harakawa is working on room temperature IR detectors for 10 µm. His approach may be useful in an SOI program.



A pattern of Ge much like the cross-section of a pulled crystal at initiation is produced between two SiO_2 layers. A traveling strip heater and substrate heater will be used to try to grow single crystal Ge without seeds. This should be tried for Si on SiO_2. Y. Yuba has done some interesting work on deep levels by DLTS on GaAs and InP which may be of interest. Taneo Nishino provided a number of reprints on quantitative photoluminescence applied to silicon. There was one paper on room temperature pl measurements. The theory is more complete than that of Mr. Tajima of the Electrotechnical Laboratory. They are studying 3d transition metals in GaAs by pl. Dopants are Ni, Co, Fe, Cr, and Mg. Ni has a sharp line at .55 eV in GaAs pl. Yokinori Ocheai described his work on fine focused ion beams (.4 µm with .2 µm resolution). Ions can do everything was the claim. There are no proximity effects as in e-beams. One can dope, etch, do SIMS, make masks better with ions in the submicron regime. Low currents presently limit technology. There is a major effort in a-Si solar cells. Cells with 10% efficiency have been obtained. Professor Namba will be the Chairman of the next International Solid State Device Conference.

- Sony Corporation

The motto on their matchbook is "Research Makes the Difference." Sony has a 300-man staff at their Central Research Laboratory. MCZ was discussed with Keiichi Nakamura, the Director of the Semiconductor Group, and Kenyi Hoshi, Nobuyuki Isawa, and Toshihiko Suzuki. Dr. Nakamura once visited the Ohio Semiconductor Company in Columbus, Ohio, in the early '60s and bought GaAs crystals from them. The Sony Corporation has since transferred the technology to the Japan Silicon Company. Presently, all their power devices are being fabricated in MCZ wafers. I learned that they can produce high oxygen content material suitable for MOS and bipolar production. The Japan Silicon Company has provided material to IC manufacturers, but yield data is not yet available. One feature of MCZ for P and Sb is that the concentration in the crystal increases which gave me two thoughts. One might be able to increase the quantum efficiency of Si:In with this technique, and there may be a zone refining application of the effect. They grow 4" diameter crystals a meter long. The resistivity uniformity was for best case + 2.6%. They have compared NTD and MCZ, and NTD of MCZ, but I can not recall specific details.

The field required to grow MCZ crystals is given by

$$B = \sqrt{\frac{L\Delta T}{12.51}} \quad \text{(Silicon)}$$

$$B = \sqrt{\frac{L\Delta T}{35.47}} \quad \text{GaAs (less field required)}$$

L = melt depth T = temperature difference across melt

PROPERTIES	Si	GaAs
δ	$1.29 \times 10^{6}\ \Omega\ m^{-1}$	6.5×10^{5}
β	$1.4 \times 10^{-4}\ {}^{\circ}C^{-1}$	9.7×10^{-5}
ρ	$2.52 \times 10^{3} Kg\ m^{-3}$	5.7×10^{3}
κ	$3.4 \times 10^{-6} m^{2} sec^{-1}$	3×10^{-5} at 800°C (not accurate)
?	$3 \times 10^{-7} in^{2} sec^{-1}$	3×10^{-7}

The indication is that slightly smaller fields will be reouired for GaAs than for Si. Sony is looking into MCZ of GaAs in low pressure cases.

- Toshiba Corporation

Dr. K. Shimizu, Director of the Semiconductor Device Engineering Laboratory, gave an overview of Toshiba's organization. Dr. Y. Nishi spoke on general topics. He stated that Toshiba would be working on a Ministry of International Trade and Industry (MITI) Radiation Hardening Program and he gave me a copy of the MITI overall program. He said the interest was related to alpha particle tolerance from packaging material, nuclear reactor applications, and for space. It is a $300 million program. My primary host, Dr. H. Tango, had arranged discussions with five other scientists who were specialists in SOS technology and internal gettering.

The Toshiba Corporation is a leader in SOS technology. It began when they received a five year, 20 million yen per year program from MITI in 1973 to develop a Pattern Information and Handling System. Because of speed requirements, they selected a SOS approach with 3.5 μm design rules and 6 μm thick films. Since the MITI contract, the SOS effort has continued at 10 million yen per year, mainly funded internally by Toshiba's computer division. A 16-bit SOS microprocessor, the T88000, is in production for use in minicomputers, office machines, and x-ray tomography equipment. Production is presently 500 chips per month, but will double in the near future. A 16-bit high speed SOS multiplier will also be in production in the near future. It is twice as fast as the conventional TRW CML bipolar devices, and uses only 2% of the power. A modified array scheme of conventional carry save adder accounts for speed. The multiplier uses 2.5 μm design rules, poly-Si and Al metallization and dry etching. A delay per gate of .2 nanoseconds at 5V was mentioned. Best value to date is .160 n and seconds. A comparison number for GaAs was given as .080 nanoseconds with a record of .020 n and seconds. At 1 μm, design rules CMOS/SOS is 40% faster than CMOS/bulk. The chip area in SOS is smaller. As an example, for logic, SOS chip is 70% of size of bulk chip. Toshiba claims equal cost for CMOS/SOS *vs.* CMOS/bulk on the area and speed basis. Toshiba also claims that below two microns, the SOS and bulk device mobility is the same. SOS production wafers are 4" diameter, and 5" diameter wafers are being tested. Wafer detection is more difficult for SOS wafers because they are transparent and steppers, etc., and rely on optical detection. CMOS circuits usually have more transistors, but by using exclusive NOR gates this disadvantage is reduced or eliminated.

The best deposition parameters for SOS are 940° C at 2 μm/min or faster. Very interesting temperature and rate work was being done. For dual rates, if first 400 Å (complete coverage) is at 2 μm/min, the rest can be deposited at 3 μm/min to 2 μm/min without any difference. Work at 100 Å, 200 Å, 300 Å, and 400 Å comparing misorientation and twinning was very interesting, pointing out why there is a preferred sharp temperature. Twin density decreases with increasing film thickness.

In the future, recrystallized .4 or .3 μm films will be used with one micron design rules. Recrystallization increases mobility and reduced back channel leakage by two orders of magnitude (2×10^{-12} A/ μm) in n-channel without implantation and 8×10^{-12} leakage in p-channel is obtained with deep phosphorus implant. Silicon on cubic zirconia might not require p-channel implant. Interline capacitance is mainly parasitic, so SOZ dielectric constant may not be a big problem. Toshiba maintains a SOS advantage which persists to .5 μm (it does scale).

In recent, or to be published, IEEE device letters Toshiba compares epitaxial wafers, bulk, and gettering. For their CMOS process they use an oxygen concentration of 21.5×10^{18} cm^{-3} (old ASTM). Several reprints on carbon were provided which will be studied carefully. The carbon concentration one can live with depends on the thermal cycle. Oxygen precipitates have twice the volume of ingredients in solution. For PMOS, 1100 and 1200°C temperatures are used and a thick denuded zone is produced. But NMOS is lower and the process results in a thin denuded zone. If a thicker zone is required then pretreatment is required. Thermal history is of high interest in Japan. The oxygen, carbon thermal history and process are tied together. A major program of Si epi-growth on Si is being initiated in UHV + RHEED + Quadrapole Mass Analyzers, etc. The comment was made that recent progress in SOI is remarkable, but uniformity and reproducibility is not good. In conclusion, Toshiba is very optomistic about SOS and with their captive internal market, and MITI, the technology is getting a chance to compete against bulk. Toshiba says SOS does not have punch through, threshold control, and latch-up problems.

A SUMMARY OF THE ELECTRONIC DEVICE CONFERENCE'S PAPERS

- The 1982 14th International Conference on Solid State Devices

There was an interesting paper (C-Z-1) on the growth of undoped semi-insulating by LEC. High resistivity was obtained independent of the purity of the starting materials and the crucible material via a distillation process *in situ* and very low water content starting materials. There were two papers which discussed device and materials correlations (C-2-2 and B-5-4); one by NTT and one by the Rockwell Corporation. R. Zucca of Rockwell showed threshold voltage variation data which indicated that high threshold devices are on the perimeter of the 3" wafers. Improved threshold voltage control appears to be possible by bulk materials improvements. The same message was given by NTT. Dr. H. Gatos gave an invited paper on MIS structures (A-1-2) making several interesting comments. He said that more bulk growth effort is required. Within the past year progress has been made in controlling deep levels by adding silicon, and controlling As partial pressure during growth or the hydrogen (atomic) addition. Maybe surface state deep levels may also be controllable (E_C-.7 eV) and (E_C-.85 eV). The deep levels may be vacancy related, but the question may be asked whether this is due to equilibrium concentration or an "excess." The vacancy control studies in bulk and surface looks like an interesting research topic. He stated that anodic oxide looks good when charges annealed out even though it is not stable at "very" high temperatures. Dr. Eastman gave an invited talk on the limit of GaAs FETs. He gave a theoretical limit for velocity as the intrinsic (100) group velocity, a value of 9.5×10^7 (units). Presently values of 1.2×10^7 are for FETs and 2.4×10^7 for HEMTs. For .4 µm channels 4×10^7 in FETs and 8×10^7 in HEMTs will be possible. A 3000 Å path without collision has been observed. Scaling from .8 µm to .4 µm has ballistic benefits plus the usual scaling (accelerate early and let drift for high average velocity). He expects that 100 GHz practical transistors will be possible. However, there is some kind of current density problem. In some cases, a value of 100,000 A/cm^2 may flow which can "melt" things. There was an interesting paper in the late new session on DLTS (C-1-LN3). F. Hasegawa of the University of Tsukuba gave the paper. A comparison of deep levels in HB and LEC was given. There were interesting differences in EL 6's annealing behavior.

. Silicon on Dielectrics

Paper A-6-4 reported on CaF_2 and mixed $Ca_xSr_{1-x}F_2$ buffer layers for silicon/buffer/silicon structures. Organometallic depositions on silicon of these fluorides would be an excellent approach for ML LDF buffer program. There were a number of papers on using a-silicon and poly-Si to fabricate devices. A prime example was paper C-4-2. High mobility meant 1.9cm^2/V-sec. A 3d circuit was reported on. Apparently a-Si is intended for large area displays as well as cheap solar cells. Paper C-3-LN2 discussed lateral epitaxy by SPE at 550° to 550°C.

. Packaging Material

Paper B-2-4 reported on a semi-insulating SiC polycrystalline p-type ceramic substrates for heat sinking. Properties were an alpha of 3.7×10^{-6} deg^{-1}, a conductivity of 2.7 Kw/cm-deg, a resistivity of 4×10^{13} ohm-cm, and, unfortunately, an ε_0 of (42, 20) at (1 MHz, 1 GHz).

. Metallization

Paper A-5-1 discussed silicides for silicon and described an excition result upon which a paper will be coming out concerning the discovery that silicide reactions can result in As and P activation in silicon at 250°C. Papers B-5-2 and B-5-3 were of interest for GaAs. Ti/W silicide gates and Au-Ge-Au and Au Ge/Ni ohmic contacts were discussed. In B-50-3 ohmic contacts were obtained by a 420°C one minute anneal of AuGe/Ni to alloy. It would be interesting to try by laser annealing at MLPO.

. Detectors

Dr. Kosonocky (A-3-7) gave an invited talk on the Schottky-Barrier IR-CCD Image Sensors which was excellent. For IrSi, a cutoff of 8 µm and operating temperature of 60 K is possible. Paper A-5-4 covered laser photochemistry. Paper A-5-2 addressed the topic of electrical activation of Ga and Al in silicon. There is a problem of low electrical activation (as low as 1%) for both with conventional annealing. A capping technique to improve the percent that is substantially activated is described. This problem bodes ill for MBE doping sources and may provide a problem for BIBs™/IBCs.

. Silicon Crystal Growth

Paper A-6-1 presented by Toshiba Ceramics discussed an interesting approach to oxygen countrol. PBN crucibles are used and SiO_2 rods of varying amounts are placed in the bottom as a uniform oxygen source. The crystals have 10^{15} cm^{-3} of nitrogen much like SEH's FZ tough silicon.

COMMENTS ON VISITS AND CONFERENCES

- Gallium Arsenide Technology at SEH and NTT

At SEH, Isobe only silicon and GaP is grown. The GaP is grown in high pressure CZ pullers which are homemade. Dr. Abe stated that because of As contamination of Si, GaAs will be grown elsewhere. Next year high pressure LEC GaAs growth will be initiated at SEH. Mr. Abe stated there are 14 suppliers of GaAs in Japan and the market is small and highly competitive. The Musashino Electrical Communication Laboratory of NTT will plan a major effort to improve GaAs crystals. NTT has made their own high pressure puller for GaAs. Keigo Hoshikawa is a section leader in Si and GaAs crystal growth. He has done magnetic field and double crucible growth of silicon. NTT has a high pressure CZ puller for LEC GaAs. They design the pullers and the Kokusai Electric Company builds and sells them. The NTT effort is all chrome doped (0.1 to 0.2 ppm). No processing instabilities was ever observed. The undoped semi-insulating mechanism is unknown. NTT wants to try a double crucible, but has not tried it yet. They feel it is possible in a high pressure LEC puller without major modifications as would be the case with magnetic field growth.

- Magnetic Growth and Lithography at Toshiba

In discussions with K. Odagawa of Toshiba, I found the the Toshiba Corporation is doing silicon growth in superconducting magnetic fields. They do linear motor magnetically levitated car work. They also use superconductivity in mask (aligner or maker, etc.) A photoemission cathode *with a metal mask prevents emission. They* use a superconducting magnet for B field and an E field to focus. They do the total wafer in one exposure. SOS is used in in-house computers.

- SOS Development

I spoke with Robert Jecmen of Intel Corporation. The SOS was tried, but given up because the five-year growth projections indicated SOS scaling problems. They would like to have high quality .25 μm films to drive junction to full depth. He indicated that the cost would be $150 a wafer and a factor of two in die cast (4"). Better isolation techniques are being developed which compete with SOS.

- Si Materials Trends (Epi)

Texas Instruments (TI) favors an epi-layer approach to eliminate once and for all the latch up problem. I asked Dr. Chatterjie of TI about materials requirements. The epi to substrate resistivity is now 10^3, but they would like 10^4. The substrate is .01 Ω-cm and epi is 10 Ω-cm now. They would like 100 Ω-cm epi. It is now 13 μm thick. For 1.25 μm will go to 6 μm for CMOS. The thinner epi may be desirable for submicron NMOS, but submicron CMOS is a long way away.

- Si Materials Trends (SOI/SOS)

For SOI, the desirable thickness is 1 to 2 μm oxide with .5 μm film (Chatterjie).

However, if the film were perfect, thinner is more desirable. An ideal thickness would be the channel depth plus the amount consumed by thermal oxidation (Ohmer). Dr. Sze indicated scaling a .1 μm gate length would result in a transistor with a 900 Å channel depth and an 100 Å oxide (oxide thickness formed by consuming 40% of oxide thickness in silicon). The lower limit on film thickness would then be 950 Å for .1 μm gates. In the nearer term, channel depths is in the .25 μm range. In summary, a materials program in SOI and SOS to develop higher quality films in the range of .1 to .25 μm would be a good generic technology program. Mois Beguwala of the Rockwell Corporation showed a 5" diameter silicon on a sapphire wafer. Latch up was a big issue at the VLSI conference for submicrons. Note that SOI/SOS is a latch up immune technology.

- Scaling CMOS

NMOS scales to ~.3 μm, but PMOS runs into trouble at ~.7 μm. The problem is source and drain resistances. Higher P+ regions with sharp edges are required. A slow diffusing efficient p-type dopant is required. Possibly, boron by some laser annealing approach or even gallium could be used. This is a show stopper for CMOS and the basis of a good materials program. Note that N-type dopants have sharper profiles and P and Sb have high solubilities which eliminate the problem in NMOS.

INTERNATIONAL MEETINGS IN THE FAR EAST

1983-1986

Compiled by Seikoh Sakiyama

This list will be updated and augmented in future issues of the *Scientific Bulletin*. The assistance of the Australian Academy of Science and the Japan Convention Bureau in supplying a list of meetings in their countries is deeply appreciated. Readers are asked to notify us of upcoming international meetings in the Far East which have not yet been included in this report.

1983

Date	Title	Site	For information, contact
July 4-5	The 4th Topical Meeting on Gradient Index Optical Imaging Systems	Kobe, Japan	Nunoi Office Azabudai UNI-house 504 1-1-20, Azabudai Minato-ku, Tokyo 106
July (tentative)	Environmental Engineering Conference	Australia (undecided)	The Conference Manager The Institute of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
August 1-7	International Association for Dental Research	Sydney, Australia	Mr. Scott Gotjamanos Department of Pathology Perth Medical Center Verdon Street Nedlands, W.A. 6009
August 14-19	International Solar Energy Congress	Perth, Australia	Mr. P. Driver Honorary Secretary P.O. Box 123 Nedlands, W.A. 6009
August 14-19	Computers in Engineering	Australia (undecided)	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
August 14-19	1983 Solar World Congress	Perth, Australia	Solar World Congress P.O. Box X2275 Perth, W.A. 6001

Date	Title	Site	For information, contact
August 17-24	The 4th International Congress of Plant Pathology	Melbourne, Australia	Mr. B. Price Victorian Plant Research Institute Department of Agriculture Victoria, Swan Street Burnley, Victoria 3121
August 18-27	International School of Crystallography	Kyoto, Japan	Professor Ashida Department of Applied Chemistry Nagoya University Furo-cho, Chikusa-ku Nagoya 464
August 21-25	Thermal Physiology Symposium	Sunshine Coast, Australia	Mr. J.R.S. Hales CSIRO Division of Animal Production P.O. Box 114 Eastwood, S.A. 5063
August 21-26	The Ninth International Congress of Heterocyclic Chemistry	Tokyo, Japan	Dr. T. Kametani Hoshi College of Pharmacy 2-4-41, Ebara Shinagawa-ku, Tokyo 142
August 21-27	The 5th International Congress of Immunology	Kyoto, Japan	The Japanese Society for Immunology Institute of Virus Research Kyoto University Kawaracho, Shogoin Sakyo-ku, Kyoto 606
August 22-26	The 10th International Conference on Amorphous and Liquid Semiconductors	Tokyo, Japan	Dr. Kazuo Morigaki Institute for Solid State Physics Tokyo University 7-22-1, Roppongi Minato-ku, Tokyo 106
August 22-26	The 7th Australian Symposium on Analytical Chemistry	Adelaide, Australia	Mr. Don Patterson Honorary Secretary AMDEL, P.O.Box 114 Eastwood, S.A. 5063

Date	Title	Site	For information, contact
August 25-September 1	Conference of the International Union of Forest Research Organization	Melbourne, Australia	Mr. B. Cumberland Forestry Branch, Department of Primary Industry Canberra, A.C.T. 2600
August 27	Symposium Commemorating the 100th Anniversary of the Mount Krakatau Eruption	Jakarta, Indonesia	Dr. Didin Sastrapradja Indonesian Institute of Sciences LIPI, JL Teuku Chik Ditiro 43 Jakarta
August 27-31	The 25th International Geographical Congress	Sydney, Australia	Australian Academy of Science P.O. Box 783 Canberra, A.C.T. 2601
August 26-September 2	The 18th International Ethological Conference	Brisbane, Australia	Professor E. McBride Department of Psychology University of Queensland St. Lucia, Queensland 4067
August 28-September 2	The 29th International Congress of Physiology	Sydney, Australia	Australian Academy of Science P.O.Box 783 Canberra, A.C.T. 2601
August 28-September 3	The 3rd International Mycological Congress (IMC 3)	Tokyo, Japan	Professor K. Tsubaki Institute of Biological Sciences The University of Tsukuba Sakura-mura, Ibaraki 305
August 29-September 3	Fourth International Symposium on Water-Rock Interaction	Tottori, Japan	Professor H. Sakai Institute of Thermal Spring Research Okayama University Misasa, Tottori 682-02
August 30-September 1	International symposium on Measurement and Processing for Indirect Imaging	Sydney, Australia	Dr. R.H. Frater, Chairman National Committee for Radio Science CSIRO Division of Radio Physics P.O.Box 76 Epping, N.S.W. 2121

Date	Title	Site	For information, contact
August (tentative)	Hydraulics and Fluid Mechanics Conference	Newcastle, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
September 5-7	International Symposium on Guanidino Compounds	Tokyo, Japan	Institute of Neurobiology Medical School Okayama University Okayama, Japan
September 5-10	IUTAM Symposium on Turbulence and Chaotic Phenomena in Fluids	Kyoto, Japan	Professor T. Tatsumi Department of Physics Faculty of Science Kyoto University Sakyo-ku, Kyoto 606
September 12-13	The '83 International Conference on Advanced Robotics (ICAR)	Kyoto, Japan	Japan Industrial Robot Association Kikai Shinkoh Kaikan 3-5-8, Shiba-koen Minato-ku, Tokyo 105
September 12-16	The International Ion Engineering Congress	Kyoto, Japan	Professor T. Takagi Ion Beam Engineering Experimental Laboratory Kyoto University Sakyo-ku, Kyoto 606
September 19-22	International Meeting on Chemical Sensors	Fukuoka, Japan	Professor T. Kiyoyama Interdisciplinary Graduate School of Engineering Sciences Kyushu University 33 Sakamoto, Kasuga Kasuga, Fukuoka 816
September 19-23	The 12th World Energy Conference	New Delhi, India	Dr. R.J. Ramdebough 1620 Eye Street Suite 808 Washington, D.C. 20008
September 22-26	The 4th Asian and Australian Conference ISRT (International Society of Radiologic Technologists)	Tokyo, Japan	Mr. Lucky Morimoto International Department The Japan Association of Radiologic Technologists 26-7, Shinkawa 1-chome Chuo-ku, Tokyo 104

Date	Title	Site	For information, contact
September (tentative)	The 7th Rare Earth-Cobalt Magnet Workshop	Beijing, People's Republic of China	Professor Ho Wen-wang Physics Department Beijing University Beijing, People's Republic of China
October 2-5	The 3rd International Display Research Conference	Kobe, Japan	Japan Convention Services, Inc. Nippon Press Center, 8F 2-1, Uchisaiwai-cho 2-chome, Chiyoda-ku Tokyo 100
October 3-6	International Symposium on Interferons	Kyoto, Japan	Japan Convention Services Inc., Osaka Branch Ikari Building 3-1-59, Fukushima Fukushima-ku, Osaka 553
October 10-13	International Radar Symposium, India '83	Bangalore, India	Mr. N. L. Krishman Bharat Electronics, Ltd. 29 Race Course Road Bangalore, 560001
October 16-24	The 8th International Conference on Calcium Regulating Hormones	Kobe, Japan	Professor T. Fujita 3rd Division Department of Medicine School of Medicine Kobe University 7-13, Kusunoki-cho Ikuta-ku, Kobe 650
October 17-21	1983 (98th) IEC (International Electrotechnical Commission) General Meeting in Tokyo	Tokyo, Japan	Japan Standards Association 4-1-24, Akasaka Minato-ku, Tokyo 107
October 18-23	International Telecommunications Energy Conference (INTELEC '83)	Tokyo, Japan	Professor Koosuke Harada Department of Electrical Engineering Kyushu University 6-10-1, Hakozaki Higashi-ku, Fukuoka 812

Date	Title	Site	For information, contact
October 23-28	1983 Tokyo International Gas Turbine Congress	Tokyo, Japan	The Organizing Committee of 1983 Tokyo International Gas Turbine Congress Sansei International, Inc. Showa Building, 1-7-5 Akasaka, Minato-ku, Tokyo 107
October [illegible]-28	The 28th Annual Scientific Meeting of the Royal College of Pathologists of Australia	Melbourne, Australia	The Secretariat, The Royal College of Pathologists of Australia 82 Windmill Street Sydney, N.S.W. 2000
November [illegible]	Japanese National Committee of CIGRE Study Committee 34, 35	Tokyo, Japan	CIGRE The Institute of Electrical Engineers of Japan Shin Yurakucho Building 1-12-1, Yuraku-cho Chiyoda-ku, Tokyo 100
November 7-11	International Congress on Heat Treatment of Materials, (3rd)	Shanghai, People's Republic of China	Heat Treatment Institution of CMES P.O. Box 907 Beijing, People's Republic of China
November 14-15	The 4th Mathematical Programming Symposium, Japan	Kobe, Japan	Professor R. Manabe Department of Management Science Kobe University of Commerce 4-3-3, Seiryodai Tarumi-ku, Kobe 655
November 14-20	The 71st FDI Annual World Dental Congress (Federation Dentaire Internationale)	Tokyo, Japan	Japan Dental Association (Japanese Association for Dental Science) 4-1-20, Kudan-kita Chiyoda-ku, Tokyo 102
November (tentative)	Conference on Microprocessors	Australia (undecided)	The Conference Manager The Institute of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600

Date	Title	Site	For information, contact
November (tentative)	Metal Structures Conference	Brisbane, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
November 28-December 3	International Wheat Genetics Symposium, (6th)	Kyoto, Japan	Dr. S. Sakamoto Faculty of Agriculture Kyoto University Mozume Muko, Kyoto 617
November 30-December 2	Symposium on Prediction in Water Quality (SPWQ)	Canberra, Australia	SPWQ P.O. Box 783 Canberra, A.C.T. 2601
December 6-10	The 2nd International Conference on Chemistry and World Food Supplies	Manila, Philippines	International Rice Research Institute Massachusetts Ave., NW Washington, D.C. 20036
December 11-21	International Congress of Genetics	New Delhi, India	P.O. Box 2841 New Delhi 110060
December (tentative)	The 12th International Laser Radar Conference	Melbourne, Australia	Dr. C. Platt, CSIRO Division of Atmospheric Physics P.O. Box 77 Mordiattoc, Victoria 3195
December (tentative)	Applied Mechanics Conference	Australia (undecided)	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
December (tentative)	Annual Meeting of the Australian Society for Immunology	Perth, Australia	Executive Officer Australian Society for Immunology P.O. Box 206 Nedlands, W.A. 6009
Undecided	The 13th International Congress of Chemotherapy	Melbourne, Australia	Dr. B. Stratford St. Vincent's Hospital 59 Victoria Parade Fitzroy, Victoria 3065

1984

Date	Title	Site	For information, contact
April 3-5	Tele Conference (tentative name)	Tokyo, Japan	Data Communications Department Kokusai Denshin Denwa Company, Ltd. 2-3-2, Nishi-Shinjuku Shinjuku-ku, Tokyo 160
February 12-16	The 14th Australian Polymer Symposium	Ballarat, Australia	Dr. G.B. Guise P.O. Box 224 Belmont, Victoria 3216
February (tentative)	International Conference on Mesoscale Meteorology	Australia, (undecided)	Royal Meteorological Society Australian Branch P.O. Box 654 Melbourne, Victoria 3001
May (tentative)	The 5th International Soils Expansion Confer- ence	Adelaide, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
June (tentative)	The 4th Congress on World Computing Services Industry	Tokyo, Japan	Japan Software Industry Association Kikai Shinko Kaikan 3-5-8, Shiba-koen Minato-ku, Tokyo 105
August 24-30	The 5th International Congress on Mathematical Education	Adelaide, Australia	Dr. John Mack Department of Mathematics University of Sydney N.S.W. 2006
August 26-31	The 3rd International Congress on Cell Biology	Kyoto or Kobe, Japan	Japan Society for Cell Biology Shigei Medical Research Institute 2117 Yamada Okayama 701-02
August 26-September 1	International Conference on the Photochemical Combustion and Storage of Solar Energy	Osaka, Japan	The Society of Kinki Chemical Industry 1-8-4, Utsubo-hommachi Nishi-ku, Osaka 550

Date	Title	Site	For information, contact
August 27-September 1	The 9th International Conference on Raman Spectroscopy	Tokyo, Japan	Professor M. Tasumi Department of Chemistry Faculty of Science University of Tokyo 7-3-1, Hongo Bunkyo-ku, Tokyo 113
September 1-7	The 6th International Congress of Virology	Sendai, Japan	Professor T. Ebina Department of Bacteriology, Medical School Tohoku University 2-1, Seiryo-cho Sendai, Miyagi 980
September 2-7	International Symposium on Snow and Ice Processes at the Earth's Surface	Sapporo, Japan	The Institute of Low Temperature Science Hokkaido University 8-chome, Kita 19-Jyo Kita-ku, Sapporo 060
September 2-8	The XIIth International Biometric Conference	Tokyo, Japan	Dr. T. Okuno Department of Mathematical Engineering and Instrumentation Physics Faculty of Engineering Tokyo University 7-3-1, Hongo Bunkyo-ku, Tokyo 113
September 3-7	The 1st International Conference on Technology of Plasticity	Tokyo, Japan	Japan Society for Technology Plasticity Torikatsu Building, 3F 5-2-5, Roppongi Minato-ku, Tokyo 106
September 11-14	The 10th International Conference of IMEKO TC-3 (International Measurement Confederation)	Kobe, Japan	Professor T. Ono Department of Mechanical Engineering College of Technology University of Osaka 4-804, Ume-machi, Mozu Sakai, Osaka 591
September (tentative)	Shiga Conference '84 on Conservation Management of World Lake Environment	Shiga, Japan	Department of Civil Life and Environment Shiga Prefectural Government 4-1-1, Kyo-machi Otsu, Shiga 520

1984, continued

Date	Title	Site	For information, contact
October 7-12	XVIIth International Congress of Internal Medicine	Kyoto, Japan	The Japan Society of Internal Medicine Hongo Daiichi Building, 8F 3-34-3, Hongo Bunkyo-ku, Tokyo 113
October 16-18	1984 International Symposium on Electromagnetic Compatibility (EMC)	Tokyo, Japan	Professor T. Takagi Department of Electrical Communications Faculty of Engineering Tohoku University Sendai, Miyagi 980
October (tentative)	The 3rd Asian Pacific Regional Astronomy Meeting of IAU	Tokyo, Japan	Professor T. Kogure Department of Astronomy, Faculty of Science University of Kyoto Sakyo-ku, Kyoto 606
November 22-23	Technology: Past, Present, and Future	Melbourne, Australia	Executive Officer Australian Academy of Technological Sciences Clunies Ross House 191 Royal Parade Parkville, Victoria 3052

1985

Date	Title	Site	For information, contact
February 11-14	International Symposium on Characterization and Analysis of Polymers	Melbourne, Australia	Polymer 85 Royal Australian Chemical Institute 191 Royal Parade Parkville, Victoria 3052
March (tentative)	Annual National Conference of the Institution of Engineers, Australia	Melbourne, Australia	LtCol. J.A. McDonald Secretary, Victoria Division Institute of Engineers, Australia National Science Center 191 Royal Parade Parkville, Victoria 3052

1985, continued

Date	Title	Site	For information, contact
May 20-24	The 3rd Conference on Steel Development	Melbourne, Australia	Australian Institute of Steel Construction P.O. Box 434 Milsons Point, N.S.W. 2061
August (tentative)	Coastal Engineering Conference	Melbourne, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
August (tentative)	International Association Hydraulic Resources Conference	Melbourne, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
September (tentative)	The 11th International Teletraffic Congress ITC-11	Kyoto, Japan	ITC-11 Committee Musashino Electrical Communication Laboratory 3-9-11, Midorimachi Musashino, Tokyo 180
October 15-18	International Rubber Conference	Kyoto, Japan (tentative)	The Society of Rubber Industry, Japan Tobu Building 1-5-26, Motoakasaka Minato-ku, Tokyo 107

1986

Date	Title	Site	For information, contact
May 11-17	Congress of the International Society of Haematology and the International Society of Blood Transfusions	Sydney, Australia	Dr. I. Cooper, President Haematology Society of Australia Cancer Institute 481 Little Londsdale Street Melbourne, Victoria 3001
September 21-25	The World Congress of Chemical Engineering	Tokyo, Japan	Society of Chemical Engineers Japan Kyoritsu Kaikan 4-6-19, Honhinata Bunkyo-ku, Tokyo 112

Date	Title	Site	For information, contact
Undecided	International Microbiological Congress	Perth, Australia	Australian Academy of Science P.O. Box 783 Canberra, A.C.T. 2601
Undecided	International Institute of Welding Annual Assembly 1986	Tokyo, Japan	Japar Welding Society 1-11, Sakuma-cho, Kanda Chiyoda-ku, Tokyo 101

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983-406-592

NOTICE

The Office of Naval Research Scientific Liaison Group, Tokyo was disestablished on 30 September 1981. Effective 1 October 1981, the Office of Naval Research, Liaison Office, Far East (ONRFE) has been established as a tenant of the Akasaka Press Center, Tokyo. The ONRFE office is located on the second floor of Bldg #1, Akasaka Press Center and it bears the following mail identification:

Mailing address:	Department of the Navy Office of Naval Research Liaison Office, Far East APO San Francisco 96503
Local Address:	ONR Far East Akasaka Press Center 7-23-17, Roppongi Minato-ku, Tokyo 106
Telephone numbers:	Civilian 03-401-8924 Autovon 229-3236 Telex 222-2511 SANTEL TOKYO

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 12503 WASHINGTON, D.C.

POSTAGE AND FEES PAID BY DEPARTMENT OF THE NAVY

OFFICE OF NAVAL RESEARCH
LIAISON OFFICE, FAR EAST
APO SAN FRANCISCO 96503

ATE
LME