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Acquaculture	Hakuho Maru	Chinese science	Alloy
Fish	Immunology	Chinese education	Chemistry

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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 Tokyo, 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.

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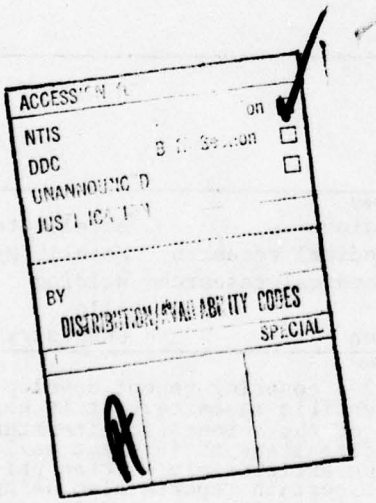

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CONTENTS

MARINE SCIENCE AND GEOCHEMISTRY IN THE METEOROLOGICAL RESEARCH INSTITUTE, TOKYO

Francis A. Richards

INTRODUCTION

As my first contribution to *Scientific Bulletin*, it seems appropriate to report an updating of the activities of my close friends and associates with whom I worked in 1970-71, when I was in Japan under the auspices of the NSF United States-Japan Cooperative Science Program. In those years I spent six happy months at the Geochemical Laboratory of the Meteorological Research Institute (MRI); the second six moths were at the Research Institute for Food Science of Kyoto University. So my first liaison activity in Tokyo was to revisit MRI at Koenji, a delightful enclave west of the heart of Tokyo.

MRI, under the Ministry of Transport, is part of the governmental sector of research in Japan. The institute is the research arm of the Japan Meteorological Agency, which evolved from the former Central Meteorological Observatory in July 1956. The institute dates from February 1942. Since its formation the institute has continued to grow until it now has nine research divisions plus an Office of Planning and an Administration Department.

The nine divisions are 1) Forecast Research, 2) Typhoon Research, 3) Physical Meteorology, 4) Applied Meteorology, 5) Meteorological Satellite, 6) Seismology and Volcanology, 7) Oceanographical, 8) Upper Atmosphere Physics, and 9) Geochemical.

Taking the narrower view and separating marine and atmospheric sciences, the former is scattered among several of the research divisions, particularly the Seismology and Volcanology Division, which has a major concern in ocean bottom seismography and submarine geophysics; obviously the Oceanographical Division, which is concerned with physical oceanography; and the Geochemical Division. This article will be concerned with the Geochemical Division; physical oceanography and submarine geophysics will be treated in a later installment.

THE GEOCHEMICAL DIVISION

This division has active programs concerned with geochemical aspects of the environment. For many years, beginning with its founding, it was under the direction of Professor Yasuo Miyake, a pioneer geochemist-meteorologist-chemical oceanographer whose many publications have touched on an enormously wide range of interrelated topics. He is well known for his early work on the fundamental physical-chemical properties of seawater, but he became famous in world-wide circles outside his field for his reports on the geochemical effects of early nuclear bomb testing in the Pacific. The combination of his expertise in chemistry, specifically radiochemistry, oceanography, and meteorology put him in a particularly good position to predict and to follow the course of radioactivity introduced into the ocean and the atmosphere by bomb testing. Probably the most long-standing project of the Geochemistry Division has been the monitoring of radionuclides in rainfall at the Koenji laboratory and at six other places in Japan. This project is continuing, and the laboratory is now in a good position to observe possible fallout effects of Japan's new nuclear fuel reprocessing plant.

General areas of interest of the division are stated as 1) exchange of chemical substances between atmosphere and ocean, 2) circulation of chemical substances in atmosphere and oceans, 3) radioactive materials in fallout, rain water, and seawater, and 4) vertical diffusion of radioactive materials near the ocean floor. Under this broad umbrella current projects include studies of the effects of disposal of low level radioactive wastes in the sea, the effects of nuclear fuel reprocessing on radioactive fallout, the possible prediction of earthquake activity by monitoring the radon content of deep well waters, the organic complexation of trace metals in sea-

water, the distribution of the different oxidation states of selenium in the ocean, and the development of methods for chemical analyses.

Although now retired from the Institute, Dr. Miyake continues his close ties with MRI and has recently collaborated with Yoshio Sugiura and Katsuko Saruhashi on a study of the levels of radioactive wastes suitable (or unsuitable) for dumping at sea. In two papers (Miyake and Saruhashi, 1976; Sugiura, Saruhashi and Miyake, 1976) they examine the recommendations of the International Atomic Energy Agency (IAEA, 1975) and the biogeochemical oceanographic model of Webb and Morley (1973) on which the recommendations are based. They examine a two-layer circulation-diffusion model and arrive at quite different criteria for levels of radioactivity above which wastes are unsuitable for dumping at sea:

IAEA: (a) 10 Ci/ton (Curies/ton) for α active wastes of half-life greater than 50 years (in the case of ^{226}Ra, not more than 100 Ci/y may be dumped at any one site).
(b) 10^3 Ci/ton for β/α -active waste (excluding tritium), but the limit for ^{90}Sr plus ^{137}Cs is 10^2 Ci/ton
(c) 10^6 Ci/ton for tritium.

Miyake et al.:
(a) 10 Ci/ton for β/α -active wastes (excluding tritium) but the limit for ^{90}Sr plus ^{137}Cs is 1 Ci/ton.
(b) 10^4 Ci/ton for tritium.
(c) α-active waste of longer half-lives, such as ^{226}Ra and ^{239}Pu, may not be dumped at any site.

Some facts about the proposed dumping of radioactive wastes at sea from Japan's new nuclear fuel reprocessing plant at Tokai in Ibaraki Prefecture are as follows:

The wastes are to be transmitted through a polyvinyl chloride pipe some 25 cm in diameter 1.8 km to sea into water 20 m deep. The disposal will be intermittent and the mode of dumping may be regulated tidally. According to the final report of the Atomic Energy Commission to the Prime Minister, the major nuclides to be included in liquid wastes (about 300 tons per day) are as follows:

^{103}Ru	6%	
^{106}Ru, ^{106}Rh	48%	
^{141}Ce	1%	
$^{144}Ce + ^{144}Pr$	20%	less than 260 Ci/year,
^{89}Sr	1%	65 Ci/3 month,
^{90}Sr	1%	1 Ci/day
$^{95}Zr + ^{95}Nb$	10%	
^{137}Cs	4%	
Others*	9%	
H^3 (in water)		140 Ci/day
*Others		Pu 6.2×10^{-2} Ci/year
		^{129}I 2.4×10^{-2} Ci/year
		^{131}I 2.3 Ci/year

Under the direction of Dr. Yoshio Sugiura, Director of the Geochemical Laboratory, the coastal waters off Tokai have been surveyed for many years to establish baselines and to predict the distribution of radioactive wastes.

Deep-ocean dumping of steel encased concrete castings is contemplated and a test ocean dumping at 26°N, 150°E in 6,000 m of water is being planned. This location is some 900 km southeast of Tokyo. The Atomic Environmental Safety Center, a non-governmental foundation established in 1976, is the agency responsible for the dumping programs. The Center has several committees including the Ocean Research Committee, the Transportation Safety Committee, and the Environmental Assessment Committee. Drs. Saruhashi and Sugiura of the Geochemical Laboratory are members of the latter committee. Plans are underway for the modification of a commercial ship for use in the dumping program.

A group of the Geochemical Division under the leadership of Dr. Yukio Sugimura is concerned with pure chemical oceanography and has been studying the occurrence of organically bound trace elements. A new method has been developed for the separation of inorganic and organically bound metals. In the case of iron (Sugimura, Suzuki and Miyake, 1978) a 300- to 500-ml sample of filtered (0.45-μm membrane filter) seawater is acidified to pH3. The iron is absorbed on XAD-2 resin packed in a glass column. After washing with dilute HCl, the iron is eluted with ammonium hydroxide. The organically bound iron is then dried, oxidized, and determined colorimetrically. In more recent work the method has been modified by first passing the seawater through the resin column without previous adjustment of the pH. The water that passes through is acidified to pH3 and then passed through a second XAD column. After elution and oxidation the metals are determined by atomic absorption spectrophotometry or spectrophotometry. The method has been used to determine the "neutral" organic, "acid" organic, and total iron, cobalt, nickel, copper, zinc, silver, cadmium, lead, and uranium from both open ocean and coastal samples. Surprisingly large fractions of the metals are found to be organically bound--on the average 94% of the iron, 90% of the cobalt, 10% of the nickel, 90% of the copper, 34% of the zinc, 14% of the silver, 98% of the cadmium, 100% of the lead, and 16% of the uranium. No attempts have been made to identify or to characterize the organic moieties, but the knowledge of their existence is important in understanding biochemical processes in the ocean.

Studies of the oxidation state and distribution of selenium in seawater are being carried out by Y. Sugimura and Y. Suzuki. In earlier work (Sugimura and Suzuki, 1977) they developed a new fluorometric determination of selenium in seawater. The method separates Se (IV) by complexing it with diethyldithiocarbamate (DDTC) and adsorbing the complex on a column of Amberlite XAD-2 macroreticular resin. Eventually the Se (IV) complex is eluted with a base and determined fluorometrically after complexing with 2, 3-diaminonapthalene (DAN). Total selenium is determined following coprecipitation with tellurium carrier, reduction to the elemental state, and subsequent solution and fluorometric determination as the DAN complex.

The method has been applied to studies of the western North Pacific (Sugimura, Suzuki and Miyake, 1976). Total selenium in surface waters ranged from 0.06 to 0.12 μg/liter and increased to ca. 0.20 μg/liter in the deeper (5,000 m) water. Se (IV) was low (0.05-0.09 μg/l) and distributed fairly uniformly in the water column, but Se (VI) increased some fourfold with depth (from 0.02 or 0.03 μg/liter in surface water to up to 0.12 μg/liter at depth). The ratio of Se (IV) to total selenium tended to decrease with depth, from values of 0.6 to 0.8 in the upper layers to 0.4 or 0.5 in the deep water.

Miyake, Sugimura and Suzuki presented a paper at the 26th International Congress of Pure and Applied Chemistry in Tokyo, September 1977, on a geochemical study of selenium in the hydrosphere. In addition to the seawater data cited above, they reported on the selenium content of Tokyo rainwater, which ranged from 0.01 to 0.12 μg/liter, of which 40 to 80% of the total was in the quadrivalent form. The remaining 20 to 60% was in particles. A sample of water from the Kuji River near the Japan Atomic Energy Research Institute in Ibaraki Prefecture contained 0.05 μg/l of total selenium, of which 60% was quadrivalent, 20% hexavalent, and 20% particulate.

Selenium in six deep-sea sediments ranged from 0.23 to 0.74 μg/g, considerably higher than the mean abundance in the earth's crust of 0.05 μg/g. Selenium was also concentrated by marine plankton, in which it ranged from 3.3 μg/g (dry weight) in diatoms to 1.03 μg/g in radiolarians. Concentration factors varied between 1.4 to 3.9 x 10^4.

In returning to the Geochemical Laboratory, I have been more and more impressed by the high quality of the research this small, busy group produces. In addition to their research, they are deeply committed to societal problems of the environment and to the advancement of science in general. At present Dr. Miyake is president of the Oceanographical Society of Japan and a member of the Science Council of Japan. Dr. Saruhashi is the editor of the Journal of the Oceanographical Society of Japan, Dr. Sugiura is the treasurer and Dr. Sugimura is the secretary of the Geochemical Society of Japan--more evidence of the vigor and competence of the group.

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AQUACULTURE IN JAPAN

F. A. Richards

Having read that newly imposed 200-mile fishery limits could curtail the availability of fish meal from demersal fish and thus effect the culture of such carnivorous fish as rainbow trout, my curiosity was aroused as to the subject of aquaculture in Japan in general. Through Professor A. Hattori of the Ocean Research Institute of Tokyo University, I was put in touch with Professor Reijiro Hirano, Department of Fisheries, Faculty of Agriculture, Tokyo University. Hirano is professor of Fisheries Oceanography and an obvious expert on aquaculture. In about two hours Dr. Hirano gave me an introductory overview of the culture of fin fishes, shellfish, and seaweeds that was both informative and interesting. The interview was assisted by Mr. Yodying Dhebtaranon, from the Marine Fisheries Laboratory in Bangkok, Thailand. Mr. Dhebtaranon is a graduate student working toward his doctor's degree under the direction of Professor Hirano.

FIN FISHES

Although there is adequate technology for the culturing of about 15 species of fin fish, including such species as plaice and turbot, the emphasis in Japan is on the yellowtail (*Seriola quinqueradiata*), red sea bream, and eels.

Perhaps the most important aquaculture (in terms of value) is that of the yellowtail (*buri, hamachi*). Some 100,000 tons are produced annually, mostly in the waters of the Shikoku side of Seto Inland Sea, near Nagasaki, and around Kagoshima, at the southern end of the island of Kyushu.

The fish are reared in liveboxes constructed of bamboo (or steel) frames supporting nylon netting. The liveboxes are about 10 x 10 m, 8 m deep, and are maintained in water around 20 m deep. Because the yellowtail is an active swimmer and jumper, it is necessary also to provide nets over the top of the liveboxes to prevent their escape.

The fish are fed meal made from anchovies, sardines and mackerel, which are caught in Japanese waters, mostly off northern Honshu, off Hokkaido, and in the Sea of Japan. Some 9 lbs. of food are required for the production of 1 lb. of harvestable fish. The industry depends largely on the use of naturally produced larvae, but research is being carried out on artificial spawning and hatchery methods.

The yellowtail grows from 10 to 30 cm long in about seven months. Most are marketable at about this size, but some are kept to grow much larger (up to 1 m). It is very popular in the form of raw fish (sashimi, sushi).

The extent of culturing yellowtail is limited by the availability of food, by the supply of larval fish, by environmental problems, and by economics. Environmentally, the concentrations of fish result in excessive concentrations of organic matter on the bottom and in the water under the liveboxes. This can result in both bacterial contamination and the development of anoxic conditions, with the eventual production of noisome and toxic hydrogen sulfide. Red tides sometimes kill yellowtail in culture, as the organism, a dinoflagellate of the genus *Harnillia,* accumulates on the gills. Researchers are studying the organism and now have it in pure culture.

Both the yellowtail and the red sea bream are luxury items and production is limited by the ability of the product to demand a high price on the market. Thus the supply must be limited; otherwise production costs cannot be met.

The red sea bream (*tai*) is even more of a luxury item than the yellowtail and only about 6,000 tons are

produced annually. The limitations are about the same as those on the production of yellowtail. However, the larvae are reared by cultivation, so the supply is not the problem it is with yellowtail. Prefectural experimental fisheries stations can produce red sea bream "seed" in mass, but not yellowtail. Mortality from hatching to juvenile fish is 10 to 20% for the cultured young red sea bream. Culture methods are about the same as for the yellowtail, but, as it is a deep-water fish, if grown in intense sunlight it develops a brown color, much less attractive than its more natural red. The pens are therefore shaded and the fish retain their beautiful color.

Both the Japanese eel, *Anguilla japonicus* (*unagi*), and the French eel are cultivated, although the Japanese eels are more disease resistant. About 50 tons of young eels are imported each year from France. The total annual product is 25,000 to 30,000 tons; an additional 10,000 tons are imported annually from Taiwan and Korea. Eels are cultured in ponds, either in running water or in aerated standing water. They may be fed either dry artificial food, requiring about 1.5 kg per 1 kg of marketable eel, or fresh fish food, requiring 6 kg to yield 1 kg of eel.

SHELLFISH

Shrimp (*Penaeus japonicus*) of the kind known as *kuruma* on the Japanese market are the most important shellfish cultured. They may be cultured in large ponds at low density or in small artificial ponds at high density. In either case they require seawater. The industry is carried out mainly in lower Honshu and around Kyushu. The seed is produced by a very simple artificial process. Formerly the main feed was *asari*, a kind of clam, but this has become expensive and now cheap fish and small shrimp are fed. In high density culture, ground squid is used as food.

High density cultivation is carried out in circular concrete ponds some 10 meters in diameter and 2 meters deep. Sand covers the bottom of the ponds and water drains out through the bottom. In addition, rotating aerators cause particles from the water to gather at the center, where a drain carries them away. High density culture is practiced only in the Kagoshima area of Kyushu.

Over 2,000 tons of shrimp are produced each year and although the economic problems are the same as with the yellowtail and red sea bream, seed is now released to open coastal areas to insure a good supply. The seed is produced at prefectural centers, which also produce red sea bream larvae and abalone seed. The latter are also released on coastal areas to develop naturally.

BIVALVES

Oysters (*kaki*) are cultured around Sendai, Miyagi Prefecture, and around Hiroshima in the Seto Inland Sea. The species *Crassostrea gigas* produces an abundance of seed naturally, although they can be produced readily by artificial fertilization. Seed is sufficiently abundant to be exported to the United States and France. For the collection of the spat, shells of a large oyster, *Pinctada* sp., are suspended horizontally on ropes. Sometimes large scallop shells are used. The oysters are natural plankton feeders, so no feeding is necessary. Although red tide organisms sometimes cause toxicity in bivalves in the United States, the problem is not common in Japan.

Some 120,000 tons of oysters (with shell) are cultivated annually.

Although the edible mussel, *Mytilus edulis*, is widely cultivated in Europe, it is neither consumed nor cultivated in Japan, where it is considered a pest, growing readily on nets and lines used for culturing other organisms.

Scallops are cultured in Hokkaido and northeastern Honshu. Seed can be produced by artificial culture, but it is very abundant naturally. The seed is collected on shells as in oyster culture. Spats are collected from muddy bottoms, where they would have little chance of survival, and placed in liveboxes made of nets as in yellowtail and red sea bream culture. Natural plankton feeders, they need not be fed.

Clams are naturally abundant and are not cultivated, although the technology for producing seed by culture methods exists. Abalone spats are produced in culture and released to natural habitats.

SEAWEED

Several species of seaweed are cultured for use in the Japanese diet. Centers of seaweed culture are Kyushu, Hiroshima on the Seto Inland Sea, Kumamoto Prefecture on Kyushu, the Seto Inland Sea, Ise Bay, around the Chiba Peninsula, and around Hokkaido. *Nori* is the Japanese word for a *Porphyra* species. It has very thin (one cell thick) broad thalli that are dried and sold in sheets. The spores of this alga are produced artificially and can be preserved for release when environmental conditions are favorable for their attachment and growth. Attachment is on nets suspended horizontally in the sea. *Ao-nori* (blue *nori*) is also cultivated. Two kinds of algae are known as *ao-nori: ao-nori,* which is of the genus *Enteromorpha* and *hitoegusa,* which is a species of *Monostrome.* Some seven billion sheets of *nori* are produced annually: a sheet is 10 x 20 cm and weighs 3 to 4 grams.

Konbu and *wakame* have heavy thalli and the small plants are planted on ropes suspended in the water. *Konbu* is a *Laminaria* species, *wakame* an *Undaria* species. The "seed" for both may be either cultured or acquired naturally.

Currently some 10,000 tons (raw weight) of *konbu* are produced annually.

Some years ago Athelstane Spilhaus suggested that crossbreeding, species selection, and such methods might be used to improve algal species so that we would speak of sea fruits and vegetables rather than seaweeds. The first steps along these lines are now being taken. In Japan, strains are selected for the culturing of *nori,* in China such selection for *konbu* is practiced. The need for such improvement may not be seen in Japan, where the products are already considered choice, but there is always room at the top, and intensive experiments along this line could lead to some exciting results.

A final observation is that although aquaculture is extensively practiced in Japan, the products are luxury items and in several cases the economics dictate limiting production so that prices remain high enough to make the expensive operations profitable. At this point it is evident that aquaculture is not an essential factor in supplying protein to the Japanese nation. The enforcement of 200-mile fishing limits may eventually alter the picture and force more reliance on the mass culture of more efficient protein producers.

THE *HAKUHO MARU* AND HER SCHEDULE FOR 1978-1979

Francis A. Richards

ONR Tokyo recently hosted two American Science Fair winners who were visiting Japan and participating in award ceremonies for Japanese Science Fair winners. As part of their tour, the Oceanographic Research Vessel, *Hakuho Maru*, was visited. I had previously seen the vessel when she visited Seattle in 1970, and she is known to many American scientists. She remains an impressive unit of the academic research fleet. In many ways the ship is equal to or better than most of the ships in the American academic fleet, being larger, fast, and more comfortable.

The ship is owned and operated by the University of Tokyo, Ocean Research Institute, 15-1, 1-chome Minamidai, Nakano-ku, Tokyo 167. She was completed in 1967, has a gross weight of 3,200 tons, is 95 m long, has a cruising speed of 12 knots, and a range of 15,000 miles. With a crew of 55 she can accommodate a scientific party of 32.

The vessel is characterized by large working spaces, good over-the-side handling equipment, and many amenities that were not being put on American research vessels built 10 to 12 years ago. The suite of permanent scientific equipment is mostly of Japanese manufacture, but some is American, such as their conductivity-temperature-depth (CTD) system and her rather old Magnavox satellite navigator system.

The *Hakuho Maru* is a busy ship, operating over 200 days a year. In one seven-year period she covered over a quarter of a million nautical miles on 33 cruises in the Pacific Ocean, the Sea of Japan, and adjacent areas.

Her schedule for the coming months is presented below. (The cruise numbers are based on a fiscal year, so the first cruise in 1978 is KH-78-2.) The schedule reflects the diversity of the ship's capabilities and of the scientists' interests. Although the chief scientists for 1978 are all from the Ocean Research Institute, the ship is operated for the benefit of all the Japanese academic community, and frequently space is available for visiting foreign scientists.

The master is Captain Ichiro Tadama, who has commanded the ship for most of her life.

SCHEDULE

KH-78-2: A geotraverse of the East China Sea and the western North Pacific.

Purpose: To obtain as much data as possible on the seabed, to get an integrated understanding of the seabed between 25 and 28°N in the Philippine Sea.

Survey Items: Continuous observations of earth magnetism, gravity, and soundings, including the use of sonarbuoys. Careful measurements and precise ship positioning for the determination of subsurface structure and daily variations in earth magnetism.

Area: The belt including Okinawa, the Ogasawara Islands and Marcus Island.

Schedule: 53 days, 18 April 1978–9 June 1978.

Chief Scientist: Dr. Yoshibumi Tomoda, Professor of Submarine Geophysics.

KH-78-3: Studies of biological production and nutrient cycles in the Bering and Chukchi Seas and northern North Pacific.

Purpose: Studies of biological and biochemical activity and of the dynamics and recycling of biogenic and other chemical variables.

Survey Items: Water sampling at various depths, large scale water sampling, net sampling from different depths, CTD observations, bottom sampling and measurements of biological activity.

Area: Bering Sea, Chukchi Sea, northwestern North Pacific.

Schedule: 49 days, 5 July 1978–22 August 1978.

Chief Scientist: Dr. Akihiko Hattori, Professor of Marine Biochemistry.

KH-78-4: Research on the circulation and structure of the Kuroshio current and adjacent areas.

Purpose: To understand the structure and circulation of the Kuroshio and adjacent areas and to relate them to unusual changes in oceanic weather.

Survey Items: Determination of the three-dimensional fields of temperature, salinity, currents, etc.

Area: The Izu submarine mountain chain and the area east of it.

Schedule: 20 days, 18 September 1978–7 October 1978.

Chief Scientist: Dr. Toshihiko Teramoto, Professor of Physical Oceanography.

KH-78-5: Research on modeling for the utilization and preservation of the coastal zone.

Purpose: To develop a method for integrated surveys of the coastal zone marine environment to elucidate the structure and specific characteristics of the coastal zone of Japan.

Survey Items: Synoptic observations of the coastal zone; continuous long term observations at several specific points; tracking of drift buoys; physical-chemical observations and sampling and observations of the water and of marine organisms.

Area: Sagami bay and its related coastal zone.

Schedule: 20 days, 29 November 1978–18 December 1978.

Chief Scientist: Dr. Syoiti Tanaka, Professor of Population Dynamics.

KH-79-1: Research on the oceanic circulation structure and its variations in the subtropical zone; research on the sea bed and deep-sea bed ecosystem around the Philippine Islands.

Purpose: To understand the dynamic structure of circulation systems in the subtropics and the ecosystems of the sea bed and deep-sea bed.

Survey Items: Detailed description of the circulation structure using the CTD and XBT, current measurements, and water temperature. Beam trawls, otter trawls, bottom samples, Phleger corer, sledge net for sampling organisms, deep-sea camera, deep water sampling, and observations of the sea bed configuration.

Area: Western end of the subtropical circulation zone, including east of Taiwan and the Philippine Islands; the region of the Izu submarine mountain chain.

Schedule: 59 days, 24 January 1979–23 March 1979.

Chief Scientists: Dr. Toshihiko Teramoto, Professor of Physical Oceanography, Dr. Masuoki Horikoshi, Associate Professor of Marine Ecology.

REPORT ON THE INTERNATIONAL CONGRESS OF IMMUNOLOGY SYDNEY, AUSTRALIA

Jeannine A. Majde

The Third International Congress of Immunology was held at the University of New South Wales in Sydney on 3-8 July 1977. It was sponsored by the Australian Academy of Sciences in collaboration with the Australian Society of Immunology and under the auspices of the International Union of Immunological Societies. The Second Congress was held in Brighton, England, in 1974, while the First Congress took place in Washington, D. C., in 1972. The Fourth will break the language barrier and take place in Paris, France, in 1980. Attendance at this year's Congress was down from 4,000 in 1974 to 1,600—reflecting the cost of getting to Australia rather than a reduced interest in the field. Some 500 Australian immunologists (one in every 28,000 Australians is an immunologist!) worked very hard to make foreign delegates comfortable and to acquaint them with the country. Surprisingly, there appeared to be relatively few delegates from Asia, most came from the United Kingdom or the United States. This bias was also reflected in the choice of speakers, indicating that an Asian nation will be forced to host a Congress in order to showcase its work.

The program covered five days and consisted of four concurrent symposia each morning and twelve concurrent workshops each afternoon, except one when nine concurrent discussion groups (more informal than workshops) met. In addition two Harbor Ferry workshops on more general topics were held each afternoon, and two special clinical immunology sessions were conducted during the week. The workshops were organized around a one-hour poster display by all invited participants followed by a two to three hour discussion session. The proceedings will be published by the end of the year by North Holland-Elsevier, running to about 1,000 pages in five volumes. This report will cover the highlights of those sessions I attended. The program provided only the country designation of speakers, and thus no institution affiliations are provided here.

SYMPOSIUM ON CELL MEMBRANE STRUCTURE AND FUNCTION

M. J. Edidin, United States—Discussed findings on diffusion of membrane lipids in mouse-human cell hybrid heterokaryons. Fluorescent antibody studies reveal that membrane lipids of only 10% of the cells behave as predicted by membrane viscosity calculations ($3 \times 10^{-9} cm^2/sec$. diffusion rate), and 30% of the cells fail to equilibrate by three hours. Cytochalasin B treatment slows rather than enhances intermixing of the lipids. Lipid diffusion was found to be dependent on the polarization state of the cell and could be altered by changing potassium concentrations, etc. These studies have implications as to the number of membrane receptor molecules necessary to guarantee an interaction of receptors (10^6 molecules per cell) and point to another mechanism of regulating cell function. J. J. Marchalonies, United States—Described techniques for studying cell surface proteins. Specific labeling of certain classes of cell surface glycoproteins is a rapidly expanding field. A general survey of techniques was given, featuring the use of lactoperoxidase combined with affinity chromatography as one that has been effective in isolating alloantigens and cell-bound immunoglobulins. M. J. Crumpton, United Kingdom—Continued the discussion of the state-of-the-art of methodology. He indicated that only 0.6% of the cell's protein is located in the cell membrane, but highly effective detergents are now available, which along with definitive membrane markers such as 5'-nucleotidase, permit precise recovery of these miniscule quantities. Such studies indicate that cell microfilaments are attached directly to pure plasma membrane. G. L. Ada, Australia—Reviewed the current concepts of cell receptors. The cholera toxin receptor is best understood: the toxin binds to a cell surface ganglioside, this complex equilibrates in the cell membrane, then activates adenyl cyclase following binding of a toxin subunit to the cyclase. Recent studies with cytotoxic T (thymus-derived) cells sensitized to influenza virus reveal that viral M protein in the infected cell membrane acts as a receptor for the T cells, causing cross-reactivity with all A strains of the virus.

WORKSHOP ON SPECIFIC AND NON-SPECIFIC IMMUNOPOTENTIATION IN MAN

This workshop was devoted to transfer factor, immunomodulating drugs, and interferon. (a) No resolution of the nature of transfer factor has taken place, but it now seems clear that there is a heterogeneous mix of substances in lymphocyte extracts which may transfer specific immunity to an anergic host but probably acts by non-specifically enhancing expression of immunity directly induced by test antigen administration. One of the non-specific enhancing components is an inosine-peptide moiety—others are now being isolated. (b) The writer was the primary discussant for the immunomodulatory drugs section, reviewing the concepts rising out of the very limited work in this field. Drugs which appear to function by non-specifically stimulating immune functions are levamisole, inosiplex (an inosine derivative), SM-1213 (a glucose derivative under study in the laboratory with which I am associated), ascorbic acid (vitamin C), muramic acid dipeptide (component of Freund's adjuvant), and assorted simple nucleotides and sugars. These have been collectively termed "prohost drugs" as they seem to function in many systems as well as the immune system by stimulating general cell functions such as protein synthesis. My studies have shown that their effect is very much determined by the state of the host, i.e., that the drugs have no apparent effect when the animal is healthy and producing its maximal response; an effect is only evident when the animal is compromised in some way, in which case a depressed response is returned to normal levels. Interest in this field is growing now that some of these basic principles are becoming evident. (c) Studies with interferon as an immunopotentiator have been limited, but it is now becoming more accepted that interferon has a general regulatory function in cells, only one (perhaps incidental) effect of which is to inhibit viral growth. Clinical studies with hepatitis and herpes viruses are being conducted at Stanford where some evidence of successful cures of these diseases in compromised hosts is being accumulated. The role of the immune response in these cures is unknown.

SYMPOSIUM ON ANTIVIRAL IMMUNITY

D. O. White, Chairman, Australia—Reviewed the current concept of viral immunity which involves macrophages (which both contain the virus and produce interferon); T lymphocytes (which function by activating macrophages to kill the virus, produce interferon (Type II), help in producing antibody, and effect cytoxicity and delayed-type hypersensitivity); and B (bone-marrow or bursa-derived) lymphocytes (which produce cytolytic and neutralizing antibodies). Current work is focussing on the numerous cytolytic mechanisms which act to destroy infected cells: cytotoxic antibody plus complement, "armed" macrophages, killer or K cells which bind antibody, cytotoxic T cells which do not require antibody, and a recently observed class of natural killer (NK) cells, present prior to infection, which selectively destroy virus-infected cells without specificity for the virus. R. V. Blanden, Australia—Reviewed the status of cytotoxic T cells. They have been observed in a wide range of viral infections, and generally display a peak response on days 5-7 following infection. There is a good correlation between their activity *in vitro* and the rate of viral clearance in the spleen. The histocompatibility genes appear to generate the receptors which these T cells recognize. They kill without the aid of antibody and may kill one another as a form of regulation. R. Welsh, Scripps Clinic, California—Reviewed the natural killer (NK) lymphocyte picture. These display peak cytotoxicity on day 3 following infection, are non-specific as to target virus, but are not induced by all viruses or by *Listeria.* They do not bear theta antigen or surface immunoglobulin and may therefore be "null" cells. They are present in athymic nude mice, are labile at 37° in culture, and do not observe H-2 restriction (as with cytotoxic T cells). Another cytocidal mechanism, the cytotoxic antibody plus complement mechanism, has been found to function without C4, suggesting that the alternate complement pathway is active. This mechanism not only kills infected cells by lysis, but may also kill enveloped virus particles directly. Another area discussed by Dr. Welsh was the role of defective interfering virus particles in permitting a chronic viral infection to become established. These particles, which lack a complete genome and are noninfectious, prevent complete particles from producing normal levels of membrane proteins, the substances responsible for recognition of infected cells by cytotoxic T cells. Thus the infected cell is not "seen" and is not eliminated by the immune system. W. H. Burns, National Institutes of Health—Discussed the current status of herpesvirus immunity. The mechanisms by which herpesviruses establish latency and escape the immune response remain mysterious. Recent work shows that spleen cells from mice latently infected with cytomegalovirus (CMV), cultured on syngeneic or allogeneic fibroblasts, release virus only when in the presence of allogeneic fibroblasts. Allogeneic skin grafts will activate CMV *in vivo.* These phenomena appear to be related to the stimulation of B cells by host vs. graft reactions, which then replicate the virus. LPS treatment of spleen cells *in vitro* will also activate the virus. Studies with other herpesviruses indicate that T cells are critical in recov-

ery from herpes simplex as T cell depleted (but not B cell depleted) mice are much more susceptible to the virus. It is thought that a class of T cell other than the cytotoxic T cells is relevant—perhaps that which mediates delayed-type hypersensitivity. R. H. Purcell, National Institutes of Health—Discussed the role of the immune response in viral hepatitis B. Extensive evidence now points to a role for the immune response in producing acute as well as chronic hepatitis. The pathological picture suggests that immune complexes with viral surface antigen are important in the acute disease process—why the virus is not eliminated in these patients is unknown. Very encouraging results with a formalinized surface antigen vaccine have been obtained in chimpanzees. One hundred chimps were immunized subcutaneously twice with 50μg of purified surface antigen. All animals produced antibody to the antigen. They were challenged six months after immunization and all were protected. One displayed elevation of antibody, but no illness. Vaccination following exposure to an infectious challenge was also protective—vaccination gave superior protection to that obtained by administration of passive antibody. No evidence for induction of hypersensitivity or cell mediated immunity as determined by macrophage migration inhibition was seen. An animal model for hepatitis A is still not worked out.

SYMPOSIUM ON SOLUBLE FACTORS INFLUENCING IMMUNE RESPONSES

G. Goldstein, Mt. Sinai, New York—Reviewed the two thymic hormones discovered in his laboratory, thymopoietin and ubiquitin. (Another thymic hormone, thymosin, has been discovered by A. Goldstein of the University of Texas Medical Branch, which may not be related to these substances.) Thymopoietin is a small protein consisting of 49 amino acids—a 12 amino acid active region has been defined and synthesized *in vitro*. It induces prothymocytes from the spleen and bone marrow, which have no T cell markers, to differentiate *in vitro* to cells with all known T cell markers. It functions by amplifying cAMP, but does so by a receptor distinct from the beta-adrenergic receptor. It will not drive pro-B cells to differentiate unless they are nearly mature, i.e., pro-plasma cells. Thymopoietin is required to maintain T cell function in thymectomized mice, declines during the aging process in man and mouse, and can reverse some age-related immunologic defects in mice. Ubiquitin is so named because it is found in all tissues in animals, in plants, and in bacteria. It is a 74-amino acid basic protein and may be a histone (associated with DNA in chromatin). It also stimulates cAMP-mediated functions and can complicate hormone purification procedures. A 7-amino acid peptide named bursapoietin has been discovered recently in birds which causes B cells to mature. Dr. Goldstein cautioned his audience to strive toward isolation of purified hormones rather than work with crude "factors" which will rarely yield consistent results. A. Schimpl, West Germany—Characterized the T cell replacing-factor, TRF, which induces "intermediary" B cells to differentiate to produce antibody. It is a 35,000 d glycoprotein produced by antigen-activated complement receptor negative T cells, and will replace T cells in *in vitro* immune response assays. It appears at 24 hours following Concanavalin A or mixed leukocyte stimulation of T cells. It is active at concentrations of 10^{-10} to 10^{-9} molar.

C. W. Pierce, United States—Discussed the suppressive T cell product "soluble immune response suppressor" or SIRS. This substance is a heterogeneous glycoprotein, distinct from interferon, made by Concanavalin A-stimulated T cells bearing the Ly 2, 3^+ marker. It appears to bind to macrophages and cause them to produce another factor (uncharacterized) which inhibits B cell proliferation and thus antibody production. It will inhibit B cell proliferation in response to B cell mitogens such as LPS. All mouse strains but the DBA/1 produce the factor—the consequences of its absence in these mice have not been determined. Other similar chalones are being isolated currently, and interferon is being studied in this context. E. Diener, Canada—Discussed the role of macrophages in immune regulation. Although the exact role of the macrophage in induction of the immune response is not certain, its importance in this process is agreed upon. Two classes of macrophages can now be distinguished which bear on regulatory functions. One is a large peroxidase-negative cell which suppresses antibody production and is cytotoxic toward tumor cells. The other is a small peroxidase-positive macrophage which stimulates antibody production and is not cytotoxic. A popular concept of macrophage function at this time is that the macrophage "processes" the antigen and produces a product (antigen fragment?) which binds to specific B cells. These B cells are now capable of binding T cell helper factor which stimulates them to divide, mature, and secrete antibody.

DISCUSSION OF HORMONES AND IMMUNITY

N. Fabries, Italy–Chaired an informal discussion of this sadly neglected field. He has worked out radioimmunoassay procedures for measuring seven basic hormones in mouse sera (0.7 ml) and has initiated an analysis of the relationship of various classes of immunologic phenomena to aberrations, genetic or acquired, in hormone levels. J. Hadden, Sloan-Kettering, New York–Works at the cellular level, looking at hormonal effects on cyclic nucleotide levels and their consequences for macrophage function. He is also active in evaluating prohost drugs in his models, laying the groundwork for the emerging field of immunopharmacology. More specific areas were discussed by Comsa, France–Interaction of an undefined thymic hormone with adrenal corticosteroids in controlling skin graft rejection; Feigen, United States–The relationship of estrogen and progesterone to tissue histamine levels and enhanced immune responsiveness in females; Plaut, United States–The relationship of histamine and histamine$_2$ receptors on cytotoxic T cells to their cytotoxic activity, suggesting that histamine may function as an immunoregulator. The general discussion emphasized the importance of recognizing the role of stress in influencing the outcome of immunologic studies. Such trivia as how animals are removed from the cage, noise in the animal room, and the number of animals in a cage will dramatically affect some classes of immune responses (an area under active study, soon to be in collaboration with Dr. Fabris).

SYMPOSIUM ON IMMUNOLOGY AND EPIDEMIOLOGY OF COMMUNICABLE TROPICAL DISEASES

G. Nossal, Chairman, Australia–Reviewed the new WHO Research and Training Program aimed at intensifying research in tropical diseases. Specifically they are initiating large scale support of research in malaria, schistosomiasis, leishmaniasis, trypanosomiasis, filariasis, and leprosy. Some 10 million dollars will be made available in 1977 and they anticipate a research budget of 35 million in 1981. G. Curlin, Bangladesh–Reviewed the current state of cholera vaccine research. No really effective cholera vaccine for the two cholera serotypes yet exists. Ideally an attenuated live bacterial vaccine which would penetrate the lamina propria and produce antibodies both to the toxin and to the vibrio somatic antigens is called for. This has yet to be achieved, but recent research has defined a number of host factors important in the acquisition of the disease with this rather unique pathogen. (Cholera, unlike most pathogenic organisms, does not invade the host. It simply adheres to the gut mucosa and multiplies at a prodigious rate, releasing its highly bioactive toxin which causes body fluids to reverse their normal flow. Other related organisms, such as *Vibrio parahemolyticus*, function in a similar manner and also cause severe diarrhea in man.) G. F. Mitchell, Australia–Reviewed the immunology of metazoan parasitic infections. Work with mouse liver tapeworms has shown that complement fixing antibody is important in the elimination of this organism. Ways in which parasites subvert the immune response include: 1) antigenic modulation by mutation or developmental changes; 2) masking of antigens by binding host proteins; 3) secretion or passive release of substances which form immune complexes which then function as anticomplementary and antiinflammatory components; 4) intracellular or tissue sequestration of the parasite; 5) immunodepression by a) release of toxic or mitogenic molecules; b) generation of suppressor T cells or macrophages; c) architectural disruption of lymphoid tissues. Some of the candidate antigens for induction of protective immunity include: 1) parasite recognition structures for target cells; 2) parasite-dependent antigens on parasitized cells; 3) enzymes used in tissue invasion; 4) enzymes and secretions required for feeding or maintenance at mucous membranes; 5) factors which block the immune response; 6) antigens introducted by vectors. The role of the T cell in parasite immunity is under active investigation in athymic nude mice; these animals can resist schistosomiasis, fasciola, and ascaris but not other parasites. Eosinophilia and IgE or IgG classes of antibodies are well recognized defense mechanisms against parasites and are T cell dependent phenomena, and thus the role of the thymus should prove significant in parasite immunity. V. Houba, Kenya–Discussed the role of immunopathology in parasitic infections. Two areas are now under intense investigation: the tissue-destructive role of immune complexes (especially the renal glomerulus) and the induction of autoallergy. Immune complexes are very conspicuous in malaria, schistosomiasis, and typanosomiasis. Autoallergy is less well-studied, but antinuclear antibodies and hemolytic antibodies, as well as basement membrane antibodies secondary to immune complex glomerulonephritis, are probably significant in parasitic disease processes. A. Sher, United States–Reviewed immunity in schistosomiasis. Lung granulomas appear to result from delayed hypersensitivity while larval rejection is effected by antibody-dependent cell mediated immunity. Eosinophils are critical in both processes as well as in egg destruction; they destroy parasite forms by discharging cytoplasmic granules onto the parasite surface. There is some evidence that eosinophils express immunologic memory.

SYMPOSIUM ON LYMPHOCYTE POPULATIONS IN HUMAN DISEASE

S. F. Schlossman, Chairman, United States–Presented a concise summary of the current knowledge of cell markers related to lymphocyte function. L. Chess, United States–Broke down the T cell class with respect to their functions in the mouse. Recent observations have permitted definition of two classes of human lymphocytes comparable to recognized mouse cell classes: sera from juvenile rheumatoid arthritis patients have antibodies to the equivalent of thy-1 or theta antigen on T cells; another antigen on human lymphocytes, termed the p 23, 30 antigen, appears to be equivalent to the mouse Ia antigen. M. Seligman, France–Reviewed the relationship of surface IgD-IgM levels to the degree of maturity of malignant lymphocytes. Maturation blocks occur at different levels in different patients. R. C. Williams, Jr., United States–Discussed some of the problems of studying lymphoid cell markers in non-malignant diseases, and the reasons for the confusion in this field. He also mentioned some recent observations on C-reactive protein, which appears to bind to antigen-reactive or "committed" cells. The number of circulating lymphocytes binding this protein is about 3% in normal children–16% of the cells bind it in rheumatic fever patients. Another comment related to the fact that the plastic in hemodialysis equipment activates leukocyte complement receptors and causes the cells to lodge in the lungs–the same phenomenon may occur following plasmaphoresis. T. A. Waldman, United States–Discussed concepts of immunologic inbalance. He has developed a system for culturing lymphocytes with pokeweed mitogen so that they mature, with the aid of helper T cells, to secrete immunoglobulins. In this system one can evaluate helper and suppressor cell function in various disease states. Suppressor T cells may account for a number of immunodeficiency states–certain types of suppressor T cells can suppress individual immunoglobulin classes, such as IgA. Suppressor T cells are corticosteroid sensitive. Studies in NZB mice, which lose suppressor function with age, reveal that their lupus syndrome can be controlled by treatment with soluble immune response suppressor (SIRS) substance discussed above. Suppressor monocytes also exist but are poorly characterized.

SOME BIOMEDICAL RESEARCH ACTIVITIES IN AUSTRALIA AND NEW ZEALAND

Jeannine A. Majde

ROYALD AUSTRALIAN NAVY SCHOOL OF UNDERWATER MEDICINES, BALMORAL, N.S.W., AUSTRALIA–July 1977

I met with Surgeon Commander John Anderson, Commanding Officer of the School, and Mr. John Pennefather. Dr. Carl Edmonds, who was out of the country, completes the underwater medicine research staff for the Australian Navy. Mr. Pennefather, assisted by an electronics technician, is effectively the research staff except for clinical studies conducted by Drs. Anderson, Edmonds, and other local physicians (who conduct clinics for divers at the nearby Hale Clinic). Except for Mr. Pennefather's instrumentation studies (described below), the focus of the group is on clinical problems with sinuses and ears (of special interest to Dr. Edmonds), and recompression therapy of divers from all over the South Pacific. The Balmoral chamber plus one in Perth, Western Australia, are the only facilities for diver treatment other than oil industry chambers in that vast region.

Dr. Edmonds and associates have published two books locally, one on venomous marine animals and therapy for their stings/bites (beautifully illustrated with colored photos of the culprits), and one entitled "Diving and Subaquatic Medicine," a practical manual for treating diver problems. I understand that the latter will soon be reviewed in "Undersea Biomedical Research."

I inquired about the status of sharks in the eyes of the Australian Navy. Despite endless horror stories delivered by Australian laypersons regarding shark attack, Dr. Anderson asserted that the Navy makes no allowances for sharks! He claimed that no naval personnel have ever been attacked, and that the Australian Navy is not interested in shark behavior, repellants, etc. Whether this reflects their attitude towards their personnel or whether sharks are less attracted to divers than to surface swimmers in those waters are some considerations here.

Another area of no interest to the Australian Navy is deep diving. They do not anticipate expanding their depths beyond those where compressed air is used and devote all attention to shallow water problems.

Mr. Pennefather is trained in physiology and engineering. He is currently working on a breathing apparatus which is significantly more effective at removing CO_2 from breathed air than current United States or English designs. He indicated that he will send me a preprint describing its design when the manuscript is completed. He has also designed a diver telemetry system which is in its final stages. He plans to be able to monitor heart rate, core temperature, etc., using a surface transmitter (inside a round float with a direct lead to the diver). He and Dr. Edmonds are trying to design a device for evaluating diver trainees (the training school is a few hundred yards up the street) with regard to their capacity to tolerate sinus barotrauma. Unfortunately my notes and my memory do not serve to recall the principle being used. They are not yet successful in this project. Another project relates to a side interest. A local neurologist has observed that hyperbaric oxygen therapy (of the type used in decompression work) has the capacity to reverse certain forms of spinal cord injury normally leading to permanent paralysis. Mr. Pennefather has been working on a device for measuring evoked responses while inside a chamber containing an oxygen atmosphere. This is in the early stages. All activities in his laboratory are reported to the Naval Coastal Systems Laboratory in Panama City, Florida.

It is apparent that this group and the Australian Navy in general are very pragmatic in determining their research interests. Much stress was placed on the fact that the researchers are in constant contact with working divers and this heavily influences their interests. It is noteworthy that they are very conscious of research in other countries and maintain an excellent library. Also, they do not collaborate with local university scientists but with practicing physicians.

JOHN CURTAIN SCHOOL OF MEDICAL RESEARCH, THE AUSTRALIAN NATIONAL UNIVERSITY, CANBERRA–July 1977

The Immunology Department of the Curtain School is one of the three major centers for immunology research in Australia. They conducted an open house and some "hands-on" workshops following the International Congress in Sydney. Dr. Bede Morris, the Chairman, introduced us to the rather unique philosophy which pervades this group. They feel that immunologists have worked too much with inbred mouse strains and are not looking at realistic animal models. All investigators at Curtain work with outbred sheep, which just happen to cost about $6, or only twice as much as an inbred mouse. They have developed surgical procedures on these animals which permit them to study such factors as cell traffic in a lymph node draining an organ rejection site, etc. They are also expert at surgical procedures on fetal lambs. One of the rather amazing findings made there is that the thymus gland does not appear to be of much use to a sheep. They have animals which have gone three generations following fetal thymectomy in each generation with no apparent effect on the immune response. Mice, on the other hand, do not generally survive to breed without a thymus and show severe impairment of immune responsiveness following neonatal thymectomy. A number of investigators there are busy purifying and characterizing sheep immunoglobulins, lymphocyte classes, etc. Ironically, the aspect of developing the sheep as an immunological model which causes the most problems is the fact that sheep red cells cannot be used as antigens or lymphocyte markers! However, parasite immunity in the natural host is a very fertile area for development with a number of potential payoffs for Australian sheep farmers.

VISIT TO NEW ZEALAND UNIVERSITIES–July 1977

Two universities (The University of Otago in Dunedin and the University of Auckland) and a university affiliated government research laboratory (Wallaceville Animal Research Center in Wellington) were visited in New Zealand. Rather than detail the specific research activities there I would like to convey some impressions of the research climate.

It appears that few native New Zealanders (locally referred to as Kiwis after the national bird) are found in the universities. The faculty I met were predominantly Americans, English, Canadians and Australians. Kiwis with advanced educations leave the country in order to expand their horizons (and escape the climate?). Unlike Australians, who feel self-sufficient in their rather isolated situation, Kiwis just feel isolated. Certainly they do not leave to find better equipped laboratories or research funding, since their laboratories are indistinguishable from the better American facilities and research funding is relatively abundant. Further, they would be hard pressed to find a situation where they are more independent of research direction. The researchers I met are able to indulge in truly basic research without having to justify their activities. For example, one investigator is cataloging the biological and chemical properties of assorted streptococcal bacteriocins (bacterial secretions which are toxic for other bacterial species) just to see if they have any interesting features. Someday he may get around to looking at their role in human disease. Despite this freedom from "relevance" the preoccupation of the Kiwis with sheep and bovine husbandry, the base of their economy, has stimulated considerable research into the diseases of these animals. Consequently they are deeply involved in the study of economically important parasitic and fungal infections. Their close association with other islands in Oceania has resulted in analyses of infectious diseases in Fiji, New Guinea, etc., which are quite unique. The Antarctic is another area of interest because of its proximity. So despite their freedom to pursue the most esoteric subjects, microbiologists in New Zealand tend to get involved in the problems around them and attack very practical areas. Perhaps "relevance" is not such a burden after all, at least in the field of microbiology.

One final comment on the impact of isolation on research. It became rather apparent, despite the above-average competence of the researchers I met in New Zealand, that working thousands of miles from the mainstream of scientific activity tends to cause problems. They are about a year out of date due to their inability to attend meetings and become aware of new developments prior to journal publication. On the other hand, they are freer to develop new ideas unimpeded by current fashions in thought. In the balance, however, the researchers feel they are missing out and they try hard to tour laboratories abroad whenever possible. They also welcome foreign visitors and are trying to initiate international symposia in their country. One of the first, on microbial ecology, took place in Dunedin in August.

GLIMPSES OF CHINA

Leslie S. G. Kovasznay

After completing a tour of duty in Tokyo, on the return trip from Japan to the United States, I had the opportunity of visiting China. The person who made this possible was Professor Chou Pei-yuan of Peking University, by providing recommendations to the appropriate Chinese agencies. In addition to visiting several universities, I was invited to lecture at Peking University and also to participate in a discussion session there with a large number of fluid mechanicists.

I entered China on land from Hong Kong, accompanied by my wife. On the way to Peking we stopped at two provincial universities: Chekiant University at Hongchow, and Futan University in Shanghai. In Peking, I also visited the Aeronautical Research Institute, which is, in fact, a university level school of aeronautical engineering.

Before providing details, it may be of interest to give some general observations about travel in China. All visits by foreigners are prearranged far in advance of the arrival, and foreign visitors are escorted by English-speaking guide-interpreters. Our "permanent" guide, who came from Peking to meet us as we arrived in China, was always joined in each city by another, local guide. A car with a driver completed the party. Naturally, it was quite possible to stroll in the cities unaccompanied but we did this mostly in Peking, where the hotel was sufficiently centrally located. Also, the language barrier and unfamiliarity with the transportation systems made individual ventures more difficult than in other countries. I was encouraged to take photographs everywhere except inside the laboratories of the Aeronautical Institute in Peking. Our Chinese contacts were invariably pleasant, not only polite, but actually friendly and eager to please. I received the distinct impression that once the decision was made to let a particular foreigner enter China, they decide to treat him as a friend and make him feel as comfortable as conditions permit. Later, talking to officials of the International Travel Agency (Luxingshe in Chinese) in Peking, I was told that at the present time they receive foreign visitors primarily in order to "win friends," as the income from the foreign tourist trade is still not sufficiently important. They have very limited facilities for tourists, such as hotels, inter-city flights as well as trained personnel who can serve as guides, interpreters, etc. This way it was not surprising that our tour through China was highly structured.

Our guide came from Peking with a detailed program, which included a great variety of visits. It included visits corresponding to my professional interests, such as universities and industries. It also included some sightseeing of important monuments. Last, but not least, was "seeing the New China," namely the accomplishments of their new society. These included visits to agricultural communes; hospitals, where typically Chinese achievements in medicine were shown or demonstrated; housing projects and quite a few kindergartens, both day-care and boarding types. The permanent industrial exhibits were shown us in Shanghai as well as housing projects at several different places. It was their admitted goal to show us as broad a sample as possible and this appears to be a rather general policy, as we found out from comparing notes with other foreign travellers.

The Chinese are quite proud of their accomplishments and most local leaders we encountered were quite eloquent about them. They were also young and enthusiastic (one must remember that more than one half of the population was born after the "Liberation" in 1949).

The format of each visit was about the same: we arrived with our guides at the place (university, hospital or commune). Waiting outside the entrance gate were the members of the Revolutionary Committee (this is really the administration) and after some formal greetings and introductions, we were led into a large room and were seated in comfortable chairs and tea was served. In such rooms there are always pictures of Marx, Engels, Lenin and Stalin, as well as Chairman Mao and Chairman Hua. Then, a "leading member" of the revolutionary committee of the institution gave us a briefing in Chinese (translated by the interpreter) about the history of the place. If the institution existed before 1949, what progress was made afterward was described. The Cultural

Revolution that began in 1966 was discussed as it profoundly affected nearly everything, especially science and education. Finally, the recent adverse effects of the "harmful machinations of the Gang of 4" were criticized, which brought us up to the present. Finally, statistics on the present state and projections for immediate future were given. Questions were asked and finally the inspection of the premises followed. My questions were generally answered rather unhesitatingly, but, of course, the language barrier had to be overcome.

Two general impressions must be mentioned here. One is that China is still a very poor and largely developing type of country, so it cannot be compared with Japan, which is highly advanced industrially. On the other hand, everywhere we went the people were clean, they wore simple but clean clothes, everybody wore sandals and the only barefoot Chinese seen were working in the rice paddies. They all appeared healthy and well fed. Presently there are no dogs or cats permitted as pets and the only dogs I saw in China were trained dogs in a circus show in Peking. The Chinese we encountered on the street watched us with equal curiosity. In a few places we mingled with the Chinese tourists from other cities, who also took pictures of each other, ate their box lunches and generally enjoyed themselves. The overseas Chinese visitors are treated just as any other foreigners. (At airports and railroad stations there is always a better waiting room marked for "our foreign guests and overseas Chinese.") It is quite easy to spot the overseas Chinese by their more colorful dress, their louder, more agitated demeanor, while the local Chinese women wear no make-up or jewelry. In general, there are no frivolities visible; no neon signs in the cities, which is a great contrast from Hong Kong or Tokyo; no advertising except for some government posters. All this gives a rather drab appearance to the cities. At night opportunities for entertainment are extremely limited. Theatre, Chinese style opera, movies are all available, but they are all based on approved revolutionary or edifying themes so from a Western point of view the total choice is rather limited. On the other hand, good food is available. The hotel fare was generally abundant and good, and at some places even excellent.

The four universities I visited have many common traits, so these will be given first. The Cultural Revolution (1966-67) made very profound changes, some of which I was not fully aware of before my visit. First of all, higher education came to a total standstill for four academic years. The students whose studies were interrupted by the Cultural Revolution were dispersed and in general could not return to continue their studies. In all institutions enrollment still has not reached the pre-1966 level, although most professors believe that it will increase in the near future. Since the resumption of higher education (essentially since 1971), all secondary school graduates must return first to manual work, either to a farm or to a factory (some go to the army) for at least two years before they can make application to a university. The local working group, essentially the young person's "peer group," decides who should go to the university, the primary concern being who can best bring back the fruits of the learning for the benefit of the working group since the majority of the university graduates are expected to return to the same factory or farm they came from.

After 1971 the universities could not impose any selection by academic criteria. It was pointed out to me repeatedly that the "Gang of 4" insisted that no academic requirements be imposed by the university. Now, with the "Gang of 4" vanquished, there are admission requirements again. I questioned this point repeatedly and the answer was about the same: the work brigades recommend about three to four times as many candidates as may be admitted. Among those already approved, the university may select according to academic requirements. In practice both written and sometimes even oral examinations are required. This return to academic standards was understood to be a great victory overcoming the harmful effects of the "Gang of 4."

Another such change is the return of research as a respectable pursuit. Following the Cultural Revolution, research fell into great disrepute; according to then current opinion, the only proper road to progress, even in technology, was by innovation proposed by the workers themselves. Workers did propose many useful improvements, but now most professors and factory managers admit that further progress may need important laboratory research, even basic research. During the extreme radicalism, discredited and attributed to the "Gang of 4," even preoccupation with production figures in a factory by the factory management was reprehensible, but now it has become proper again. Similarly, incentive pay to workers who produce more was stopped during the Cultural Revolution. It is making a slow and discreet comeback. When talking to engineers and to professors, especially engineering professors, one has the impression that they really welcome a return to the more pragmatic outlook when production figures and research results will speak for themselves.

After the Cultural Revolution the universities adopted a new type of curriculum. First of all, the total length of studies was shortened from five to six years to three or three and one half years. They also made mandatory the integration of studies with practical experience in productive work. As a result, all campuses now have "factories" and the products are sold to institutional customers (factories, farms, government laboratories, etc.). Some of the products were really interesting. Computer-controlled machine tools were developed and sold by one university laboratory I visited (Futan University on the outskirts of Shanghai).

PEKING UNIVERSITY

Let us turn now to the individual institutions. The most important was Peking University, or "Pei-ta" as popularly known. Coming from Japan, it is interesting to observe the same construction for popular abbreviations, such as "To-dai" for the University of Tokyo. Peking University was founded in 1898 with ten science departments, seven liberal arts departments and three language departments. After 1949 it was reorganized, together with the other prestigious university in Peking, Hsing Hua University. (This latter one dates from the Boxer Rebellion Indemnity the Chinese Empire paid to the United States in 1901. The United States Government returned it to found a university.) According to the 1949 reorganization, Peking University became responsible for Arts and Sciences and Hsing Hua University for Science and Engineering. Presently Peking University has 83 specialities and the total teaching staff is about 2,700. The student body is 7,600 for the three-year undergraduate course, but it is still under the 10-11,000 students enrolled before 1966. On the other hand, the students per graduating class is about the same. There are also about 200 foreign students who do mostly graduate work, studying some special subject. Typically, they stay for one to one and one half years.

The main objective of my visit to Peking was to see Professor Chou Pei-yuan, who is well known among specialists of turbulence for his theoretical work on homogeneous isotropic turbulence. More than 30 years ago he spent some time at the California Institute of Technology and he was the first who carried the formal analysis up to the fourth order correlations. In the late 1940's he returned to China and there began to build up turbulence research. In recent years he was also active in directing Peking University as Vice Chairman of the Revolutionary Committee of Peking University (roughly equivalent to the role of Vice President in the United States). He made a few occasional visits abroad, and in 1975 he led an official Chinese group on science and technology, to both the United States and to Western European countries. I heard that at the request of Premier Chou En-lai Professor Chou was preparing a new plan for scientific research, but after the death of Chou En-lai the political climate was not favorable (now usually described as the "machinations of the Gang of 4"), and this plan suffered a temporary setback. Now Professor Chou is active again with the plan and he assured me that large comprehensive plans are being made for scientific research in China and that also implies the spending of sufficiently large funds. He was quite optimistic about the success of reorganizing science in China. He was equally optimistic about the future of scientific exchanges with foreign countries.

In addition to his many public responsibilities, Professor Chou has not abandoned his personal research. Some time ago he developed a new model for elementary vortex structures, and he succeeded in building up a model of homogeneous turbulence by random superposition of these elementary vortices. Since the original publication in 1956 (Chou Pei-yuan and Tsu Sho-tang, "Acta Scientiarum Naturalium Universitatis Pekinensis,"2, 39-51, 1956), there has been a steady development along the same lines. At the present time he and his associates are working hard on the extension of the original solution to moderate Reynolds numbers so as to describe a somewhat earlier than final stage of turbulence decay. Professor Chou told me that experimental work on turbulence will begin again soon. On the first day of my visit, I was asked to give a lecture on turbulence to an audience of about 40 people. After the lecture, many questions were asked and I had the impression that there is interest in turbulence. The second day I participated in a kind of "round table discussion" attended by a number of research workers interested in fluid mechanics, especially in turbulence. There were about 30 persons present, some of whom had worked in America, such as S. K. Chuang (formerly at California Institute of Technology) and H. S. Tan (formerly at Cornell). The questions addressed to me were quite numerous but they mostly dealt with technique; some were about experimental techniques but others were quite interested in that up to the present time their research interests were of an extremely pragmatic nature, consequently turbulent shear flow calculations were foremost among their questions.

AERONAUTICAL RESEARCH INSTITUTE IN PEKING

It is primarily an educational institution, although it is operating under the "ministry of aeronautics" (more correctly The Third Ministry of Machinery). I was shown around by Mr. Shen Yuen, Vice Chairman of the Revolutionary Committee. Professor S. K. Chuang (mentioned in the paragraph above) was also among the group receiving me.

Presently, there are about 3,000 undergraduates enrolled in the Aeronautical Institute for a three-year course; consequently about 1,000 a year are graduating. Before the Cultural Revolution (before 1966) there were about 5,500 undergraduates enrolled in a five-year course. Of a large teaching staff there are about 1,400 classified as teachers. Upon further inquiry I was told that only about 80 of these are professors and assistant professors, so I was naturally curious about the role of the majority of such a large number of teachers (student-teacher ratio is nearly two). Finally, from the answers, I gathered that many of these "teachers" are participating in a role that would be equivalent to a junior instructor in the United States. I was told also that many of them have received insufficient training during the Cultural Revolution so I suspect that many of them are receiving more education than they are providing. This arrangement may also serve a useful purpose of absorbing some of those former students whose education was abruptly interrupted by the Cultural Revolution.

I was shown some of the laboratories. These were all essentially teaching laboratories, although some research is being carried out. The equipment included testing machines to determine the strength of materials and also to test whole structures. Some fatigue tests were shown too. Outside the building they established a major aircraft park in order to show students some examples of aircraft. Among a variety of aircraft they also have an eight-person passenger plane that was designed and built entirely by students back in the 1950's. They also built up a rather large aircraft engine demonstration exhibit that serves to show the students various examples of foreign technology. The samples include both Soviet and American engines, MIG's as well as one from a U-2. It was especially interesting to see that the Chinese collected so many of one particular type of American jet engine (CAE-69), so that they were able to reconstruct and assemble several operating engines, and on some of these engines they conduct performance tests. I was shown one of those engines mounted in a test cell where they measure thrust, rpm, manifold pressure, etc. Several high-speed wind tunnels were shown, all fed by a common eight-atmosphere storage tank. A supersonic wind tunnel with a working section of 40 cm x 40 cm at $M = 2.5$ can be operated for about a minute. Combustion facilities including testing for altitude effects were shown, and at one stand they were studying the problem of re-ignition at high altitudes.

FUTAN UNIVERSITY IN SHANGHAI

The school was originally a French missionary school, named Ching Tan University, but in 1905 it was transformed to what my interpreter termed a full university under the name of Mashanba University, founded by progressive, liberal, democratic citizens. After 1949 it was reorganized with the rest of the educational system. Presently it operates with 14 departments. Of those there are seven liberal arts departments (Chinese Literature, Foreign Languages, International Politics, Economy, Philosophy, History and Journalism), and six science departments (Physics, Chemistry, Biology, Optics, Nuclear Science, Computer Science). The 14th department, independent from both sciences and humanities, is Mathematics.

In addition to the teaching departments, there are also Research Institutes (Mathematics, Genetics, History, Historical Geography, and Chinese Literature). In accordance with the current policy, there are also so-called campus factories at Futan University. These are a Chemical Factory and an Electrical Instrumentation Factory. Before the Cultural Revolution, there were 6,000 students enrolled but presently there are only 4,100 in a three-year undergraduate program. The number of teaching faculty is nearly 2,000 and of those, only 122 are listed as professors or assistant professors, some 376 as lecturers. The rest of the faculty is classified only as teachers. Of those teachers, about one third are full time research workers. An interesting special activity: the University operates a correspondence school with an enrollment of about 18,000. They expressed the hope that with the demise of the "Gang of 4," their regular enrollment will climb steadily.

After the general briefing, I was shown some research and development activities in progress. The last thing shown was the development of thin film deposited integrated circuits. Position control by laser interferometer applied to machine tools is one of their specialties. In the Mathematics Department, I saw a domes-

tically produced model computer, 1973 vintage. It operates with 48 bit words, and the speed was quoted as 120,000 operations per second. It has a 32,000 word (random access) memory and a 6,000 word per second tape deck. The software they use is based on ALGOL. I was told that they were doing problems with a finite difference method. Two-dimensional problems, both in elasticity and in fluid mechanics, were calculated typically on a 170 x 170 point grid. I was somewhat surprised to find that fluid mechanics research was located in the Mathematics Department. The faculty member who showed me around was Dr. Liu Chao-long. He is doing research work aimed at predicting pressure pulses occurring in pipelines. In this case I had the most difficulty since the interpreter lacked the technical vocabulary. Essentially, they appeared to be doing a study in the dynamics of the problem. They did that both by setting up analog problems in the laboratory with reduced size and correspondingly increased frequency so they built a laboratory duct system instrumented with microphones. In addition, they are in the process of developing instrumentation to be installed in a real pipeline.

I was shown a teaching laboratory in fluid mechanics. The principal tool is a return-type wind tunnel about 75 cm in diameter and a maximum velocity of 45 m/s. The tunnel is equipped with a three component force balance to measure lift, drag and moment on airplane models and on two dimensional airfoils. What was especially interesting to me was to learn that the equipment was already completed in 1965 (just before the Cultural Revolution) but only now are they beginning to use it as a teaching and academic research tool as the return to normal academic operations begins.

CHEKIANT UNIVERSITY IN HANGCHOW

The University is in the lovely region of Hangchow (West Lake), considered one of the premium resort areas before 1949. I was shown around by Professor Yang Shih-lin. The University was founded in 1897 by the Provincial Government and it had seven faculties before 1949. After the new regime became established, the University became reoriented. Before 1966 it had a five-year undergraduate course, but now there is a three-year course with only 3,422 students enrolled. When I asked about evening school, I was told that following the resumption of teaching after the cultural revolution, night schools were abolished because "the Gang of 4" were against it (I never fully understood why). Here I had a chance to discuss extensively the admission process, described earlier in the general comments.

At Chekiant University, the entering students are distributed as follows: 65%-75% coming from factories, and about 25%-30% from farms. Also, there are about 25%-30% female students. In addition, the University has special arrangements with neighboring factories who send their selected personnel for short term stays, especially for special courses. The three-year undergraduate program has about half of the total time spent in classrooms working on the main technical subject. About 10% is spent in practical work in one of the campus factories. The rest of the time is taken up by humanities, which includes political indoctrination, agriculture, physical education, military science, etc. The students have about five weeks vacation a year, four weeks in the summer (usually they take off the month of August), and another week in winter around New Year. For practical experience, there are campus factories. They are special ones producing machinery: there is one in chemical engineering, one in electrical engineering (electric power), one in radio engineering (electronics) and one in optics.

The undergraduate instruction is divided into seven departments (General Machinery, Electrical Machinery, Chemical Engineering, Civil Engineering, Optical Engineering, Electronics and Natural Sciences). The inspection tour began with the General Machinery Department, where I was shown mostly metallurgical developments. Another area was new developments in automatic control. The principles of automatic control were being taught to the students, including some use of computers, which were proudly displayed.

Naturally, a short visit to the four institutions cannot be a profound survey. It can give only a glimpse of the Chinese higher education and scientific research. To sum it up, the visits to the teaching institutions have shown clearly that much that is being taught is pragmatically oriented. The student, having come from a working environment and knowing that he must return to the same group, is quite aware that he is expected to take back knowledge to improve the productivity and the lot of his comrades there. Only the future will tell, however, to what extent these institutions will be able to reconcile these immediate practical goals with the longer range objectives of building up research teams in more sophisticated subjects where there is no direct relevance to immediate production problems.

SOME IMPRESSIONS OF THE INTERNATIONAL CONFERENCE ON NUCLEAR STRUCTURE, TOKYO

Richard G. Allas

This is the second time that the international conference on nuclear structure was held in Japan (September 5-10, 1977). The previous Tokyo conference was almost exactly ten years prior to this one. Many of the attendees had also been there at that time and thus invariably comparisons were made and new observations and old memories exchanged.

The success of a conference cannot entirely be judged by cold statistics of papers presented and number of attendees, not even by the "who is who" in the field present. The warmth, the outstanding organization, the helpfulness of our Japanese hosts, and the memories carried back, all were important to make this an outstanding conference.

However, the statistics also are quite impressive: 868 contributed papers (not counting post deadline) by some 2,000 authors and co-authors; 32 foreign countries represented by some 310 attendees plus some 440 fully registered and about 120 observers from Japan. The largest non-Japanese groups were from the United States, close to 90; West Germany and France run neck to neck about 50 each; Italy and the Union of Soviet Socialist Republics had 15-20 each and all the other countries had below 10 attendees. In addition some 30 invited talks by experts on various topics were presented.

It is rather infrequent that such large numbers of nuclear physicists from all over the world, many of them experts in their particular subfield, gather in Japan. To take full advantage of this expertise, to more fully exchange ideas on specialized subjects, to show the newest Japanese research facilities and equipment and to introduce the younger Japanese physicists and physics students to the international physics community many symposia and (mini-) conferences were organized. These symposia were of a varying degree of formality and size and either preceded or followed the main conference and were held in various locations in Japan. As a matter of fact, there was even a ripple effect to India as several people headed for the cyclotron dedication in Calcutta and a variety of gatherings throughout India.

To illustrate the diversity of interests of the Japanese nuclear physicists as expressed in the topics of these symposia and to describe some of their facilities, I shall mention a few of these meetings and the research equipment available at the laboratories where the meetings were held.

An informal symposium on highly excited states and polarization phenomena was held at the Research Center for Nuclear Physics (RCNP), Osaka University. Since this national institute is rather new, experiments having just started in January 1977, the purpose of this informal symposium was to discuss topics related to work done at RCNP as well as to show the facilities of RCNP.

The RCNP is a new national institute. Its main facility is an AVF (Azimuthally Varying Field) cyclotron. The cyclotron provides protons (polarized and unpolarized) up to 75 MeV, alphas up to 120 MeV, ^{3}He particles up to 150 MeV and various kinds of heavy ions with Energy/nucleus = 10-15 MeV. Experiments have just started since last January, and various kinds of nuclear experiments using polarized ($\vec{p}$) and unpolarized protons, alphas, ^{3}He, and heavy ions are now being carried on. Some of them are studies of pre-equilibrium and equilibrium (i, xn, yp) reactions, gamma ray multiplicities and multipolarities, direct and break-up reactions induced by ^{3}He, inelastic scattering and particle transfer reactions, elastic and inelastic $\vec{p}$ scattering, $\vec{p}$ -$\vec{p}$ and $\vec{p}$ -He scattering, high resolution studies of whole analogue states, studies of highly excited states and polarization phenomena. The large number of papers contributed to both the main conference and this symposium already shows a very active and productive group.

The Institute for Nuclear Study, University of Tokyo, sponsored a post-conference symposium on nuclear instrumentation, especially magnetic spectrometers and detector systems. The four main research areas being pursued are: low energy physics, high energy physics, theoretical physics and a special study group for the high energy heavy ion project to accelerate ions up to uranium to 100-1,000 MeV/nucleon.

Here the accelerator facilities for low energy nuclear physics are: a frequency modulated (FM) cyclotron with a nearly continuous beam achieved by the use of a debunching system and a sector focusing (SF) cyclotron with the availability of polarized protons and deuterons. The SF cyclotron accelerates protons (including polarized) from 7.4-45 MeV and deuterons (including polarized) from 15-35 MeV; in addition it will accelerate ^{3}He and alpha particles and some heavy ions. The FM cyclotron will give 55 MeV protons or 80 MeV ^{3}He particles.

The high energy physics division has a 1.3 GeV electron synchrotron. This accelerator also provides a synchrotron radiation port for solid state physics experiments. For experiments they provide a variety of equipment including a polarized photon system, liquid hydrogen and deuterium targets, a polarized proton target and on-line computers.

The theoretical physics division is engaged in studies of a wide range of fields in nuclear physics, from microscopic description of nuclear collective modes to the theory of heavy ion reactions. The particle physics group is interested in the study of the structure of particles and their interactions.

However, the most interesting and far-reaching project is the study group for a high energy heavy ion facility NUMATRON (Nuclear-Matter-Tron). In the last few years, heavier ions and higher energy are called for in several fields of research and applications, especially among nuclear physicists in Japan. Responding to such demands, a study group has been organized at the Institute for Nuclear Study.

The aim of the project is to open up a new field of nuclear physics including possibilities to study the high-density and high-temperature nuclear matter as exists in stars under controlled laboratory conditions. This facility, the major project in nuclear physics in Japan, is planned to provide heavy ions up to uranium in the relativistic energy range of 100-1,000 MeV per nucleon. The design studies also were presented at the main conference. Basically, the idea is to accelerate heavy ions (stripped at several stages) into a storage ring and from there eject them into a synchrotron for final acceleration to the desired energy. This facility most likely will be funded and constructed. When it becomes operational it will open new areas of experimental research and theoretical investigations and it will be the most powerful facility of its kind in the world.

A pre-conference symposium was held at the Science University of Tokyo on the subject of few-body problems. It was attended by about 70 people, about half of whom were from outside Japan. One of the non-Japanese speakers probably expressed the feelings of most attendees when he noticed, to his surprise and delight, that so many Japanese physicists were interested in the few-body problems.

This symposium was not coupled with any facility visit, but devoted to a more thorough discussion of the few body problem than could be possible in the main conference. Thus there was a certain amount of overlap. The major points of discussion were the nuclear potential, the amount of D state in the deuteron, the calculational aspects of the Fadeev three body formalism and the possible existence and extent of a three body force. In case of the nuclear potential the contributions of the on-shell and off-shell parts in selected regions of phase space were discussed. It has become increasingly evident that higher partial waves (P, D. . .) and tensor forces play an important role, especially if polarization measurements are considered. The estimates for the D state of the deuteron range from 3.5% to 7% with most results being somewhere in between. From all evidence there seems to be a need for a three body force. It is especially indicated in calculations of the binding energy of the triton. However, the form and properties of such a three body force are open questions. Of course, the ever present question on how to properly treat the Coulomb effects in all calculations still is a topic of discussion.

The main conference dealt with various topics of current interest in nuclear structure. Some of these topics were the same as discussed in greater detail in the various specialized symposia. The talks consisted mainly of invited papers with a few contributions selected for oral presentation. It is to be noted that all contributed papers had already been reproduced and bound as Volume I of the proceedings and were made available to the participants at the time of registration. The other volume will contain all invited talks and will be published as

a supplement to the Journal of the Physical Society of Japan.

The conference was opened by the President of the International Conference on Nuclear Structure, Sinitiro Tomonaga. In his talk, and especially in the remarks of S. Miyahara, President of the Physical Society of Japan, the place of nuclear physics in Japan was discussed. Nuclear physics is still remembered by many Japanese in terms of the atomic explosions in Japan. Therefore all energies and efforts of the Japanese nuclear physicists are now concentrated towards basic research and the peaceful applications of nuclear physics to benefit mankind and not to bring destruction.

The introductory talks were given by J. P. Schiffer, Argonne National Laboratory, and T. E. O. Ericson, CERN. In his talk Schiffer stressed how new technological advances lead to improved experimental possibilities, e.g., the new and proposed facilities for heavy ion research and medium energy physics ("meson factories"). New experiments frequently require changes in existing theories and thus lead to new theoretical insight. In particular he mentioned heavy ion reactions where high angular momentum (L = 32) states can be excited. The understanding of such high angular momentum states is still rather crude. In heavy ion reactions such as $^{12}C+^{12}C$ many resonances are observed, but the tools of light ion reactions (coupled channels, etc.) have only limited success. Interesting applications to atomic physics are possible, because in heavy ion reactions very high Coulomb fields can be generated. The proposed new high energy heavy ion accelerators will lead to collisions of nuclei at relativistic energies. It is not known what to expect from such interactions. However, Schiffer also stressed the need for "conventional" nuclear physics. It still is the core of the subject and holds many unexplained phenomena. He also mentioned that nuclear theory is in somewhat of a trouble because the number of theorists that concern themselves with experiment, with actual data, is decreasing.

Major problems in nuclear physics are to some extent the volume of information (data) gathered; there is not enough activity in compilation efforts. In particular nuclear reaction data compilation is totally neglected. What appears in the literature are just a few numbers arrived at by theoretical analysis and interpretation. If the theory changes the original data still is valid, but not available for reanalysis. Schiffer also suggested that the smaller accelerators and the proposed new facilities should be carefully balanced. Some of the greatest advances in physics have come from careful systematic work.

Ericson devoted his introductory talk to topics not explicitly covered by Schiffer. He first remarked about the purpose of large vs. small conferences. Large conferences, held at proper intervals, give a platform for discussion and for learning about developments in related fields in the broader perspective rather than just one's own narrow interests. Thus, for example, nuclear physics is a mature science as can be judged by its applications. However, it has many promising areas, some outside the regular field. Some of these more exotic fields are: studies of neutron rich and neutron poor nuclei (edge of stability), superheavy nuclei, high spin states (forced rearrangement), high momentum transfer (short distances), new particles or resonances. He also emphasized that the ideas about a three body force have advanced from speculation to necessity based on the present theoretical picture of the nucleon-nucleon interaction.

Mitra, University of Delhi, noted that this was the first time a structure conference has devoted a session to the fundamental problems of nuclear forces and few nucleons, a subject still basic to all of nuclear physics and on which ultimately all structure is based. Horiuchi, Kyoto, stretched the problem of linking the known shell structure to the specific two body nuclear force. Akoishi, Sapporo, concluded that the three body force plays an important role in reproducing the energy levels of the alpha particle. A survey of few nucleon systems was given by Slaus, Zagreb.

A full session was devoted to some of the new or proposed accelerators as well as to suggested improvements and updates of existing machines. Most of the talks dealt with heavy ion accelerators. Some of the technical advances are incorporating superconducting magnets in the machine design. Thus Michigan State is proposing a superconducting cyclotron. They already have a fully tested magnet and just recently were given funding by the National Science Foundation to convert the magnet to a working cyclotron. They expect the first beam about mid 1979. Argonne is going to use a small superconducting Linac to increase the energy of their tandem accelerator. They hope to be able to run experiments by the end of 1978. A similar superconducting Linac is under construction at Stonybrook. The Laddertron accelerator project at Daresburry, England, is presently experimenting with specialized insulators to sustain accelerating voltages of 2.2 MV/meter. The

Holifield heavy ion accelerator laboratory at Oak Ridge is presently under construction. This accelerator is designed to accelerate ions throughout the periodic table. In France the GANIL project (Saclay) is under construction. It is designed to accelerate uranium to about 10 MeV/nucleon and up to about 100 MeV for light ions. It consists of two identical isochronous separated sector cyclotrons, one feeding the other with a stripper between them. Probably the most ambitious project discussed was the Japanese NUMATRON (previously described) to accelerate heavy ions to the relativistic energies of 100-1,000 MeV/nucleon.

Some of the other topics discussed were heavy ion collision, shell and cluster structure, nuclear spectroscopy, giant resonances, super-heavy elements, hypernuclear spectroscopy and weak interactions. It is impossible to touch upon all of them and the interested reader is deferred to the forthcoming proceedings.

The conference ended with the concluding talk by H. Morinago, Munich. This Tokyo conference had more contributed papers than the previous one four years ago held at Munich. In general the science of nuclear physics has established its international nature and it should remain that way.

The general impression all during the main and subconferences was that nuclear physics as a science is active and advancing, is exploring new approaches for development without neglecting the "conventional" path. Attendance figures should not be used in direct comparison of interest in the field between different nations. However, the last ten year development of nuclear physics in Japan and the interest and support for it displayed at this conference firmly establishes Japan in the forefront of nuclear physics in the world.

CONCERN OF THE OKINAWAN PEOPLE IN DEVELOPMENTS IN METEOROLOGY

Suguru Ishijima

THE ISOLATION OF THE RYUKYUAN ISLANDS IN THE SOUTHWEST PACIFIC

The Ryukyuan Islands, administratively called the Okinawa Prefecture of Japan and consisting of three sub-groups (Okinawa, Miyako and Ishigaki-island groups), run in a southwest-northeast direction facing the wide East China Sea to the west and the Pacific to the east. The latitude of the northernmost island is about 27°N and that of the southernmost 24°N. The latitude of the capital city, Naha, is about the same as that of Miami, Florida. The climate in the Ryukyu Islands is quite similar to that of the Bahama Islands off Florida, owing to the similarity in size and relative locations to a continent to the west.

Historically, the ancestors of the Okinawan people had contacts with people in other districts of Japan to the north, with the coastal regions of China on the continent to the west across the East China Sea, and with Taiwan and other countries to the south; this helped to overcome various handicaps associated with small islands isolated in the middle of the ocean. It is easily imagined that there might have occurred many major events involving unexpected weather changes in the oceanic area of the Ryukyu Islands. In fact, legends or records concerning the drifts of ships or people have been kept for posterity. For instance, it is said that the famous Japanese warrior Tametomo Minamoto drifted down to Unten-harbor in the north of Okinawa Island in 1165 and that his son was crowned the first king of the Ryukyu Islands. It is also said that the ship carrying officials of Miyako Island back from a mission to deliver tribute to the king of the Ryukyus at Shuri on Okinawa Island floundered upon encountering a typhoon and was stranded on the east coast of Taiwan. Most of the officials who landed on Taiwan were unfortunately killed by native headhunters in 1874.

The ancestors of the Okinawan people might not have been able to make their livelihood on such small islands without becoming involved with the sea. It is easy to understand that the fears of the ancestors concerning the dangers over the sea in bad weather naturally led to a desire to increase this knowledge of meteorological phenomena. Under such circumstances numerous proverbs about weather have been born. Some examples are: "the weather gets worse if the moving speed of middle or high clouds increases"; "the wind becomes violent if the level of water in a well increases unusually"; "the violent wind blows if swallows come to land in flocks."

OBSERVATION STATIONS AND THE STUDY OF METEOROLOGY IN OKINAWA

In 1890 the Okinawa Observation Station opened in Naha, 15 years after the establishment of the Tokyo Observation Station. Several years later an Ishigaki Observation Station was established. For nearly 80 years these two observation stations at Naha and Ishigaki have kept records that would be helpful for the long range analysis of weather variation. In particular, the observations at the Ishigaki Observation Station have been very valuable because they were not interrupted even for the several years of administrative confusion right after World War II, and because observations have been consistently taken at the same location. Currently, there are three regional observation stations (Ishigaki, Miyako and Minami-daito islands), four local observation stations (Kume, Nago, Iriomote, and Yonaguni islands) and six airport observation stations (Naha, Kume, Minami-daito, Miyako, Ishigaki, Yonoguni islands) under the main Okinawa District Observation Station in Naha. The total number of staff employed in these stations is 340.

Surface observations as well as high atmosphere observations, utilizing a radar system of releasing sonde-balloons, are routinely made. Recently a Japan geostationary meteorological satellite was launched over the the equator at 140°E, which will soon be contributing to the weather watch. It should be noted here that the typohoon watch information provided by the United States military has been contributing greatly to the analysis and prediction of the behavior of typhoons in the area of Okinawa.

Providing various meteorological information for the daily activities of people in fishery, agriculture, industry, etc., may be the major task of such governmentally-supported observation stations, but one cannot disregard the fact that the data obtained by those routine observation stations has contributed to the development of meteorology and has opened the possibility of all kinds of meteorological research.

At this point the author wishes to describe briefly who does research in meteorology, and where the meteorologists or researchers are trained and educated. Among about 400 Japanese universities (88 national, 33 prefectural or municipal and 307 private), only a few universities have a geophysics department which has some enrollment in courses in meterology. At the rest of the universities some outline of meterology is given as a part of earth science courses open to any student and an introductory meteorology course is offered for those students who plan to be teachers after graduation. There is a professional school, the National College of Meteorology, under the Ministry of Commerce and Industry. Graduate level courses are offered only in the few universities which have Departments of Geophysics or Departments of Applied Sciences, like Hokkaido, Tohoku, Tokyo, Kyoto and Kyushu Universities.

As described above, professional education in meteorology is provided in a limited number of places in Japan. This, in turn, implies that most of the staff of meteorological observation stations in Japan feel it is their mission to get involved in education or research work in meteorology. To promote research for the development of meteorology, the Okinawa Branch of the Japan Meteorological Society was organized in 1972, immediately after the reversion of Okinawa to Japan. There are more than one hundred members in this Branch, five being affiliated with the University of the Ryukyus and all the others, except for a few, being affiliated with meteorological observation stations located in the Ryukyu Islands. One general assembly is held in March every year where the members present the results of their research.

METEOROLOGICAL TOPICS IN OKINAWA

Weather changes that we encounter in this district throughout one year are largely related to the alternation of monsoons, the passage of moving highs and lows, and the comings of the *baiu* rainy season and typhoons.

Cold and Warm Seasons

Groups of Sashiba, a kind of hawk, are observed over the Ryukyu Islands when the northerly winds (winter monsoon) begin to blow. The arrival on Ishigaki Island of the first group is usually around the 10th of October. This is considered to be an indication of the start of the cold season which continues until the following March or April when the southerly winds start to blow frequently. The weather in the middle of the cold season is marked by the growth of cold and dry air mass over the continent of China. Cold and windy weather is experienced when this air mass flows out from the continent toward the Ryukyu Islands. People flying in from Tokyo at the peak of the winter monsoon are often perplexed by the unexpectedly severe weather upon landing at Naha airport. Strong winds cause people to feel colder than they would expect from the actual air temperature in Naha. Average air temperature is 61°F in Naha and 39°F in Tokyo, but there are quite a number of days with winds of 10 m/s blowing in Naha. Sometimes accompanying the cold air mass flowing out over the East China Sea are Taiwan depressions which form north of Taiwan and threaten fishing boats and ships travelling during this season. Aiming to study the formation mechanisms of this type of depression the Airmass Transformation Experiment (AMTEX) was conducted in February 1974 and 1975 with international cooperation in the oceanic region centered near Okinawa Island. AMTEX was a sub-program of the Global Atmospheric Research Program (GARP) in which more than 200 participants were involved.

During the warm season with its peak in July through September the wind is mostly southerly bringing in the warm and moist air mass which develops under the strongest heat of the sun over the subtropical Pacific east of the Japan islands. The weather in this season is very uncomfortable because of its heat and humidity. It is interesting to compare the temperature, humidity and discomfort index in July of Naha (26.7°N, 127.7°E), Honolulu (21.3°N, 157.9°E) and Yap island in Micronesia (9.5°N, 138.1°E) which are 83°F, 82% and 81 for Naha, 79°F, 64%, and 74 for Honlulu and 81°F, 86% and 79 for Yap. People on Okinawa feel compelled to strip off their clothing to cool their bodies and get rid of the perspiration. This situation is quite different in the Hawaiian Islands where they feel it is necessary to dress at least in Hawaiian dress (aloha shirts or muumuu) to protect themselves from catching cold.

Baiu and Typhoons

The period from the end of April to June is called the *Baiu* season (baiu means the rainfall observed in the season of the blossoming of the *ume* plum trees). An outstanding feature of this season is the large amount of clouds or rainfall. In the months of May and June, 564 mm of rainfall is recorded on an average at Naha, which is obviously an appreciable percentage of the yearly total of 2,118 mm. People in the Ryukyus appreciate the coming of the *Baiu* season for the rain in this season ends the water shortage and the drought that tends to occur in the cold winter season. A secondary rainfall peak is brought about by typhoon whose comings are not always predictable on a long range basis but which statistically hit the Ryukyu Islands three to four times a year in the months from July through September. The rainfall resulting from *Baiu* and typhoons amounts to approximately half of the total annual rainfall.

On the one hand, one can derive benefits from the typhoons bringing water but, on the other hand, one is always exposed to the violent wind of the typhoons. The maximum rainfall brought by a typhoon during its stay within a distance of 300 km from any island grouping of the Ryukyus is 846 mm and the highest gust of wind is 85 m/s. In Japan a typhoon (a storm with the maximum wind speed of more than 17 m/s) is given the number that shows its order of birth in that particular year, a different system of describing typhoons than that used in the United States. However, a particular typhoon that causes extreme damage to a particular locality is named after the locality that it hit. About ten such notorious typhoons in Japan including the Ryukyus have been experienced since the beginning of this century; for example, the Muroto peninsular typhoon, the Isebay typhoon, and the Miyako Island typhoon. Normally, a typhoon reaches its mature stage in the latitudes of the Ryukyu Islands and becomes most violent. However, fortunately the damage due to typhoons is less severe and infrequent in the Ryukyu district because of the diminished orographic effect and because of the small size of the islands; but lack of preparation for the coming of a typhoon at times brings calamities. Most recently on July 30 and 31, Ishigaki Island and its neighboring islands were severely damaged by an unexpected typhoon: there were 6 deaths, 97 completely destroyed houses, 8 sunken ships, 24 overturned cars. This typhoon showed the need to clarify several unknown points: how it was formed in such a higher latitude (25N); how it could intensify in such a short time (45 mb in one day July 29 to 30); why it took such an unusual course from north to south, and so forth.

CONCLUDING REMARKS

In conclusion the author wishes to assert that although various types of instruments (radar, satellite, and other remote sensing apparatus) are now in use and we are able to track meteorological disturbances so long as they are perceived by these equipments, our knowledge of the causes of the turbulence is very limited. In particular, there are many unknown factors about the atmosphere over the East China Sea to the west and the Pacific Ocean to the east of the Ryukyu Islands still unsolved. In order to continue to live in such a localized area isolated by the ocean, people in the Ryukyus cannot ignore the development of the science of weather, as their ancestors did. The desire now is to study the weather changes more precisely and to be able to predict them on a longer range basis. This requires that we promote fundamental research based on the physics of the atmosphere to increase the accuracy of predictions on the behavior of atmospheric phenomena.

NAGOYA UNIVERSITY

George Sandoz

Nagoya University is one of the leading technical universities in science and engineering. Formerly Nagoya Imperial University, the school was renamed Nagoya University in 1947, and reorganized in 1949 under a so-called new educational system. In addition to science and engineering there are postgraduate schools of Letters, Education, Law, Economics, Medicine and Agriculture. At present there are also four Research Institutes in Environmental Medicine, Atmospherics, Plasma Physics and Water Research. An Institute in Aeronautical Medicine was abolished in 1945 after only two years' existence, obviously a casualty of the war. The industrial and center city of Nagoya has been largely rebuilt since the war and the University of Nagoya has also mostly been built during the post-war period.

Within the Department of Metallurgical Engineering, there are several research-teaching units. They are Metal Physics, Non-Ferrous Metallurgy, Ferrous Metallurgy, Chemical Metallurgy, Welding Metallurgy, Metal Casting, Analytical Chemistry, Metallic Materials, Process Engineering Metallurgy, Reaction Engineering, Solid State Physics, Plastic Working of Metals and Strength of Metals. Three of these units were visited—Welding Metallurgy, Metal Physics and Strength of Metals. A lecture on "Stress-Corrosion Cracking in Some High Strength Steels" was presented to a student faculty assembly.

Professor Isao Masumoto is the well-known leader of the Welding Metallurgy Group and Laboratory. The group investigates welding technology with emphasis on the relation of mechanical properties to metallurgical structure. As one example of the work, methods have been devised to improve the fatigue strength of welded joints. Galvanized joints (after welding) should be quenched to improve aging characteristics and the residual stress pattern. The function of plastic (epoxy resin) coatings of welds in improving resistance to fatigue has been shown to be the exclusion of moisture and oxygen from the atmosphere.

Professor Masumoto and his colleagues have also done some important research on the avoidance of hot-cracking in weld metal and in the welded joint. The important finding is that the weld metal should solidify within the delta ferrite region of the peritectic phase diagram, to avoid sulfur grain boundary segregation. Thus there are limits to the amounts of C, S, and Ni (and to the Cr in austenitic steels) in order to avoid hot cracking. The threshold values have been specified by Masumoto in many articles over the past decade.

Masumoto and colleagues have also published widely on electroslag welding (IIW Doc. XII-J-8-71), and CO_2 Arc Welding (Welding Journal Res Sup. July, 1958, IIW Doc. XII-B-135-73). Research on underwater welding of steel and electroslag welding of aluminum has also been undertaken.

Recently computer programs for the critical parameters for welding by electron beam, CO_2 and submerged arc welding processes have been studied. Another area of curent interest is the transfer of such metals as Ca, La and Mg in the arc from the metal wire in MIG and Ar-CO_2 weld processes. This metal transfer can influence the ease of welding and the properties of the welds. The refrigeration of welds to improve properties is also an important study of continuing interest.

In the study of strength of metals, Professor A. Otsuka concentrates primarily in fracture and fatigue. His studies on fracture are based on the COD concept coupled with metallurgical observations. The problem addressed is the fibrous fracture initiation in the mixed mode loading condition. The fracture initiation from a precrack in low and medium strength steel occurs by fibrous cracking at high temperatures and by cleavage cracking at low temperatures. The transition temperature is greatly influenced by the degree of plastic constraint.

Otsuka and his colleagues define the transition temperature Ti as the transition in fracture mode which is accompanied by a large change in toughness. A steel should always be used at temperatures above Ti.

At temperatures higher than Ti, the COD (crack opening displacement) at fracture initiation (δi) becomes almost constant, showing little sensitivity to temperature, specimen geometry or loading rate. At temperatures below Ti, δi is sensitive to these factors. Therefore Otsuka defines the fracture toughness of low and medium strength steel by Ti and δi. The transition temperature Ti is dependent on specimen size, loading rate, etc., and is therefore not a material constant. The crack opening displacement, δi, is a material constant however, and may therefore be useful in material strength-toughness regimes where fracture mechanics cannot be used.

At the maximum values of Ti, plane strain conditions are reached. Otsuka has developed an expression which defines the critical value of Ti for plane strain, as follows:

$$a, B, W - a > 0.4 \frac{\delta_1 E}{\sigma_y R}$$

where a is crack length, W is specimen width, E is Young's modulus, σ_y is yield strength and R is the ratio of yield strength to ultimate tensile strength. The ratio of maximum tensile strength to maximum shear strength ($\sigma_{y}max/\chi_{max}$) is also at a maximum when plane strain is reached.

Otsuka measures with SEM a value of "stretch zone depth" (SZD) which is a maximum at the point of static fracture. The value of SZD is directly proportional to COD up to the Ti temperature above which the notch tip COD increases rapidly while the plastic COD, which is proportional to SZD, becomes constant.

These results appear to be important in the application of quantitative analytical techniques to steels which are not normally tractable to fracture mechanics techniques. The work of Otsuka's group seems to offer the means of measuring a material constant, δi, which can be a useful toughness index as well as a means of determining the value of Ti where plane strain is obtained. Further details on this work is given in Engineering Fracture Mechanics, Vol. 7, p. 419, 1975, and in a paper by A. Otsuka, T. Miyata and S. Nishimura entitled "Fracture Toughness and the Transition in Fracture Initiation Mode in Low and Medium Strength Steel" which was delivered at the International Conference on Fracture Mechanics and Technology in Hong Kong, March 1977.

Otsuka and his group have also studied the initiation of fatigue crack growth in mixed mode conditions (see Engineering Fracture Mechanics, Vol. 7, p. 429, 1975). Precracked low-carbon steel specimens were used, with the notches introduced at both surface and center, and at various angles to the applied fatigue stress. It is concluded that the fatigue crack growth is fractographically divided into two modes, shear and tensile (the fractographs were not sensitive to notch activity). The critical condition for fatigue crack growth is given by the local tensile stress and shearing stress at the notch tip, which relate to the stress intensity factors K_2 and K_{II}. Under plane loading conditions this criterion is generally applicable.

The Metal Physics Group under Professor T. Imura is very active in high voltage electron microscopy (HVEM). In situ dynamic thermal and mechanical effects (dislocation movements) have been observed. This work of *In-situ* is widely known, and no attempt to provide details will be undertaken here. For those interested, the following papers of Imura and coauthors are recommended: a) "*In-Situ* Dynamic Experiments on Plastic Deformation in HVEM," Fourth International Congress, Toulouse, 1975, and b) "*In-Situ* Dynamic Observations of Dislocation Behavior in Metals and Alloys by High Voltage Electron Microscopy," Memoirs of Faculty of Engineering, Nagoya University, Vol. 28, No. 1, May, 1976. Imura also served as co-chairman and program chairman of the Fifth International Conference on High Voltage Microscopy in Kyoto, Japan, August 29-September 1, 1977, sponsored by the Japanese Society of Electron Microscopy.

Associate Professor N. Yukawa is developing interesting high-temperature *in-situ* composites based on the monovariant eutectic line in the Ni-Cr-C system and the Co-Cr-C system. The hope is to obtain both fiber and dispersion strengthening. An alloy composed of 39 Cr-2C-22Ni- 34 Co - and 3 Al has been made. The eta Cr_7C_3 phase and a strong gamma matrix are expected to provide high temperature strength and the oxidation and corrosion resistance should be provided by the Cr. Preliminary tests show that the structure is entirely stable for 30 hours at 900°C. Yukawa feels the alloy will be stable to over 1,000°C, but this has not yet been proven. An ultimate use in gas turbine components is visualized. At the time of the meeting, Yukawa had not decided where to publish the work.

Imura with T. Masumoto of Tohoku University and Y. Yoshiro of Nagoya Institute of Technology reported on the "Structure and Stability of a Splat-Cooled Fe-P-C Alloy" at the Second International Conference on Rapidly Quenched Metals at MIT in November 1975 (published in Materials Science and Engineering, *23* (1976) 169-1972). The alloy (80 Fe-13P-7C) was found to have a significantly higher recrystallization temperature (from the amorphous state) after irradiation with electrons of 100 keV to 1,000 keV up to a total dose of about 10^{23} electrons/cm^2 in the HVEM. This could have practical applications.

In general, Nagoya University appears to be first class by every standard. Each of the three groups visited in Metallurgical Engineering proved to be very strong and it is sincerely regretted that there was not time to visit the other groups.

TOMOEGUMI IRON WORKS

George Sandoz

Dr. Hiroshi Nakayama, Plant Manager, was my host for a visit to Tomoegumi Iron Works. Both the Oyama plant in Tochigi-ken, about 50 km from Tokyo, and the Welding Laboratory in Tokyo were visited.

The company was founded in 1917 as a fabrication shop and has grown since to serve primarily the building industry, in both design and fabrication. The company is famed for its "Diamond Truss" concept, a method for constructing curved, wide-span surfaces with trusses arranged in diamond forms. In addition to the two main lines, steel towers and Diamond Truss structures, the company builds bridges, prefabricated houses and schools and all manner of steel frame structures. The architectural section of the company is integrated with the planning, design and field construction activities, which is claimed to be unique in Japan.

With the extensive involvement of the company in fabrication it is natural that welding would be important. In this respect, the company appears to be almost exclusively employing variations of the CO_2 arc welding process which the company and Nakayama in particular have developed. There are both automatic and semi-automatic processes for in-plant or on-site operations. Some of these processes for narrow-gap welds are as follows:

1. NOW-T – This is a semi-automatic process for making vertical T weld joints. It involves CO_2 welding with the lower part of the joint contained by a copper chill and with coated rod laid in the square butt groove.

2. NOW-H – Similar to NOW-T but the weld is horizontal T and the chill is L shaped to contain the weld metal. This is intended for on-site welding.

3. NOW-F – This is a flat semi-automatic shop welding CO_2 arc weld process. The weld is flat horizontal with a granular flux backing.

4. NOW-B – This is a flat automatic shop horizontal welding CO_2 arc weld process. A small strip is welded just to the back side to contain the filler metal. Welding is performed in one-pass, one layer in a square butt groove.

5. NOW-HB – This is an automatic on-site horizontal process with a small strip welded to the reverse side to contain weld metal.

6. NOW-TB – A semi-automatic process for T joints, similar to the NOW-T process except that a steel backing strip is used.

7. NOW-V – This is a vertical narrow gap CO_2 arc weld process involving arc weaving and copper chills which move with the weld. CO_2 gas enters through an opening in the chill.

8. NOW-VB – This is a vertical T welding process similar to the NOW-V process but with the chills located appropriately for a T-joint.

These brief descriptions are recognized to beg better illustration and further clarification and for this purpose the papers which Nakayama and his colleagues have produced are perhaps the best source. Some of the more important of these are listed as follows:

1. H. Nakayama et al., "Use of Narrow-Gap One-Side Arc Welding Process (NOW Process) to Steel Structures of Building," IIW Doc. XII-B 97-71

2. H. Nakayama et al., "A Study of Narrow-Gap One-Side Arc Welding Process for Horizontal Position Welding," IIW Doc. XII-B-105-72

3. H. Nakayama et al., "Development and Application of Narrow-Gap One-Side Arc Welding Process (NOW-Process) to Steel Structures of Building," IIW Doc. XII-B-160-74

4. H. Nakayama et al., "A Study of Narrow-Gap One-Side Arc Welding Process of T-Joints (NOW-T Process) in Steel Building," IIW Doc. XII-B-133-73

5. "Development and Application of Narrow-Gap Arc Welding Process in Japan," IIW Doc. XII-B-584-74

6. H. Nakayama et al., "Application of Narrow-Gap Automatic CO_2 Arc Weaving Welding Process to Heavy Steel Structures," IIW Doc. XII-B-188-75

7. H. Nakayama et al., "Application of Narrow-Gap Automatic CO_2 Arc Weaving Processes to Heavy Steel Strutures of Building," 2nd International Symposium of the Japan Welding Society, August 1975, No. 2-2 (21). Also IIW Doc. XII-B-193-76

Nakayama's group has also been involved in studies of deformation and stress due to welding in steel buildings (IIW Doc. XV-292-70) and in studies to prevent weld cracking in high strength steel welds of building structures (IIW-Doc. IX-787-72). In the latter study a new method to prevent weld cracking was proposed involving succeeding passes within the incubation time for crack initiation without employing preheating.

At the Welding Laboratory, a recent achievement is a tandem sensor for the ultrasonic detection of defects in welds. This is claimed to be particularly effective in the NDT of narrow-gap welds. The company plans to develop the instrument for sale in the near future. Work is also under way on the development of a circular automatic CO_2 on-site welder. The goal is to provide automatic circular welding capability (girth welding) for underground columns of an electric power station.

At the time of the visit, Nakayama was engaged in writing a book on CO_2 welding and also preparing a Welding Terminology Dictionary. He was doing this in the evenings. Perhaps it is this kind of dedication that produces so many excellent industrial organizations in Japan. Tomoegumi Iron Works is one of these.

HITACHI ZOSEN

George Sandoz

Hitachi Zosen (Hitachi Shipbuilding and Engineering Company, Ltd.) has grown since being founded in 1891, into another giant Japanese company, employing upwards of 25,000 people. The main products are 1) ships (passenger, cargo, ore, oil, LPG, Naval craft, hydrofoil boats), 2) ship repair and remodeling, 3) ocean development equipment (oil drilling equipment, pipe laying barges, etc.), 4) marine engines (diesel, steam turbines, boilers, etc.), 5) machinery (steel rolling mills, cranes, hydraulic presses, etc.), 6) steel structures (bridges, stacks, penstocks, towers, etc.), 7) environmental equipment (incinerators, anti-air pollution equipment, etc.), and 8) castings and forgings.

The Technical Research Institute of Hitachi Zosen was established in 1949 and is the " corporate" research laboratory. The mission is to improve conventional technology and product quality as well as to develop new technology and new products. As outlined by Dr. Eng. Shojiro Okada, Director of the Technical Research Institute, 50 percent of the effort is problem solving, 25 percent is seeking technical alternatives, 20 percent is finding new markets using present techniques and 5 percent is seeking new markets through new technology.

There are about 280 people at the Technical Research Institute of whom about half are professional technical level. The budget runs at about 7 million dollars per year which is distributed among several research departments. The No. 1 Department, headed by Dr. Eng. Seizou Watanabe, was the only department visited because this department conducts most of the materials work. However, the Sakai Department studies yard applications of welding techniques. The No. 1 Department studies welding, coating and painting, properties of industrial materials, materials tests and process metallurgy.

The visit began with a presentation on the activities of ONR and NRL in the materials area. This was followed with a Hitachi Zosen movie and discussion on the welding and testing of pressure vessels. The movie illustrated, through unnotched and notched fatigue tests on a 30 ton welded pressure vessel, that the new Hitachi Zosen electro-slag welding process (HINES welding method) produces better welds of thick plate than shielded arc welding. Since HINES is an automatic process the speed is also much greater. The development came about following difficulties welding 80 Kg/mm^2 high tensile steel. The high heat input required causes upper bainite to form and this becomes brittle on slow cooling. Therefore manual welding was formerly required to provide faster cooling rates. The HINES welding method quenches the welded part by forced cooling immediately after electroslag welding, and follows with an immediate temper.

The next discussions were on some interesting alloy development work which has produced a series of so-called HZ alloys. A brief description of these follows:

1) CE-1 – a cavitation and erosion resistant alloy of copper, aluminum and beryllium (Cu-8 Al-1 Be nominal composition). The alloy may be further hardened to give very good wear resistance. The major application is high speed marine propellors where the cavitation problem is severe. In this respect the HZ-CE alloy is far superior to Mn-bronze and Ni-Al-bronze, according to Hitachi Zosen test data. The alloy is apparently commercially available and has previously been tested by the U.S. Navy (NAPL by D. Kallas).

The improved cavitation resistance is attributed to the development of a very fine beta phase and an alpha phase which is strengtehened by the presence of beryllium. The beta phase contains some K phase.

2) CE-3 – This is a filler material for inert gas welding (TIG, MIG) of the CE-1 material. Weldability is good, cavitation-erosion resistance is outstanding and the mechanical properties are good. Corrosion resistance in a number of media including saltwater is excellent. Overlay of parts produces outstanding wear resistance. For example, overlay on a nickel-aluminum bronze propeller for a small hydrofoil boat resulted in spectacular improvement in cavitation resistance as measured by weight loss and by visual inspection.

3) HZ-CM – a copper base alloy used for molds in the continuous casting process for steel. This alloy contains nickel and silicon. The alloy is strong at high temperature and is a good heat conductor.

4) HZ-CL – a nickel base alloy (Ni, 15-30 Mo, 1-5 W, 1-4 Cu, < 5 Fe, < 2 Cr, < 2 Co, 0.5 Ti) with very high corrosion resistance to HCL, H_2SO_4, NaOH, H_3PO_4, HF and organic acids. In addition the alloy is forgeable, weldable and castable and can be drawn. The alloy is similar to Hastelloy but the weld HAZ zones are precipitate free and hence more corrosion resistant.

The HZ-CL alloy is also useful as a submerged arc weld wire for 9 percent nickel steels. The alloy Ni, 15-30 Mo, 1-5 W, 1-4 Cu has been licensed for manufacture by Nippon Steel as a weld wire for submerged arc welding of pressure vessels, LNG tanks, etc. A cooperative agreement is also being arranged with Chicago Bridge and Iron Co.

5) HZ-SO – a lead base alloy resistant to H_2SO_4. The addition of a small amount of Te or Se is the means of conferring resistance greater than that of pure lead.

6) HZ-PO – an alloy resistant to phosphoric acid and generally useful in chemical plants where wet process mechanical action is involved. The alloy is composed of Fe, 38-40 Ni, 20-23 Cr, 7.5-8.5 Mo.

7) HZ-80C – a low alloy steel used in casting K and leg bracing for off-shore and undersea structures of 80 Kg/mm^2 steel (welds at regions of high constraint are thereby avoided). The composition of the alloy is patented. As quenched and tempered, the steel is resistant to stress corrosion cracking. At the present time research is underway to develop a similar steel at the 100 and 130 Kg/mm^2 strength level.

The company is very active in studies of NDE techniques, with emphasis on acoustic and ultrasonic monitoring of large pressure vessels. A multi-probe tandem technique involving many transducers has been developed for the ultrasonic inspection of very thick steel plates. A prototype has been made but there is no commercial availability.

Much of the technical progress cited is described in company brochures, but there are also published works in the literature and in company technical journals. The low-temperature fatigue behavior of weld joints of 9 percent nickel steel is described, for example, in IIW DOC. XIII-649-72. A study of fatigue crack growth in 9 percent nickel steel plate appears in Engineering Fracture Mechanics, *7*, 481, 1975. A strain energy release rate relationship to the increase in area of a surface crack subject to fatigue was established.

A series of reports have been issued on the subject of pressure vessels and piping. See Hitachi Zosen Technical Reports HTZR-PVP-1 through HTZR-PVP-7. These reports deal with design, fatigue tests, fabrication, quality assurance, etc. One paper (HZTR-PVP-4) discusses the means of preventing hydrogen-induced cracking of weldments, in terms of the preheat and postheat conditions required before cooling the weld metal to 100°C.

Several recent papers in the Hitachi Zosen Technical Reviews are in the materials area. One article is on the adaptability of calorized steels to hydrogen sulfide at high temperatures (*37*, No. 1, 8, 1976). At 600°C the coatings are resistant to corrosion in H_2S but are very brittle and thermal shock resistance is poor. Coated welded joints are not corrosion resistant.

In a later issue (*37*, No. 4, 1, 1976) the question of wear and seizing of flake graphite case iron (as cylinder liners, piston rings, etc.) is addressed. A harder matrix improves seizing resistance. Vanadium additions also improve seizing resistance while copper and chromium improve wear resistance but deteriorate seizure qualities. Another paper (*37*, No. 4, 10, 1976) discusses the effects of carbide precipitation on the creep of 18-8 stainless steel at 700°C. The effects of the precipitation are greatest between stress levels where creep is controlled by stress and lower stress levels where creep is controlled by metallic diffusion.

In the same issue (*37*, No. 4, 33, 1976) an automatic vertical TIG welding method for 9 percent nickel steel spherical tanks is described. The alloy HZ-CL wire is used. Good welds are apparently achieved with savings of from 50 to 70 percent in weld time and weld cost compared to manual welding.

In summary, the Technical Research Institute of Hitachi Zosen appears to be one more highly efficient and practical-minded Japanese corporate laboratory. As one visits a succession of such activities, the feeling grows that they make a significant contribution to the health and growth of the parent industry as well as to all Japan.

DAIDO STEEL COMPANY

George Sandoz

The Research and Development Division and Control Research Laboratory of Daido Steel Co., Ltd., were visited in connection with a lecture delivered to the Japan Iron and Steel Institute and the Japan Welding Society in the Daido facilities.

The Central Research facilities include an experimental melting shop equipped with various special melting furnaces and test shops for forging, heat treatment and welding. The laboratory is equipped with mass spectrometers, thermal fatigue testers, electron microscopes and the usual mechanical test apparatus.

Among the achievements of note is the Daido-developed plasma induction melt furnace (PIF) for vacuum induction melting (VIM). For the vacuum arc remelt (VAR) and electroslag remelt (ESR) processes Daido has developed its own plasma progressive casting furnace (PPC). These processes are claimed to reduce nonmetallic inclusions, gases and other impurities even more efficiently than conventional VIM, VAR, ESR and EBR (electron beam remelt) processes.

Daido also is actively engaged in developing improved weld wire for a number of applications. For example, a wire for improved CO_2 ($CO_2 - O_2$) - arc welding has advanced automated welding. Ultra low carbon stainless electrodes have been developed for atomic and chemical equipment. At present efforts are being made to make further improvements in filler materials for joining cryogenic as well as heat and wear resistant materials.

Of course there are continuing efforts to make steel stronger and tougher. Such efforts, it was pointed out, have nearly doubled the strength of structural steel over the past 30 years.

Other special properties under investigation are machinability (inclusion control), corrosion and stress-corrosion resistance (precipitation hardening stainless steels and duplex stainless steels), high temperature properties, magnetic properties, glass sealing properties and properties of powdered metals (Daido has developed a unique metal atomization process).

The company is under the strong leadership of President Kizo Takeda. He is gradually diversifying the product line and the company is now producing industrial furnaces, environmental control systems, labor-saving devices and other items not ordinarily associated with a steel company. The claim is made that Daido Steel Company is looking forward to and preparing even now for the 21st century, when it is visualized that the company name may have to be broadened to "Daido of New Materials." Whatever it may be called, one is impressed with the forward-looking attitude, and whatever the challenge ahead, one is confident that Daido will be as prepared as any.

ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.

George Sandoz

The Ishikawajima-Harima Heavy Industries Co. Research Institute is composed of the Research Instiitute in Tokyo and the Welding Research Institute in Yokohama. On this occasion only the Tokyo Institute was visited, but a delegation from the Welding Research Institute was present for the discussions.

The IHI Company is so large and diverse that a description of its activities in any detail is impossible in this brief account. IHI supplies a range of products to industries on land, sea and in the air. On the land, machinery and entire plants for such basic industries as steel, electric power, chemicals, material handling and construction are supplied. For the water, ships of every type are built including the world's largest tankers. The company also builds jet aircraft engines. In percentage of sales, land machinery plants provide 56 percent, ships 38 percent and jet engines 6 percent. Products and services are exported to 80 countries around the world. For example IHI has constructed three blast furnaces (capacity 2.4 million tons annually) in Ipatinga, Brazil.

The Research Institute serves these extensive business activities with a variety of basic and applied research efforts. The work is carried out in a number of departments. These were described by Dr. T. Maeda, Associate Director of the Institute, as follows:

1) Fundamental Technology Department – physics of solids; non-destructive testing; chemical processes; catalysts and catalytic reactions; applied microbiology.

2) Structures and Strength Department – structural analyses; structural vibration; anti-fatigue design; earthquake-proof design; fracture mechanics; structures; cryogenic materials.

3) Machinery Department – machine elements (bearings, seals, gears); friction and wear; plastic working of metals; forming of plastics; vibration.

4) Fluid and Heat Department – fluid dynamics; compressors; turbines, rocket engines, diesel engines; heat transfer and heat exchangers.

5) Turbomachinery Department – centrifugal compressors; fans; blowers, superchargers; freezers and air conditioners; radial turbines; gas turbines; steam turbines; helium turbines; organic compound gas turbines.

6) Metallurgy Department – science of metallic materials; advanced casting; heat treatment; strength; toughness; fatigue (cryogenic through refractory temperatures); marine service materials; metallurgical refining processes.

7) Chemistry Department – analytical instruments; oils and fuels; lubricants; paints; corrosion; organic materials.

8) Measurement Science Group – measurement and statistical evaluation of forces; stress analysis; photoelastic studies; vibration analysis.

9) Nuclear Power Technology Department – components for nuclear reactor systems (especially liquid Na-cooled fast breeder reactor and high temperature gas cooled reactor); He technology; Na technology; materials for nuclear power components.

10) Ship Performance Department – ship resistance; ship propulsion; maneuverability; seakeeping; hull vibration; propellor cavitation; hydrographical/hydraulic studies (marine structures, dams, water gates, buoys, etc.).

11) Ship Propulsion Department – ship model experiments (resistance, self propulsion and propellor open water tests, wake and wave analysis); ship models and propellor models; prediction of propulsive performance.

12) Ship Strength Department – hull structural analysis; hull vibration analysis; design optimization; hull reliability; wave load.

13) Chemical Equipment Department – pilot plant studies of chemical industry processes; desulfurization and denitrogenation of exhaust gases; desalinization of seawater; waste utilization.

The Welding Research Institute, described by Mr. H. Okabayashi, Manager, performs welding information service and studies welded structures, welding mechanics, welding design, welding metallurgy and welding technology (common materials and special alloys). Other activities are the development of high-speed welding, automatic welding and testing and inspection of welds.

The specific groups contacted on this visit were the Structure and Strength Department and the Metallurgy Department of the Research Institute, as well as the delegation from the Welding Research Institute. Informal contact was also made with persons from other Departments who attended the lecture on ONR activities which was given in the afternoon.

Dr. M. Fukagawa discussed work on grain boundary embrittlement due to precipitation of AlN in high strength (80 Kg/mm^2) steels. Fukagawa and his colleagues conclude that once AlN or niobium carbonitride precipitates in the austenitic range steels became embrittled, and it is also impossible to recover their ductility by subsequent heat treatment. Therefore production of AlN or Nb bearing steels should utilize procedures designed to impede the undesired precipitation while cooling through the austenitic region (see Trans. Iron and Steel Institute of Japan Suppl. Trans. Vol. 11, 1971).

One of the very active younger members of the Research Institute, Nobu Iino, described some work on fatigue and fracture. One paper suggests that the concept of COD (crack opening displacement) is a quantitative criterion for the onset of brittle fracture in large steel structures (IIW Doc. X-628-71). Iino and others presented a paper at the recent International Conference on Fracture Mechanics and Technology in Hong Kong, March 1977, entitled "A Generalized Strip Yield Model Applied to Fracture Initiation Studies." The effects of plastic constraint and multi-axiality of stress state in relation to the COD concept and fracture initiation were considered. A strip yield model, proposed originally by B. A. Billy, was modified to encompass the multiaxial state of stress and combined mode loading (cracks at an angle to the direction of stress were treated).

Along similar lines, Iino has discussed fatigue crack growth in a structural member subject to combined tensile and bending stress (Int. Jr. of Fracture *11* p. 685, 1975). The results showed that the mean stress has effects on the fatigue crack growth rate and growth. The growth rate can be expressed as,

$$\frac{da}{dN} = (K_{max})^m \ (\Delta k)^n$$

The results were applied to implications of combined bending and tensile stresses on the leak before fail concept.

A paper entitled "Effect of Angular Distortion or Fatigue Strength of Transverse Butt Welds in High Strength Steels" was prepared by Iino, in collaboration with well-known Professor K. Iida of University of Tokyo, for presentation at Commission XIII of IIW in Copenhagen, 1977. The advantages to fatigue life of overstressing angularly distorted butt welds was discussed. Another paper by Iino, intended also for the 1977 Copenhagen Conference is entitled "Fracture Toughness Testing Using Precompression Induced Crack." A precompressed machined notch was found to give about the same fracture toughness value as a fatigue crack. The procedure is first to apply a compressive bending load, then a tensile load in bending at liquid nitrogen temperature (-196°C). The tension cycle initiates a sharp precrack.

Mr. Okabayashi of the Welding Institute discussed research activities in which he and his colleagues have been involved. One concern has been stress relief cracking in heat affected zones, especially of low alloy steels (IIW Doc. IIX-X-531-69 and Trans. Japan Welding Soc. Vol. 1, No. 2, 1970). The cracking problem is related to fine intergranular precipitates which lead to stress concentration at three-grain junctions. The effects of pre- and post-heating on weld cracking has also been studied (Trans. Japan Welding Society Vol. 5, No. 2, 1974).

The effects of hydrogen and carbon on fracture toughness of low alloy steels has also been considered by Okabayashi and others. Noting first that linear elastic fracture mechanics may be applied to hydrogen-induced cracking evaluations, an expression is developed which relates fracture toughness to temperature: $G_{1c} = G_o \exp T/T_o$, where G_{1c} is the fracture toughness and G_o and T_o are material constants. G_o is affected by the carbon content, but not structure. T_o depends on the structure, such as grain size.

An interesting experiment was described. A fracture toughness test shows reduced toughness if the hydrogen charged specimen is pre-loaded first at room temperature before fracturing at -196°C. This supports the concept that hydrogen diffuses to regions of stress concentration causing the reduced fracture toughness. This work was followed up with further studies of delayed fracture of steels at room and low temperature. Activation energies were obtained to account for incubation times at various temperatures for HT-80 steel.

The work on delayed failure may be seen in IIW Doc. No. IX-796-72; Proc. of Conference on Mechanical Behavior, Kyoto, published in 1973; Engineering Fracture Mechanics, Vol. 7, p. 541, 1975.

The mechanisms of heat affected zone cracking under weld overlay cladding were discussed in Trans. ASME Vol. 98, p. 348, 1976. The causes of this cracking and suggestions for prevention are presented.

A tour of the Research Institute revealed much activity with respect to problems of corrosion and SCC of the BWR reactor. (IHI is cooperating with Hitachi and Toshiba and General Electric Company). There are, for example, test loops with control over pH, dissolved oxygen, temperature, pressure and electrical conductivity. Flow rates of 60 liter per hour, maximum pressure to 100 Kg/cm^2 and maximum temperature to 400° are important features. There are also tests of pipe (4 inch diameter) of 308 ULC steel in mock up of reactor conditions. The steel is very low in carbon percentage.

There are of course numerous creep and creep rupture tests also under way. Some of these tests apply to the high temperature gas-cooled reactor. The effects of impurities such as hydrocarbons, hydrogen and oxygen on the high-temperature properties of Inconel 617 are under study, for example. The findings have been that at the temperatures of 800-1,000°C, which are of interest, the superalloy is decarburized. The investigators are now studying the possibility for preventing this by adding methane to the helium.

Studies were also observed on the effects of environment on creep and fatigue, with the variable of temperature and hold-time of interest.

The usual massive machines for tests of fatigue and brittle fracture of ship and massive land structures were also seen. It was pointed out that Japan with its involvement in massive ships and structures favors these massive tests as being perhaps more predictive, but that the trend in the United States is to "go small." Of course, small tests are much to be preferred if they do predict service performance, so perhaps a measure of confidence in technical capabilities as well as a taste for gambling is involved.

A system for nitriding with ionized nitrogen was observed. This has been a development of IHI which is now available commercially.

A computer-controlled electron probe microanalyzer was also seen (JEOL JXA-50A) which can analyze for carbon.

In summary, there is no question that IHI is highly advanced in the heavy industry area. The Research Institute and the Welding Research Institute both seem to be contributing to this strong position.

POLYMER SCIENCE IN JAPAN

Roger S. Porter

INTRODUCTION

This report covers the contacts, readings and perspectives obtained during the author's 1 August 1977 to 15 September 1977 visit to Japan. Emphasis follows from personal interests, particularly in the areas of polymer characterization, physics and rheology with concentration on high modulus organic materials. Views resulting from attendance at meetings in Japan, including the International Union of Pure and Applied Chemists (IUPAC) on 4 to 10 September 1977, are also included. Thus current work in several countries, as discussed in Japan, is also cited.

The perspective and promise for polymer science in Japan remain positive. Government funding for polymer research appears to remain substantial, particularly considering the major academic interest in polymer science in Japan compared to the United States, and indeed relative to the rest of the world. Many, if not most, of the successful post-war professors in polymer science are approaching their early mandatory retirement age. In the next years, major changes in emphasis may thus occur as "kozas," i.e., chairs, become reassigned to the large and young group of skilled academic polymer scientists.

First offered here are excerpts from an interesting talk by Dr. Maurice L. Huggins in Kyoto. This is followed by some casual comments about interesting polymer compositions and techniques followed by a more complete discussion of research that interested the author in the area of high modulus fibers. The latter is divided by flexible and rigid chain polymers, by fiber treatment, and composites.

GENERAL

In Kyoto, at the post IUPAC conference on polymers, September 14, 1977, a talk on horizons in polymer science was given by Dr. Maurice L. Huggins. Instead of talking about future developments that are obvious extensions of present trends, he talked about several research fields that are practically ignored today. These included:

1. Slightly-flexible glasses[1]. Ordinary silicate glass consists of a giant network of macroanions with small cations in the interstices. The many crosslinks and the coulombic attractions between the cations and the network make such glasses rigid and brittle. He is sure that small changes of the glass composition, aimed at reducing the degree of crosslinking and the number of cations, will yield very useful, strong, slightly flexible, non-brittle glasses. Dr. Huggins suggests we should make some. Options he suggests to reduce the network include replacing double-bonded oxygen with single-bonded fluorine and tetravalent silicon with trivalent phosphorous.

2. Electron-conducting polymers. Much effort has been expended in recent years, trying to make chain polymers that are good electron semiconductors. There have been difficulties due to defects – insufficiently long conducting systems and no good mechanism for electrons to get from one chain to another. In recent years one linear electron-conducting polymer (sulfur nitride) has been reported and doubtless there will be others. Dr. Huggins thinks that many 2- and 3-dimensional electron-conducting polymers will be made. They have the inherent advantage that structural flaws can be bypassed. This will be an exciting field of polymer research.

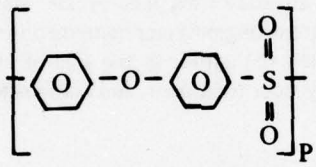
[1] M.L. Huggins, "The Physics of Non-crystalline Solids", (G. H. Frischat, Ed.), Trans. Tech. Publ., Aedermannsdorf, Switzerland, 1977, p. 659.

3. Chains of "super hydrogen bonds."[2] Many examples are now known of "super hydrogen bonds": hydrogen bonds that are short, strong, and symmetric or nearly so. The energy curves, controlling the motion of the proton along the hydrogen bond axis, are very flat, with no energy barrier (or only a small one) in the middle. The hydrogen bonds are therefore very polarizable. If such hydrogen bonds are connected together, either directly or through resonating conjugated systems, they are polarized cooperatively. Some crystalline compounds are known (for example, potassium dihydrogen phosphate and sodium potassium tartrate tetrahydrate) that contain 3-dimensional networks of cooperating hydrogen bonds. They tend to be polarized alike over large regions. Similarly cooperating systems of super hydrogen bonds connected together in chains should exhibit very high polarizability in one dimension. I think they should be very interesting and useful. Why don't you make some, suggests Dr. Huggins.

4. Connected oligomers. Natural short chain polymers – oligomers – are very plentiful. Many of them we use for fuel, lubrication, road building, etc. Dr. Huggins feels that practical methods will be found to tie these short chain molecules (or others made synthetically) together, making long chain or network high polymers. For some obvious applications it would be useful to have the connecting links breakable under specific environmental conditions. A considerable amount of work on the synthesis of conditionally-fragmenting high polymers has been done in recent years, but Dr. Huggins believes that much more can and will be done.

POLYMER COMPOSITIONS

Among possible new high performance thermoplastics is the preparation by Dr. Rose of ICI at Wellwyn Garden City, U.K., of



Block copolymers with rigid-rod hard blocks of controlled length, e.g., poly-(amino acid esters) are being developed by the group of Professor T. Tanaka of Kyushu University. A promising avenue is the development of block copolymers with crystalline hard blocks, viz., poly (butylene terephthalate) in polyether soft blocks.

Professor J. K. Stille, Colorado State University, reported on thermally stable polymers containing quinoline units in the chain. They can be synthesized by a polymerization reaction which allows a variety of structural modifications, resulting in a range of chain stiffness that can be altered from a relatively flexible polymer of low Tg to a rod-like molecule with high Tg. Most of these new polymers have high crystalline melting temperatures but a low degree of crystallinity.

It is well known that the polymerizations of vinyl monomers give polymers mainly consisting of a head-to-tail (h-t) structure. On the other hand, the preparation of polymers with a head-to-head (h-h) structure has been attempted by many workers, and the following routes have been reported:

1) Chemical reaction of 1, 4-polybutadiene and its 2, 3-dichloro derivative,

2) Alternating copolymerization of ethylene and stilbene with maleic anhydride,

3) Cyclopolymerization of divinyl monomers, and

4) Alternating copolymerization between symmetrically 1,2-disubstituted ethylenic monomers.

[2]M.L. Huggins, Prog. Colloid Polym. Sci. *59*, 82 (1976).

Dr. Otsu of Osaka City University has reported properties of certain h-h polymers through these preparation routes for:

1) h-h Poly (vinyl Chloride) and h-h Poly (vinyl Bromide),

2) h-h Poly (methyl Acrylate) and higher h-h Poly (alkyl Acrylates),

3) Attempts to prepare h-h Poly (methyl Methacrylate) were less successful.

Professor William J. Bailey, University of Maryland, has shown that the polymerization of spiro ortho carbonates produces an expansion in volume as high as 17%. He has synthesized functional derivatives of these spiro ortho carbonates that can be incorporated into a variety of polymers, either by end-capping or copolymerization, followed by crosslinking with either no change in volume or a slight increase in volume.

Professor P. H. Geil, Case Western Reserve University, reported at IUPAC on plastic peptide-triblock (ABA) copolymers of poly (γ-benzyl-L-glutamate-butadiene/acrylonitrile-γ-benzyl-L-glutamate) that have been synthesized and characterized. These triblock copolymers offer the advantage of desirable surface properties provided by the benzyl glutamate segments with improved mechanical properties derived from the butadiene segments and the domain formation developed in film casting.

Recent developments in the use of polymers as reactants in organic reactions were presented by Professor C. G. Overberger, The University of Michigan. Topics presented were:

1) Hydrolysis of esters catalyzed by L-histidine graft copolymers,

2) Optically-active polyvinylimidazoles and asymmetric substrates,

3) Hydrophobic interactions in catalysis by imidazole-containing polymers,

4) Esterolytic activity of water-soluble, hydrophobic terpolymers of 4(5)-vinylimidazole.

Dr. Takashi Inoue, with others at the Japan Synthetic Rubber Company, reported a study on the preparation and characterization of extremely high molecular weight polymers with fairly narrow molecular weight distributions. They prepared the polystyrene by emulsion polymerization using low molecular weight dialkyl peroxides as initiators. Methyl methacrylate, ethyl acrylate, butadiene, and isoprene were also polymerized in their redox system to give the very high molecular weight polymers with high conversions. Some of the results are:

	$M_v \times 10^{-6}$	M_w/M_n
Polystyrene	48	1.32
Poly (methyl methacrylate)	18	1.10

Professor Harry B. Mark, Jr., University of Cincinnati, reported on the characteristics of fully-oriented, epitaxially-grown thin films and crystals of polymeric sulfur nitride [polytiazyl or $(SN)_x$]. An ordered array of parallel fibers make up the $(SN)_x$ crystal whose dc electrical conductivity is highly anisotropic with the highest conductivity, about 2.5×10^3 $(ohm\text{-}cm)^{-1}$ at room temperature, along the chain of the polymer. Thus, the polymer may be classified as a metal. The conductivity perpendicular to the chain axis is less by a factor of about 16. This work describes the properties of $(SN)_x$ as an electrode material. Results indicate a strong dependence of electrode behavior on the crystal plane orientation to the solution.

POLYMER TECHNIQUES

Most impressive are the approaches of Professors T. Takemura and K. Takamizawa of Kyushu University for the study of polymer effects at high pressure. Their groups are now equipped for studies to 10 kbars by dilatometry, DSC, x-ray with position sensitive detectors, NMR, ultrasonics plus Raman and light scattering through sapphire windows.

At Tohoku University, the group with Professor Umeya has developed a new viscoelastic measurement based on the time (t) response to a single cyclic deformation of the form (1 - cos t). This has been called the Raised Cosine Pulse Method and is being developed into a commercial instrument.

Professor Corradini, University of Naples, at IUPAC presented information on a remarkable new study involving a comparison of minimum conformational energy calculations for isolated chains with analysis of x-ray data for the amorphous halo of semicrystalline polymers. Initial results suggest an absence of short range correlation, i.e., an absence of amorphous order.

Dr. T. Hashimoto, working with Professor H. Kawai at Kyoto University, has successfully combined small angle x-ray scattering with dynamic mechanical measurements to characterize domains and their boundaries in diverse classes of systems such as block copolymers, polymer blends, and in semicrystalline polymers.

Fluorescence measurements have found several new applications for polymer systems. Professor Y. Nishijima has found that a remarkable fluorescence from poly (ethylene terephthalate) can be used to measure its orientation.

Fluorescence differences of the type noted in dye solutions and caused by molecular aggregation have also been found in aromatic stiff chain polymers such as polybenzimidazoles by Professor Kambe in Tokyo and his group. The concentrations and compositions for solution association have thus been noted and corroborated by NMR [Rep. Prog. Polym. Phys. Japan *19*, 391, 447 (1976)].

Fluorescence polarization measures of molecular orientation and of dynamics of stretched polyisoprene networks have been studied by L. Monnerie, Laboratoire de Physiochimie Structurale et Macromoleculaire, Paris. This technique has been applied to an atactic polyisoprene (Shell I.R. 307) with 2 percent of the polymer chains containing a dimethyl anthracene group in the midchain. The experiments have been made at different temperatures and for various crosslink densities.

A new area for study of structure and dynamics of solid polymers is by elastic and inelastic neutron scattering of partially deuterated systems. This method has been widely applied to amorphous polymers. It has also been recently applied by various groups to the crystalline state in polyethylene, poly (ethylene oxide), isotactic polypropylene and polystyrene. New results aid understanding concerning the problems of chain folding and the question of chain adjacent re-entry into the crystal. By this method of molecular origin of the various relaxation processes observed in crystalline polymers can also be estimated. Professor Erhard Fischer, Johannes Gutenberg Universitat, Mainz, Germany, has obtained results from model compounds (n-alkanes) enabling the separation of various types of chain motion (rotational and longitudinal translational jumps, continuous rotation).

The conformation of polystyrene adsorbed on an electropolished chrome surface has been studied by means of ellipsometry by Akira Takahashi, et al., of Mie University. They measured extension of the adsorbed polymer molecule normal to the surface. Below $M_w = 5 \times 10^5$, the polymer molecule in the adsorbed layer prefers an unextended flat conformation, whereas above $M_w = 5 \times 10^5$, the conformation of adsorbed polystyrene chain changes to a more extended form.

Professor Tadao Kotaka, now of Osaka University, carried out a solution light scattering study of polystyrene (A) and poly (methyl methacrylate) (B) block copolymers of AB and BAB types. The solvents were toluene (TOL), p-xylene (pXY) and mixtures of TOL and p-cymene (pCY). All of the solvents are nearly isorefractive with PPA; all are good to moderate solvents for PS. For PMMA TOL is a moderate solvent, pXY is a θ solvent (θ = 35°C) and pCY is a nonsolvent. Therefore in pXY and in TOL/pCY mixtures PMMA blocks form virtually invisible aggregates.

In the common good solvent, TOL, certain ordering takes place upon increasing polymer concentration (~ 1%) as revealed by a sudden increase in apparent intermolecular excluded volume. At higher concentrations, the solutions often first turn blue (~ 10%) and later iridescent (~ 15%), indicating the formation of mesophases.

In selected solvents, pXY and TOL/pCY, the behavior of the AB- and BAB-block copolymers are in contrast: The AB-diblock copolymers first form spherical micelles, in which the "invisible" PMMA blocks form the core and the visible PS blocks constitute the stabilizing arms. Upon reducing the solvent quality toward PMMA blocks by increasing pCY content, huge micelles consisting of up to 1,000 molecules are formed. The BAB-triblock copolymers in a limited environment appears to form unimolecular micelles presumably caused by intermolecular aggregation of the two B blocks within each molecule. Most micelles are unstable and develop into three dimensional networks exhibiting extreme high viscosities and a high elasticity. The morphology of block copolymer micelles are thus dependent on molecular weight, composition, the type of block and on the nature of the solvent.

Dr. Shinzo Yamashita and Dr. Nariyoshi Kawabata of Kyoto Institute of Technology have found that the phenylhydrazine – $FeCl_2$ system was a very effective reagent for the reclamation of many commercial rubber systems. This system was shown to be effective for the reclamation of natural rubber in tires and in the following ten types of synthetic rubber vulcanizates at room temperature: sulfur vulcanizates of synthetic isoprene rubber, SBR, acrylonitrile-butadiene rubber (NBR), ethylene-propylene terpolymer (EPDM), and butyl rubber; the organic peroxide vulcanizates of SBR, chloroprene rubber (CR), and EPDM; and the sulfur donor vulcanizate of SBR; and 2-mercaptoimidazoline vulcanizate of CR. Revulcanization of these reclaims gave useful elastomers. The reclaiming process was shown to involve atmospheric oxidative degradation of the vulcanized rubbers.

POLYMER STATES

Professor P. H. Geil, Case Western Reserve University, reported a reproducible means of preparing small samples of amorphous linear polyethylene. The samples are sufficient for electron diffraction, electron microscopy, and differential scanning calorimetry. Thin films of linear polyethylene (Marlex 6015) were mounted on carbon – or aluminum – coated electron microscope grids and quenched from the melt. The molten samples are shot by a spring-loaded device into a dewar containing liquid and solid nitrogen. The samples were placed into a vacuum evaporator, an electron microscope, or a differential scanning calorimeter without warming. Electron micrographs of shadowed films *show nodules* of varying sizes, those in the thinnest areas being 100Å or less in diameter. Upon warming, the nodules do not rearrange into lamellae or spherulites. Electron diffraction patterns of cold samples are amorphous. Upon warming, crystalline diffraction appears in the same areas. The diffraction patterns were taken from areas of 1,000Å diameter or less; the diffuseness of the crystalline patterns indicates the crystals formed upon warming are extremely small. Thermograms of quenched samples have a pronounced exotherm between approximately 155° and 175°K that vanishes on subsequent scans of the same sample. Crystalline samples do not produce this peak.

Professor Hiroyuki Tadakoro of Osaka University cited the models of (5/2) and (5/1) helices that had been proposed for isotactic poly(methyl methacrylate). However his calculations of the intramolecular interaction energy suggest that helices of larger radii, such as (12/1), should be more stable. He thus re-examined molecular models of larger radii and found that the x-ray data can be explained satisfactorily by a crystal structure consisting of *double helices,* the first known case for synthetic polymers (also see, however, section on rigid chain high modulus polymers). The double helix consists of two (10/1) helices. From the viewpoint of stereo-complex formation, studies continue in cooperation with Professor H. Inagaki of Kyoto University. They found that oriented crystalline samples of syndiotactic (st) PMMA can be obtained by adsorption of various solvents such as chloroacetone and diethyl ketone. Samples giving an x-ray diagram essentially equal to that reported as the stereo-complex can be prepared from it-PMMA without st-PMMA!

HIGH MODULUS POLYMERS

GENERAL

The demand for traditional synthetic textiles such as polyesters and nylons has been noted for its tremendous growth rate of about 20% per year. The reduction in this rate over the last years, concomitant with marked over-production, has not aided further development of fundamental studies on new textiles. Interest, however, seems to remain concerning specialty fibers and their application, particularly for high modulus organic materials and composites.

FLEXIBLE CHAIN POLYMERS

It is clear that there is still marked activity in studies to produce high modulus morphologies from semicrystalline thermoplastics. Efforts of many groups have led to high modulus thermoplastics prepared from polymer solutions and from melts. The preponderance of studies in Japan and around the world involve a morphology conversion, many as variations of conventional drawing.

At Kyushu University the group of Professor M. Takayanagi has "zone-drawn" polypropylene to tensile moduli near 10 GPa or about one third the theoretical value. The tensile stress, more than the initial morphology, is deemed to determine the efficiency of draw.

Since the late sixties, Professor Masao Horio with others in Kyoto have been extruding the polyolefins in the solid state. They use industrial hydrostatic extrusion presses, originally designed for metal processing (Kobe Steel Ltd.) and evaluate the products as by birefringence. Clever coextrusions have also been accomplished such as the production of aluminum clad polypropylene.

There are several other on-going extrusion draw studies being conducted in Japan. The group with Professor Takayanagi has developed an impressive analysis of the deformation on extrusion of semicrystalline polymers through conical dies. Dr. Kanetsuna at the Research Institute for Textiles and Polymers in Yokohama has studied many facets of solid state extrusion for polyethylene including the variables of die angle, pressure, and the use of lubricant.

To date, almost the exclusive goal of drawing has been to increase tensile properties. Not to be overlooked, however, is that efficient drawing processes can produce the most anisotropic polymer samples yet available. Piezoelectricity is just one of the many potential examples of a property that takes added meaning on generation of long, highly-oriented polymer crystals. From this view, extensive studies are being made in Japan and elsewhere on poly (vinylidene fluoride). It has provided the highest piezoelectric effect among polymers investigated, see Polymer J. *2*, 656 (1971). The effect is achieved with crystals produced by drawing followed by poling in an electric field. Drawn PVF2 in the beta form is now being used in Japan in the construction of microphones and earphones. Interestingly, drawn PVF2 is also used for fish nets since its refractive index is a match for sea water.

W. J. Farrissey of The Upjohn Company reported a simple, one-step process to yield a polyimide. It is based on the reaction of a diisocyanate with a dianhydride accompanied by the evolution of carbon dioxide. This method can yield polyimide of high molecular weight, suitable for processing. Fibers were spun from the reaction solutions, using either wet or dry spinning techniques. Drawing at elevated temperatures yielded fibers of some strength and elongation. Strengths of 3 - 3.4 g/d were obtained with elongations of 30%. In keeping with the thermal resistance of polyimides, these fibers retained 70% of their strength after 500 hours at 250°C.

Dr. H. K. Reimschuessel of Allied Chemical Corporation discussed how the glass transition temperature, T_g, of nylons decreases monotonically toward a limit upon increasing the moisture content. This decrease is paralleled by a reversible loss in Young's modulus. For nylon 6 and other polymers characterized by hydrogen bonding, these phenomena may be explained by a mechanism that entails the reversible replacement of intercatenary hydrogen bonds by interaction with water.

Dr. Hans Craubner, Institut fur Physikalische Chemie der Universitat Dusseldorf, Germany, has studied a continuous polymerization-melt spinning-drawing-windup process for nylon 6 multifilaments. The data obtained are approximately equivalent to fiber properties of the same polymer produced by the standard discontinuous melt spinning process.

Elastic moduli perpendicular to the chain axis (E_t) for ethylene-vinyl alcohol copolymers have been reported by K. Nakamae, et al., of Kobe University. They determined the moduli of the polymer crystalline regions by x-ray and pointed out that E_t depends on crystal structure and on intermolecular cohesion forces in the crystallites. E_t values for poly (vinyl alcohol) (PVA) are greater by a factor of two to three than those for

polyethylene (PE). This is consistent with the greater intermolecular forces for PVA due to hydrogen bonds. They propose that EVA copolymers are cystallizable over the entire range of copolymer composition to produce isomorphous crystallites. For the anisotropy of E_t for (100) and (002) planes, i.e., the anisotropy of interchain forces in basal plane, the direction of the hydrogen bonding seems to be parallel to the a-axis.

RIGID CHAINS

Only a small fraction of research, particularly from industry, has surfaced on the development of stiff chain polymers. Kevlar compositions are, of course, the first commercialization of a synthetic rod-like polymer via liquid crystal processing. Other compositions and different coagulants and processing for the same composition will likely lead to yet further advances particularly in stress and strain-to-break for this class of high modulus polymers. As model systems, and as analogs to both biological and Kevlar-type polymers, studies continue on the rod-like synthetic polypeptides, particularly at high concentration (liquid crystal) ranges and in the solid state. Assistant Professor T. Asada and Professor S. Onogi of Kyoto University have used rheo-optical studies to reveal orientation and time dependent behavior of concentrated solutions of poly (benzyl-L-glutamate) (PBG). This polymer and related compositions can be processed to high orientation and thus to high tensile modulus. Associate Professor T. Kajiyama of Kyushu University has studied the viscoelastic transitions in single crystal mats of the corresponding methyl derivative. Other properties have also been studied such as the piezoelectricity observed in uni- and biaxially oriented PBG by Dr. Fukada, e.g., J. Polym. Sci., Polym. Phys. *14*, 1979 (1976).

The synthesis (by Professor T. Kunitake), fiber formation and morphology (by Professor M. Takayanagi), have been developed at Kyushu University for a new stiff chain composition, poly (spiro [2, 4] hepta-4, 6-diene).

Mention must be made of the continuing impressive work by Professor S. Ohtani of Gunma University, the inventor of a patented method of making carbon fibers from organic pitches. Many problems and opportunities remain in understanding the chemistry and physics that lead to formation of mesophases and eventually graphite fibers of high strength and utility.

Professor Tohru Kawai, Tokyo Institute of Technology, has pursued the possibility of extended chain crystals formed on heterogeneous polymerization of L- and DL-alanine N-carboxy anhydrides in acetonitrile. Morphological studies indicate that the polypeptide chains were extended α-helices in the crystals throughout the polymerization. The polymerization of anhydrides of glycine and β-alanine has also been studied in acetonitrile with n-butylamine as the initiator. As expected from the similarity of the backbone to nylons, the polymer precipitated in the form of spherulites consists of crystalline units similar to that for nylons.

Dr. Hiroshi Ohnuma, Nagoya University, with Professor Guy C. Berry, Carnegie-Mellon University, have measured the properties of poly (1-4, phenylene terephthalamide), PPTA, and Kevlar (duPont deNemours & Company, Inc.) in solution. Both polymers are prone to association but the overall chain anisotropy can be determined with solutions free of association in $ClSO_3H$. The viscosity and light scattering results indicate a rod-like conformation. The invariance of $[\eta]M_w$ with association means that plots of $[\eta]M_w$ versus elution volume in gel permeation chromatography will appear normal, even though $[\eta]$ and Mw may each be in error. Concentrated solutions of PPTA are never free of interchain association. At sufficiently high concentration, well ordered, optically anisotropic solutions are developed, in (qualitative) accord with theory. Data were also obtained on the rheology of isotropic and anisotropic Kevlar solutions. Results may be related to the fiber spinning process which leads to high strength fibers.

Dr. J. Economy, IBM Research, San Jose, California, reported on the synthesis of the homopolymer of p-hydroxybenzoic acid. A crystal structure for this polymer was proposed which involves a double helix with the two chains in the helix in a reversed head-to-tail order (see also Section on Polymer States). Structural modifications of this homopolymer with bisphenol-A and phthalic acids were also achieved. The properties of these meltable, moldable copolymers have been described. Of particular interest is the observation of anisotropic melts for the copolymers over specific compositional ranges. Such anisotropic melts have also been described for p-hydroxybenzoic acid units copolymerized into poly (ethylene terephthalate). Preliminary data on the

preparation of high modulus fibers, to 15 million PSI modulus, based on the parent polyester was presented and compared to data on fibers from aromatic polyamides. The modified and moldable copolymers exhibit lower moduli, < a million PSI.

FIBER TREATMENT

An interesting technique for modifying the properties of highly-drawn semi-crystalline thermoplastics has been developed by M. Todoki and T. Kawaguchi of Toray Industries, Otsu, Japan. The method involves gamma irradiation of drawn polymer held in acetylene gas. The acetylene diffuses into the polymer amorphous regions and serves as a crosslinking agent (and also as a sensitizer) to modify the properties of the drawn morphology, see, for example, Kobunshi Rombunshu *31*, 106, 427 (1974); *32*, 363 (1975).

The effect of surface treatment on reinforcing aromatic organic fibers by nitric acid has been studied by Professor Kambe in terms of the torsion and tensile properties of the resultant composites, J. Soc. Rheology Japan *5*, 33 (1977).

COMPOSITES

An idealized state for design and properties has been formulated by Professor M. Takayanagi of Kyushu University in terms of molecular composites. Although this ideal state has not been reached in terms of strength, stiffness and dimensional stability, real progress has been made in developing macrocomposites approaching these goals. A contribution from the University of Massachusetts on composites from a single polymer has been recently presented in Japan and at the Fall 1977 meeting of the American Chemical Society in Chicago. Other studies include the work of Professor H. Kambe on the dynamic mechanical properties of graphite and related fiber composites, J. Soc. Rheology Japan *4*, 37 (1976).

Dr. H. Tanaka and coworkers of the Tokyo Institute of Technology have studied the oxidation behavior and the mechanical strength of carbon composite as a function of structural change accompanying the graphitization. Unidirectionally-reinforced composites were prepared using PAN-based carbon fibers and furfuryl alcohol condensate as matrix carbon precursor. The mechanical strength of the composite graphitized at 2,800°C was increased by about four times, compared with that of the composite carbonized at 1,000°. Carbonized composite, in which the matrix was still glassy carbon, showed brittle fracture and no fiber pull-out. The graphitization was accelerated by the existence of fibers. The oxidation and the strength depended strongly upon matrix graphitization.

A REPORT ON THE JAPAN POLYMER SCIENCE SOCIETY POLYMER COLLOQUIUM (KYOTO)

G. C. Berry

The opportunities to attend scientific meetings in Japan during August and September were plentiful and diverse. For example, during that period, the writer participated in three international conferences plus a Polymer Colloquium, the latter under the auspices of the Society of Polymer Science of Japan (SPSJ). This communication reports on the Polymer Colloquium in particular, with some brief remarks on the three international conferences – detailed reports on some of the latter may perhaps be found elsewhere in these pages.

Fortunately for all concerned, Junji Furukawa, President of SPSJ, and his organizing committee acted to take advantage of the many visitors present for the various meetings in Japan by arranging a Polymer Colloquium on 14-15 September, to follow the Congress of the International Union on Pure and Applied Chemistry. Part of the expenses associated with the colloquium were contributed by the Yamada Science Foundation, the remainder being borne by SPSJ through registration fees and other resources. The organizing committee prepared a program with 20 American, six European and five Japanese speakers. (The distribution of foreign speakers roughly paralleled foreign participation at the preceding international meeting).

The colloquium was well attended, with the distributed list of participants having 217 entries, 184 from Japan. The 22 Americans listed represented the largest group of foreign participants, most of these coming from university or research institute laboratories. Sessions were held at Kyoto Kaikan, with a buffet banquet at a nearby hotel. Kyoto Kaikan provided ample space for simultaneous sessions, together with facilities for the private discussions that are an invaluable feature of such meetings. Moreover, it is conveniently located near hotels, restaurants, etc.

The colloquium was arranged in three simultaneous sessions, following a brief opening address by SPSJ President Furukawa and an opening lecture titled "Some Horizons in Polymer Science," given by M. L. Huggins.

The writer experienced some momentary consternation when a preliminary program from *KOBUNSHI* was produced by a colleague during a chance encounter in a trolley ride from Kyoto station to the Kyoto Kaikan early on the first day of the meeting. The preliminary program had our contribution scheduled for a session following Huggins' opening lecture, rather than for the following day as in the final program. Fortunately, the uncertainty was quickly resolved at the registration desk.

The program sessions were A) Polymer Synthesis (11 lectures), B) Polymer Structure (10 lectures), and C) Polymer Properties (9 lectures), all lectures being of one hour duration, and Sessions A, B and C being run concurrently. The following list of subsections within the three sessions will provide some idea of the topics covered:

A1. Graft and Block Copolymers – Synthesis and Characterization
A2. New Polymerization Processes and New Polymers
B1. Polymorphism in Polymer Crystals
B2. Conformational Analysis of Polymers
B3. Polymer Crystallization under High Pressure or Stress
B4. Amorphous and Disordered Structures of Polymers
C1. Relaxation Phenomena in Polymer Systems
C2. Dilute Polymer Solutions
C3. Thermodynamics of Heterogeneous Systems
C4. Properties of Polypeptides

A paperbound set of the four-page preprints of each contribution was distributed to participants by SPSJ.

Incidentally, the above list also appears to be a fair representation of research subjects of interest in Japanese universities. In addition to attendance at the lectures, the participants engaged in vigorous and detailed discussion after the lectures. In Session C, which we attended, this discussion was about evenly divided between foreign and Japanese participants. All in all, the colloquium was a good idea carried off well. The extended lectures provided plenty of time for authors to present material for discussion, and the discussions were unusually active.

Although we cannot offer an adequate summary of all the contributions, perhaps the following can indicate the general nature of the colloquium. Huggins' opening remarks, emphasizing research areas he believes deserve more attention in the immediate future, tended to cut across topics discussed in all three sessions. Session A had several talks dealing with ring opening step-growth polymerizations, including the preparation of thermoplastic elastomers based on poly (pivalolactone), R. Pariser (duPont de Nemours & Company), the synthesis of materials useful in polymer blends, H. L. Hsieh (Phillips Petroleum) and L. A. Pilato (Union Carbide Corporation), the polymerization of polyamides by a route free of the evolution of small molecule by-products, D. A. Tomalia (Dow Chemical), the preparation and properties of polyphosphonates by the Arbuzov condensation reaction involving cyclic phosphates, M. S. Cohen (Borg-Warner Chemicals), and the polymerization of chlorophenyl-glycidyl ethers, Z. J. Jedlinski (Polish Academy of Sciences). Investigations of the synthesis of block copolymers by cationic polymerization were discussed by J. P. Kennedy (University of Akron) and T. Higashimura (Kyoto University), and Takekoshi (General Electric Corporation) described the use of an electrophilic substitution reaction to prepare soluble, linear poly (aromatic ethers). D. P. Tate (Firestone Tire and Rubber Company) reviewed the synthesis and properties of polyphosphazene elastomers and Yamazaki (Tokyo Institute of Technology) reported the preparation of polyamides and polypeptides by a novel reaction using phosphonium salts.

Session B on polymer structure had both theoretical and experimental contributions. The former included a discussion of conformational disorder in the cyrstalline state of poly (tetrafluoroethylene), PTFE, using the rotational isometric state model for chain conformations, P. Corradini (Universita di Napoli), a calculation of phase transitions in polymer crystals based on the isometric state model, A. J. Hopfinger (Case-Western Reserve University), and a Monte-Carlo simulation of polymer dynamics with bond 3 and 4 bond motions on a diamond lattice, L. Monnerie (Ecole Superieur de la Ville de Paris). Aspects of the structure of the amorphous state were discussed by several speakers, P. H. Geil (Case-Western University), G.S.Y. Yeh (University of Michigan) and M. Takayanagi (Kyushu University), with Geil describing work on amorphous polyethylene, and Takayanagi discussing the properties of a polymer with rigid elements in the chain backbone. Both R. S. Porter (University of Massachusetts) and T. Takemura (Kyushu University) presented work involving crystallization at high pressure. B. Fanconi (National Bureau of Standards) presented an analysis of Raman spectra on PTFE and other perfluoro compounds in terms of longitudinal acoustic modes.

It is more difficult to find a common theme among papers in Session C on Polymer Properties. The session contained four papers of a theoretical nature and five experimental studies. H. Yamakawa (Kyoto University) discussed a new model for the statistical mechanics of polymers with a tendency to form helical sequences, and D. J. Meier (Midland Research Institute) reviewed statistical mechanical theories for the domain structure of block copoiymers. M. Shen (University of California) reported numerical calculations of the loss and storage moduli using a model for the effects of chain entanglements, J. D. Ferry (University of Wisconsin) discussed the nature of entanglement coupling on the basis of stress and birefringence relaxation at small deformations, and G. C. Berry (Carnegie-Mellon University) presented data on the nonlinear viscoelastic properties of polymer solutions in the entanglement regime. R. Koningsveld (Central Laboratory, DSM) analyzed the bimodality of spinodals observed for mixtures of two polymers, W. Hertz (Philipps Universitat) showed data on the high resolution chromatographic separation of oligomers on a stationary crosslinked polymer, W. G. Miller (University of Minnesota) discussed ESR data that appears to be inconsistent with an Ising-model interpretation of the helix-coil transition, and G. L. Wilkes (Princeton University) reviewed some general property-structure relationships for synthetic polypeptides.

One general remark concerning the three international conferences we attended is that foreign attendance did not reach the levels anticipated by the Japanese. This was particularly evident for the Fifth International Conference on Thermal Analysis (ICTA) (Kyoto, 31 July to 6 August), but the same remark applies to a lesser extent for the Second International Symposium for Artificial Internal Organs (ISAIO), (Tokyo, 26-28 August), and the 26th International Congress on Pure and Applied Chemistry (ICPAC) (Tokyo, 4-10 September). Interestingly, the foreign participation of the polymer science and engineering community appeared to be about as expected at the IUPAC Congress even though the overall foreign attendance was down.

Some fifty Japanese and American polymer scientists had the pleasure of an informal evening together during the Congress, thanks to Dr. Elliot Kearsley of ONR Tokyo. The evening provided an unusual opportunity for the visiting Americans to spend a few hours of discussion, scientific and otherwise, with their counterparts from all over Japan. This kind of relaxed encounter seems to increase effective communication between Japanese and American scientists.

Finally, a specific comment concerning the sessions of the ISAIO that dealt with "biomaterials." As with similar sessions in the United States, the polymer chemistry or physics content of these sessions was sparse. Instead a great deal of attention was devoted to biological tests and testing methods, and to device-oriented designs. Apparently, in Japan, as in America, a disproportionately large share of available resources is devoted to technology of the latter kind as opposed to the synthesis and characterization of new polymer systems for use as biomaterials.

THE 26TH INTERNATIONAL CONGRESS ON PURE AND APPLIED CHEMISTRY – TOKYO

E. A. Kearsley

Though I am myself no chemist, some of my best friends are chemists and so, when the International Union for Pure and Applied Chemistry (IUPAC) came to Tokyo in September 1977 for their 26th International Congress, it was an event I had looked forward to. A number of good friends were to give talks among the many scheduled sessions on polymers (or macromolecules as IUPAC will have it). This year the theme was Chemistry for the Welfare of Mankind and an appropriate symbol was designed consisting of a circle enclosing two interlocking benzene rings each with a stylized head to suggest mankind. The plenary session of the Congress was held at Tokyo's NHK Hall (normally the scene of concerts, operas and other extravaganzas) although the attendance fell somewhat short of the plans for 4,000 participants.

Two Nobelists had been invited to address the full Congress. Paul Flory's plenary lecture was entitled "Chemistry, Macromolecules and the Needs of Man." He began by speaking of that hierarchy of sciences for which the laws of each apply to those below. Chemistry (which Flory defined loosely as the study of molecules and molecular behavior) stood at the apex of that hierarchy in the late 18th century (Dalton, Lavoisier, etc.) but physics has long since displaced chemistry. Does this mean that chemistry as a science can be deduced from the laws of physics? Not so, Flory points out, citing the fact that "complex systems have their own rules. Knowledge in one of the hierarchies of science does not confer the capability to deal effectively with a subordinate discipline." In fact, progress in understanding the behavior of polymers (a field in which he is a principal contributor) serves as a perfect example of this point. In the past chemists generally have concentrated their attention on simple molecules and, hence, up until the 1930's they considered what is now known as macromolecules as aggregates of simple molecules acting like a colloid. It was the work of Staudinger and Carothers which established that these materials were actually composed of flexible long chain molecules. And it is the analysis of the spatial configurations of these long molecular chains which was the key to explaining the mechanical and physical behavior of these materials.

The mathematical theory of random walks has been applied to this analysis through modelling a molecular chain as a sequence of freely jointed segments. Of course, these segments do not correspond to the actual skeletal bonds because enough bonds must be included in each segment to assure that the joints can be considered completely free. Therefore actual bond lengths, bond angles and torsional potentials affecting bond rotations are not taken into account in these models. In spite of that failing, the models successfully account for many of the principal properties of macromolecules. Over the past 15 to 20 years methods have been developed to treat these macromolecules more exactly. Rigorous methods of averaging over the multitude of conformations possible to a macromolecule are known. Flory pointed out that to this day these methods are not widely accepted and that their full potential remains to be exploited.

Flory then referred to recent results from neutron scattering experiments on polymers. By comparing scattering from deuterated polymers with scattering from undeuterated polymers it is possible to generate information on the spatial configuration of the chains. Recent results obtained in this way indicate that in amorphous bulk polymers the molecules adopt configurations much like those occurring in dilute solutions. Presumably, this also holds true for the molecules of polymer melts. Now, the current view of polycrystalline polymers is that typically they contain plates of "chain folded" cystals in which the macromolecules extend through the thickness of the plate, folding regularly at the surface something like an old-fashioned folded carpenter's rule. Flory finds this picture faulty, saying, "That randomly configured chains chaotically intertwined with one another in the amorphous polymer, in the course of crystallization, disengage themselves from their neighbors and make the extensive rearrangements necessary to achieve the regularly folded arrays widely assumed as a description of the molecular morphology in semicrystalline polymers is inconceivable."The point is certain to be controversial; Flory sees an analogy with the earlier controversy over the colloidal-aggregate picture of polymers.

The special relation of macromolecular science to biology was then recalled and the necessity of comprehensive and radical extensions of polymer science to deal with biological systems was proposed as a major reason to expand fundamental research. Beyond that, the versatility of polymers as materials for chemical "tailoring" and the possibility of renewable replacements was cited. Looking into the future, Flory finds it not inconceivable that a "polymer age" may supplant the present age of steel.

Finally, Flory considered the question of the financing of science, pointing out that the future demands the utmost science can offer. But, he recognized that science has become expensive, that the limitations of financial support cannot be ignored and that consequently choices must somehow be made. His principal concern was that scientists themselves are best qualified to decide which scientific activities should be preferred. To maintain the support of society at large for decisions by scientists, Flory sees the need for broader views in the scientific community. The problem is to make science flourish at a time when the demands upon it are staggering and the support is weakening.

George Porter of the Royal Institution, United Kingdom, received the Nobel Prize in chemistry in 1967. He gave the second of the plenary lectures entitled "Pure and Applied Photochemistry." Advances in pure photochemistry and applications of photochemistry were touched on and the question of whether "synthetic" photosynthesis could be applied to energy production was considered.

Progress in photochemistry has been marked by an increasing sophistication in approach. Whereas, years ago a photochemist thought in terms of molecule + light → stable product, and later in terms of molecule + light →radicals→ stable product, nowadays, the idea is molecule + light→excited state→chemical and physical processes. Since there is energetically only one ground state and there are many excited states, this modification in thinking enormously increases the magnitude and complexity of the subject. Porter pointed out that a simple consideration of electron affinities shows immediately that excited states are always more reactive than ground states. On the other hand, the dipole moment of each excited state may be either greater than or less than that of the ground state and hence the direction of a reaction may change on going from one excited state to another. This is the basis of an explanation of some chemical reactions which go in opposite directions according to which of two solvents they are conducted in. Porter emphasized that the excited state of a molecule is to be viewed as a new species with its own chemistry and physics and not as a "hot" molecule. The chemistry of the molecules ultimately depends on the distribution of their electronic states. It is a marriage of photochemistry and spectroscopy which has accelerated the development of this field. Progress in photochemistry has resulted from the development of equipment for producing ultra-short flashes of light. The use of Q switching lasers produced nanosecond pulses, mode block lasers speeded things up to achieve picosecond pulses and now, interest is aroused by reports of a Bell Laboratories technique for producing continuous chains of pulse from tunable dye lasers. The method is said to produce pulses of about 300 femto seconds (3×10^{-13} sec.) duration. Porter pointed out such short times are perhaps near the end of the line for this approach to photochemistry since they are within a factor of ten of the usable limit imposed by the Heisenberg uncertainty principle associated with chemical energies.

As for applications, at the heavy industry level, little has yet been achieved. On a smaller scale, problems of chemical degradation and the fading of dyes have been solved. Photochemical polymerization has been applied commercially (avoiding the use of noxious solvents in some instances). The printed circuits of solid state electronics have been developed using photo resists. Isotope separation by means of photochemistry is seriously proposed. Environmental problems of smog, weather and ozone-layer are studied through the discipline of photochemistry. One hears speculations on the development of "Microphotonics" in which fiber optics and photochemistry would replace semiconductor electronics. But the most exciting potential application of photochemistry is probably in the use of solar energy to manufacture fuels by a renewable cyclic process. Of course, nature already does this, but perhaps not well enough to meet man's needs. The question is, can we emulate natural photosynthesis *in vitro*? The answer at present is "not yet" and it is clear that the whole process is a very complicated one with some of the primary processes occurring in nanoseconds. Porter suggests that for now we can perhaps select some part of the photosynthesis process for use *in vitro*. He points out that for the resulting process to be an economical system a suitable material must be found to collect the sunlight at a cost of something like $12 per square meter or less. That is indeed a tough problem. It was suggested that a liquid phase system (avoiding electrodes–they are inherently expensive) is the way to go. In an upbeat note, Porter concluded that already "the basic theory and limitations are known" and that "the promise of success for the foreseeable future is considerably greater than, for example, that of nuclear fusion."

The principal scientific programs of the Congress consisted of parallel sessions (as many as 23 at a time) at lecture halls in the various public buildings (Kaikans) within a few blocks of the Akasaka Prince Hotel. The program and abstracts of the Congress filled four volumes totalling about 1,600 pages. In addition, it was necessary to supply a fold-out chart in eight colors at the back of the program to identify the locations of the many sessions.

There were five scientific programs, viz:

1. Joint Symposia on Chemistry for the Welfare of Mankind.
2. Physical Chemistry
3. Analytical Chemistry
4. Organic Chemistry
5. Macromolecular Chemistry

The Joint Symposia on Chemistry for the Welfare of Mankind was an innovation at this meeting. It contained a broad selection of papers on particularly "relevant" bits of chemistry with direct (and often newsworthy) applications. There were five symposia included as follows:

SELECTIVITY AND SPECIFICITY IN CHEMICAL REACTIONS

Recent advances in increasing the selectivity and specificity in chemical reactions have been considered one of the best hopes for improving the utilization of natural resources. Papers on organo-metallic compounds and transition metal complexes figured prominently in this symposium. Chiral structures and synthesis of optically active molecules were common topics (terms like "stereo-selective" or "regiospecific" appear often in the titles). Studies of topics such as chemically active sites and photoreactions were scattered among the papers of this session.

PHASE BOUNDARIES AND MULTIPHASE SYSTEMS

This symposium was kicked off with a paper on reverse osmosis by S. Sourirajan of the National Research Council of Canada. The paper began by making the point that the term "semi-permeable membrane" is a completely misleading one. Instead, the idea of a preferential-sorption interacting with the capillary-flow through the pores is to be thought of and, on this basis, a thorough study of the effect of various parameters on reverse osmosis is possible. Other papers in this symposium treated of chemisorption, surface chemistry, electrode and electrolytic chemistry, ion-exchange membranes, liquid crystals, immobilized enzymes and emulsions.

BIOLOGICALLY ACTIVE SUBSTANCES

Among the subjects covered in this symposium were applications of new techniques to the isolation and identification of biologically active chemicals. Insect pheromenes and insecticides were particularly frequent topics. Hormones in general, immunotherapy and narcotics physiochemistry were also much discussed. Biosynthesis and carbon tagging experiments were included. Several papers were presented on the effects of industrial chemicals (PCB's, cyanide) on workers.

SEPARATION AND DETECTION OF TRACE FROM ELEMENTS

This symposium had many papers on the dispersion of chemicals in natural waters: rivers, lakes and oceans. Papers on the possibilities and problems of recovering uranium and thorium from the ocean were presented by both German and Japanese scientists. (In Japan a pilot study of this process is now underway.) Manganese and PCB's were also discussed in terms of their dispersion in the ocean. Recent techniques of identifying trace elements were reported on – neutron activation, proton-induced X-ray emission and X-ray fluorescence. A proposal for identifying the source of crude oil pollution by tagging and trace analysis was presented as a way of policing the oceans.

MODERN ASPECTS OF INDUSTRIAL MATERIALS AND RESOURCES

This symposium was a medley of papers on various chemical solutions to modern problems. The topic was introduced by Melvin Calvin (a Nobelist) of the University of California, Berkeley, with a talk entitled "Chemistry, Population, Resources." It may have startled a few people when a contrast was drawn between legislative attitudes toward pharmaceuticals as compared to that toward tobacco (which Calvin characterized as "the most widely used health-impairing material in the world").

Energy related topics dealt with in this symposium included the conversion of coal to liquid fuel, the desulfurization of petroleum, various aspects of a hydrogen fuel cycle, systems of solar energy (including splitting of water to produce hydrogen and chemical aspects of semiconductor photocells) and electrochemical conversion problems. Various papers dealt with the reclamation of materials (rubber, polyethylene, etc.) or the recovery of chemicals from waste (for example, red mud, a waste from aluminum production) and the utilization of seaweed as a resource.

New and interesting materials mentioned in this symposium included biomedical materials, a new amorphous solid electrolyte with high ionic conductivity, polymers with graded index of refraction for use as optical guides, carbon and glass fiber composites and new fluoroelastomers produced by radiation polymerization. Methods of improving the storage, nutrition and taste of foods were presented, although some might claim "A Study of Improving the Quality of Beer with Additives" is a contradiction.

The four programs other than these joint symposia were more-or-less conventional programs containing the more usual technical papers (although many papers in these programs could just as easily have been classified with those of the Symposia on the Welfare of Mankind). The following sessions took place:

Physical Chemistry

Analytical Chemistry
- Methodology for the Characterization of Materials
- System Chemical Analysis
- Complex-Formation in Analytical Chemistry
- New Instrumental Methods in Analytical Chemistry

Organic Chemistry
- Structure-Reactivity Relationships
- Syntheses Leading to Compounds of Special Interest
- New Information Obtained through Mathematical and Physical methods
- Chemistry of Natural Products

Macromolecular Chemistry
- Macromolecular Design and Characterization
- Excited States in Polymer Systems
- Rheology and Relaxation Processes
- Synthetic Macromolecules of Biological Interest
- Structure, Superstructure, and Properties of Polymers

I will not attempt even a rough account of the contents of these sessions and can only refer you to the 1,600 pages of abstracts.

SIXTH INTERNATIONAL CONFERENCE ON INTERNAL FRICTION AND ULTRASONIC ATTENUATION IN SOLIDS

E. A. Kearsley

When I was a graduate student at Brown University in the early 1950's, I used to hear about the group (just organized by Professor Rohn Truell) which was using ultrasonic attenuation to study the mechanical properties of solids. At the time, the technique (which primarily employed 10 MHz equipment to measure the elastic constants of single crystals) was relatively new. Only when it was realized that good results come only with near optical tolerances between parallel faces on the sample, did it become possible to make reliable measurements of ultrasonic attenuation over the range from 5 to 300 MHz. Andy Granato was at that time a fellow graduate student who later went to become a professor of physics at the University of Illinois and a leading researcher in the field of solid state physics. The Granato-Lücke vibrating string model of the damping effects of pinned dislocations is a frequently cited way of accounting for acoustic absorption. When I heard that the Sixth International Conference on Internal Friction and Ultrasonic Attenuation in Solids (ICIFUAS-6) was to be held in Tokyo in July 1977, I expected to find him among the international committee members and I was not disappointed. I had never before attended one of these conferences and therefore I took advantage of our old association to extract from him an account of its history. As a source Andy Granato is a prime one since, as far as I know (although it is not listed in the Guinness Book of World Records), he is the only living soul to have attended all six of these conferences.

ICIFUAS-1 was held at Brown University in 1956 (after I had left to seek my fortune). It was organized by Rohn Truell and Kurt Lücke to promote what they saw as a promising new tool for the study of mechanical properties of solids. The older low frequency internal friction techniques were included in the program only as a result of a persuasive approach to Truell by A. S. Nowick. The attendance of A. Seeger and W. Köster from Stüttgart justified the international label. About 20 papers were given, dealing mainly with effects from both line and point defects. At this meeting occurred the first public discussion of the vibrating string model of dislocation damping of Granato and Lücke. Another notable paper was that of Robert Morse (then of Brown University also) reporting on the unusual changes in attenuation of metals entering the superconducting state. Within about a year these results were to play a vital role in providing the first experimental evidence for the validity of the new BCS theory of superconductivity, altogether a very auspicious beginning for the subsequent series of conferences.

Five years later, ICIFUAS-2 was held at Cornell University. The character of this conference had not changed much from the first one. It was jointly chaired by H. Sack and A. S. Nowick and consisted of three invited review papers and about 25 contributed papers–subsequently mostly published in Acta Metallurgica *10* (1962). Among the notable developments were (a) a review of the growing collection of data on Bordoni peaks found in deformed crystals (Sack), (b) a survey of dislocation pinning effects which among other things established the usefulness of the vibrating string model which had been presented at the previous conference (Gordon), (c) a review of point defects which seems to have ultimately resulted in the famous book on anelasticity by Nowick and Berry (Berry), and (d) various papers tracing development of the usable frequency range up to above 1 GHz.

ICIFUAS-3 was held four years later in 1965 in Manchester, England, chaired by G. M. Leak. Again, this meeting was little changed from the previous one in size or character. Principal topics included dislocation effects, interstitials in metals, vacancies and substitutional atoms. One innovation was the award of a prize (to W. Köster for studies of the temporal variations of internal friction and modulus in metals after deformation).

In 1969 ICIFUAS-4 returned to its birth place at Providence, Rhode Island. Tragically, Rohn Truell had

died since the last conference and this one was dedicated to his memory. The conference was co-chaired by D. N. Beshers, C. Elbaum and A.S. Nowick. A broadening of scope was accompanied by a considerable increase in size: five invited reviews and 62 contributed papers (J. Phys. Chem. Solids *31* (1970)). The topics covered now included electron transport and superconductivity, point defects, phonons and spin, dislocations, phase transitions and miscellaneous. W. P. Mason was awarded a prize for his widely know contributions to the study of ultrasonics.

ICIFUAS-5 was held in 1973. It was organized by K. Lücke at the Technische Hochschule in Aachen. Again an expansion occurred–ten invited reviews and about a hundred contributed papers dealing with internal friction effects due to electrons, phonons, magnetic effects, phase transformations, point defects, grain boundaries, and dislocations. By this time techniques had pushed up the accessible frequency limit to 1000 GHz. The amount of material had so expanded that publication required two volumes (*Internal Friction and Ultrasonic Attenuation in Crystalline Solids*, D. Lenz and K. Lücke, editors, Springer-Verlag 1975).

That brings us to ICIFUAS-6 held in Tokyo July 4 to 7 of this year (1977) and that's where I came in. Again a big expansion in scope and size occurred. Seventeen invited papers and 126 contributed papers were given. The large number of papers forced a system of two parallel sessions in two hour periods over the four days of the meeting for a total of 32 sessions. Of course the topics of previous conferences were again covered, but new topics included phonon echoes, liquid and solid helium, liquid metals, amorphous materials, surface waves, hydrogen in metals, self interstitials in metals, elastic properties, acoustic emission and high-damping alloys. Again new techniques extending the usable frequency range were described. This time the extensions were toward lower frequency. The variety of disciplines and approaches represented at this conference has become extremely broad; consequently, the title is now perhaps a bit misleading. To be sure, no one can be surprised by the inclusion of "Ultrasonic Attenuation Anisotropy in a Nematic Liquid Crystal" (Castro, Hikata and Elbaum) in a conference purportedly on solids, but some papers had no striking connection with either ultrasonic attenuation, internal friction or even solids. Consider for instance, "Ultrasonic Velocity Measurements in Mercury at Temperatures up to 1500°C and Pressures up to 1700 kg/cm^2," (Suzuki, Inutake and Fujiwaka). Other papers dealt with dielectrics, piezo-electricity and Rayleigh waves on the surface of a metal and one proposed a solution to the 35-year old problem of the Kapitza Resistance, a temperature discontinuity at the boundary between solid and liquid helium (see "Tunneling as a Mechanism for the Kapitza Resistance" by T. Nakayama in the previous issue of the ONR Tokyo *Scientific Bulletin*). There is no doubt in my mind that all these subjects do indeed form a related complex of theoretical concepts and experimental techniques, with the ultrasonic study of dislocations in crystals as a sort of central focus. The idea of the broad conference is excellent, but what *would* be a good title expressing the unifying idea? It is a small point and perhaps I had best leave well enough alone.

The participation at this conference consisted of some 230 scientists from 16 countries. Japan itself accounted for the majority (164) and, indeed, international conferences such as this one may always count on a heavy local participation in this very science-conscious country. The delegation from the United States, on the other hand, amounted to only 14 (equal to that of France) which is a bit surprising when you consider the scientific importance of the meeting and its origin at Brown University. I am confirmed in my vague impression that, in general, United States participation in international science has fallen off greatly in the last year or so.

Professor Ryukiti Hasiguti of the Science University of Tokyo was the conference chairman. He is internationally known as one of the pioneers in this field (Professor Lücke of Aachen dedicated his talk to "Hasiguti, the founder") and still among its leading researchers. His opening plenary lecture set the scope of the conference and pointed out the practical importances. Through the cartoon slides, it also demonstrated the speaker's delightful sense of fun.

Dislocation damping was, of course, the major topic of this conference, as it has been from the beginning, although the range of materials considered is now broader than in the early conferences. Two groups from Tokyo described new results on quantum crystals. Y. Hiki of the Tokyo Institute of Technology reported a maximum in the decrement of ^{4}He crystals in the frequency range between 5 and 50 MHz and the temperature range 1.38 to 2.25K. The dependence of this maximum on orientation strongly suggested that it is an effect due to dislocations. The results seem to be well explained by assuming that the main source of the loss is the

overdamped resonance of dislocations vibrating on the basal planes. I. Iwasa of Tokyo University (Iwasa, Araki and Suzuki) described the data on an anamolous temperature dependence of the ultrasonic velocity in ^{4}He crystals. A pulse-echo method was used at 10 and 30 MHz between 0.7 and 1.7K. They too explained their results by the string model but by assuming the dislocations are underdamped in this temperature range. These two papers seem to demand a careful measurement of both attenuation and velocity through the overlapping temperature range to see whether dislocations in ^{4}He change continuously with temperature from the underdamped to the overdamped state.

Theories for dislocation-pinning point interactions are fairly well developed for the case of annealed or segregated point defects on dislocations. At this conference, new theories for the case of interaction of dislocations with immobile non-segregated point defects were presented by J. Schlifp (Technischen Hochschule, Aachen), H. Araki and T. Ninomiya (Brown University and University of Tokyo, respectively) and A. Granato (University of Illinois). The latter two papers attempted to take into account the viscous damping by phonons in the thermally activated processes of overcoming obstacles by dislocations. Araki and Ninomiya gave a theory for very large damping. Isaac and Granato, on the other hand, estimated that dislocations will always be underdamped in dilute alloys (with the possible exception of extremely pure specimens) so that the principal effect of the viscous drag is to allow dislocations to overshoot subsequent obstacles once they have thermally overcome one. The theory is applied to internal friction and flow stress changes observed in superconductors. Other papers dealing with these problems suggested that initial effects can play a role also in overcoming obstacles by dislocations. A paper by S. Ishioka of Tohoku University looked at the theoretical aspects of this question, for instance, while T. Moriya and T. Suzuki of the University of Tokyo used data of ultrasonic velocity in lead single crystals in the normal and superconducting state.

The study of cold-work peaks in metals continues to be a topic of considerable interest. There are two types of such peaks generally recognized. Bordoni peaks appear at very low temperatures (in copper, for example, the peak is at 55K for 1 Hz). At higher temperatures the Hasiguti peaks mentioned earlier appear (in copper, again, three such peaks appear at 1 Hz: at 145K, 165K and 230K). Bordoni peaks appear in cold-worked crystals and Hasiguti peaks in cold-worked or in cold-worked and irradiated crystals. Two papers proposed theories for the Hasiguti peaks. K. Lücke of the Technischen Hochschule, Aschen, and W. Benoit of Ecole Polytechnique Fédérale de Lausanne explained this phenomenon in terms of a combination of dislocation pinning and drag by point defects. All papers on Hasiguti peaks and Bordoni peaks or other cold-work peaks stimulated a good deal of active discussion.

The study of point defects through internal friction measurements remains an active area and new progress was reported. A paper of great contemporary interest was the review of the contributions made by internal friction methods to the understanding of radiation damage in metals which was presented by W. Schilling of the Institut für Festkörperforschung der Kernforschungsanlage, Jülich. The cognoscenti tell me that a "log-jam" has existed for some time in this field on the question of which of two models applies (the one interstitial model or the two interstitial model). As a result of the fact that internal friction methods permit a determination of self-interstitials, the one interstitial model seems to be favored (for which the interstitial is split (100) in fcc metals and split (110) in bcc metals). Another review by H. K. Birnbaum of the University of Illinois pointed out that these internal friction methods are playing a similar decisive role in elucidating the quantum nature of the diffusion of hydrogen in metals.

P. Moser of the Centre d'Etudes Nucléaires de Grenoble gave a review of research on point defect migration in bcc metals. These are more complicated in behavior than fcc metals and hence less well understood. He used an example from Fe (in which the internal friction data corresponded with the (110) symmetry predicted theoretically, while magnetic techniques indicated a higher symmetry) to issue a caveat for care in interpretation of symmetry determinations.

An invited talk, "Ultrasonic Studies of Liquid Helium Three," was given by E. R. Dobbs of the University of London. Below 3.2K, liquid helium forms a viscous quantum fluid of fermions. Below 3mK it becomes one of two forms of superfluids (an isotropic form or a magnetically anisotropic form analogous to a liquid crystal). Acoustic attenuation measurements of these superfluids have been used to reveal details of their quantum structure and Landau parameters. The existence of a "collisionless region" at these low temperatures is a justification for the appearance of this talk at a conference on solids, since solid-state concepts are appropriate. Of

some interest was the question of transverse zero sound—can it be observed? Longitudinal zero sound due to collective oscillations of the Fermi surface is well known. Transverse second sound would imply shear waves due to distortional oscillations of the Fermi surface. Direct transmission of such shear waves would be difficult to detect and therefore an impedance method was used. I neither could nor would attempt an account of the results. I only quote the author to the effect that "there is some doubt about the observation of transverse zero sound" or as expressed another way, "the difference between clapping and flapping has not yet been observed."

Several sessions of the conference were devoted to magnetic effects and materials. An invited talk by M. Tachiki of Tohoku University keynoted these papers. He pointed out that sometimes small magnetic fields can produce large effects in ultrasonic attenuation and he traced this fact to the effects of spin coupling and spin fluctuations.

N. S. Shiren of IBM's Thomas J. Watson Research Center gave a well-attended review of phonon pulse echo and polarization echo phenomena. Typically, in these phenomena an initial pulse (electric, magnetic or ultrasonic) is followed by a second applied pulse at time t later. One or more echo pulses are then seen at times 2t, 3t, etc. These results have now been seen in a wide range of materials and circumstances. Bulk piezoelectric materials, non-piezoelectric glasses and piezoelectric powders have been used. Parametric echoes and holographic "three pulse echoes" can be set up. Acoustically-induced charge transfer in a piezoelectric semiconductor can store information for long periods of time. The echo in this case is the "rattling of the charge grating." Each of these echo phenomenon can be looked upon as a time-reversal phenomenon. Each therefore depends upon a non-linearity in the material Hamiltonian. The form of the decay of the echo pulses is a clue to the processes involved.

These piezoelectric semiconductor and powder pulse-echo techniques seem to offer great promise for practical applications. It is a subject little studied in the United States, however, and interested researchers are scattered. Hence, the paper by K. Kajimura of Tokyo, K. Fossheim of Norway and N.S. Shiren and R. L. Melcer of the United States. Three continents represented in one paper!

Amorphous materials were not of central interest in the early ICIFUAS conferences. This time, however, there was considerable attention given to them. An invited talk by S. Hunklinger and K. Dransfield from the Max Planck Institut in Stuttgart reviewed the ultrasonic attenuation in these materials. Their properties differ fundamentally from those of crystals. Below 1K, ultrasonic absorption seems to be independent of the chemical composition but to depend strongly on acoustic intensity. In the mK region the attenuation approaches a constant high value. "Phonon echo" phenomena are of particular interest.

The interpretation of grain boundary damping measurements was the subject of a talk by G. Roberts and G. M. Leak of the University of Manchester. Despite the fact that it is a relatively old subject, it is still little understood. I noted the talk of activation energies and amplitude dependent effects and felt myself at home. When I heard the terms "solvent peak" and "solute peak" I almost thought I was back in my old polymer rheology laboratory! In fact, polymers did appear in the program—a paper on the dynamic moduli of monodisperse polystyrene latex done with a torsional crystal viscometer and another paper on internal friction measurements on polyvinylidene flouride irradiated with gamma rays. I also noted among the officials of the conference Y. Wada of the University of Tokyo, widely known for his work on polymers. Could this all signify the thin edge of the wedge?

Ultrasonics as a method of non-destructive evaluation of materials (NDE) is a most popular field in these days of "relevance." The subject was well covered at this conference and some interesting results were reported. D. O. Thompson reviewed a large program in this field being conducted at Rockwell International. Work on transducers, signal processing, imaging and acoustic scattering was touched on. Testing of cohesive and adhesive bonds, graphite-epoxy composites and ceramics were mentioned. Of considerable interest was a new technique for measuring residual stresses in ferrous metals through acoustic surface waves.

An entire session was devoted to papers on acoustic emission (AE). A model of AE sources based on the idea of motion of dislocations was presented by P. F. Gobin of Institut National des Sciences Appliquees, Lyon (Rouby, Fleischmann, and Gobin). Data were developed during tensile testing of 4N pure aluminum with two different grain sizes. The AE intensity distribution differed in the two cases, showing peaks at 2% and 6%

strain for 3.6mm grain size aluminum and at only 0.3% strain for the 0.2mm grain size aluminum. (I understand that others have also confirmed such effects.) A dislocation model was proposed which seemed to be consistent with the essential features of the data.

A paper presented by Y. Fukuzawa of Tokyo Institute of Technology (Nakamura, Hatano, Ro, Fukuzawa and Sensui) examined AE signatures of Fe-C alloys (C from 0.10% to 0.55%) with differing ferrite-pearlite ratios. Fracture toughness tests were used and crack opening displacement data monitored. Fractographic and metallographic observations were used to establish initiation and propagation of cracks. The shift of ductile-brittle transition with increasing pearlite content was consistent with a shift between two types of AE signatures. This interesting AE study of the systematic variation of pearlite content is apparently a first reported attempt and should yield fruitful results.

The sole paper I encountered at this conference which acknowledged ONR support (Physics Branch) was presented by K. Ono of the University of California, Los Angeles (Ono, Huang and Kawamoto). By taking account of the anisotropy of hot-rolled steels of varying sulfur content, Ono's group has succeeded in separating the contribution of continuous and burst types of AE during tensile tests. Burst-type emissions were found only in samples which contained flattened inclusions of MnS normal to the tensile axis. (Fracture or decohesion of the inclusions was established as the source of these emissions.) The longitudinal or transverse direction samples of the same steels produced only continuous-type emissions which were correlated with the plastic deformation of ferrite and the shearing of pearlite. Continuum analysis of elastic internal stress in and around a spheroidal inclusion suggested that the main contribution to the inclusion-induced AE source is what might be called thermal misfit stress. (An important lesson contained in this work is the value of amplitude distribution analysis in identifying AE signal characteristics.)

Perhaps the ultimate in large-scale AE studies (terrestrially, at least) was described in a talk on seismic waves and earthquake prediction. This was a so-called "friendly evening lecture" presented in conjunction with a social evening on the first day. Professor R. Rikitake of the Tokyo Institute of Technology, a member of the Government Coordinating Committee for the Prediction of Earthquakes, was the speaker. He described the mechanism of an earthquake prone region (plate tectonics, etc.) and discussed methods of measuring the distortions of the earth's crust (laser measurements of 1 cm. in 50 km!) and the correlation with earthquakes and tremors. So-called "long-term precursors" seem to follow a rough linear relation between the logarithm of precursor time and the magnitude of the main shock (7 to 8 years for a magnitude 7 earthquake but only 40 to 50 days for one of magnitude 5). On the other hand, short-term precursors are often observed with precursor times of several hours. In predicting earthquakes the tactic, then, is to catch the three-hour precursors after a warning of some years earlier, a task made exceedingly difficult (but perhaps not impossible) by the noisy information channels.

Despite the careful organization of this conference, the wide range of subject matter and the large number of papers presented made the parallel session format imperative. As a result, among the conferees there were questions raised as to whether the conference should continue to grow in scope or rather should be limited to those topics of particular interest to the majority of conferees. It is a thorny question left in the hands of B. Vittoz of the Ecole Polytechnique Fédérale Lausanne, who was elected chairman of the next conference. It will be interesting to see what results in Lausanne in 1981.

Those of my readers who know me as a rheologist working principally with polymers may well wonder at my coverage of such a broad conference. I must confess it was done with considerable help from many. Certainly, A. V. Granato, R. R. Hasiguti, K. Ono and N. S. Shiren ought to be mentioned, but I do so with the hope that I have not disgraced them.

VERY LARGE INTERNATIONAL CONFERENCE ON VERY LARGE DATA BASES*

David K. Hsiao

The Third International Conference on Very Large Data Bases (VLDB) was held in Tokyo, Japan, on October 6 through 8, 1977, and had a very large attendance of 378 representing twenty countries and five continents. The host country provided 275 attendees. There were 60 from the United States, 11 from Germany, six from Sweden, three each from Belgium, France, and Malaysia, and one or two each from the other thirteen countries. It was truly an international event which also coincided with Japan's Information Week.

The Third VLDB Conference also had a very large number of sponsors including ACM's SIGBDP, SIGIR, and SIGMOD, IEEE Computer Society's TC on Data Base Engineering, IECE (The Insitute of Electronics and Communications Engineers of Japan), IFIP, IPS (Information Processing Society of Japan), Japan Special Research Project on Scientific Information Systems, and SMIS (Society for Management Information Systems).

The attractiveness and success of the Conference was due very largely to the range and quality of its program. It was apparent that papers on very large databases covered a broad range of computer science and engineering. There were papers on hardware for very large database management and store (e.g., database machines, terabit memory, and tertiary store), on software architectural issues (e.g., security, integrity, and recovery), on experimental software systems (distributed, interactive, multi-leveled and self-descriptive), on database design tools, on physical database structuring, manipulation, restructuring, on natural and user-oriented language interfaces, on theoretical treatments (e.g., study of imprecise data, precise dependencies and data models), and on applications (for medicine, music, statistics). There were over 120 submitted papers. With the help of nine program committee members and 130 referees, 44 papers were included in the program, of which seven were selected by the ACM *Transactions on Database Systems* (TODS) for publication consideration. The remaining 37 were published in the *Proceedings of the Conference* which may be obtained from the sponsoring societies. The editors and referees of TODS had some difficulty in restricting the number of selected papers since there were many high-quality papers from the Conference. However, TODS accepted seven because it does not intend to devote more than one issue to the Conference and seven papers usually make up an issue of TODS.

In addition to contributed technical papers, there were sessions for survey and tutorial presentations whose quality and range of coverage were good. There were two papers on database machines, four on distributed databases and systems, three on design aids and methodology, one on theory, one on languages, one on standardization and three on psychological issues and human interfaces.

The third outstanding element of the program was the panel discussions: one on user's view of very large database applications, and one on directions in database research. The selections of the panelists were first rate.

If one must single out a few individuals to credit the attractiveness and success of the Conference, this observer would attribute Stuart E. Madnick for his untiring organizational skill as the Conference Chairman in putting the Conference together and in getting a strong showing of United States participation; Toshio Kitagawa, the Honorary Chairman, for his prestige and for inciting his colleagues at Fujitsu to make local arrangements and schedules; Alan G. Merten for his care in handling and processing the contributed papers as the Program Committee Chairman; Toshiyasu L. Kunii for his promotion of surveys and tutorials as the General Chairman; and Hermann Schmutz for his leadership as the European Coordinator in contributing a heavy European participation. There were, of course, many known and unknown heroes in a large undertaking such as this one. Whether as an attendee or as an organizer, everyone associated with the Conference learned something.

*With an apology to Howard L. Morgan (see *CACM* 18, 11; November, 1975, p. 670).

In echoing a successful conclusion for a promising beginning, Janis Bubenko of Chalmers University of Technology in Sweden and Bing Yao of Purdue University welcomed the participants at the closing of the Conference to come to West Berlin in September of 1978. As organizers of the Fourth VLDB Conference, they made it very obvious that the next VLDB Conference would be as attractive and successful as this one was.

STATISTICAL RESEARCH IN JAPAN

K. O. Bowman

INTRODUCTION

From April 21 to July 16, 1977, I visited Japanese universities and industries to observe the statistical research going on in Japan, under the assignment of the Office of Naval Research. During this period I visited the Institute of Statistical Mathematics, 14 universities, three industries and some other organizations. In the following section I would like to give a brief history of the development of statistical research in Japan so that it would be easier for a foreigner to understand the structure of present statistical community of Japan and some detailed research topics.

BRIEF HISTORY

The development of statistical research is relatively new in Japan for it started after World War II. The study of probability was always a part of mathematics and some books on probability were published in Japanese in the prewar period. In 1930, Professor R. Sato (now at Aoyama Gakuin) was sent abroad to study in England with Professors J. Neyman and E. S. Pearson and he brought back new ideas in statistics, resulting in a first book on statistics published in Japan. In 1940, Professor M. Masuyama (at present, Tokyo Science University) received a degree in physics, and when studying a structure of protein cells in the blood at the Climatology Laboratory of the Medical School of Tokyo University happened to come across R. A. Fisher's paper on statistical inference. He was inspired by Fisher's work so much that he started to study statistics from available literatures. The relation between Japan and the Western world became strained and scientific communications were broken, but Masuyama published a short book *How to Treat Small Samples* (the book has been revised and is widely read in Japan today), the first book of applied statistical methodology in Japanese. The book became required reading material for medical students of Tokyo University and Kyushu University. During the same period Professor T. Kitagawa (at present with the Fujita Research Institute) was in the Mathematics Department of Kyushu University and was pressing the statistical approach, so he welcomed the opportunity to recommend Masuyama's book to the Medical School at the University. Kitagawa became a very strong educator of statistics in Japan and produced many followers like Professor C. Asano, Institute of Information Sciences, Kyushu University, and Professor A. Kudo, Mathematics Department, Kyushu University, but always remained mathematically oriented.

In 1943, there was some feeling in the government after they acquired a report on the logistics of war, that Japan needed some study in statistics, and in 1944 the government established the Institute of Statistical Mathematics under the Ministry of Education, with seven research scientists. Today it is the only large statistical research group existing in Japan, with about 50 research statisticians. Immediately after the war several young people (they are the backbone of the statistical research community of Japan today) were taken with the new idea when they saw books like *Sequential Analysis* by Wald and others. At that time, it was very hard to acquire the book so they borrowed and copied it by hand, and formed a group to study it and similar books. In particular, in the Tokyo area, M. Masuyama, T. Okuno (formerly at the Ministry of Agriculture, now Professor, Department of Mathematical Engineering and Instrumentation Physics, Faculty of Engineering, University of Tokyo), A. Asai (Professor, Department of Mathematics, Faculty of Sciences, Chiba University), M. Kogure (formerly at the Tokyo Institute of Technology, now at Hiroshima University) formed a group which became a base to lead industry into good quality control activity when Dr. E. Deming visited Japan. This group became the nucleus for the applied statisticians of Japan and hand in hand with the Union Of Japanese Scientists and Engineers promoted quality control activities of Japanese industry. In the Osaka area, there was another group studying statistics on their own, including J. Ogawa (now Professor at University of Calgary, Canada), and S. Yamamoto (now Professor in the Mathematics Department, Faculty of Sciences, Hiroshima University).

The timing was right, and it would have been natural for statistical education in Japan to flourish, but the structure of the university system in Japan prevented the wide spread growth of statistical education. The Universities consist of several faculties (colleges), and faculties consist of several departments with a number of "koza." "Koza" is one discipline of the departments; for instance in the department of mathematics, algebra is one of the "koza" with one professor, one assistant professor (United States equivalent of associate) and two assistants (United States equivalent of assistant professor or lecturer). In many instances assistants were actually working on their dissertations for D. Sc. or D. Eng. Another discipline, functional analysis, formed a "koza" which consisted of about four faculty members. The total number of faculty members and students in each "koza" is rigidly decided from outside the university system (the Ministry of Education in the case of a public university). Each department could admit a given number of students each year, and once they are admitted, it is extremely difficult to change their major subject; the total number of graduates each year is almost constant; i.e., there are few drop-outs. Everytime the question was raised to form a new statistics department, the main concern was "are there enough bright students enrolled in statistics department or are they not strong enough for the mathematics department so that the statistics department was their second choice"; also "is statistics theoretical or applied?" If theoretical it could be placed in the faculty of sciences but if not it would be assigned to the engineering faculty. Until today there is no statistics department in the national university system. One attempt has been made at Nihon University (private) with Professor Ogawa as head of the department, but unfortunately it failed during the student uprising of 1960. Mathematical statistics remains as a "koza" in the mathematics department, and as long as it is in the mathematics department of the faculty of sciences, it will remain theoretical with no flavor of application.

Within the last 10 years, there were new information science departments established in some of the universities and statistics has become part of their education as undergraduates. Also I should mention here that, in general, in the faculty of sciences, there are no set courses given at the graduate level which are the equivalent of required courses of a masters degree as given in United States universities. Traditionally each graduate student selects a research topic and studies on his own with his professor. An assistant professor is generally a professor's student, and assistants or lecturers are also students in similar topics dominated by the professor of this particular "koza." In the field of statistics the national universities which are authorized to give the doctors' degree in sciences are Kyushu University, Hiroshima University and Tokyo University. Authorized to give doctors' degree in engineering are Tokyo University, Tokyo Kogyo University, and Osaka University. There are also several private universities which offer a doctorate degree: Tokyo Science University, Keio University, Waseda University and Ritsukyo University. It is expected that the new university Tsukuba will soon get authorization to award the degree. When I visited these universities, I found statisticians engaged in statistical research in each department.

STATISTICAL SOCIETIES AND JOURNALS

The Annals of Statistical Mathematics is known widely throughout the world, but there are many more journals related to statistics which are published in Japan. Table 1 shows the societies which relate to statistics, with numbers of membership which were available to me, and the names of the journals they publish.

The university system dictates the column-structure in all scientific fields, but in statistics this trend is harmful to the active interaction of ideas. For example, there have never been joint meetings of two or more societies listed in Table 1. Besides the journals listed in Table I, Reports of Statistical Application Research are published by the Union of Japanese Scientists and Engineers three times a year, and Hiroshima Mathematical Journal is published by Hiroshima University (includes D. Sc. Dissertation).

I do not understand why the statisticians who were educated at the engineering school and continue studies on their own do not generally join the Japan Statistical Society. So it is difficult to estimate how many statisticians are in Japan, but my rough estimate is around 2000.

INSTITUTE OF STATISTICAL MATHEMATICS

The Institute of Statistical Mathematics (Tokei-Suri Kenkyuzyo) is a national research organization which

is concerned with the study of statistical theory and its applications. As a national organization its finances are supported by the Government of Japan.

To administer its research programs, the Institute has at present six research divisions, and each division is divided into several research sections. The first division is the most influential.

DIVISION	PURPOSE AND CONCERN	HEAD
I	Theory and methods of statistics	K. Matsushita
II	Statistical methods in natural & social sciences	I. Higuchi
III	Operation research & optimization techniques	C. Hayashi (Director of Institute)
IV	Numerical analysis and computer science	M. Ishida
V	Prediction & control of stochastic systems	H. Akaike
VI	Statistical methodology for behavioral sciences	T. Suzuki

TABLE 1: PUBLICATIONS OF ACADEMIC SOCIETIES

Journals: quarterly (q), three times (t), semi-annually (s), annually (a)

1. Japan Statistical Society (membership, 950)
   Journal of Japan Statistical Society: s.

2. Mathematical Society of Japan, Probability and Statistics Section (630)
   Journal of Mathematical Society of Japan: q.

3. Research Association of Statistical Sciences
   Bulletin of Mathematical Statistics: a.

4. Japan Society of Economic Statistics
   Statistics (in Japanese): a.

5. Japan Society of Quality Control
   Quality Control (in Japanese)

6. Behaviormetric Society of Japan (880)
   Behaviormetrika: a.
   Japanese Journal of Behaviormetrics (in Japanese): s.

7. Japan Society of Applied Statistics (organized in 1976)
   Japanese Journal of Applied Statistics: t.

It is a policy of the Institute that the research projects are always controlled by the research staffs of the Institute. Educational activities are carried out by a training school attached to the Institute.

There are about 40 research statisticians and 20 assistants in the Institute and this comprises the largest group of statisticians in a single institute in Japan. The annual budget is about 2.5 million dollars at present.

The Institute publishes three journals:

(i) Annals (mostly in English):
(ii) Proceedings (in Japanese with English abstracts):
(iii) Computer Science Monographs (in English):

The most interesting work taking place at the Institute is the study of the amount of information criterion (AIC), developed by Akaike. By definition, AIC= -2 ln (maximum likelihood) +2 (number of free parameters in the model), and a procedure was developed in 1974 to select the best model by choosing the smallest AIC. Since then he and his coworkers have applied this minimum AIC estimation procedure to time-series analysis, autoregression models, and other modeling problems rather successfully. Akaike has been invited to speak at the Special Interest Session on identification method at the 1978 IFAC World Congress in Helsinki. The title of the paper will be "On Newer Statistical Approaches to Parameter Estimation and Structure Determination" and will discuss the use of minimum AIC estimation procedures and their generalizations, the entropy maximization principle, both in relation to the problems of stochastic system identification. The group considers this method powerful in the determination of complicated models. The list of titles of recent papers related to this topic are as follows, and there are program packages written for this procedure.

Akaike, H. (1971). Autoregression model fitting for control, *Ann. Inst. Statist. Math.*, 23, 163-180.

Akaike, H. (1973). Information theory and an extension of the maximum likelihood principle, *2nd International Symposium on Information Theory*, B. N. Petrov and F. Csaki, eds., Akademiai Kiado, Budapest, 267-281.

Akaike, H. (1974). A new look at the statistical model identification, *IEEE Trans. Automat. Contr.*, **AC-19**, 716-723.

Akaike, H. (1976a). Canonical correlation analysis of time series and the use of an information criterion, *System Identification: Advances and Case Studies*, R. K. Mehra and D. G. Lainiotis, eds., Academic Press, New York, 27-96.

Akaike, H. (1976b). Spectrum estimation through parametric model fitting. A paper presented at the *IUTAM* Symposium on Stochastic Problems in Dynamics, Southampton, England, July 19-23, 1976.

Akaike, H. (1976c). Time series analysis and control through parametric models. A paper presented at the Applied Time Series Analysis Symposium, University of Tulsa, Tulsa, Oklahoma, May 14-15, 1976.

Akaike, H. (1977a). On entropy maximization principle, *Proc. Symposium on Applications of Statistics*, P.R. Krishnaiah, ed., North-Holland, Amsterdam, to appear.

Akaike, H. (1977b). Role of the prior distribution in Bayesian modelling, Research Memorandum No. 110, The Institute of Statistical Mathematics, Tokyo.

Akaike, H., E. Arahata and T. Ozaki (1975). TIMSAC-74–A time series analysis and control program package–(1), *Computer Science Monographs, No. 5*, The Institute of Statistical Mathematics, Tokyo, March 1975.

Akaike, H. and T. Nakagawa (1972). *Statistical Analysis and Control of Dynamic Systems*, Saiensu-sha, Tokyo. (In Japanese, with a list of a computer program package TIMSAC for time series analysis and control written in a Fortran IV type language and with English comments).

Fukunishi, K. (1977). Diagnostic analysis of a nuclear power plant using multivariate autoregression processes, *Nuclear Science and Engineering*, **62**, 215-225.

Fukunishi, K. and Kiyokawa, K. (1976). Dynamical analysis of a boiling water reactor by multivariable autoregression model, *Journal of Nuclear Science and Technology*, **13**, 139-140.

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A long range study on the Japanese national character has been undertaken by the Institute, headed by Hayashi and Suzuki. Their research results have been published in the Annals of the Institute of Statistical Mathematics over a number of years. In this study they have developed a method to predict results, so that they could measure their accuracy and detect changes in the national character.

They are also doing a study on cross-social research, in particular comparing the attitude of Japanese with Japanese-Americans, and Filipinos with Japanese. A parallel study concerns changes in Japanese attitudes during the last two decades.

Other on-going research concerns methods of survey, analysis of response reliability, response error, and biased information.

TOHOKU UNIVERSITY

The description of the Tohoku University has been well reported by Leslie S. G. Kovasznay in his article "Fluid Mechanics at the University of Tohoku," *Scientific Bulletin*, Vol. 2, No. 1. As in all other universities of Japan, there is no separate statistics department at Tohoku University, but some interesting research at the various faculties of the university is taking place.

Professor S. Toshima in the Applied Chemistry Department of the Faculty of Engineering is interested in reliability theory which is applicable to quality control of manufacturing precision machinery. Besides this research he consults with industry and gives short statistical courses to industrial employees in the area.

The Electrical Engineering Department and Research Institute of Electrical Communications (Denki Tsuushin Kenkyusho) are noted for their active research in electronic communications. In this huge network comprising many researchers, a small group interested in probability and statistics consists of Professors H. Takeda, K. Abe and O. Saito. They are working on problems in the estimation of stochastic control parameters. Takeda and Saito's paper "Prediction Model of Air Pollution Adapted to Pattern of Daily Fluctuation" was presented at the IFAC Symposium on Environmental System Plan and Control in Kyoto, August 1977. Their abstract states, "Daily fluctuations of the density of air pollution have various patterns caused by atmospheric phenomena and human activities. So this paper proposes a new prediction model which is adapted to the pattern of daily fluctuations. The prediction model is identified by applying the following multivariate analysis to the accumulated data of SO_2 density. First of all, the data are classified into some clusters corresponding to some pattern by the hierarchical cluster analysis. Second, the relationship between the patterns and the atmospheric phenomena are clarified, and for each cluster the correlation matrix is computed, and the regression model is constructed with the characteristic modes of the matrix. Based on the above models, the density can be predicted by the following two steps. At the first step, an optimal regression model is selected among regression models by the discriminant function of the quantitative and the qualitative data; at the second step, the coefficients of the selected model are determined by the data observed up to the present, so that future SO_2 densities can easily be predicted. Finally the results, which are obtained by applying this method to prediction of SO_2 densities one and two hours ahead, are brought out."

The following list gives some other noted publications by this group.

1. A nonlinear estimation algorithm based on the stochastic approximation method.
2. State estimation of nonlinear systems by applying stochastic approximation methods.
3. On the finite parameter estimation problem under incomplete statistical information.
4. Finite parameter estimation problems under incomplete information on stochastic matrices.
5. Learning control and Markov processes.

Professor Takeda is also doing joint research with the Institute of Brain Disease. With respect to this research he is developing distinct multi-factor contours for normal persons and those afflicted by disease. From the contours, indications of the recovery process may be discovered. In the Division of Neurophysiology of the Institute of Brain Disease, Professor H. Nakahama and his coworkers have been developing a new measure to estimate the order and values of Markov processes of time series events. With the use of this measure they are able to explain the stability of neuronal functions. Many members of this group are taking part in the project labelled "Biocontrol, Bioinformation System" which was initiated in 1974 under the approval of the Science Council of Japan. Their specific interest is in models for the higher order central nervous functioning of the brain and the evaluation of these models by systems methods.

Professor K. Takeuchi in the Faculty of Economics has recently become interested in the history of statistics. He is an avid reader and also multi-lingual and is recording some hitherto unknown theoretical derivations of certain classical statistics which are not well known because of the language in which they were written. He is fluent in Russian, German, French, and English.

Professor Suzuki in the Econometric Information Research Center for Applied Information Sciences is interested in the problems of autoregression models of econometrics. He has worked on the problems of estimation of parameters of autoregression models for short term series and derived new estimation algorithm based on an orthogonal transformation of the observations.

TOKYO AREA

Tokyo is the center of all the research activities in Japan and Professor T. Okuno of Tokyo University heads the statistics "koza" in the Department of Mathematical Engineering and Instrumentation Physics. At this time, "koza" students are admitted irrespective of their major field and this situation holds at no other university. Thus his domain of influence is somewhat similar to that which holds in certain situations in the United States. Dr. Okuno's interest has been in multivariate analysis and experimental design, and he has authored two books on multivariate analysis. At present, he is involved with the ISO (International Standards Organization), which for the last several years has been studying the effects of non-normality on standard tests. In particular there is much interest at present in comparisons of several tests for departures from normality, especially (a) simplicity, (b) effectiveness in detecting types of departure from normality (skewness, kurtosis for example), and (c) their prognostic value with respect to indications of the alternative populations which may be the source of data information.

Another well known scholar, Professor M. Masuyama of Tokyo Science University, is working on many practical problems using advanced statistical and probability theories. Recent papers from this prolific writer include:

(1) Biochemical variability of a temporal variate, *Rep. Sta. Appl. Res. JUSE* 22, 1975.

(2) Stochastic models for quasi-constancy of biochemical individual variability, *Rep. Stat. Appl. Res. JUSE* 23, 3, 1976.

(3) Individual variability of ages of onset and latent periods, *TRU Mathematics* 12-2, 1976.

NAGOYA UNIVERSITY

Nagoya University, one of seven original Imperial Universities, is located in Nagoya city about 200 miles west of Tokyo facing the Pacific Ocean. Nagoya is the only city in Japan where city fathers planned its structure after World War II and laid out wide streets systematically.

The statistical activity at Nagoya is mostly of an applied character. In particular, I must mention the work of Dr. Isao Yoshimura in the Engineering Mathematics Department of the Faculty of Engineering. He is considered the foremost authority to apply statistical argument in court cases, in particular those involving private citizens in litigations against industrial polluting concerns. In a legal case involving the birth of an abnormal baby, against a pharmaceutical company, he successfully presented the argument that there are indeed relations between abnormal births and the use of narcotics; he made use of the correlation coefficient and a combination of logic and statistical analysis of contingency tables. The case resulted in a huge sum of damages being paid to victims and aroused awareness of the public concern and the responsibility of industry. Since the above initial major victory for an individual victim in Japan, Yoshimura participates in most of the important civil suits as a special acting attorney. At present he is involved with a case on chronic vinyl compound poisoning (he is using a Poisson model in the analysis of the data).

OSAKA AREA

Osaka University is one of seven original Imperial Universities of the prewar period. Its engineering school is one of the few departments which awards a doctor of science degree in statistics. Professor M. Okamoto heads this "koza" consisting of the following members: N. Inagaki, S. Shirahata, T. Isogai, and R. Miura. Okamoto's main interest is multivariate analysis, and in particular canonical correlation analysis of categorical data; he is also interested in advanced matrix algebra.

Inagaki is concerned with simultaneous estimation theory from a mathematical point of view, and his representative works are:

(1) "The weak convergence of likelihood ratio random fields and its application";

(2) "On the limiting distribution of a sequence of estimators with uniformity property";

(3) "Asymptotic relations between the likelihood estimating function and the maximum likelihood estimator."

Shirahata is studying nonparametric tests, specifically tests of ordered alternatives. The related field of nonparametric tests and estimation is researched by Miura.

The dominant interest appears to be theoretical aspects of multivariate analysis in its many ramifications.

We must also mention here Dr. Goro Ishii at the Osaka City University, a separate institute. He has worked on diversified problems over the years, for example nonparametric tests, contingency tables, PBIB design, and hypothesis testing. He is more or less an isolated worker but carries on research enthusiastically.

OKAYAMA AREA

Okayama city is located about midway between Osaka and Hakata. Several statisticians at Okayama University are working on some problems with Dr. K. Wakimoto (Professor of Statistics in the Department of Mathematics, School of General Education of Okayama University) as a leader. The main research of Wakimoto has been the field of multivariate analysis, and at present he is using graphical methods to represent multivariate data. Wakimoto and Taguri (Chiba University) have derived a graphical method called "constellation graph" and are using this method for discriminant analysis. Another graphical method called "linked vector pattern" was developed by Drs. M. Taguri, T. Kitaka (Department of Mathematics, School of General Education, Okayama University) and Wakimoto to represent the correlation analysis of ordered data graphically; a computer program has been developed. At present they are trying to apply this method to the problems of pattern recognition. Wakimoto is also working on a graphical method called "tree graph" to represent multidimensional data.

Professor Taichi Kariya is in the Department of Statistics at Kawasaki Medical University which is located in Kurashiki city near Okayama city. His speciality is estimation problems arising from his consulting experience in the medical school. In the field of biostatistics he observes that the sample data often inadequately represent the population. For example in the case of quantal responses, the data is often incomplete. In these problems he derived estimators using the method of maximum likelihood, and applied them to estimation of the parameters of menarche age distribution, and also to finding the age distribution for the first eruption of teeth in babies. The method was effective for incomplete data and data not easy to collect. At present he is working on the problem of a test of homogeneity for the singly-ordered categorical data, and he presented some of the results at a recent meeting of the Japan Statistical Society at Hakata.

T. Nakamura of the Department of Mathematics, Kawasaki Medical School, is interested in applications of mathematical programming to statistics specifically related to the Neyman-Pearson lemma. T. Kariya, T. Nakamura, and E. Yamamoto (Department of Applied Mathematics, Faculty of Science, Okayama University) are working on the problems of the test of ordered alternatives of contingency tables and its application to pollution problems arising from chemical spills from industries and drug poisoning. Solutions to the above

problems were originally derived by Bartholomew but his solutions were limited to categories up to 5. Taguchi presented new solutions in 1974 and Kariya's group is now trying to perfect Taguchi's results so that the test could be applied to larger categories of experiments. Also they claim that their procedure is much simpler than that of Bartholomew.

Dr. Hiroshi Ohsaki, Assistant Professor in the Department of Industrial Science, School of Engineering, Okayama University, is interested in computer oriented statistics. He calls his research, computer "aided" statistics. Actually he is interested in selection procedures of variables in multivariate analysis. He has written a Fortran program called FORBAG for forward selection and backward elimination procedure in multiple regression analysis. He also wrote another program called FSBEDT for the forward selection and backward elimination of linear discriminant analysis and test for the difference of two multivariate population means. He considers that forward and backward methods are better than all possible selections, or stepwise selection procedures, which consume too much computer time when the number of parameters increases.

Osamu Sugano, mathematics teacher at an area senior high school, is interested in multiple regression and applications of "AIC" (Akaike's information criteria).

The group then as a whole in the Okayama district is similar to the group of Chiba University mentioned earlier.* They are a group of relatively young scientists who had some statistics education at the university level but did not major in it. They are trying to establish a discipline somewhere between statistical mathematics and applied fields.

HIROSHIMA AREA

Hiroshima has been reconstructed in the last 35 years and today more than eight hundred thousand people live there.

Hiroshima University was established by integrating many area educational institutions with the post-war educational reform and now consists of nine faculties, ten graduate divisions, two research institutes and many other centers with 10,000 undergraduate and graduate students.

Hiroshima University is one of the few universities which award a doctor of science degree in mathematical statistics, and Professor Sumiyasu Yamamoto heads the Mathematical Statistics "koza" in the Department of Mathematics. He is considered one of the great educators of statistics in Japan. Professor Yamamoto's professional career consists of two periods, one being 1946-1962, during which he belonged to the medical school and practiced biostatistics. The other is the Hiroshima period, 1962-present, during which his research became oriented to mathematical statistics and information science. In the early days, his research topics were in experimental design in medical statistics and he popularized biostatistics and biomathematics in the medical field of Japan. Recently he became more interested in combinatorial mathematics related to experimental design and information retrieval. Professor Yamamoto, Dr. Hamada, assistant professor in Yamamoto's "koza" and Yamamoto's student, and their assistants are engaged in research on balanced fractional factorial design, PIBD, BIBD, using association algebras, geometrical methods and combinatorial mathematics.

In contrast to the group in the Mathematics Department, I must mention Professor Masao Kogure in the Faculty of Engineering, Hiroshima University. He retired from Tokyo Institute of Technology as Professor Emeritus and became professor in the Faculty of Engineering. This faculty has just established a new system which is more like the structure in a U.S. university. They abolished the traditional "koza" system so that instead of 11 departments with 57 "koza," there are now four departments with 17 "koza," and all the faculty members belong to each department not to each "koza." Professor Kogure's interest has been in applied statistics and he actively participated in quality control industry with the Union of Japanese Scientists and Engineers. He was given the Deming award in 1952 for his contribution to quality control activity. He has published a book entitled *Theory of Process Capability and Its Application*, for quality control engineers. The book is

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unique in the sense that it successfully blends theoretical concepts with expertise gained from many years of industrial and pedagogical experiences. He has worked on problems of noncentral distribution of standardized and studentized range, but recently his interest has shifted more to operational research than statistical research.

In Hiroshima city there is another group engaged in statistical research in the field of epidemiology; they are located at the well known research institute RERF (Radiation Effects Research Foundation) which developed from the Atomic Bomb Casualty Commission. RERF is supported jointly by the United States and Japan. Its statistical department consists of both American and Japanese statisticians, headed by I. Moriyama. Some of the staff members are J. Norman, C. Odoroff, Y. Chikuse, M. Ohtake. Many outstanding American Statisticians have been there as research associates in the past. Their research has involved analysis of vast amounts of data collected continuously for the past 30 years. The main topics pursued by RERF are:

(1) The life span study of survivors (and their progeny) of the atomic bomb; it has involved 100,000 persons.

(2) Adult health study to determine the effects of radiation on health. From the records of the study of 100,000 persons, a group of 20,000 was selected for biennial examination.

(3) Pathology studies to elucidate, by material gathered by autopsies, histological changes in patients which cannot be detected by clinical examinations. Reports and results of the studies (published in Japanese and English) are readily available to the public.

KYUSHU UNIVERSITY

Kyushu University is a national university and one of seven original Imperial Universities. The main campus is located at Hakata, the metropolis of Kyushu Island, and about 750 miles west of Tokyo. In the early days Professor Toshio Kitagawa was in the Department of Mathematics and chaired the statistical mathematics "koza." In 1967, the Research Institute of Fundamental Information Science within the Faculty of Sciences was established, and Kitagawa became the director of the Institute and head of the Information Processing Division. Professor Akio Kudo, Kitagawa's student, assumed Kitagawa's position in the Department of Mathematics. After Kitagawa's retirement, his student, Professor Chooichiro Asano, took over the position of head in the Information Processing Division of the Research Institute; previously Asano was working at Shionogi Pharmaceutical Company as a statistician. Since Kitagawa's research was mathematically oriented, the research in statistics at Kyushu University became dominated mainly by statistical mathematics, especially multivariate statistical theory.

At present, Professor Asano is heavily engaged with research in statistical program packages. The Ministry of Education financed for a period of three years (1976 to 1978), with a budget of about $30,000 (excluding annual salaries), a group of statisticians to complete a statistical program package for Japan. For the first year they critically examined the existing program, while the second and third years were used to construct a new program package. The aim of the project is to construct a package which is not only efficient from the program point of view but also theoretically correct. In the western section of Japan, Asano, Sugimura (Ohita University), Wakimoto (Okayama University), and Okamoto (Osaka University) are responsible for the project, and are working on problems of cluster analysis, factor analysis, and scaling problems. Since the personnel involved in constructing the program package are mainly professional statisticians with strong theoretical backgrounds, the end result is a diversified package of interest and usefulness to applied and research oriented statisticians.

Asano is also working in collaboration with the Medical School of Kobe University on problems of correct diagnoses using the pattern recognition approach to syndromes. Academically, he is interested in multivariate analysis (his two books on the subject were published a few years ago) and with several colleagues is trying to improve the plan of sequential selection with "play-the-winner" sampling rule. Some of the new results are to be applied to the theory of selecting medical treatment for patients.

The Department of Mathematics at Kyushu University includes an applied mathematics "koza," so the statistics "koza" might have flourished in comparison to situations elsewhere. Unfortunately Professsor Kudo

has been in ill health and Assistant Professor T. Yanagawa is pursuing his interests and studying abroad, so the activities in the department are limited. During a visit to Professor Kudo in Kyushu University Hospital, he told me about the difficulties encountered by the Japanese statistical community. One difficulty is the fact that they do not have a department of their own in which theory and application can be approached and taught as a combined entity. Secondly, the Government encourages established scholars to visit the United States and Europe, whereas young statisticians for the most part get their basic training in Japan, and do not get an overall education in theory and methods. Some feel that it would be an improvement if basic training for a few was undertaken abroad. Thirdly, there is a lack of education and research in Japan in biostatistics, ecological statistics and related fields. Professor Kudo would like to promote research in these and other environmentally oriented fields.

INDUSTRIES AND OTHER ORGANIZATIONS

INDUSTRIES

I visited three industries which are considered as exercising good quality control methods. On my first visit, I went to the Konishiroku Photo Industry and was pleasantly surprised by their factory manager, T. Yoneyama, who keeps in touch with modern developments in applied statistics. His knowledge of statistics shows an appreciation of theoretical advances and the usefulness of these in the factory. He told me that he still attends courses in statistics offered by the JUSE (Union of Japanese Scientists and Engineers). He has authored two books on quality control for factory workers, one of them a best seller.

In my observations of this factory and subsequent visit to the Toyota Motor Company, the methodology used in quality control is not new, but it is successful because of a united and concerted effort from factory floor worker to top management.

For example, at the Konishiroku, they are using a demerit "C-scale" index, and everybody in the company from the president to the floor worker understands the system. This methodology was orginially developed by the Bell System Laboratory in 1956. Very briefly, (Dodge and Torry, Bell Telephone Laboratories, Inc., New York, N.Y., 1956) in the classification of defects, fraction defective (or defects per unit) ignores two important aspects:

(a) defects of different kinds are not necessarily equally serious,

(b) defects of the same kind differ in seriousness according to the extent of departure from specified limits or standards.

The factory has accumulated 20 years of this defect index, so that now, from historical records, they know what levels must be maintained to achieve efficient operation. C-scale values are posted every month, and everyone in the company is aware of this fact and naturally works to maintain or improve performance. At present Yoneyama is interested in a more refined analysis of the demerit system, and this runs into new problems such as the effect on the t and F statistics of population perturbations (namely small departures from normality) when sample sizes are moderate to small.

At the Toyota Motor Company (located at Toyota city) a similar situation exists. The whole city is practically managed by the company. Employees can reside in company apartments with a very favorable rental charge and be cared for (subject to a nominal fee), by the company operated hospital. Other aspects of welfare have been included (grocery store, transportation, etc.) and since 1951 no days have been lost due to strikes.

CITRUS EXPERIMENTAL STATION, SHIZUOKA PREFECTURE

Shizuoka prefecture is located southwest of Tokyo facing the Pacific Ocean and its harbor is surrounded by many hot springs. The Citrus Experimental Station is located between Shimizu and Shizuoka cities, and here the largest scale of citrus experiments in Japan have taken place. Of the citrus crop in Shizuoka, 95 percent consists of tangerines. The station is headed by T. Noro and the experimental program was designed by A. Hirosaki of

the Ministry of Agriculture. The tangerines produced in this area are strong in acidity but deficient in sweetness, in contrast to the tangerines produced in most southern regions of Japan (for instance in Kyushu). The temperature of this region is marginal for the production of tangerines, so it is necessary to plant them on steep hills facing south to absorb sufficient heat and avoid frost damage. However, this mode of operation has obvious drawbacks; soil erosion presents a constant renewal problem and is exacerbated by the poor soil conditions on the mountain slopes. Mulching is rarely permanently effective.

In 1971 they initiated a long term experiment involving a 4x2x2x2x2x2x2 factor fractional factorial design of 64 plots. Records were started in 1973 and although it is too early to claim any specific results, a visual inspection holds promise for the future. The analysis of the data is being carried out by a computer program developed by C. Okuno, Ministry of Agriculture.

There is a *Handbook of Design* prepared by T. Okuno and published by the Ministry of Agriculture; most of the agriculture experimental stations in Japan follow designs stated in this handbook.

JAPANESE STANDARD ASSOCIATION

Japanese Standard Association (JSA) was established in 1945, as a foundation under Government authorization to represent standardization business. The purpose of the association is the improvement of productivity in industries, by standardization and quality control. Statistical activity is one of their major objectives. They have been publishing some statistical monographs and texts since it was founded. They published *Statistical Tables and Formulas with Computer Applications JSA-1972* (edited by J. Yamauchi), and these tables were recalculated from the originals entirely by Japanese scientists. The table is about 700 pages long and took some eight years to construct, being the work of many scientists. Titles are in English but illustrations and explanatory remarks are in Japanese. A concise version of the tables with some additions has just been published, and this is a very handy work to carry around. One slight defect is the absence of references.

The new *Handbook of Quality Control* had just been published during my visit and was quickly sold out, showing the popularity of quality control in Japan and the serious view of its importance.

The association conducts, periodically, courses in quality control and also special topics in related fields. Study groups are welcomed and facilities provided.

CONCLUDING REMARKS

The statistical research taking place in Japan leans heavily toward mathematical developments. The most popular fields are multivariate analysis, stochastic processes, time-series analysis, decision theory, and the theory of sample surveys. Another active area concerns the production of sophisticated and rigorous accounts of results and ideas commonly used in applied statistics and probability.

On balance, since many statisticians have developed their expertise after an initial mathematical training, they are naturally inclined towards theoretical and mathematical developments. There is a shortage of scientists who have a blend of pure and applied statistics, so that many challenging problems of relevance and importance are not receiving the attention they deserve.

TIDAL POWER AND OTHER RESEARCH AT THE KOREA RESEARCH INSTITUTE OF SCIENCE AND OCEAN

Morton A. Bertin

At the time of my earlier visit to Korea in 1974, I met with Chung H. Youn, at that time Director of Shipbuilding Industry Technical Services, an institute organized the year before to provide technical services to the shipbuilding industries. Their primary function appeared to be the development of a ship design capability and to decrease reliance on foreign sources. Mr. Youn had stressed the needs of the Koreans to develop their own technology and he was undertaking a program to attract Korean scientists who had studied abroad and never returned. It appeared that only about one out of ten who achieved foreign degrees ever went back to the homeland, and there was a program to increase salaries and provide other attractive incentives to stimulate their return. Youn is himself an American of Korean descent who studied at Berkeley and Michigan.

It became readily apparent that much has transpired in the past three years. The original organization has expanded both in personnel and mission, and they are in fact building a campus which will allow for future growth. From essentially a one man operation they have almost 200 people working, with another 30 presently being trained abroad. To underscore the broadened scope of operation the name was changed in 1976 to the Korea Research Institute of Science and Ocean (KRISO), actually effecting the merging of two institutes. Mr. Youn assumed the office of President at that time.

At the time of the present meeting, Byung Don Lee, Vice-President for Ocean Research, spoke of the tidal power project, of which KRISO is the prime contractor and moving force. Support for the project comes through the Korea Electric Company and is thus actually funded by the government, specifically the Ministry of Commerce and Industry. The project is an attempt to find an answer to the growing need for expanded energy sources and to decrease reliance on foreign suppliers. This potential power source appears fruitful in light of the large tidal range on the Korean west coast and for many years inconclusive and incomplete studies have been carried out. The planned effort is to conduct a feasibility study, to select the site with highest potential, and to construct a facility in the optimum location. Eight places have been picked but for political reasons only seven are under consideration: Garorim Bay, Cheonsu, Ahheung, Namyang, Siheung, Seosan, and Inchon Bay. Dr. Lee pointed out some of the desirable and less than optimum features of the various sites and provided a schedule for the work.

During phase one a study will reevaluate the potential energy to be derived from tidal power, attempting to overcome the shortcomings of the inadequate past assessments. This is to be completed in 1978. During the next phase they will select a site for the initial construction, hopefully the most potentially fruitful one, and set priorities for future sites. This is scheduled for 1979. During this period they will also study such factors as social and economic effects, estimate costs, and develop a basic design. The final phase is the construction of the first installation to be followed by as many others as is deemed feasible.

It appears that companies from three countries, the United States, the United Kingdom, and France will be bidding on the initial contract, the study phase. Of interest is the fact that there are only two operational tidal power facilities in operation, and only one of them, La Rance, Isles de Chausey, France, develops substantial amounts of energy. The other is in Kislaya Inlet, Lumbovskaya Bay, the Soviet Union, and this is a very small station of an experimental nature. A senior engineer of the Korea Electric Company is now in France studying the plant in operation there. Everyone connected with the project is hopeful that this effort will partially alleviate the critical and ever-growing need for energy, though all recognize that there is a long and difficult period ahead.

President Youn reviewed the growth of the Institute and spoke of future plans. He stressed the need for coming up with answers to pressing immediate problems and told how they were building teams for this purpose. The Institute is comprised of several departments, though some are largely in the formative stages. The

primary areas of concern of the Hydrodynamics Department is research on propulsion, resistance, and ship motion, the purpose being the construction of vessels assuring high economic and safety levels. Another function is the study of propellers, special purpose ships, and off-shore structures. Youn pointed out that they are in the process of installing a high speed towing tank on the new campus, which will greatly enhance their research capability when completed.

In Structure and Welding the emphasis is on ship structure, vibration and noise, material testing, welding metallurgy, and welding dynamics. There has already been some pay-off of this work in computer-aided structural analysis based on the finite element method. Also, hull vibration analyses have been done based on the transfer matrix method. Under construction is test equipment which will allow for expanded work on ship structural strength, vibration and noise, and associated areas.

Under Shipboard Machinery and Hull Outfitting is research on the main engines, auxiliary machinery shafting and engineering systems. Here too, new testing equipments are anticipated for the future to allow for expanded activities. Ship design techniques are underway to improve economy and performance, much of this work being fed directly to operational shipyards. Under Technical Development is research on software for computerization of shipbuilding design and methodology.

The Department of Oceanography is one in which Youn and his associates see great promise and one which they would like to have greatly expanded. It is his feeling that the study of the Korean coastal areas is urgent and holds great potential for the economy and well being of the country. There are three sections: physical oceanography, ocean engineering, and tidal power. Within these studies are being carried out in physical, geological, biological, and chemical oceanography. Under physical oceanography studies are undertaken in properties of sea water; currents, tides, and waves; ocean and atmosphere interaction.

Areas of interest for those in geological oceanography include research on marine sediments, continental shelf, the ocean floor, and undersea mineral deposits. Biological oceanography is concerned with marine organisms, productivity, food resources, and marine ecology. Those in chemical oceanography study pollutants, control measures, desalinization, and the recovery of marine resources. They stressed the necessity for a major effort to resolve the growing problems of ocean contamination and pollution of rivers and coastal areas.

The work on tidal power is under the Ocean Engineering group, which has been developing mathematical models of tides, sedimentation, and water pollution. They look forward to the establishment of a hydraulics laboratory in the near future. Of interest also is the development of deep diving techniques, and in this area they have been exchanging information with colleagues in Japan and other countries.

In fact there have been several cooperative programs with other countries, and the French have been particularly helpful in providing equipments, technical support, and training for KRISO scientists. Almost from the beginning there has been a close working relationship with Battelle in the United States. As stated earlier, this group has been moving very fast and appears limited primarily by the amount of support provided by the Korean government and industry. The leadership is energetic and forward-looking, which holds promise for future growth.

NAGOYA REVISITED

Morton A. Bertin

Nagoya, one of the most industrialized of Japanese cities, was practically obliterated during the war. However, as a result of this destruction the city was planned and has developed into a modern metropolis, with broad avenues and fine parks. It has re-emerged as a center for industry and appears prosperous and bustling. It is also the seat of several fine universities, some of which have been reported on previously. (See A Review of Some Psychological Research in Japan, ONR 32, 1972, and ONR Tokyo *Scientific Bulletin* Vol. 1, No. 1, 1976.) The impression in visiting the schools of Nagoya is one of activity, possibly reflecting the character of the city itself. My host for this visit was Takuo Goto, whose research has been discussed in the above cited volumes.

One of the schools which had not been previously covered is the Nagoya Institute of Technology, and I took the opportunity of arranging to see the laboratory of Noriyoshi Ichikawa, Chairman of the Department of Humanities and Social Sciences. Ichikawa was out of the country and Associate Professor Kohmura provided an overview of the past and on-going research. The work is primarily in the area of vision, though Ichikawa and Kohmura are planning to move into morale studies with both students and workers. One of the completed studies dealt with field effects in the vicinity of light stimuli and their summation, essentially designed to investigate three problems: to clarify the field effect of a single light stimulus set in close proximity; to examine summation of two light stimuli; and finally, to determine whether the field effect of a single stimulus is weakened or blocked by another stimulus that lies in the direction of the effect. In all the experiments they used lines and small light point(s), placed in various positions. For the first two experiments results indicated a significant rise in the threshold value at the edge of the linear stimulus; the threshold values between the two lines were higher than outside the lines; similarly within the lines there was a summation of values for each position, which did not occur outside the stimuli. In the final experiment the blocking effect appeared in threshold values but not in relative values. Ichikawa concluded that there is a definite strengthening of the field effect within and on the edge of the light stimulus and that there occurs a summation between the two stimuli.

Another study examined the difference of field strength in binocular and monocular vision by measuring the threshold luminance. A point of light was shown at various places near a line, square, and circle and the threshold luminances were measured. It was found that the threshold luminance values decrease logarithmically as the angular distance from the figure increases. Also, values for binocular vision were somewhat less than for monocular, but relative values of threshold luminance were about the same. The conclusion was that no true difference exists in level of field strength between binocular and monocular vision.

Ichikawa has also carried out a series of studies on figural effects in the third dimension, extending the work of others on how a stimulus point placed in the vicinity of certain figures would be influenced by the figure in one's perceptual field. He postulated that findings in two dimensional space would also show up in some way in three dimensional space. Using a circular and an angular figure, he presented a test point in various positions. For the circular figure it was found that the test point placed closely in front was displaced in the direction of the figure. The amount of displacement was strongly influenced by the placement of the point such that as it increased in distance away from the figure, the displacement decreased and finally reached zero. At the greatest length the displacement was the longest distance away from the circle. In the angular figure a point placed within the angle opening showed the largest displacement near the corner of the angle; placed outside it decreased to zero. Ichikawa has also carried out research to measure the figure effect in the third dimension by using the light threshold method.

Some of Ichikawa's earlier work studied the relationship between supervisory leadership behavior and worker satisfaction. In one study questionnaires were filled out by employees of a medium-sized industrial firm and it was found that the supervisory leadership style greatly influenced the feeling of job satisfaction of the workers. In a follow up study, the aim was to determine what type of leadership behavior led to subordinate satisfaction and which detracted from it. Two groups were selected, one with high job satisfaction reactions

and the other with low. They then proceeded to study the leadership behaviors of the supervisors of each group. It developed that level of job satisfaction generally was related to supervisory behavior involving such matters as handling of grievances, level of communication, providing of advice when needed, level of agreement of ideas or policies, and personal supervisory opinions. In general the workers showed a desire to form a personal bond and to be treated in a personal way. This is interpreted to mean that it is essential for the successful leader that he satisfy certian social needs of the workers.

At the Faculty of Engineering of Nagoya University Shiro Usui and Michel Janisse are working together on a project to study anxiety of college students through the use of a pupillometer developed by Usui, an electrical engineer. Janisse, a psychologist, is on a one year sabbatical from the University of Manitoba to carry out, with Usui, two independent studies of anxiety, the first using a subjective paper and pencil approach, the second the pupillary response. Data collected in Japan will later be compared to similar information on Canadian university students.

Janisse postulates two aspects of anxiety involving cognition: memory of an experience, and anticipation of a forthcoming happening. It is his contention that anxiety is a state experienced and recognized as such, e.g., if one feels anxious, one is anxious. The reverse also holds. There are, he states, two anxiety parameters which must be measured: frequency and intensity. Thus he and a colleague developed the Frequency Intensity Anxiety Scale, which is being translated into Japanese. It is hypothesized that Japanese will have higher intensity ratings, that inter-personal-ego threat will occur most frequently, and items will be rated of higher intensity by males than by females. The second study will be a replication of one done by Janisse and Dumoff using the effect of a stressful stimulus on the pupillary response. In this experiment it is hypothesized that the Japanese will show a higher degree of physiological reaction than did the Canadians. Janisse feels that this research will add to the knowledge of cross-cultural experiences of anxiety and pain.

In developing the pupillometer to be used in this work, Usui considered the frailties of existing systems and the difficulties in making precise measurements in physiological reactions. He developed an infra-red TV pupillometer with 50 dB/2mm signal to noise ratio, bandwidth of 15Hz with a processing average delay of 27 msec. A time series program has been developed and together with a continuous system simulator was used for modeling studies. Usui described the operation of the device, which appears relatively standard, except that it seems to have increased the level of precision.

While at the University of Nagoya I seized the opportunity of revisiting Ryoji Osaka, at the Institute of Environmental Medicine, previously reported on in Vol. 1 No. 2. He is presently developing research to study the ever-present and growing problem of avoiding collisions in air traffic and is planning to construct a circular dome to allow him to map visual space in much the same way as color space is mapped.

Also revisited was Genyo Mitarai (see Vol. 1, No. 1) who has developed a means for inserting an electrode into a single fiber to obtain and classify single fiber responses. He, together with Takuo Goto, is continuing his research on the study of the organization and arrangement of the different kinds of horizontal cells and the correlation existing between different cell types and S-potential types in the carp retina.

It was also a great pleasure to again meet with Michiaki Uchiyama, now Dean of the School of Letters, who still finds time to continue his active and diversified research program. (See A Review of Some Psychological Research in Japan, ONR 32, 1972.) He spoke about the growing interest technologists are showing in such areas as worker morale and other industrial problems. He also discussed his concern with such items as the managerial personnel factor and expressed his interest in problems concerning time perception. He feels it is appropriate to regard time perception as a psychological variable and to direct research accordingly. In other studies, he is working with the medical school on the effects of minor tranquilizers on humans and the relationship of early age factors to drug usage.

SOME PSYCHOLOGICAL RESEARCH AT OSAKA UNIVERSITY

Morton A. Bertin

Formerly known as Osaka Imperial University, the school has a long history dating back to its dimly related origin as Tekijuku Academy in 1838. The early association was with the medical field, and it underwent several transitions from hospital to medical shcool. To this day the Faculty of Medicine is an important and well regarded component of the university It is a fairly large school for Japan, situated just at the outskirts of the bustling metropolis of Osaka. My host for this visit was Jyuji Misumi, who shuttles back and forth between the Faculty of Human Sciences at the University of Osaka and his position as Director of the Institute of Group Dynamics in Fukuoka. Thus he appears to maintain an excellent balance between research and teaching. The Institute is almost completely supported by industrial firms, for whom Misumi and his staff carry out applied studies on problems related largely to personnel matters. He appears to be well suited to this type of work, having developed the by now widely known P-M Leadership Theory. A complete description of this may be found in my monograph "A Review of Some Psychological Research in Japan," 10 November 1972, ONR-32.

Misumi has just completed and is putting finishing touches to a massive work on the "Behavioral Science of Leadership," which will be published in the spring of 1978. Much of the writing covers his own research and it consists of five primary sections: Perspectives of Leadership Research, Behavioral General Morphology of Leadership, Behavioral Specific Morphology of Leadership, Behavioral General Dynamics of Leadership, and Behavioral Specific Dynamics of Leadership. A concluding section ties it all together.

In a chapter entitled "Administrative Leadership in Local Government Offices" Misumi draws a comparison between the situation in industrial enterprises and governmental offices. He prepared a questionnaire for evaluating leadership behavior in section and sub-section heads, assuming that striking differences would emerge between govenment and private enterprise. Indeed, certain differences were established in quality of leadership, but no P-oriented factor (goal achievement or problem solution) was seen. In government the emphasis was on such things as "discipline guidance" and "observance" of regulations, as against outcome performance, more likely in an industrial setting. Surprisingly, in M-oriented (maintenance-oriented function) leadership involved with group maintenance and human relations, there were no appreciable differences, which Misumi interprets to indicate that between supervisors and subordinates basic human relationships are not a function of the type of work involved. Perhaps one of the most interesting findings, the hierarchical order of the four P-M leadership types was found to be the same for both government and private enterprise, though as stated earlier quality differences did appear. There were, however, disparities in communication, teamwork, and motivator morale, with sharpest variations in communication showing up in the influence of supervisory behavior in government and teamwork and motivator morale in private industry. Misumi drily commented on some of the difficulties encountered in attempting to collect such data from government bureaucrats.

In a study of the effects of group decision-making processes, Misumi instituted a program at the Nagasaki shipyard owned by Mitsubishi Heavy Industries. One of the primary purposes was an attempt to reduce the rate of accidents, particularly in the hull construction department, considered to be the most hazardous work area in the shipyard. After an initial five hour orientation session, work teams were divided into small groups and they discussed the theme of why accidents happen. Guidance was provided by a member of Misumi's staff and the product of this brainstorming session was a set of items which was posted for further study. Team members then wrote comments and opinions on cards and the group reviewed and classified these according to similarities. Each group set goals for themselves and it was decided that they would meet at the end of work each day to discuss safety factors. Each member wrote a resolution regarding safety and kept it somewhere where he could see it frequently. Many of these resolutions seemed unrelated to work and referred to home matters and family life.

P-M ratings were obtained for supervisory personnel and a sensitivity training program was instituted to develop leadership behavior. Through comparing self-rating and rating by others, foremen were made to realize

the gap and each attempted to modify his behavior to lower the discrepancy between how he saw himself and how others saw him.

Finally some 4000 workers began to meet for fifty minutes each Friday morning to analyze and evaluate safety procedures and accident prevention measures, to review the week's occurrences, and to plan for the week to come. The results were striking in that over a three year period the total accident rate decreased about 60 percent. Interestingly, despite the time spent on meetings, there was no decrease in the level of production, and there appeared in fact to be a slight increase.

While at the Faculty of Human Sciences I had the opportunity of meeting with Yasuhisa Nagayama, who is engaged in a long-range study of the "Characteristics of Today's Youths as Indicated by Their Inclinations for Vehicles." This title cannot help but strike a responsive chord for those of us living in Tokyo. In fact, the traffic and style of driving are frequent topics of conversation, particularly among foreigners who have recently arrived. Aside from the *kamikaze* cab drivers, what appears to be the greatest road threat to life and property are the *bosozoku*, the hot rodders who congregate in droves in selected areas of the cities, ignoring traffic regulations or conventions, racing their souped up vehicles crazily through traffic in cadence with their specially cut-out mufflers, designed to produce eerie and cacophonous discordancy. They almost always congregate on week-ends (where they "hole-up" during the week is a mystery), and the only method the police have to control them is to block off the selected streets to all traffic, whereupon they seemingly move to other areas.

From Nagayama I learned that this so-called new type of driver began to show up as far back as 1955. The early generation has been variously known as *kaminari-zoku* (thundering tribe), *otokichi-zoku* (noise-crazy tribe), or *car-kichi-zoku* (car-crazy tribe). It appears that they have been an occasional phenomenon in various parts of the country in the past and the new generation of *bosozoku* are the reckless driving descendants of these early groups. To offer some concept of the pattern of operation, they are, as stated earlier, week-end drivers, who apparently remain active throughout the night. I have occasionally been awakened at the ungodly hour of three in the morning to their passing, motors revving, horns at the steady in all manner of raucous and melodious sounds, waiting patiently for as much as fifteen minutes for the cavalcade to pass. Nagayama correctly terms it a "serious social problem." He differentiates between the *bosozoku* of eastern and those of western Japan, those of the west seemingly operating more dangerously (the wild west?), though those of the east are reported to engage in group vandalism and gang warfare. Their western brothers have been variously charged with rioting attacking the police and others, pilfering, overturning a taxi, arson, and homicide. Small wonder that the International Association of Traffic and Safety Sciences has commissioned Nagayama and a group of associates to study the phenomenon.

The group has issued an interim report which seeks to look at the western *bosozoku*, comparing them to high school students of similar age in terms of such items and desires, interests, behavioral characteristics, personality traits, etc. There were three groups of high school students and two of the hot rodders as follows: Group A, those with driver's licenses or in process; Group B, no license but intend to get one; Group C, no license and no intent to get one; Group Y, the bosozoku ages 16-18; Group E, those above age 19. All groups were given a series of questionnaires which provided no clue as to the direction of the study.

In addition to the basic data, much other information was gathered about differences among the groups, for example, access to vehicles, months needed to get licenses, home ownership of vehicles, reasons for getting licenses, frequency of riding vehicles, magazines read or subscribed to, and others. Factorial analysis was carried out on the responses and clusters were derived as follows: pleasure, machine operation, mathematics-sciences, sports, arts health, Japanese language-social science, family communication, perserverance, loneliness, game, and music. The characteristics of each of these factors were developed and some relationships were assumed. For example under inclination for automobiles there were pleasure seeking, machine operation, sports, health, and music. Under non-inclination for automobiles there were arts, Japanese language-social sciences, and solitude.

It is obvious from the above that a vast amount of data was accumulated and that countless inferences might be drawn. Certain conclusions are readily apparent. Naturally enough, the *bosozoku* have easy access to automobiles but surprisingly, one third of the high school students also had cars available. As might have been expected the hot rodders tended to read automobile magazines, the A Group read comics, whereas the C Group

was more interested in study and hobby magazines. In the area of interests and behavioral characteristics sharp differences emerged. The automobile inclined were drawn to work involving the senses, enjoyed operating machinery, established close relations with friends, showed traits of delinquency, and favored physical activity. The others exhibited essentially the opposite characteristics tending to be quiet, introverted, and lonely. As to behavioral characteristics, the Y Group and the C Group appeared to be most cohesive in terms of homogeneity, or as Nagayama puts it, they were "considered to exist apart from the other groups."