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EUROPEAN SCIENTIFIC NOTES

ESN-25-9

30 SEPTEMBER 1971

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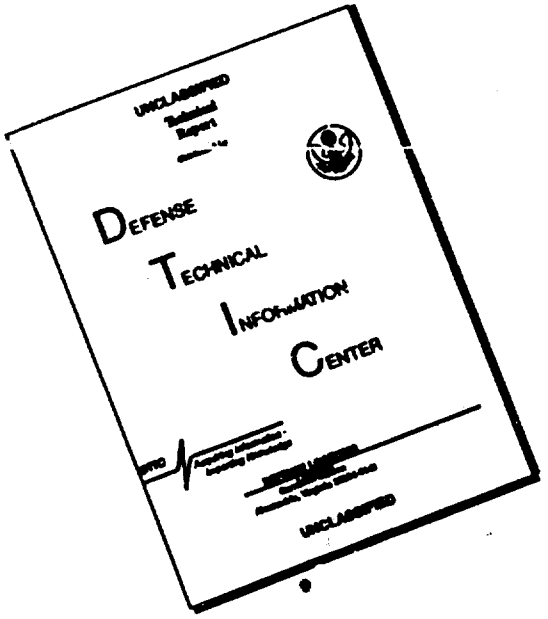

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EUROPEAN SCIENTIFIC NOTES
OFFICE OF NAVAL RESEARCH
LONDON

Edited By John G. Foss and Victoria S. Hewitson

30 September 1971 Volume 25, No. 9

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(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)* Office of Naval Research Branch Office London, England	2a. REPORT SECURITY CLASSIFICATION 2b. GROUP
3. REPORT TITLE EUROPEAN SCIENTIFIC NOTES, 25-9	
4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)* N.A.	
5. AUTHOR(S) *(Last name, first name, initial)* John G. FOSS and Victoria HEWITSON, Ed.	
6. REPORT DATE 30 September 1971	7a. TOTAL NO. OF PAGES 35 — 7b. NO. OF REFS
8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) ONRL-25-9 9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
10. AVAILABILITY/LIMITATION NOTICES APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED	
11. SUPPLEMENTARY NOTES N.A.	12. SPONSORING MILITARY ACTIVITY N.A.

13. ABSTRACT

This is a montly publication ~~presenting~~ of brief articles concerning recent developments in European scientific research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by disclosing interesting information well in advance of the usual scientific publications.

The articles are written by members of the scientific staff of ONRL, with an occasional article contributed by a visiting stateside scientist.

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AEROSPACE BEHAVIORAL SCIENCES BIOLOGICAL SCIENCES EARTH SCIENCES EDUCATION ENGINEERING MATHEMATICAL SCIENCES PHYSICAL SCIENCES NEWS AND NOTES						

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Index of ONRL Technical and Conference Reports, 1970 a-c

European Scientific Notes is Group II Newsletter type Class B periodical prepared & distributed by the Office of Naval Research London in accordance with NAVEXOS P-35. Prepared and submitted by the scientific and technical staff.

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Captain, USN
Commanding Officer

AEROSPACE

L'INSTITUT DE MECANIQUE DES FLUIDES - MARSEILLE

The Institute of Fluid Mechanics (IFM) which was formerly associated with the Université d'Aix-Marseille (UM), is now part of the Université de Provence which has been created by separation of the Faculté des Sciences from UM. These are clearly two different universities, each having its own president or chancellor. Specific details and the overall significance of the new university were not made clear to the writer because a number of changes due to the recent reorganization are still taking place. Prof. Jacques Valensi, Director of IFM, has become deeply involved in the reorganizational changes and presently devotes a considerable amount of his time to these matters.

IFM was created in 1930 and Valensi became the Director in 1948. At the present time, the Institute's staff consists of approximately 40 scientists and engineers who are supported by another 20 shop and office personnel.

A variety of research areas are currently being pursued at the Institute. Simplified methods have been developed for calculating the performance of helicopter blades in vertical motion. This work is being extended to include forward flight and will involve wind tunnel tests. It is very likely that the large subsonic wind tunnel which was built in 1940 will be used. It has an elliptical test section 3 m x 4 m, and a maximum velocity on the order of 40 meters/second.

Very interesting resonance tube experiments are being performed by E. Brocher. Much of this work was reported in the paper entitled "Fluid Dynamics of the Resonance Tube," (J. Fluid Mechanics 43, Part 2, 1970). More recent studies have been concerned with a new type of oscillator which consists of a jet discharging into two adjacent resonance tubes.

Cascade studies and a limited number of industrial aerodynamic applications are also being explored.

In addition to the subsonic wind tunnel, the main laboratory building houses a Mach 1.4-6 supersonic wind tunnel, a Mach 5-9 hypersonic tunnel, and a Mach 9-15 arc tunnel.

The main hypersonic facilities are located at the laboratory annex which is located at Marignane Airport (principal airport at Marseille). This laboratory, which was created in 1964, consists of a number of shock tubes and tunnels which have been used to study the interaction of ionized gases with a magnetic field, dissociation and ionization of gases, non-equilibrium effects and other phenomena associated with the dynamics of plasma. The funding for this type of hypersonic research work has been discontinued, and Valensi is concerned about the future use of these facilities. He hopes to keep the hypersonic laboratory operating at a greatly reduced level for the development and application of lasers. Some work has been carried out in the development of gaseous lasers. Future work will include the application of lasers to the generation of plasmas and to the measurement of gaseous properties in the hypersonic tunnels.

The group at IFM also carries out a limited number of theoretical and experimental studies in industrial aerodynamics. For example, Valensi recently designed a large barrier, 40 meters high and 100 meters long, to prevent the blowing away of large stockpiles of variable size ore and coal in strong winds. The final design of the barrier with a porosity of 0.58 was the result of a number of wind tunnel tests. Additional tunnel tests will be carried out to determine the conditions for which the mean velocity or the turbulence level of the flow behind the barrier becomes the predominant factor. From time to time, aerodynamic studies of the flow around the superstructure of ships and of the emission of smoke from ship funnels are also carried out.
(R.D. Mathieu)

A DAY AT THE VON KARMAN INSTITUTE

I recently spent a very pleasant and interesting day at the von Karman Institute for Fluid Dynamics, better known on this side of the Atlantic as simply VKI. Happily, the Institute is located a short distance from Brussels, some 15 kilometers from the Hotel Metropole in the heart of the city, on a

lovely wooded site called Rhode-Saint-Genese. A car from the Institute met me at the hotel and the driver treated me to a beautifully scenic and enjoyable ride that led through an extensive forest of beech trees which is home for a large herd of deer. Caution signs along the road alert you to their presence and to their habits of jumping across in front of cars. Luckily we did not bang into any of them. As we turned off the main road and into the drive leading to the Institute, I was immediately impressed with the natural beauty of the surroundings and I thought to myself how pleasant it must be for the students and for the staff of the Institute to come together in such an agreeable and peaceful environment.

For those who are not familiar with the origins of VKI, it seems worthwhile to mention briefly here that it was founded in 1956 largely through the individual efforts of Dr. Theodore von Karman and thus the Institute is named in his honor. It was apparently his dream to have such a place where students and professionals alike from many nations could come together for the purpose of education and research in aeronautics. Thus, it was that through cooperation with the countries of the North Atlantic Treaty Organization the von Karman Institute for Fluid Dynamics came into being.

The present director of the Institute is Prof. Jean Smolderen who is the third director since its inception and, interestingly, the first European. He is a very kind and thoughtful host. Previously the Institute was directed by an American and by a Canadian.

In our discussions I learned from Smolderen that the VKI operating funds are obtained largely through contributions from the participating NATO countries. The US participation has amounted to about $150,000-$200,000 annually with the Air Force as the administrating agency. The US support was a sizable share representing about 25% of the total budget. As of 1 July 1971, however, the US support has ceased altogether and Smolderen and his associates have been trying desperately to bring the US back into the fold. He indicated that the State Department and other agencies of the US Government had been approached as possible alternative sources of financial support, but to date all of the appeals have fallen on deaf ears.

When the Air Force announced about a year ago that their support would terminate as of 1 July, the future of the Institute was very much in doubt. The problem was finally resolved when Belgium agreed to increase her contribution to take care of the deficit left by the US withdrawal. But Denmark at this point, chose to drop out anyway. As a result, Belgium is now supplying 52% of the budget while the remaining NATO countries make up the balance. The present arrangement insures the Institute of at least three more years of existence, but what will follow after that is still uncertain since Canada who is also a major participant has indicated a desire to withdraw her support at the end of this period. Hopefully, some new US support will be forthcoming by that time to give this important international institute a new lease on life.

The educational activities of VKI take four distinct forms. Approximately 30-40 students per year enroll in the Diploma Course Program which is essentially equivalent to a master's degree program in the States. This is a nine-month tuition-free course open to all NATO participants and approximately 100 students in total have successfully completed it since its inception. A regular curriculum of both theoretical and experimental studies is followed in this program. Under a special arrangement, US students will be allowed to continue in the Diploma Course Program, but they will have to pay a tuition fee of $3,000.

The very popular Short Course Program is open to all interested persons and through the mechanism of tuition charges it is completely self-supporting. On the average, there are about 12 of these short courses offered each year with a total attendance in the neighborhood of 700 people. An announcement of these short courses can be obtained by writing The Director, VKI, Chaussée de Waterloo, 72, B-1640 Rhode-Saint-Genese, Belgium.

In addition to these educational programs, the Institute also offers a Doctoral and a Post Doctoral Program. There are, on the average, about 20 students working on doctoral research while five or so are doing postdoctoral study. Since all of the VKI staff are members of the faculty at either the University of Brussels or the University of Liège, the advanced degrees pursued at the Institute are awarded by one of these institutions.

The laboratory facilities at the Institute are both modern and extensive. I was impressed right from the beginning with the equal emphasis given to both the experimental and the theoretical aspects of the student training. It was

refreshing to see this balance because at many institutions in the States, the experimental training of students has been drastically cut back, and I for one think this deficiency will eventually catch up with us. I might also point out that the laboratory facilities are not used just for student instruction. Actually, a number of research projects funded by US and European organizations are underway, and many of the advanced students receive financial aid by working on these contracts.

One of the major laboratory facilities at the Institute is the Compressor and Turbine Lab where Prof. Jacques Chauvin and his students are working on a number of problems connected mainly with the operation of axial and radial compressors and cooling problems of high temperature turbines. Approximately one-half of the total research effort at VKI takes place in this facility which has assigned to it five permanent staff and ten PhD candidates. A lot of effort is being devoted here to the development of efficient supersonic compressors.

Hypersonic studies are being pursued by Dr. Brian Richards in the Longshot free-piston tunnel. The problems under investigation here are those associated with turbulent and laminar boundary layer phenomena, lee-side heating on a delta wing, free-flight force tests on statically stable models, dynamic stability of cones, and determination of cross-coupling derivatives on elliptical cross-section cones.

In addition to these facilities, experimental studies are also being done in a low-density tunnel, a fluidics and low speed laboratory, a supersonic laboratory, and in the newest facility - an industrial aerodynamics laboratory.

Smolderen explained that the present budget of VKI is set at about $850,000 a year of which $650,000 comes directly from the NATO participants while the remainder is realized from research contracts. Contracts currently held with the USAF amount to about $50,000 and the rest are with Westinghouse, Rolls-Royce, Rateau, and Suecma.

I left the Institute with the solid impression that it is serving an extremely important international function as a meeting place for students and professionals to come together for the purpose of exchanging ideas and knowledge. The educational program and facilities are excellent, and the staff is distinguished and dedicated. It would be a shame if this valuable organization were allowed to slip from view in three years time. (A.A. Ranger)

BEHAVIORAL SCIENCES

SOME EUROPEAN PSYCHOLOGY - HEART RATES AND WEATHER TO ORDER!

Dr. Walter L. Wilkins, Scientific Director of the Navy Medical Neuropsychiatric Research Unit in San Diego, visited some German and French psychologists in July and kindly provided us with his impressions in the following reports which should be of interest to our psychologically oriented ESN readers.

University of Konstanz, Germany

The University at Konstanz, now about seven years old, is still very small. It has grand plans, but delays in construction have prevented the implementation of these programs. A good number of high-rise academic buildings are well along, with chemistry apparently closest to completion. Until these new facilities are occupied, classes are held in some fairly new apartment buildings, designed as student housing, but being partly used now for classrooms, offices, and small laboratories.

The Department of Psychology of the University is largely staffed by former members of the Max Planck Institut für Psychiatrie at München. It was natural, then, for their research interests to include behavior of patients with psychiatric illnesses. The research is psychological and neurological rather than psychiatric, however.

In the new buildings (four years old) of the state hospital the Department has a research wing with instrumentation for EEG, EKG, and psychophysiological measurements.

Going along with the current research interest on the conditioning of autonomic functions, the laboratory worked for a while on the conditioning of the Alpha rhythm of the brain. They became convinced, however, that such conditioning was successful only in persons trained in meditation and in persons with an initial low mean alpha level. So they turned to conditioning of heart rate, where the therapeutic payoff, if successful, might be dramatic for some sorts of patients.

How patients react to the world around them ought to be measurable with psychological and psychophysiological methods. How do autistic patients, for instance, differ from normals -- do they have more concern with their own internal states? Apparently not, but there are a

number of measures on which psychotics differ from normals. Some of the work done at Langley Porter Neuropsychiatric Institute at San Francisco under ONR sponsorship has been replicated in Konstanz. Evoked potentials in psychiatrics are less reliable. In Konstanz, work with depressive patients has shown that with the presentation of pairs of stimuli there might be intervals which heighten or lessen the stability of the reaction. Individual variability also tends to increase.

The laboratory has been measuring social distance and territoriality in backward schizophrenics of 15 years average hospital stay, and finds that the same rules as apply to normals apply to schizophrenics, although the distances are greater than in normals or, say, alcoholics who tend to be less distant in experimental social situations.

Dr. Susanne Meyer-Osterkamp is working on behavior therapy research with stutterers, but her principal research efforts have been in size perception in schizophrenics. She finds that conflicting reports in the literature reflect different types of stimulus used and directives, as well as the expected effects of age and of type of schizophrenic process. Roughly, one finds a sort of expanded attention in paranoids and hebephrenics and a narrowed attention in autistic schizophrenics.

When Dr. Rudolf Cohen became Professor of Psychology, he brought from the Max Planck Institut staff members to fit this program of research. It represents very fundamental psychology with stress on perception, learning (in therapy), and psychophysiology -- all with a practical eye on applications to patients so handy to the research laboratory.

CNRS, Strasbourg, France

The Centre d'Etudes Bioclimatiques du Centre National de la Recherche Scientifique, while intimately tied in with the research and teaching functions of the medical school at Strasbourg, has an independent budget from the Ministry of Education and thus has a sort of independence of the University similar to that of the Medical Research Council units located at medical schools in the UK. The Director, Prof. Bernard Metz, has a progressive and very active research program devoted to practical problems of effects of heat, cold, noise, vibration, and all sorts of working conditions on productivity and on the health of workers. The Centre serves as a research arm for his Department of Applied Physiology at the University.

The Centre is located in a very large new building, built to Metz's specifications, in the suburb of Cronenbourg (where Kronenbourg beer is produced), among a set of other institutes devoted to mathematics and computer sciences, nuclear chemistry, etc. Formal organization dates from 1 January 1963, but the work is an extension of the work begun at Strasbourg in 1955 by Metz. The present building, equipped in ways to make visiting researchers envious, was first occupied at the end of 1967, but only now are the first giant rooms, designed to allow study of very rapid shifts in climatic conditions, being finished.

The University, with some 18,000 students, has about 3,000 medical students, but these latter would include young men and women pursuing what in the United States would be called the upper levels of premedical study. In addition to the heavy teaching demands on the main campus, there is a large clinical load for all the departments and clinics. The location of the new Centre on the outskirts of the city removes the applied physiology staff from these demands.

An early emphasis in Metz's work was on industrial safety. Studies of accidents among factory workers showed that, among those who routinely shifted from day to evening to night shifts, there seemed to be a reduction in number of accidents during the "graveyard" shifts. In Metz's view this was partially because all managerial, maintenance, and repair personnel were then absent. The accidents that did occur might be more severe, however.

A study of the influence of ingestion of alcoholic beverage on accidents, using 5,000 workers in eight factories, showed that no more accidents occurred after a lunch including wine than before lunch. Whether this finding, upon a typical French, wine-drinking population, would readily generalize to Detroit or St. Louis seems doubtful -- or at least, we should say that it might require cross-validation on a sample of Missourians.

These studies have led to a variety of work with health, safety, and efficiency measures in railroad workers, oil drillers in the desert, sailors and soldiers, and to an expansion of methods of study to include measures of noise and other specific industrial sounds, temperatures, sleep and the lack of it, muscular work and effort, psychophysiology, psychopharmacology, and psychophysics. Until just recently, Metz had his Centre organized with two principal sections -- one for Physiology and one for Psychology,

with supporting services under four sections: Biochemistry, including endocrinological, metabolism, and isotope studies; Calcul, including statistical and computer services; Technical, including electronic and mechanical support; and Administrative, with a good, although recent, library.

At present, however, the research efforts are ordered not by discipline but by problem area, and teams of researchers, always interdisciplinary, are assigned (and volunteer for) programs expected to require two to four years of concentrated effort to achieve results which will be practical and also generalizable to other situations.

In the new building are two very large areas, which look like small field-houses for winter practice of track and field events. One of these is being kept for reserve and the other contains the first of five concrete chambers of great size, with extremely accurate control of air flow, temperature, and humidity, with close to complete absence of vibration or noise.

Metz has many contacts in the USA. After finishing his war-interrupted medical studies, he spent the year 1949-1950 with Ancel Keys at the University of Minnesota, just at the time when the World War II classical work on The Biology of Human Starvation was reaching publication. He has visited the Army's laboratories at Natick, and some of his work on heat protective clothing and equipment is similar to Natick's. In the Spring of 1971, he lectured for CHABAS at Cape Kennedy and at NUC in San Diego.

Hôpital Val-de-Grâce, Paris

The principal teaching hospital for the French Army's medical services is Val-de-Grâce. It is housed in very old buildings -- the church was built by Queen Anne of Austria in fulfillment of a vow she made on the birth of her son, afterwards King Louis XIV. The former abbey buildings have served as a military hospital for many years. The psychiatric services are located on the third floor of one of these buildings, but will move to Percy Hospital, in the suburbs, next year. In anticipation of the moves, the size of patient load throughout the military hospital is being reduced from 750 (two years ago) to 450 (now), and will continue to decrease until a new hospital building is built.

Val-de-Grâce is used as a teaching hospital for a six-month training program for physicians in the regular army. Draftees get only a two-month orientation at Libourne, near Bordeaux. After a young physician has served two years, he is eligible for residency training in Paris or some other large urban center with university medical connections.

The psychiatric service at Val-de-Grâce has at present 100 beds, with eight medical officers and two (female) clinical psychologists, and the family and dependents service has 25 beds, with two physicians and two psychologists. In the Army, apparently all medical officers are male, and the clinical psychologist officers are all female.

The head of the service is Prof. P. Juillet - also a colonel. Chiefs of service in the teaching hospital carry the title of professor for seven years or until promoted out of it by becoming generals or commanding officers of hospitals.

Located in the capital, the psychiatric service provides consultative service for the Army and Navy and some emergency service for the Air Force.

A recent publication from the psychiatric service by Doctors Juillet and Pierre Moutin, his deputy, Psychiatrie Militaire (Paris: Masson & Cie, 1969), is an encyclopedic review and analysis of psychiatric problems in the military forces from before 1914, through the Great War, World War II, Korea, and later. It is thoroughly international with first-rate coverage of both Army and Navy clinical practice and research effort for the US and presumably therefore for other countries. It should introduce the research worker in psychology and psychiatry to areas other than his own and to contributions from countries other than his. Principal topics covered include the military milieu in time of peace and during wartime; epidemiology of psychiatric casualties; neurotic and personality difficulties in the armed forces; problems of treatment in the military, including medico-legal complications; criminology and the prediction of military offenses; aptitude and selection; mental hygiene and the prevention of illness.

Val-du-Grâce is not, in its present quarters, organized for research except as a by-product of the clinical services to soldiers and dependents. The Army's medical psychological research activity is concentrated at Lyon under Médecin Colonel Defayalle. (W.L. Wilkins, Navy Med Neuropsychiatric Res Unit, San Diego)

BIOLOGICAL SCIENCES

NEW SOURCES OF PROTEIN FOODS

With the world looking ever more like an overcrowded petri dish something should obviously be done now to prevent future famines and all of their accompanying human misery and political upheavals. Science and technology, through their application to raising the world's living standards and lowering the death rate, are partly responsible for this increased population. Science and technology must now be applied to alleviate the problem. For this reason, it seemed quite appropriate that the very first meeting sponsored by the newly organized "Industrial Biochemistry Group" of the British Biochemical Society should concern itself with new sources of protein foods.

The meeting was held 9 July at Oxford and opened by Prof. J. Hawthorn (Food Science, Strathclyde University), who commented that an annual increase of some four million tons of (dry) protein is needed to simply keep up with the world's expanding population. This tremendous increase amounts to about 10% of the world's current protein production, and it probably cannot be met using only conventional agricultural methods. Non-conventional approaches presently center on the use of petroleum or carbohydrates for protein production.

The first paper was presented by Dr. D.E.F. Harrison of Shell Research (Sittingbourne, England) who described their current research work in the use of single carbon compounds for producing protein from micro-organisms. From a theoretical point of view methane would be the most efficient single carbon compound substrate, but thus far only mixed cultures can utilize it. Since there are so many headaches associated with mixed populations in continuous culture, most efforts at Shell have been with Pseudomonas entorquens, using a methanol substrate.

Harrison presented data for yields obtained with batch cultures which fall from 33 to 15 gms dry cell weight/gram methanol as the initial methanol concentration varies from 2.5 to 25 gm/liter. Since the methanol may be somewhat toxic at high concentrations, they also tried gradually adding the substrate over a 15-hour interval, and this gave a 30 gm/liter yield for 20 gm/liter total methanol.

Some experiments were also done to learn if the presumed intermediates of formaldehyde and formic acid could sustain growth. The aldehyde gave only half the yield of the alcohol and no growth was obtained with the acid. Neither result is surprising, and it was not clear why these particular experiments were even tried.

Harrison seemed reasonably optimistic about the economic prospects for the process described and, as I learned from private conversations, Shell is presently installing a small pilot plant chemostat to begin continuous culture work.

Work at British Petroleum (BP) is much further along, and it was described in some detail by Dr. A.A. Yeo from their laboratory and pilot plant at Grangemouth, Scotland. Their studies began in the early fifties when they discovered yeast contaminating jet aircraft fuel. Since the yeast would only metabolize linear hydrocarbons, BP thought they might be useful for reducing the wax content of diesel fuel and incidentally, they might get some useful protein byproducts. However, by the end of the fifties their position was reversed, and the production of animal feed was set as the primary target.

By 1962 the project looked feasible economically, and a pilot plant with a 12 m^3 fermentor was built at Lavera, France. In this plant a petroleum distillate, with both linear and branched hydrocarbons, was used as the feed. Centrifugation and solvent extraction were used to remove the metabolized branched hydrocarbons. Unfortunately, it also reduced the yeast lipids from about 8 to 0.5% leaving a somewhat less nutritious product and the problem of disposing of the lipids.

During the development of the Lavera plant another group was established in Grangemouth to do fundamental studies on the details of the process. By 1968 this group had developed an alternate process which used pure linear hydrocarbons extracted from petroleum for the yeast substrate. The process looked sufficiently promising that a 4000 ton/year pilot plant was built at Grangemouth. Furthermore, since the Grangemouth group's interests were now centered on development work, a third group was established in Paris to do fundamental research.

Yeo showed results of feeding studies for producing chick broilers, eggs, pork and fish. In this work the yeast was added in various amounts to standard rations as a protein supplement, and similar experiments were made with fish meal as a control. There appeared to be no significant difference. Yeo hedged on

the price of the yeast meal, but indicated it was competitive with fish meal. At present two-year toxicity carcinogenicity tests and multiple generation studies on rats are underway as well as 18-month carcinogenicity tests on mice.

No clear economic advantage favors the Lavera or Grangemouth processes. The additional cost of removing branched hydrocarbons from the first product is offset by a similar cost for preparing the linear hydrocarbon substrate in the second process. Consequently, both pilot plants are being scaled up. A 16,000 ton/year plant should be completed at Lavera by the end of the year and additional 4,000 ton/year units will be added at Grangemouth.

A carbohydrate based approach to protein synthesis was described by Dr. G. Solmons (Lord Rank Research Centre, High Wycombe). He began his talk by briefly discussing the "net protein utilization" (NPU) assay used by nutrionists. In this assay gelatin, which lacks certain essential amino acids, cannot by itself be utilized by animals and has an NPU of zero. Whole egg has an NPU of 100. On this scale wheat is 40, casein 70 and meat 65-75. Solmons explained that the initial goal of his research was to produce a protein with an NPU of 70 without using amino acid supplements.

One of the few microorganisms which meets this criterion are the filamentous microfungi. As a substrate for them the Lord Rank Centre hoped to use readily available cheap starches such as casava. (In fact, the motivation for the entire project lies in the large price-spread between these cheap carbohydrates and typical proteins.) But unfortunately the fungi will only readily metabolize mono- and di-saccharides, and Solmons indicated a key role was played in the project by chemists at the Lord Rank Centre who were familiar with the technology of starch hydrolysis needed for producing these substrates.

At present the fungi are being grown on a rather small scale in a 10-liter chemostat with carbohydrate as the limiting growth factor and ammonia as the nitrogen source. The long (80-1000 micron) filaments of the fungi cause considerable difficulty in handling since the suspensions are highly viscous ("like a thick porridge") and are consequently also difficult to aerate adequately. However, the same filaments also provide a desirable meat-like texture in the final dried and reconstituted product. Solmons mentioned that if you weren't told what you were eating, you might mistake pieces of the final product for pieces of meat - if it was in a curry dish!

Solmons believes the problems of texture and taste can be most readily overcome if the material is treated as a new food - like cornflakes or potatoes were once new foods - rather than as a meat substitute. But there is one serious nutritional problem remaining, and this is the excessive amount of ribonucleic acid (RNA) in the fungi. The RNA content can be reduced by lowering the growth rate, but the levels are still excessive, and Solmons was obviously troubled by this point.

After the individual speakers were finished, they returned as a group to the front of the lecture hall for questions from the audience of about 150. Most of the questions were friendly enough except those from one individual who tried to give a speech suggesting the speakers were out to poison us all. Rather surprisingly the only question not answered concerned the nature of the mixer used by the Grangemouth group. (Introducing oxygen into their two-phase mixture was apparently one of their more serious problems.)

I left the meeting with the feeling that considerable progress has been made toward meeting the four million ton annual protein deficit mentioned by Hawthorn at the opening of the meeting. The experimental British Petroleum pilot plants were already at one half percent of the figure and there seemed to be no problem in scaling them up. However, since the world's petroleum resources may be largely gone in thirty years, the ultimate solution to the food problem must be in population control. (John G. Foss)

MICROBIOLOGY AT THE UNIVERSITY OF MANCHESTER

Among new buildings close to the city center, an impressive modern university is being fashioned in an older part of Manchester. With the removal of antiquated dwellings, brick, steel and concrete have provided utilitarian structures with eye appeal and space for this growing seat of learning. A new medical school building is under construction near by. When completed, the number of medical students will be increased from the present 160 to almost double that number per year. Recently a second teaching hospital has been added and a third is planned.

Microbiology in the Department of Bacteriology and Virology is taught under the direction of two Professors: T.S.L. Beswick in Virology and P. J. Collard in Bacteriology. Besides the medical students,

instruction in microbiology is given to fourth year dental students, science and medical graduates working for Master's and PhD degrees, and students of nursing, pharmacy, botany, and medical laboratory technology. In addition, an intensive one-year course leading to a Diploma in Bacteriology is given to specially qualified graduate students. Only two universities in Britain offer the Diploma in Bacteriology (Dip. Bact.): Manchester and the London School of Hygiene and Tropical Medicine. This degree is unique and is recognized throughout Britain and abroad as a qualification which is earned by only a select group who have a thorough advanced training in microbiology.

The Department is divided into three sections: Virology, Bacteriology and Immunology. With the heavy teaching load which is required when a total of approximately 600 students are instructed each year, the research activities of the staff are somewhat restricted. Nevertheless, an active program of research is maintained.

In the field of Virology, Beswick is interested in the effect of live poliovirus vaccine in tropical countries. He is working closely with WHO authorities in these studies. Because of the reported interference with replication of poliovirus in the intestines of some people, in particular those living in the tropics, he is investigating the role of interferon. He found that there is no interferon in the gut contents. Further, it was determined that interferon is rapidly destroyed in the intestine of man and animals. The mechanism of destruction, however, is not known, but it is not due to the action of trypsin. It is hoped to extend this work.

With Mr. Graham Cleator, Beswick is studying the role of Australia antigen in infectious hepatitis. While this antigen is found regularly in infections classified as serum hepatitis, its place in hepatitis with short incubation has not been made clear. Tissue culture studies with liver cells have not worked out well in attempts to isolate the virus which may be associated with hepatitis. New approaches are being made from considerations of normal liver functioning. Since the liver has a temperature slightly higher than other less centrally located and less metabolically active tissues, the conditions for culture of liver cells are being altered accordingly. It was also determined that the liver is normally fairly rich in amino acids and is slightly more alkaline than other organs. With modifications of technique along these lines it is hoped that significant results will be obtained.

Another result of the work is the finding that some preparations of yeast extract prevent the development of cytopathogenic effects by vaccinia virus in primary or secondary human amnion cell cultures. Studies are under way to isolate and identify the component which inhibits growth of the virus and elucidate its mode of action.

Studies of the growth of respiratory syncytial virus in cell cultures are being undertaken by G. Corbitt. Generally only low titers are obtained with this RNA virus, and methods to improve virus yields are being investigated. The relationship of replication of the virus in cultured cells to production of interferon by the cells is also under examination. Dr. A. Mostratos is working on non-specific inhibitors of viral hemagglutination.

In the Bacteriology Section Collard is studying mixed populations of bacteria in continuous culture. He is particularly interested in the interrelationships of growth of intestinal bacteria under controlled conditions, and the role of resistance transfer factors in development of antibiotic tolerance among enteric bacteria. In a related area, Dr. A.F. Tuxford is studying the intestinal flora of children and the relationship of the bacterial contents of the gut to gastroenteritis. Tuxford has just completed a study of bacteriuria in 2000 children. A number of unsuspected urinary infections were found. Dr. N.W. Preston has been studying antigens of Bordetella pertussis. He is also examining the efficacy of pertussis vaccines in children and is investigating experimental infection of monkeys with B. pertussis in order to determine the pathogenesis of these bacteria. Preston is working closely with the Public Health Laboratory Service Whooping Cough Committee. Dr. P.S. Corfield is studying the ultrastructure of Group D streptococci and their L forms. Dr. D.B. Drucker has an interest in experimental dental caries of rats. As a means for identifying strains of bacteria which are found in his caries program, he developed techniques for obtaining characteristic reaction patterns when cultures are grown under standardized conditions in defined media and examined by gas-liquid chromatography. Identification of bacterial strains and species is made on the basis of the amount and kind of each constituent found in the culture.

In the Immunology Section Dr. G. Taylor has provided dynamic leadership for the staff members who are interested in problems of hypersensitivity and tumor

immunology. He has investigated the role of hypersensitivity in the disease of byssinosis which occurs in cotton workers. He has established that workers who come in contact with parts of the cotton plant, other than the cotton, develop a sensitivity which can be detected by precipitin tests using an extract of the leaves and pod of the plant and serums of the workers. In studies with human breast carcinomia, a tumor-specific T-like antigen has been found which may be of value in diagnostic work. Dr. A. Panikker has been investigating cellular aspects of immunity. In these studies she has worked with Salmonella typhimurium infection of mice (mouse typhoid fever) as a model.

Special studies have been undertaken by H. Mamattah on the use of a purified antigen from Neisseria gonorrhoeae in a complement fixation test for diagnosis of infection.

The laboratories of this Department are well equipped and there is a stimulating environment for research. The emphasis for research is secondary to the responsibility for teaching. Yet the interest in acquiring new knowledge is so great that each staff member has found an area where he feels he can make a worthwhile contribution. These contributions are providing a more complete understanding of the nature of infectious microorganisms and the pathology which they produce. (G.A. Hottle)

MICROBIOLOGY AT THE UNIVERSITY OF LIVERPOOL

The University of Liverpool has undergone considerable face lifting and expansion within the past 20 years. A reasonably attractive city campus has evolved with modern buildings and towers interspersed among the Victorian-style original University halls. The student body of about 7000 includes the medical, veterinary, science, engineering, legal and humanities faculties. This institution ranks as one of the top "Red Brick" universities in Britain. At present 135 medical students and 50 dental students are admitted each year.

The Department of Medical Microbiology has recently changed its name from that of Bacteriology. Moreover, its interests go beyond medical matters and extend into general microbiology. The staff has an extensive teaching program in the Science Faculty as well as in the Medical Faculty. As in other British universities an "Honours" program in Microbiology is provided for those undergraduates who show special aptitude and who spend an additional year in concentrated studies. When the program with its special examination is successfully completed, the candidate is graduated with "Honours" in microbiology. At present eight "honours" students are working in the Department, and 60 general science students are enrolled in its microbiology courses.

The chairman of the Department of Medical Microbiology, Prof. K. McCarthy, with his staff of four senior lecturers and three lecturers, has responsibility for the teaching and research program in microbiology. It was estimated that one third of the time of each staff member is devoted to teaching. The research activities of the Department follow five main areas: influenza, rubella, the Herpes group of viruses, poxviruses and antibiotics. Dr. D. Hobson is studying genetic markers for virulence in influenza viruses, and has undertaken collaborative clinical trials of selected live attenuated strains of influenza viruses to determine their immunizing capacity in human volunteers. The degree of immunity is determined by challenge with disease producing strains of virus. Hobson is a member of the Medical Research Council (MRC) Committee on Influenza and other Respiratory Virus Vaccines.

McCarthy and A.E. Caunt are studying cell-associated herpes viruses including varicella and several viruses recently isolated from fatal simian infections. The biology of infection of animals with these viruses is being studied in comparison with non-cell associated simian and human herpes viruses. In an outbreak of a lethal exanthematous disease in patas monkeys, a cell-associated virus of the herpes group was isolated in monkey and human tissue cultures. It was possible to reproduce the disease in healthy patas monkeys with both the isolated virus and extracts of tissues from infected monkeys. The virus could not be grown in any other tissue. The clinical and pathological features of the disease in monkeys were similar to those seen in vervet monkeys from which a virus (Liverpool vervet virus) with similar properties was isolated a year earlier. McCarthy is Secretary of the MRC Simian Virus Committee and an active member of the MRC Committee which is organizing clinical trials of rubella vaccines.

Studies of strains of rubella virus and their characteristics which may serve as markers of attenuation are being carried out by Dr. C.H. Taylor-Robinson. He has under way field trials with several prototype vaccines and is including in these studies the communicability of the strains to unvaccinated contacts. The first rubella

vaccine licensed for use in Britain arose out of the research of this scientist. He is a member of MRC Rubella Vaccine Committee.

The works of Dr. Carl Taylor-Robinson is in the best tradition of the Taylor-Robinson family, with a brilliance rivaling that of his older brother David who is working at the Clinical Research Centre Laboratories of the National Institute for Medical Research in London.

Research with poxviruses is being conducted by Dr. D. Baxby and Emeritus Professor A. W. Downie. In studies of buffalo-pox, a disease known for a long time in India, Baxby has shown that this complex syndrome is caused by more than one virus. However, among the micro-organisms isolated from infected animals, a new poxvirus has been recognized and described as buffalo-pox virus. Downie has just completed an investigation of a poxvirus, which he isolated from children in the Tana Valley, Kenya. This new virus, Tanavirus, was found to be identical with several viruses which were recently isolated from monkeys and their attendents in the US. The virus caused cutaneous eruptions in the personnel, and African monkeys were identified as the probable sources of the infections. The World Health Organization has made calls on the staff and isolation facilities of the Department to help determine the identity of other poxviruses which had caused several outbreaks of smallpox in Africa. Collaborative studies here and in London, Utrecht, Moscow and Atlanta have indicated recently that the virus isolated was not typical smallpox virus, but was the virus of monkeypox.

Other studies include investigations by Dr. B.C. Pratt of the surface structure of mycoplasma by the scanning electron microscope and visualizing various antigenic sites with ferritin-labeled antibody. The antibiotic control of bacterial infections is under study by Dr. A. Percival. His interests have been applied to urinary tract infections and their treatment with mixtures of antibiotics. He is engaged in studies of bacterial respiratory infections and infections due to members of the anaerobic Gram negative bacteria of the bacteroides group. The latter appear to have an increasingly important role in wound infections recently.

Although the laboratory space may be somewhat cramped for teaching purposes, the research facilities of the Department are well arranged and there is adequate equipment for the work being undertaken. There was every indication that the staff members are enthusiastic in the pursuit of their research studies and that they are supported by the University and the national medical research authorities. (G.A. Hottle)

MICROBIOLOGY AT THE UNIVERSITY OF LUND, SWEDEN

The University of Lund is located in this lovely ancient city of Southern Sweden. While portions of the University still occupy some buildings in the older part of the city, the University Hospital and Medical School are situated on high open ground in modern buildings nearby. The Institute (Department) of Medical Microbiology under the direction of Prof. Rune Grubb occupies one of the new buildings of the Medical School. The work of the Institute includes teaching 200 medical students each year. One hundred students each term receive instruction in virology, bacteriology and mycology. In addition, a large program of diagnostic work is carried out for the local hospitals and physicians in the surrounding area. This program is highly organized with different groups of technicians engaged in specialized diagnostic activities, each in a separate laboratory. There are groups working in the following areas: immunochemistry of blood, gonococcus isolation, cultures of wound and skin infections, throat cultures, blood culture, urinary tract infections, mycoplasma isolation, tuberculosis cultures and fungus infections. The technicians engaged in this work are trained in special schools. A two-year intensive course after their basic education in public school gives them the equivalent of a BS degree and qualifies them for the work they are doing. In addition to their teaching and diagnostic work, the staff are expected to conduct a program of research which is related to the responsibility for diagnostic work.

An interesting activity at the Institute of Medical Microbiology is the immunochemical determination of the various complement components and of immunoglobulins in the serums of patients. Prof. A.B. Laurell, who worked as a bacteriologist for some years, is now actively engaged in detailed analyses of serums for IgA, IgM and for the $C^1 1$, $C^1 2$, $C^1 3$ and $C^1 4$ factors of complement. This work has proceeded so well that his laboratory has been designated a

Regional Reference Centre for Genetic Factors of Human Immunoglobulins by the WHO. In a recent study it was shown that IgM levels are elevated in some patients with early syphilis and in most serums from patients with late syphilis. The IgM level is suggested as useful for estimating the activity of late syphilis. In studies of complement components in the serums of patients with hereditary angioneurotic edema, levels of $C^1$1 esterase and $C^1$1 esterase inhibitor were followed. With these tools it was possible to diagnose the disease and control treatment, first with epsilon-aminocaproic acid and later with trans-4-(aminomethyl) cyclohexane carboxylic acid.

In the area of bacteriology Dr. Göran Kronvall is studying the reaction of staphylococcal protein A with human and mouse gammaglobulins. The protein A, which is extracted with phosphate buffer at 100° C from carefully washed selected strains of staphylococci reacts with the Fc H-chain structures of IgG but not with IgA or IgM. In addition it precipitates with mouse myeloma globulins Ig2a, Ig2b and Ig3. Since normal human and mouse serums will give direct precipitin reactions with protein A, it was initially thought that the reactions represented naturally acquired antibody to staphylococci. Later work showed protein A to be a marker for a particular Ig amino acid sequence or conformation. Now it is known that all members of the class Mammalia except the American oppossum show reactions with this protein. The finding that serums of germ-free mice have agglutinating antibodies for protein A containing strains of staphylococci is additional indication for the phylogenetic aspect of this reaction. One practical consideration from these studies is the need for animals other than mammals for preparing antiserums against staphylococci. Kronvall is interested in investigating the role of protein A in the survival of staphylococci. He has found that rabbits do not harbor staphylococci for long periods, but whether this is due to enhanced anti-protein A activity or to a combination of factors is not known. To study this situation further, he is planning the experimental infection of mice with protein A positive and protein A negative strains of staphylococci to determine the factors responsible for the purulent walled-off lesions which often develop during staphylococcus infections.

This Institute has all the appearances of an excellent place to work in medical microbiology. A great amount of clinical diagnostic microbiology is being done, and there is a large staff of workers. Whether this situation will permit a scientist to engage in a worthwhile research program depends on the individual. Perhaps the best that can be said is that this Institute provides an ideal laboratory for the practice of medical microbiology. From the microorganisms found in the daily operation of the laboratory, it would not be difficult to find some facet to interest an inquisitive microbiologist.

In the Department of Microbiology of the Natural Science Faculty, Prof. Claes Weibull has a staff of 15 of whom 12 are graduate students and three are staff assistants. With this staff, research and teaching of general microbiology are carried out. Classes of approximately 20 students are instructed each term, many of whom are undergraduates majoring in microbiology.

Weibull is studying the structures of L-forms of bacteria as revealed in the electron microscope. The occurrence of vacuoles in L-forms and not in the parent bacteria has been observed. Apparently the vacuoles are not caused by defects in the cell membrane, nor by artifacts. They may be due to a deficiency of some enzyme system, permitting the accumulation of certain metabolites. Such a deficiency is known to occur when bacteria are converted to stable L-forms. These studies have shown that L-forms and parent *Proteus mirabilis* contain comparable amounts of endotoxin.

Another member of the faculty, Dr. Börge Norén, is interested in the growth and enzymic properties of various species of myxococcus. He is also studying the ecology of bacteria in soil, in collaboration with soil and botanical scientists. In this work changes in the character and composition of the soil are being followed for numbers and kinds of bacteria and fungi that can be recognized. This collaboration is also extended to investigations of methods for biological control of plant disease microorganisms, with the aim of replacing the resistant

biocides, now in use, with predators that can coexist at an acceptable level in the biosphere. In his studies of thermophilic bacteria, Norén found that they require more calcium ions than mesophilic organisms. These ions apparently stabilize protein so that normal functions can be carried out at the higher temperatures.
(G.A. Hottle)

THE MEDICAL RESEARCH COUNCIL LABORATORY ANIMALS CENTRE

Situated one-half hour train ride to the south of central London in Carshalton, Surrey, the Laboratory Animals Centre occupies spacious and pleasant quarters overlooking a green, tree-filled expanse. On a recent visit, I was greeted by the Director, Mr. John Bleby, who outlined the history and functions of the Centre. Founded initially in 1947 as the Laboratory Animals Bureau for the exchange of information on all aspects of laboratory animals, the Centre moved some years later to its present quarters consisting of two main permanent buildings, some converted stables, and outdoor holding areas for a small number of larger animals. Over the years it has expanded its activities into four main areas: service, supply of animals, training, and research.

The service function is broad and varied, from the answering of many individual questions from the UK and elsewhere, to the establishment of standards for laboratory animal equipment and feed and the testing of such items. The Centre cooperates widely on the international scene with individual investigators and organizations involved in the use of laboratory animals. It publishes a semi-annual News Letter detailing its activities, a Mouse News Letter concerned with mutant strains of this species, and a Catalogue of Uniform Strains listing all important strains of common laboratory species maintained throughout the UK.

The Centre's second important role relates to control over the supply of laboratory animals. This is accomplished by an accreditation scheme for commercial breeders, which is not mandatory but is sought after by the great majority of breeders. To be accredited the breeder must satisfy rather strict requirements on condition of premises and animals, and on sources of animals. In return, he may obtain free veterinary advice and laboratory tests from the Centre, as well as recommendations on sources and buyers of animals.

The Centre is itself a small but very important supplier of animals. These are essentially of two types, several inbred strains of mice, on the one hand, and Specific Pathogen Free (SPF) animals (mice, rats, guinea pigs, rabbits and cats),on the other. The latter operation is carried out in the isolated SPF unit with rigid control on personnel and equipment to avoid contamination. Recently, germfree animals have been maintained at the Centre.

An active training program for veterinarians in the principles and practice of laboratory animal medicine is carried out at the Centre. Visitors from throughout the world have availed themselves of this opportunity.

Research activities by the scientific staff are directed towards the main missions of the Centre. Although limited in extent by the administrative and technical demands on the staff, the work is of high quality. I spent most time with Dr. G. Clough, Environmental Physiologist, a young man who received his doctorate at Oxford on aspects of comparative reproductive physiology and who has been at the center somewhat more than a year. Clough's duties, as his title suggests, center about problems of the effects of environmental factors on the health and development of laboratory animals. He, like his other colleagues at the Centre, is called on frequently by animal users for advice on the maintenance of their animals, and is heavily involved in the supervision of the Centre's own animal colonies. He is just in the process of setting up several small environmental chambers to study the effects of noise, temperature and lighting on reproductive behavior and development.

Dr. Michael Festing, Geneticist, is in charge of the breeding colonies, including both the maintenance of purity of strains and the development of useful hybrids. He has recently been studying the heritability of learning ability in mice through selection for learning to escape in a water maze, and showed me evidence indicating some success.

An independent project carried out over the past two years, and now nearing completion, by Mr. K.R. Hobbs, Primate Officer, involves problems of the importation and use of primates in laboratories of the UK. One of the main issues is the advisability of establishing a primate center in the UK. Hobbs has visited the several such centers in the US, and has thoroughly explored the various aspects of the problem. His report is due to be submitted to the Medical

Research Council this year.

The Centre also has professional staff in pathology, nutrition and parasitology, but time did not permit me to visit these departments.

To my knowledge the Centre is unique, and would appear to serve as an invaluable support in many ways to biological laboratories throughout the UK. Through the one operation alone, the accreditation of animal suppliers, investigators are assured of at least minimal control over the condition of their experimental animals. This, of course, means higher cost per animal, but in the long run should imply more consistent and meaningful experimental results. Biological laboratories in the US could well benefit from availability of this and the other sorts of service which the Centre provides to the UK laboratories.
(R.R. SONNENSCHEIN)

SYMPOSIUM ON RECENT PROGRESS IN FUNDAMENTAL PHYSIOLOGY OF DIVING

Under the general chairmanship of Dr. Karl E. Schaeffer of the USN Submarine Medical Center, New London, Conn., and the local direction of Professors J. Corriol and J. Chouteau of Marseille, an active two-day conference with about eighty participants was held at the pleasant quarters of the Centre National de la Recherche Scientifique (CNRS) laboratories in Marseille on 23-24 July 1971. This was one of the thirty or so "satellite symposia" organized along special interests and held in various European centers just preceeding and following the International Physiological Congress in Munich. Participants in the Symposium naturally came chiefly from laboratories engaged specifically in the problems of human diving, but also included were a number of investigators in other aspects of basic respiratory and cardiovascular physiology.

P.E. Paulev (Copenhagen) introduced the first session, on diving bradycardia, with a review of factors which have been implicated in the phenomenon, including stimulation of trigeminal afferents, as by cooling of the face, alterations in transmural chest pressure (a positive correlation with degree of bradycardia), and the increase in reflex bradycardia when the subject is exercising. The importance of cooling of the face was stressed by A.B. Dubois (Philadelphia) whose experiments indicated an insignificant role of O_2 and CO_2 tension, lung volume, and intrapleural pressure in the reflex bradycardia of face immersion. S.B. Strømme and colleagues (Oslo) showed that hypercapina alone is not responsible for the demonstrated potentiation of diving bradycardia by exercise. R. Elsner, B.A. Gooden, and S.M. Robinson (La Jolla and Adelaide) stressed the primacy of neurogenic factors in the response to face immersion, while T.O. Moore, D.A. Zally and S.K. Hong (Honolulu) considered a multiple-factor hypothesis to be most acceptable.

Passing on to the topic of the limiting factors in breathholding diving, A.B. Craig discussed the role of the blood gases, principally CO_2, and O_2 secondarily, and the possibility that a shift of blood to the central circulation, accommodating for the space lost by compression of air in the lungs, may account for dives below the "theoretical limit." Hong described the changes in alveolar and arterial gas contents, cardiac output, and arterial, right atrial and esophageal pressures during prolonged breath holding. Some aspects of physiological performance in the famous diving ama of Japan were presented by T. Yokoyama (Tokyo) who stressed the adverse effects of cold on the maximum duration of dives. Schaefer spoke of some of the respiratory and circulatory factors that affect depth limits in breath holding dives, including the role of lung compression. Finally, R. Sciarli and colleagues presented the results of measurements made on J. Mayol, a record holding free diver, during a dramatic 3 min. 32 sec. breath holding, during which his Hb saturation fell from 100 to 26%, while alveolar P_{CO_2}, which was low to begin with, stayed essentially constant.

Most of the remainder of the Symposium was devoted to effects of pressure on physical and cellular mechanisms, on respiration and on performance. D.Doell (Montreal) reported on depression of the ventilatory response to CO_2 at depth, and the facilitation of the response by hypoxia, while R.R. Martin (Montreal) showed that pulmonary exchange of O_2 is improved at depth in the presence of a dense gas such as SF_6. Several other investigators (W. Sterk, J.V. Salzano, J. Vorosmarti, B. Broussole and J. Chouteau) discussed additional aspects of the respiratory effects of increased pressure.

These represent just a taste of a full, active program which included, in

addition, papers on effects of high pressure on a range of physiological variables (performance of the isolated heart, spinal reflexes, EEG, etc.), inert gas exchange, and the "nitrogen problem."

This meeting, bringing together as it did workers from throughout the world with an intense interest in the problems of human diving, was marked by the enthusiasm of the participants and the active exchange among them. The organizers are to be congratulated on their selection of speakers and their overall planning.

Corriol, the genial and effective host of the Symposium, hopes that the proceedings of the Symposium may be published by the Marseille University Press.

Announcement was made of the forthcoming meeting on Underwater Physiology to be held in the Bahamas on 21-25 August 1972. Dr. C.J. Lambertsen, University of Pennsylvania, is chairman of the planning group for the meeting, to be sponsored by the UK Society of Underwater Technology, the University of Pennsylvania, the Undersea Medical Society and ONR. (R.R. Sonnenschein)

XXV INTERNATIONAL CONGRESS OF PHYSIOLOGICAL SCIENCES

With the growth of physiology, and the consequent increase in size of the international meetings, one often wonders whether these congresses have not long since outlived their usefulness. As physiology and physiologists have become increasingly specialized, shouldn't the attempt be abandoned to bring together all who share that title, just for the sake of tradition? After all, the muscle biophysicist doesn't talk with the microcirculationist, nor the exercise physiologist with the axonologist, and if they were to try they wouldn't understand each other anyway. Besides, the sheer numbers of participants at the congresses must preclude the attainment of primary aims of such meetings: the face-to-face encounter with the previous stranger known only through his writings, the informal discussion of what <u>really</u> happened in the experiments, the renewing of old friendships in a relaxed way. Fortunately, this Congress, held in Munich on 25-31 July 1971, with close to 4000 participants, showed that these objections need not be true - with proper planning and appropriate physical facilities, the Physiological Congress, held every three years, can be educational, stimulating and otherwise enjoyable.

All scientific activities were held in Messagelände, the large fair grounds some 10 minutes by tram from the city's center. Adjacent to a pleasant park, one large and two small neighboring buildings sufficed to house the many simultaneous sessions, as well as provide a large lounge area for informal discussions.

The organization of the Congress was imaginative and efficient. Each morning and afternoon two 3-hour symposia were held on current, active topics selected from the broad span of physiology. These ranged from "Regulation of Respiration and Acid Base Balance" to "What is New in Epithelial Transport?" Not only were the older, recognized leaders in the particular areas invited to participate in these symposia, but also many of the younger active workers.

Simultaneously, in other halls, series of invited lectures on special topics were given. Here, the specialists, carefully chosen, reviewed their topics for the general audience, and at least among the speakers I heard, did their job exceptionally well. It was possible, as must have been the intent of the Program Committee, for the physiologist-in-general to grasp the essence of developments in special topics outside his own area. The speakers must have been well instructed. In these lectures, especially, the effort was made successfully to bridge the language gap among the physiological subspecialities.

Throughout the several days and in parallel with the symposia and invited lectures, there were nine or ten sessions of "free communications," the usual 10-minute papers, each with a 5-minute discussion period, grouped according to topics; some 1800 of these were listed. As usual, quality varied, but again, perhaps through some prior screening by the Program Committee, the overall level seemed to be higher than customary.

The social activities likewise showed evidence of excellent planning and forethought. Daily tours to the museums and sights of Munich and its surroundings attracted the families of participants (and some of the scientists as well), and two splendid evening performances were offered: Bach's B-minor Mass and the Marriage of Figaro. A high point was the Congress dinner held at a massive beer hall, complete with a Bavarian band and songs.

From the introductory greetings to the closing session, in which Konrad Lorenz spoke on the importance of a

ıolistic approach to biological investi-
·ation, this Congress was indeed a
uccess. To the extent that the next,
o be held in New Delhi in October 1974,
ınd subsequent ones can approach the
ame standard, the value of the Con-
ıresses is assured.
(Ralph R. Sonnenschein)

EARTH SCIENCES

INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS (IUGG)

IUGG meets every four years, the XV General Assembly being held in Moscow 30 July - 14 August 1971 under the presidency of J. Coulomb of France. The Union consists of the International Associations of Geodesy (IAG), Seismology and Physics of the Earth's Interior (IASPEI), Meteorology and Atmospheric Physics (IAMAP), Geomagnetism and Aeronomy (IAGA), the Physical Sciences of the Ocean (IAPSO), Volcanology and Chemistry of the Earth's Interior (IAVCEI), and Scientific Hydrology (IASH) plus the Upper Mantle Committee and Tsunami Committee. Some 71 countries are represented in the Union and support it financially.

These meetings are always huge and somewhat unwieldy. The Moscow assembly was no exception with almost 3000 scientists registered. On any given day a dozen simultaneous scientific symposia were going on plus meetings of the executive committee, the council, special commissions, working groups and committees. As usual, there was some muttering in the halls about the awkwardness of such a large assembly, but the general opinion still seemed to be that the opportunities provided for contact among scientists of many nations are of great value.

The host Soviet scientists worked very hard and reasonably successfully to provide the facilities and amenities needed at such a congress. Meetings were held at the huge Moscow State University (40,000 students who, happily, were not in attendance at the time). Their efforts and graciousness were, unfortunately, somewhat marred by the massive bureaucratic nature of Intourist and the various hotels. Most attendees had some unpleasant experiences attributable to compartmentalized administration, lack of concern and the language barrier. One learned anew the virtues of patience, and I found the most useful word in my meager Russian vocabulary was NICHEVO (it's nothing; it doesn't matter).

Such a large meeting makes it impossible to attend more than a small fraction of the sessions, consequently this report will deal with only those papers I happened to hear and which appealed to my personal tastes.

Certainly, the entire day devoted to a progress report on GARP (The Global Atmospheric Research Program) was an outstanding event. Theoretical-numerical modeling and prediction of the state of the atmosphere has progressed to the point where one now asks what are the factors limiting the period of time for which useful forecasts can be made. Analysis of the effect of observational errors in the initial conditions suggests that these will render the forecast useless in about two to three weeks. Current prediction becomes invalid in much less time than this, and the immediate problem must lie with the physical adequacy of the current models and with lack of completeness in the global, 3-dimensional observations needed to start a computation. The observational deficiencies can be remedied, which would then permit an exploration of the kinds of generalization of the models needed to reach full potential. Indeed, the issue is circular because the nature of the "ultimate" model will dictate the kinds of global data required. GARP is, therefore, a proposal to provide a global set of observations in about 1976 to permit refinement of the models and to test the limits of predictability.

GARP has political, technical and scientific problems to solve. The first kind stems from the international nature of the experiment and the need for scientists and governments to work closely together. Thus, it was necessary to establish a relationship between the International Council of Scientific Unions (a non-government body promoting GARP) and the World Meteorological Organization (WMO - an arm of the UN and, therefore, a governmental body). WMO has responsibility for the World Weather Watch (WWW), an international effort to improve the observing network for immediate practical benefit. GARP is a research experiment and while its needs overlap those of WWW they are not identical and this creates some problems.

The outstanding technical problem revolves around finding the best way to gather the needed global data (wind, temperature, pressure, etc.) at accept-

able cost. At first, high hopes were vested in a system of large numbers of contant-level balloons, tracked and interrogated by satellites. We now know that at the very important middle levels of the atmosphere too many balloons accrete heavy loads of ice and sink. The cost of replacing them is too high. Hope is now pinned on obtaining temperature soundings by infrared methods from satellites. This is extraordinarily cheap (per sounding) but fails when clouds block the radiation from lower levels. It is now proposed to narrow the instrumental field of view so as to get the complete vertical structure by peeking between clouds. This, however, is less than ideal because there surely are continuous cloud shields over large storms. When this happens over a region sparse in standard radiosonde data, like the Pacific Ocean, a sizable hole in the data will result. It is also proposed that winds may be determined by tracking clouds on successive satellite photographs, and some promising experimental results have been produced. This is impacted by a political problem, however, since it now seems that the four geostationary satellites needed to do this on a global basis will not be forthcoming. No more than one or two seem reasonably assured in 1976.

The chief scientific problem of GARP stems from the importance of the tropical atmosphere and our very much lesser understanding of it as compared with the atmosphere of higher latitudes. On a scale of one to two days of prediction one may safely consider the N and S hemispheres to be independent. On a scale of a week or more the hemispheres interact across the tropics which then become important. Moreover, most of the heat input to the atmospheric engine takes place in the tropics. Hence, we need to learn much about the small-scale processes that transfer heat, momentum and moisture across the boundary layer of the tropical oceans as well as the larger-scale processes that transport these properties throughout the troposphere and laterally to middle latitudes.

To these ends there will be mounted for three months in 1974 a GARP Atlantic Tropical Experiment known, inevitably, as GATE. (It is distressing to see an acronym generate another acronym. This bodes an explosion of the already large population of acronyms and even raises the possibility of acronymical incest.) Many ships will be involved in the observations as well as aircraft and a geostationary satellite. This project, smaller than GARP itself, is large enough to be highly international in support and execution. This inevitably means political problems as exemplified by a contest to determine whether the site would be in the Atlantic or Pacific Oceans.

Despite the emphasis in this note on unresolved problems, the GARP progress report at IUGG made it evident that there is much good will and support for GARP and that many highly competent scientists are working very hard to bring it to fruition. One may reasonably expect that GARP will come off successfully although not with all the power that the scientists concerned would consider ideal.

Another prominent symposium was that on planetary atmospheres. This assembly was the first in the history of IUGG to address itself to this rapidly growing subject. The importance attached by the convenors to the area was indicated by the fact that academician A.M. Obukhov, one of the truly distinguished atmospheric scientists of the USSR, chaired the morning session.

There were several outstanding papers. M. Ya Marov reviewed the structure of Venus' atmosphere as determined by the Soviet Veneras 4, 5, 6 and 7 and by the US Mariner 5. Kerzhanovich, Andreyev and Gotlieb exhibited results on wind velocity and turbulence on Venus as determined by Doppler results from the Venera spacecraft. The USSR has achieved notable success with their Venus entry probes, culminating in the first successful landing on a planetary surface. It is gratifying to see that they are extracting the maximum possible from the data despite the failure of a commutator on Venera 7 that led to loss of all data on pressure and altitude, leaving only the temperature trace during descent. By intercomparison with earlier probes which did succeed in measuring pressure (but failed to reach the surface), it was possible to establish the surface pressure of Venus as about 90 atm. The measured surface temperature is 747 K (as Marov commented, "The same as your airplane") and the temperature decreases with height at the adiabatic rate, within the errors of measurement. The Doppler data indicate the presence of turbulence and of modest horizontal winds.

Zilitinkevich, Monin, Turikov and Chalikov presented results on a numerical calculation of the atmospheric circulation of Venus in the session I was privileged to chair. This was a very important paper since it is the first such calculation done in three dimensions.

They found a circulation largely between day and night hemispheres, not between equator and pole. Most of the kinetic energy generated was associated with this large-scale flow between day and night sides and not with smaller disturbances. They found typical horizontal wind speeds of 5 m/s (not inconsistent with the results of Doppler data), vertical velocities of about 2 cm/s, a range of temperatures in the upper part of the model of a few tenths Kelvin and at the surface a few K (completely consistent with earlier infrared and microwave measurements). The reported results were based on a 2-layer model with a horizontal mesh of 2500 km. The calculation is being repeated with finer vertical and horizontal resolutions.

I shift now to an apparently very different symposium, that on ocean-floor spreading. This field has become highly active in a very few years because the evidence impresses most people as being overwhelmingly in favor of the hypothesis of mantle upwelling along the mid-oceanic ridges with associate plate displacements. The fundamental process must be hydrodynamical in nature, thus the subject is not conceptually so different from meteorology and oceanography.

There is no need to review the many papers on evidence for the hypothesis, mechanism of the processes or interpretation of the implied plate motions since they were very like papers in many other earlier symposia around the world. To me, as an occasional observer of this field, the most interesting event was the emergence of skepticism as represented by Prof. V. Beloussov's paper, "Criticism of the Hypothesis of Ocean-Floor Spreading." Cognoscenti tell me his reservations have been expressed before and are considered minor in comparison to the large body of positive evidence. However, I found it healthy to hear a well-known figure caution the scientific world that they have leaped onto a bandwagon and have perhaps lost some scientific discretion and caution in their haste. Beloussov points to certain discordant evidence, and the seeming reluctance of proponents to come to grips with these difficulties lends support to some of his cautions. Reservations about ocean-floor spreading are widespread among Soviet scientists (but are not their exclusive possession), and one wonders whether leading figures like Beloussov are creating a Soviet orthodoxy on this matter. Some detect a faint odor of "Lysenkoism" here, but the situation does seem far from that dismal state. Indeed, I suspect the Soviet geophysicists might reply that the mad western rush which has elevated the hypothesis to a "sacred" level is more nearly like a descent to Lysenkoism.

An extensive symposium was held on the energetics and dynamics of the stratosphere, mesosphere and lower thermosphere. There are many reasons why this region of the atmosphere attracts attention. It absorbs ultraviolet radiation from the sun and is of low density, so this direct solar heating is substantial, in contrast to the lower atmosphere which is heated mostly indirectly through absorption at the earth's surface. Photochemical reactions become important here, especially those responsible for the formation and destruction of ozone. Strange phenomena occur such as the "explosive" polar stratospheric warmings of the winter season. Man now has the ability to inject SST exhaust products into the stratosphere at rates that might alter its heat balance and photochemistry. Finally, satellite infrared techniques are particularly suited to indirect sounding of this region and are beginning to yield large amounts of data.

To a substantial extent it is found that the properties of the region cannot be fully explained by the comparatively simple techniques of photochemical and radiative equilibrium. Atmospheric motions diffuse and carry constituents and properties vertically and laterally in important degree. This was pointed up in papers by Hesstvedt, Khrguian and Gusev, Manson, Roper and others.

Although the major aspects of the pertinent photochemistry are well in hand, a host of possible reactions are known (involving, for example, H_2O and nitrogen oxides) for which reaction rates are poorly known. Laboratory studies are needed and some were reported by Volman. Calculations are proceeding with the best data available as reported by London and Park and by Crutzen. There is controversy about the effects upon ozone of water vapor and nitrogen oxides. However, there is agreement among scientists that the matter is so important that mass use of SST aircraft should await resolution of this question.

Sudden stratospheric warmings, first discovered by Scherhag in 1952, were discussed extensively. Labitske's report based upon radiosonde data, rockets and satellite observations made quite certain what had been extensively suspected -- namely, that these warmings begin at high levels and progress down-

ward. Thus by the time the highest-reaching radiosondes detect the phenomenon, much of its evolution is over. This raises a serious problem for the N. America rocket program intended to elucidate the process. The rockets are too expensive to launch except when something interesting is happening, but we have not known about a development until too late in its life cycle.

Fortunately, developments in satellite instrumentation are coming to the rescue. Houghton reported on the very impressive results of groups at Oxford and Reading Universities who have a selective chopped radiometer on Nimbus 4. This instrument is particularly suited to the problem of temperature determination in the stratosphere and mesosphere up to heights of 50 km. Results so far show that they can detect and map these warmings in their early, high-level stages as well as subsequently.

Fritz and Soules reported infrared results from several satellites showing that polar stratospheric warmings are accompanied by widespread equatorial stratospheric cooling of more modest amount. This indicates that descent and adiabatic warming near the poles during these incidents are accompanied by ascent and adiabatic cooling in the tropics. The phenomenon is now no longer polar but global in nature.

Of necessity, I have skipped many interesting individual papers and, indeed, whole symposia. Among these should be listed the sessions on tsunamis, forerunners of earth quakes, atmospheric electricity, air-sea interaction, cloud formation and dynamics, pollution, remote sensing, structure and evolution of planets and energy fluxes over polar surfaces.

The Congress ended with a plenary session in the impressive and opulent conference hall of the University at which the new president of IUGG for the next four years, Prof. H. Charnock of the UK, was announced. The Executive Committee apparently had something of a debate on the site for the next Congress in 1975. Informal word was available that invitations had come from India (New Delhi), Mexico (Mexico City) and France (Paris). The decision was for Paris. (S.L. Hess)

ENGINEERING

THE BRITISH CONSULTING ENGINEER: A PERIOD OF CRISIS

The British consulting engineer has lost a lot of public confidence in recent months. He has been put into the spotlight, carefully dissected, and found wanting. Although this started with the structural engineer, it has spread throughout the whole engineering profession to the extent that repercussions must inevitably follow.

Bridges That Fall - The troubles began a year or so ago with the collapse of a steel box-girder bridge in Wales which killed four men, and have really erupted in earnest this summer with the publication of an Australian Royal Commission's report into the disastrous collapse in Melbourne, Australia, of a British-designed steel box-girder bridge with the loss of 35 lives. (During the last year, two other box-girder bridges have suffered severe buckling, although not failure. One, over the Danube in Vienna, buckled because of a large temperature drop one evening -- after erection, but before completion of the bridge -- requiring substantial repairs.) However, the public itself wasn't directly affected by these tragedies, and couldn't have cared less, until the drastic reduction of traffic imposed on some 40 similar bridges in Britain by the Department of the Environment. The construction or design of another 60 of these bridges is being held up. These measures have directly affected the public, and apparently it has been these measures, and not the collapses themselves, which sent a delegation of French engineers to Britain to study the situation.

Box-girder bridges are not a new concept, having been in use in Europe for the past 10 or 15 years. However, they have been introduced into the US only recently, at the Popular Street Bridge in St. Louis, and the San Mateo Bridge in California. Superficially, they are somewhat different from the usual bridge, being slender and esthetically very pleasing, their smooth continuous lines made possible by the use of welding. Indeed, such bridges could not be possible without welding, which is needed for the effective transfer of the stresses. Essentially, box-girder bridges are longitudinal boxes, and carry the loads by interaction of all the plates which make up the boxes. Torsion is an important part of the

structural action of the boxes, and has been very difficult to analyze realistically until the advent of sophisticated numerical computer methods. The behavior of these bridges differs from that of the usual beam and truss bridges in the same way that a chassisless unit-construction automobile body differs from one in which the chassis carries the loads. Economies of 10 to 20%, and even more, can be effected through the use of box-girders, because of their efficient use of material. This efficiency itself has created some problems as the steel plate has become thinner and the structure less redundant and more prone to violent failure.

Why Should a Bridge Collapse?- Before reporting any further, and to assuage any worries among the readers, it should be pointed out very clearly that the failures in box-girder bridges have all been during erection, and that the principle of such a bridge is basically very sound. If a bridge has survived the critical period of erection, then there appears to be every chance that it will carry its design loads with no distress at all. Unfortunately, the designer sometimes does not consider erection and construction procedures and the accompanying abnormal loading conditions -- in general, most structural engineering failures are during erection. The bridge could have some localized plate buckling or twisting as a result of the erection loads -- these buckles would strongly influence behavior under the traffic loads.

From all available sources, it seems that the major problem with these bridges is underdesign at and around the supports. The Australian report goes further and states that, even if web buckling at the supports does not create problems during erection, it will nevertheless reduce the life of the bridge, negating the very reasons for choosing it in the first place. (All bridges move under load, and the flexing of a badly-buckled web leads to a much earlier crack initiation and fatigue failure than if the web were reasonably flat. The problem of web buckling is very real, and constitutes one reason for the inspection and re-evaluation of all British box-girder bridges, both in use and in design.)

The Australian report puts the major part of the blame for the failure of the Melbourne and the West Gate bridge, on the internationally famous, London-based consulting engineers, Freeman, Fox and Partners. (Freeman, Fox also designed the Welsh bridge that failed earlier. Dr. O. Kerensky, senior partner of the concern and son of the prime minster of the short-lived 1917 Russian Republic, is well known in the U.S.). The construction companies and all who had part in the erection were also held responsible for the failure to a lesser degree. In fact, only the suppliers of the steel escaped blame.

The West Gate Bridge failure, and the events leading to it, would be a comedy of errors except for the tragic results. There was little or no cooperation between the erectors and the designers, and the relations between the engineers on the site and the designers in the London office broke down completely very early. The site engineers had no experience in this type of construction and received no help from the designers; they had to work out the erection details with no access to, or knowledge of, the design assumptions and requirements. There was complete chaos.

The published reports do not make clear exactly what happened on the West Gate Bridge on the fateful day in October 1970, but it appears to be the following. The two longitudinal halves of the 370 ft. span, in effect, separate box girders, had been erected -- but, they were not in line horizontally, one being some 5 inches higher than the other. To correct this, the construction engineer decided to place 10, 8-ton concrete blocks on the higher box to lower it so that both boxes could be joined. (Although it may sound a lot, this is not a heavy loading.) Unfortunately, a horrible buckle resulted in the web -- to correct this, it was decided to remove some bolts from a transverse splice, an asinine act of someone "entirely unfamiliar with even rudimentary stress-analysis." Even after this was done, the span hung in the air for one hour before it collapsed onto the workmen having lunch below. There was no realization of the seriousness of the events even up to the last moment.

The Commission report was rather adamant in pointing out that the concrete blocks could not have caused the buckle if proper safety factors had been used. Secondary effects. such as wind and temperature, had not been considered in the design at all!

What is reported in these lines is only a small part of the Australian investigating commission's report of 272 pages, 80 days of sitting, and three million words of evidence. The description of the whole design and construction process is at once illuminating, sad, and educational.

Freeman, Fox, and Partners - Freeman, Fox, and Partners, the British consulting firm, has a 114-year history, and has been successful in bridge-building having been responsible for over 20 major bridges in the past 20 years. They have designed the

suspension bridge to link Europe and Asia near Istanbul, and they are the designers for a proposed English suspension bridge to have a main span of 4580 ft. Not limited to bridges, the company works with tunnels, power stations, and turnpikes also, employing over 600 persons including about 300 qualified engineers.

The question has been asked -- can they survive the latest blows, the failure in one year of two box-girder bridges of their design? (The Welsh bridge failure was not investigated publicly, but the assignment of blame for the Australian bridge could be an insurmountable obstacle for them.)

Chilling indictments were made by the Australians, all reported at length in the British press: slipshod design, the use of ridiculously low safety margins, the lack of consideration of unknown factors, but worst of all, the fact that their designer, Dr. W.C. Brown "worked from intuition." The Commission showed that the design was full of errors, and that "Freeman, Fox had failed altogether to give proper and careful regard to the process of structural design."

Freeman, Fox have been replaced as designers, and a big insurance battle is now shaping up. The losses to be recovered for the bridge itself are at least $10 million, while that involving surviving relatives could be much more. Freeman, Fox have consistently maintained that their design is not faulty, and the contractors for the erection deny any negligence. The complete checking of the actual design, a program of full-scale testing, and a complete re-design are currently underway in Australia. The battle to assign negligence is starting to shape up, and it promises to be long and bitter.

The British Consulting Engineer - The whole affair of the box-girder bridges has brought discredit to British design offices. By and large, university people in Britain feel that many British designers are ill-prepared for today's world -- they feel that too much design is by intuition, and that most designers are not equipped to handle the more sophisticated analyses and designs. And so, there is a flurry of refresher courses, with the universities reaping the benefits both by supplying the advanced courses to the engineers, and by receiving some government research sponsorship. With over 100 box-girder bridges in Britain in use, in construction, or in design, this activity is not without reason.

The spotlight in the press has now been thrown onto consulting engineers, and onto engineers in general with no distinction as to their specialty. Quoting from the London Times, "a visit to almost any of the offices gives the very definite impression of otherworldliness. This is not just the result of the Dickensian offices which many of them inhabit, but also the profession's great reliance on traditional ideas."

The press has discussed at length the lack of responsibility of the consultants, the fact that the prestige of British engineers is being hurt, and that all of this is leading to a decrease of international contracts. The London Times also had a rather telling editorial on the danger of divided responsibility, "... the absence of any seeming allegiance to the principle of hierarchial responsibility. It is a principle which may well be vulnerable in an era of increasingly complex technical projects in which the work of various groups or departments overlap." The article goes on to decry the lowering of professional standards, and argues that "personal responsibility is one of the prime ingredients of professionalism."

In this writer's opinion, the 20th Century has reached the British engineer, just as it did decades ago to his political counterpart, and only yesterday to the exporter. The British engineer can no longer expect to stand upon the fruits of his centry-old reputation, he can no longer expect his cultivated and haughty clipped accents to cow his customers and to embarrass his competitors, and to give inferiority complexes to all -- the time has obviously come for a change, and, as always, the younger generation is already well in the forefront.

In Summary - designing for erection is at least as important as designing for regular use.

- one person should have an undivided responsibility to see the whole job through from design, through construction, to final use.
- the British consulting engineers are under critical review which cannot help but to upgrade them and to propel them well into the 20th century. (Lambert Tall)

STRUCTURAL ENGINEERING AT UNIVERSITY COLLEGE, LONDON

University College is one of the many independent institutions which make up the University of London. It was founded in 1826 largely through the efforts of Jeremy Bentham to found a non-sectarian university. It is a curious fact that Bentham was very much the autocrat, presiding over board meetings even after his death! A rather life-like likeness cre-

ated for this purpose sits in a huge glass-cased roller-bottom box in a conspicuous part of the main building -- even today his foreboding visage commands respect. The description on the box includes the following: "Jeremy Bentham. 1748-1832. This case contains the skeleton of Jeremy Bentham dressed in his usual clothes. His skull is in the small case at his feet."

The main areas in the Civil Engineering Department are: Environmental Health, Transportation and Planning, Building and Construction, Hydraulic Engineering, and Surveying and Photogrammetry. In common with most British schools, and compatible with the comparatively high entrance requirements, only a minimum of three years are needed for the bachelor's degree, which is a much more specialized degree than in the US. The first two years are essentially devoted to core courses, although about a quarter of the courses required are electives. In the third year, considerable freedom is allowed to the student to study in his own fields of interest, and it is in this year that the student conducts a research project under the supervision of a staff member. Computers are introduced during the first year, and the students are encouraged to use the IBM 360 as much as they desire.

The research facilities are not particularly inspiring, the laboratories being small and ancient. It is obvious that large sums of money do not exist for sponsored research. In this situation, the research tends to become exclusively theoretical, and although the rather sophisticated level is impressive, little of it seems to offer solutions to practical problems.

The structural stability group is made up of Messrs T. Barta, J.G.A. Croll, S.P. Christodoulides, A.W. Hunt, J.M.T. Thompson, A.C. Walker, and E. Yarimci. Barta is a relatively recent newcomer from Romania, and Yarimci is a Turk who received his PhD from Lehigh University in Pennsylvania some six years ago. Christodoulides is a Briton who also has his own consulting firm, and within his department this is regarded apparently as a definite advantage in balancing an otherwise highly theoretical group.

The group has divided its studies into two parts, one of which is phenomenological, and the other concerned with analysis and design. Most of the phenomenological studies seem to have been made some years ago when A.H. Chilver (currently heading the Cranfield Institute of Technology) was leading the group, and were concerned with the classical assumptions and general theories of elastic stability. The more recent studies have diverged somewhat from this -- these include for example, the problems of multiple loading (Huseyin), the behavior of heavily-cracked cooling towers and other degenerating structures (Hayman), and torsional-flexural buckling of core-stiffened high-rise buidlings (Yarimci). No full-scale testing is underway, but a number of model tests have been conducted, such as on shell and plate buckling, cooling towers, and the core-stiffened high-rise buildings. The relative merits of numerical approaches for use in analysis and design have been studied, and the simularities of the finite-element and finite-difference methods enumerated, (Cross, Walker). A study is underway to extend to box-girder bridges a technique of a finite-element study considering complicated loadings rather than simplified assumptions (Walker). There didn't seem to be any urgency associated with the projects, and clearly in a predominantly teaching insitute, unsponsored research must take the back row.

The overall impression is that the staff are extremely competent in their own specialized self-contained theoretical fields, which will eventually lead to results which could then be extended to practical situations.

A current ONRL Report describes this visit, and the research in progress, in more detail. (Lambert Tall)

WELDING AT THE CRANFIELD INSTITUTE OF TECHNOLOGY

The Cranfield Institute of Technology was formerly the College of Aeronautics, and as such, I had visited it some years ago. This present visit showed that there were no obvious physical changes since becoming, in effect, a university for graduate students. This visit did show a somewhat more excited and enthusiastic staff -- the overall impression was that of a well-balanced, reasonably dynamic institution. It seems that the new president, (Vice-Chancellor A.H. Chilver of structural engineering fame) has brought a new sense of importance and direction to the school. He has even made it known that those areas which do not make a name for themselves will be dropped - rather unusual for Britain where job security has been a natural right! Another obvious change is the acceptance of the idea of letting others know of research findings -- earlier it had not been regarded as gentlemanly.

Cranfield has been described earlier, see ESN-24-11, November 1970. Briefly it is a purely graduate institution offering mainly masters degrees in applied sciences, aeronautical engineering, mechanical engineering, production and manufacture management, and transport. The degrees usually result from a combination of research and coursework, and there are opportunities for the doctorate. The campus is quite pretty, in beautiful green countryside some 50 miles north of London -- and it has its own airfield. Indeed, visitors and attendees of the special courses are encouraged to come by private plane.

A surprising amount of research in the area of welding is underway at Cranfield -- there is a degree program in Welding Technology in the Dept. of Materials, and welding research is underway there as well as in the Dept. of Aircraft Design.

High-Speed Electroslag Welding. A rather sensational development has been underway for some time -- a standard electroslag machine has been modified to allow welding speeds of up to five times the normal. In other words, instead of the usual 80 inches per hour for a 1.1/2 inch plate, the speed has become as high as 400 inches per hour, although it seemed to me that much of the research had been done at half that speed. The machine used was modified from an old electroslag machine which I noticed had been manufactured in the Paton Institute in the Ukraine,where, of course, the basic electroslag method was developed over a decade ago.

Dr. B.M. Patchett, a young Canadian with the position of Research Officer in the Department of Materials and one of the developers of the process, showed me the machine, the specimens, and test results. The method has resulted in excellent welds. Usually, electroslag welding gives a coarse-grained structure in the weld and heat affected zone for thick plates, generally requiring normalizing after welding to prevent weld cracking. The welds with the Cranfield method have a very fine grain structure and excellent mechanical and impact properties, all obtained at fast speeds and no heat-treatment.

Their method uses a consumable guide (the ones I saw were tack-welded rods) which fills the gap almost completely. The gap itself has been made substantially narrower than usual. The flux used is basic rather than acidic, the filler wire speed is increased from the usual, and the current is substantially increased. Development work on the current supply is also underway. For example, a pulsing dc current rather than a steady one is being investigated, and this shows some promise of energy economy.

Rather than use solid copper shoes for water cooling, Patchett developed a relatively thin copper-faced steel type which he feels works better, and is much cheaper.

In general, the method does appear to have the possibility of offering considerable economies for the welding of pressure vessels and the like -- the fast speed and no need for heat-treatment are important developments.

Lamellar Tearing, Vibration-Dampers, and Other Studies - I spent some time with Mr. J. Jubb, Lecturer in Aircraft Design, whose research and teaching efforts are mainly in the area of welding. He is known to American readers through his studies of lamellar tearing. His current program includes the development of a slice-bend-test for lamellar tearing, rather than the usual through-the-thickness test. He is investigating six steels with different inclusion contents. The study will form the basis of the MSc thesi of one of his students.

Jubb is of the opinion that most of the tests for welding required in Britain are quite unnecessary, and reflect a former era when little was known about materi properties. He will be presenting a paper on this topic in the Fall, which should be quite controversial.

Another of his current studies, again part of an MSc thesis, concerns the effect on vibration characteristics of residual stresses due to welding. This work may provide an interesting solution to an old problem; how to remove vibrations from a plate or machine in service. He proposes to dampen, or to remove entirely, the vibrations by heating a specific part of the material. After cooling, a pattern of residual stresses will remain which, if it is of the right magnitude and distribution, will change the mode of vibration. This study is based on the similari between the influence of residual stresses on plate stability, and on plate vibration The early results are very encouraging.

Mr. C.K. Trotman, Senior Lecturer in Aircraft Design, and the head of the testing labs, showed me around the laboratory and explained their program to me. This past academic year, the whole of the second-year class had the complete design of a STOL (short take-off and landing) aircraft as their design project. The amount of work required, calculations, working drawings and the like, is quite impressive -- the intent is to make the project typical of what the students could expect in industry, working together as a team. (I couldn't help but wonder

at the chance of the graduates obtaining jobs in the present depressed aircraft design market.)

An interesting MSc thesis just completed under Trotman's guidance is concerned with the effects of the compression part of the cycle on fatigue strength and crack propagation. By taking account of the fact that the stress intensity factor K_c is changed by going into tension, he obtained a good correlation for the prediction of crack propagation rates. (Lambert Tall)

REPORT ON "LIMITS OF LUBRICATION" CONFERENCE, IMPERIAL COLLEGE, LONDON

The second biennial conference on tribology (the study of rubbing surfaces) was held at Imperial College, London, from 12 to 16 July 1971. Approximately one-hundred scientists, comprising what was to be a representative cross section of the international community working in this discipline, planned to attend. The goal fell somewhat short of expectations when a brief, last-minute message from the Russian Embassy informed the organizers that the USSR delegation of 5 or 6 scientists would be unable to attend. A representative of the (North) Vietnam Polytechnic Institute, Hanoi, also did not put in an expected appearance.

Dr. Alastair Cameron of the Department of Mechanical Engineering, Imperial College, organized the meeting which was modeled on the Gordon Conference format, i.e., technical sessions were held twice daily (forenoons and evenings), well-organized afternoon tours to points of interest were laid out by the University, and participants were quartered in the dormitories and dined (surprisingly well) together. These arrangements helped attendees to become well acquainted, and provided an excellent basis for informal discussions ranging from elastohydrodynamic theory to the Common Market to the edifying spectrum of apparel worn by the London young set.

Two or three lead papers were read at each topical session, together with as many shorter papers as time permitted. An informal and free-wheeling discussion period was held following each session. Since almost all of the work discussed was new and unpublished, conference ground rules specified that, to protect authors' publication rights, attendees not report specifics of the research results presented.

Session topics included: 1. Turbulence: Basic concepts, experimental approaches, etc.; 2. Hydrodynamics: Computing methods, Reynolds equation analysis, etc.; 3. Elastohydrodynamic lubrication; 4. Pitting: Influence of oils and additives, fretting, rolling, contact fatigue; 5. Metals in fatigues; 6. Scuffing: Thermodynamics of scuffing, transition from hydrodynamic to boundary lubrications, etc.; 7. Plastics and wear; 8. Surface coatings and additives; 9. Metal working.

There was a general consensus that the conference was highly productive, and the attendees agreed that another meeting be scheduled in 1973. (Harold Ravner, NRL)

THE LABORATOIRE D'ELECTRONIQUE, CATHOLIC UNIVERSITY OF LOUVAIN

The Catholic University of Louvain was founded in 1425 by Papal Bull. It is now one of the largest universities in Europe, with over 28,000 students. The University is divided linguistically, with half of the faculty and students speaking and using French, and the other half using Dutch. The French faculties are in the process of moving from Louvain to new quarters in Ottignies. The Science and Engineering Faculties will move in late 1972 and the Humanities in 1975. Presently, the Dutch and French speaking faculties maintain completely separate but equal facilities. I did not fully appreciate the impact of the separation until I visited a number of laboratories in the French-speaking Electrotechnical Institute. All instruments, benches, chairs, and even individual coaxial cables and plugs were marked with color-coded tape (blue, I think) to denote "French-speaking." The two Electronics faculties even have separate microelectronics fabrication laboratories, with all of the attendant costs that this implies. My host, Professor Paul Jespers, felt that separation was unfortunate, but necessary, in view of the long history of unhappiness that has divided the two faculties.

Since my visit was solely with the French-speaking Electronics faculty, I was not able to find out what the Dutch-speaking faculty were doing. However, the work of Professors Jespers and Van de Wiele and their students is most impressive. Research is currently being carried out on the following problems: Schottky barriers in silicon junctions, how charge moves from one MOS structure to another, the effects of different impurity profiles on MOS transistors,

high-voltage, high-current thyristors, switching on inversion layers in MOS structures, and matrices of photodiodes as sensors for pattern recognition. Most of the above work is experimental, in which the students work in a new microelectronics laboratory reserved for the exclusive use of French-speaking graduate students. The work on high-voltage, high-current thyristors is being conducted in conjunction with an industrial laboratory and most of the experimental investigation is carried out in industry.

Jespers is most optimistic about cooperative research and development programs with the Benelux electronics industry. In the past, industrial support for university research has been negligible in Belgium. However, in recent years, Jespers' laboratory has received industrial grants and contracts in increasing amounts. In addition, industry has offered to provide various electronic measuring instruments that were either too costly or too specialized to justify state support. Since the move to their new facilities in Ottignies is only a year off, Jespers has delayed acceptance of this equipment until after the move. In the meantime, several of his students are working in industry to make use of equipment that is not available in his laboratory.

Finally, two computer-aided design (CAD) projects should be mentioned. The first is the computer-aided design of frequency stable feedback amplifiers. By use of a frequency analysis program, the return difference F for a bilateral element of value X is calculated and a Nyquist diagram generated. Then a least squares procedure is utilized to find the value of X for optimum stability as well as overshoot and bandwidth. The program for frequency analysis is written in FORTRAN for the IBM 360/44 computer. It is based upon a state-space procedure and utilizes sparse matrix computational algorithms. The program handles circuits with up to 60 linear elements, of which a maximum of 20 may be reactive. At present there are no plans to add transient analysis capabilities to the program. The second CAD project is the synthesis of microwave amplifiers with 1-2 GHz bandwidth and 5-dB gain with less than 0.1-dB ripple. A computer program for calculating scattering parameters of a distributed line is the key program in this project. It is written in FORTRAN and is currently running in the IBM 360/50 machine at the IBM Brussels Scientific Center. Access to this machine is provided by an IBM 1052 terminal at Louvain. This project is another cooperative undertaking between the University and industry.

Because of the heavy burden imposed upon creating separate facilities, the Belgian government is unable to provide substantial support for Jespers' research and graduate students. Consequently, Jespers feels that industrial support and cooperation is essential to maintain a balanced research program. (F. F. Kuo)

MATHEMATICAL SCIENCES

MBLE RESEARCH LABORATORY

The Manufacture Belge de Lampes et de Materiel Electronique S.A. (MBLE) is the largest and most broadly diversified electronics manufacturing company in Belgium. It is also a part of the farflung industrial giant, N.V. Philips Gloeilampenfabrieken, of Eindhoven, the Netherlands. Since Philips is a world-wide federation of companies, its research activities are also multinational. The principal Philips research laboratories are: Natuurkundig Laboratorium der N.V. Philips Gloeilampenfabrieken at Eindhoven; the Mullard Research Laboratories, Redhill, Surrey, England; Les Laboratories d'Electronique et de Physique Appliquée, Limeil-Brevannes, France; Philips Zentrallaboratorium, GmbH, Aachen and Hamburg, Germany; and the MBLE Research Laboratory, Brussels, Belgium. Although each laboratory reports to the management of its own national organization, its research activities are coordinated by Eindhoven.

The MBLE Research Laboratory was established in 1963 as a center for theoretical research in electronic systems. It serves as an applied mathematics center for not only MBLE, but also for all the other Philips' laboratories. Its director, Dr. V. Belevitch is a world-renowned circuit theorist. The Laboratory has a staff of less than 25 professionals, all applied mathematicians of high calibre. The leaders of the various groups are: P. L. Wodon, Computer Languages; P.J. Courtois, Data Systems; Y. Kamp, Circuit & Systems Theory; M. Davio, Logical Design; and J.M. Geothals, Discrete Mathematics. J. Neirynck, the associate director, is also a circuit theorist.

There are almost no administrative functions at the Laboratory since they are handled by the MBLE headquarters

staff. Consequently, everyone, including Belevitch and Neirynck are engaged in research, fulltime.

In the formative years the Laboratory concentrated on circuit and system theory, emphasizing filter design. Since then, its research activities have included work on coding theory, celestial mechanics, and computer software.

The Laboratory is becoming very well-known for its work on computer languages, especially on ALGOL 68. The Lab's computer people, Messrs. Wodon, Branquart, Lewi, Sintzoff, Loeckx, and Cardinael have all made important contributions to the development of ALGOL 68. Wodon has worked on garbage collection methods. Branquart and Lewi have developed schemes for storage allocation, implementation of coercions, and implementation of local names. About sixteen man-years have gone into the implementation of a six-pass ALGOL 68 compiler for the MBLE computer, a Philips Electrologica X8 machine. The people directly involved in the project were Branquart, Lewi, Cardinael, Delescaille and Van Begin. The compiler is nearing completion, although debugging and documentation might delay its full use.

It should be noted here that the group has done a thorough critique of the original language specifications for ALGOL 68. The critique, given in a report Remarks on the Draft Reports on ALGOL 68, M. Sintzoff, (Editor), led to a version of ALGOL 68 that all implementers have agreed upon, and which has been frozen until 1972. At that time, most ALGOL 68 groups will have implemented the language on their own compilers, and will probably suggest improvements based upon actual experience. The MBLE Research Laboratory is serving as the coordinator of a world-wide group of ALGOL 68 implementers. Although most of the group are European-based, the US implementers include: Westinghouse Research Laboratory, Pittsburgh; University of Washington, Seattle; Northwestern University; UCLA, Purdue University, Brown University; and Rice University. The point of significance here is that the MBLE Laboratory is the focus of international activities in ALGOL 68.

Finally, we should note that Belevitch, Neirynck, Davio, and a number of others have visiting lecturer appointments with the Institut Electrotechnique of the University of Louvain (French faculty). They often supervise student research, but students usually come to them at the Laboratory.

The MBLE Research Laboratory, in my opinion, is one of the outstanding small research labs in Europe. The work it produces compares favorably with that of a US lab such as Bell Laboratories. (F.F. Kuo)

COMPUTER SCIENCE EDUCATION AT THE EINDHOVEN UNIVERSITY OF TECHNOLOGY

Founded in 1956, the Eindhoven University of Technology has over 4000 students and 120 professors. The campus is situated about one-half mile from the city center and is a most impressive, modern complex with a number of 10-story steel and glass office towers.

In the computer world, the University is known as the home institution of one of Europe's most eminent and respected computer scientists, Professor E.W. Dykstra. I visited Dykstra on 14 July 1971 to learn about computer science education at Eindhoven.

The discussion began on a more general level in that we talked about education in computing science, or informatics, in the Netherlands as a whole. There are two streams, a non-University stream offered by the Study Center for Informatics (SCI) based in Amsterdam, and a University stream, centered principally around the Technical Universities of Eindhoven, Delft, and Twente. The Study Center for Informatics offers professional training courses on about the same level as that offered by IBM or CDC institutes. Students are able to attend the school on a part-time basis since a normal one-year course requires only 30 evenings. An examination is given at the end of the course to certify the skills achieved, and this examination is recognized by the Netherland's Ministry of Commerce (not by the Ministry of Education). It seems that the non-University stream corresponds strongly to the course of study offered by the Technical Institutes in the US.

Computing Science education at Eindhoven is offered by the Subdepartment of Mathematics in connection with the degree program of Mathematical Engineer which is unique to the Netherlands. The program is designed to be completed in five years, but usually the student takes six or seven years because of the rigorous examinations required. Upon receiving his degree, the Mathematical Engineer has attained the competence equivalent to the US Master of Science. As the name implies, the Mathematical Engineer is a specialist in Applied Mathematics. At Eindhoven, there are four

specializations within the degree program: Mathematical Physics, Stochastic Processes and Operations Research, Numerical Mathematics, and Informatics. We shall concentrate on the Informatics curriculum here.

All students at Eindhoven receive their first exposure to computing during the second year, when Dykstra teaches an introductory course in ALGOL 60 programming. The course is short: eight hours of lectures and five afternoons of programing laboratory. The course is really one of "computer appreciation" in which the student is told what a computer system is, how it works, and what its many uses are. He is also taught the idea of an algorithm, and the fundamentals of programming with ALGOL 60. At the end of the course, the students form into groups of four to write an actual ALGOL 60 program.

After the first general exposure, the non-Informatics majors learn the specifics of the ALGOL 60 language through short courses offered by the Computing Center. Upon completion, the student is fully competent in the intelligent use of computers to solve problems in his field of specialization.

In the third year, the Informatics student takes a course taught by Dykstra called "Introduction to the Art of Programming." In this course Dykstra presents programming - to quote N. Wirth - "as a discipline on its own merits, as a methodology of constructive reasoning applicable to any problem capable of algorithmic solution." He does not teach any programming language in the course, but assumes a prior knowledge of a "decent' higher level language such as ALGOL-60. The course begins with a formal approach to algorithmic processes. Next he considers the fundamental notion of a machine (or a "computer") which he defines as "a mechanism capable of causing actions to take place following a pattern of behaviour as can be described by algorithms expressed in terms of a repertoire of primitive actions that belong to this machine." The course then turns to the concept of a program which he defines as being an algorithm intended to control the behavior of a machine. A general discussion of programming languages and their implementation follows, in which specific attention is paid to sequential algorithms. Dykstra then presents a number of theorems on correctness of programs based upon a formalism introduced by C.R. Hoare. Finally, a number of programming techniques are illustrated by a number of examples: the shortest spanning tree of a graph, the towers of Hanoi, and the problem of the eight queens. All of the examples given are non-numerical, and emphasize combinatorial ideas which Dykstra believes give students a more intuitive understanding of the art of programming. I have Dykstra's notes on the course which will eventually appear in book form. Dykstra said that "half of his soul" went into the course notes which give an indication of the care and scholarship that went into their preparation.

In the fourth and fifth years, Informatics students are required to take four full-year courses: Logic, Operating Systems, Compilers, and Data Structures and File Management. Other courses such as Numerical Analysis are considered subsidiary and may be elected on an optional basis. At present, Eindhoven does not have a course on Programming Languages so the student is required to learn any language himself. Delft, however, offers a course on LISP and other list processing languages. The emphasis in all these courses is on software, rather than on hardware. Systems aspects of computers are covered quite adequately, so that upon completion of these courses, the Informatics student emerges as a software engineer, well-trained, and a thoroughly useful computer professional. It should be noted that very few Mathematical Engineers go on for the Doctorate in Informatics. In fact, as well known as Dykstra is in the field, he has supervised only one PhD student, A. Nico Haberman, who is now an assistant professor of computer sciences at Carnegie-Mellon University, where he is regarded as a leading expert in operating systems.

With a graduate program that is growing, the Technical University of Eindhoven is sure to become one of Europe's strongest centers in computing science, if it is not already so. (F.F. Kuo)

PHYSICAL SCIENCES

TEA's AT BALDOCK

The Services Electronics Research Laboratory (SERL) at Baldock, Herts, started work on increasing the operating pressures of carbon dioxide lasers about one and three-quarter years ago. Dr. D.C. Tyte has been the primary researcher. Since the announcement of the Canadian work (DSRV) on Transversely Excited Atmospheric (TEA) pressure carbon

dioxide lasers (Beaulieu, A.J., Applied Phys. Ltrs. 16, 504-505, 1970), the group at SERL has studied two electrode designs, one similar to but developed independently from Laflamme, (Laflamme, A.K., Rev Science Inst. 41, 1578-1581, Nov. 1970) aimed at getting around the problem of the large ratio of dead space to excited volume and the high aspect ratio usually associated with the pin-to-bar discharges reported originally by Dr. Beaulieu. In both designs an auxiliary discharge of sorts is used in imitating the main discharge making it more uniform and almost square in cross section.

The first system uses a stainless steel mesh cathode stretched over a dielectric sheet in which is embedded a trigger electrode, connected to the anode with a capacitor. The anode is of solid metal with edges roughly shaped in a Rogowski profile (Rogowski, W., Arch. Elektrotech 12, 1-15, 1923) appropriate to twice the electrode separation. The area of the mesh is much larger than the area of the anode. A short high voltage pulse is applied between the anode and cathode which also gives a field of about 100,000 volts/cm between the mesh and the trigger electrode. This field is thought to produce a distributed source of electrons over the whole of the cathode enabling the production of a uniform main discharge. The highest pulse energy per unit volume obtained in this way was six joules/liter. Typically, the cathode mesh and the anode were separated by 3.2 cm, the length of electrodes was 100 cm, and the discharge width was 2.5 cm. The optimum volumetric ratio of CO_2: N_2: He was 1.3:1:13 at atmosphere pressure, and gave an efficiency of 6.3%. The output energy increased linearly with input energy to the limits of the power supply, giving the above quoted values. If the concentration of either CO_2 or N_2 is increased over that quoted, transition to an arc discharges was observed. The SERL workers think that such a laser can be extended to larger systems although no plans were described for doing so.

The second design uses two identical solid electrodes with edges shaped to a Rogowski profile. However, two fine tungsten wires are placed parallel to the main electrodes, offset from the center line of the main electrodes and connected to the cathode with coupling capacitors. The effect of these wire electrodes does not seem to depend critically on the position between the main cathode and anode, but this point awaits further determination. An initial discharge takes place from these wires and hence provides an electron source for the main discharge. The role of photoemission is thought to be important but has not yet been conclusively determined. Changes in the main electrode material do not produce significant changes in the laser characteristics. Although there are uncertainties in the method of measuring pulse energies, no doubt giving a lower energy limit, pulses of two joules were obtained at an efficiency of 4.3 percent with a discharge of 28 cm x 2.6 cm x 1.5 cm. This is close to 20 joules/liter.

No direct experimental data were presented to give an assessment of the modes contained in the output beam in either design. Indirect evidence indicated multimoding, probably in both designs. When this second design was operated, obviously multimoded, excited by a 55-kV pulse of rise time about 10 nanoseconds and halfwidth about 100 nanoseconds, the beam specific peak power was about 90 kW/cm^3 with the total pulse peak power greater than 9 MW. This second design gives much higher output energy densities, operates with higher values of storage capacitor and higher concentrations of molecular gases. Additionally it is a very rugged design, which is not damaged even by arcing. The design is also quite clean aerodynamically in case one should choose to use fast transverse gas flow.

The TEA laser work at SERL is quite well known within the UK. A smaller laser, about one foot long, using the second design, but pulsed at 50 pulses per second, is under construction at SERL for field use at another institution. The SERL group is also experimenting with N_2O and HCN lasers using the same design.

Some practical experience has been gained on window materials used in the CO_2 TEA research: Commercially available windows of gallium arsenide have not been so damage resistant for the pulse work (100 Megawatts) as germanium. While considerable interest exists at SERL in the window problem, extensive research has not yet been performed there.

In discussions with the SERL researchers about future uses for lasers, particularly naval use, the point was made that no Royal Naval requirements exist at present for lasers. Applications which are considered reasonable are for target designation, intraship

communications, and short range radar. Considerable interest also seems to exist in oxygen assisted metal cutting with lasers, an application started at SERL and now being pursued under contract by the Royal Navy with the Welding Institute. (W.J. Condell)

ELECTROCHEMISTRY AT SOUTHAMPTON

Though not as well known in the US as "Oxbridge," the "Redbrick" universities in the UK now play a major role here in higher education and research. Among the more prominent ones is the University of Southampton which has about 4000 students, mostly in Science and Engineering. The emphasis on technical subjects is apparent, for example, from the size of the Chemistry Department which has about 35 faculty members (including five full professors), 30 undergraduates, 80 graduate students and 40 postdoctoral fellows.

Recently, as part of a trip to Hampshire, I had an opportunity to visit Prof. M. Fleischmann who is the Electricity Council Faraday Professor of Electrochemistry and head of the large Laboratory of Electrochemistry at the University. Fleischmann, himself, is a pleasant person about forty years old whose slight German accent betrays his Continental origins and who positively bubbles over with enthusiasm and ideas about electrochemistry! Because of this well-known enthusiasm, I had been warned earlier that a visit with him would provide me with a real mental workout in trying to follow his lightning-quick reasoning and abrupt changes of subject -- and it was! In brief, his various electrochemical interests include electrode kinetics (with particular reference to organic electrochemistry in aqueous, nonaqueous protic polar, nonaqueous aprotic polar, nonaqueous protic nonpolar, and fused-salt media), electrosynthesis, electrocrystallization and electrocatalysis, electrochemical reactors and generation of electrical noise by electrochemical reactions. Fleischman tried describing all of this work, as well as that of his colleagues, in about half an hour! Fortunately, my discussions with the other members of the Laboratory weren't conducted at quite that pace.

One of the projects underway in the Laboratory is the electrochemical initiation of polymerization reactions. In particular, if one carries out an electrolysis in a cell containing an alkene (A) and an alkyl dihalide (BX_2), free radicals are formed which polymerize to polymers of the type $(AAB)_n$. A student has been studying the reaction, using,e.g., alpha methyl styrene and dibromobutane as monomers, to learn something of the mechanism of the polymerization. One not surprising result is that by varying the concentrations of the monomer, polymers with blocks of more than two A's can be formed. More interesting is the finding that by using hexamethyl phosphoamide as a solvent, polymer fouling of the electrodes can be reduced markedly.

Another problem just being completed by an Asian student is a study of the efficiency of the bipolar packed bed electrode for the manufacture of propylene oxide. This novel electrode system, which I discussed in last month's ESN, consists of a mixture of graphite coated and uncoated half-mm glass beads packed into a small cylindrical cell approximately 1 x 5 cm. About 300 V are applied longitudinally (which gives some 3 V across each bead) and a propylene saturated, 0.01 M aqueous bromide solution is run through the cell parallel to the electric field. From an economic point of view, the most important finding was that (on this scale) propylene oxide could be produced for about $180/ton if the cost of power is approximately 1 cent per kWh.

One of the electrochemists' favorite tricks for studying the mechanism of electrodes reactions is to rapidly switch from oxidizing to reducing conditions (and vice versa) by changing electrode voltages and then observe what happens. The Electrochemistry Laboratory must have at least half dozen such specialized potentiostats, but unfortunately, I only had an opportunity to briefly speak to one of the students using them. He described his work on the mechanism of alkyl halide reduction on various electrode surfaces, e.g., lead, tin and cadmium. Fleischman, himself, also mentioned that various oxide electrodes (e.g. nickel oxide) are also being studied. Reactions studied include the stepwise oxidation of alkenes all the way to carboxylic acids.

Going the other direction, a reaction that could be of considerable commercial interest is the electrochemical reduction of carbon dioxide. Fleischman told me of some intriguing results obtained in his laboratory several years ago when it was found that the reduction gave both malic and crotonic acids. Since these four-carbon acids are both considerably more expensive than carbon dioxide, it looked like they had hit paydirt! Unfortunately, however, it has

not been possible to reproduce that work, although Fleischmann hopes to pick up the project again sometime. (There was no difficulty in the analysis of products -- crotonic acid in particular can be readily "nosed out." Presumably some easily poisoned catalytic characteristic of the electrode was lost.)

One of Fleischmann's associates, Dr. A. Bewick (pronounced Buick) told me of his current interest in the use of reflected light spectroscopy to study electrode processes. In this method very small changes in reflectivity can be detected since the light beam is periodically modulated by varying the voltage on the electrode and detected by a phase sensitive detector. Not only are changes in reflectivity observed inside absorption bands (e.g., in thiantrene) but also outside bands, as for example with platinum electrodes in the visible. (Bewick's belief in the usefulness of this method for studying electrode processes is apparently shared by many fellow electrochemists as judged from its prominence at a Faraday Society Symposium on thin films held in London last December.) Two other spectral techniques in use or development in the Electrochemistry Laboratory are ellipsometry and Raman spectroscopy.

In addition to these optical studies, Bewick is also interested in the use of free electrons as reducing agents. What makes the electrons very interesting is their great mobility -- many orders of magnitude greater than protons. This means that reductions can be effected at distances far outside the usual approx 0.01-cm thick electrode region. Bewick mentioned, for example, that in studies of the reduction of anthracene (10^{-3}M) in hexamethyl phosphoamide, this high mobility permitted current densities as large as 1 amp/cm^2. (John G. Foss)

MOLECULAR BEAM RESEARCH AT THE MAX PLANCK INSTITUT FÜR STRÖMUNGSFORSCHUNG, GÖTTINGEN, GERMANY

The MPI for Fluid Dynamics, as its German title may be properly translated, has recently acquired a new field of activity. About two years ago, Professors J.P. Toennies and H. Pauly, who had been working on molecular beam scattering at the University of Bonn for a number of years, were appointed to the MPI to start a new division concerned with some basic aspects of fluid dynamics, viz. the mechanisms of collisions between gas molecules and of gas-surface interactions. From the appearance of their laboratory which occupies a medium-sized two-story building, they must also have received a large budget for equipment which tops everything I have so far encountered in any other laboratory engaged in this field of research. The installation phase is about completed, and experimentation has been going on for about one year.

The principal research objective is a systematic investigation of molecular interactions using extreme precision so that a number of problems heretofore attacked with insufficient means can now be solved. With these precise measurements accurate potential energy curves for several pairs of molecules have now been obtained, and the distribution of the energy of reaction in chemically reacting pairs over the different degrees of freedom has been determined.

The technique most frequently employed is that of the scattering of molecular beams or of beams of atoms and ions by other molecules, contained either in a scattering chamber or in a second beam crossing the first. In some experiments, the primary beam consists of alkali atoms which can easily be detected by the surface ionization method. The energy of the primary particles is carefully controlled, either by the use of a rotating-disc velocity selector or by electrostatic acceleration of ions and subsequent charge exchange, and the energy distribution of the scattered atoms is measured by the time-of-flight technique. Intensity and velocity of the scattered particles are usually measured as functions of scattering angle and of the energy of the primary particles. For the use with primary beams which are not detectable by the surface ionization method, the "universal" detector employing ionization by electron bombardment and subsequent counting of the charged particles, has been developed to a high degree of sensitivity and stability.

Among the experiments presently under way are the measurement of the differential scattering cross sections for the Na-Hg, K-Hg and Cs-Hg system, from which the interaction potential curves have been obtained; the scattering of He, HD, and D_2 beams by a variety of other gases;[2] of He beams by He and H_2 in the energy range from 0.01 to 2.8 eV, and of scattering of Li^+ ions on H_2. The last mentioned experiment merits a more detailed description even within the limited frame-

work of this report because it combines a number of techniques which have now been refined to the degree necessary for obtaining quantitative results:

First, Li^+ ions from a Kunsman-type source are formed into a monoenergetic beam by passing through an electrostatic velocity filter and are focused on a nozzle beam of H_2 molecules passing through a scattering chamber at right angles to the direction of the ion beam. Both scattered and unscattered ions are collected by an ion multiplier, and a beam interrupter at the source permits time-of-flight measurements on the original and the scattered ions. The resolution of these measurements is so good that it permits the separation of the peaks produced by scattered ions which have excited the H_2 molecules to the first, second, and third vibrational state, as well as those which have undergone only elastic collisions.

One of the interesting features of the experimental arrangements is that the back scattered ions, i.e., those that are scattered by 180° in the center-of-mass system, appear as slow ions in the forward direction in the laboratory system because the mass of the Li^+ ions is larger than that of the scattering H_2 molecules. As a result, the unscattered as well as the scattered ions appear at the same detector but with varying time delays.

In a related experiment, Li^+ ions of higher energies, 90 to 250eV are scattered by a H_2 nozzle beam, and the onset of dissociation is observed in the time-of-flight spectrum of the Li^+ ions.

Several theoreticians are attached to the Molecular Beam Group and the interplay between theory and experiment seems to be very effective. The group also enjoys close collaboration with molecular beam researchers at the adjacent laboratory of the Deutsche Versuchsanstalt für Luft und Raumfahrt where Dr. U. Bossel (formerly at Berkeley and Syracuse University) is working on skimmer design. (I. Estermann)

DEPARTEMENT DE LA PHYSIQUE DU PLASMA ET DE LA FUSION CONTROLEE

At the invitation of Prof. M.C. Sexton, University of Cork, Ireland, I visited the Département de la Physique du Plasma et de la Fusion Controlée at Fontenay-aux-Roses on the outskirts of Paris, France. Sexton is spending a six-month sabbatical at Fontenay working on HCN lasers. This installation had been visited previously by Dr. Alfredo Baños in 1968 (see ONRL-50-68) and Dr. Howard H.C. Chang in 1970 (ONRL-R-10-71). They spent several days at four institutions in the vicinity of Paris which are working in Plasma Physics and their reports are therefore more complete.

Fontenay-aux-Roses is one of the original installations of the Commissariat a l'Energie Atomique (CEA) and one of the buildings houses the first French nuclear reactor. It is located in a former fort on the outskirts of Paris which was built to allow rapid and effective control of the city. Only one wall of the original fort still remains. The remainder of the installation is composed of modern buildings and well-equipped laboratories. Many of the people working here are non-French citizens and are paid either by their respective countries or Euratom. In the past, weapons-related research may have been done at this installation, but at the present time the majority of the work seems to be in nuclear power.

During my visit I had the opportunity to talk with Mr. M. Tocheris, Chef du Département, who outlined the organization and program. The Department consists of three services or divisions. The first is the Service du Confinement des Plasmas which is concerned with techniques for confining thermonuclear plasmas. The second is Section de Physique des Plasmas which carries out research on plasma diagnostics and plasma techniques in support of the overall plasma effort. The third division is doing theoretical work.

In the past, work has been done on a rather wide range of techniques and many of these devices are still in existence at Fontenay. However, a major reorganization has taken place in the last few years with the efforts phased out on these devices and concentrated exclusively on a Tokamak.

The HCN laser, which is to be used as a diagnostic tool on the Tokamak, has recently become operational, although considerable work remains to be done before it can be considered a routine piece of laboratory apparatus. It will be used to measure plasma densities in the vicinity of $10^{14} cm^{-3}$. The Chief du Section is Mr. D. Veron who designed this particular device. The laser is 2 1/2 meters long, 10 cm in diameter and is expected to produce tens of milliwatts at 337 microns. Alignment of the laser is maintained by four water-cooled silica rods, which Veron says is preferable to invar. The silica

rods are not stressed since the main weight of the apparatus is supported by an optical bench. The laser beam is brought out of the laser by means of a polyethylene beam splitter. This group extensively investigated the use of thin uncoated polyethylene and mylar sheets as beam splitting devices. They found that mylar is less suitable because it has significant absorbtion whereas polyethylene appears to be lossless. One of the interesting details on this project is an imaging camera which uses a temperature-dependent liquid crystal to obtain the image of the beam. The laser beam is partially absorbed by a metallic layer on a thin sheet of plastic. The reverse side of this plastic is coated with a liquid crystal which changes color with temperature. The cool spots are red, warm spots are green and blue spots are very hot. At the present time they are using a liquid crystal from the US with a temperature resolution of about 5°, but they soon will have a crystal with a finer resolution. By taking a picture of the liquid crystal using interference filters, they can record zones of equal intensity in the beam. Using this technique, they have been able to demonstrate that the laser can be adjusted in different modes. At the present time they are seeking a good way to accurately measure the power of the laser beam.

Veron also discussed some of his work on laser produced plasmas. This work had been done sometime ago before he started to spend full time on the HCN laser. He had been interested on the effects of pulse length on plasma production by laser radiation of lithium hydride pellets. In an article published in the Physics of Fluids, (14, No. 3, Mar, 71) he shows that the amount of charge generated by the plasma initially increases with pulse length and then levels off. The point at which the charge production levels off depends on the size of the pellet. For 50-μm pellets this time is 20 nsec. For 120-μm pellets it is longer than 20 nsec. Consequently, he sees no need to use pico-second pulses to produce thermonuclear plasmas by laser radiation.

Laser-produced plasmas were discussed with Mr. C. de Michelis who is using a CGE laser to study non-linear observations of laser radiation. He has used both pellets and solid targets in his research. His main point is that while classical theory says that most of the laser light should be reflected from a solid target, experimental evidence shows that a significant proportion (20-60%) is absorbed. He is attempting to explain this observation in terms of non-linear optics. One of his techniques is to look at the structure of the spectral line profiles which change with intensity. His main interest is in laser breakdown of gases which he still does when he has time, and he is presently writing a review paper on the subject. The laser used in the experiments consisted of parts obtained from CGE with the final amplifying rod being 16 mm in diameter. At the time of my visit the laser had been brokendown for two weeks or a month, and replacement parts were not obtainable because CGE was on vacation.

I briefly reviewed the confinement programs being carried out at Fontenay by talking to Mr. P. Ginot and by making a quick visit to the experimental areas. Evidently the past program was primarily concerned with exploring various novel ideas for confinement. For example, the Harmonica device was built to test a concept put forth by a theoretican who predicted that such a device should have a stable mode of operation. Research showed that this idea was more or less true. However, extreme difficulty was experienced in attaining such a condition. Therefore, research on the Harmonica is essentially completed. Additional confinement devices were explained by Baños in his report so will not be described here. Future work seems to be completely directed towards the construction of a French Tokamak which will be slightly larger than the Russian T4. If all goes well, this should be operational in a couple of years.

I was received very cordially in all portions of this institution although it is located within a fenced area with guards. Most, if not all, of the work appears to be unclassified, however. This institution is presently in a state of change, not only because of a change of emphasis on the programs, but because this work was supposed to be transferred to the CEA laboratory at Grenoble. However, the student uprisings several years ago required that the plans to move the research be cancelled for lack of funds. (Lothar O. Hoeft)

MISCELLANEOUS

PA TECHNOLOGY AND SCIENCE CENTRE

Second in size only to Booz-Allan in the UK, PA Management Consultants Ltd, has a staff of 1250 spread over 20 countries. Its consulting services range over corporate strategy, international development, financial control, personnel, production, marketing, acquisitions and mergers, international marketing, administration training, technical services, and management sciences.

One of its seventeen divisions is the Technology Division with headquarters at Hyde Park House, Knightsbridge, London, S.W.1. This Division is directed into five main areas: product innovation and development, product process improvement, investment appraisal and decision, management of research and development, and technological forecasting. To support the technology interests the PA Technology and Science Centre has been established recently at Cambridge, England (285 Milton Road). At the Centre there are three main functional groups: physics, electronics, and mechanical sciences. The Centre presently employs 20 full-time engineers or scientists, has a growth rate of one engineer or scientist per month, and has 200 individual university consultants. It lets contracts to universities for specific research, exercising close control over performance, and has established three or four "Centers of Excellence" at universities. It has developed a new sampling oscilloscope and will incorporate the sampling capability into a standard oscilloscope designed to perform both functions. Drawing on its experience in the electronics for the sampling scope, it has some ideas for increasing the frequency response of Josephson junction devices, particularly for use in neuronal activity sensing. The areas it now considers especially important and appropriate to the expertise of its staff are electron-optics, thermoplastics, amorphous semiconductors, Josephson junction devices, infrared detectors using domains in semiconductors, and digital filtering. (W.J. Condell)

NEWS & NOTES

FORTHCOMING ENGINEERING MEASUREMENTS CONFERENCE

What should prove to be an interesting conference on engineering measurements will be held in London on 5 - 7 April 1972. The conference is on "The Recording and Interpretation of Engineering Measurements," and is sponsored by the Institute of Marine Engineers, acting on behalf of the Joint British Committee for Stress Analysis.

About 300 attendees are expected, and the conference will be international in character, with a number of speakers and guests coming from outside Britain.

Approximately 30 papers are expected to be presented at the three-day conference, and these have been divided into six groups. The titles of the papers in the provisional program are:

Strain Gages - Three examples of how modern recordings aided the development of heavy marine engineering designs
- The strength testing of struts, using extensometer-controlled loading
- The measurement of residual stresses
- Two examples of the use of strain gages in unusual environments
- Some field experience in residual stress measurements
- Strain gage measurements on a rotating perforated hollow cylinder
- Static and dynamic measurements on ships' hulls
- Stresses and strains generated in road structures by moving vehicles
- A foot ground reaction force plate

Computing Techniques
- Recording and interpretation of strain measurements in military bridges
- Dynamic analog data handling by magnetic tape recorder and digital computer
- The processing of photoelastic and moiré data by means of digital computer and plotter
- Extracting fatigue testing and design data from service loading records
- Star: a modern modular data acquisition and recording system specifically designed for marine research
- A sophisticated monitoring system for biomechanical studies
- Automatic processing of test data
- Stress measurements in Concorde

Temperature Recording
- The recording and interpretation of temperatures and transient thermal stress in epoxy turbine casing models
- An electronic approach to the dynamic pyrometry of a moving target
- Thermal sensitivity of pressure transducers

Photoelasticity
- The photoelastic determination of thermal stresses in finned tube waterwalls of boilers
- A technique for measurement of deformations applied to the bores of housings for rolling bearings
- An automatic polariscope for photoelastic stress analysis
- A lightweight extensometer for use of low modulus materials

Optical
- A miniature oblique incidence meter for use on photoelastic coatings
- Laser and coherent optical techniques in engineering measurements
- Capacitative measurements of end-winding displacement of electric machines
- A new measurement technique for rotating structures

Noise
- Measurement and Analysis of rotor/propeller noises
- Gear noise and vibration - its recording and analysis

The Conference will be held at the Institute of Marine Engineers, which is in the interesting and quaint finance district of the City, quite close to the Tower of London. Anyone interested in attending should contact the Assistant Secretary at 76 Mark Lane, London, EC 3. (Lambert Tall)

THE SECOND INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC WINDOWS

The second International Symposium on Electromagnetic Windows took place on 7-10 September 1971, at the "Ecole Nationale Supérieure de Techniques Avancées" (previously "Ecole Nationale Supérieure de l'Aéronautique"), 32 Boulevard Victor, 75 Paris XVe, France.

This meeting was organized by "Delegation Ministerielle pour l'Armement (CMA)" in conjunction with "Société Française des Electroniciens et des Radioélectriciens (SFER)." The purpose of the Symposium was to synthesize the present knowledge concerning radome technology. The chairman of the Symposium Committee was Mr. Delorme, Chief Engineer of the Armament.

If one is interested in obtaining a copy of the proceedings of the Symposium, you should address your request to:

Direction Technique des Constructions Navales
Bureau de l'Aéronautique Navale
2eme Colloque International sur les Fenêtres Electromagnetiques
8, Boulevard Victor
75 Paris (15eme), France

(A.A. Ranger)

RESEARCH ON ECOLOGY OF CRUSTACEANS

At the University of Liverpool, research is to be carried out at the Marine Biological Station at Port Erin, Isle of Man, to provide background knowledge of the behavioral ecology of commercial crustaceans which may explain why catches vary regionally, seasonally and throughout the day. The Natural Environment Research Council has awarded a grant of £ 10,849 over three years to Dr. E. Naylor, who will be the director of the Station. The project will study the rhythms of activity noticeable in commercial crustaceans, including the Norway lobster (scampi), prawns and shrimps.

PERSONNEL

Prof. F.M. Arscott, University of Surrey, has been appointed professor of pure mathematics in the University of Reading, in succession to Prof. R. Rado, on whom the title of professor emeritus has been conferred.

Dr. J.L. Bobin of CEA Centre d'Etudes de Limeil, Limeil, France, will be spending three months, starting in October, at Osaka University, Japan, with Prof. Tamanaka.

Dr. D.L. Gardner has been appointed to the Musgrave chair of pathology and to the directorship of the University Institute of Pathology in the Queen's University of Belfast.

Dr. W.M. Hutchison has been appointed to a personal professorship of parasitology in the University of Strathclyde, Scotland.

Dr. N.B. Kreitman has been appointed director of the MRC Unit for Epidemiological Studies in Psychiatry, at the Royal Edinburgh Hospital, in succession to Prof. G.M. Carstairs.

Dr. J. Pitt-Rivers, Ecole Pratique des Hautes Etudes, Paris, has been appointed to the chair of anthropology, London School of Economics.

Dr. H.P. Rang, Oxford University, has been appointed to the chair of pharmacology, University of Southampton.

Dr. Findlay L. Swinton, University of Strathclyde, has been appointed to the second chair in chemistry in the new University of Ulster.

Professor J.G. Taylor, University of Southampton, has been appointed to the chair of mathematics, King's College, London. Also, within the University of London, the following titles have been conferred: professor of biochemistry on Dr. J.B. Pridham, in respect of his post at Royal Holloway College; professor of chemistry, on Dr. J.H. Ridd, in respect of his post at University College; professor of mathematics, on Professor Herman Bondi, is respect of his post at King's College; professor of bacteriology and immunology, on Professor D. Gwynne Evans, in respect of his post at the Lister Institute of Preventive Medicine; professor of chemistry, on Dr. M.L. Tobe, in respect of his post at University College; professor of nuclear medicine, on Dr. E.S. Williams, in respect of his post at the Middlesex Hospital Medical School.

Dr. J.J. Turner, Cambridge University, has been appointed to the chair of inorganic chemistry at the University of Newcastle upon Tyne, and Dr. F.E.

Hytten has been appointed to a personal professorship in human reproductive physiology at the University.

At the University of Liverpool, the title of professor has been conferred on Dr. F.J. Weatherall, Dept. of Medicine.

ONRL NEWS

No doubt in reading the last several issues of ESN, you have noted some new authors and, perhaps, missed a few now familiar names. This, of course, is due to our annual change of scientific staff, which occurs, usually during the summer months. We welcome aboard the following scientists and indicate their major field and the subelements of it they will cover during their tour of duty with ONRL:

Dr. William J. Condell, Jr. - who joins us from ONR Washington. Dr. Condell is a physicist and will cover electro-optics.

Dr. Seymour L. Hess - from Florida State University, who will cover meteorology, including general circulation of the earth's atmosphere, and meteorology of other planets.

Dr. Franklin F. Kuo - from the University of Hawaii, who is an electrical engineer and will cover in addition to electrical engineering, computer sciences, including systems theory, digital computers, numerical analysis and information transmission.

Dr. Arthur A. Ranger - from Purdue University, who is an aerospace engineer, and will cover aerodynamics and propulsion.

Dr. Ralph R. Sonnenschein - from the University of California at Los Angeles, a physiologist who will cover autonomic regulation, cardiovascular, and general organ physiology.

Dr. Lambert Tall - from Lehigh University, a civil engineer, who will cover structural welding, structural engineering, materials science and research organization.

In addition, of course, we still have our Scientific Director, Dr. Edward I. Salkovitz who covers materials including metal physics and biomaterials, and Dr. John G. Foss, chemistry, which includes physical chemistry, biochemistry, spectroscopy, biopolymers, thermodynamics and biophysics.

In the Naval Applications Branch, we welcome the following officers:

CDR Robert M. Dowe, Jr. - Director of the Applications Division, who will handle command and control systems, including computers, displays and digital communications.

CDR Jamieson K. Deuel, undersea systems including submarines, torpedoes, sonars and surface ships.

LCDR Alfred E. Victor, airborne systems including navigation and landing. Continuing in the Division are CDR Bart M. Dalla Mura who handles weapons systems including guided missiles, rockets, guns and fire control; and LCDR Kelson E. Slayman, who handles military oceanography, including sonars and mine warfare.

Attached to this Office is a representative of the Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland. This year Mr. James W. Elam completed his two-year tour of duty and returned to NOL; his relief is Mr. William D. Grimes.

We bade goodbye to the following scientists, all of whom returned to their former positions:

Dr. Alfredo Banos, Jr. Professor of Physics, UCLA.

Dr. Roy E. Hanson, Program Director for Geophysics, National Science Foundation.

Dr. Robert A. Hein, Naval Research Laboratory.

Dr. George A. Hottle, School of Public Health, University of California, Berkeley.

Dr. Richard M.D. Mathieu, Senior Professor of the Engineering Department, US Naval Academy.

Dr. Robert H. Owens, Professor of Applied Mathematics and Computer Sciences, University of Virginia.

Dr. Richard O. Rowlands, Professor of Engineering, Ordnance Research Lab., Pennsylvania State University.

On the Applications side, the following officers have departed:

CDR Robert D. Melim, Director of the Division and Undersea Systems to Naval Station, Keyport, Washington.

LT Peter L. Hendricks, Airborne Systems to the Medical School, University of Texas, for duty under instruction.

ONRL REPORTS

The following reports have recently been issued by ONRL. Copies may be obtained by Defense Dept. and other US Government personnel, ONR contractors, and other American scientists who have a legitimate interest. Requests for ONRL reports should be addressed to: Commanding Officer, Office of Naval Research Branch Office Box 39, Fleet Post Office, New York 09510, or the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314

R-37-71 The Institute of Theoretical Physics, University of Warsaw, Poland, By A. Baños, Jr.
R-38-71 Viking Biochemistry, by J.G. Foss
R-39-71 Computer Aided Ship Design - by R.H. Owens
R-40-71 The Institute of Plasma Physics at the Nuclear Research Establishment, Jülich, West Germany, by A. Baños, Jr.

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ONRL	R-59-70	"	Surgical Research at Rikshospitalet, Oslo, Norway (AD-720 303)
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