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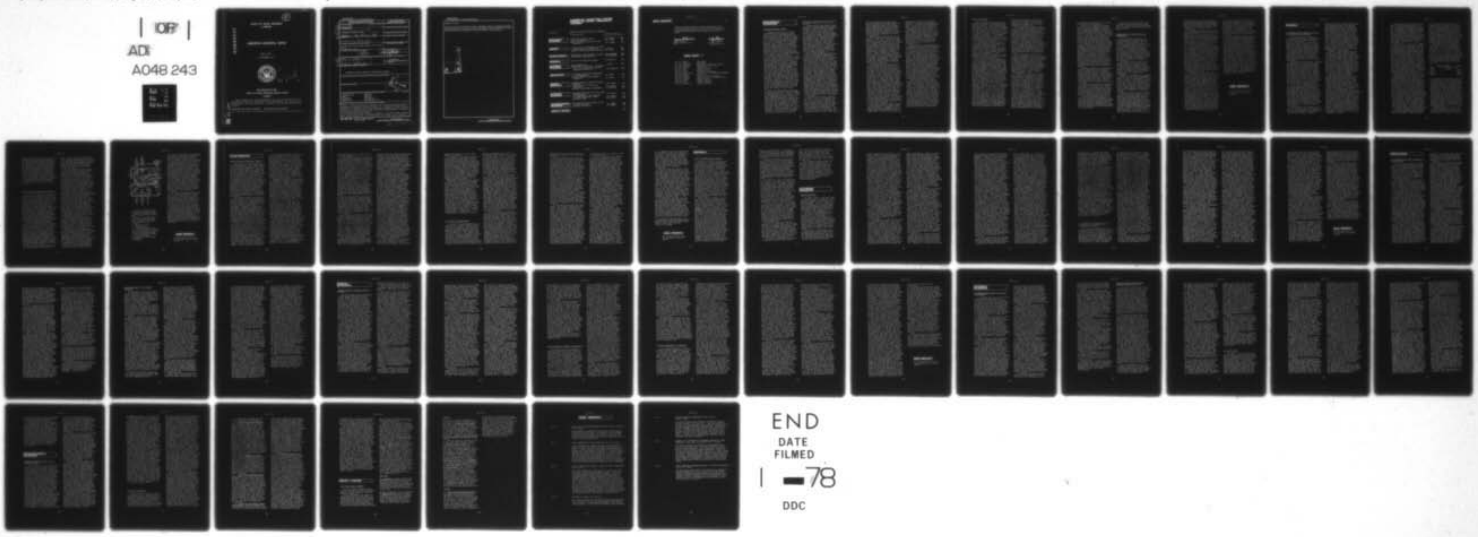

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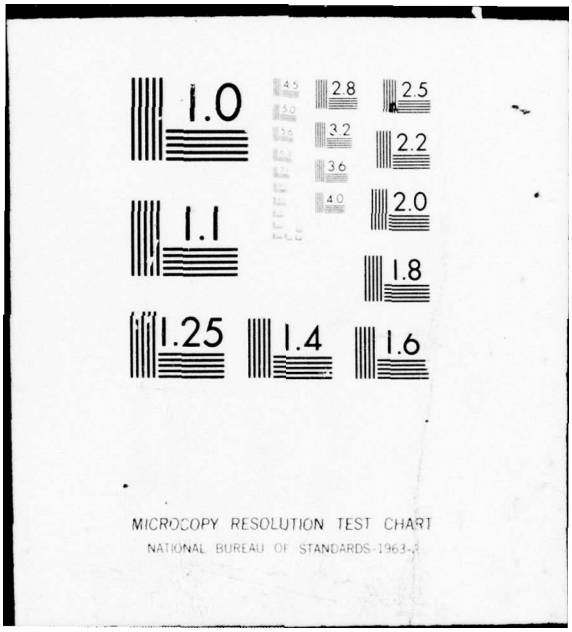
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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists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

The articles are written primarily by members of the staff of ONRL, with certain articles prepared by, or in cooperation with, members of the scientific

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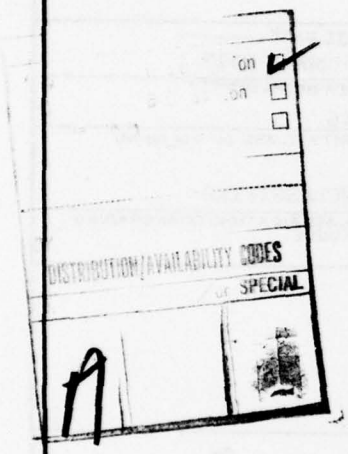

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OFFICE OF NAVAL RESEARCH
LONDON

Edited by Aubrey W. Pryce and Victoria S. Hewitson

31 October 1977 Volume 31, No. 10

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BIOLOGICAL SCIENCES

CHAIM SHEBE MEDICAL CENTER

During a recent visit to Israel, I was fortunate to be able to spend some time at the Chaim Shebe Medical Center located at Tel-Hashomer, a suburb just outside Tel Aviv. Little is heard of this great hospital because it seems to be always in the shadow of Hadassah Hospital in Jerusalem. It is a large hospital, some 1,100 beds, dispersed over 150 acres, having an affiliation with the Medical School of Tel Aviv University. The staff of 1,500 includes about 200 doctors and 600 nurses. It provides medical care for metropolitan Tel Aviv as well as the Gaza Strip-Sinai area. Space is also provided for several major medical research projects.

The hospital came into being in 1948 when the Israeli Army took over a British outpost that contained a hospital. After the bombing of Tel Aviv it became both a military and emergency hospital for evacuees from the city. Following the cease-fire, it became known as the General Military Hospital Number 5, and specialized in chest and limb injuries. At this time the hospital consisted of several Quonset huts set up in a horseshoe shape. The entire facility grew from these huts and each expansion put more outbuildings on the post, so that it is known to many as the "Hut" hospital. Even at this time there is no central building. It is quite common to see stretchers being moved over the roads to the different buildings, from wards to diagnostic centers. Although it is not a military hospital now, it gives the impression of a military post.

After the cease-fire in 1949, the hospital was used for surgical treatment of tubercular patients. With the influx of new immigrants to the country, a pediatric department was also set up to combat neonatal mortality. During this time, the interiors of the Quonset huts were renovated to conform to hospital standards. Even though it was treating more civilians than military, the hospital was still considered a part of the Army. However, as there was a great need for a civilian hospital, it was eventually transferred from the Ministry of Defense to the Ministry of Health, with the provision that in time of emergency it would revert to the Army. Indeed this happened in 1956, 1967, and 1973.

In the early fifties Hebrew University Medical School (Hadassah) assigned students to Tel-Hashomer for various periods. However, that was brought to a halt in the late fifties. In October 1954 Tel Aviv University Medical School was formed, and Tel-Hashomer was considered a major teaching hospital. In addition to its expected role of participant in the clinical teaching of medical students, it also has a major role in the preclinical years, teaching gross anatomy, histology, embryology, biology of the cell, pathology, and human genetics. For these courses, there has been assembled a faculty with research interests that have resulted in several solid basic science research programs.

Even though the Medical Center's research is low-keyed, perhaps because of Jerusalem's Hadassah Hospital's being so much better known, significant research is being carried out there. While much of the research is statistical evaluation of case records, there are several areas of superb investigation, one of which is genetic disorders. Since Jews have lived in relative isolation over the many centuries of exile, and since there was much in-breeding within the small communities, there is frequent manifestation of genetic disorders. Because many of the immigrants come from these isolated communities, genetic anomalies are seen more frequently than one would expect in a homogeneous population. The Medical Center has seen many cases of familial Mediterranean fever in North African Jews; familial jaundice and bleeding anomalies in Iranian Jews; thalassemia among Iraqui and Kurdish Jews; hemolytic anemia, Tay-Sachs, and Gaucher's disease among Ashkenazi (Eastern European) Jews; and other disorders that are less common. Several different institutes in the Medical Center have investigated these diseases.

The Heller Institute of Medical Research, a part of the Medical Center, has as one of its primary interests, characterization of familial Mediterranean fever. Among the consequences of this disease are periodic bouts of high body temperature and the development of amyloidosis. Dr. Ezra Sohar and Dr. Joseph Gofni, Directors of the Institute, have done an enormous amount of study on this disease

with Dr. Mordechai Pras and others. They have shown that the amyloidosis of familial Mediterranean fever is more like rheumatoid arthritis and Hodgkin's disease than multiple myeloma or idiopathic amyloidosis. They have also shown that the prophylactic use of colchicine decreases the number of febrile attacks and also decreases the extent of amyloidosis.

Another interesting project of the Heller Institute is on heat stress and function. They have a climatic chamber which can be regulated up to 45°C (113°F) and 99% humidity. Among the many temperature studies being performed was one on the Swedish sauna. They found that exposure to 80°C to 90°C at 30% to 40% humidity for 20 minutes produced cardiovascular and respiratory changes that would appear to endanger a person's health. Severe changes were sometimes noted; several of the subjects experienced syncope and one developed an anginal attack. ECG changes were suggestive of coronary insufficiency. They concluded that sauna bathing endangered the bather's health, and the symptoms appear without warning.

A physical-fitness survey of the Israeli population came up with the startling observation that the Israeli is 20-40% less fit than his Western age-counterpart due to lack of physical activity. In the Kibbutzim where physical labor is done, the level of fitness matched the rest of the world, while the religious-school children were found to be less fit than their nonreligious-school peers. Ethnic differences were also found. Non-Ashkenazi Jews, especially Yemenites, showed a far higher physical-fitness level than the Ashkenazi Jews. Other areas of research in this unit cover effects of heat on man's ability to work, adjustment of living and working conditions to the various climatic zones, long-term urban (desert) planning, military-operations planning in desert conditions (e.g., water intake, sleep, dress, length of march, extent of physical effort, and behavior). An interesting outcome of this research was the determination of a requirement of 30-40 liters of water intake per day during desert exposure.

The Heart Institute seems to be an active group delving into many aspects of heart disease. It appears to have many cooperative arrangements with the high-powered research institutions of Israel such as the Technion (Haifa) and the Weizmann Institute of Science (Rehovot). Probably this is needed because of staffing and equipment problems. The several areas included in their research are, the epidemiology of atherosclerotic heart disease, electron-microscopic studies on structural changes within the coronary arteries during the progression of coronary artery disease, metabolic changes following myocardial infarction and ischemia, predictive indicators of the clinical course of this disease, investigations into antiarrhythmic drugs, and research on indices of contractility.

One of the most active groups of Tel-Hashomer was the Cardiac Evaluation and Rehabilitation Institute directed by Dr. Jan J. Kellerman. This group is interested in the rehabilitation of patients with coronary heart disease and the prevention of this disease by the use of mental and physical hygiene. They have produced guidelines for the rehabilitation of patients with myocardial infarction (MI) from their experience with thousands of studies. Most of the participants go through an exercise program while being monitored with an ECG and respirometer. After recovery from the infarction, stress testing is recommended, followed by a supervised physical training program. The group emphasizes that not all patients recovering from an MI can be put on such a program, but believes that with proper testing and evaluation most people can be restored to a normal and productive life.

There were many other research activities going on at the Medical Center, but because of the time limit I was unable to meet all the investigators. I hope that I have given some idea of the competence and sophistication of the researchers. From the outside one cannot imagine the high degree of sophisticative and inventive pursuit of knowledge here. Whereas it looks externally like an Army base, on the inside one perceives a center of clinical and research excellence. I'm sure, in the near future, Chaim Shebe Medical Center at Tel-Hashomer will be equally as well known as the Hadassah Medical Center in Jerusalem. (Harvey I. Miller, Louisiana State Univ. Medical Center, New Orleans)

ELISA IN STOCKHOLM

There have been significant developments in serologic methodology during the past 25 years. This evolution has been predicated upon the need to improve sensitivity in the detection of antibodies while preserving specificity. A perfect correlation of sensitivity and specificity has not been achieved uniformly, but efforts continue. In this age of automated technology, a method that combines all of these criteria with rapid examination certainly would be a valuable tool for the diagnosis and surveillance of infectious diseases.

A major step in the development of the "ideal" method has been the introduction of the Enzyme-Linked-Immunosorbent Assay (ELISA). First described by E. Engvall and P. Perlmann [*Biochem. Biophys. Acta* 251, 427 (1971) and *J. Immunol.* 100, 129-135 (1972)], it has been evaluated as a serodiagnostic method for bacterial, viral, fungal, and parasitic diseases by investigators in several countries.

In order to establish etiology of diseases, emphasis has long been placed on the isolation of the offending organism, generally regarded in a classical sense as a "pathogenic" organism. When isolation methods are unsuccessful, the indirect procedure of diagnosis by measuring antibodies to infectious diseases has been widely used. This approach may be expanded even further to counter the problem of diagnosing diseases caused by organisms which are ordinarily present in the human microflora. When mixtures of organisms are isolated, difficulties are presented in differentiating those that have opportunistically infected the host from those that have normally colonized. It is becoming more apparent that some previously considered "normal" organisms are capable of causing infection. In this sense, the use of appropriate serological methods is intuitive. A number of tests are currently in use and are generally considered worth improving, e.g., the Widal and Weil-Felix tests. Other methods with wide application are being used, but these have some inherent difficulties; for example, nonspecificity and/or lack of sensitivity in agglutination and precipitation tests; anticomplementary substances in the complement fixation test; preferential detection of one group of antibodies (IgM) over another group (IgG) by passive hemagglutination; expense, such as radioimmuno assay; subjectivity as with fluorescent antibody, etc.

My interest in discussing applications of ELISA with scientists in Europe originated with research being done by colleagues in the microbiology department of the Naval Medical Research Institute, Bethesda, Maryland. They have adapted the method for detection of antibodies to salmonella and neiseria, rickettsia, and hepatitis B virus. I therefore welcomed the opportunity to discuss similar work with Drs. Hans Carlsson and Alf Lindberg at the National Bacteriology Laboratory in Stockholm, Sweden. Since 1972, Carlsson and his colleagues have been implementing the ELISA method for the detection of antibody to various bacteria, beginning with the salmonella group.

The ELISA method essentially is similar in principle to the fluorescent-antibody technique. Briefly described, antigen is coated on the sides of tubes or microtiter plate wells, followed by antiserum and then specific antibody linked to an enzyme system such as alkaline phosphatase or peroxidase. After an appropriate incubation period, the system is washed and a substrate appropriate for the enzyme used is added. The reactions are measured spectrophotometrically.

Carlsson and colleagues have been able to use lipopolysaccharide (LPS) and subsequent refinements or modifications of this substance as antigen to diagnose salmonella infections. First using rabbit antisera made more specific by absorption and LPS from different salmonella, they showed a high degree of specificity except for cross reaction between *S. strasbourg* and *S. anatum* both of which have a 6-ß-mannose-1,4-α-rhamnose-1,3-α-galactose trisaccharide as a common repeating structure in their O antigentic chain. Sensitivity, in comparison with hemagglutination and tube agglutination was 10 to 100 times greater with the ELISA. This finding may, in part, lie in the detection of both IgM and IgA antibodies by the ELISA method as compared with the other two methods which preferentially detect IgM. Carlsson and Lindberg have recommended ELISA for diagnosis

of salmonella infections since it offers both sensitivity and quality.

Using LPS of salmonella serogroups A, B, and D, they applied the test to human infections and found a statistically significant difference between sera of suspected salmonelloses patients and those of healthy blood donors. Reactions with *S. typhi* and *S. typhimurium* LPS were similar, revealing small differences in titer. They surmise that commonality of antigenic structure explains this, because the only antigenic difference between LPS from the serogroups studied is the nature of the dideoxyhexose linked α-1,3 to mannose in the repeating unit. Lindberg, Carlsson, and colleagues have responded to this provocative situation by preparing synthetic antigens with only the group-specific disaccharide as determinant (e.g., containing terminal paratos α-1,3-mannose for group A, abequose-α-1,3-mannose for group B and tyvelose-α-1,3-mannose for group D) and by using LPS from selected mutants that are unable to add the glucose residue to the O antigenic chain. Results of ELISA tests with these systems are encouraging and thus far have shown specific response with sera of immunized rabbits.

Further, Lindberg and colleagues have attempted immunization with these synthetic antigens covalently linked to bovine serum albumin and suspended in Freund complete adjuvant. When examined by bactericidal assay, it was found that antibodies were produced in high titer and were specific in nature, thus offering the possibility of more reliable and longer lasting vaccines against these organisms.

Carlsson has extended his technology with ELISA to examining sera for other infections, i.e., yersiniosis, brucellosis and candidiasis with good success. Attempts to use an indirect method for the determination of antigen or toxins have been successful but are only partially satisfactory, since the method has been insufficiently sensitive.

Carlsson and Lindberg propose the ELISA for detection of antibody response for several reasons including high reproducibility and sensitivity, potential for class-specific immunoglobulin determinations, simple instrumentation, potential for automation, and the requirement for small samples.

References for further review may be obtained from the Librarian, ONRL. (CDR S.W. Joseph, MSC, USN, Microbiology Dept., Naval Medical Research Institute, Bethesda, MD)

WATER POLLUTION, PURIFICATION, AND METHODOLOGY

The Water Quality Institute in Horsholm, Denmark, formally the Vand Vandkvalitets Instituttet (VKI), is a grant-supported nonprofit self-governing institution. Started in 1964, it was formally established in 1972 by the Danish Academy of Technical Sciences. It has official status, granted by the Minister of Commerce, as a service institute operating under the technological services act through the Danish Council of Technology. The Institute receives considerable government grants toward its activities in research, development, information, and training.

Generally the VKI undertakes laboratory and field studies of water-quality problems including emission of industrial waste, domestic sewage, and cooling water; water and wastewater treatment technology; water-quality surveys in rivers, lakes, and coastal waters; and water planning and management.

Within this structure Dr. Krongaard Kristensen has performed a considerable amount of research on pathogenic bacteria, viruses, and parasites in various aquatic systems. I was impressed by his energy, interests, and activities. He is quite concerned about the world's water quality and, as I mention later, is very serious about trying to formulate a world committee to establish standards and methods for controlling quality.

His long interest in microorganisms of marine origin has produced a great deal of interesting information on methodology, environmental contamination, and control measures. He is involved with the joint WHO/UN Coordinated Mediterranean Pollution Monitoring and Research Programme and is assisting in the preparation of two manuals under WHO/UN Environment Programme auspices. Because of my interest in marine bacteria, essentially the halophilic vibrios, I elected to visit Kristensen and discuss various facets

of his research. In the past he has been actively involved in developing sophisticated quantitative and qualitative methods for monitoring safety and potability of various water systems. This has led to a considerable number of publications.

Kristensen's research in the coastal waters around Denmark has led to the finding that *Vibrio parahemolyticus* and *Vibrio alginolyticus* are present in abundant numbers during the warm months of the year. He has further shown that these organisms are extremely important in fish diseases. Very recently, in collaboration with others, he isolated, characterized, and described a *Vibrio cholerae* NAG (nonagglutinating, i.e., not Group I) from a Danish poultry farm. The consequences of this type of finding are important when viewed with the findings of others in which NAG vibrios have been isolated in several countries of the world and have been incriminated in cholera-like diseases. This has particular importance for environmentalists and medical microbiologists in the US as two cases of NAG vibrio disease there have been described in recent years. Pertinent to this, Dr. R.R. Colwell and her colleagues at the University of Maryland recently isolated these same organisms from Chesapeake Bay, and very significantly, these have been recognized as toxin producers when tested in several biological systems.

Kristensen has also delved into the possibility of detecting the bacterium *Yersinia enterocolitica*. He has attempted to answer two questions: (1) How to isolate the organism from water? and (2) What is the importance of the findings once the organisms has been isolated? Holding samples from water on a suitable medium he has been able to isolate the organism by using its uncommon ability to grow relatively well at 4°C. Yersinia, which Kristensen has found in most of the water and sewage samples he has tested, grows very well when held for approximately three weeks. Significantly it is a common cause of gastroenteritis in Denmark. It has also been found in Sweden, and more recently, has been discovered in cases of gastroenteritis in the US. In several instances Kristensen has found the particular serotypes 0-3, 0-8, and 0-9, that are believed to be the most pathogenic types. Additionally, based on the work of Dr. Hannover Larsen, there is some evidence to indicate, that *Yersinia enterocolitica* may be related to common arthritis and perhaps to chronic deformative arthritis. Kristensen feels that yersinia is just as common as salmonella in diarrheal disease in Denmark. Interestingly, he has found that if yersinia and *E. coli* are placed in seawater over a period of time, *E. coli* tends to die out whereas yersinia numbers tend to remain constant.

In conclusion Kristensen indicated that he is extremely concerned about the standardization of water-quality testing for various microorganisms. He suggested that a worldwide committee for clean-water problems should be established with scientists from as many countries of the world as possible meeting to discuss these problems. They should establish new standard methodology for maintaining clean water supplies and assist in monitoring water quality. Obviously such standards would include regulations for controlling pollution as well. He agrees that biological water-quality problems should be solved systematically and not by arbitrary, wholesale, blind treatment of water supplies. Currently, there is enough interest among environmentalists and microbiologists in various countries that some impetus could be given to Kristensen's suggestion. (CDR Sam W. Joseph, Microbiology Department, Naval Medical Research Institute, Bethesda, Maryland)

ONRL REPORTS

See the back of this issue for abstracts of current reports.

ENERGY

A CONFERENCE ON THE ECONOMICS OF SOLAR ENERGY—CAN THE UK AFFORD IT?

The UK Government's expenditure on solar energy research is approximately $3,000,000 per annum—a piddling amount by US standards. Yet, in some way, it represents the UK's current evaluation of the importance of solar energy to Britain, taking into account the full picture of continuing economic stresses and extant energy potentials. In a nation blessed with ample fossil fuel, growing North Sea oil flow, and an oversubscription to nuclear power and suffering from economic perils f more than a quarter of a century, it might seem reasonable to devote little attention and resources to solar power development.

Nevertheless, there exists in Britain a vocal group, with substantial impact, that promotes solar power unabatedly. The core of this solar-power advocacy lies with the UK Section of the International Solar Energy Society (ISES). This Section is housed at the Royal Institution (21 Albermarle St., London), a prestigious location, where notable scientists of the past (Davy, Faraday, and others) have worked. In fact, the close coupling of ISES and the Royal Institution owes much to the presence at the Institution of its present Director and most notable in-house scientist, Sir George Porter, Nobel Laureate.

It was in this setting—the lecture hall of the Royal Institution—that a one-day Conference on the Economic and Commercial Assessment of Solar Energy Conversion was held on 5 July 1977, sponsored by ISES. The asserted assessment goal was largely unrealized, but the Conference did provide an opportunity to feel the pulse of the public sector; commercial developments were conspicuous by their absence, an absence which attests to both the scope of such developments and a reluctance of commercial developers to engage in public discussion.

The difficulty in arriving at assessments underscored papers delivered by Peter T. Landsberg (Univ. of Southampton), "How Much Investment in Conversion Devices?", and B. McNelis (General Technology Systems, Hounslow, Middlesex), "Solar Water Heating—Some Economic and Commercial Aspects." Landsberg emphasized that he was concerned with the mathematical methods of assessing investment policy, rather than on the actual numbers that resulted. Since many of the quantities that go into obtaining numerical results are poorly known (e.g., inflation rate), this approach is clearly one with great appeal to a mathematician, Landsberg's occupation. Landsberg did emphasize, furthermore, that the resulting conclusions are sensitive functions of input parameters. Despite this he concluded by guessing that 4-8% of the energy consumed by the UK in the year 2000 would be supplied by solar energy.

McNelis's paper demurred from any attempt at thorough economic analysis but emphasized the strong dependence of solar-power development on economics, and the muddle that exists today. Thus, according to McNelis, the existing solar industry is now placing great emphasis on the cost savings and investment value of their products, but there are invariably no clear statements concerning the thermal performance to be expected or assumptions made when claiming that a system is economically viable. McNelis gave the example of one company that claims to deliver more solar energy than is available.

The rising star of science/technology/economic assessments in the UK today almost certainly is Peter Chapman (Energy Research Group, Open Univ., Milton Keynes, Bucks.). This Conference was my first opportunity to hear (and see) Chapman—and it was a very distinctive event, indeed. His demeanor and dress is in sharp contrast to those with whom we are generally familiar—and comfortable. By no stretch of the imagination could Chapman be identified with the dark wool-suited authorities of Britain; instead he sported jeans and long hair, in a style that would tempt one to write him off as a "protestnik." His address quickly dispelled any such illusions. He was both smooth on delivery and facile with content. He speaks with authority—and the comments following his address were as complimentary as one might expect to be made about an older, senior member of the technical community. Follow Chapman in future years; it will certainly be interesting to see to what pinnacles he climbs.

Chapman spoke on "The Economic Evaluation of Solar Energy Schemes." In part, he repeated Landsberg's mathematics, introducing the methods of economics; particularly discounted cash flow, for an audience less atuned to economics than to technology or ecology. But, having done so, he specifically cited the limitations of applying full economic artillery when so little is known about the factors that enter calculations. According to Chapman, these factors are not so much poorly known as they are unknowable.

It is unclear to me whether Chapman's introduction of the concept of unknowable quantities is serviceable. In the final discussion of the Conference, one participant (whom I would place in the ecology-centered classification) took the concept to its limit and called for an end to economic analysis and predictions for solar energy—calling it a waste of time and resources. I was delighted with the reply of the chairman of the discussion: "Unless you do estimations, you make Concordes." I fear that those who advocate solar-energy conversion the most may do it real harm by adopting an attitude that smacks of anti-intellectualism in its gut-feeling that solar energy "is right." Economic analysis may be fragmentary, but it must be pursued unless an alternative is found, an event that I do not foresee.

However, progress can be made without being slavish toward precise economic considerations. For example, D.J. Toop (British Standards Institution, London), speaking as an individual and explicitly not for his institution, demonstrated that solar panels currently are too expensive and too inefficient to justify their installation where fossil fuel is to be saved, but they may be justifiable where electric power is used. He arrived at these conclusions using assumptions that were always favorable to solar heating, allowing for fuel price inflation as high as 25% per annum and prevailing interest rates as low as 5% per annum. Toop described himself as a philistine among sun worshipers—and, indeed, one could scarcely escape the feeling that the organizers had included this paper as a gesture of balance and fairness. Yet Toop's paper was never discussed, let alone contested.

Perhaps the most valuable paper for solar-energy technology was delivered by J. Keable (HELIX Multi-Professional Services, London). Keable appealed for the utilization of heat pumps as a supplement or alternative to solar panels. Heat pumps have been mainly used in air-conditioning or refrigeration. According to Keable, the technology of heat pumps has so advanced recently that it is appropriate to bring them into the UK heating picture. In his calculation, a solar system with thermal storage would repay the extra capital expenses in seventy years, while a pumped system would do so in four! Keable's paper was a powerful appeal for increased study of heat pumps.

C.W. Smith (Univ. of Salford) presented what by its content might be termed the most entertaining paper. Smith spoke on "Units for Cost/Energy Accounting." The paper was basically an embellishment of a journal article of his in *Collective Phenomena* [2, 211 (1977)] "On Physical Units for Modelling Energy-Monetary Systems." What he has done is to draw analogies between units describing energy flow and monetary flow; the MKSQ system is paralleled by an MKS£ system. Some of the analogies are:

	Electrical	Monetary	Units
Charge	C	pound (or dollar)	£
Current	A	pound/day	$£T^{-1}$
Energy	J		ML^2T^{-2}
Potential	V		$ML^2T^{-2}£^{-1}$
Power	W		ML^2T^{-3}
Impedance	Ω		$ML^2T^{-1}£^{-2}$

The inclusion of impedance in the listing demonstrates how far the analogy can be carried. If the monetary potential leads the monetary current, the monetary impedance is inductive, etc. A monetary potential gradient can be defined, also, and Smith drew an equivalent circuit in which the sun is the power source, with approximate value of 8.6 MJ/day, the solar converter is the analog of a constant power transformer, the price of money is paralleled by an inductance and the investment by a capacitance, power losses are paralleled by resistors, and the useful power is delivered to another resistor. The whole analogy is both clever and good fun; whether it can make any contributions to the energy field remains to be determined.

Neglecting unusual events, such as the hot summers of 1975 and 1976, Britain is not a country noted for great amounts of sunshine. Supporters

of higher levels of solar-energy research counter this observation by pointing out that the amount of UK insolation is, nevertheless, appreciable—approaching one-half of the average amount in the US. Still, I cannot escape the feeling that the firmest justification of enhanced attention to solar-energy conversion in Britain was hardly mentioned at the Conference. There will be a growing market for solar-energy devices and systems in more favorable areas of the world, and this could be a spur to research in the UK. Is Britain once again missing a potential market, or are those pursuing these markets too busy to talk at public meetings? (A. Sosin)

SWEDEN'S BIOMASS PRODUCTION POTENTIAL

One of the approaches to the world's energy crisis is the use of its "biomass." It is generally recognized that no country has a greater biomass production potential than Brazil with her immense rain forest. While not nearly as large as Brazil, Sweden has, in addition to her established forests, a large biomass production potential in more than a million hectares (4000 square miles) of unused ground that is suited for cultivation of rapidly growing deciduous trees. This area could produce an annual contribution of energy equal to nearly one-third of her present crude-oil imports. Wood chips can be produced at perhaps half the cost of heating oil and are a good starting material for methanol production.

In late December 1976 Professor Gustaf Sirén (Royal College of Forestry, Stockholm) stated that certain species of willow can convert over 5% of the solar energy into biomass (excluding roots). This is at least as good an efficiency as tropical forests and may be compared with the potato's 1%. A species of Salix from Värmland (Salix Smith) is now under cultivation at Bogesundslandet outside Stockholm, the so-called "minirotation forest." Salix and poplar contain a thermal value of 21,000 kJ/kg with 3% moisture. Poplar from Bogesundsland contains 18,800 kJ/kg and only 1.7 ±0.1% of ash.

Tests at the Forestry College show that Salix species, in practice, may yield a net of 24 m^3 of wood per hectare. Energy expenditures for fertilizer, manufacture of the forest machinery, and other requirements, have been taken into account to arrive at this value. The "Salix Smith" species produces 87.4 m^3 gross of wood per hectare and year.

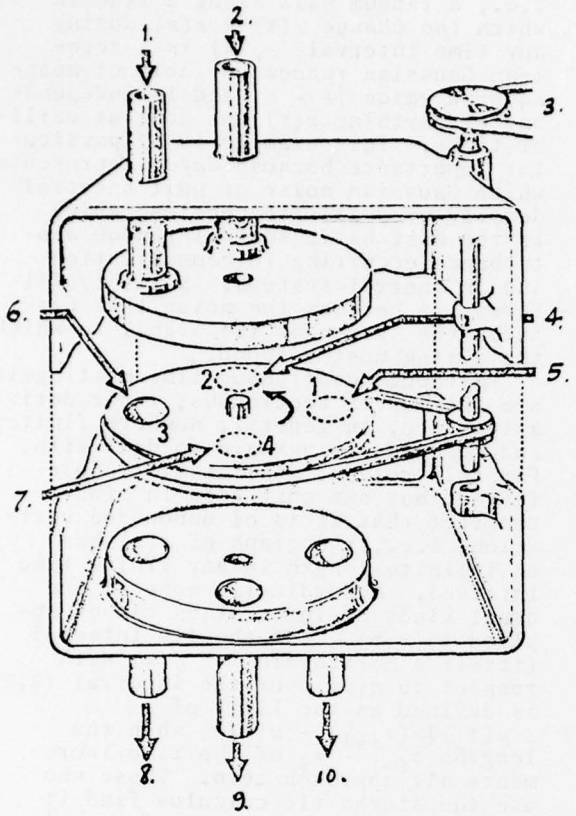
In June, Sirén received a grant of about $750,000 to continue experiments on the cultivation of poplar and willow trees at Roslagen and Studsvik. The yield per square meter of these "energy forests" corresponds, in heat value, to 1 to 2 kg of oil. At Studsvik, Sirén will use waste heat from the nuclear research station to warm the soil and greenhouse. Theoretically energy forests could yield enough energy to meet Sweden's total requirement for oil, but they are not expected to produce cheaper energy than today's energy sources.

According to a report recently published by Professor Per-Olof Nilsson (Forestry Institute, Garpenberg), about 4.5 million tons of tree remnants (waste wood), corresponding to 1.9 million tons of oil, are left to rot each year in Swedish forests. Practical tests have shown that such "splinter wood" could be taken annually at a cost less than that for oil. According to Nilsson, dry burnable wood could be delivered to the heating plant at a cost of $60-$80 per ton. Since about two tons of waste wood corresponds to a cubic meter of oil in fuel value, the cost of waste wood is comparable with the price of oil, approximately $150 per m^3.

The collection and handling of waste wood demand no more work than ordinary felling of trees, and the methods are simple enough to be of interest to owners of small forests. The collection of the large masses of waste wood will also help eliminate breeding places for insects.

While, with simple adjustments, a new district heating plant (fluidized bed) in Enköping can shift to a variety of fuels including waste wood, Jan Åbom, a research engineer at the Chalmers Institute of Technology, Gothenburg, has developed an injection-pump mechanism that uses wood powder as a fuel. The Volvo Motor Company provided Åbom with "a little green diesel" motor for experimentation.

The heart of the injection-pump mechanism is shown in the diagram.



1. When the precombustion chamber passes here it is emptied by air.
2. When the precombustion chamber passes this tube, it is filled with fuel.
3. Spinning. An electric motor drives the precombustion-chamber disc. The other discs are fixed. The discs have very close tolerances.
4. Fuel supply, powder.
5. Pressure source.
6. Precombustion chamber. This hole is simultaneously the bearer of fuel and the vent which releases the fuel into the combustion chamber.
7. Here the precombustion chamber is filled with air again.
8. To the diesel motor's combustion chamber.
9. Air source.

It consists of three discs, the center disc being free to spin. The discs have holes at different positions, one for intake of wood powder, one for air intake, and one for air exhaust. The center disc has only one hole and it functions as both a valve and a transport chamber for the fuel (wood powder). The sequence of events for the center disc is as follows: (a) When the precombustion chamber passes the vacuum orifice, all air is removed from the chamber; (b) the disc rotates 90 degrees to receive fuel injection (wood powder); (c) another quarter turn and the precombustion chamber is aligned with the injection vent to the cylinder; an air pressure vent forces the wood powder into the cylinder; and (d) the final quarter turn brings the precombustion chamber in line with an air source. The center disc is driven by an electric motor. The three discs fit closely together and must withstand pressures of 200 kg/cm^2.

The fuel is made from poplar wood which is ground and refined so that it is as soft and smooth as ordinary baking flour. The finished powder has a moisture content of about 3%. According to Åbom, wood powder suitable for fuel costs about 35 to 50 öre (about 8 to 12 cents) per kg. The cost of the wood and its processing are included in this price. Åbom is continuing his work at Chalmers and is now experimenting with a few kilos of sycamore wood supplied by Dr. Klaus Steinbeck of Athens, Georgia. It appears that this is providing a better class of wood powder than poplar. Åbom has patented his invention in Europe as well as in the United States (US Patent No. 3981277). (Ernest R. Sohns, Scientific Attaché, US Embassy, Stockholm)

ONRL REPORTS

See the back of this issue for the abstracts of current reports.

ELECTRONICS

COMMUNICATION AND STOCHASTIC CALCULUS

Communication is both helped and hindered by randomness. The random noise that inevitably accompanies the received signal obviously hinders it. The fluctuations of the signal that result from the vicissitudes of the propagation medium sometimes hinder and sometimes help. But the randomness of the signal itself (i.e., the receiver's ignorance as to what message it will carry) is definitely helpful, for a signal (such as a never-ending sinusoid of fixed amplitude and phase) that is completely predictable conveys no information and need not be transmitted. Uniting the topics of communication systems and random-process theory, J.K. Skwirzynski (GEC-Marconi Research Lab., Great Baddow, Essex) organized a NATO Advanced Study Institute, which took place 8-20 August 1977 at the Europa Lodge Hotel just outside Darlington, County Durham, in northeastern England.

The 120 participants from the US, UK, Italy, France, Germany, Netherlands, Turkey, Canada, etc., included both recent doctorates and leading authorities as well as people in between—the great majority of them from academe. Skwirzynski endeavored to involve all as speakers, chairmen, commentators, discussers, or panel members, and he distributed a lengthy annotated reading list in advance of the Institute. There were 45 formal papers (some 2 hours in length but most of them shorter and labeled as "discussions") as well as several panel discussions and a special half-day session on the work of the SHAPE Technical Centre (see next *ESN* article).

Sessions on random processes emphasized the use of martingales and the Ito stochastic calculus as well as models for radio and underwater acoustic propagation and for non-Gaussian noise. The present article concentrates on the first two of these topics. A martingale is a random process whose expectation at any future time for given present and past values is its present value. The capital of a gambler who makes fair bets at regular intervals is an example of a discrete-time martingale. In fact, the name derives from the French language, in which it denotes any betting scheme. A continuous-time example is a one-dimensional Brownian motion $x(t)$, i.e., a random walk along a line in which the change $x(t) - x(s)$ during any time interval (s, t) is a zero-mean Gaussian random variable of mean-squared value $|t - s|$ and is independent of anything $x(t)$ has done at earlier times. This example is of particular importance because dx/dt represents white Gaussian noise of unit spectral density over all frequencies, which is the most basic sort of random disturbance occurring in communication and in control systems. Suitably filtered, it becomes the noise that disturbs the system or the signal to which the system must respond.

Although continuous-time martingales are themselves continuous, their derivatives are, in general, nowhere finite, and so dx/dt is awkward to deal with. For this reason, $x(t)$ itself is preferred, but one must keep in mind the fact that it is of unbounded variation, i.e., the graph of $x(t)$ has an infinite length in any finite time interval. Accordingly, none of the usual kinds of integration can be applied to $x(t)$. But the Ito integral (itself a martingale) of $y(t)$ with respect to $x(t)$ over the interval $(0,T)$ is defined as the limit of $\Sigma\, y(t_i)[x(t_{i+1}) - x(t_i)]$ when the lengths $t_{i+1} - t_i$ of the time increments all approach zero. Those who use the stochastic calculus find it often permits the removal of restrictive assumptions, gives insight into the structure of results, simplifies proofs, and provides an easy way to handle signal-detection, filtering, and control problems because it deals with sample paths rather than just with their statistical characterization.

Dr. Mark H.A. Davis (Dept. of Computing and Control, Imperial College, London) organized the sessions on stochastic calculus, which opened with an introduction by Prof. Eugene Wong (Univ. of California, Berkeley). Davis followed with an explanation of semimartingales—processes equal to the sum of a martingale plus a term of bounded variation. He pointed out that a nonlinear function of a semimartingale is again a semimartingale, and he elucidated numerous other aspects (see M.H.A. Davis, *Linear Estimation and Stochastic Control*, Chapman & Hall, London, 1977). His colleague Dr. J. Martin C. Clark continued the topic

with applications to the nonlinear filtering of signals.

In the ensuing discussion it was suggested that the Stratonovich stochastic integral might be preferable to the Ito; unlike the latter, it obeys the usual rules for the manipulation of integrals because the integrand $y(t)$ is evaluated at the center $(t_{i+1} + t_i)/2$ of each time increment rather than at the beginning. Wong agreed in regard to piecewise-constant (counting) processes, and Clark agreed in regard to elementary problems but asserted that the Stratonovich approach, though equivalent to the Ito, is less robust and does not demonstrate the continuity of the outputs. He referred to E.J. McShane's *Stochastic Calculus and Stochastic Models* (Academic Press, New York, 1974) for a more thorough and more difficult treatment. Prof. Adrian Segall (Electrical Engineering Dept., Technion, Haifa, Israel) stated that the use of martingales has allowed the introduction of feedback in a quite natural way into detection, estimation, and control theory when the signal may not be independent of past noise.

However, mastering the concepts and theorems of stochastic calculus might, as some felt, take an inordinate amount of time away from more obviously productive efforts on the part of those specializing in other areas. In fact, Wong suggested that the "application" of Ito integration to stochastic control problems may be like applying an abstract algebra to topology; he feels that really practical applications need to be developed.

In a talk on his own work concerning n-dimensional random fields, Wong hinted at applications to turbulence, wave propagation, image processing, and quantum mechanics. The two-dimensional case turns out to be sufficiently complicated (replacing one-dimensional time by a partially ordered coordinate pair, which makes recursive computation difficult) that Wong has not yet ventured beyond $n = 2$. Although it would make sense to have the past and future correspond to the two sides of a moving boundary, Wong has not been able to incorporate such a property as yet, and much work remains to be done in this area.

Dr. Pierre Brémaud (Institut de Recherche d'Informatique et Automatique, IRIA/LABORIA, Rocquencourt, France) observed that, like coding theory, martingale theory is larger than its applications, but he expects the latter to come. His paper dealt with point processes (e.g., the pulses from a roving Geiger counter) and the number of events (counts) $N(t)$ that have occurred up to any time t, which he felt offers pedagogical advantages in the explanation of martingales. He applied it to queuing problems (birth-and-death processes), where customers arrive randomly, are served for random times, and then disappear from the queue.

Finally, Prof. D.L. Snyder (Washington Univ., St. Louis, Mo.) discussed the multidimensional point process arising in optical 1-Gbit/sec (10^9-bit/sec) satellite-relay communication in the presence of (lognormal) fading. Here the blurred image of a laser source (keyed on and off to convey messages) falls on a photoemissive surface, producing an electron-emission process that depends on x, y, and t. Because of fluctuations in the refraction of the atmosphere, the laser image wanders randomly over the surface, and the x and y coordinates of the photoelectrons must be sensed in order to be able to correct the tracking errors. (The fading of the image results from numerous inhomogeneities along the transmission path through the atmosphere, each producing a random number of decibels' attenuation, and the total attenuation is therefore a normally distributed number of decibels, i.e., lognormal.) Snyder found stochastic calculus indispensable for analyzing this tracking problem. The "brass-boarded" system built by Micro-Term Inc., St. Louis, Mo., has achieved a tracking error of less than one microradian.

Dr. R.E. Morley (Micro-Term Inc.), formerly a student of Snyder's, explained the communication aspects of the system, including the use of the Viterbi algorithm for keeping down the amount of computation needed in evaluating likelihood ratios (on the assumption that the channel has a finite memory) to determine the received message. When asked if numerical evaluation of the Ito integral involved in the likelihood ratio yielded agreement with the theory, Snyder replied this would be a good check, which has yet to be carried out.

It thus appears that, in the hands of an expert, stochastic calculus can be very useful, but it has a way to go before it becomes a part of every

communication theorist's and control theorist's toolkit.

In addition to martingales and stochastic calculus, sessions of the Advanced Study Institute (ASI) were devoted to data communications, algebraic and probabilistic coding, multiuser communications, source coding, and adaptive signal processing as well as propagation and noise modeling. These will be discussed in a subsequent article. While some of the work presented on these topics was new, the emphasis was primarily tutorial so as to enable those in other areas of specialization to appreciate the present state of each field and thereby to promote interdisciplinary communication and progress.

Darlington, with its slogan "Say NO to NOISE," was a particularly appropriate venue for the Institute, and the borough provided buttons bearing that motto. This NATO ASI was, in fact, the second to unite its two topics, the previous one having been organized by Skwirzynski at the same location in 1974. Its 664-page proceedings were published by A.W. Sijthoff, Leyden, Netherlands, in 1975 under the title *Signal Processing in Communication and Control* ($57.40), and this publisher will handle the proceedings of the 1977 ASI also. It is a testimonial to Skwirzynski's excellent organization of the Institute that, throughout its two weeks, nearly all of the participants attended most of the talks. It is to be hoped that he will succeed in organizing another in 1980; he is considering focusing it on multiuser communications. (Nelson M. Blachman)

NATO SHAPELY COMMUNICATIONS

The SHAPE (Supreme Headquarters Allied Powers in Europe) Technical Centre (STC) in the Hague is a NATO research organization operated under the policy guidance of SACEUR (Supreme Allied Commander, EURope), in Mons, Belgium (see also *ESN* 30-8:363). It comprises four Divisions: Operations Research, Command and Control Systems, Mathematics and Computers, and Communications. The unclassified work of this last Division was the topic of a special half-day session on 10 September 1977 during the NATO Advanced Study Institute on Communication Systems and Random Process Theory in Darlington, County Durham, UK. Of the 350 STC employees, 130 are scientists or engineers under two- or three-year contract, and 35 of the latter work in the Communications Division. Four of these attended the Institute and presented six papers. Their Division is responsible for NATO terrestrial, aircraft, and fleet communications, including satellite relaying as well as the NICS (NATO Integrated Communication System) area grid network, and these papers covered a variety of topics bearing on this mission.

In the absence of the Division's head, Dr. A.N. Ince, Mr. D.W. Brown discussed STC's activities and presented a tutorial paper on VHF teletype communication by reflection from meteor trails [P.J. Bartholomét and I.M. Vogt, "COMET—A New Meteor-Burst System Incorporating ARQ and Diversity Reception," *IEEE Trans. Communication Technology* COM-16, 268-278 (April 1968)]. Because of the rapid growth of satellite communication (despite its greater cost), the COMET system has never really been used operationally, but Brown expressed the belief that, when meteor bursts' advantages (low cost, low interceptability, and low vulnerability to jamming) and limitations (200-bit/sec average information rate with delays of the order of two minutes between bursts that last for something like ten seconds) are properly taken into account, there will be a resurgence of interest in radio transmission by reflection from meteor trails.

Dr. E.V. Stansfield presented a survey of speech processing for secure, low-data-rate voice communication of good quality that can be carried by ordinary telephone lines. Thus, the data rate should be 8,000 bit/sec or, if the line is to be used without correction of its frequency response, no more than 2,400 bit/sec. Like the succeeding four papers, this one also described new (though not novel) work which is of importance not only in military communications but also for commercial service and for businesses seeking to insure the privacy of their telephone calls. Here the aim is to achieve the stated goal with cost-effective equipment of small size. The difficulty of this problem is indicated by the fact that commercial telephone services use 64 kbit/sec to achieve high quality with pulse-code

modulation, while the armed forces use multiples of 8 kbit/sec to obtain something less.

STC's speech-processing group has found that pulse coding and delta modulation in their many forms are unsuited to high-quality, low-data-rate voice transmission, but analysis-synthesis techniques based on the transmission of speech-waveform parameters show promise. Channel vocoding and linear and adaptive predictive coding are currently available examples of such techniques, but they generally have produced an undesirable artificial sound and are, moreover, at some disadvantage in the acoustic-noise environment of a vehicle. Transmission errors further degrade the performance, but STC has been making progress in overcoming these problems as well as those of reliable voiced-unvoiced-silence decisions and pitch detection. Stanfield's group has been developing new techniques in spectrum vocoding by eliminating oversimplifications usually made in the linear-prediction modeling of speech waveforms. Involved in this improvement is a better mathematical model of the production of speech by the vocal tract. Stanfield plans to implement the improved vocoding with the aid of high-speed array microprocessors for the critical tasks and efficient programming of general-purpose hardware.

Dr. M. Darnell presented two survey papers, "New HF Data Transmission Techniques" and "Channel Evaluation Techniques for Dispersive Communication Paths," dealing with the means for carrying such traffic as processed speech toward its destination. Because high-frequency (3-30 MHz) propagation involves ionospheric reflection, the signal can simultaneously travel over a variety of paths, which may interfere constructively or destructively to produce fading. Because of these effects as well as the crowding of the HF spectrum, communications have been shifting to satellite relays, but Darnell feels HF communication merits renewed exploitation by broadening the class of waveforms that may be employed and thus including, for example, the use of spread-spectrum signaling for combating the multipath transmission. In particular, he emphasized that, because of the fading, constant-data-rate systems are mismatched to the HF channel, and the efficient use of this channel requires its continual monitoring and the adjustment of the transmission system in accordance with its observed state.

The last of the four STC speakers was Dr. P.T. Nielsen who discussed the characterization of troposcatter channels for digital transmission utilizing inhomogeneities in the troposphere to return signals to the earth. Although these channels involve much higher (microwave) frequencies and information rates, they suffer from multipath dispersion and fading somewhat like those at HF, and adaptive signal-processing techniques are required in order to allow data transmission at rates comparable with the reciprocal of the multipath spread. Knowledge of the statistics of the multipath structure is needed in order to optimize the adaptation, and STC has conducted experimental studies to obtain such information on the parameters of the "wide-sense-stationary uncorrelated scattering" model. This work is continuing, along with simulation of the troposcatter channel and prediction of the performance of a digital link on the basis of the model and the statistics of its parameters. Troposcatter communication equipment is particularly suitable for use in situations where terrestrial microwave relays cannot be installed (e.g., at sea) and where satellite relays would be too costly. STC has obtained troposcatter equipment both from GTE Sylvania and from Raytheon.

Finally, Dr. A.N. Ince's paper on code-division multiplexing (CDM) for satellite systems was presented by Nielsen. This mode of operation is also described as a spread-spectrum technique, since each terrestrial transmitter utilizes a bandwidth much larger than the rate of the digits it transmits. There is consequently spectral overlapping of different transmitters, but the receiver is able to separate them by crosscorrelation with locally generated versions of their codes. Both theoretical and experimental studies have been conducted in regard to the performance of a particular 4-phase CDM system [A.N. Ince, "Design, Testing and Operation of X-Band Satellite Communications System," *IEEE Trans. Communications* COM-22 (Sept. 1974)], including the effects of nonlinearities and means for their alleviation. Among the advantages of CDM are its resistance to interference and its "graceful"

(i.e., gradual) error-rate degradation as the number of active transmitters increases. Although such a signal format can be used to combat multipath propagation, this problem does not arise in the case of satellite relaying. Ordinarily the codes used would not be complex enough to provide much message security, but for some purposes their cryptographic effect may be sufficient, e.g., in commercial applications.

The STC system uses CDM for combining signals at each transmitter in contrast with the time-division multiplexing (TDM) used by others along with code-division multiple access to the satellite from different transmitters. Spectral spreading is achieved by the pseudo-random selection of one out of four possible carrier-frequency phases for each successive coding interval ("chip"), with the (much longer) information bits altering these choices in a deterministic way. The same carrier frequency is used in all channels handled by a given transmitter, but with a different code generator for each, and the sum of the resulting spread-spectrum waveforms is radiated. The use of CDM for combining information channels relieves timing problems arising with TDM.

In addition to the work described above, on which detailed reports are available from the STC (Office of U.S. R&D Coordinator, Shape Technical Centre, APO New York 09159), there has also been unclassified STC Communications Division work on traffic routing and switching. It seems evident that this Division has very competently surveyed the fields in which it is working and has been developing communication equipment which, while not radically new, is clearly advancing the state of the art.

An article discussing other work presented during the two-week-long NATO Advanced Study Institute appears elsewhere in this issue of *ESN*.
(Nelson M. Blachman)

ONAL REPORTS

See the back of this issue for abstracts of current reports.

GENERAL

CUTS IN FRENCH RESEARCH SUPPORT

During the Gaullist period (1958-1969) science in France prospered: the percentage of the GNP devoted to research and development grew steadily from 1.15% in 1959 to a maximum of 2.15% in 1964; however, by 1974 it had declined to about 1.7%. Since her manpower and raw material resources are not expected to increase drastically in the years to come, France has to rely more and more on export of technological expertise to keep her place among the rich nations. This position was clearly understood by President Giscard d'Estaing who, early in 1976, also concluded that growth of research was essential and was one of the means by which his country's prestige could be maintained and increased. Thus, the scene seemed to have been set for a momentum of French research which would have been reflected, in part, by an increase in scientific positions both in government laboratories and in universities.

Until early this summer, however, there were strong indications that this increase would not materialize—worse, that the support of French research would be given a severe blow by the implementation of drastic reductions. *Science & Government Report* [VII(12), 8 (1977)] described these pending cuts and provided some of the background explaining such a turnabout in terms of recent changes made in the structure of research administration. To ensure a unified research policy on a national scale, the Minister for Industry and Research had, until recently, the role of interministerial coordinator between the various Ministries and the task of implementing the nation's research and development policy. Until the spring of 1977, Mr. d'Ornano occupied this very powerful and influential position. After his unsuccessful bid to become mayor of Paris, he was dismissed and his former role was eclipsed by the creation of a new Sécretariat. Mr. Jacques Sourdille became the first Sécrétaire d'Etat à la Recherche (Secretary of State for Research) and is directly responsible to the Prime

Minister, Raymond Barre. The latter, a former university man, was responsible for this restructuring, which uncoupled some of the strong ties that previously existed between science, research, and industry.

It seems that much of this scenario was motivated by political ends in an attempt to regain votes in the looming future elections, for, at the present, the government finds itself in a very precarious position while the opposition has acquired appreciable momentum. It therefore appeared that research support might be sacrificed by the government in order to improve its posture in the coming elections and that the long-range goals were being disregarded at the expense of obvious short-term ones.

According to *Le Monde* of June 1977 and *Science et Vie* (Aug. 77), the battle for "adequate" research support has not been entirely lost. Sourdille recently scored appreciable gains for research by obtaining from Prime Minister Barre an additional 293×10^6 FF for certain areas of the 1978 research budget. These monies will enable French research to survive during the coming fiscal year. This gain must be contrasted with substantial cuts of the order of 15% which were in the cards in May-June of this year for all areas except the "Programmes d'Actions Prioritaires" which were to receive some 6% increase.

There has been a shift in the priorities of research support: for instance, Commissariat à l'Energie Atomique (CEA) will have an increase of 14% in its budget; the Institut National de la Santé et de la Recherche Médicale (INSERM), the Centre National d'Etudes Spatiale (CNES), the universities, the Organisation de la Recherche Scientifique et Technique Outre Mer (ORSTOM), and the Institut de Recherche d'Informatique et d'Automatique (IRIA) will get an increase of about 10%.

On the other hand, agricultural research will suffer cuts: The Institut National de Recherche Agrononmique (INRA) will have its budget increased by only 2.3% (while the inflation rate runs at some 12% per year). The Centre National pour l'Exploitation des Oceans (CNEXO) will have an increase of only 5.3%, and the Centre National de la Recherche Scientifique (CNRS) will suffer the same fate with only an additional 4.3%.

There will be some 380 new scientific positions in 1978 (versus 437 in 1977) and 209 for engineers, technicians, and administrators (versus 513). While the current French Plan (the VIIth prepared in 1976) calls for a yearly increase of some 3.7% for the next five years, 1978 will see an overall increase in the support of research by some 3%.

Thus although having a budget somewhat below what was forecast this time last year, French research will be able to survive after having come so close to being severely cut. It appears that the shift in priorities will be accompanied by the creation of new scientific positions at the expense of capital equipment and new laboratory buildings, and this will do much to lift the sagging morale of many French scientists.
(Albert Barcilon)

MATERIAL SCIENCES

BOHRISH METALLURGY

The image of Bohr, first Niels and more recently Aage, is indelibly written in Danish science. That physics and chemistry should bear this imprint is understandable. A visit to the University of Copenhagen and to Risø (Danish Atomic Energy Commission Research Establishment) demonstrates that Bohrish activities occupy a significant role in materials investigations, too.

Professor L.T. Chadderton was my host at the H.C. Ørsted Institute of the University of Copenhagen. Chadderton, originally from Britain and more recently a colleague at the North American (Rockwell International) Science Center (California), has assembled an active group of young investigators working in several closely related areas: ion implantation, channeling, radiation damage, and surface studies.

E. Johnson, T. Wholenberg, and Chadderton have looked at CaF_2 in the electron microscope as the fluorite was bombarded with 100-keV electrons. The major observations are familiar to investigators working on the formation of voids (three-dimensional

vacancy agglomerates) in metals. As in metals, voids are observed to form, at small radii, in a random spatial distribution in the material, then to adopt a superlattice structure as they continue their growth. In metals, the superlattice is parallel to the host crystal lattice, with a larger spacing, of course. In fluorite, the superlattice is a simple cubic, unlike the host matrix, but like the structure of the fluoride-ion sublattice. That the voids are composed of fluoride-ion vacancies is further supported by the observation that the voids move to the surface, apparently emitting gas on reaching it. The disposition of the calcium is unknown; it may simply be retained as colloidal aggregates. Elasticity theory, usually invoked to explain the parallel void lattices in metals, fails to predict the observed simple cubic lattice in CaF_2. Chadderton *et al* support a one-dimensional crowdion-diffusion mechanism suggested by A.J.E. Foreman (Harwell, UK); such crowdions would diffuse on sublattices, allowing fluoride activity with metal-ion immobility. The requisite long range required for such a mechanism has stirred criticism, and no stable crowdions have been directly observed as yet. The matter remains open to further study. Interestingly, Johnson has observed the Brownian motion of the voids which accompany vacancy aggregation and void diffusion.

Nickel bombarded with Dy^+ is observed to become amorphous. Chadderton *et al*, in collaboration with Carter (Univ. of Salford, UK) have looked in the electron microscope at such samples and observed three separate stages of recovery toward crystallinity; the details of these stages are under investigation.

S.A. Komolov, a guest scientist from the Leningrad State University, has returned to the USSR after a year with Chadderton. During this period, a new effort was established in the laboratory: total current spectroscopy (TCS). TCS differs from related secondary electron techniques in which the reflection of low-energy (<10 eV) electron beams from a surface are monitored as a function of primary electron energy. In fact, TCS is the complement of such methods and considerably simpler experimentally. In principle, one merely measures the beam current which is collected through the sample; in practice, modulation and lock-in techniques are used. Nevertheless, there is a great amount of simplicity achieved, and this allows the experimenter to reach out and include experimental variables which would be more formidable otherwise. Komolov and Chadderton have looked at the TCS of a vanadium surface during both desorption and absorption, in the temperature range from 20 to 1500°C. They concurrently measured the surface potential and observed a somewhat complex behavior which mirrors the processes of sorption occurring on the surface. They believe that they are able to distinguish major effects related to interband electronic transitions in the crystal and minor effects caused by quantum mechanical resonances in the residual adsorbed layer. The work has been extended to CdS, as well. Since Komolov has now left the Institute, the work has been interrupted to allow the improvement of the apparatus.

Still another visitor, J.L. Whitton (Chalk River Nuclear Laboratories, Canada), has also left after contributing several valuable achievements. His scanning-electron microscopy work on the surface topography of copper bombarded with 40-keV argon ions is fascinating. For example, after a dose of about 10^{19} ions, the surface of some of the copper crystallites are covered with well-defined geometric cones. Neighboring surfaces may have considerably fewer cones, or essentially none at all. The cones are clearly formed by the sputtering away of material; the cones which appear on a well-populated surface lie in a "valley" below the neighboring crystallites and have apexes that are below those neighboring crystallites, also. Generally the cones are right-cylinder in geometry, but rotation of the sample during bombardment produces canted cones. Even more intriguing is the observation that cones, inevitably close to the higher altitudes of neighboring crystallites, may appear bent over, much like a bent candle. Again, the cause of this bending is unknown, but an "ion-wind" effect is among the speculations.

The work of P. Sigmund, generally theoretical, is related in thrust but largely different in specific details. Sigmund has been interested for some time in the details of the energetics and momenta of ion collisions in solids. Recently, U. Littmark and Sigmund

have calculated the depth distribution of momentum deposited by heavy-ion bombardment, using a transport equation method. J. Vukanic, a guest from the Boris Kidrich Institute (Belgrade, Yugoslavia) has considered the reflection (total backscattering) of keV light ions from solids. He uses a single-collision approximation with Coulomb interactions that is claimed to allow a bridge to be made between computer-simulation techniques, appropriate at low-ion energy, and Rutherford backscattering or transport theory, both appropriate at high energy. Littmark and Sigmund have turned their newest techniques to the problem of sputtering and are cooperating with H.H. Andersen at Aarhus University on a combined experimental/theoretical program.

B. Buras, working with J.S. Olsen and with investigators in other laboratories, has been concentrating on the advancement and utilization of energy-dispersive x-ray diffractometry. This technique, introduced in 1968, has been used most heavily for studies of powdered crystals. Buras *et al* use single crystals, a most significant improvement for many studies. A collimated polychromatic (white) incident x-ray beam is placed incident to the sample and the scattered x-rays are measured at a fixed angle, a feature that provides both simplicity and accuracy. The wavelength of the scattered x-rays is measured using either germanium or silicon detectors and energy-scanning multichannel pulse-height analyzers. The sample may be rotated if desired. The rotating-sample method provides more diffraction details, but the fixed-sample technique provides a diffractogram which is remarkably free of "noise." They have also considered the theory of observed intensities, including the polarization of the x-rays scattered from thick targets in tubes which may serve dispersive analysis. At present they are applying this formidable experimental/analytical expertise to a variety of materials problems including, for example, phase transformations. The techniques lend themselves advantageously to studies in which ovens, high-pressure devices, and time-dependences are important.

E. Veje and coworkers are pursuing studies of beam-foil spectroscopy and atom-ion collision excitations which are somewhat removed from the interests of Chadderton, Sigmund, and Buras. At a minimum, there is an overlap in that Veje maintains an accelerator facility which provides a wide range of available ions, used in the past by Chadderton and coworkers for ion implantations into various metals. The accelerator is a portion of the 90-keV isotope separator installed in 1966. Modification in 1970 raised the upper energy to 150 keV, and recent work has boosted this to 300 keV. The target end of the accelerator systems is fitted with a liquid-nitrogen-cooled stage plus a three-axis goniometer. Work down to 20 K is being implemented as well, leading to studies of Rutherford backscattering and channeling at low temperatures. In fact, the collaboration between Veje and the others goes beyond instrumentation for they are all generally interested in high-energy collision phenomena.

Only a little over an hour's distance from Copenhagen lies the Danish Atomic Energy Commission's research establishment at Risø. Metallurgy at Risø is headed by Dr. Neil Hanses; Bohrish metallurgy, as defined in this report, lies in a small group led by Dr. B.N. Singh. This group maintains an active program of cooperation with the Harwell laboratories in the UK, to the benefit of both. The emphasis of this group is directed to the problem of void formation in reactor materials: their properties and their effects on radiation-hardening and high-temperature creep. Perhaps their most interesting work involves the effects of alloying on void formation. Copper is their primary base, and they are investigating alloys with 0.02 wt% Al, 0.2 wt% Al, varying amounts of Al_2O_3, and particularly, varying amounts of Ni. As in the case of a number of laboratories, voids are not formed by reactor irradiation but by a much more rapid simulation technique, in this case by the use of a well-focused, 1-MeV electron-microscope beam. The damage rate (displacements per atom) is high: 5×10^{-3} sec^{-1} to 10^{-2} sec^{-1}; by comparison, highest available reactor rates are about 10^5 slower so that in a matter of minutes simulation experiments provide information which would require perhaps a year in-reactor. Singh *et al* observed that void-size growth is limited near 10% Ni concentration. The number density of voids continues to increase with electron influence so that the

swelling rate is reduced over lesser Ni-concentration alloys. The significance of the 10% is attributed to the insolubility of nickel in copper in this concentration range at the temperature of irradiation. (This insolubility is not apparent in most phase diagrams. It has been thoroughly studied by W. Schule at Ispra, Italy and has been a matter of some controversy.)

Singh *et al* have also examined stainless steels fabricated with no carbide formers and with the addition of Al_2O_3 particles greater in diameter than 500 Å. No void formation was observed; a paper, in collaboration with A.J.E. Foreman (Harwell), is in preparation describing these observations. In another collaborative effort, Singh and Foreman report on the "anomalous" rapid shrinkage of some voids in stainless steel at 650°C. They emphasize that this is a rare event and should not be taken as indicative of the fate of all voids. They consider several mechanisms for this rapid shrinkage and reach a conclusion that is in agreement with intuition—that rapid shrinkage occurs when a void has encountered a dislocation line, allowing rapid vacancy drain from the void by pipe diffusion.

R.M.J. Cotterill and collaborators at the Technical University of Denmark, Lyngby (just north of Copenhagen), form a logical third "pole" to Bohrish Metallurgy. Unfortunately, I did not make it to Lyngby on this occasion. Most of Cotterill's most recent work is concerned with melting phenomena, molecular dynamics, lipid membranes, etc., and involves the concerted use of computer-simulation techniques that he started while working at Argonne National Laboratories. (A. Sosin)

SAFETY ONLY IN A VACUUM?: THE EFFECT OF THE ENVIRONMENT ON STRUCTURAL INTEGRITY OF MATERIALS

Over 100 people attended an International Conference on Mechanisms of Environment Sensitive Cracking of Materials held 4-7 April 1977 at the University of Surrey in Guildford (formerly the Battersea College of Technology). Although there were participants from the US, Germany, France, Holland, Finland, Poland, Australia, Japan, and Canada, the Conference, in terms of numbers, was dominated by the British, reflecting their continuing (and increasing) awareness of the importance of environmental degradation and embrittlement of structural alloys. Undoubtedly, recent service failures in the UK have served to accent the importance of this problem area. As a reflection of this, several new research groups at UK laboratories, such as Harwell and the Central Electricity Research Laboratory (CERL, Leatherhead, Surrey), have been formed to examine both the mechanisms of environmental embrittlement and the more practical and immediate concern as to how to achieve increased reliability in aggressive service environments. Thus the Conference was both topical and of broad interest.

The atmosphere was warm, the facilities good, the food tolerable, and the weather poor; a not-unusual sequence for UK-held conferences. A midweek banquet showed improved cuisine and typical dry wit as the British and foreign contingents exchanged toasts.

The Conference focused on mechanisms controlling environmental cracking in a wide variety of materials, metallic and nonmetallic, with the stated goal of identifying common elements of behavior and hopefully palliative measures that could cut across material groupings. Only plenary sessions were held in order to encourage interaction among various subgroups. Each topic area, of which there were six, *viz.*, mechanisms of dissolution-controlled cracking; liquid metal embrittlement; environmental cracking of polymers; ionic crystals and glasses; corrosion fatique; and hydrogen embrittlement, was introduced by a keynote speaker who attempted, usually successfully, to summarize the state-of-the-art in his specialty area. Since these speakers were by-and-large currently active in research, their presentations were detailed, often provocative, and usually stimulated lively discussions. Following the keynote talks, topical experimental and modeling papers usually of good quality were presented. Most did not address mechanisms *per se*, but they did provide necessary data to test any proposed mechanisms.

In the area of metals, the debate rapidly focused on the relative contributions of anodically-controlled dissolution and hydrogen-induced failure in promoting environmental failure

of both pure metals and structural alloys. Dr. Peter Ford (CERL) championed an effort to demonstrate unequivocally that stress corrosion cracking of high-strength aluminum alloys was solely a result of anodic dissolution. The thrust of his argument was that observed crack propagation rates could be quantitatively accounted for by localized anodic dissolution. However, in discussion, it was suggested that the necessary assumptions to support this approach were not usually physically realistic. Instead, other speakers, namely Prof. P.R Swann (Imperial College, London), Dr. G.M. Scamans (Alcan Laboratories, Ltd., Banbury, Oxford), and Prof. I.M. Bernstein (Carnegie-Mellon Univ., Pittsburgh, PA) suggested that hydrogen can be an important contributor even when occurring in parallel with anodic dissolution, and thus could affect the behavior in aluminum alloys.

In other materials, namely austentic stainless steels and mild (low carbon) steels, controversies similar to those with aluminum alloys have existed and still continue. However, a consensus appeared to emerge, as above, that both electrochemical processes, anodic dissolution, and hydrogen embrittlement, could occur and rate-control would then be determined by the relative kinetics of each, or if the kinetics are similar, joint control is possible. This approach was proposed by Prof. R.N. Parkins (Univ. of Newcastle Upon Tyne), Dr. F. Perdieus (Katholieke Universiteit, Leuven, Belgium), and others.

In high-strength steels there was almost unanimous agreement that hydrogen controls environmental embrittlement, and attention then focused on how this is accomplished. In his keynote talk, the author reviewed potential mechanisms ranging from internal pressure caused by hydrogen-gas recombination, to a decrease in the bonding energy between iron atoms owing to the presence of dissolved hydrogen. He suggested that since hydrogen could be present in iron in dissolved form, combined with other elements or with itself (as a gas), or adsorbed upon various defects, a unique mechanism might not exist. Instead the specific and dominant state of hydrogen in the embrittled material would determine the precise means by which hydrogen embrittles steel. Other investigators chose to focus their attention on hydrogen's ability to reduce the strength of iron-iron bonds, one of the more seductive of the mechanisms. Prof. R. Raj (Cornell Univ., Ithaca, NY), and Drs. Doig and Jones (Central Electricity Generating Board, CEGB, Gravesend) examined the diffusion kinetics necessary to accumulate a critical, but unknown amount of hydrogen near the crack tip. While the mathematics, mainly from diffusion theory, are well developed in this approach, the lack of information, particularly hard data, on how iron-iron bond energies are affected, makes such a model only speculative at the present time.

Dr. S. Tablot-Besnard (Centre National de la Recherche Scientifique, CNRS, France) examined yet another of hydrogen's effects, *viz.*, on mechanical properties, and suggested that by its interaction with dislocations, hydrogen could promote premature failure. This possibility is receiving increased attention, but since so little is known and since much of the data is currently contradictory, more work in this area is deemed desirable.

The hydrogen problem was also considered for zirconium and its alloys, uranium, and titanium by Drs. B. Cox (Atomic Energy of Canada, Ontario), J.P. Fidelle (Atomic Energy of France, CEA, Bruyères le Châtel), and J.C. Scully (Univ. of Leeds), respectively, as well as others. In these materials the roles of hydrogen both in solid solution and precipitated as a hydride must be considered, so the complex problem becomes even more complex.

Corrosion fatigue was also considered in some detail. The joint action of an aggressive environment and a cyclic stress can be extremely damaging, and, as was pointed out, has been responsible for large numbers of service failures, particularly in such sensitive applications as aircraft and pressure vessels. In his keynote talk, Prof. D. Duquette (Rensselaer Polytechnic Institute, Troy, NY) demonstrated that this problem is as complex and the mechanisms as unknown as for static stress environmental cracking. This stems largely from a lack of understanding of the individual components to the process. When they act in concert, synergistic effects exacerbate any attempt at understanding. Specific interest in this area focused on the electrochemical contribution to crack advancement with discussions by Dr. D.E.J. Talbot (Brunel Univ., Uxbridge, UK), Dr. V. Rollins (Lancaster Polytechnic), and Dr. P. Neumann (Max-Planck Inst. für Eisenforschung, FRG)

as well as others. They related the contributions of chemical dissolution on active crack planes (often the slip plane) to either crack opening or reweld-ing. As with the other problem areas, no consensus emerged, and the call for additional research was heard once again.

An interesting development in the area of liquid-metal embrittlement oc-curred at the Conference. It has long been thought that this fracture process is highly brittle and where one wide va-riety of liquid metals can promote the fracture of an equally large number of solid substrates, with no associated deformation required, other than perhaps a specific tensile stress level. Dr. S. Lynch (Dept. of Defense, Melbourne, Australia) provided compelling fracto-graphic evidence that, at least in alum-inum alloys, this is not true. The frac-ture surface of the alloys he examined exhibited significant amounts of plas-ticity, suggesting to him that chemi-sorption of the liquid-metal atom facil-itated dislocation formation at crack tips rather than reducing the bond strength between substrate atoms. This apparent dichotomy of views is a situation similar to that discussed for hydrogen embrittlement.

Dr. A.R.C. Westwood (Martin-Marietta, Baltimore, MD) gave an interesting over-view of the potential commercial exploi-tations of surface-active species on ionic and ceramic solids. Since such species can affect fracture behavior, he suggested that their use in a con-trolled manner could facilitate machin-ing, grinding, polishing, drilling, and erosion and wear of such materials as rocks. He also considered the possi-bility of such control in metals as well as nonmetals. He is a highly persuasive speaker on this subject, and he left many people convinced that commercial exploitation is likely (when, is another subject).

The environmental problems in poly-mers are apparently as complex as those in metals. Dr. R.P. Kamborn (General Electric, Schnectady, NY), in his key-note talk, described how glassy polymers and other thermoplastics and rubbers are affected by the environment. Such effects as crazing, oxidation cracking, and swelling can occur. The mechanisms for these effects depend on the specific polymers examined, and as pointed out by Prof. J.G. Williams (Manchester Poly-technic), Prof. E.J. Kramer (Cornell Univ.), and Prof. S. Okuda (Dorhusha Univ., Japan), the ability of the en-vironmental species to become incorpor-ated into the polymeric structure is a major factor in controlling suscep-tibility. For this reason, solubility coefficients, surface tension, and detergent action are important control parameters.

Prof. R.W. Staehle (Ohio State Univ., Columbus) closed the Conference (held on the last day at CERL) and attempted to summarize the current status and understanding of environ-mental embrittlement, searching partic-ularly for common behavior patterns among different materials. Although some of these emerged, such as the need for stress, the mobility of the embrittling species, and the importance of specific microstructural heterogene-ities, no broad ranging consensus was apparent. Rather, it was the general view that while important advances are being made, the mechanism or mecha-nisms of environmental embrittlement are still as diffuse as the phenomena itself. Hope was expressed that the large number of conferences on this subject, held in recent years, reflects a growing research commitment to what is certainly one of the more serious constraints on the effective use of high-strength materials in critical service environments.

By the way, lest the title lead the reader astray, even a vacuum can be an aggresive environment, particu-larly under cyclic stress conditions. Alas, materials have no place to hide.

The organizers of the Conference, Drs. P.R. Swann and F.P. Ford, were as adept at extracting manuscripts as in planning and stimulating discus-sions. For this reason, the proceed-ings (indexed), published by the Metals Society, should be available in the late fall of 1977. (I.M. Bernstein)

ONRL REPORTS

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MECHANICS

THE SECOND INTERNATIONAL CONFERENCE ON DRAG REDUCTION

The British Hydrodynamics Research Association (BHRA) organized and sponsored the second of a series of conferences on drag reduction at St. John's College, Cambridge, 31 August to 2 September 1977. That there is great interest in the field is evident from the wide diversity in the country of origin as well as the representation from industry and academia among the authors and attendees.

The methods of drag reduction discussed in the papers were concerned mainly (though not exclusively) with the flow of liquids, and for this case, the various aspects of macromolecular additives were explored. A few papers dealt with the effects of heating at the boundary of a liquid flow, and one described an experiment involving an actively driven boundary of a flow in air.

Interest in drag reduction arose when, some years ago, Max Kramer devised a flexible boundary that he claimed could function like the skin of a porpoise and reduce the drag of a vehicle in water. His idea was that the boundary, in its motion, would remove energy from a disturbance in the boundary layer and thus prevent the build-up in amplitude that would otherwise lead to turbulence. Since that time, the idea that porpoises reduce their drag has been challenged, although there are some (including me) that continue to believe. Other methods of drag reduction, such as the addition of macromolecular substances to the flow as well as heating at the boundary, have since been explored. The greatest success, thus far, has been obtained with additives.

In order to try to understand how various methods of drag reduction work, one must first try to understand how a boundary layer becomes turbulent. Having attended a number of conferences on instability, transition to turbulence, and "fully developed" turbulent flow, I feel free to say that I have not yet heard a clear description of the transition process, although I have fought successfully (most of the time) to stay awake through many (and repetitive) presentations of experimental data that unfortunately never arrived at the synthesis of a mechanism for transition. However, I will try to supply such a mechanism, no matter how imperfect, so that the various methods of drag reduction can be viewed in some sort of context.

The process of instability of the laminar boundary layer is well understood; in the linear case, a self-excited normal-mode oscillation in the form of a traveling wave begins building up. When the disturbance becomes finite in amplitude, the energetics of the disturbance are that energy from the steady motion goes into the disturbance and then proceeds into a second harmonic and/or is dissipated by viscosity. The drag associated with the finite-amplitude disturbance alone (in a boundary layer), however, is not large. Soon after the disturbance has become finite, its interaction with the steady boundary-layer flow causes local regimes (spaced one wavelength apart) in which the velocity distribution has a point of inflection; such distributions are much more unstable than those without points of inflection, and so, a new (or secondary) instability develops. The distinguishing features of this secondary instability are that it is much stronger than the primary instability and has a shorter characteristic wavelength. S.J. Kline of Stanford first described the transition process to this point during the 1960s, and many experiments since have confirmed his description.

The difference between the primary and secondary traveling wave instabilities lies in the fact that of the two, the secondary instability is much the stronger and quickly leads to "wave breaking" much as waves break on a beach. The wave breaking brings about turbulent mass transport. I would define the point of transition to turbulent flow as being the point where mass transport begins.

It was first expected that a "properly designed" flexible boundary would inhibit the primary instability in a laminar boundary layer, but theoretical studies have shown that, if anything, it is enhanced. On the other hand, cooling at the boundary layer in a gas (or heating at the boundary layer in water) alters the velocity distribution in such a manner as to render the flow more stable. If a flexible boundary is to be at all

effective in drag reduction, it must interact with the secondary (inflectional) instability so as to delay it; the possibility of an enhanced primary instability (which causes little drag) and an inhibited secondary instability might possibly explain the "secret of the dolphin." Early experiments with flexible walls raised hopes of dramatic drag reduction, but later investigations have failed to confirm the earlier results.

It is probable that additives are effective in inhibiting the severity of the turbulent bursting in the wave-breaking secondary instability. The way a polymer (long-chain molecular) additive functions is that when an element of fluid containing the molecule undergoes a rapid rate of strain, the molecule lines up in the principal extensional direction and provides a viscous drag to the rapidly deforming fluid. Since the wave-breaking region of a flow is the most rapidly deforming area, the polymer would tend to reduce the severity of the process. That the polymer actually does reduce drag is very well known, and the use of "slippery water" in fire fighting equipment is currently being practiced.

And so at the Conference the overwhelming majority of the more than two dozen papers dealt with investigations concerning additives; the topics covered ranged from scaling laws, various industrial applications such as flows in large ducts and hydraulic machines, hydrotransport of fly ash-water mixtures, flow in storm and sanitary sewers, oil pipelines, through efficiency of various additives under different pH and salinity conditions, and the degradation of macromolecules. Papers in drag reduction and roughness build-up by M. Poreh (Technion-Haifa, Israel), degradation and drag-reducing efficiency of polystyrene by J.L. Zakin and D.L. Hunston (Naval Research Laboratory, Washington, D.C.), and turbulent diffusion and destruction of polymer molecules in a pipe and boundary layer by L.I. Sedov, V.A. Ioselevich, V.N. Pilipenko, N.G. Vasetskaya (Moscow State University, USSR) were of particular interest. The degradation of a polymer occurs when the resistance of the long-chain molecule to extension causes the molecule to fail in tension. Since entrance flow regions in pipes have thin boundary layers and correspondingly high fluid shearing rates, such regions account for a considerable portion of the degradation of a polymer additive.

A systems study on drag reduction in water by heating by E. Reshotko (Case Western Reserve Univ., Cleveland, OH) disclosed the possibility of drag reductions of 60% at 50 knots with an overheat of 40°C. The effects of pressure gradient and heating on the stability and transition of boundary layers in water were reported by A.R. Wazzan and C. Gazely, Jr. (Univ. of Calif., Berkeley, and Rand Corp., respectively) with resulting suggestions regarding the tailoring of the boundary-layer shape parameter in order to maintain a laminar flow for as long as possible.

A paper on an electrostatically driven surface for flexible-wall drag reduction in air by L.M. Weinstein (NASA-Langley) and R. Balasubramanian (Old Dominion Univ., Norfolk, VA) presented the theory and experimental results for the same without any flow-theory or flow-test results. It is not clear to me what the investigators are really trying to do, but if they wind up with an electrostatic loudspeaker, it will all not have been in vain. Certainly, porpoises do not have an actively driven skin.

Experiments with soluble polymeric drag-reducing coatings by M.T. Thew, Y.T. Lee (Univ. of Southampton, UK), R.F. Long (Admiralty Materials Lab., Holton Heath, Dorset, UK), and R. Bragg (Univ. of Manchester Institute of Science & Technology, UK) were reported as indicating drag reductions up to 30%.

A paper by P.S. Virk and T. Suraiya (MIT) on mass transfer at maximum drag reduction shows, in line with the previous discussion, the expected reduction of mass transfer with drag reduction. However, the concentration of additive (in the form of a soluble coating) for maximum mass-transfer reduction was greater than that required for maximum drag reduction.

In all, the Conference was well organized (in line with the usual standards of BHRA) and beautifully sited at one of the most distinguished of the colleges of the University of Cambridge. I certainly gained by attending. (Martin Lessen)

THE XIII BIENNIAL FLUID DYNAMICS SYMPOSIUM

The Department of Fluid Mechanics of the Institute of Fundamental Technological Research, Polish Academy of Sciences, conducted the thirteenth of a biennial series of symposia in fluid dynamics subtitled "Advanced Problems and Methods in Fluid Dynamics" in the historic city of Olstyn (sometime Allenstein in Prussia) from 5-10 September. Olstyn is in the beautiful Masurian Lakes region (northern) of Poland where the Mazurka is the local ethnic dance that inspired the famous stylized dances of Chopin. The meeting sessions were held at the Institute of Agriculture and Technology in the suburb of Kortowo.

Since the conference was held in an Eastern-bloc country, it was easily accessible to, and hence well attended by, researchers who are not ordinarily seen at meetings in the West. There was a large delegation from the USSR, headed by Academician A.A. Dorodnytzin, Director of the Computation Center of the Academy of Science in Moscow. In addition, there were smaller groups from other eastern European countries, representatives from Greece, Turkey, Egypt, and Japan, most of the Western European countries, and a large contingent from the United States. For the second time running, the famed Russian physicist Academician Ya. B. Zeldovich attended and presented a paper.

The meeting was organized into common sessions for invited papers and parallel sessions, arranged according to field, for the contributed papers. In the opening invited paper, "Semi-analytical Applications of the Computer," M. Van Dyke (Stanford Univ.) discussed the use of a computer to calculate successive terms of a perturbation series about some singularity or critical phenomenon of a problem. In this way he obtained not only better approximations than had been previously obtained to solutions of problems, such as the torque on a sphere spinning in a viscous fluid, laminar flow through a curved pipe, deep water waves, and compressible flow about a circular cylinder, but also estimates of the rapidity of convergence of the series.

Another particularly notable invited paper was "Some Theoretical Methods in the Mathematical Transport Theory" by H. Neunzert (Univ. of Kaiserslauten, FRG) who presented a measured theoretical justification of "Point in Cell" finite-difference methods and illustrated the theory with a computed example of a 2-stream instability. D. Joseph (Univ. of Minnesota) presented an invited paper, "Bifurcation Theory and Hydrodynamic Stability," which was more a rigorous mathematical classification of bifurcations between modes than a calculation of any particular problem; whether or not any of the higher bifurcations are at all realizable in nature because of secondary instabilities interceding is an area that will necessitate study of specific problems. A very interesting invited paper, "Physical Aspects of Fluid Mechanical Noise," by K. Karmcheti (Stanford Univ.) discussed, among other things, the relevance of large-scale structures of turbulence to the noise problem.

In his paper "Large Reynolds Number Fluid Mechanics of Circulation," T. Pedley (Univ. of Cambridge) discussed pulse-wave propagation in the aorta. It has been known for some time that although waves in the aorta are damped (through viscoelasticity in the wall and viscosity in the flow), the pulse wave steepens and increases in amplitude as it propagates downstream. Reynolds numbers in man vary about a mean of 1,200 to peaks of approximately 6,000. In larger animals, the flow may be turbulent. Pedley also discussed flow in the venous system that, consisting of flaccid tubing, presents a resistance to flow that is a function of the venous pressure. Since most analytical work on the fluid dynamics of the circulatory system has been involved with the flow of a Newtonian fluid (constant viscosity), it is timely that work involving fluids with rheological properties similar to blood be attempted to determine by what order of magnitude the results will differ.

The contributed papers ranged in subject matter from multiphase flow, compressible flow, and environmental fluid mechanics through hydrodynamic stability, viscous flow, turbulence, boundary layers, magnetohydrodynamics and plasma flow, low Reynolds-number flow, rarefied flow, and aerodynamics and aeroelasticity.

Among these papers, J. Zierep and R. Bohring (Univ. of Karlsruhe) discussed the normal shock-boundary layer

at a curved-wall interaction. Because of the wall curvature and the expansion region behind, the shock tends to keep the boundary layer attached. An analysis, based on a three-layer model for the boundary layer, yields bounds for no separation and certain separation, respectively. The work, though representing a much more advanced development, was somewhat reminiscent of an early paper by H.S. Tsien and M. Finston (circa 1950) on shock wave-boundary layer interaction where the boundary layer was represented by a single inviscid layer. F.K. Wippermann (Technische Hochschule, Darmstadt) presented a theory on "The Formation of Longitudinal Vortex Rolls in the Atmospheric Boundary Layer." There are two separate mechanisms that can form such rolls—one is a wave-like instability caused by a point of inflection in the velocity distribution, and the other is an interchange instability caused by an entropy distribution that decreases with altitude. For the wave-type instability, the rolls rotate in the same direction while for the interchange instability, the rolls rotate in alternate directions.

In an exact solution of the Navier-Stokes equation for the case of flow between parallel planes rotating about a common, normal axis, R. Berker (Bosporus Univ., Istanbul) showed that the classical solution consisting of rigid-body motion about the axis is not unique and the problem admits an infinite set of solutions. P.J. Zandbergen and D. Dijkstra demonstrated a similar phenomenon for the swirling flow about a single rotating plane as first examined by Von Karman.

The conference was privileged to hear a paper presented by Ya. B. Zeldovich (co-authored by A.A. Ovchinnikov) (Institute of Applied Mathematics, Soviet Academy of Sciences) concerning "The Influence of Diffusion and Fluctuations on the Chemical Reaction." The thrust of the paper was that, for a mixture of reactants, the initial reaction is governed by the chemical reaction kinetics, but in the later stages, owing to initial variations in the mixture composition, the reaction is diffusion-dominated because the remaining local surpluses in reactants have to diffuse toward each other through the reaction products. The paper underlines the necessity for the interdisciplinary field of physicochemical hydrodynamics advanced by V. Levich because mixtures of reactants generally occur in flow processes where hydrodynamic instabilities and wave breaking interleave the reactants. The final mixture takes place by diffusion that never quite removes all nonuniformities in composition.

"The Anatomy of a Turbulent Spot with Some Implications for the Turbulent Boundary Layer" by D. Coles, B. Cantwell and P. Dimotakis (Calif. Institute of Technology, Los Angeles) reported on laser-Doppler as well as flow-visualization studies of turbulent boundary layers. Evidence of longitudinal Taylor-Goertler vortices in the sublayer was noted. Studies on "The Stability of the Laminar Supersonic Boundary Layer on the Cooled Surface" by S.A. Gaponov and A.A. Maslov (Institute for Theoretical and Applied Mechanics, Academy of Sciences, Novosibirsk) found that the usual asymptotic theory did not apply for high-Mach-number flows. Also, the destabilizing effect of the entropy mode found by E. Reshotko (Case Western Reserve, Cleveland) in his classic work was not confirmed even though he had not used asymptotic theory either. N. Ph. Polyakov (of the above Institute in Novosibirsk) reported on "The Influence of the Low Free Stream Perturbations on the Condition of the Laminar Boundary Layer." He found that transition could be greatly affected by perturbing sound waves in the free stream and obtained experimental data that differs quantitatively though not qualitatively from that of Schubauer and Skramstad.

The fact that the Symposium was conducted in its entirety in English was impressive and caused me to reflect on just how successful an attempt to hold a similar affair in another language in the United States would be.

Though there are some meetings where the same characters follow each other around as in a roadshow, this Symposium was not of that class. It provided a vehicle for people to see new faces, hear new voices, and be exposed to new ideas. There should be more of this. (Martin Lessen)

OCEAN SCIENCES

EUROPEAN UNDERSEA BIOMEDICAL SOCIETY MEETING

The Third Annual Scientific Meeting of the European Undersea Biomedical Society (EUBS) was held on 15 and 16 July in the superlative setting of Toulon, on the Côte d'Azur of France. The title is something of a misnomer, since there have been four meetings of the EUBS—one designated a "workshop"—and they have not occurred every year. Previous meetings have been reported in *ESN* 27-7, 28-8, and 30-12. I was glad to see, anyway, that the Meeting was successful and well attended, since less than two years ago the Society nearly collapsed (*ESN* 30-12). More than half of the 170 people attending came from beyond France, some from as far away as Australia, Japan, and Indonesia.

The Scientific Meeting consisted of two days of 15-minute presentations covering the entire fields of underwater and hyperbaric medicine and physiology. Organized tours of nearby research institutions were offered earlier in the week. Dr. Bernard Broussolle (Centre d'Etude et de Recherches Biophysiologiques Appliquées à la Marine, CERB, Toulon) supervised the arrangements. An important improvement over previous meetings was the provision of simultaneous translations of the scientific papers and discussions into English and French.

The Scientific Meeting itself was of a reasonable standard, but those who attended the May meeting of the Undersea Medical Society in Toronto would have found the papers to be repetitious. A minority of the papers were poor either in content or delivery; some of those could have been screened out by the program committee. With few exceptions, there was little discussion after the sessions, and the session chairmen were rather ineffective. Nevertheless, a wide variety of interests and institutions were represented, so the opportunity for productive personal contact was worthwhile in itself.

Broussolle promised that full texts of all the presentations would be published within six months, probably as a supplement to the French *Journal de Médecine Aéronautique et Spatiale et de Médecine Subaquatique et Hyperbare*.

The 49 scientific papers were loosely grouped into sessions of three to nine each. Highlights are described below.

The session on the toxicity of respiratory gases at high pressures consisted mainly of papers on oxygen toxicity and the high-pressure neurological syndrome (HPNS). F. Brue *et al* (CERB, Toulon) described remarkable differences in sensitivity to central-nervous-system oxygen toxicity among three inbred strains of laboratory mice. The differences were in the same order as their susceptibility to radiation, an observation which implies commonality of mechanism. A paper by T. Shields (Royal Navy Physiological Laboratory, RNPL, Gosport, UK) offered a clear demonstration that, in pulmonary O_2 toxicity, alveolar edema precedes any significant structural or hemodynamic alteration. This supports the hypothesis that the primary effect is on the production or integrity of alveolar surfactant. Papers on HPNS included two by groups of authors whose work has been in conflict for the past two years. R. Brauer *et al* (Institute of Marine Biomedical Research, IMBR, Wilmington, NC) described the effects of rates of compression and various gas mixtures on the development of the HPNS in animals, mainly tremors and convulsions. J. Cromer *et al* (Duke Univ. Medical Center, Durham, NC) have shown that if the animal is kept at normal body temperature, the effects of compression rate and gas mixture are unimportant. Despite heated discussion, these studies were not reconciled.

The second session, on effects of pressure *per se*, included two papers by A. MacDonald's group (Aberdeen Univ., UK), on very high-pressure effects on model membranes and on functions of ganglion cells and axons of marine organisms. A paper by A. Baret *et al* (CERB, Toulon) reported preliminary results of a unique experiment which showed pressure-inhibition of hormonal activity. They measured adenyl-cyclase activity in isolated hepatic cell membranes which were stimulated by glucagon.

A brief session on vigilance and performance in divers involved some minor studies in human deep diving, and included a paper by A. Bachrach

(Naval Medical Research Institute, NMRI, Bethesda, MD) on human engineering of hyperbaric-chamber systems. He showed how the application of simple ergonomic principles to the arrangement of chamber-control systems could improve the efficiency and comfort of operating personnel. This concept is remarkable only in that it has been so neglected in previous chamber designs.

J. Landolt and co-workers (Defence and Civil Institute of Environmental Medicine, Toronto, Canada) made a notable contribution to a short session on the ear and diving. Their studies are beginning to define the specific histopathology of inner-ear decompression sickness in squirrel monkeys. This is the closest analog to the human disease yet studied.

During a session on dysbaric osteonecrosis (a bone disease associated with diving), three groups discussed the prevalence of the disease in different populations of divers. The Newcastle group (Univ. of Newcastle-Upon-Tyne, UK) updated their figures from the report of last year (*ESN* 30-12). The results of other x-ray surveys were similar: the USN selective survey (R. Sphar *et al*, Naval Submarine Medical Research Lab., Groton, Conn.) revealed 16 definite cases in 934 divers; the French result (Hauteville *et al*, Service de Radiologie, Toulon-Naval) was 1 out of 52. Two other important new studies were described which also concern this disorder. C. Weatherly *et al* (Newcastle) have produced an analogous lesion in the femur of a mini-pig after nineteen weeks of repetitive exposures to a compressed-air profile identical to one used in human caisson work. This is the first time an animal model of dysbaric osteonecrosis has been produced without grossly shortened decompression. J. Davidson (Western Infirmary, Glasgow, UK) reporting for a multi-institutional British group, described an x-ray survey of 100 Royal Navy divers and 100 age-matched controls, which seems to settle a long-standing issue. They found that the prevalence of so-called bone islands and cystic areas was the same in both groups, and therefore these lesions are not variants of osteonecrosis.

A highlight of the session on decompression was a paper by P. Giry *et al* (CERB, Toulon). It is well known that circulating blood platelets decrease in number after decompression and that the decrease is probably related to the etiology of decompression sickness. This study shows, by isotopic-labeling techniques, that large numbers of platelets are sequestered in the lungs and skeletal muscles of splenectomized rabbits subjected to decompression. Another contribution, by P. James (Wolfson Inst. of Occupational Medicine, Dundee, UK), described a simple technique, using a standard clinical ultrasonic flowmeter, by which pneumothorax could be detected more reliably in the hyperbaric chamber. Such a method should prove valuable to doctors in the field.

C. Edmonds (Diving Medical Centre, NSW, Australia) stirred up the session on hyperbaric therapeutics with his promotion of the use of recompression in the water, while breathing pure oxygen, for divers with dysbarism who are far removed from a recompression chamber. This proposition, although not new, is still opposed by the majority of diving physicians, since treatment in the water is dangerous and can be counter-productive. This was followed by F. Barale *et al* (Dept. d'Anesthésiologie, CHU, Besançon, France) recounting their subjective, uncontrolled experience using the hyperbaric-oxygen treatment for a wide variety of human diseases. This paper was typical of a kind of activity not rare in the field of hyperbaric O_2 therapy, and it unleashed a flood of similar anectodal reports from kindred spirits in the audience.

The final session, in two parts, dealt with dive-induced cardiorespiratory modifications. A study reported by R. Guillerm *et al* (Centre d'Etudes et de Recherches Technique des Sons-Marins, CERTSM, Toulon) appears to discredit the hypothesized "Chouteau effect," that is, that the diluent inert gas breathed at very high pressures would act as a diffusion barrier to the exchange of oxygen in the lung, by stratification. Guillerm and the others have developed a vascular-shunt technique that allows them to measure arterial blood gases of sheep exposed to normoxic helium-oxygen mixtures at pressures up to 1,000 m of seawater. These blood-gas measurements showed no important hypoxia and only a mild rise in blood CO_2, even at the maximum pressure. The final noteworthy paper in the Meeting was a summation by C. Lambertsen (Univ. of Pennsylvania,

Philadelphia) of the unique experiments by his laboratory group on the phenomenon of isobaric gas counter-diffusion. This involves severe pathological effects which result from the diffusion of different inert gases from the blood to the atmosphere through the skin and vice versa. These experiments have been described elsewhere but have frequently been misinterpreted, so this lucid overview was useful.

The business of the Society was discussed at a brief meeting conducted by the President, Dr. Xavier Fructus (Compagnie Maritime d'Expertises, COMEX, Marseille, France). It was reported by the membership secretary that the current membership is 173, a considerable gain over last year. The most important item for discussion was the nature of future scientific meetings. The Society's constitution calls for annual scientific meetings, but the executive committee feels that large-scale, expensive meetings, like this one cannot be repeated annually. It was proposed that future sessions should take the form of workshops, that is, discussion meetings aimed at specific problem areas within the Society's purview. Unless response from the membership dictates otherwise, it appears that the executive will follow that course.
(CDR K.M. Greene, MC, USN, Exchange Officer, Undersea Medicine, Institute of Naval Medicine, Alverstoke, Gosport, Hampshire, UK)

DIVING RESEARCH IN TOULON AND MARSEILLE

During the week of the European Undersea Biomedical Society (EUBS) Meeting, covered in the previous article, tours of diving-related research establishments in the Toulon-Marseille area were arranged by the EUBS. I also made official visits to CERB and GISMER (see below), two Naval laboratories in Toulon.

Naval medical activity in Toulon was described in a 1973 ONR London Report by R.C. Bornmann (R-22-73), entitled *Underwater Research and Military Medicine in Certain European Countries: Part II. France*. One of the institutions I visited has been renamed since that report was published. The Groupe d'Etudes et de Recherches Sous-Marines is now known as the Groupe d'Intervention Sous la Mer (Undersea Intervention Group) or GISMER for short. The functions of the Group seem to be unchanged. Capitaine de Vaisseau Fritsch is the Commanding Officer. Although GISMER is not a medical institution, it does conduct all the French Navy's manned deep-diving work. It also controls the TRITON, the Navy's deep-diving ship. The Group has a physiology laboratory headed by a medical officer, Médecin-en-Chef Jacques LeChuiton. GISMER is responsible for the development of decompression tables and procedures and some items of diving equipment. They are currently working on an electronically controlled closed-circuit underwater breathing apparatus.

The Centre d'Etudes et de Recherches Biophysiologiques Appliquées à la Marine (Naval Applied Biophysiological Research Center), known as CERB, is little changed from the time of Bornmann's report. The Commanding Officer is now Médecin-Général Esquirol, and his deputy is Médecin-en-Chef Bernard Broussolle, who is the Navy's senior specialist in diving medicine. CERB is on the grounds of the Hôpital Sainte-Anne, the local armed forces' teaching hospital, and it continues to provide clinical laboratory support for the hospital. However, they have a broad and effective program of biomedical research, much of it related to diving. Particularly noteworthy are the studies of blood platelet responses in rabbits and men to diving (see Giry *et al* in the EUBS meeting report above) and of the hormone-enzyme effects of high pressures (see Baret *et al* above). Oxygen toxicity and central-nervous-system pressure effects are two principal areas of interest. One study in the latter involves recording the EEG from deep brain structures of animals exposed to high pressures of narcotic and nonnarcotic gas mixtures. T. Obrenovitch *et al* are using a novel technique of instant remotely controlled freezing of whole mice at pressure, which allows improved measurement of brain metabolites in animals exposed to oxygen or high pressure.

These research organizations have suffered in the past from limited facilities to do human pressure exposures. That will soon be corrected by the formation of the Centre Hyperbare (Hyperbaric Center). This new entity will have two man-rated chamber complexes. One is already installed at GISMER and is rated to 1,500 m.

The other is under construction and will be located near GISMER at CERTSM, the Centre d'Etudes et de Recherches Techniques des Sous-Marins (Submarine Technical Research Center). I did not visit the latter, but it is described in the Bornmann report. Broussolle will be the Medical Director of this Hyperbaric Center, which is likely to be a very productive unit.

A visit to Marseille organized by the EUBS included tours of the hyperbaric center of the French diving company COMEX (Compagnie Maritime d'Expertises), and the new Unité de Physiologie Hyperbare (Hyperbaric Physiology Unit) of the medical school in Marseille. The COMEX center is mainly involved in human deep-diving studies in the range of 300-400 m and some experiments with primates to depths up to 1,000 m. This work is, in general, well covered in the literature.

The new Hyperbaric Physiology Unit at the Hôpital Nord is under the direction of Prof. Maurice Hugon. His staff includes Drs. Jean-Claude Rostain and Guy Imbert. Their laboratory has a very complete small-animal pressure chamber and a PDP-11 computer facility. Current projects are an original effort to measure spontaneous respiration in cats at very high pressures and the quantitation of tremor and EEG data from animal and human deep-diving experiments performed at other facilities. (CDR K.M. Greene,MC, USN, Exchange Officer, Undersea Medicine, Institute of Naval Medicine, Alverstoke, Gosport, Hampshire, UK)

PHYSICAL OCEANOGRAPHY IN CAMBRIDGE

The research interests of the Department of Applied Mathematics and Theoretical Physics (DAMTP) at Cambridge are extremely wide (see *ESN* 31-8:286). I would like, however, to discuss a very small part of these interests: the ongoing activity in physical oceanography.

Dr. A. Gill, aside from being interested in oceanography, has been responsible along with Drs. P. Killworth and D. Anderson for the short publication entitled: *Ocean Modelling*. The creation of such a publication arose from discussions between various scientists attending the International Union of Geodesy and Geophysics in August 1975, in Grenoble, France. It was further discussed at a SCORE meeting in Edinburgh a year later, and publication initiated with ONR support. It is prepared at the DAMTP in Cambridge and mailed to the international scientific community interested in Physical Oceanography; on average there are about 8 issues a year and the present readership numbers about 400. This "newsletter" is gratis, and the interested reader wishing to receive it should write to: The Editors, *Ocean Modelling*, DAMTP, Silver Street, Cambridge CB2 1TT, UK.

There were several reasons for creating such a newsletter. First, formal articles submitted to a technical journal take several years to appear from the time the research is started till it appears in print—and then it is in concrete! On the other hand, the newsletter publishing short articles and contributions without delay enables researchers to be aware of who is doing what, where, and when. As a result, experience as well as numerical codes can be shared and some scientific pitfalls avoided. Further, it serves as a vehicle for involving scientists on the fringe of physical oceanography and stimulates them to interact with ongoing oceanographic research. Examples of such an involvement follow. Ocean currents that replete or deplete an area of nutrients are quite important to ocean biologists. By looking at the bottom sedimentation ocean geologists can infer conditions on oxygen levels in past ages. The oxygen level, in turn, is related to ocean vertical currents which bring down that essential substance from the upper ocean layers to the lower ones. Another example of possible interaction between disciplines has to do with the opening up of the Drake Passage. What type of ocean circulation will result? Since ocean circulations are intimately coupled with the atmosphere, what will be the resulting climatic changes?

Gill is interested in the dynamics of tropical oceans and its effects on climatic changes occuring over time scales of a few years. One such problem is called "El Niño" that occurs at infrequent intervals along the west coast of South America. Countries on this coast with economies that are heavily reliant upon the anchovy catch are affected by "El Niño." Fish are found in abundance if nutrients are upwelled from the deep cold layers

of the Pacific Ocean; this upwelling occurs in the vicinity of the coastal areas, but every few years around Christmas time (hence the name "El Niño," The Child) it does not take place, and the fish catch falls considerably.

Gill feels that this problem is, typically, a central one in physical oceanography as well as dynamical climatology because: 1) there is a body of data extending over the past 30 years; 2) the phenomenon is not localized but depends on atmospheric and ocean dynamics taking place in other parts of the Pacific. It seems that the dynamics of the thermocline, an ocean layer in which the water density changes abruptly and which is located on average at a few hundred meters below the sea surface across the tropical Pacific must be better understood. Monsoons taking place on the western side of the Pacific might, via the thermocline dynamics, have an important effect on the "El Niño"; 3) it has strong economic repercussions; and 4) it is a good case study for learning about problems in dynamical climatology having a time scale of a few years. It is observed that sea-surface temperature anomalies affect the weather on seasonal time scales. These anomalies seem to be especially effective when found in tropical waters. Therefore, the presence or absence of upwelling of cold water does produce these anomalies and the resulting climatic repercussions.

Gill is also interested in seeking a dynamical explanation for the presence of the warm waters of the Gulf Stream found as far north as the tip of Scotland and beyond. He argues that the sinking of cold-water masses in the Greenland Sea could induce a thermally driven circulation; topography and bottom effects seem to be important in this problem. A preliminary experiment on this phenomenon will be carried out by Dr. R. Hide's group at the UK Meteorological Office. The experiment involves a rotating container filled with fluid and having a bottom topography that crudely models the North Sea basin; heavier fluid will be injected at the bottom and center of this container to model the cold water sinking.

Gill has also been interested in hydraulic-type problems in rotating fluids. These problems play an important part when narrow straits or sills are present. Conditions at these entrances can have a strong effect on the overall dynamics in the larger portion of the basin.

Coastally trapped waves in the atmosphere is another research area in which Gill recently contributed; he suggested that the coastal lows observed off southern Africa are similar in structure to coastally trapped waves in the ocean. The presence of a high mountain barrier and of an atmospheric inversion layer that prevent escape of energy upwards are the necessary ingredients for trapping these atmospheric waves. Similar conditions are also found in the southern California region, and probably some of Gill's analysis which has been reported might also apply [*Quart. J. Roy. Met. Soc.* 103, 431-440 (1977)].

Dr. Peter Killworth has a long-standing interest in models that describe the deep bottom-water formation. This general area was the subject of his thesis completed in Cambridge in 1973 under Gill's supervision. The numerical model he used dealt with the formation of deep bottom water off the Weddell Sea, a large shallow continental shelf off the Antarctic Continent. In this two-dimensional model wind stress provided the drive; the induced surface motion in the presence of a coast was responsible for a return deep circulation. This model was unrealistic inasmuch as, for a large part of the year, the Weddell Sea is frozen and wind stress cannot be claimed to be the dominant driving mechanism.

To improve on that model Killworth sought to understand the dynamics in a three-dimensional model which crudely represented the basin of the Weddell Sea. The dynamics had to be driven by density differences because the rate of ice freezing varies as one moves offshore. As ice forms, the seawater becomes more salty and therefore, its density changes. He found that these density changes could generate a circulation inside the Weddell Sea basin and that a current formed and spilled in the open ocean. His results showed that this current did not reach the observed depth and that the amount of deep bottom-water formation was too small by a factor of 20.

Killworth was able to locate the cause of this difficulty which appeared to be due to the pressure dependence (therefore, depth dependence) of the

coefficient of volumetric expansion. When realistic values of this coefficient were used, the results provided bottom-water formation at the correct depth and only too small by a factor of 4. Killworth argues that other areas around the edge of Antarctica must contribute to that formation; therefore, he feels that the amounts predicted are reasonable. The interested reader is referred to articles by Killworth that discuss some of the above in greater detail: "A two-dimensional model for the formation of Antarctic Bottom Water" [*Deep-Sea Res.* 20, 941-971 (1973)]; "On the Circulation of a Homogeneous Ocean Induced by the Presence of Continental Slopes" [*J. Phys. Oceano.* 3, 3-15 (1973)]; "A baroclinic model of motions on Antarctic continental shelves" [ibid., 21, 815-837 (1974)]; "Mixing on the Weddell Sea Continental Slope" [ibid., 24, 427-448 (1977)].

Deep bottom-water formation also occurs closer to home, so to speak! It takes place in the Mediterranean, specifically in the Gulf of Lyon where the Mistral and the Tramontane meet. The Mistral is a strong, cold wind blowing in the Rhône Valley from the cold mountain slopes to the warm sea, and the Tramontane is a similar type of wind blowing in the valley between the Pyrenées and the Massif Central. These winds blow in the winter and spring months; when they meet, they stir and cool sufficiently the surface waters of the Mediterranean Sea for these to sink in columns; these are some 30 km in horizontal extent and reach the bottom some 2 km below; in general they reach bottom depths after the wind has blown for some ten days. The formation of these "chimneys" has been studied by Killworth [*Prog. Oceanog.* 7, 59-90 (1976)]. The Mistral is known to turn off abruptly—the breaking up of water columns occurs as a result of complicated processes, for one finds strong horizontal and vertical velocity shears that can become unstable and play a major part in this decaying phase. Killworth looked at a two-dimensional, time-dependent numerical model whose results appeared to fit the data nicely as long as the wind was present, but it did not model the decaying stages properly. To represent that stage adequately, variations in the third direction are necessary. He proceeded to use the velocity and density fields produced by the two-dimensional model in a three-dimensional stability numerical calculation. The results seem to agree with the observations.

In addition, Killworth has worked with Gill and Anderson on the spin-up of stratified oceans; some of this work is done in parallel with the Geophysical Fluid Dynamics Laboratory (GFDL) of Princeton University and the National Oceanic and Atmospheric Administration. At GFDL scientists perform elaborate numerical calculations while the Cambridge group investigates idealized models. The results have been very gratifying. The spin-up of a stratified ocean in the presence of bottom topography yielded the following results: the spin-up time is shorter than one obtains in the absence of topography; a layer near the bottom forms that shields the upper layers from the presence of bottom irregularities. The interested reader is referred to Anderson and Killworth, "Spin-up of a Stratified Ocean with Topography" [*Deep-Sea Res.* 24 (1977)].

Killworth is also interested in stability problems related to ocean dynamics. He recently published a paper on an aspect of this subject to which the interested reader is referred [see Hart and Killworth, "On Open-Sea baroclinic instability in the Arctic," *Deep-Sea Res.* 23, 637 (1976)].

Thus, despite the fact that there are no formal courses in oceanography—for a student trains for the first three years in courses in applied mathematics and physics and only takes a 24-lecture course in geophysical fluid dynamics—the research in physical oceanography at the DAMTP is among the best in Europe. (A. Barcilon)

ONRL REPORTS

See the back of this issue for the abstracts of current reports.

PHYSICAL SCIENCES

DYE-LASER INVESTIGATIONS AT THE ECOLE POLYTECHNIQUE

As I walked into the Ecole Polytechnique building complex at 17 rue Descartes near the Sorbonne in Paris, I thought I had come to the wrong place. The buildings were dilapidated and appeared to be deserted. Dr. Y.H. Meyer emerged from one of the buildings and escorted me inside to his laboratories. He explained that most of the Ecole Polytechnique had moved to new quarters in Orsay just outside of Paris and that his group would also be moving there in a few months.

Meyer is head of the Groupe de Physique Moléculaire, which specializes in experimental and theoretical studies of dye lasers. The group consists of five people and is funded in equal amounts by the Ecole Polytechnique, Centre National de la Recherche Scientifique (CNRS), and military contracts. They are interested in understanding dye-laser mechanisms from a molecular point of view as well as from the purely optical aspects. I also met and talked with the other members of the group: C. Loth, P. Flamant, P. Gacoin and R. Astier.

Meyer showed me several experiments currently in progress and discussed some earlier work that has been completed. I will briefly describe some of the more interesting projects.

The understanding of injection locking of dye lasers to a specific wavelength, coupled cavities, and various other properties of dye-laser devices is improved by knowledge of a basic property of dye lasers called "spectral evolution" (the variation of dye-laser emission with time). This work required the simultaneous solution of a set of nonlinear coupled differential equations involving state populations and cavity gain and loss mechanisms. Meyer showed that the spectral-temporal behavior of a dye laser operating above oscillation threshold can be described by considering only basic molecular and cavity parameters. Knowledge of state populations is not necessary because of the homogeneous nature of the fluorescence. He developed an expression for the spectral evolution in dye-laser emission in the form of a single analytical equation. Meyer's results disagree with other published work in regard to amplification line narrowing and to the predictability of the laser central-frequency shift above threshold. His results indicate that there is no amplification narrowing for a narrow line in a homogeneous broadband amplifier and that the laser central-frequency shift cannot be predicted above threshold from the time-dependence of the gain maximum.

Locking of a dye laser to atomic lines is not well understood. For example, when Na is introduced into a Rhodamine-6G dye-laser cavity, locking apparently occurs in the wings of the D lines rather than at the line centers. Meyer feels this may be due to the anomalous dispersion of Na vapor at the absorption lines. The spectral width of a dye laser locked in this manner may be of the order of 10 GHz or so. Meyer's group is conducting theoretical and experimental work to gain a better understanding of the mechanism. In one experiment described in a recent publication [Y.H. Meyer, *Opt. Commun.* 19, 343 (1976)], the Na atoms were adsorbed on an intracavity glass plate. In this way Doppler-free linewidths were achieved which would not happen if a heated vapor were used.

Meyer pictures the locking as the result of spectral-temporal behavior brought about by the presence of a selective loss in the cavity. He states that this behavior results in spectral condensation of the laser energy. He used a flashlamp-pumped Rhodamine-6G laser emitting 50 mJ in 3-μsec pulses. The broadband laser emission was peaked at about 5900 Å by adjusting the dye concentration. The Na layers were condensed on windows of an intracavity cell. The thickness was controlled by heating or cooling the cell and the Na reservoir.

Locking on both Na D lines was observed. In addition, however, antilocking or a hole in the broadband emission was also observed at times. Meyer attributes both the locking and antilocking to a small dip and bump in the transmittance vs wavelength curve of the Na layer-window interface arising from the anomalous dispersion of the Na atoms.

An additional phenomenon worthy of note in this experiment was the observation of absorption at the Na

D lines with no Na having been added. Sufficient Na was present in ordinary dust deposited on the windows and mirrors in the cavity, however, to induce the effect.

Meyer's group collaborates with Dr. G. Megie of the Service d'Aéronomie du CNRS at Verrières-le-Buisson. They have developed a high-power near-ir dye laser for Megie's upper-atmosphere lidar work. A powerful, narrow-band, stable source at 7698.96 Å was needed to coincide with the K D_1 line. The laser medium was 3,3' dimethyl 2,2 oxatricarbocyanine iodide (DOTC) in dimethyl sulfoxide (DMSO). An oscillator and four stages of amplification were pumped by a Q-switched ruby laser. Wavelength selection was obtained with three tandem Fabry-Perot interferometers placed in an oven for stability. The laser specifications achieved are: bandwidth = 0.065 Å, pumping energy = 2.8 J, output energy = 1 J and pulse width = 15 nsec.

Another near-ir dye laser was also developed for operation at 8100 Å. This device is an oscillator with six stages of amplification and uses flashlamp excitation. The dye is the same as for the preceeding laser.

Flashlamp-pumped near-ir dye lasers suffer from relatively poor performance. This has been attributed to triplet-triplet absorption losses. Loth and Gacoin studied the effects of triplet-state quenchers on the performance of DOTC, 1,3,3,1',3',3'-hexamethyl-2,2'-indotricarbocyanine iodide (HITC) and 3,3'-diethyl-2,2'-thiatricarbocyanine iodide (DTTC) in DMSO. They found that the greatest improvement was obtained with the additive N-aminohomcpiperidine (AHP). Deoxygenation of the DMSO also improved the performance of DOTC, while DTTC and HITC did not lase at all.

Meyer is collaborating with Megie on an injection-locked dye laser. They want to achieve 1-J pulse energy on a Na D line with a bandwidth of 5×10^{-3} Å. This work is now in the initial stages.

Meyer's group is highly specialized in dye-laser work. Within that framework, however, they are diversified into experimental, theoretical, and developmental efforts. The group is quite productive in all three areas. (Vern Smiley)

ULTRA-HIGH-ENERGY LASER COATINGS AVAILABLE FROM ELLEN VANNIN

Even after finding out that Ellen Vannin is Gaelic for the Isle of Man, one probably would not immediately think of going to this small island located in the Irish Sea for high-quality optical products. However, anyone involved with laser fusion or other laser work should be interested in one or more products of Optics Technology, Ltd., located there in Onchan, just north of Douglas. David Lunt, director of this company, claims to have developed coatings for laser optics capable of withstanding 64 J/cm^2 at wavelengths of 1.06 and 1.315 μm. This energy-handling capability is better than one can obtain from other suppliers by a factor of two.

The company has about eight employees and is family oriented. Mr. Lunt's brother, Michael, is also a director and another brother, Peter, works for the company. One advantage in locating a company on the Isle of Man is the low tax rate for personal and corporate income—21.25% maximum. In addition, the local government encourages small capital-intensive industries to establish themselves on the island through grants. Lunt stated that 40% of the cost of his building and the same percentage of the cost of his capital equipment was paid by such a grant. Transportation is no problem as regular air service operates to London, Birmingham, Dublin, Belfast, and many other locations in the UK, and good connecting services are available to major European cities.

Lunt was an early starter in the business of making high-quality coatings for laser applications. He worked for a small company in New Jersey which made high-reflectance mirrors for gas-laser research at Bell Laboratories in the early 1960s. He also developed an ultra-narrow-band filter with 0.5-Å spectral width while working for another firm in the US. This early work formed the basis for the present product line at Optics Technology, Ltd.

This establishment has now been accepted by several laser groups as a reliable high-energy coating supplier. Associations with laser fusion groups at the Lawrence Radiation Laboratory in Livermore, the Rutherford

Laboratory near Didcot, Oxfordshire and the Atomic Weapons Research Establishment (AWRE), Aldermaston, Berkshire in the UK have been established.

The development of high-energy, ultra-hard coatings was a fortunate accident. The group was attempting to make some specialized uv coatings. The coatings didn't work too well for the intended application but were extremely durable. Lunt explained that no secret new materials are involved; the manner of putting down the layers and treatment of the substrate are the crux of his development. The purity of materials, such as ZrO_2, is also important. The deposition equipment is basically the same as that used by other coating suppliers. An electron-beam deposition system with a 6-kW power supply is used for dielectric coatings, and a direct thermal-deposition system is used for metallic coatings. A homemade optical film-thickness monitor and a crystal oscillator monitor are used to determine film thickness during deposition.

According to David Lunt, the time period between final polishing of an optical surface and coating should be short, for the damage threshold is increased considerably if coating occurs within a few hours of polishing. For this reason Lunt feels that he has an advantage in supplying high-energy coatings as he produces the optical elements as well as the coatings and can therefore control the surface treatment, the time between polishing and coating, and the coating process. Few suppliers carry out the entire processing themselves.

In addition to specialized high-energy optics, the company also produces Fabry-Perot etalons for tunable dye lasers, high-reflectance, broadband coatings (4000 - 7000 Å), and a range of tunable narrow-band filters. The tunable filters are piezoelectrically scanned Fabry-Perot interferometers having bandwidths as small as 0.5 Å in the visible spectrum and 0.1 Å in the uv.

The company makes filters for wavelengths as short as 2500 Å in the uv and out to wavelengths greater than 25 μm in the ir. They also make a variable-gap, tunable Fabry-Perot interferometer in which the mirror spacing is adjustable from 0 to 50 mm.

Several special R&D problems have been taken on by the group. One example is the development of a 30 to 35-μm tunable filter for a joint space program between the Max-Planck Institute (MPI), FRG and NASA. Lunt and his fellow workers designed and built this filter which sequentially tunes to various hydrogen and deuterium lines having different emission strengths. In this way one can "see" to various distances in intergalactic space. The goal of the measurements is to determine the age of the universe. The first ir filter took 18 months to develop. Practical problems such as making materials like Ge very thin and durable for a space environment had to be overcome. Also the device had to work at -77K. Measurements of the operational wavelength and bandwidth, which are difficult at these wavelengths were made with a Fourier interferometer at the MPI in Stuttgart.

Tunable interferometers have also been developed for other special purposes. One was constructed for operation at 16 μm for sequentially monitoring pertinent ^{235}U and ^{238}U lines for isotope separation work. A similar device, made for a German company, controls gas-mixture ratios by monitoring transmission in the mixing container at wavelengths corresponding to absorption lines of the various individual gases.

Optics Technology, Ltd., although a small company, produces high-quality special products and off-the-shelf optical components. They already have a significant percentage of the laser optical work in Europe, and their sales in the UK and the US should improve as they become better known there. (Vern Smiley)

dBs AND THE FANS

The noise of large low-speed fans was the subject of a one-day meeting held on 7 September at the University of Nottingham on behalf of the Aerodynamic Noise Group of the Institute of Acoustics (UK). J.S.B. Mather, who organized the meeting, is a firm believer that there is much unpublished information from the aerospace side of the aerodynamic noise field that could and should be brought to bear in the reduction of noise from such fans. He further believes that the Group, which he chairs, can play an

important part in making this information usefully available by specialized meetings. Mather appears particularly well qualified to explore these possibilities. He has worked extensively on aerodynamic and fan noise, and, as the meeting demonstrated, has good contacts among the various interests and talents—regulatory, governmental, industrial (manufacturers and users), and academic.

Apart from the technical questions the issue is largely one of the motivation for noise reduction. While industry has some recognition of the problem, industrial installation problems can often be more cheaply handled by silencing and many installations in any event are "in the bush." Again more than a few contend that "in-shop" industrial noise problems can be solved by persuading workers to wear protective gear. Others emphatically disagree. It must be recognized, however, that noise legislation is already on the books and that things will get tougher.

The nature of the environmental noise issue is evident to some. They face the design of large chemical plants with 100 or more large fans and must meet local environmental standards—some perhaps unreasonable. Their problem is one of more and more demanding environmental standards being established by national governments, frequently made more restrictive by local government regulation.

The meeting itself was a tribute to Mather's organizing ability and knowledge of the field. In a matter of weeks he had arranged for a representative series of contributions. Failure of two speakers to arrive provided him an opportunity to discuss his own current unpublished work. Chairing the meeting, he succeeded in achieving a degree of informality and discussion that carried over to all the participants, who numbered about forty and who, from the discussion, clearly represented a good cross section of the interests.

National Coal Board requirements for ventilating fans outlined by N.S. Stainer (NCB, Mining R&D Establishment) typify the problem. NCB uses three major types of fan—main ventilators, boosters, and auxiliaries. The first, usually large radial units, are installed at the surface and ventilate a whole mine complex. While they are noisy, silencing can be built into the surrounding structure, and complaints have been few, possibly because shaft complexes are rarely close to living areas. Instability has been experienced, however, when these large units are operated off their design characteristics prior to the full development of the mines for which they were designed. Main ventilator noise is inherently low frequency and can propagate to considerable distances, and it is intended to look into this aspect.

Boosters installed underground are a more difficult problem. Safety, especially fire proofing, is paramount. Flow through the units is restricted, and the guardshields and the rotor and stator blades are quite close. Large units of 48-in. diameter, they are usually installed in three cylindrical banks, each of three units in series. Normally two banks are operating with the third held in reserve. Tube silencers installed at each end of each bank give about 8-10 dB reduction. Untreated levels underground are about 116 dB(A). As a quick treatment in an installation in the S. Nottingham field, splitter silencers are being built in the tunnel at each end of the banks with a central brick dividing-wall intended to stop noise leakage. Auxiliaries, used to provide additional ventilation in side tunnels and workings, are equally difficult with underground levels of 95-112 dB(A).

Quite apart from the noise problem, NCB fans have an average efficiency of only 60%, whereas it should be possible to approach 80%. This efficiency question is important in a situation when 50% of the electrical power in a colliery is used for ventilation. It is hoped that increased fan efficiency can be accompanied by reduced noise levels. To this end work has been initiated at the National Engineering Laboratory (NEL), East Kilbride, Glasgow, first to review current designs and practices and thereafter to work on improved designs. But safety considerations are overriding, the poor noise characteristics of colliery fans are not generally recognized, and an NCB policy on fan noise has yet to be formulated.

Measurement of the noise of large-diameter fans used in chemical plants, was then discussed by A.N. Bolton (NEL). He stressed the difficulty of scaling for model work and emphasized the importance of making acoustic

measurements under correct loading conditions. Discussing the results obtained with an NEL test set-up for heat-exchanger fans, he noted differences of 6-7 dB in reduced data depending on the measurement procedure adopted, and expressed a preference for the hemispherical technique, or a weighted modification of it. The value of tip speed as a guide to noise characteristics among fans with the same aerodynamic features was noted in a final comment.

Mather then outlined his recent work at the University on modal analysis of fan noise which aims at understanding the sources and nature of the components of this noise. These include, in addition to discrete frequencies and broadband noise, narrow bands of noise arising from distortion of the airflow. His experimental set-up employs both a fixed microphone in the flow and a wall microphone rotatable around the cylindrical test section. Using cross-spectral-density techniques, Mather has been able to identify rotational and nonrotational components, permitting their sorting into those caused by rotor-stator interaction and those from distorted flow. He has confirmed the technique by use of small guide struts at the wall.

A contrast to the NCB situation was provided by R. Ginder's review of some aspects of noise work on the Rolls-Royce RB211 and similar engines being undertaken by the National Gas Turbine Establishment (Pyestock, Hants). The principal discussion centered on the difference between static testing and flight data and the need to simulate the operating conditions. The engines are substantially noisier in the static condition than in flight, a difference associated with much higher noise levels at blade-passing frequencies. This is attributed to the elongation of turbulent eddies in the air flow into the engine as the flow converges into the intake in the static case, whereas in flight the eddies reach the blades unmodified. Steps in overcoming this difficulty were summarized. Hamilton Standard suggested a honeycomb structure in the intake, reducing the static blade-passing frequency level by some 10 dB, but with possible effects on the noise emitted forward. Boeing had proposed the use of gauze screens placed further forward in a funnel intake, but this restricts measurement of the directional characteristics of the noise. Rolls-Royce (Derby) have now produced a large hemispherical honeycomb shell for use in front of the engine intake. Tests with it suggest that noise conditions fairly close to those in flight can be obtained, although some lobe-like effects on the directional pattern of the engine noise remain.

Two other brief talks covered current modification of the 24-ft open-jet wind tunnel at the Royal Aircraft Establishment (Farnborough, Hants) designed to improve its noise characteristics (R. Trebble), and a review by A.W. Moore of some of the work at the Admiralty Research Laboratory (Teddington, Middx) on axial flow devices. At RAE it had been necessary to relocate the impellor system, and change the layout and some dimensions of the tunnel, and to incorporate noise splitters. As designed, the latter utilize fiberglass in metal-supporting screens with 40%-by-area circular holes. Calico has been adopted as a cover immediately behind the metal support to prevent the fiberglass being carried into the high-speed flow. Noise levels in the working section have been reduced more than 20 dB in the frequency range 1-10 kHz. The ARL work concerns noise under conditions of shear flow with or without specific objects ahead of the fan. Theoretically radiated-tone levels can be calculated, but specification of the inflow is required. While modeling is difficult because of scaling problems, a technique has been developed (based on a judicious mixture of modeling experience and of the results of research on flow downstream from obstructions) that permits choice of the optimal number of blades, spacing, and skew.

Design of quieting systems for large and noisy industrial plants was discussed in a lengthy review by a consultant, A. Walker (Nottingham), of the procedures adopted by his company in the development of their recommendations. The need to check specifications for their reasonableness was stressed and the particular point made that experience suggests that casing radiation is rarely more than 5 to 10 dB down from fan inlet and outlet levels.

There is no doubt that many fans are noisy. There appears to be no

question that quieter fans are possible, and that knowledge and experience are on hand that could be applied.

Despite the fact that one discussant contended that he does not believe quiet fans will be the order of the day for decades, Mather may well have brought attention to a technically soluble problem, and started the educational process, in the nick of time. Clearly, noise problems will make both fan and plant sales, at home and overseas, increasingly more difficult as regulations become more and more severe. In this context perhaps the most telling comment was that little can be expected until industry's current ignorance of how to specify its noise requirements to fan manufacturers is overcome. (A.W. Pryce)

PSYCHOLOGICAL SCIENCES

MEASURING FLYING PROFICIENCY IN THE SWEDISH AIR FORCE

If the obvious fact is accepted that the pilot and the aircraft are in separable union, and that the success of a mission depends upon the capabilities of both, then we should be as concerned with the operating levels and reliability of the pilot as with those of the aircraft. The attention to operating efficiency and reliability of equipment has made reliability engineering a respectable arm of the engineering profession, but we can claim no similar regard for the operating efficiency and reliability of the pilot. If the aircraft is not a single seater, a pilot might receive a check ride from a peer and, although these exercises are not useless, they are often not objective, reliable measures of proficiency. Alternatively, a simulator might be used as an accessible way to obtain objective indices of flying skills, but there is the unanswered question with most simulators of how simulator measures relate to corresponding ones in the aircraft. In the absence of attempts to collect objective measures in the aircraft or the simulator, it is assumed that a certain number of flying hours is enough to maintain flying proficiency, so pilots will log their flying time dutifully even though it may mean little else than more and more practice in inappropriate modes of responding and getting better and better at the wrong ways of doing it. None of these efforts compares to the objective checks, tests, and evaluations that engineers give the airframe and its subsystems.

In Sweden, the Airborne Electronics Division (Ingemar Carlsson, Head), Defence Materiel Administration, Air Materiel Department, Stockholm, has decided that the state of technology has reached the point where the measurement of pilot performance can be easily done. They have under development a recording system and a playback system for routine, objective feedback on flying skills. The performance of the pilot will be automatically recorded in the air, and the data will be speedily processed by a playback unit so that the pilot, and anyone else, can have immediate feedback about his proficiency. The system is for the JA37 aircraft, which is a fighter-interceptor.

The presence of an onboard computer on modern military aircraft has made easy inflight recording possible and it is a source of many kinds of information. Data from the computer will be recorded on a four-channel tape recorder at a sampling rate of either one or four times per second. The maximum recording time will be 90 minutes for the one-per-second rate, and 23 minutes for the four-per-second rate. Forty-two variables will be recorded, and they include a rich variety of display, control, weapon, and engine measures. The aircraft has a head-up display, and because a replay of the head-up display must include a view of the outside world along with its electronic indicators to be interpreted meaningfully, a motion-picture camera will photograph the head-up display when it is in use.

The playback unit is more of a problem than the recording unit. Not only must the tape information be digested, but there must be swift processing of the film of the head-up display so that it can be shown along with the tape data. The plan is for the film to be processed in five minutes after landing. In addition to the film, two graphic and one

alphanumeric display will be available for the presentation of information.

The success or failure of the system is liable to ride on the software of the playback unit which will prescribe the processing of the variables that have been recorded; it is not clear how the raw data will be summarized and presented to the pilot. Conceivably, raw data might be presented so that the pilot would see, directly, his heading, airspeed, altitude, etc., on a maneuver. However, the presentation of a lot of raw cockpit information is only slightly informative; it is about as revealing of flying proficiency as the leafing through of 1200 Gallup questionnaires would be of the public's opinion. What would be better, and probably more difficult, would be summary measures of proficiency that could be related to standards and norms, where the pilot could relate his scores to his own previous performance and to the performances of fellow pilots. Squadron commanders could monitor the performances of their pilots, and relate the performance of their squadron to other squadrons. The top Air Force management could set standards for squadrons to maintain and monitor their performances with respect to them. A measure that is commonly used in human factors research, and which might prove useful for the playback unit, is error as the integrated deviation from the ideal value for each variable on a maneuver over time. This approach would require specification of the ideal value from which error is to be calculated, both at the time a maneuver is run and when error is computed at the playback unit. Whatever the Swedes have in mind, and whether they succeed or not, they are to be credited with a nice idea and a nice try. (Jack A. Adams)

BOOZE AND BEHAVIORISM

The code word to unlock for understanding the slant of the NATO International Conference, "Experimental and Behavioral Approaches to Alcoholism," held in Os, Bergen, Norway 28 August to 1 September, is "behavioral." To psychologists, the word in this context connotes behavior-change techniques that have arisen from the influence of the unswerving behaviorist, B.F. Skinner. The generic expression for the Skinner-inspired movement is "behavior modification," and a commonly used particular term is "behavior therapy," which refers to the change in maladaptive behavior that is sought by the clients who visit psychological clinics. Behavior modification has one major axiom that separates its practitioners from other kinds of psychologists and from psychiatrists: maladjusted behavior is primarily learned, and so it can be extinguished and replaced with more acceptable behavior. Pursuing the corollaries of the axiom causes behavior modifiers to reject the medical disease model. Alcoholism is not a disease whose causes and cure can be discovered, as with smallpox, but is an inadequately-learned social behavior that can be replaced. A neurotic can be retrained to behave satisfactorily, just as a coach can retrain a bad golf swing, and this is how alcoholics are seen. They have learned a mode of responding that is hurtful to themselves and others, and they can be retrained away from damaging amounts of alcohol. The behavior therapist will accept either abstinence or moderate drinking as a trainable goal, but the Conference sentiment tilted toward moderate drinking. Abstinence is a severe goal for an alcoholic to achieve and maintain, and backsliding, with an accompanying sense of failure and a loss of self-confidence, is common.

Any science that has a socially useful side will have scientists who, in their zeal to help suffering mankind, will perform poorly designed experiments. Research on alcoholism suffers from this affliction, and the Conference participants were paternalistically lectured by their peers on appropriate experimental design. A.R. Lang (Univ., of Wisconsin, Madison) gave an excellent paper on research methodology, in which he strongly emphasized the need for controlling expectancy effects. A subject in an alcohol experiment who has received no alcohol in a drink, but has been led to think that he has, will often show the same behavioral effects as one who has received alcohol disguised in a drink. This insight into experimental design is relatively new and probably discredits much of the research of the past and will be a requirement for research of the future..

The behavioral research had five visible themes at the Conference:

1. Alternative skills training. This approach assumes that alcoholics have inadequate skills to cope with life's problems, and that they can be taught new, appropriate ones. P.M. Miller (Hilton Head Hospital, South Carolina) reported that alcoholics are less assertive than nonalcoholics and they drink more than nonalcoholics after episodes that require assertiveness. Miller uses assertiveness training as one of his techniques by which clients learn to express both their rights and negative feelings. He cited a case history of a hotel clerk who could not confront housekeeping personnel for poor work and, as a result, drank heavily. Assertiveness training, where he learned to confront his staff, was the answer. Teaching alcoholics to assert themselves to turn down offers of drinks is another social skill that could profitably be learned, Miller said.

2. Self-management procedures. Miller also recommended for alcoholics the self-management technique that is used elsewhere in behavioral therapy. The client is trained to monitor on a recording sheet his drinking behavior and the situations in which it occurs. The acts of recording presumably produce a self-awareness of drinking patterns and give the drinker the information on which to rearrange his social behavior and avoid situations that aggravate drinking.

3. The tension-reduction hypothesis. Alcoholics are more tense than nonalcoholics, the tension-reduction hypothesis contends, and so they drink to reduce tension. If the hypothesis is true, methods to reduce the tension, and thus the drinking, could be worked out. Electromyography and biofeedback figured prominently in reports from this area of research. Electromyography is the recording of minute electrical potentials from the muscles, and tense muscles have more electrical activity than relaxed muscles. The subjects in these experiments were fed back information regarding the state of their muscular tension in the hopes of reducing it. In a word, evidence reported for the hypothesis was slight and inconclusive.

4. Learning to discriminate blood-alcohol level. Does an alcoholic get drunk before he knows it because he has not learned to discriminate the internal sensory cues associated with drunkedness? The paradigm for these studies is to give a subject alcoholic drinks in the laboratory and periodically ask him to estimate his blood-alcohol level. After the estimate he will be told his true level. This feedback information should improve the subject's estimates, as indeed it did in the experiments reported by P.E. Nathan (Rutgers Univ.), and by V.J. Adesso and J.S. Henning (Univ. of Wisconsin, Milwaukee); they presumed that the improvement in estimates was accompanied by an improvement in internal awareness. The discrimination of light and heavy drinkers was essentially absent in the studies, however. The difficulty with this research is that there are difficult problems of interpretation and control, and these will be discussed in the more comprehensive conference report now in preparation.

5. Conditioned taste aversion. Who among us has not become ill from eating or drinking something and has never again been able to stand the taste of it? This common experience is the essential character of taste-aversion research. In the past ten years or so the topic has had theoretical interest for animal-learning psychologists because conditioned taste aversion is different from traditional Pavlovian conditioning, but in the realm of practical alcoholism research the interest is in ways of making an alcoholic so sick of liquor (literally) that nary a drop will pass the lips again. The technique is easy: associate a sickness experience with a flavor, and as few as one pairing is sufficient for conditioning to occur. Thereafter the subject will have a strong tendency to avoid the flavor, and the avoidance tendency will be slow to extinguish. C.S. Mellor (Memorial Univ., Newfoundland) was attracted to this paradigm for alcoholics. His approach was to associate the experience of drinking alcohol with a small dose of lithium carbonate, a substance which in large amounts would kill one but in small amounts will only make one sick. His subjects were 25 acute alcoholics. Only 9 subjects were abstinent after 6 months, which is a modest outcome for the experiment. (Given the animal research on this topic, he should have done better.) The hazards of lithium

carbonate make it unlikely the substance will ever be used for routine therapy, so in his current research Mellor is using a small human centrifuge as a harmless way of inducing motion sickness.

One of the most interesting experiments of the Conference was conducted by R.L. Elkins and R.P. Murdock (VA Hospital, Augusta, Georgia). The experimental manipulations were entirely cognitive; no use was made of strong chemicals or devices like a human centrifuge, so the methods are clinically easy and attractive. They had their clients imagine all of the sensory dimensions of drinking (the conditioned stimulus), and then imagine nauseous sickness (the unconditioned stimulus). They were able to create physical illness in 90% of their clients when nauseous sickness was imagined. When conditioning has occurred by pairing the conditioned stimulus and the unconditioned stimulus a number of times the mere imagining of drinking sensations will produce nausea. They reported an experiment with 35 alcoholics. Sixteen of them had conditioned nausea, and an average of 15 months of abstinence followed. When conditioning failed, the abstinence was 3-4 months. It is unlikely that Elkins and Murdock would contend that they have a cure for all varieties of alcoholism, but, nevertheless, it would appear that they are on to something. (Jack A. Adams)

NEWS & NOTES

29TH IUPAC GENERAL ASSEMBLY

The 29th General Assembly of the International Union of Pure and Applied Chemistry (IUPAC) was held in Warsaw, Poland, in August 1977.

General Assemblies are devoted to working meetings of the divisions and commissions plus the business meetings of the governing council; there are no presentations of scientific papers as there are at the IUPAC Congresses. As the decision-making and policy-making sessions of the largest scientific union these General Assemblies do have significant impact on industrial as well as academic chemistry.

What were the important decisions coming out of the Assembly? No drastic changes in policy, but an emerging feeling that the commissions, which are organized along discipline lines, are being faced with the same multidiscipline problems which have led to project-oriented reorganization of many research laboratories. The new President of IUPAC, Dr. George Smets of Belgium, seems to favor the project-oriented approach, but the mills of IUPAC grind slowly so there is not much likelihood of quick restructuring. The IUPAC continues to pursue and support CHEMRAWN (Chemical Research Applied to World Needs), and the first CHEMRAWN conference is planned for Toronto in July 1978; it will be jointly sponsored by the American Chemical Society and the Chemical Institute of Canada along with IUPAC. A new publication is being planned by IUPAC. It will be called *Pure and Applied Chemistry News* and is intended for the widespread dissemination of news about IUPAC activities as contrasted with the old-line journal *Pure and Applied Chemistry* which prints IUPAC documents and other learned dissertations. As to a decision on the previously discussed naming of elements beyond atomic number 100, nothing was done. (L.S. Birks, Naval Research Laboratory, Washington, DC)

ONRL NEWS

Dr. Jack Adams, Liaison Scientist for Psychology, and Professor of Psychology at the University of Illinois, Champaign, has received the Franklin V. Taylor Award for 1977 from the Society of Engineering Psychologists, Division 21 of the American Psychological Association.

We were saddened to learn of the death of Robert T. Webber on 12 September in Washington. He served as Liaison Scientist for Physics and as Deputy Chief Scientist with ONRL from 1957-1960. He subsequently served as Science Attaché in Tel Aviv, Israel (1963-66), and in Tokyo (1966-70).

PERSONAL

Two of the four Research Councils in Britain have recently announced new appointments. Professor Geoffrey Allen, FRS, Professor of Chemical Technology, Imperial College, London, takes over the chairmanship of the Science Research Council from Sir Sam Edwards. Sir Sam is returning to Cambridge University as John Humphrey Plummer Professor of Physics after four years as chairman of the SRC. Professor R.L.F. Boyd, FRS, Professor J. Brown, and Mr. D.H. Roberts have been appointed new members of the Council.

The newly appointed chairman of the Natural Environment Research Council is Professor J.W.L. Beament, who has been Head of Applied Biology at Cambridge University since 1969. He takes over from Sir Peter Kent, who will remain a member of NERC for another three years. New members of the NERC are Professor J.A. Allen, Director of the University Marine Biological Station, Millport, Isle of Cumbrae, and Dr. J.C. Coulson, Reader in Animal Biology at the University of Durham. Professors A.H. Cook and T.J. Chandler have been reappointed, and Professors R.B. Clark and G.M. Dunnet are retiring.

Dr. A.H. Chilver, Vice-Chancellor, Cranfield Institute of Technology and Sir Ieuan Maddock, FRS, Secretary of the British Association for the Advancement of Science, have been appointed members of the UK Government's Advisory Council for Applied Research and Development. In addition, Sir Ieuan, formerly Chief Scientist at the Department of Trade and Industry, has joined TecQuipment, one of Britain's major exporters of educational equipment.

Professor R.L. Wain, FRS, Head of the Department of Physical Sciences, Wye College, has been awarded the Actonian Prize of the Royal Institution.

OBITUARY

Professor John Edensor Littlewood, FRS, FRAS, Rouse Ball Professor of Mathematics at Cambridge University from 1928 to 1950, died 6 September at the age of 92. For 35 years he collaborated with G.H. Hardy on such subjects as the theory of series (particularly Fourier Series), the distribution of primes, the Reimann zeta function, diophantine approximation, inequalities, theory of functions, and the famous series of papers on "Partito Numerorum." Littlewood was the author of *Elements of the Theory of Real Functions* (1926), *Lectures on the Theory of Functions* (1944), and *A Mathematician's Miscellany* (1953). He was elected to the Royal Society at the age of 30, and subsequently was the recipient of three of its medals. He was a Corresponding Member of the French Academy, and a Foreign Member of the Dutch, Danish, and Swedish Academies. According to the London *Times*, he was one of the strongest classical analysts in the world until well into his 80s.

ONRL REPORTS

R-6-77 EFFICIENCIES OF VARIOUS METHODS FOR SOLAR ENERGY CONVERSION by W.G. Soper

Three methods are examined for converting solar energy to electricity or shaft work: heat engines, thermal decomposition of water to produce H_2, and solar cells. Maximum efficiencies of conversion are found to lie between 20% and 50%. For most applications, the heat engine is superior to the water-splitting process.

R-8-77 ACUTE RHABDOMYOLYSIS FROM EATING QUAIL by J.B. Bateman

Acute rhabdomyolysis results from susceptible persons eating quail during the migrating season. The etiology is unknown. Muscular exercise is an important precipitating factor. In this paper the literature on this and related rhabdomyolytic and hemolytic syndromes is reviewed, ranging from biblical times to the present day. It seems likely that the responsible agent present in the quail is of dietary origin and that susceptibility to poisoning in man is based upon an inherited biochemical defect. In view of the importance and seriousness of acute exertional rhabdomyolysis among military personnel, all types of rhabdomyolytic illness are thought to be worthy of close attention.

R-9-77 LIAISON TECHNOLOGIST PROGRAM: OCEAN FACILITIES ENGINEERING by R.N. Cordy

This report summarizes the findings of a review of ocean-facilities engineering technology in Europe. Principal investigation areas included cable/pipeline burial and trenching, undersea work systems, underwater inspection and nondestructive testing, geotechnical properties of seafloor materials, seawater hydraulic power transmission and diver electrical safety. The investigation which this report summarizes was conducted during May, June, and July 1977. Of particular interest to readers from Naval Laboratories will be the Appendix to this report which describes the Liaison Technologist Program under which this investigation was performed. The Appendix also describes the investigation techniques and concepts on the benefits of the Program. For more detailed technical information the reader is encouraged to contact the writer at the Naval Civil Engineering Laboratory, Port Hueneme, California 93043.

R-10-77 RESEARCH IN RANCE by A. Barcilon

This report reviews some of the mechanisms of research support in France as well as the major organizations dealing with research. It also provides a glimpse at the mood of French scientists in the face of shrinking research budgets.

C-7-77

HYDROGEN-IN-METALS CONFERENCE, PARIS, JUNE 1977
by W.N. Cathey

The Second International Congress on Hydrogen in Metals was held in Paris, 6-10 June 1977. This report presents a review of a few important papers. Most of the papers were related to applied problems. In particular, problems of H-related damage to engineering alloys were treated extensively. In addition to work on H in pure metals such as Pd, Nb, and other transition metals, some work was also reported on H in alloys such as Nb-Ti, Pd-Ag and various steels. Storage of H in intermetallic compounds such as $FeTiH_x$ or $LaNi_5H_x$ was of great interest because of their importance as energy converters.

C-9-77

INCOMAT 1977—INTERNATIONAL CONFERENCE MARTENSITIC TRANSFORMATIONS, KIEV, USSR, 16-19 MAY 1977 by J. Perkins

The third conference on martensitic transformations was held in Kiev in May 1977. This report presents a review of oral presentations made at the conference, generally in Russian, which provided a unique opportunity to learn of the extent of the Russian work in the field. Topics treated at this conference covered many aspects of martensite transformations: morphology of transformation; thermodynamics and kinetics of transformation; impact of lattice stability; wave propagation of nucleation; crystallography and structures; effects of deformation, dislocations, and stacking faults; shape-memory effects; and effects of stresses and strains.

C-11-77

THIRD SYMPOSIUM ON NEUTRON DOSIMETRY IN BIOLOGY AND MEDICINE, 1977 by L.S. August

The major topics discussed at the Symposium are summarized, including depth-dose studies, dosimetry and monitoring, sources and facilities, spectrometry, radiation-quality studies, ionization chambers, solid-state detectors, novel dosimetry systems, and dosimetry intercomparisons. Post-symposium visits to two UK neutron cancer-therapy centers are also briefly discussed.