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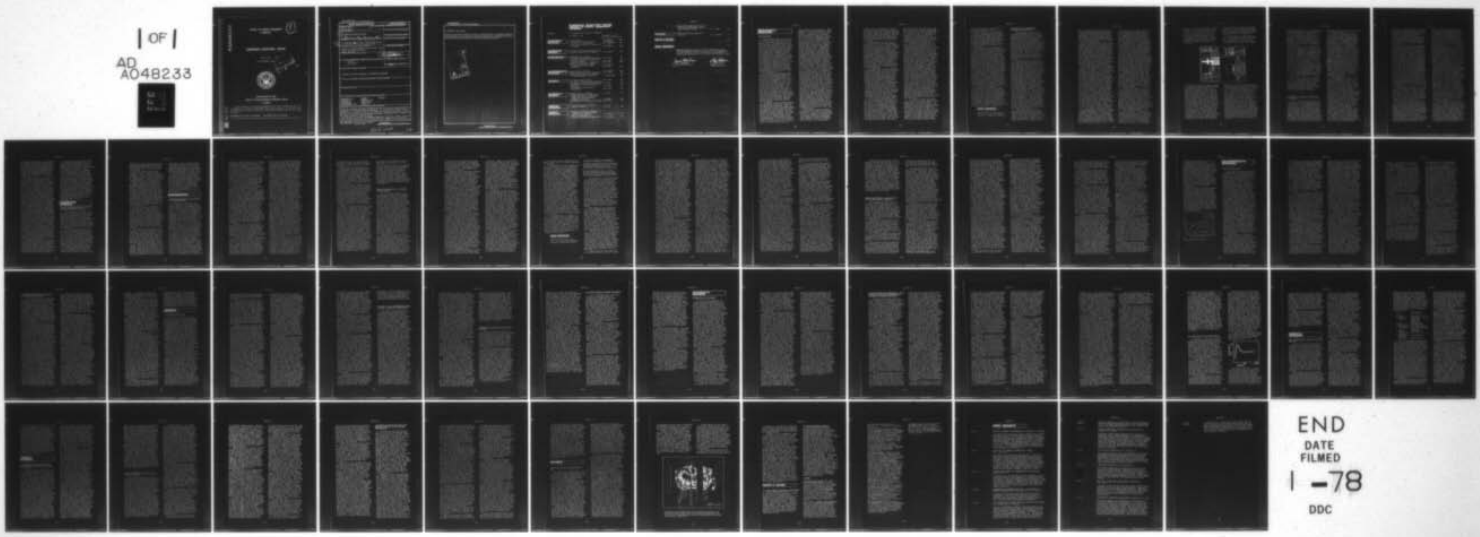

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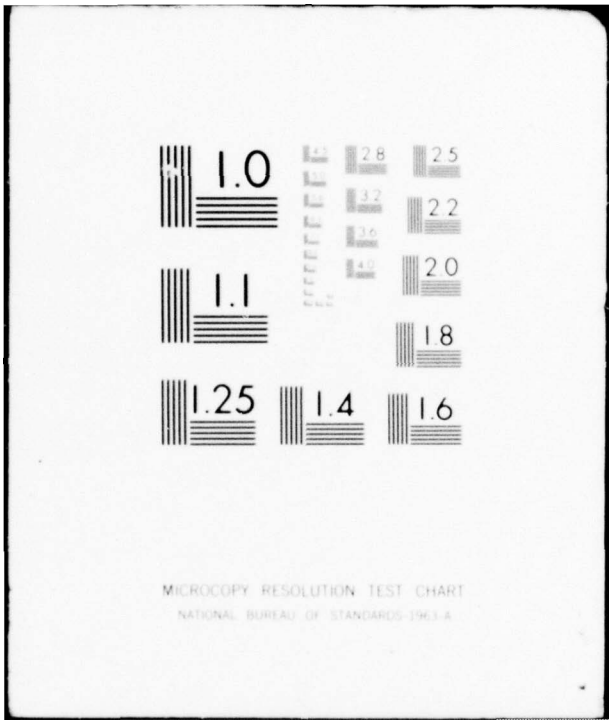
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OFFICE OF NAVAL RESEARCH
LONDON

EUROPEAN SCIENTIFIC NOTES

ESN-30-11

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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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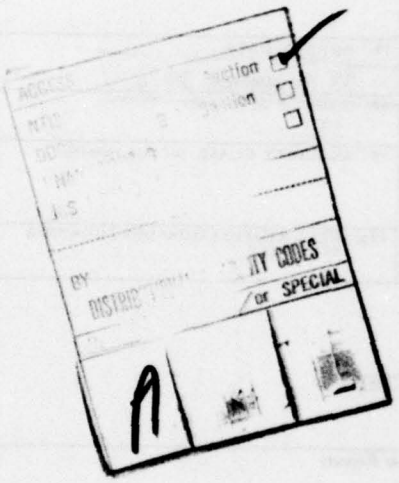
staffs of the United States Air Force's European Office of Aerospace Research and Development and the United States Army Research and Standardization Group. Articles are also contributed by visiting Stateside scientists.



EUROPEAN SCIENTIFIC NOTES
OFFICE OF NAVAL RESEARCH
LONDON

Edited by J.B. Bateman and Victoria S. Hewitson

30 November 1976 Volume 30, No. 11

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James H Schulman
J.H. SCHULMAN
Scientific Director

L. Roy Patterson
L. ROY PATTERSON
Captain, USN
Commanding Officer

BEHAVIORAL SCIENCES

PARAPSYCHOLOGY

Parapsychology remains one of the most controversial fields of investigation. Because of the uncertainties related both to the methodology utilized and the substantive content, emotions run extremely high among investigators in the field as well as between outside critics and the parapsychologists themselves. Parapsychologists continually find themselves trying to convince others that there is, in fact, anything to investigate at all. The 19th Annual Convention of the Parapsychological Association proved once again that this is still the case. For readers not familiar with the term parapsychology, Webster defines it as "a branch of psychology concerned with the investigation of evidence for telepathy, clairvoyance, thought transference and the like, and with experimentation in the field of extrasensory perception."

The Convention took place in the University Building (Academiegebouw) located in the Cathedral Square in the center of the beautiful city of Utrecht, The Netherlands, 19-21 August. The meeting, attended by about 150 persons, was divided into three kinds of sessions referred to as Research Briefs, Symposia, and Papers. The backgrounds of the attendees were quite varied and ranged from nuclear physicists to healers. The nature and quality of the presentations also were widely divergent and ranged from a detailed description of a poltergeist event occurring many years ago to statistical and metallurgical analyses of metals which reportedly had been bent by persons possessing psychokinetic powers.

The general topic of psycho-kinesis (PK) received considerable attention throughout the Convention. Many of the presentations described experiments or situations in which physical objects were moved or whose movement was influenced by psychic powers. There was one entire session devoted to the discussion of PK demonstrations by Uri Geller, who is widely known for his reported ability to bend metal objects by stroking them or in some instances without touching them at all. Descriptions of others claiming to have similar powers also were given. Such individuals were referred to as "mini-Gellers." In an early paper in this session S. Wendlandt (U. Freiburg, FRG) discussed the reaction of the public to Geller. Wendlandt reported on a survey he had conducted which revealed that 50 of 80 persons who believed in Geller's powers were oriented towards the occult. He was unable to find a correlation, however, between the "believers" and scores on personality tests. Although he could not explain the acceptance of Geller by the public, he felt that it was an attempt to enlarge one's consciousness which attracted many. H. Bender (Freiburg Institute, FRG) reported on a PK session in June 1975 in which a man named Silvio was able to bend metal and plastic objects under controlled conditions. Bender showed a movie in which a spoon presumably was being bent by Silvio without being touched. Unfortunately, the film was of such bad quality that it was difficult to see what was going on. A. Ellison (City U., London) reported on the claims of a number of South African children who felt they had psycho-kinetic powers after watching Uri Geller on local television. Interestingly, the PK power of these children was initially attributed to the direct psychic influence of Geller transmitted via television. In fact, there were three television broadcasts of the Geller demonstrations in the same geographic region. One was live and the other two were on video tape. Although the audience thought all three were live, a subsequent analysis of audience responses showed no differences in reported PK power between those resulting from the live and taped broadcasts. Ellison expressed great concern over the fact that, in many cases of metal bending, conditions are neither controlled nor is even an attempt made to control them. He made a strong plea for increased experimental rigor if data are to be accepted in the future by other than a few believers.

Still another plea was made by W. Wolkowski (U. Paris) for parapsychologists to step back and ask where all this is leading. He reported on a man named Girard who purportedly could transfer PK power to members of an audience, as well as perform other PK feats like influencing a

liquid crystal thermometer to show an increase of up to 4°C without touching it. While recognizing the need for much additional supporting evidence regarding the very existence of PK power, he expressed concern about the application of such power in untoward deeds which could be detrimental to the safety of the public.

Three papers were delivered by physicists in which PK metal bending was reported. In one, J. Taylor (King's College, U. London) described an event which took place months earlier in which a spoon was broken by Uri Geller by stroking it when the spoon was being held by Taylor himself. Although Taylor, a well-known physicist in the UK, was regarded at the meeting as a pragmatist and skeptic, he apparently feels that there is some basis to the claims that certain individuals have PK powers. He discussed the physical forces by means of which a spoon could be bent or broken under such circumstances and concluded that none of them explained what had happened.

Two other physicists, R. Mattuck (U. Copenhagen) and J. Hasted (Birkbeck College, U. London), described experimental sessions in which metal bars or spoons allegedly were bent by mini-Gellers under controlled conditions after which a detailed metallurgical analysis was performed to determine whether the metal was compressed, stretched, heated, etc. Unfortunately, in one case no one actually observed the "bending," and in the other the television camera which was set up to record the "bending" failed at the critical time. Thus in both cases the audience was presented with a detailed description of the preparations, the experimental set-up, and a post-experimental analysis but was unable to observe the critical event itself.

Extra-sensory perception (ESP) which is now generally referred to as "psi" was the subject of several presentations. E. Spinelli (U. Surrey, UK) described an experiment in which the effects of chronological age on psi ability in man was investigated. His experiment involved 1000 subjects divided into 500 pairs. In each pair one was designated as a "sender" and the other as a "receiver." The stimulus material was five cards with different pictures on them. The task was for the receiver to guess what picture the sender was viewing at the time. The subjects were divided into 10 age groups starting with 3 to 4 year olds and ranging up to groups of adults 65 to 70 years of age. The results were all negative except for the groups composed of children aged 3 to 8. A number of experiments were reported along a similar vein in which the stimulus material was different, but the general technique was the same.

During the past three to four years several psi investigators have utilized the "Ganzfeld" (this is a German word meaning "whole world" which is commonly used to describe an environment in which sensory input is reduced) as an environment in which to study psi phenomena. This environment can be achieved by placing halved ping pong balls over the eyes and cotton in the ears. The result is a reduced sensory input which presumably will enable the receiver to attend more effectively to psi signals. A study using this technique was reported by A. Parker (U. Edinburgh) in which 24 pairs of subjects participated. One of each pair underwent a 35-minute Ganzfeld period during which he was required to give a continuous report of his experiences and mental state. During the last five minutes of this period, the other person (the sender) viewed slides showing works of art and tried to influence the receiver's imagery. The receiver was later given six picture cards (one of which had the same content as one of the slides used by the sender), and was asked to rank them in order of proximity to his experiences. The experimenter was seeking an answer to the question: Was the picture used in the Ganzfeld phase of the experiment perceived as closer to his imagery during the Ganzfeld experience than the other five pictures? The results in each case were negative.

A variation on this technique was reported by W. Braud (Mind Science Foundation, San Antonio, Texas). In addition to using the Ganzfeld to facilitate the psi effect, Braud provided immediate and positive feedback to the receiver whenever he made a correct guess as to what picture was being viewed by the sender in the next room. Whenever the receiver mentioned some content of the slide that was being viewed by the sender at that time, he heard a 2-sec 180-Hz audible tone. This type of feedback also has been

used in experiments on biofeedback of cortical or visceral events (ESN 30-10:433-435). The results in Braud's experiments were positive in that the experimental group receiving feedback did significantly better than the control group. The investigators believe that "the improvement reflects a learning effect attributable to immediate feedback, but a psi-mediated experimenter effect remains a viable alternative explanation for these results."

While there was a real attempt on the part of some investigators to conduct properly controlled experiments, several of the presentations were devoted to a rather rambling review of undocumented events involving poltergeists, metal-bending and subjective accounts of unusual happenings. Unfortunately, the writer was unable to determine, based on discussion and comments during the sessions, whether such reports were believed or simply tolerated by the other attendees. If parapsychology is to achieve greater acceptance in the future by other scientific disciplines, considerable effort needs to be expended to ensure that presentations and subsequent publication are carefully screened. Similarly, in my opinion, increased attention needs to be given to describing critical events and producing credible films when appropriate, rather than creating an aura of pseudoscience by concentrating on overly detailed statistical or physical analysis when the event being analyzed is itself barely documented.

In summary, attending a parapsychology meeting for the first time, I found it to be interesting and generally informative, but was surprised to observe the casual and undocumented manner in which much of the information was described, on the one hand, and the painfully detailed exposition of irrelevant but scientific sounding data on the other. There obviously is a significant credibility gap waiting to be filled. Whether it will be filled remains to be seen. (J.W. Miller)

ONRL REPORTS

See the back of this issue for a list of current abstracts, and how to obtain the reports.

A NEW LOOK AT THE NETHERLANDS INSTITUTE FOR PERCEPTION

The Netherlands Organization for Applied Research (TNO) is well known to many ESN readers. It is an independent non-profit organization created under government charter in 1930 and consists of 5 corporate bodies: The Central Organization (CO), the Organization for Industrial Research (NO), the Organization for Food and Nutrition Research (VO), the National Defence Research Organization (RVO), and the Organization for Health Research (GO). The total staff numbers about 4700 and they are not civil servants. Each of the major organizations embraces a number of specialized institutes (about 40) and working groups located throughout Holland.

The Institute for Perception (IP), which now employs about 100 persons, falls within the National Defence Research Organization (RVO-TNO) and is located in Soesterberg. Mr. P.J. Houtzagers, Director of External Relations, explained that about 65% of the support for the Institute comes from the various Defence departments with the balance coming from various private groups including consumer organizations. While the research is directed and carried out by scientists within the Institute, many of the projects are in effect assigned by the supporting organizations who have specific questions for which they want answers. Although there are many exchange scientists working at the Institute, the basic staff is quite stable both with regards to numbers and individuals. For these and other reasons the Institute has an excellent reputation both in Holland and throughout the international scientific community. The main theme of the Institute is to deal with the cycle: Perception → Processing → Decision → Action, with an evaluation of the action to determine whether it has accomplished its purpose, repeating the process until the desired end result is achieved.

The IP has five divisions: Vision Research, Hearing and Speech Research, Experimental Psychology, Human Engineering, and Road User Behavior. Dr. J.J. Vos (head of Vision Research) described a number of programs now underway. One of his current efforts is the compilation of

new tristimulus (distribution coefficients of an equal energy spectrum) color tables which he feels will be more suitable for developing future conceptual models of color perception than those now in use because they will take into account data which are not considered by existing tables.

Vos and other members of the Vision Division are involved in several applied projects including the development of acceptable levels of human exposure to lasers; lighting requirements for highways, ships, and inland waterways; and the development of visual requirements for ships' captains and crews. He also is working with representatives of the Soviet Union and other European countries on the development of standardized water-route signs. Inasmuch as there are basically no such signs in many areas, the kinds of difficulty encountered when road signs were standardized in Europe several years ago are minimal.

Also under development are standardized eye charts for use in the military, schools, and industry. Of particular interest is a new set of charts designed to test depth-perception, originally developed to select military service people who were best qualified to operate optical rangefinders. Charts were developed containing various geometrical and insect patterns composed of dots of red and green on a white background, superficially resembling charts used for testing color blindness. Some of the patterns can easily be discerned by the unaided eye, but others emerge only if the charts are viewed through spectacles containing one green and one red filter lens. Using these spectacles, one set of images can be detected only by people with extremely good depth perception. This set is used as a selection test for rangefinder operators, whereas other images emerge from the patterns even for people with average depth perception. These charts, it turns out, can be used to test children--even those below school age--for the so-called "lazy eye" syndrome.

Dr. A.F. Sanders (Behavioral Research Coordinator) described a current program relating to the effects of drugs on human performance. Of particular interest is the effect of amphetamines and barbiturates on arousal and activation. Sanders is attempting to determine the underlying mechanisms by manipulating the task variables rather than by varying the task itself. For example, one of the tasks being used is a reaction-time test in which the subject is required to make a forced choice among spatial intervals. In this experiment the subject places his finger on a switch (A) and is asked to lift his finger and press a second switch (B) when he sees a pointer appear in one of four corners of a lighted square. He is required to press one of four switches (B) corresponding to the corner immediately adjacent counter-clockwise to the corner in which the pointer appeared. The clarity of the displayed pointer is sometimes decreased intentionally so as to increase the difficulty of the task. Both the reaction time [time required to lift the finger off the first switch (A)] and the decision time [time to press the second switch (B)] are recorded. When 200 mg pentabarbital or 20 mg Phentermine HCl were used as the drug, the results did not show any effect on reaction time but did show a significant effect on decision time. Sanders interprets this as evidence that the higher cortical centers were affected by the drugs.

Sanders indicated during our discussion that although there are hundreds of studies described in the literature pertaining to the effects of drugs on performance, there is almost a complete lack of standardization of methodology or experimental procedures. This comment is consistent with those heard at the recent International Congress of Psychology (ESN 30-9:389-391).

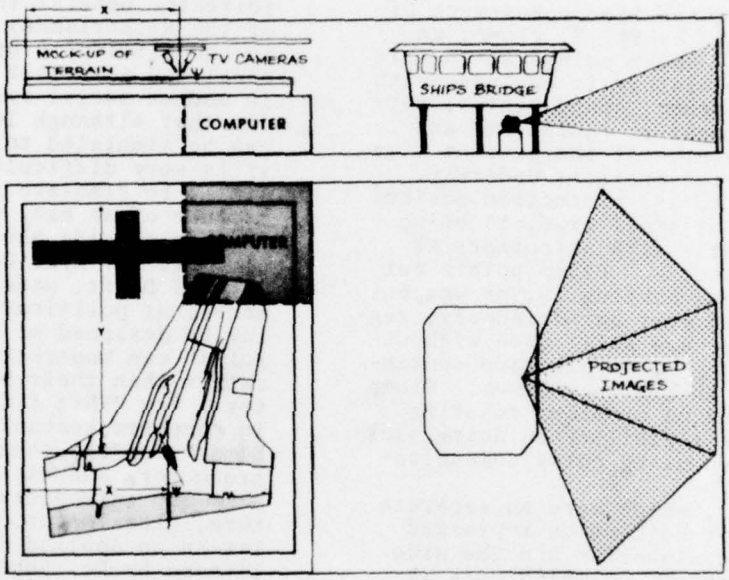
Sanders described the International Association for the Study of Attention and Performance which held its 7th symposium in August 1976. These symposia, which are attended by 60-70 invited scientists, are highly specialized and have been very successful in the past. Sanders is chairman of the Association which was registered in January 1976 in The Hague. Those wishing more information should write either to Sanders or to Sylvan Kornblum, Mental Health Research Institute, University of Michigan, Ann Arbor, Michigan 48109.

The IP has a most impressive simulation facility. This resource reflects the general policy in Holland of simulating a variety of tasks and systems (and eventually building life-size mockups and transporting them to their final site for experimentation) prior to the construction of permanent structures. For example,

they can simulate ships' bridges, inland waterways, highways, automobiles, and combinations of the above. The largest simulator is spread over an area of 17 x 23 m^2 and may be described with the aid of the accompanying figure. A full-scale model of a ship's bridge is located in a large darkened room facing three contiguous screens on which television images of a waterway are projected.

and maneuvering problems of big barges going down waterways before they make decisions on large engineering projects, such as removing or constructing breakwaters or other protuberances, or dredging.

The second major simulation project is designed to assist in the layout of new freeway intersections. The technique is the same as in the ship studies except that cars, trucks,



The images come from a 3-camera assembly on a moveable servo-controlled mounting in another room which scans a very faithful scale model of the waterway and its surrounding terrain. The ship pilot or trainee steers the camera assembly along the path he is trying to take, and the televised mini-scene appears on the large 3-screen projection which he observes through the windows of the bridge. Projected onto the central (straight-ahead) screen is a perspective view of the ship or tanker that he is presumably steering as it would be observed from the bridge; this projection is, of course, stationary and is thrown on the central screen from a slide projector located below the bridge (where the 3 television projectors are also located). The effect is extremely realistic. The Dutch use this technique, with experienced captains at the helm, to study the navigation

highways, etc., are used in place of ships and rivers. The highway program is under the direction of Dr. J. Moraal, Head of the Road User Behavior Division. In these experiments, the subject sits in a fully instrumented, but stationary, car and "drives" down the highway. The visual input for the subject is obtained from the 3 cameras mounted on the simulator boom and projected onto a 120° screen mounted in front of the car. Data, automatically recorded, include steering behavior, lane changes, braking, eye movements, heart rate, respiration, and other parameters associated with driving behavior. An interesting point about these studies is that the Institute was asked to undertake them by the highway developers, etc., rather than the scientists at the Institute having to sell the idea of using simulators. The PDP-15 computer is

sufficiently flexible so that variations in display parameters and experimental design can easily be introduced.

The simulation facility is backed up by an instrumented Volvo which is equipped to record eye movements, car functions, as well as heart rate, respiration, etc., during actual highway driving. An army truck is similarly equipped to measure the performance of truck drivers.

The Hearing and Speech Research Division is headed by Dr. R. Plomp, an internationally-known scientist in this field. The laboratory is equipped with an anechoic chamber, sound booths, very up-to-date laboratory equipment, and a PDP-11 computer. At the present time Plomp has several projects underway. One, relating to ear protection devices for the users of small arms, is being conducted jointly with scientists at Fort Knox, Kentucky. Plomp points out that while crews manning larger weapons are required to wear ear defenders, regular small arms are still used without such protection. This practice continues to result in hearing losses. Plomp also is working on problems relating to speech intelligibility in noisy backgrounds or when using noisy communications systems.

The visits, which were on separate occasions, left both of us impressed with the professionalism and the wide variety of problems on which work is being conducted. The combination of basic and applied research serves to stimulate new ideas as well as evolve solutions to current problems.
(J.W. Miller and J.H. Schulman)

INTERNATIONAL CONGRESS ON SIMULATION OF SYSTEMS

The 8th AICA (Association International pour le Calcul Analogique) Congress was held at the Delft University of Technology in The Netherlands, from 23-28 August. The Congress was organized and planned by the Delft University Computing Center under the patronage of the AICA and the Dutch Computer Society, NRMG. The facilities were outstanding as was the organization and manner in which the Congress was managed. It clearly was the most professionally-run meeting I have attended during the past year, and judging from the comments overheard, many of the 320 registrants had similar feelings.

A series of opening addresses set the tone for the Congress and, in an overall sense, made an appeal to the participants to remember that in spite of the complexity and sophistication of a burgeoning computer technology, a real effort must be made to maintain the human element. For example, Dr. E. Van Spiegel (Director General for Science Policy of The Netherlands) called attention to the difficulty of simulating the moral and political issues involved in modern social systems. He pointed out that although long-term issues can be simulated to a limited extent, it is very difficult, if not impossible, to simulate short-term issues because of so many uncontrollable factors outside the realm of the model. Dr. IR. A.P. Oele, Mayor of the City of Delft, made an appeal that models of political problems and policy be designed so that "regular folks" can understand and use them rather than their being designed just for a few "Whiz Kids" specializing in computer technology. "Keep it human" was the theme of all the introductory addresses.

The introductory technical lecture, "The Impact of Computer Simulation on Applied Science," was delivered by Dr. Robert Vichnevetsky (Rutgers U.), the President of AICA. He discussed both the obvious advantages and the serious concerns relating to the tremendous increase in the use of computer technology. He feels that in addition to the classical modes of research (experimental and theoretical) there is now a third approach, namely the "computational approach," as evidenced by such terms as computational fluid dynamics, computational physics, and computational mechanics. In his opinion, "computational research is not an extension of either the theoretical or experimental approaches; it is a new way of doing research." Vichnevetsky went on to express concern about the lack of mature application of discipline by the scientific community in the utilization of computers to solve problems and to simulate systems. He attributes this trend to the explosion of the availability of computers and to the lack of traditions and standards

with regard to methodology. The latter, he feels, has been due in part to the rapid application of computer-simulation methods by social and environmental scientists, who--perhaps simple-mindedly--believe that availing themselves of computer simulation would bestow upon them the rigor and power of exact mathematics that heretofore has been the exclusive province of other disciplines.

In his invited survey lecture, which opened the session on System Modeling, W.J. Karplus (Computer Science Dept., UCLA) echoed some of the concerns expressed by Vichnevetsky. Karplus presented a spectrum of problem areas ranging from electric circuits (which can usually be modeled readily) to social problems which are currently difficult if not impossible to model meaningfully. An ever-present danger, according to Karplus, is that the users of mathematical models will attribute validity to the data far out of proportion to what is actually warranted. He concluded by saying: "It is of paramount importance that the designers of models and the specialists in the art of simulation communicate to the ultimate users of the models the general validity of the model predictions. It is important, moreover, that this communication be couched in terms readily understandable by the ultimate user and that they be repeated sufficiently frequently so that no improper inferences can be drawn from computer printouts or other computational display."

The talks that followed were divided into three general categories: System Modeling; Simulation Tools; Simulation of Specific Systems. Because of the large number of papers, there usually were three or four simultaneous sessions. Most presentations were both technical and highly specialized, so the 886-page volume of reprints distributed at the meeting was of great value.

In the first session attended by the writer (Simulation of Specific Systems, Mechanical Engineering) presentations were made on several topics including "Hybrid Simulation of an Impact Hammer," "Simulation of Occupant Safety During Car Crashes," "Hybrid Computation of Axisymmetric Transonic Flow Around Slender Bodies," and "Simulation of an Airplane with Structural and Non-Stationary Effects." In each presentation, because of the specialized nature of the conference, the emphasis was on methodology and internal consistency with relatively little effort relating to the validity of the model. For example, in the paper entitled "Simulation of Occupant Safety During Car Crashes" (G. Hornstein, Volvo, Göteborg, Sweden), a mathematical model was developed and tested which took into account seat belt forces, air bag forces, forces against the seat, forces between foot and floor, kneebar forces and the forces of gravity. The various joints of the body were considered and the body was divided into a three-mass system: head, torso (including arms, chest and hips), and legs. In the model the head bone was connected to the neck bone, the neck bone connected to the back bone, the back bone connected to the leg bone, etc. In this instance, although an effort was made to validate the computer model against the real world, there was a serious gap. The real world was represented by a dummy which was fabricated in the Volvo laboratory, placed in a car and used in simulated crashes. The missing link, according to Hornstein when questioned from the floor, was that the dummy itself had not been sufficiently validated against outside parameters. Such parameters could include passenger position at time of impact, body size, build, weight, angle at which vehicle was struck, and the use of live people as passengers in low-speed impacts. Thus, although the dummy-model system was internally consistent, validation in the real world was not part of the analysis. This same problem with different specifics seemed (in the writer's opinion) to be present in several of the simulated systems described. Sophisticated mathematics and conceptual systems were developed and validated in a way so as to ensure the model consistency, but ofttimes ignored external validation.

In the session on Water Resource Systems, S. Marsali (System Science Group, U. Florence, Italy) presented an excellent paper describing a model of the Florence Municipal Water Plant. In keeping with a planned expansion of this plant, a dynamic model was developed based on the operation of the entire plant. Digital simulation was used to reproduce some typical events of plant functioning. This was followed by the development of a stochastic model designed to assist in studying the system sensitivity

to input disturbances, i.e., variations in the level of the Arno River, etc. The result was a set of control parameters which minimized the effect on the output-flow of such input disturbances. This is one of several models described which were developed to assist in the management of water resources and in my opinion is a good example of a proper use of simulation technology.

In a paper entitled: "Simulation--Is It Worth It?" R.E. Crosbie (U. Salford, England) reviewed the costs and benefits of simulation. He pointed out that in the '60s, the question of the day was: "Simulation--what can it do?" and that in the early '70s the question changed to: "Simulation--does it work?", which has now evolved to the question asked in the title of his talk. While recognizing the valuable contribution of many models, he feels there is a proliferation of unvalidated, untested, useless models. Crosbie is of the opinion that we shall see an increasing return to interactive simulation (a procedure in which the operator interacts with the computer in real time as opposed to a completely pre-programmed simulation) which was more prevalent when analog simulation was in vogue. Interactive simulation will become more popular again because of increasingly sophisticated software packages and because the cost of utilizing computers is decreasing. The increased use of microprocessors in parallel also will facilitate digital flexibility, hence more man-computer interaction. According to Crosbie the key to effective simulation in the future will be with the software. "The shifting balance of costs between hardware and software will be reflected in a decreasing ratio of running costs to development costs for a given size of model. Thus, in many areas, running the very large models necessary for realistic simulation could become a paying proposition, thereby realizing the potential of much of the exploratory work which is now in progress."

In summary this Congress was both technical and reflective. In addition to the many technical innovations discussed there seemed to be a great concern for where are we going and what constraints should we place on ourselves to avoid the tail wagging the dog. Those asking the questions represented both the specialists and the users.

Because of our insatiable quest for technical achievement it is important that we pause and ask ourselves where we are going. Lewis Mumford, in his article: "From Erehwon to Nowhere," in *The New Yorker*, 8 Oct. 1960, says that "...perhaps one of the reasons the machine has ridden roughshod over so many areas of our life is that we have treated it as if it were a creature far outside the sphere of historical experience and not subject to ordinary moral or political judgment--so far outside that only engineers, inventors, and scientists could pass on its methods or aims." In the writer's opinion, by constantly reminding ourselves that man, in addition to being the user, is the real purpose of our advancing technology, we not only will improve our efforts but will better maintain our perspective with regard to the relationship between man and his machines so that man continues to be the ruler, not the subject.
(J.W. Miller)

COMPUTER SCIENCE

THE STATISTICS DEPARTMENT AT TRINITY COLLEGE, UNIVERSITY OF DUBLIN

The University of Dublin is one of the two major universities in the Republic of Ireland, the other being the National University of Ireland. When the University of Dublin was founded (in 1591), it was contemplated that Trinity would be but one of a number of constituent colleges. However, none other was ever established, so for most practical purposes Trinity College and the University of Dublin are identical.

Given the present emphasis of the Statistics Department, it might better be called Operations Research and Statistics. The Department confers two MSc degrees--one in Statistics and Operations Research and the other in Applied Statistics--a Diploma in Statistics, and a PhD in Statistics. However, the course offerings and particularly the interests of the faculty go beyond statistics *per se* and include a large chunk of what is usually called operations research.

The Diploma in Statistics is awarded at the end of a 1-year evening program meeting 4 hours per week

during term. The program aims to have students understand the nature of statistical methods and be able to identify problems that can be approached statistically.

The 2 MSc degrees differ only slightly in their required courses. The goal of each is to prepare persons intending to make a career in business or industry. Both require participation as a team member in a year-long applied research project. A faculty member is ordinarily the team leader/advisor.

Research projects are sought out and administered by the Statistics and Operations Research Laboratory, an adjunct of the Statistics Department. The lab is directed by a non-academic professional employee (who holds an MSc in Statistics from Trinity) and employs 2 technical aides. Projects may come from Trinity College, from industry, or from local and national governmental organizations. Not all project sponsors are able to provide funds for the conduct of the research work. Unfunded work is done as a public service. The following are 3 examples of recent research projects:

1) A study of how to integrate and better use the emergency units at 7 local hospitals. It had been recommended that some of these units be closed, others merged, and a new one built. The study involved: examining hospital records to determine classification of cases, duration of treatment, usage patterns for personnel, beds, operating theatres, etc. and constructing mathematical and computer simulation models with which to project patient flows and concomitant facilities and staff needs for various organizational schemes.

2) A study of the computerization of master scheduling of classes for the University. Interestingly, this study concluded that human schedulers could do the task better manually than a computer algorithm could. The reasons for this are based in part on the belief that it is hard to include in an algorithm all the constraints that humans can rather readily keep in mind.

3) A study of the economics of solar energy. This study investigated the economic viability in Ireland of 2 methods for collecting and storing solar thermal energy for use in domestic water heating. For each method a stochastic model was constructed to relate output to system parameters and meteorological conditions. Under a particular set of assumptions, one of the methods studied was considered to be viable even at present prices. Additional questions answerable with the present models and adaptations needed to answer other questions were identified.

The Department is staffed by Professor F.G. Foster and Lecturers J.P.G. MacAirt, Sarah David, John Haslett, M. Dummer and Michael Stuart. It is housed in what appears to have been a residence on a fairly busy street adjacent to the University. The Department will shortly move to the campus in a building which will also house a computer facility and related Departments.
(E.M. Scheuer, California State U., Northridge)

ENGINEERING

TELEVERKET-THE SWEDISH TELECOMMUNICATIONS ADMINISTRATION

Televerket is the short name for the Swedish Telecommunications Administration, a state-owned public utility under the jurisdiction of the Ministry of Transport and Communications. It has charge of Sweden's domestic and international telephone, telegraph, telex, data and radio communications. As may be expected, telephone service is Televerket's main activity, both financially and in terms of the personnel employed. The telephone was first introduced in Sweden in 1877. Its use spread rapidly and now its density is about 625 per 1000 inhabitants. In this respect, Sweden has for a long time been second only to US where the telephone density is 660 per 1000 inhabitants.

In spite of its being a government agency, Televerket is required to defray its operating, depreciation and interest costs from its current revenues and to show a surplus. It is organized as a market-adapted, result-oriented business enterprise with about 20 telecommunication areas as the primary "result units." Operative and service tasks are decentralized to these areas and decision powers are made by local management-labor councils. There are also centralized "result fields" covering the different activities (telephone, telegraph, telex, data communication, and network

planning), constituting a matrix organization and providing avenues for a degree of centralized management control. Considerable emphasis is put on marketing. Two central Marketing Departments, one dealing with telephones and the other with the rest of Televerket's businesses, are charged with the responsibility of developing customer policy and new services from the viewpoint of results. The Marketing Departments also act as consultants to the telecommunication areas. A third central unit, the Network Planning Department, has coordinating capacity for the optimal dimensioning and utilization of the trunk network.

There are three national result units that provide service for the telecommunication and radio branches: a Materials Division, a Construction and Plant Installation Division and an Industrial (Factories) Division. The Central Administration consists of an Administrative Department (Director-General's Office, personnel, salaries, legal matters, etc.), a Financial Department (budgeting, accounting, contacts with the ministries, international relations, etc.) and a Technical Department, about which more will be said below. The total number of people employed by Televerket is around 41,000 and the annual revenue is roughly one billion US dollars.

Televerket's Technical Department has 12 Divisions and two Laboratories. Not all the Divisions have technical responsibilities (e.g., Buildings and Real Estate Division, Technical Documents Division, etc.). The two laboratories are the Testing and Research Laboratory and the Model and Prototype Development Laboratory.

Recently I had an opportunity to visit the facilities of the Testing and Research Laboratory at Farsta which is approximately 20 km south of Stockholm. This Laboratory has a scientific and technical staff of 85 working in four sections: Acoustics and Telemetry, Telephone Interference & Protection, Chemical & Mechanical, and Instruments.

An impressive facility of the Laboratory is a large anechoic chamber which measures roughly 10 m x 11 m x 13 m. All of its six interior walls are lined with 1-m glass-wool sound-adsorbing wedges (8000 such wedges altogether). Experimental apparatus are suspended in the middle of the chamber on taut metal wire grids. The chamber has an absorption coefficient of 30 dB (99.9%) over the 70-Hz to 20-kHz band and has been indispensable for telephone, speech quality and loudspeaker measurements. It was built at a cost of a quarter of a million dollars in 1962. The structural design of the foundation and the walls was to give an essentially vibration-free room. Unfortunately a new highway was allowed to be built only 30 m away, and the reliability of the measurement results at the low-frequency end is affected by heavy high-speed vehicles.

In direct contrast to the anechoic chamber with very low wall-reflections, a reverberation room with very high wall-reflections is also needed for acoustic measurements such as the sound-insulation quality of wallboards, etc. Televerket has such a room with a volume of 176 m^3 and a reverberation time of between 5 to 6 s over the frequency range 100 Hz to 8 kHz. A reverberation room is not expensive to make; its interior is simply lined with ordinary ceramic tiles. The distribution of sound intensity in such a room can be accurately calculated.

One of the most costly damages which telecommunication equipment and networks suffer is the result of an overvoltage caused by lightning. The probability that telecommunication networks will be struck directly by lightning is very small. In the rare cases in which this happens, the networks in general cannot be wholly protected against the detrimental effects of the lightning currents, but these effects can be reduced by suitable measures. In the majority of the cases lightning damage to telecommunications networks is due to resistive or inductive coupling of the lightning current paths to open-wire networks and overhead or buried cables. The finite conductivity of the ground gives rise to earth potentials when lightning strikes, and buried cables particularly can be badly damaged by the lightning current.

The occurrence rate for thunderstorm days in Sweden is in the range of 5 to 20 per year which is low compared with the European average of 15 to 35. At ground level the lightning current increases to a maximum of between 25 kA and 200 kA within a few μs. A special problem in Sweden is that the soil resistivity is high, as high as between 3 to 10 kilo-ohm-meters compared with an average of 300 ohm-meters on the

European Continent. A higher ground resistivity means a higher earth potential when a lightning current strikes the earth.

Considerable work has been done at Televerket on the mechanism of lightning discharges; the calculation of overvoltages in overhead lines, overhead cables and buried cables; and the comparison of various types of overvoltage protector under different service conditions. The cost factor is, of course, also important. Rare-gas tubes are ten times more expensive than carbon protectors (unit cost is about $2.20 for the former).

Televerket's present annual consumption of protectors is about 70,000 rare-gas tubes and 230,000 of the carbon variety. In spite of the precautions, the annual damage to the Swedish telecommunication network due to lightning is $2-3 M. P.-O. Persson, Head of Televerket's Telephone Interference and Protection Section, and his staff gave me some spectacular demonstrations of simulated lightnings, their damage to unprotected circuits, and methods of protecting telephone equipment in the high-voltage laboratory.

Several disturbing effects may occur in unprotected telephone lines when they run in the proximity of high-voltage power lines. Among them are acoustic shocks which may result from large induced electromotive forces due to earth-faults in the power lines, and the hissing and buzzing noise disturbances caused by audio-frequency currents and voltages in power installations. By and large, these disturbing effects have been greatly reduced by suitable rectifiers and filters and proper planning of network installations. One vexing problem of telecommunication disturbances comes from the use of thyristors for continuous power adjustment in the operation of electric railways. This results in highly non-sinusoidal waveforms, whose harmonics are a source of noise disturbance that can be only partially eliminated by equipping the railway engines with filters. This problem is receiving special attention in Televerket's Interference-Protection Laboratory. Theoretical calculations of the audio-frequency disturbances have been made under various conditions. To aid in simulated experimentation, a large (about 6 m x 4 m) electrolytic tank with remote control of the positions of electrodes has been designed and constructed; it is now under test.

In the sense that it is a market-adapted, result-oriented telecommunications enterprise, Televerket is similar to the American Telephone and Telegraph (AT&T) Company. It must operate efficiently and give its customers good service. Some research work is done at Televerket, but the major effort appears to be directed mostly toward problem-solving. A parallel to AT&T's prestigious Bell Telephone Laboratories does not exist. (D.K. Cheng)

PEIRIANNEQ FECANYDDOL AT UNIVERSITY COLLEGE CARDIFF

One of the few contrasts that confront the traveller who journeys from England to Wales is the appearance of what seems to be gibberish on public signs. Traffic warnings are written in two languages--Welsh and English--and so too are the signs found in public places such as universities. Thus it was that when I visited University College Cardiff I learned that *Peirianneq Fecanyddol* means Mechanical Engineering in Welsh. As is the case in Wales in general, Cardiff seems to live with one foot in the past and the other in the future: the downtown University Buildings rise in modern relief against the rolling hills from which coal was extracted at the annual rate of 200 million tons in the peak year of 1912. Though this production would now supply the entire coal needs of the UK, mining activity has been greatly reduced in Cardiff because of the comparative economics involved--a situation that appears to be reversible with the current trends in energy resources development.

University College Cardiff is one of four major campuses of the University of Wales (the others are at Aberystwyth, Bangor, and Swansea). There are about 4000 students enrolled at Cardiff and every year about 30 of these receive the BSc degree in mechanical engineering, having completed a three-year course. What the M.E. operation lacks in size is compensated for by enthusiasm and, judging from the impressions gained during my visit, excellence. These

qualities are very much a part of the character and philosophy of the Department Chairman, Professor Eric Markland, who does not hide his pride in the output of his faculty of 11 and support staff of about 15--one of the smallest M.E. departments in the UK.

Markland himself has made continuing contributions to the technology of fluidics, particularly in jet and free streamline flows, and Dr. N. Syred complements these efforts with his interests in vortex flows. Syred's laboratory contains a large number of devices in which the characteristics of swirling flows are applied to good advantage. A major effort is connected with the development of vortex diodes, and a large high-performance device is currently under study for use as a non-return valve in large fluid lines. The diode will produce a 15-to-1 reduction in flow rate when a given pressure drop is reversed across inlet and outlet--the operation occurs in about 1/2 second whereas a comparable mechanical valve in a 2-ft line, say, would take several minutes to operate. Other applications of vortex diodes under investigation include an ingenious back-to-back arrangement for a no-moving-parts pump (for use, perhaps, in the pumping of radioactive slurries), and a pressure regulation system for glove boxes (again intended for use by nuclear industries).

At another end of the spectrum of swirling-flow applications, Syred and his coworkers are investigating the performance characteristics of cyclone chambers. The goal of the program is to develop a combustor with controllable burning characteristics so that low-quality fuels with high sulphur content can be burned cleanly and efficiently. Syred has found, for instance, that when chalk is added to the swirling flame produced from high-sulfur oils, the resulting sulfates and sulfites can be separated from the exhaust gases by means of perforated inner walls. Another application of the device is the burning of mine exhaust vapors which characteristically contain about 5% methane. Many of Syred's projects receive industrial support, and it is apparent that he maintains a nice balance between fundamental engineering enquiries (such as the investigation of the mixing and instabilities present in vortex diodes) and practical applications.

Dr. B. Brinkworth supervises eight or nine projects in solar energy and is thought of by many as "Mr. Solar Energy in the UK." (When I visited him he was busy preparing his notes for the Isaac Newton Lecture Series, sponsored by the IMechE.) Brinkworth expressed dismay at what he perceives to be an illogical balance of UK expenditures in energy research. Whereas solar energy can provide 3-4% of the nation's needs, the £1-2M spent on it is not a proportionate part of the annual energy research budget of about £600M. Funding for Brinkworth's operation comes about equally from the UK Science Research Council, industry (including the EEC--Brinkworth sees this as a rare instance of the UK getting some of its own money back from investment in the Common Market), and miscellaneous other sources.

A large part of the effort of the solar energy program is related to the gathering of useful data which, according to Brinkworth, are especially scarce in the UK. He feels that solar energy systems will become competitive only if a considerable amount of optimization goes into their initial design. To do this, extensive and accurate spectral information is needed on both the solar input and the user's demand. Large day-to-day changes in solar radiation, as well as long-term variations, can have a marked influence on optimal design. Interestingly enough, user demand can be even more difficult to quantify; a recent survey of student hot-water utilization indicated that women, on the average, use 2 1/2-times as much as men. Information on thermal materials is also badly needed and in quest of all of these data Brinkworth's group is vigorously pursuing other UK sources and, where needed, developing and installing sophisticated new equipment.

One such new device is an insolation simulator that is designed to serve as a standard testing rig for solar panels. The simulator provides spectral and geometric conditions that are adjustable to suit particular test requirements. A driving force for this project is the "worrying thing" that in the UK there are about 30 small backstreet firms--their number is rapidly increasing--with little technical proficiency, and even less integrity, that are actively foisting solar devices on an innocent and receptive public.

For this reason alone, standards are urgently needed for solar energy components and systems.

The Department is well endowed with modern computation and instrumentation equipment. A particularly intriguing use of the computer was demonstrated by Dr. R.W. Snidle whose experiments are designed to measure three-dimensional surface roughness contours to a spatial resolution of 2 μm. The measurements are controlled by the computer which also processes and stores the data. The goal of the project is to be able to predict failure of contact surfaces based upon their roughness characteristics. Another useful application of computerized data acquisition was demonstrated by Mr. C. Bates who has developed a laser-Doppler velocimeter system in which photomultiplier outputs are fed directly to a minicomputer. A sampling rate of about 1000 s^{-1} is attainable with direct output of flow velocities and turbulence components. Bates' instrumentation system is currently dedicated to a water-flow system that permits measurements at pipe Reynolds numbers of up to 6.5×10^5. The large size of the facility (the maximum test-section diameter is about 25 cm) makes it unusual in Europe and has attracted interest from well beyond the confines of Cardiff. For example, Dr. F. Durst, from the University of Karlsruhe, is planning to visit in order to take advantage of the facility.

It is appropriate, in summary, to mention the high morale of the M.E. faculty at Cardiff. Each individual whom I visited was highly enthusiastic about the creativity of his work and its impact upon the educational and industrial world. Listening to Markland, it is not difficult to see why. With a vigorous but graceful style, he clearly intends to lead his Department to a position of prominence in engineering academia. (R.H. Nunn)

ONRL REPORTS

See the back of this issue for a list of current abstracts, and how to obtain the reports.

TILTING AT WINDMILLS IN CAMBRIDGE

The world is too much with us, late and soon,
Getting and spending, we lay waste our powers:
Little we see in nature that is ours;
We have given our hearts away, a sordid boon!

The sea that bares her bosom to the moon;
The winds that will be howling at all hours,
And are up-gathered now like sleeping flowers;
For this, for everything, we are out of tune.

Wordsworth, in this passage from *Miscellaneous Sonnets*, seems to indicate an awareness of Man's wasteful indifference to his environment; perhaps if there had been more poetry in the last 100 years or so of engineering practice, it would not have taken us until now to become seriously interested in harvesting the abundant renewable energy that surrounds us. As far as the "winds that will be howling at all hours" are concerned, there is now considerable interest and progress, and the International Symposium on Wind Energy Systems, held at Cambridge (Wordsworth's alma mater) on 7-9 September, indicated that many nations are now involved in the development of such systems on massive scales.

The Symposium was organized by the British Hydromechanics Research Association (BHRA--see ESN 30-3:112) whose reputation as real pros in organizing conferences remains intact. There were some 160 registrants from 21 countries and the attendance appeared to be complete. Pre-distribution of the 27 papers was just one of the BHRA procedures that contributed to the atmosphere of friendly efficiency. The sessions were planned so that ample time was available for discussion--almost as much as for the presentations--and the exchanges between the delegates were interesting and enthusiastic.

The sessions were nicely balanced among systems, theory, and experiment, and were arranged under the headings of Wind Sites and Forecasting, Horizontal and Crossflow Turbines, High Speed Vertical Axis Turbines, Economics, Augmentors, and Storage. I shall describe only a few of the many highlights. More detailed coverage will be provided in an ONRL Conference Report and the Proceedings will be available from BHRA (Cranfield, Bedford MK43 OAJ).

Even without the hot vapors associated with bombast, there is plenty

of wind around (the winds across the Great Plains are easily sufficient to provide the entire US electrical demand). But like most energy stemming from solar sources the wind is unevenly distributed in space and time so that, before worrying about converting it to useful work, it must be found. O. Ljungstrom (National Swedish Board for Energy Source Development) described the current status of Sweden's program that was begun in 1975. A large part is devoted to "wind energy prospecting" in order to establish an inventory of Sweden's wind energy resources and their characteristics such as climatology, best production areas, and wind spatial and temporal profiles. Siting studies include the consideration of optimal grouping of wind turbines, and current Swedish thinking is in terms of station outputs on the order of 100 MW produced by arrays of individual units numbering from 20 to 100. The mutual interference resulting from wind turbines within such arrays is a matter of current research interest and adds a further variable to the already complex modeling situation. Few aspects, if any, are left out of the analysis, which now indicates the feasibility of installing a capacity of up to 30 TW hr/yr that would provide about 20% of the projected electrical energy demand for 1990 and use about 1% of Sweden's land area. Ljungstrom's talk was the first of the Symposium, and his concern for a better understanding of the cost effectiveness of wind energy systems (WESs) served as a keynote for the meeting.

Other geographical areas considered in the session on wind sites and forecasting included New England (C.G. Justus, Georgia Tech), and Singapore (G.K. Nathan, *et al.* U. Singapore), and papers in later sessions alluded to these factors in connection with WESs for West Germany, Denmark, Holland, the UK, and Tanzania (for water pumping).

Wind generators are currently classified as wind-axis (propellor-like) machines, or crosswind-axis machines such as the Darrieus rotor, which looks like an egg-beater, and the S-shaped Savonius rotor. The Symposium dealt with theory, experiment, and practice related to both types of generator, although the crosswind-axis types, which are less common in current applications, received the most attention. The Savonius rotor is seen to be most appropriate as a booster or starting aid. Some advantages of the Darrieus rotor over wind-axis generators include an omnidirectional capability (no yaw control required), the use of fixed-pitch blades that can be fabricated as single extrusions, and the mounting of equipment at the base (with a favorable center of gravity location and ease of maintenance). A serious drawback, however, is the use of relatively long and vibration-prone blades for equivalent swept areas. Theories are less well founded for the Darrieus device, but there is much yet to be understood about the behavior of both types and they also share other problems such as starting difficulties and unknown environmental and economic factors. The crosswind-axis generators are likely to find application in relatively low power situations such as that described by R.J. Templin and P. South (NCR, Canada), in which a 200-kW Darrieus rotor with a swept area of 595 m^2 is to be put into operation on the Magdalen Islands in the Gulf of St. Lawrence. Larger wind-axis generators are planned or are in operation at several sites in North America and Europe and have specific power outputs on the order of 100 to 500 W/m^2 and diameters of 50 to 100 m (corresponding to swept areas of up to about 10,000 m^2). Theoretical models for both systems were proposed at the Symposium. Crosswind generators were treated by P.B.S. Lissaman (AeroVironment Inc., US), J.M. Strickland (Texas Tech. U), and O. Holme (Saab-Scania, Sweden). Wind-axis turbines were the subject of a theoretical paper by R.E. Wilson and S.N. Walker (Oregon State U.) and both types were considered by T.E. Base and L.J. Russell (U. Western Ontario) who have developed practical if preliminary performance modeling techniques.

One of the intriguing things about wind power and other "alternative" energy schemes is that the field has an inventive flavor that has survived the dormant periods when national priorities were not energy-oriented. Several departures from "standard" designs were described at the Symposium and they all had the usual characteristic of promising (on paper!) significant improvements. R.E. Powe (Miss. State U.) described his system in which vertical airfoils are mounted on an oval track that rotates in a plane parallel to the ground. As an example, his calculations show that the monthly energy output per unit

of swept area for his system may be as much as 54% greater than that for an efficient windmill operating in the same location. The Variable Geometry Vertical Axis Windmill (VGVAW), described by P.J. Musgrove (Reading U., UK) uses two straight blades which are hinged to a horizontal cross-arm, below their centers, and connected to each other near their upper tips by a spring-loaded cable. The blades are vertical when stationary, but as rotational speed increases they tend to tilt outward at the top with the adjustable tension in the spring-load cable balancing the centrifugal forces. The device, which is similar in principle to the Darrieus rotor, is extremely simple in construction, can be mounted on a shorter tower, and is self-compensating to avoid large excursions in power output caused by variable wind speeds. Offhand, I could not see any area in which the VGVAW would not be equal to or superior in performance to the Darrieus design.

Several of the proposed design improvements were aimed at concentrating wind energy in the vicinity of the rotor so that more efficient use is made of the available swept area. P.M. Sforza described the ERDA-sponsored project at Polytechnic Institute of New York in which vortex flows are induced upwind of wind-axis rotors to produce low pressure and high kinetic energies at the inlet. He uses the simple expedient of generating tip vortices by means of a delta-wing, with sharp leading edges, mounted in an appropriate region upstream of the rotor. In wind tunnel tests the augmented rotor has exhibited power outputs on the order of five times greater than those of the basic device and the range of wind speeds over which useful power is obtained is greatly increased by the swirling flow. An improvement factor of three was obtained by J.C. Loth in experiments with a similar device at W. Virginia U. Loth also described concepts in which the acceleration of flow past obstructions is used to good advantage in the design of crosswind-axis generators. A less conventional scheme was proposed by Th. van Hollen (Delft U. of Technology, The Netherlands) who obtains a Venturi effect in the upstream flow by means of small airfoil sections mounted on the rotor blade tips. His theory, which predicts power augumentation levels similar to those cited above, has been partially confirmed by experiment.

In the session devoted to economics, the two papers illustrated the complexity of such matters. A.A. Fritzsche (Dornier-System GMBH, FRG) limited his remarks to well-known factors influencing manufacturing costs: labor, quantity, new materials, etc.. His main conclusion was that for limited power ranges (up to about 10 kW) Darrieus rotors can be built as cheaply as wind-axis machines. B. Sørensen (U. of Copenhagen) attempted a more comprehensive analysis, including energy-storage and distribution costs as well as comparisons with nuclear and fossil fuel plants, but the credibility of his verdict in favor of WESs was somewhat jeoparidized by the fact that he was still changing his cost factors even during his presentation. The session on storage provided increased insight into the complexity of the economics surrounding WESs, especially the paper titled "Balancing Power Supply from Wind Energy Converting Systems," by J.P. Molly (DFVLR, West Germany).

It was clear from the presentations that there is a variety of ways in which windmills can extract useful energy from the wind--some quite effectively--and that this process is likely to be greatly improved with technological advances. It was equally clear from the discussions, however, that economic and social factors will dictate the future of these systems. The merits of alternative energy sources cannot be adequately assessed until there is a better understanding (and appreciation!) of the value of energy whatever its source. The issues of wind-generator siting and integration and switching into existing electricity grids are likewise difficult to resolve, although there are indications that these problems can be tackled. What about environmental factors? Will the noise be acceptable? Will people tolerate windmills now as they used to tolerate oil derricks? These issues were discussed with great enthusiasm, and at least one thing is clear: windmills won't get anywhere if engineers allow themselves to become fascinated by technological problems while neglecting the realities of the marketplace.

Solar energy utilization, with its benign effect on the earth and its atmosphere, is the closest thing to a panacea that has recently, perhaps ever, been made available to the engineering community. And yet the advances come slowly. Wind power has certainly been shown to be "in the ball park" with respect to cost, and many at the Symposium were somewhat impatient with continued bureaucratic preoccupation with costs. As one devotee put it, it will probably take 50 years, starting now, to reach the condition in which 1% of our total consumed energy is renewable. By that time we may be burning our money to keep warm. Delegates to the International Symposium on Wind Energy Systems dream of the battlefield of Don Quixote, where "those things over there are not giants but windmills." (R.H. Nunn)

ASSAULT ON BATTERIES: TENTH INTERNATIONAL POWER SOURCES SYMPOSIUM

Environmental pollution and the prospect of dwindling supplies of low cost fuels have intensified interest in electrical storage systems. In power distribution networks, more efficient means for storing electrical energy will permit the satisfaction of peak demands without investment in larger generating plants. Also, with such storage capability, plants can be operated continuously at peak efficiency without wasteful low-load periods.

Electrically powered vehicles will undoubtedly play an increasing role in transportation as alternative energy sources are developed and as pollution controls become more stringent. For these vehicles, higher energy batteries are vital if range and payload are to be at all comparable with the hydrocarbon-powered vehicles of today.

This was the established background for the 10th International Power Sources Symposium which was held at Brighton, England on 13-16 September 1976 and was devoted entirely to batteries (and fuel cells).

Some unplanned further background was encountered: the announcement appeared in the daily newspapers and was read to the conference that President Ford had vetoed the $90 M bill for development of the electric vehicle, citing the belief that battery development was not yet sufficiently advanced to warrant this expenditure now. In the words of the session chairman who read this announcement: "Gentlemen, we have our work cut out for us!"

The Symposium began with a session on the familiar Pb - H_2SO_4 storage battery. Two papers dealt with the potential distribution in the current-collecting grids and presented means for optimizing conductor dimensions to minimize resistance losses. M.G. Jayne (Gwent College, Wales) has studied battery efficiency under pulsed loading typical of chopper-controlled vehicles. Surprisingly, he found that the efficiency is at least as high as would be expected for steady load at the average current flow, a result attributed to an as-yet unexplored recovery phenomenon which occurs between pulses. The session was concluded with a paper by N.E. Bagshaw *et al.* (Chloride Industrial Batteries, Manchester) which described their latest aircraft batteries whose energy density is 22 Wh/kg, about twice the capacity attainable a decade ago.

The Edison Ni-Fe battery, which has greater mechanical strength and higher theoretical output than the Pb-acid battery, has been refined and applied to electrical vehicles by Westinghouse Corp. In a very thorough program, the battery has been developed and tested in 3 road vehicles for a total of more than 15,000 miles. Energy density for the new battery is approximately 50 Wh/kg, twice that of the Pb-acid battery.

Several papers in the Symposium explored the basic chemistry and optimum design of the Leclanché cell, the familiar primary Zn-MnO_2 "dry cell." Ion transport within the electrolyte, which largely controls the performance of the Leclanché cell, was discussed by S. Altung *et al.* (Fysisk-Kemisk Institut, Denmark). A.M. Bredland *et al.* (ESB, Wisconsin) described a thin, flat battery especially designed for high power density. This work in improving older types of cell by applying the latest technology is surely an essential first step in the systematic development of more efficient sources. It is worth noting that the highly refined older cells have energy density efficiencies of about 20%.

Progress in Secondary Cells--From the older systems, the Symposium

moved into more recent developments such as Ni-Cd batteries, with papers on improved plate design, better manufacturing techniques, and the use of plastic for structural parts. M. Cenek (Brno Technical U., Czechoslovakia) described a process in which electrodes are formed from powdered active materials bonded together by an alkali-resistant plastic. The familiar problem of damage from over-charging was investigated by R. Bernard *et al.* (Eveready Co., London) and attributed to the formation of Ni_5Cd_{21}, with electrochemical potential reduced by 100 mV.

Two papers described work with sealed, secondary Ni-H_2 batteries. The chief merits over Ni-Cd batteries are resistance to damage from overcharge and very long life. High self-discharge rate is the principal shortcoming. F. Betz *et al.* (NRL) estimated a 10-year life for their cell in satellite applications, with major failure due to separator dry-out. K.V. Kordesch (Union Carbide, Cleveland) has developed a small (D-size) secondary cell with energy density 40 Wh/kg, excellent cycle life, high current charge and discharge, and safe overcharge capability.

The formidable problem of irregular deposition of zinc during charging of secondary batteries has been successfully attacked by O. von Krusenstierna (AGA Innovation Centre, Täby, Sweden) in a purely mechanical manner. He vibrates the Zn electrode in a Zn-Ni battery through ±2.5 mm at 20 Hz. The technique avoids the beautiful Zn dendrites von Krusenstierna displayed and smoothes the deposition of Zn to such a degree that the 1000-cycle life of the battery is set by the Ni electrode. Tested in an electric road vehicle, the battery was found to be superior in power density to the Pb-acid type. Energy density is also higher--50 Wh/kg. The battery may have no advantage over the Westinghouse Ni-Fe battery, however, since the additional cost is considerable. Furthermore, S. Tajima *et al.* (Tokyo Metropolitan U.) followed von Krusenstierna with a paper which extolled the virtues of fixed electrodes in a cell using synthetic sponges which held all of the electrolyte, acted as a separator and filled all available space. This structure prevented the fragments of Zn deposits from falling off, causing short-circuiting and cell failure.

Any battery which uses oxygen as one element of the couple has the obvious advantage that the ambient atmosphere can provide an inexhaustible supply of one of the reactants. J.W. Cretzmeyer *et al.* (Gould, Minnesota) reported the development of a primary Zn-air "button" cell (hearing aids) with twice the capacity of Zn-Hg and Zn-Ag cells. The cells are leakproof, vented, protected against overcharge and ecologically acceptable. L. Langrish (Chloride Technical, Swindon, England) described a lightweight primary Zn-air battery to replace Ni-Cd batteries in man-portable communications gear which operates well down to -20°C but poorly above 55°C (desert condition) and has a 10-year shelf life.

An ambitious attempt to use the high-energy couple provided by Al and O_2 was described by A.R. Despic *et al.* (U. Belgrade). Since Al cannot be recovered from aqueous solutions of its salts, the battery is an "exchangeable plate"-type of secondary--essentially a primary battery in which replacement of the aluminum electrode constitutes recharge. The electrolyte is NaCl, and one unsolved problem is the growth in volume as $Al(OH)_3$ is formed during discharge. An energy density of 80 Wh/kg Al has been achieved, and 200 Wh/kg is considered possible. The theoretical energy density is about 8000 Wh/kgAl--far in excess of that of cells which must carry both reactive components.

An increase in the longevity of the air electrode has been achieved by A.J. Appleby *et al.* (Laboratoires de Marcoussis, France). They have found that electrodes press-formed from a mixture of Teflon and graphite withstand over 1000 charge-discharge cycles. In conjunction with techniques being developed to control Zn deposition (several are referenced), they believe that their electrode now permits the construction of a Zn-air secondary battery.

There was only one fuel cell described in the Symposium, a H_2 - O_2 unit developed by H. Grüne *et al.* (Siemens Co., Erlangen, Germany). Fuel cells--in reality batteries where both reactants are supplied continuously from external sources--have been extensively developed in the recent past but have failed to find a market because of cost. The Siemens unit produces 6700 W, or 95W/kg (0.06 hp/lb), has a life of 1000 hours,

and is modular in construction. Efficiency of conversion of chemical to electrical energy is 45%, about twice the efficiency of an internal combustion engine in converting chemical to mechanical energy.

Air batteries and fuel cells possess the theoretical energy density to compete effectively with hydrocarbon fuels. However, the results reported by the Belgrade group (80 Wh/kg obtained in practice vs 8000 Wh/kg theoretical) illustrate the distance yet to go in metal-air secondary cells They expect to attain 200 Wh/kg with a major effort, and set 600 Wh/kg as an outer practical goal.

Calculation of energy density for a fuel cell requires selection of a certain mass of fuel to add to the weight of the cell itself. If a 5-hour supply of H_2 and O_2 is assumed, the energy density for the Siemens unit is found to be 400 Wh/kg. This encouraging figure is, however, rather academic in that the bulk of the reactants and the weight of the vessels required to contain them have not been considered. A 5-hour supply of H_2 would occupy 1.0 m^3 at 600 psi and might require a vessel mass of 175 kg (aluminum stressed to 30,000 psi assumed). The corresponding supply of O_2 would occupy 0.5 m^3 at the same pressure and might require a vessel mass of 88 kg. These factors reduce the energy density to 95 Wh/kg.

The theoretical energy density for a H_2-air fuel cell is 16,000 Wh/kg. If the 20% efficiency of energy density now realized in older types of cell could somehow be achieved in fuel cells, 3000 Wh/kg would be obtained. The quest for higher-energy batteries and the attendant need to incorporate the more active metals have led to a class of batteries with one or more molten components. Among the potential benefits are (1) possible ability to electrodeposit the metal from a molten salt electrolyte--hence a reversible cell; (2) elimination of shape-distortion problems by use of liquid electrodes; and (3) high mobility of ions in the molten state, i.e., lower internal resistance.

G.C. Bowser (Catalyst Research Corp., Baltimore) reported the development of a primary thermal battery with a pure (molten) lithium electrode. This battery is intended for reserve usage. A pyrotechnic heat pellet provides the operating temperature of 500°C. In comparison with older batteries, which depend upon the *in situ* formation of a Li-Ca alloy to serve as one electrode, the higher Coulombic efficiency of the new cell increases the energy density by 100 to 200%. A value of 150 Wh/kg was reported.

Development of a reversible Cl electrode for an Al-Cl_2 battery was described by S. Marimovitch *et al.* (Laboratoire d'Electrolyse du CNRS, Bellevue, France). The electrolyte in these cells is a molten mixture of NaCl and $AlCl_3$ at the modest temperature of 110°C. The chlorine electrode is a mixture of graphite and metallic compounds such as $MoCl_5$. Charge storage capacities as high as 90 mAh per gram of electrode have been obtained. Previous Al-Cl_2 batteries have been primary units with an external supply of Cl_2.

From the presentations by E.G. Gay *et al.* and W.J. Walsh and H. Shemotake (all at Argonne National Laboratory), it appears that development of the Li-Al/Fe-S secondary battery is advancing well. This cell, which has solid electrodes in a 450° eutectic of LiCl-KCl, is an outgrowth of earlier work with the Li-S couple. Energy density is in the range of 100-150 Wh/kg and power density is greater than 100 W/kg. Life has been extended to several thousand hours, but is limited to several hundred charge-discharge cycles. An extensive technology transfer program involving several manufacturing firms has been undertaken.

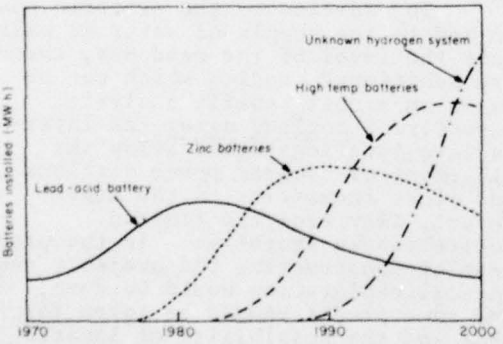
The final battery to be discussed is the Na-S type, on which 3 industrial firms made presentations. This cell operates at about 300°C. The anode is molten Na while the cathode is a graphitic current collector (such as graphite felt) which is saturated with sulfur. In operation, Na ions pass from the anode, through a ceramic (β-Al_2O_3 or β"-Al_2O_3) container, and combine with S ions at the cathode. The cell is the "inverse" of the Pb-acid cell, say, in that the electrodes in the Na-S cell are liquid and the electrolyte is solid. Energy densities as high as 200 Wh/kg have been achieved.

Experiments with the structure of the S electrode were reported by H. Klemschmager *et al.* (Brown, Boveri and Co., Heidelberg). Rechargeability is improved and internal resistance is reduced by providing passages within the graphite felt at

the anode-felt interface, as well as by adding Se and B to the S.

Reactions at the interface between the graphite and the melt have been studied by M.P.J. Brennan (Chloride Silent Power, Runcorn, England). Under certain conditions during both charge and discharge, films form at the interface and produce voltage losses. A. Gibson (same firm) also reported a study of the interface between the molten Na and the beta alumina solid electrolyte. It was established that the Na does not wet the alumina below 300°C, and a high contact resistance prevails. Above 300°C, wetting occurs and contact resistance becomes negligible.

The resurgence in battery research was fully evident in the Symposium, prompting von Krusenstierna to make the forcast summarized in his figure below concerning the amount of usage of different advanced high-energy battery systems in electric vehicles during the years 1970-2000. The observer of this plot is cautioned not to be concerned by the lack of an ordinate scale. As von Krusenstierna pointed out, the beauty of this plot is that the uncertainties in his actual predictions allow one to use a linear scale or logarithmic scale (or others, as well) with impunity.



Forecast of the use of different advanced high energy battery systems in electric vehicles during the years 1970-2000.

(W.G. Soper and A. Sosin)

ENVIRONMENTAL SCIENCES

ISRAEL ENERGY OPTIONS

Energy policy planning in Israel is dominated by two countervailing currents, one a concern for national security, the other a concern for the economic situation which is rather tight. Oil matters generally are under the direction of Dr. Zevi Dinstein who is a senior official in the Treasury. His activities will soon be transferred to the Ministry of Commerce and Industry where is now located all concern with electric energy and energy research. Once this consolidation is complete, it will be possible to produce a more coherent energy policy than now exists.

As a result of the Sinai agreement negotiated by Kissinger, Israel relinquished to Egypt the oil field of Abu Rodeis which had the potential of supplying about two-thirds of Israel's oil needs for perhaps another 10 years. With the loss of this important resource, Israel is spending a good deal of effort in oil exploration in the southern Gulf of Suez, as well as onshore and offshore in the Mediterranean. Presumably, oil discovered in the southern Suez would be an item to be negotiated in any eventual peace settlement between Israel and Egypt. Another consequence of the Sinai disengagement was a US commitment to Israel to aid in the setting up of a strategic stockpile of oil. Work is therefore proceeding to develop a low-cost method of stockpiling. Unfortunately Israel does not have the kind of salt-dome geology which is so prominent in the Gulf region of Texas and Louisiana and allows relatively cheap underground storage.

A major effort is underway to substitute coal for oil. Israel, which has an installed electric generation capacity of 1800 MW, is now planning to build 4 power stations in Hadera (between Tel Aviv and Haifa) of 350 MW each, burning either oil or coal. Unfortunately this not only raises the cost but also environmental and other problems in relation to coal burning and transportation. One of the primary issues is whether to unload the coal in Haifa and ship

it by rail, or to invest in coal unloading and handling facilities in Hadera.

The Israeli government has finally approved the nuclear cooperation agreements made between its negotiators and US officials nearly two years ago. The agreement calls for the purchase by Israel of two 450-MW(e) units and is expected to cost about $800 million. The reactors would be constructed and become operational by 1985. It has not yet been decided when the agreement will be officially signed as it must still be approved by the US Congress.

Israel has no appreciable hydrocarbon resources. The only established ones are peat in the Hula region and oil shale near the Dead Sea. An effort is underway to determine the economic feasibility of using these native resources.

Israel is, of course, a pioneer in the use of solar energy. On my first visit to that country twenty-five years ago as an ONRL liaison scientist, I was struck by the fact that every building had a solar water-heater. In the meantime, the low cost of oil has displaced solar water-heating, but it is now making a comeback. More efficient and advanced systems have been developed, some by the original inventor, Dr. Harry Tabor. In addition to carefully monitoring research in other countries, Israel is investing some of its limited resources in solar energy research. It should be noted that the Dead Sea Chemical Company is probably the world's largest industrial user of solar energy, by extracting minerals of the Dead Sea in solar evaporation ponds.

Probably the most exciting of the energy options now being discussed is the revived study of the Mediterranean-Dead Sea conduit. Such a project was first suggested by the early pioneers and studied quite seriously by Walter Lowdermilk about 40 years ago. He was an agricultural hydrologist at the University of California at Berkeley. At that time, he visualized the production of hydroelectric power and the provision of water to be desalted and used in agriculture. Hydroelectric power would be generated by the great drop between the sea level and the Dead Sea which is at -400 meters.

A special committee under the chairmanship of Professor Shlomo Eckstein, an economist of Bar-Ilan University, has restudied the project--or rather several versions of it--and has recommended that a full-scale feasibility study be done. (See also A. Barcilon's article "From Solar Ponds to Solar Lakes," ESN 30-3:107.) As now visualized, it would be a project carrying 10^9 m^3/y from the Mediterranean through open channels and tunnels to the Dead Sea region where it could produce 300 MW of electric power. This power would be used for peaking purposes, and therefore would command a higher price than base-load power. An additional reason for urgency is the fact that the diversion of water from the Jordan and Lake Kinneret to supply fresh water for Israel agriculture and cities through the National Water Carrier (NWC) has reduced the inflow of water to the Dead Sea so that its level has been dropping. It has been estimated that in another ten years it will have dropped sufficiently to jeopardize the Dead Sea potash operation, one of the largest resource industries in Israel. The water transferred from the ocean to the Dead Sea would be 3 times the amount carried by the NWC, about 3.2×10^8 m^3. The excess water would be removed by evaporation from the Dead Sea. The project would carry the water mainly in a conduit, but would tunnel through the mountains near the Dead Sea. The tunnel would be of the order of 5 m in diameter and 75 km long under one version of the scheme.

In addition to the electric power and to the supply of water to maintain the level of the Dead Sea, there are additional credits which can be taken in a cost-benefit analysis. A supply of cooling water for intermediate locations would allow the placement of nuclear power stations and other industries in the Negev desert, away from the limited Mediterranean shoreline. In the process of constructing the project, geological exploration would be done, and some credit should be taken for that and the possibility of locating ore bodies or other resources. The recreational and tourism benefits should be considerable, bringing bathing beaches and boat trips into the inhospitable desert. Even aquaculture may become economic. Desalination for certain specialized agriculture should provide a livelihood in addition to industry. Altogether then, there would be the possibility of settling and supporting a considerable population in the southern part of Israel which is now very sparsely

inhabited. The defense and security aspects of such a project need also to be considered fully.

The major unknowns are environmental, and some of them are quite subtle. One needs to be concerned, of course, about the possibility of modifying the climate, at least on a microscale. In the arid desert this may actually represent a plus. But one also needs to consider the possibility that a general climatic change can vary the level of the Dead Sea, thereby making the project obsolete. Natural changes in the level of the Dead Sea have been of the order of 10 m over rather short periods of time, although there has been a trend towards a lower level during historic times primarily because of the poor agricultural practices which came into being after the Second Temple was destroyed.

Archaeological and geological evidence has given a rather complete picture of the variations in the level of the Dead Sea. One of the fascinating aspects is its hydrology. The southern basin, which is superficially connected to the northern basin, is very shallow, of the order of a few meters, while the northern basin is quite deep, of the order of several hundred meters. (The northern basin, incidentally, was first surveyed by a US Navy scientific expedition in 1848, and these data still form the backbone of all hydrological studies of the Dead Sea.) Evaporation dominates the southern basin; any rise in its level would lead to a large increase in area and therefore an immediate rise in evaporation, so that a considerable amount of self-regulation exists.

It is expected that within about two years enough detailed studies will have been carried out to allow a firm decision on the general project, also on which route to choose, as well as on other features designed to optimize the overall economic performance and minimize any adverse environmental impact. (S.F. Singer, Dept. Env. Sciences, U. Virginia, Charlottesville)

SOUND PROPAGATION IN THE ATMOSPHERE

Dr. Michael E. Delany of the National Physical Laboratory, Teddington, UK has recently completed an exhaustive review of the development of knowledge of sound propagation in the atmosphere. Treating each of a series of six topics--sound velocity; attenuation; refraction; fog and precipitation; scattering and fluctuation; ground-reflection and the effects of vegetation--he traces knowledge of that topic from the earliest observations to the present, pursuing the theoretical and experimental work in parallel, and reviewing the inherent problems associated with each. The depth of coverage of the subject and the extent of the source references will undoubtedly make this review one of prime importance to anyone concerned in more than a cursory way with atmospheric propagation of sound. Among other contributions it identifies important gaps in our knowledge of propagation in the atmosphere: for example, of attenuation in refraction shadow zones.

The importance of clarification and explanation of apparent discrepancies and differing views to the development and understanding of a scientific area is evident. Examples in the present instance include the inconsistency between observed sound speed and Newton's derivation; the diametrically opposite views of Tyndall and Henry as to the importance of refraction; Lindsay's explanation of Boyle's bell-in-a-vacuum experiment as an impedance phenomenon; and the successive identification of the various contributors to atmospheric attenuation which now permit prediction of attenuation over a wide frequency range.

To one more familiar with the underwater acoustic area, the similarity of the type of problem in development of understanding in the two media is most noticeable, as is the number of 'firsts' associated with atmospheric propagation: e.g., Milne's development of ray-tracing techniques.

Given in part as the John Tyndall Lecture to the British Institute of Acoustics in September, Delany's review is expected to appear first as a National Physical Laboratory Report. (A.W. Pryce)

CONFERENCES ON NUMERICAL MODELING IN THE ATMOSPHERE AND OCEANS

Two conferences dealing with various aspects of modeling of atmospheric and oceanic flows were held, one in Hamburg and the other in Paris. The one at Hamburg University was sponsored by the Deutsche Meteorologische Gesellschaft e.V. and the American Meteorological Society and dealt with "Simulation of Large Scale Atmospheric Processes." Although a number of participants and scheduled speakers could not attend this meeting, it still numbered about 140 scientists; the majority of the speakers and audience were from the Federal Republic of Germany (74 papers), and the US was well represented with some 30 papers.

This meeting celebrated the 20th year since the First International Numerical Weather Forecasting Conference was held in Frankfurt. In his opening remarks, Dr. J. Smagorinsky (Director of the Geophysical Fluid Dynamics Laboratory, NOAA, Princeton) reviewed progress made in these last 20 years and the problems that still remain to be solved. Some of his remarks are embodied in this article, but the interested reader should be able, in the near future, to read this address in an expanded article to appear in "the GARP topics" of the American Meteorological Society Bulletin. All of the presentations dealt with various aspects of numerical modeling of atmospheric flows, and the reaction to these papers was mixed. Some scientists were pleased to find that so much was going on in their field in Europe and Germany in particular, while others felt that this Conference was not the place for graduate students to air their difficulties. I will try to summarize the essence of the meeting and the areas of importance rather than dwell, in detail, on each speaker's presentation. For more details of some of the papers, the reader is referred to the volume of extended abstracts (4 pages per abstract) that has been published (Prof. G. Fisher, U. Hamburg).

Data initialization and assimilation (ESN 30:5, 233) appears as an important problem to deal with in the years to come and arises from the input of meteorological data in a numerical model in an asynoptic fashion, i.e., data are updated on a limited area covered by the numerical model. Such is the case when satellite data, obtained in a swath of the globe, are used to update numerical weather forecasting models. There are still problems in this field, for one wants to discriminate unwanted modes which induce "initialization shocks" in the numerical models. Up to the present, filtering of unwanted modes was done on the basis of their frequency. It seems that such discrimination might be more successful if done on the basis of how these modes "look," i.e., their spatial structure, rather than on their frequency.

Limited-area models were very popular at this Conference, because each country strives to develop its own for detailed meteorological forecasts over the limited area covered by that country. These models are coupled to coarse, large-scale global models. The problem consists of using the coarse model to provide boundary conditions on the perimeter of the limited-area model. There are several difficulties: spurious oscillations are excited by the boundary conditions; because these limited area models are "open," i.e., atmospheric flows are allowed to move in and out of their boundaries, the presence of gravity waves with their tendency to propagate along characteristic lines complicate the specification of appropriate boundary conditions.

Some papers posed fundamental questions regarding the propagation, reflection or trapping of energy propagating upwards from the lower layers of the atmosphere. In that connection, the dynamics of the stratosphere ought to play a decisive role in determining whether vertically propagating energy is reflected, absorbed or transmitted. Therefore the dynamics of this atmospheric layer also will be an area of active research in years to come.

The question of predictability will certainly occupy us for some time. In Europe and in the US, groups are working on means of extending numerical forecasts from 5 to 10 days. Loss of usable forecasting capabilities appears to occur in present-day models after some three days, although there still appear to be some forecasting skills at levels of 200-400 mbars. Persistent features linked to sea-surface temperatures might be an area to explore in order to obtain models capable of providing monthly forecasts. Vacillations of

atmospheric variables on time-scales of several weeks might also provide us with clues to be used in long-range weather predictions.

Finally, there appears to be some concerted effort to produce more accurate short-range weather forecasts (24-48 hours). With the physics presently found in these models great improvement in forecast could be achieved by reducing the grid size by a factor of 4. This will open a new area of research whose output could be readily used in a number of human activities which depend on accurate weather forecasts.

The other conference, the Euromech 78 Colloquium, was held in the buildings of the prestigious "Ecole Normale Supérieure," in the Latin Quarter of Paris. It grouped about 40 attendees and some 20 speakers. The talks, given in English, lasted for some 45 minutes. The main theme of this Conference was turbulent flows in the atmospheric and oceanic boundary layers, but not all the presentations dealt exclusively with numerical modeling.

Several experimental results were described pertaining to idealized situations which were modeled in the laboratory under conditions presumably found in the ocean. They dealt mainly with stratified turbulent flows in which measurements were made to study how the turbulence decayed. Along similar lines, field measurements in the atmospheric turbulent boundary layer were applied to conventional theories yielding results that are well established in the classical literature. A 3-dimensional numerical model of the dynamics of the planetary boundary layer was presented. It dealt with a volume of approximately 5 km x 5 km x 2 km. The amount of computer time for such a model is still such that the running time on CDC 6600 is about 10 times the simulation time. Data used in that model were obtained from meteorological data gathered near Puerto Rico. Hopes are that such models can be useful tools in understanding the parameterization of the boundary layer and its various fluxes in larger scale atmospheric flows. Several closure schemes for turbulent flows were presented based on the justification that they seem to work for a given situation but no novel mechanistic theory was presented.

Theoretical models were also discussed. Langmuir circulations, found in the form of rolls aligned with the wind in the upper ocean layers, were considered and their equations were found to be similar to that of Bénard convection. Finally, in a clear presentation, A. Coantic (Institut de Mécanique Statistique de la Turbulence, Marseille) argued that radiation is a mechanism that ought to be included in the models if one wants a better description of these atmospheric and oceanic boundary layers. (A. Barcilon)

GENERAL

ISL--SCIENCE SPANS A GAP

L'Institut Franco-Allemand de Recherchee de Saint-Louis, informally known as ISL, was established in 1958 by joint convention of the German and French governments. This integration of the efforts of two countries is an enduring example of the professional fusion that is stimulated when individuals interact on scientific and technological levels. The cooperative operation at ISL is all the more remarkable in the light of its mission--scientific studies and fundamental methods related to armament. The ISL receives guidance from the French and German Defense Ministries and there is a Directeur, Ing. Gen. A. Auriol, as well as a Direktor, Dr. R. Schall. Since Auriol was in Paris at the birthday party for the Office National d'Etudes et de Recherches Aérospatiales (ONERA) (ESN 30-7:279), my welcome to ISL was extended by his German counterpart, who described the general philosophy of ISL operation and reviewed its short but intriguing history.

At the end of armed conflict in Europe in 1945, about 40 German scientists were sequestered in Saint-Louis to pursue their research interests under a new management. As is well known, the laying-down of arms proceeded a good deal more rapidly than the cessation of socio-political hostilities in Europe, but as peace broke out in its gradual fashion the existence of a German scientific enclave in France made less and less sense. In order to maintain the collective expertise resident in Saint-Louis, the group was gradually augmented by French scientists until the transition was completed and the ISL was organized under its 1958 title and charter. The completeness of the national duality of ISL is underlined by its

location about 2 km west of that point in the Rhein River where the borders of France, Germany, and Switzerland intersect.

The central theme at ISL, in a word, is ballistics. This can be further categorized as internal, external (aerodynamics), and terminal. High speed measurement technology overlies these fields and is very much the hallmark of ISL expertise. The annual budget is about 50 million francs (about $11 M) which sustains a staff of 450 persons, 90 of whom are researchers. In Saint-Louis, the lab is situated on about 75,500 m^2 near the town center (the allowable amount of explosives and propellants is therefore limited), and 30 km away there is 874,000 m^2 of test range including a 4-km high-speed sled track.

ISL was the site chosen for the recent AGARD Conference on "Applications of Non-Intrusive Instrumentation in Fluid Flow Research," 3-5 May (to be the subject of an ONRL Conference Report), a selection that highlights the optics orientation of the Laboratory. After touring the facilities I had the definite impression that behind every door could be found some sort of optical measurement system, with lasers by far the most common source. In the area of gun internal ballistics an especially ambitious attempt is underway to determine the nature and properties of the gases entrained in the wake of a projectile. Dr. F. Aulinger is working with a time-of-flight mass spectrometer mounted adjacent to the barrel of a small calibre (about 25 mm) gun. It is his goal to draw a sample of the gas following a projectile down the barrel and to analyze "instantaneously" its chemical composition. This formidable project is backed up by several more conventional experiments, under the direction of Dr. A. Zimmerman, to determine the effects of various breech parameters (such as charge-to-mass ratio and forcing-cone angle) on the pressure, temperature, and velocity history at various points along the barrel.

The ballistics range at ISL is one of the few that remain operational in Europe, and it has been the source of a series of exceptionally high-quality photographs of projectiles in flight. The launcher is a solid propellant cannon (about 150 mm) which has been used to propel a wide variety of projectiles down a tunnel that is superbly equipped for high-speed Schlieren and shadow photography as well as in-flight tracking by means of a Doppler radar system. Ballistic range experiments are especially useful for determining time-dependent effects under realistic Reynolds number conditions. For example, it has been shown that critical Reynolds numbers are heavily influenced by unsteady effects at transonic projectile velocities: boundary-layer transition has been shown to vary markedly because of accelerations near Mach 1. Shock standoff distances have also been observed to exhibit a dependency on projectile acceleration; and factors such as these are extremely difficult to identify, let alone quantify, in the flow past bodies suspended in wind tunnels.

In the area of terminal ballistics, double-exposure holography is employed in order to study the surface distortion of ceramic plates due to bullet impacts. Under the direction of F. Albe, the optical systems available in this laboratory are also used to examine structural defects such as those found in solid propellant grains.

Several of the programs underway at ISL are aimed at the analysis of flow-generated noise. Professor H. Oertel is the "proprietor" of a facility that contains a collection of shock tubes including a device that can be driven by H_2 gas at 1000 atm. The very high Reynolds numbers and temperatures attainable in these shock tubes have been useful in the study of heat-transfer and real-gas effects, but, as is common these days, shock tubes are falling into dormancy. Oertal has found a new area for their application, however, in the generation of hot high-speed free-shear layers (jets) for the study of the acoustic properties of such flows. An ingenious double-exposure differential interferometric scheme ["Jet Noise Research by Means of Shock Tubes," *Proc. Tenth Shock Tube Symp.*, Kyoto, Japan (1975)] has enabled Oertal to visualize the acoustic field surrounding these flows in spite of the disturbances attendant upon their generation. His measurements clearly show radiated Mach waves that persist with time and travel within the jet mixing layer at approximately the same speed. Oertal's work has led to a characterization of these waves in terms of the jet properties, a task that has been

greatly facilitated by the wide range of conditions (especially temperature) obtainable from the shock tube.

Laser-Doppler velocimetry (LDV) is a prominent ingredient of many of the ISL experiments and, in the field of flow noise, a program is just beginning to attempt to correlate LDV signals with acoustic measurements in the far field. The LDV technology is well developed in the Laboratory, as evidenced by the fact that they have recently delivered a "package" to an industrial test facility for the measurement of jet flows from prototype reaction propulsion systems.

In the worldwide scurry to apply lasers to more and more endeavors, ISL seems to have kept pace. Exemplifying this is the partially-completed 6-kW gas-dynamic laser system for testing the structural effects of such radiation. Massive power supplies are on hand and gaping holes have been knocked through walls to accommodate this installation. One facet that may be particularly significant is that the target area of the laser is within the test section of a wind tunnel.

Since the range of programs underway at the ISL is very broad, even from my constricted viewpoint, this report perforce has a pot pourri section. Here I must mention the extensive studies of sonic booms and their effects on inert and living systems. The ISL is continuing a comprehensive investigation that employs everything from shock-tube tests to supersonic fly-overs using human guinea pigs. And, finally, there is a lively activity at ISL to develop new sensors and instrumentation for external markets. A noteworthy example is the line of hi-g telemetry transmitters that are capable of withstanding accelerations in excess of 100,000 g. These units are compact (they can be mounted in the space required for the igniter of a 2.75-in. rocket), relatively high-powered (800-mW antenna output), inexpensive (about $200), and, of course, extremely rugged. One such device has been tested in a 30-mm gun projectile under a launch environment of 80,000 g and 4000 atm.

The level of the work at ISL seems to be commensurate with that of other government laboratories in Europe and the US. One of its special strengths is in the area of optical measurements, and new insights into flow-generated noise can be expected. The Franco-Allemand flavor of the Institute is remarkable: national identities are maintained--*vive la différence!*--but, as far as I could see, the system is such that mutual professional interests transcend any traditional socio-political barriers. (R.H. Nunn)

THE PERILS IN THE DEMONSTRATION PHASE OF RD&D: CLIPPER VS. SILENT RIDER

That only a small fraction of research and development matures to reach technological application is well known. Rejection can occur in a variety of manners and, particularly with potentially large technologies, a critical phase may be the demonstration barrier. Can anyone question the wisdom of subjecting a new technology to a preliminary step of demonstration? Perhaps not, but one can question the demonstration itself. This appears to be the lesson of a recent exercise in Britain.

The case arose with the need of the Leeds City Transport to provide bus service into a pedestrian area in the center of Leeds. Small buses were chosen as the solution, and the eventual demonstration program fixed on a maximum passenger capacity of 26 passengers--technically in a no-man's land between "mini" and "midi" buses. Laudably, it was decided to investigate an out-of-the-norm approach: electric buses as an alternative to diesel-driven buses. Other communities expressed interest and the tests were made in 14 cities in the UK. The work was conducted under the aegis of the Department of Industry (DoI); the vehicle was named the Clipper. Several parameters were monitored: daily range achieved, reliability, availability, hours of maintenance, energy consumption and cost, operator views, passenger views, attendant benefits (smoothness of ride, emissions level, quietness), bus costs, and potential market.

According to the DoI report, "the objective ...was to manufacture two vehicles for evaluation by bus operators to enable them to fully appreciate what could be achieved using *existing (sic)* battery electric road vehicle technology and to put the quoted benefits of electric buses into perspective. The intention was not to build a production prototype

nor necessarily to be able to reach precise conclusions about the characteristics of a production vehicle." Accordingly, the traction system consisted of 2960 kg of heavy-duty lead acid batteries; final figures are compared with projections for the "equivalent" 1720 kg of lightweight lead acid batteries and 260 kg of sodium/sulphur batteries.

In the parlance of academe, Clipper rated about a D to C- in these tests. The summary report gives, among others, these statements: "The buses... were able to meet the range demands of (only) 9 of the 14 routes...Battery exchange is unlikely to offer an operationally or economically attractive solution to the range problems of the small electric bus...The DoI bus demonstrated a defect rate which was high when compared with established electric road vehicles...The poor reliability had an adverse effect on availability...Energy consumption of the DoI bus was notably higher than that of a conventional vehicle....The lower energy cost of electricity is unlikely to offset fully the cost of the higher energy consumption of an electric bus similar to the DoI vehicle...The sales prospects of small electric buses having the characteristics of the DoI bus remain very uncertain."

Aye, there's the rub: "The characteristics of the DoI bus." For Clipper is not alone in its mission; the Chloride Silent Rider--operated by the firm which produced the batteries for Clipper--sends a different message. For example, Silent Rider reports that the energy cost is lower than diesel-driven vehicles. (For further details on the characteristics of Silent Rider, see V.J. Linnenbom, ESN 28-8:201.)

Fraud? Deceit? If so, by whom?

Probably no one. Clipper had a top speed of 37 km/h compared to Silent Rider's 65 km/h. At 37 km/h, Clipper was unable to keep up with the traffic over significant portions of its route, thereby forcing driving patterns that are inefficient in energy. The range of Clipper was 39 km; this is only half of Silent Rider's 80 km, and range plays a major role in the report evaluation. Silent Rider had regenerative braking for an enhancement in energy efficiency of about 15%. Clipper did not.

So what can be concluded? Possibly little except that the report will probably retard electric vehicle development. The report's caveat that the data apply only to the two DoI buses and are not capable of extrapolation to production vehicles will probably attract little attention. Nor the statement: "It can be misleading to draw firm conclusions from much of this (*sic*) data."

At the same time, it seems appropriate to compliment the DoI for open publication of its information. There is no apparent reason to suspect that the unfavorable results from Clipper were intentionally built into the test. This merely emphasizes the potential pitfalls of demonstration. A poor demonstration can create more harm than none at all; even a good demonstration of some particular technology or state of technology, may cast unjustified reflections elsewhere. Is the moral or lesson only for transport managers? (A. Sosin)

FARNBOROUGH'S THE NAME, AND SALES IS THE GAME

Every two years the village of Farnborough, about 30 miles from London, has the dubious honor of being the meeting place for thousands of industrial front men and aerospace enthusiasts from around the world. This year the planned turnout was 50,000 tradespeople and a total attendance of over 1/4-million--and they all seemed to be there on the day I chose for my visit.

Research was definitely <u>not</u> the theme at the Farnborough International Exhibition and Flight Display, but a brief description is offered here for the ESN reader who, like me, has always wondered what Farnborough is all about. And that is selling aerospace products. Under two enormous tents, hundreds of vendors were plying their trades amidst animated displays of an unbelievable variety of gadgets ranging from propeller-powered simulated falcons (to frighten birds away from airports) to complete weapons and aircraft systems. For those companies whose corporate budgets were suitably disposed, they provided "chalets" in which invited guests were wined and dined in atmospheres especially conducive to cameraderie between salesman and shopper.

Outside the tents and chalets was an extensive static display of

weapons and aircraft (the queue for Concorde was at least 1/2-mile long with people standing 3-abreast), but the real excitement for the crowd came from a flight display that lasted over three hours. One by one, without pause, all sorts of flying things leapt (some of them literally) into the air and proceeded to gyrate over the heads of the spectators. The fighter aircraft were the most spectacular (fast and noisy) and these included the multinational Tornado, the Swedish Viggen and, from the US, the F-14A Tomcat (which executed a wing transition in the midst of a low-altitude aileron roll) and the YF-17. For sheer inspiration of awe, however, it was hard to beat the vertical climb executed from a standstill by the UK Harrier. (Of course, all the aircraft were at minimum weight--I heard that most of the pilots emptied their pockets before manning their planes.)

For the public, the Show amounts to an international aerospace circus; and for the private sector it's an opportunity to display one's wares at an international marketplace. Two things especially impressed me. First of all, there was the enormous expense involved, possibly justified by the loss of prestige and visibility resulting from not attending. And then there was the enormous arsenal of weapons and weapon systems on display, like fruit at a sidewalk grocery, presumably for sale to anyone with good credit. One advertisement contains the soothing instruction: "Rest in your bed reassured that, day and night, the security of the free world is protected by air defences ready to react in seconds--at speeds almost beyond your imagination--to any threat that could disrupt your peaceful life." This is followed, in a few paragraphs, by the proud statement that the company "provides the engines that today power the aircraft of over 200 airlines and 80 armed forces [emphasis added]...." Pretty depressing from the point of view of long-range world stability, but perhaps free enterprise in the weapons business will lead to a new kind of détente--between suppliers and users. (R.H. Nunn)

COLLOQUIUM HONORING THEODORE THEODORSEN

On 1-4 September 1976, exercises were held at the University of Trondheim--the Norwegian Institute of Technology (NTH) in honor of Theodore Theodorsen, the great Norwegian-American engineer-scientist who contributed extensively to the development of Aeronautical Engineering. Theodorsen was the second recipient of an honorary doctorate in the 70-year history of the Norwegian Institute of Technology, the only other recipient being the Nobel Laureate, Lars Onsager. Theodorsen is known particularly for his classic contribution entitled "General Theory of Aerodynamic Instability and the Mechanism of Flutter" which appeared as NACA-TR 496 (1935).

The program honoring Theodorsen began on Wednesday, 1 September, with his Doctoral Promotion, followed next day by a dinner at the Archbishop's Palace next to the Cathedral in Trondheim. The Palace, construction of which began in 1170, is one of the oldest functioning structures in Western Europe, and it was in one of its large high-vaulted rooms that forty guests were seated around a single massive table for the ceremonial feast.

On 3 September, a Colloquium organized by Prof. Torstein K. Fanneløp of the Division of Aero- and Gas Dynamics was held at the NTH. The program fell into two principal areas, Aeroelastic Stability and Turbulence, and consisted of new, invited papers which will be published in a separate volume by the Norwegian Academy of Science.

In the field of Aeroelastic Stability, there were three papers that compared experimental data with theory for single airfoils, cascades, and bridge decks. It was found that for unseparated flows, the experiments bore out the original Theodorsen theory very well in the case of thin airfoils and furthermore, for the case of thick airfoils, the agreement with an appropriately modified theory was also very good. For the case of bluff bodies including bridge decks with solid side structural members, the experimental data did not agree very well at all with the Theodorsen theory because the flow separated from the bodies and produced a periodic disturbance in the wake like a Kármán vortex trail. These were by Prof. Hans W. Försching

(DFVLR), and Dr. Jan M. Overli, Prof. Arne Selberg and Mr. Erik Hjorth Hansen, all NTH. In a related paper Prof. Krishnamurty Karamcheti (Stanford U.) discussed the effect of flow separation on oscillating aerodynamic loads.

In the field of Turbulence, there were three papers that discussed turbulence phenomena in boundary layers, jets, wakes, and stratified flow fields and represented an attempt to model such flows. There were discussions of turbulent bursting, a mechanism for triggering bursts, the production of high frequency disturbances in the boundary layer, a better modeling of the outer region of the boundary layer, a predictive theory of turbulent mixing regions, dominant disturbance spectra and characteristics of separated flow fields. The authors were Prof. Marten Landahl (Royal Institute of Technology, Sweden and MIT), Prof. Lief N. Persen (NTH), and myself.

In an interesting paper in the area of Geophysical Fluid Dynamics, "Gerstner Waves at the Interface between Stratified Fluids," Prof. Erik Mollo-Christensen of MIT discussed multi-layered finite-amplitude interface waves associated with density stratification, velocity shear, and a gravity field. It was demonstrated how these waves, first discovered in the early 19th century, could exist at surfaces of salinity discontinuity in a body of water having a calm upper surface and cause greatly increased drag on a deep draft vessel moving at or near the disturbed layers.

Two papers presented in absentia, "An Appreciation of the Contributions of Theodore Theodorsen" by Mr. I. Edward Garrick (NASA), and "Design Method for High Lift Airfoils with Given Velocity Distribution in Compressible Subcritical Inviscid Flow" by Mr. Torstein Strand (Air Vehicle Corporation), along with "Relativity and Classical Physics" by Theodorsen, completed the program.

In all, the Colloquium was a fitting tribute in quality and content to the classic contributions of Theodore Theodorsen. (M. Lessen)

MATERIALS SCIENCE

BIOMATERIALS BY THE MERSEY

To a first approximation, ICI (Imperial Chemical Industries, Ltd.) is the British hybrid equivalent of DuPont and Merck. With 120,000 employees throughout the world (80,000 in the UK) it may be the largest chemical corporation in the world. It is composed of 8 operating divisions. A corporate research laboratory reports to none of these directly but maintains ties to each. The main tie for biomaterials is to the pharmaceutical division. This relationship is both the strength and concern of the biomaterials investigators, under the direction of Mr. M.E.B. Jones. The strength is readily appreciated; the concern is centered on the problem created by the fact that recent legislation in the more advanced technological countries makes the introduction of new drugs almost prohibitive. As one researcher put it, the introduction of aspirin as a new product into today's marketplace would be almost impossible, if not prohibitive, in costs. This development has had a sobering effect on pharmaceutical managers and swung them toward deep conservatism, particularly in Britain beset by the financial problem of depreciated sterling.

This conservatism has extended to biomaterials since tougher certification programs have evolved for them, too. Aggravating this handicap is still another fact of life. Pharmaceutical companies are largely oriented toward marketing products in quantities of many millions--the "pill" market. Biomaterials market units are generally counted in much smaller numbers. The fact that, unlike drugs, biomaterials are almost inevitably incorporated into high value-added products will be their eventual salvation; for today, the mismatch between pharmaceuticals and biomaterials serves as an obstacle.

ICI's corporate research laboratory is located in Runcorn, England, on the mighty Mersey River. This is an expanding industrial area only a few miles from the bustle of Liverpool and the historic walled town of Chester.

Biomaterials activities are divided among four projects, manned

about equally by a professional staff of about 15. The work in the prosthetics project is devoted largely to finger joints for arthritic knuckles. The investigators are enthusiastic about their device, while acknowledging that the entire surgical procedure is rather extreme. The blood compatibility project is a general study area, basic to a large fraction of biomaterials applications. Even more general is the materials project, with a heavy chemistry base.

Dental materials are currently receiving the major corporate attention, probably by virtue of the advanced state of developments. Polymeric fillings have been the object of a great amount of research. While available on today's market, their acceptance has been slow; whereas wear tests performed in advance of marketing have indicated long life, actual service records have been less notable. One rationalization for this discrepancy involves the differences between controlled laboratory test conditions, with accurately mixed and cured materials, and less precise dental practice. With this in mind, ICI investigators have devised a filling system (intended for front teeth but not molars where the wear pattern is completely different) which is premixed and requires a particularly simple curing technique: light-polymerization. They have also been attentive to the toxicological aspects of dental fillings (here, too, the observation is that the dental amalgams in practice would be impossible to introduce into today's market; they contain mercury). The filling material consists of an inert glass filler and polymer, obviously proprietary, which is "end-capped"; that is, terminated in specially selected end groups. The principal investigator and developer for this filling system is Mr. M. Fortuin, and he is now actively involved in transferring the technology to the pharmaceutical division for marketing.

Another activity which could be logically included under the heading of biomaterials is found in the solid-state chemistry group. This is the work on ion-sensitive electrodes, largely under the direction and development of Dr. Jiri Janata. The current concept of ion-selective electrodes is recent in origin, dating back only to 1972, and is based on the use of field-effect transistors (FET) in conjunction with membranes, most commonly polymeric, suitably composed to provide selectivity toward absorption or permeation for a particular ion species. The wedding of these two technologies, along with the available microminiaturization of integrated circuits, provides a tool with tremendous potential. A "Gedanken-experiment," which illustrates the method, is to imagine an ion-selective electrode having a solid internal contact and connected to a pH meter through a metal lead which, internal to the meter, is connected to the gate of an input FET. Now let the metal connection shrink to zero length, bringing the solution being studied into direct contact with the transistor. The result is an ISFET--an ion-selective FET--at the front of the pH meter. Further, through the grace of microminiaturization, imagine a battery of such transistors mounted on a common base, each selective to a different ion, and one has effected a real-time diagnosis instrumentation breakthrough.

The interests and activities of ICI have been centered on the ion-selective membrane portion of the ISFET. The selectivity of a membrane is probably determined by a variety of considerations, such as ion size, charge, and polarizability, and by the corresponding features of a candidate membrane. Janata is pursuing the search for membranes and has already announced the fabrication of a potassium-ion-selective FET [S.D. Moss, J. Janata, and C.C. Johnson, *Anal. Chem.* 47, 2238 (1975)]. A concept which drives investigators and is highly attractive to the medical supply industry (e.g., the pharmaceutical division of ICI) is the fabrication of an array of ISFETs which, inserted into a blood vessel, would provide full analysis of blood components.

ICI's work on biomaterials, placed within the time frame of the 1960s, would lead one to predict a burgeoning expansion of activity. In the more conservative management climate of the 1970s, the Mersey sailor's advice would seem to prevail; steady as she blows. (A. Sosin)

THE WHY AND WHEN OF POLYMER WEAR: IUPAC SYMPOSIUM ON LONG-TERM PROPERTIES OF POLYMERS AND POLYMERIC MATERIALS

The goal of building long life into a material is a long-standing challenge to materials specialists. The need to develop short-wearing materials--or, more accurately, to provide adequate disposal and reclamation techniques--is a more recent and fast-growing concern, particularly to polymer specialists. Thus the devotion of a full International Union of Pure and Applied Chemistry (IUPAC) Symposium to "Long-Term Properties of Polymers and Polymeric Materials" was clearly justified and timely. The Symposium was held from 30 August to 1 September 1976, in the old Parliament Building (Rijksdaghuset) in the center of Stockholm, a site which served the format of the Symposium well.

If the goal of the Symposium was to bring together investigators in different sub-areas of this field, a reasonable measure of success may have been attained. In other respects, the Symposium suffered. It was unfortunate that this conference coincided with the meeting of the American Chemical Society in San Francisco. As a result, the delegation from the US was minimal in size and IUPAC authorities were largely absent. In addition, the 3 days were effectively reduced to about 2 by the plan of the program, and, during this shortened period, exposure was limited by parallel sessions.

The Symposium was preceded on Sunday evening by a social ceremony, chaired by the organizer, Professor B. Rånby (Royal Institute of Technology, Stockholm). Rånby's mission was to extol the accomplishments of Professor Herman F. Mark (Polytechnic Institute of New York, Brooklyn) for his wisdom and services to the field of polymers for many years. Indeed, Mark clearly occupies the position of patriarch of polymer science. In spite of advancing years, he continues to maintain an activity level more common in someone half his age.

The following morning, the opening session continued the theme of historical perspective with 3 invited talks. E. Guth (Oak Ridge National Laboratory), a collaborator of Mark's on a number of occasions, spoke on "The Birth and Rise of Polymer Science--Myth and Truth." His description of the earlier developments in polymer science led him to the conclusion that a Nobel prize should be awarded 3/4 to Mark and 1/4 to Guth. Mark, in sharp contrast, spoke on "Polymers for Extreme Service Conditions" and described the state of "one of the stimulating moving fronts of macromolecular science and engineering." He made no attempt at depth or completeness in these remarks, but instead provided a survey which could be of help to those involved in specialized areas. V.T. Kagiya (Kyoto U.) surveyed "Elementary Reactions in Polymer Degradation" and spoke entirely about the many varied results obtained by himself and collaborators over the years in a wide number of systems degraded by thermal, photo, and radiation exposure. He attempted to tie these processes together with reference to the activation energy of the degradation chain-reaction which, in turn, is closely related to the activation energy for reaction initiation (80-90 kcal/mol for main-chain scission and 90-100 kcal/mol for side-chain scission), for propagation (20-30 kcal/mol), and for hydrogen-abstraction (5-10 kcal/mol) in hydrocarbon polymer chains. Kagiya also showed that the reactions are heavily influenced by the presence of other compounds, a theme to which later speakers returned frequently.

The remainder of the conference was divided among 5 areas: I. Thermal and Mechanochemical reactions including Thermal Oxidation; II. Chemical and Photochemical Reactions including Photo-Oxidation; III. New Polymers of High Stability; IV. Biological Reactions; V. Reuse and Disposal Problems. Under I, N. Grassie (University of Glasgow) reviewed his work over a quarter of a century in thermal degradation of polymers, pioneering "thermal volatilization analysis" (TVA). Thermal analysis still occupies a central position in polymer degradation studies, but Grassie's review did not dwell on the supporting studies that were needed in the past to elucidate the generally complicated thermograms which TVA supplies. Nor did Grassie or, apparently, any other speaker at the Symposium, review the veritable explosion in computer-based analytical technology that has become available to researchers in polymer degradation research.

The serviceability of a polymeric material is more frequently tied to its mechanical properties, the theme

of Area I; yet it is desirable to obtain a more atomic description of mechanical degradation than conventional testing provides. K.L. DeVries (U. Utah) reviewed the use of electron paramagnetic resonance (EPR) for this purpose, citing the pioneering work of S.N. Zhurkov (U. Leningrad) and the further studies at Utah. The rationale for the use of EPR is that fracture on a macroscale is intimately connected to chemical bond rupture on an atomic scale and that this rupture provides unpaired electrons that EPR can count. This radical formation can also be achieved by irradiation (gamma or ultraviolet) or by chemical attack. At the same time, electron pairing may occur readily, particularly at more elevated temperatures, by radical diffusion and recombination reactions with impurities, etc. More recently, infrared spectroscopy (IRS) has joined the array of tools available for bond-rupture studies where samples are mechanically degraded. With fast IR scans now available, it is likely that an appreciable amount of new information on mechanisms will flow soon.

The majority of papers in Area I dealt with the influence of one or more indigenous or external factors on polymer stability. T.J. Thomas and U.S. Nandi (Indian Institute of Science, Bangalore) studied molecular weights (MW) from 10^3 to 10^6 in poly(2-vinyl pyridine) and poly(4-vinyl pyridine) using differential thermal analysis (DTA), differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) and found only a slight decrease in the decomposition temperature as the MW increased. They relate their results to random chain scission at weak links.

G.R. Rideal and J.C. Padget (ICI, Runcorn, England) performed extrusion studies on high density polyethylene (HDPE) and found that, for MW of 300,000, sheared under N_2, either increases or decreases in MW can occur depending on the melt temperature; lower MW polymers only increase in MW. When sheared in air, only a decrease in MW is found in all cases. They also reported that processing of HDPE can lead to severe structural changes unless care is taken in the design of the extrusion screw in the case of high MW. With selection of speed and screw design, such problems can be minimized.

To determine the effect of crystallite size, A. Zuk *et al.* (Instytut Technologii Chemicznej, Poznan, Poland) studied crystallite size in polyamids and found that the size depends upon the type and chemical structure of the stabilizers used; they used imidazole derivatives (mercaptoimidazole, benzimidazole, mercaptobenzimidazole, mercaptothiazole) and diphenylamine in different ratios. P.N. Gribkova *et al.* (Institute of Organoelement Compounds, Moscow) determined the resistance of some polyheteroaryls to high temperature, moisture, and oxygen. For example, in thermal resistance the poly-1,3,4-oxadiazoles ranked best and the polybenzimidazoquinazolines were the poorest investigated.

H. Zimmerman *et al.* (Institute of Polymer Chemistry, Teltow-Seehof, GDR) monitored the DTA and TGA of polyethylene-terephthalate (PET) and linked the rate of formation of carboxylic groups to stability. They also detected the formation of gels, depending on degradation rate, and suggested that this is the cause of poorer mechanical properties. More equipment capabilities were demonstrated by R.L. Levy *et al.* (McDonnell Douglas, St. Louis) who examined the mechanochemical changes in water-saturated epoxy polymers. They used Fourier Transform Infrared (FTIR) analysis--possibly the hottest new analytical method currently in the field--and observed a decrease of sulfone band intensity at 1102 cm^{-1} and 1142 cm^{-1}, induced by moisture. This points to water-enhanced chain mobility with a resultant concentration of stress in individual chains.

G. Menges *et al.* (Institut für Kunststoffverarbeitung, Aachen) are looking at the effect of tensile creep of thermoplastics in varying external liquids, attempting to establish a "critical strain" criterion for different thermoplasts in varying environments at different temperatures, "to permit a sure dimensioning of thermoplastic structural parts used in liquids as environmental media." T. Skowronski *et al.* (Politechnika, Wroclaw, Poland) tested polyvinylchloride (PVC) copolymers (with vinyl acetate or propylene for melt viscosity characteristics, important in flow processing). They found these PVC systems to be compatible within the composition range studied and that the melt viscosity is lowered by 40% over PVC. G.E. Fulmer (W.R. Grace & Co.,

Columbia, Md.) tested 19 different plasticizers, soap, and cooking oil added to acrylonitrile-butadiene-styrene (ABS) plastics and measured the time-to-failure as a function of applied stress. Plasticizers reduce stress-cracking and strength. Fulmer found two straight-line segments on a log time-to-fail vs stress plot and concludes that failure mechanisms are present. J. Holcik and M. Kosik (Dimitrov Chemical Works, Bratislava, Czechoslovakia) examined the effects of various transition metal chelates.

It is clear that the mechanical stability of polymers is a many-faceted problem. The addition of an oxidizing environment, anti-oxidants, and light obviously complicates matters further; this was the theme of Area II. The invited papers in this area included "Accelerated Reactions in Photodegradation of Polymers" by B. Rånby and J.F. Rabek; "Photo-Oxidative Reactions of Polymers" by D.M. Wiles (National Research Council, Ottawa), and "New Developments in the Mechanistic Understanding of Anti-oxidant Behavior" by G. Scott (University of Aston in Birmingham, England). Wiles' paper stressed the fact that rather subtle differences may lead to vast differences in response. For example, the photochemistry of polypropylene (PP) and low-density polyethylene (LDPE) is qualitatively the same, but the photomechanics are entirely different. A relatively small amount of photo-oxidant exposure renders unstabilized PP brittle in a few hours through tiny surface cracks and their propagation; after considerably more exposure, LDPE is still not brittle, particularly if the degree of crystallinity is low. Difficult though the subject of oxidation of polymers is, anti-oxidation is still more complex, so Scott's resumé was particularly broad. His predictions of where emphasis will be placed in the effective use of anti-oxidants are in 1: Synergistic anti-oxidant combinations acting by chain-breaking and preventative mechanisms; 2: High molecular weight anti-oxidants and stabilizers which are molecularly dispersed within the polymer structure; 3: Bound anti-oxidant and stabilizer systems formed by copolymerization, graft copolymerization and adduct formation.

The contributed papers in Area II generally extended the invited talks with current examples of work on polybutadiene, PP, rubber, polymethylmethacrylate (PMMA), PVC, polystyrene, polycarbonates, and others.

Area III--New Polymers of High Stability--might well have been labeled mainly for inorganic chemists. It is a characteristic of the polymeric materials field that the dialogue between the chemistry-oriented researcher and the physics-oriented individual is difficult. My orientation lies in physics.

The invited talk in Area IV was presented by E. Kuster (U. Giessen, Germany). The scope of this area is demonstrated by the tabulation of biodeterioration mechanisms for plastics: 1. Mechanical processes--the gnawing by termites, insects, and rodents. (The plastic itself does not form a foodstuff for animals.) 2. "Soiling" processes, in which algae or fungi attach to the plastic without using it as a foodstuff. 3. Chemical attacks, which break down into assimilatory processes, in which constituents of the plastic serve as nutrient and dissimilatory processes, in which the plastic is chemically damaged by corrosive secretions from the organisms. In many cases, it is the plasticizer which serves as the prime nutrient for microbial growth, yet elimination of the plasticizer results in mechanical degradation. The breadth of this area is readily appreciated; nevertheless, the number of contributed papers in this area was small. I merely cite two to provide flavor. P.J. Whitney and W. Williams (U. Surrey, England) looked at the changes in mechanical properties of composite films of PE and starch, fatty acid ester, and calcium stearate in actual test environments and in laboratory models of these environments, as well as in a freshwater control environment. The experiment consisted of merely hanging simple tensile samples in dead-weight loading and observing the tensile strength. For those yearning for a return to simpler times, surely this is it. In fact, they were able to see reductions in tensile strength for exposure periods up to 10 weeks and to observe that the rate of deterioration increased with temperature of exposure and with increasing sandy loam content. Unfortunately, they also noted that the control samples, exposed in fresh water, deteriorated even more rapidly! A.-C. Albertsson and B. Rånby used ^{14}C-radioactively-labeled PE and deduced an empirical relationship between the loss of weight

of a sample of PE under exposure to various fungi over a 2-year period.

Area V (Reuse and Disposal) is certainly the least "scientific," yet attracted much attention. J.E. Guillet (U. Toronto) reviewed the peculiarities of the economics of polymers. Polymer feedstock prices have escalated along with petroleum prices; however, in principle, since plastics can be made from any one of many sources of carbon and hydrogen, they should be in use as long as the carbon cycle remains dominant in our terrestrial environment. The plastics industry consumes only 1 to 2% of petroleum, yet it is clear that reclamation is required both socially and economically. Interestingly, it has been found that the plastics component of municipal garbage upgrades the heat value of incinerated garbage, providing a case where one might eat one's cake and have it. And perhaps one can design plastics to provide for automatic disposability. But that takes us back to previous areas of the Symposium. (A. Sosin)

THE INITIATION OF CAVITATION EROSION

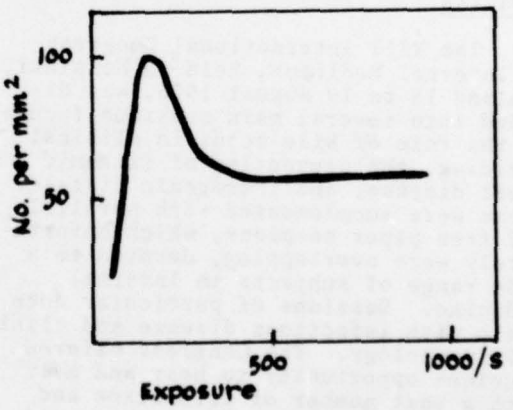
Experimental facilities developed in the '60s by the late Prof. R.E.H. Rasmussen at the Applied Physics Laboratory of the Technical University of Denmark for the study of cavitation have been adapted by Drs. K.A. Mørch and I. Hansson to the study of the initial phases of cavitation erosion. Their technique permits observation of the effects of a single cavity collapse near a surface, and of increasing numbers of collapses through to actual loss of material from the surface.

In the experimental set-up cavitation is generated in a closed flow system at room temperature with tap water flowing at 15 m/s over the specimen surface mounted in the test section. The internal pressure of the system is adjustable and allows low-level to intense cavitation in the flow across the specimen surface. After exposure to the flow, the specimen surfaces are examined using both optical and scanning electron microscopy.

Initial studies have been made on 99.7% pure aluminum specimens turned from a polycrystalline rod, without subsequent heat treatment, the test surfaces then being wet ground, diamond-polished and finally electropolished.

Two effects have been observed, both very dependent for their observation on the pressure in the system, i.e., on the cavitation conditions. The primary effect is the appearance of approximately circular depressions of the surface, which may show evidence of crack formation near their centers. The effect is being attributed to the collapse at or near the surface of cavities in the flow. The surface depressions and accompanying surface cracking appear to be consistent with Plesset and Chapman's treatment of the collapse of a cavity near a solid boundary [*J. Fluid Mech.* 47, 2, 283 (1971)]--i.e., the plastic deformation and frequently accompanying rupture of the surface are attributable to the waterjet developed during collapse. A secondary effect is the appearance of so-called "tails" under some conditions downstream from the initial surface cracks which are believed due to microcavities generated in the flow past the edges of the surface cracks. This effect will not be further discussed here.

In their studies Mørch and Hansson have paid particular attention to the early stages of the process before substantial loss of material from the surface occurs.



The curve shown here is typical of the number of surface cracks observed per mm² plotted against time for a given cavitation condition. After a rapid increase, typically of the order of one fracture/mm²s, the number of observable cracks falls; at this time new surface deformations (depressions) partially overlap earlier ones with closure of some of the previous ruptures. Thereafter, the

number remains fairly constant with substantially no loss of material from the surface. It was suggested that 3 hours exposure to the cavitation flow would be required under such conditions before any effect could be observed by weighing the specimen. It appears that in these early stages each part of the surface is subjected to repeated intermittent plastic deformation, and that only after longer exposures do parts of the surface peel away.

Mørch and Hansson reported on their work at the 7th International Symposium on Non-Linear Acoustics at Blacksburg, Va. in August '76. A first paper has been accepted for publication in the Nov '76 issue of *The Scandinavian Journal of Metallurgy*. A second paper on the "tails" observed and attributed to microcavities generated in the flow by the edges of the cracks will follow. (A.W. Pryce)

MEDICAL SCIENCES

XIII INTERNATIONAL CONGRESS OF INTERNAL MEDICINE

The XIII International Congress of Internal Medicine, held in Helsinki, Finland 15 to 19 August 1976, was divided into several main sessions focused on the role of bile acids in clinical medicine, the prevention of ischemic heart disease, and iatrogenic disease. These were supplemented with parallel and free paper sessions, which unfortunately were overlapping, devoted to a wide range of subjects in internal medicine. Sessions of particular note dealt with infectious disease and clinical immunology. The Congress offered a unique opportunity to hear and meet with a vast number of clinicians and researchers from throughout the world covering the broad field of internal medicine.

The opening session saw a number of papers dealing with bile acids. Dr. H. Dowling (Gastroenterology Unit, Guy's Hospital, London, UK) presented data which support the contention that chenodeoxycholic acid can be used effectively to dissolve cholesterol-rich gallstones. The problems with its use are that it acts poorly on obese individuals and less well when the gallstones are relatively large. In addition, 5 of 17 patients who had complete resolution of their gallstones developed a recurrence within one year of discontinuation of drug therapy.

Dr. T.A. Miettinen (Second Dept. Med., U. Helsinki, Finland) presented results utilizing the Buchwald ileal by-pass procedure which are far better than those generally reported in the US literature. This may be attributed to the length of ileum excluded (i.e., 1/3 of the terminal ileum or 2 m, whichever is longer). In Miettinen's experience, as reported, the lowering of the plasma cholesterol was greater with ileal by-pass than with the use of bile acid sequestrants such as cholestyramine, colestipol, or DEAE-sephadex.

Reduction of fat intake was recommended by Dr. A.F. Hofmann (Mayo Clinic, Rochester, MN) for the treatment of impaired micellar solubilization resulting from bile acid deficiency. Fecal weight and frequency were shown to be reduced. A water-soluble fatty acid substitute was suggested as a non-cathartic replacement which would not be dependent on micellar absorption.

During the free-paper session of the first day Dr. H.W. Intorp (Medizinische U. Poliklinik, Münster, Germany) presented electron microscopic evidence of enterocyte microvillus border changes in non-tropical sprue patients. In addition he reported the reduction of IgA levels in the gut in 8 of 10 patients with non-tropical sprue.

Although Dr. P.E. Phillips (Hospital for Special Surgery, New York) failed to identify type C oncornavirus in studies of systemic lupus erythematosis (SLE) patients while attempting to detect ^{3}H uridine labeled virus and viral RNA directed DNA polymerase, he suggested a hypothetical sequence of events which might lead to SLE as illustrated best in New Zealand mouse disease.

The main session on Wednesday heard Dr. H. Otten (Institut für Chemotherapie, Bayer AG, Germany) report that a world literature survey revealed approximately 20-25% of all drug reactions to be related to antibiotics, thus establishing antibiotics as the most frequent cause. A disturbing report on iatrogenic factors in malignant disease followed when Dr. D.B. Clayson (Eppley Cancer Inst.,

Omaha, NE) implicated contraceptives epidemiologically as a probable cause of benign hepatic tumors. Of those acquiring the tumor, about 10% die from secondary hemorrhage. Estrogens used to maintain pregnancy were shown to induce vaginal clear cell adeno-carcinoma in female progeny. This paper was followed by an excellent one by Dr. Sheila Sherlock (Royal Free Hospital, London, UK) on drug related liver disease. She suggested adoption of the following classification:

TYPE	DRUG EXAMPLES
1) Direct	Tetracycline
2) Metabolite related	Paracetamol (Tylenol) Isoniazid Methyl DOPA Halothane
3) Hypersensitivity	Sulphonamides Nitrofurantoin
4) Canalicular cholestasis	17 α Alkyl steroids Methyl Testosterone Arsenicals
5) Hepatic Fibrosis & Angiosarcoma	Arsenicals Vinyl Chloride
6) Adenoma & Carcinoma	Contraceptives
7) Gallstones	Contraceptives

During the Wednesday parallel sessions, Dr. L.R. Freedman (U. Lausanne, Switzerland) reported on his method of producing bacterial endocarditis in a rabbit model. Use of the model revealed that endocarditis could be more readily established on the left side of the heart, the side more deleteriously effected by *Streptococcus viridans*. *Staphylococcus aureus* was found to cause more damage to the right side of the heart. These studies implied that perhaps the American Heart Association recommendation of penicillin prophylaxis for patients with valvular defects may not be sufficient and combinations of penicillin and an aminoglycoside or streptomycin may be warranted. Scanning electron micrographs of endocarditis lesions revealed a tight matrix of fibrin which would barely permit the entrance of an erythrocyte but would most likely exclude most leukocytes. This would explain the frequent finding that few leukocytes appear in conventional biopsy material.

In the same session, Dr. E.H. Kass (Channing Laboratory, Harvard Medical School) considered Gram-negative bacteremias which he felt should now be considered in epidemic terms since during the last 30-40 years the majority of communicable diseases have declined while Gram-negative bacteremias have increased. The urinary tract is the primary site of origin of Gram-negative bacteremias and the major problem in this regard is created by the indwelling urinary catheter. It was stressed that ample evidence exists for this simple fact, but it is still poorly accepted.

A problem with coagulase positive [SAC(+)] *S. aureus* has been the development of metastatic foci such as endocarditis and osteomyelitis for which no prognostic method has previously been available. The detection of teichoic acid antibody (TAA) may prove to be valuable in this regard. Two papers on TAA were presented. Dr. Ulla M. Rikkonen *et al.* (Central Public Health Laboratory and U. Helsinki) utilizing gel diffusion found the highest titres (1:8-1:16) to be obtained from endocarditis patients. Dr. C.U. Tuazon *et al.* (George Washington U., Washington, DC.) using counter-current immunoelectrophoresis found that 14 of 26 patients with SAC(+) blood cultures were TAA(+); of these 50% had metastatic spread (excluding endocarditis which was not studied).

The parallel session dealing with viral infections had an excellent review of the viral aspects of acute and chronic hepatitis by Prof. A.J. Zuckerman (London School of Hygiene & Tropical Medicine, UK). He pointed to the importance of antigen E which appears to correlate with progression toward chronic liver disease. In addition an effective vaccine appears to be just on the horizon. Zuckerman felt the use of hepatitis B viral polypeptides free of host or viral DNA may offer the most promise.

Dr. G. Klein (Karolinska Inst., Stockholm, Sweden), reporting on the Epstein-Barr virus (EBV) and its relationship with infectious mononucleosis, Burkitt's lymphoma (BL), and nasopharyngeal carcinoma, presented evidence that the EBV can transform B cells into blasts and thence to an "immortal" (stable) cell line which continues to carry the viral gene.

The relationship of the EBV and BL is not uniform worldwide. The EBV has been found in approximately 97% of African BL patients tested,

but is relatively rare in patients outside Africa (approx. 5.0%).

Encouraging data on interferon were presented by Dr. K. Cantell (Central Public Health Laboratory, Helsinki, Finland). Last year Finland produced approximately 10^{11} units of a relatively purified and concentrated form of human leukocyte interferon at 10^{6} mu/ml. Preliminary data presented indicate that interferon may have application to herpes keratitis, Varicella zoster, and hepatitis B (reduction of core and E antigens). Coupling interferon with surgical resection in osteosarcoma was presented showing preliminary promising results with increased 2-year survival compared to the effects of surgery and radiation or surgery alone.
(CDR M. Stek, MC, USN)

OCEAN SCIENCE

THE NATIONAL RESEARCH INSTITUTE OF OCEANOGRAPHY LABORATORY/CSIR, DURBAN, SOUTH AFRICA

Several days last July were spent at the National Research Institute of Oceanography Laboratory, in the hills behind Durban Harbor. The present director of the oceanography effort there is Mr. Allen Pierce, whose work emphasizes various aspects of coastal oceanography. For example, one of the prime research efforts is an attempt to understand the control that the Agulhas Current, which sweeps down along the shelf edge, exerts on the inshore waters. The presence of topographically trapped eddies and spinoff eddies is being investigated with STD grids and both Aanderaa current meter moorings and ship measurements. In over-the-side measurements ship drift is calculated from a Decca navigation system; the calculations are fed into a computer, and the current-meter data are automatically corrected for the ship drift by the computer. Mr. Eckart Schumann, who is known to European scientists as co-author with Mr. Adrian Gill of papers on long wave generation on continental shelves, is now involved in the shelf oceanography program with Pierce. His particular area is the analysis, interpretation, and modeling of the current-meter data taken on the shoreward side of the Agulhas Current. Another staff member, Mr. Martin L. Grundlingh, is currently studying the Agulhas Current in detail and is also involved with the satellite tracking of the drifting buoys in the Southern Ocean. Mr. Graham Lundie is a scientific staff member who is undertaking meteorological studies from ship observations and coastal stations in an attempt to determine the influence of the weather systems on both the strength and location of the Agulhas Current and the currents inshore. His results are very preliminary, and there is no clearcut correlation between the inshore current meter observations and the weather observations.

Dr. Nils Bang has recently joined the staff at Durban after working for many years at the Capetown laboratory. Bang's recent work is on the flow to the east and south of Madagascar and the possible role of these currents in feeding the Agulhas Current. There is considerable controversy about the origin of the waters in the Agulhas stream. A considerable amount of Bang's time is also devoted to routine environmental studies, for the S. African Navy, of the temperature and salinity conditions in the waters off the east coast of S. Africa. In addition to cataloging the data, he hopes that some sort of model can be constructed, at least a seasonal one, for the temporal behavior of these environmental characteristics.

The laboratory has excellent technical support: several laboratories full of technicians and electronic testing gear readily available for all their instrumentation. Mr. Henry Chamberlain, the chief technician, performs essentially the role of a scientist. He spent a month or more with the National Institute of Oceanography in the UK becoming familiar with deployment and characteristics of instrumentation. There are several technicians in support of this operation. Mr. Larry Beamer is in charge of a well-equipped in-house computer facility. All the shipboard data are put onto computer tape and can be analyzed on the ship. There is a duplicate computer system both on board and in the laboratory in Durban. I was given a tour of the ship, the RV MEIRING NAUDE. This ship is used not only by the physical oceanography group but also for chemical, biological, and, to a lesser extent, geological studies. Data acquisition is fully automated. The vessel is about 30 m

long and has a considerable breadth and draft. Despite its short length for these waters, it apparently is an excellent research platform, being equipped with a bow thruster and anti-roll tanks. There are about eight fully-berthed, rather comfortable quarters, and ample large winches for current meter deployment on the shelf. Dry and wet labs and space on the rear for maneuvering and handling equipment are included.

We spent a considerable amount of time discussing the data acquired off Richards Bay, about 160 km N. of Durban, where a dense net of data was taken in the coastal waters over a grid of about 32 km offshore and 64 km alongshore. A salinity-temperature trace and a current meter profile were run on about a 5-km grid spacing over a period of seven days. This grid was repeated once a month for a year, so it is a rather extensive data set for coastal oceanographic purposes. Up to now it has been analyzed only in terms of mean properties and general characteristics of the salinity-temperature and velocity field. (S.P. Murray, Coastal Studies Institute, Louisiana State University)

ISRAEL OCEANOGRAPHIC AND LIMNOLOGICAL RESEARCH INSTITUTE

The main building of the Israel Oceanographic and Limnological Research Institute (IOLR) was formally inaugurated on 29 August 1976 by a gathering addressed by the Minister of Commerce and Industry (in the absence of the President of Israel who was hospitalized). The IOLR has been in operation since about 1970, in rented quarters in Haifa and in various field stations throughout the country. Since its inception it has been directed by Admiral (retd.) Yohay Ben-Nun, a former commander of the Israeli Navy. Ben-Nun is a national hero, having led the underwater demolition team which blew up the Egyptian flagship cruiser FAROUK in the independence war of 1948. He took on the directorship of the IOLR after retiring from naval service, recruited a basic staff of scientists and technicians, and has applied himself to the construction of the main building at the ancient port of Tel Shikmona, just south of Haifa. The cost of the building was Israeli £18 M (about $3 M before the recent devaluations of the Israeli pound).

The main address at the inauguration was given by Dr. K.O. Emery of the Woods Hole Oceanographic Institution, an advisor and frequent visitor to the Institute. He pointed out how much work had been accomplished both in basic and applied oceanography and in limnology since the inception of the state in 1948--all in spite of Israel's small population, the frequent political and military distractions, and the divided sovereignty over adjacent water bodies. Most of these bodies owe their origin to plate tectonics; i.e., to the rift between Arabia and Africa and the associated fracture zone of the Jordan Valley and Dead Sea. Along the rift are the Red Sea and the Gulf of Suez. Along the fracture zone are the former Hula swamp (now drained), the Kinneret Lake (Sea of Galilee), the Dead Sea, and the Gulf of Elath. Less closely associated with this tectonic system is the part of the Mediterranean Sea that borders Israel.

The work of the Institute thus deals with 4 different water bodies whose salinities span a tremendous range: fresh water in the Kinneret; ocean salinity in the Mediterranean and the Gulf of Elath; and hypersaline in the Dead Sea (about 30‰). Temperature regimes include temperate and tropical. Floras and faunas are from Atlantic and Indian Ocean sources, as well as endemic ones. Interesting problems of migration and adaptation are connected with the times of open and closed Suez Canal. Habitats include mud, sand, rock, and reef at the surface, with similar variety at depth.

Water movements are varied, but most unusual is the number of examples of down-welling due to excess of evaporation over precipitation plus run-in, especially in the Dead Sea. Currents due to salinity differences there are complemented by smaller currents caused by wind stress.

In the field of water chemistry, variety and interest is provided by the wide range in salinities, by contributions of ground water, and by sources of sediment which react with the water. Some of the biochemistry is unique to the Dead Sea and to the Red Sea, with their controls by evaporation and influx of hot brines, respectively.

In this interesting and unique research setting, the IOLR (set up

as a limited company) plays a most important role. In addition to conducting research originated by the staff, it serves in a supporting role and collaborates with a number of other institutions in Israel: for example, with the Israel Geological Survey, the Geology and Biology Departments of the Hebrew University in Jerusalem, the Biology Department of the University of Tel Aviv, the Technion (Israel Institute of Technology at Haifa), the Weizmann Institute of Science, and with many other smaller and more specialized entities such as the Dead Sea Works.

Emery concluded his survey by pointing out how the basic studies of the geology, biology, chemistry and physics of the various water bodies in and near Israel contribute not only to science, but to the economic well-being of the State of Israel. There are numerous examples: the draining of the Hula swamp for agriculture; in the Kinneret, improved fishing and maintaining also the quality of the fresh-water supply of Israel; the mining of potash and bromine from the Dead Sea; and recreation in the Gulf of Elath and the Mediterranean Sea.

The IOLR is now fully operational. The main building at Tel Shikmona has an exciting architectural form and is located right at the shore so as to be able to launch boats and have seawater intakes for the numerous laboratories. To minimize corrosion, it is fully enclosed with glass and uses a specially formulated concrete. Its interior design is also unique and uses the concept of four functional blocks in its construction. It provides about 5000 m^2, with 3500 m^2 for laboratory space. The scientific and professional staff now numbers some 20 people, all of whom have advanced degrees. The IOLR also operates 4 research vessels, 2 in the Mediterranean, 1 on Lake Kinneret (Sea of Galilee), and 1 in the Gulf of Elath.

An annual report has just been published which reviews in detail the work of the last several years and lists some 70 publications. Some of the following is taken from this report, augmented by discussion with the IOLR staff. In the field of aquaculture the major achievement has been the raising of the sea bream, *Sparus aurata*, to commercial size in less than a year. The fish have been induced to spawn. Many of the problems related to the commercial aspects of producing bream are being solved, such as the use of raceways, as well as coastal ponds and floating sea cages. The aim, of course, is to go into commercial marine farming in the Gulf of Elath, following the already successful commercial aquaculture in ponds for carp and telepia.

Israel's water supply comes mainly from Lake Kinneret. To maintain the quality of the water, and to maintain the fishing and recreational capabilities of this largest fresh-water body in Israel, the IOLR has over the last 8 years thoroughly investigated the physical, chemical and biological processes which govern the quality of the water. The scientific understanding is now adequate to predict processes and phenomena in the lake which may result from climatological variations, or from engineering operations in the lake or in its watershed area. One of the results of the research was to show that a eutrophication phenomenon can be caused by purely physical means, for example, by an event where the water level in the lake drops and where strong winds cause enhanced mixing of the sediment within the reduced volume of the water, thus increasing the phosphorus concentration and changing the algal population.

In the area of physical oceanography, a sophisticated system for the study of wave climate in the surf zone has been constructed and is ready to be tried out in the ocean. Since most of the population of Israel lives along the Mediterranean shore and uses it intensively, a good scientific understanding of shore processes is of course essential. Another continuing project is to study the bottom topography in the coastal region. The aim of all of these investigations is to understand the mechanism of sand transport along the coastline, which is a dominant factor in coastal preservation and management. (See also R. Dolan's article, "Coastal Problems in Israel," ESN 39-4:164).

A multi-year study of the marine climate over the continental shelf and the adjacent deep basins is now gaining momentum. Oceanographic data are being retrieved systematically from instruments moored on buoys and from research cruises. The aim of this study is to gain a better insight into the physical behavior of the water masses near the shore and into their acoustical properties.

Last year, a group was formed to study the physiology of plankton.

They are now investigating the special problems involved in raising the large quantities of planktonic organisms required as food for fish raised in the mariculture project. These studies will also aid the Kinneret and marine pollution groups which are interested in algal blooms and in the effects of pollutants on plankton. In addition, the extraction of chemical compounds of practical use from planktonic organisms is also under consideration.

Surveys of marine pollution involving tar and heavy metals were started two years ago. The IOLR is planning to extend these studies to include pollution from domestic and industrial wastes and their effects on the marine environment. The IOLR also represents Israel in a number of international and regional activities relating to pollution of the Eastern Mediterranean. This is a continuing program where Israeli and Arab representatives meet and cooperate.

The IOLR at Tel Shikmona, with its permanent field stations on the Kinneret and the Gulf of Elath (Red Sea), is now in a good position to undertake cooperative work with other interested scientists. On a temporary basis, investigations can be conducted in the Dead Sea and also in the Sinai lagoon of Bardawil. In the latter, the fisheries of the bream (*Sparus aurata*) were considerably improved by research. The plankton studies in the eastern Mediterranean were carried out in cooperation with a University of Miami group during the cruise of the R/V PILLSBURY. The beach investigations are conducted in cooperation with Prof. D.L. Inman of the Scripps Institute of Oceanography. Marine geological work has been done by Dr. Ben-Avraham cooperating with a group of German scientists and Stanford University. The major problem now is in acquisition of scientific equipment which is rather expensive. Currently, the budget of the Institute runs over IE7 M annually, with more than half now coming from research grants and the rest from surveys or services carried out by IOLR and the rest from a direct government budget. The granting agencies are mainly Israeli government departments, but they include also grants from the US-Israeli Bi-National Science Foundation and the US Environmental Protection Agency. (S.F. Singer, Dept. Env. Sciences, U. Virginia, Charlottesville)

INTERNATIONAL SYMPOSIUM ON THE STRUCTURE AND TECTONICS OF THE EASTERN MEDITERRANEAN

In connection with the inauguration of the Israel Oceanographic and Limnological Research Institute (IOLR) (see concurrent article in this ESN) an International Symposium on the Structure and Tectonics of the Eastern Mediterranean, the Jordan Rift Valley and the Red Sea was organized. It was held in the auditorium of the Institute at Tel Shikmona from 30 August to 3 September. Most of the participants were from Israel and the US, with good representation also from Germany, Italy, Switzerland, Greece, Turkey, the UK, and France. The speakers discussed many of the exciting and unique features of the region. The rift valley is the lowest point on the surface of the earth, the level of the Dead Sea being at -400 m. Lake Kinneret (Sea of Galilee) is also below sea level, but is a freshwater lake. At the very upper end of the Jordan is the depression known as the Hula Swamp which has now been largely drained. Between the Dead Sea and Elath, in the Arawa valley, there is a sill which separates the Dead Sea from the Red Sea.

Among the interesting papers was one by Raphael Freund (Geology Department, Hebrew U.) who pointed out that the spreading movement is dispersed over a wide zone in the northern half of the Red Sea (north of Jidda), in contrast to the southern half where it is confined to a narrow central zone as in most ocean ridges. These changes in the mode of motion between the African and the Arabian plates may be understood in terms of temperature variations in the upper mantle. Under the Gulf of Aden in the southern half of the Red Sea, the upper mantle is apparently warm, with buoyancy and low viscosity enabling it to rise and fill in the gap between the separating plates with new oceanic crust. In the northern half, it does not rise to the full extent, probably because it is cool, dense, and more viscous. Consequently, the crust is stretched and attenuated over a wide zone. Further north, the upper mantle is presumably even cooler and denser, so that it can hardly rise. The separation is replaced there by a shear which does not require the formation of new crust. These upper mantle temperature-density

variations might have originated from an old subducted lithospheric slab which has presumably descended from the Tethys Ocean in Iran and Turkey under the Levant countries during Mesozoic times. This subduction could be responsible for the formation of the eastern Mediterranean basin as a marginal sea behind the Turkish-Iranian island arc. To establish the validity of this proposition, a denser network of seismic stations is required in order to carry out travel-time studies.

The history of the rifts was discussed by Zvi Garfunkel (also of the Hebrew U. Geology Department). The once continuous African-Arabian plate began to break up in the Oligocene or slightly earlier. The rifts developed in several tectonic pulses, with the present phase of activity beginning 4 to 5 million years ago following a period of tectonic quiescence. Uplifting of the rift shoulders began some time after initial faulting and volcanism. The record is especially good in the Suez rift. Important uplifting of Sinai began only 10 to 15 million years after the inception of this rift. On a wider scale, Garfunkel noted that the rifts of the Middle East appeared when a new spreading center broke the floor of the Indian Ocean, and the plate motions changed considerably. Also, numerous uplifts and associated volcanic fields appeared concurrently over much of Africa. He then discussed possible interactions between the several plates and coupling between motions of lithosphere and mantle.

The genesis of the Mediterranean was interpreted by Kenneth J. Hsu (Geological Institute of ETH, Zurich). The three working hypotheses generally held about the Mediterranean are: (1) it is a relic of the Mesozoic Tethys Sea; (2) it was created in the Tertiary after the Mesozoic Tethys was completely eliminated by the alpine orogeny; or (3) the east Mediterranean is a relic Tethys and the western basins are Tertiary basins. From various geophysical investigations, such as deep-sea drilling, land geology, and marine geophysics, Hsu concludes that the eastern Mediterranean basins are underlaid by a very thick sequence of sediments dating back to the Mesozoic, and that the third possibility is most likely to be correct.

Many of the papers were pointed towards ocean resources. For example, the paper by A. Ginzburg (Tel-Aviv U.), E. Kashai (Oil Exploration, Ltd.) and S.S. Cohen (Sonol Israel, Ltd.) described detailed seismic surveys of the continental shelf and slope of Israel. The paper by C. Morelli (Institute of Mines and Applied Geophysics, Trieste) also confirmed the presence of thick sedimentary series in the eastern Mediterranean.

David Ross (Woods Hole Oceanographic Institution, WHOI) discussed the problems to be tackled in a proposed WHOI expedition in 1977 to the Red Sea and eastern Mediterranean. Of particular interest are the mechanisms of hydrothermal activity, following on the discovery of the hot brines existing in pools in the central portion of the Red Sea. Another point of interest is the extent of potential oil-bearing structures across the shallow parts of the eastern Mediterranean.

Other papers looked forward to the construction of nuclear power plants. M. Vered and H.L. Striem (Israel Atomic Energy Commission) described macroseismic studies of the 1837 and 1927 earthquakes in the northern Galilee and showed that the intensities were heavily attenuated along a north-south direction. The southern coastal plain of Israel seems therefore less vulnerable than inland regions of similar epicentral distances. These results are important in assessing seismic risks, especially those for nuclear power plants.

The effects of tsunamis at coastal sites were described by T. Miloh and H.L. Striem. Tsunamis can be triggered by submarine tectonic activity, such as fault displacement in the sea bottom, for example, from a series of shore-parallel faults about 18 km off the southern coast of Israel. The analysis shows that such fault displacements may cause surface waves with amplitudes as large as 6 m and periods up to half an hour. They also considered that because of the downward movement of the faults, a recession of the sea level rather than a flooding would be the primary effect at the shore. This is in agreement with some historical reports. This analysis is of interest to those designing open-cycle power plants to be located on the coast.

One of the recommendations of the conference, put forward by K.O. Emery (Woods Hole Oceanographic Institution), was to produce a synthesis volume on

the "Seas of Israel," to promote important new basic and applied research. A very useful synthesis study of Israel geology and hydrology was put together and published in connection with the 17th Limnological Conference which was held in Jerusalem in 1968. Perhaps a similar volume can be written and published in time for the forthcoming Tenth International Congress on Sedimentology which will be held in Jerusalem, 9-14 July 1978. This Congress promises to be a major scientific event featuring not only a complete program of papers but also pre-Congress and post-Congress field trips. (All correspondence and requests for scientific information should be addressed to Dr. G. Gvirtzman, Geological Survey of Israel, 30 Malkhei Israel Street, Jerusalem 95501, Israel.) (S.F. Singer, Dept. Env. Sciences, U. Virginia, Charlottesville)

PHYSICS

TEXTOR--A NEW FUSION MACHINE AT THE KFA

The recent decision (19 July 1976) of the EEC's Council of Ministers that JET (Joint European Torus) will be constructed as a Community project may affect the fortune of other TOKAMAK devices in a favorable way.

A few years back when the design of JET was first conceived, the philosophy was to build a pure research device without a particular intent to achieve reactor performance. Over the years, after several changes in design philosophy and after considering that the mood of the public is becoming more hostile to "irrelevant" research all the time, it seems that JET has turned into a fusion reactor experiment. In several newscasts on Europe's TVs one could hear the news that the EEC is going to build a "nuclear fusion reactor." While this may be due to sloppy reporting, it is certainly not entirely accidental that it was put this way.

In other words there will be considerable pressure to make JET a success, which in this context means to achieve energy breakeven as soon as possible. The consequences are that all efforts are to be concentrated to reach this goal and little or no emphasis can be given to detail problems. For this reason it is vital that EURATOM operate smaller machines which will permit research on detail problems which cannot be done on JET. One of these auxiliary machines is TEXTOR which is proposed by the KFA (Kernforschungsanlage Jülich). The project director is Dr. Hans Conrads. The design of the machine has advanced far enough for construction to be commenced as soon as the decision on funding has been made. This decision is a long drawn-out process, involving technical recommendations by several committees within EURATOM. At present, this process is approaching its conclusion. Without exception, the machine received good technical recommendations, and the decision on funding is expected at latest in the fall, '76.

The research on TEXTOR will be aimed towards a better understanding of interactions between the thermonuclear plasma and the wall of the future fusion reactor. A material wall will be necessary despite the fact that the plasma is really contained by a magnetic field configuration. Any interaction of the plasma at thermonuclear temperatures (>100 M K) with this material wall will have grave consequences, first on the composition and purity of the plasma and second, on the integrity of the wall itself. Such an interaction cannot entirely be precluded even if perfect magnetic containment could be achieved since high energy neutral particles (created by charge-exchange reactions) will not be contained by the magnetic field. The same is true for neutrons and electromagnetic radiation. In addition to this interaction, there is also a reverse flow of particles, namely vaporized and eroded (sputtered) wall material which will penetrate into the plasma region and change the composition of the plasma and, therefore, its properties, such as electrical resistance and emission of line radiation. High Z elements, which unfortunately have to be used as wall materials, will have an especially profound effect on the energy losses by line radiation. This can easily lower the plasma temperature below the ignition point. Even if JET or any other similar device would demonstrate feasibility of ignition or breakeven, it would not be possible to design and construct a prototype

thermonuclear reactor before the problem of plasma/wall interaction is solved. This is the reason why the construction of TEXTOR is of extreme importance.

TEXTOR is a Tokamak-type machine. Its external view is indicated in the Figure. Major and minor plasma radii are 1.75 m and 0.5 m. (For a comparison with other machines see ESN 29-11:456.) The magnetic field will be 2 T and the expected plasma current is 0.5 MA. The electrical power input is 45 MW which will be taken directly from the grid. The expected plasma temperature will be 10^6K, based on a particle density of 10^{13} per cc. The pulse duration will be 3 s, which is at least 30-50 times the confinement time. The wall temperature will be allowed to reach up to 600 C.

Present plans call for construction to be completed during 1979. In parallel to the design and preparation for construction of TEXTOR, several additional programs have been initiated within the same project. These are development and testing of new measurement techniques for plasma/wall interaction; design and development of possible auxiliary means to influence the plasma/wall interaction zone; development of mathematical models to describe the processes involved in plasma/wall interaction, and material studies concerning the special problems encountered in plasma/wall interactions.

As a method for measurement of plasma/wall interaction; i.e., the concentration of trace amounts of high

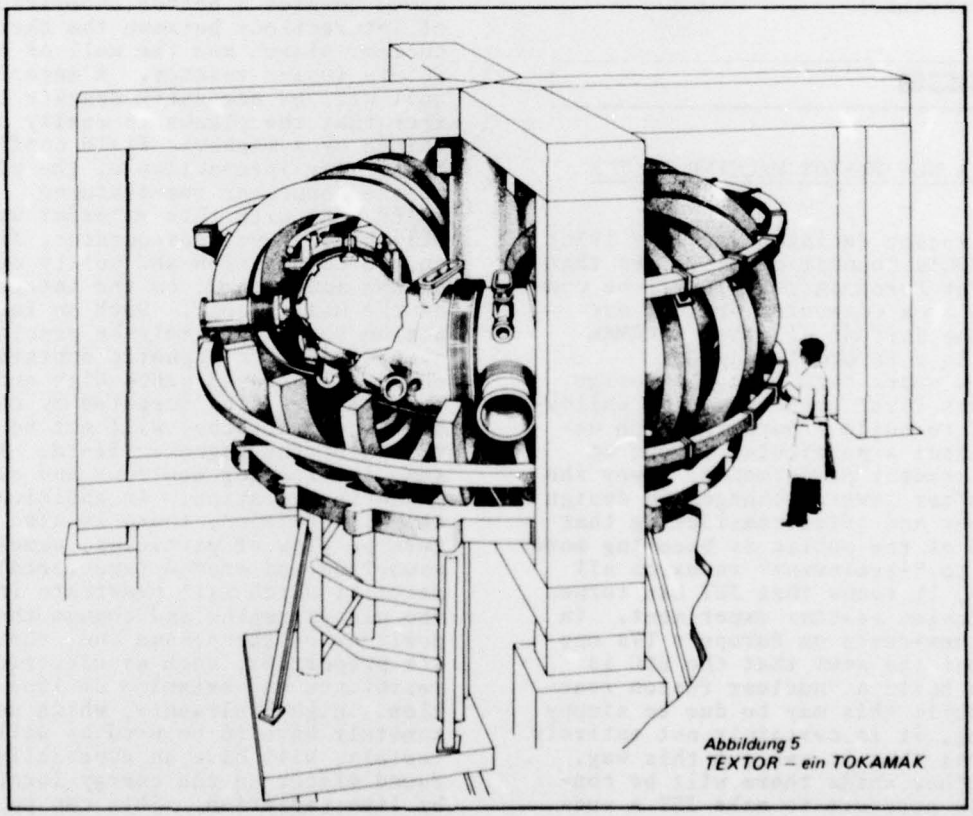


Abbildung 5
TEXTOR – ein TOKAMAK

[Reproduced from "TEXTOR Kurzbeschreibung-Torus Experiment for Technology Oriented Research" with the kind permission of the Institute für Plasmaphysik der Kernforschungsanlage Jülich GmbH, (KFA Jülich), March 1976.]

Z elements, it is planned to excite the outer electron shell of these elements with a pulsed laser and use conventional optical spectroscopy to detect and measure these materials.

Influence of the plasma/wall interaction zone is to be achieved by injection of high energetic (e.g., 50 keV) neutral particles, which also can be used for auxiliary heating of the plasma. It is intended to have a total of 4 neutral particle injection sources with a power of up to 600 kW each.

From the description given, one can see that TEXTOR pretty well conforms to the standard design of present-day Tokamak machines, which means that if JET or other large Tokamaks should generate some new insights, TEXTOR could be quickly modified to conform to the new technology. On the other hand, if the large machines should fail to achieve any breakthroughs, TEXTOR would be equally unsuccessful. This situation is similar to those in the early days of fission power reactor development, in which a newly formed nuclear establishment precluded the development of any other reactor type except light water reactors. While this was very unfortunate, it at least happened after all the particulars of nuclear fission were understood. In the fusion case, the same seems about to happen even before the feasibility of thermonuclear fusion has been demonstrated. (R.T. Schneider, Dept. of Nuclear Engineering Sciences, U. Florida, Gainesville)

NEWS & NOTES

THE ROYAL SIGNALS AND RADAR ESTABLISHMENT

On 26 March of this year, Her Majesty the Queen unveiled a plaque at the Royal Radar Establishment, Malvern, Worcs., commemorating the amalgamation of the RRE with the Signals Research and Development Establishment (SRDE), Christchurch, Hants., and the Services Electronics Research Laboratory (SERL), Baldock, Herts. The combined establishment, called the Royal Signals and Research Establishment (RSRE), is located at Malvern. SERL is now RSRE (Baldock) and constitutes the Electron Devices Group of the Applied Physics Department of RSRE.

THE BRITISH RESEARCH COUNCILS

The Secretary of State for Education and Science recently announced new appointments to both the Science Research Council (SRC) and the Natural Environment Research Council (NERC). The 7 new members appointed to the SRC are: Prof. G. Allen, Professor of Chemical Technology, Imperial College, University of London; Prof. Sir Granville Beynon, Professor of Physics, University College of Wales, Aberystwyth; Dr. Jack Birks, Technical Director of BP Trading Ltd.; Dr. Peter Chester, Director of the Central Electricity Research Laboratories; Prof. W. Farvis, Professor of Electrical Engineering, University of Edinburgh; Dr. M. Holdgate, Director General of Research of the Department of Environment; and Prof. Sir George Porter, Director of the Royal Institution. The 5 new members of NERC are: H. Fish, Director of Scientific Services for the Thames Water Authority; the aforementioned Dr. Holdgate; Prof. E. Naylor, Director of the Port Erin Biological Station and Professor of Marine Biology at the University of Liverpool; Prof. J. Sutton, Professor of Geology at Imperial College; and G. Williams, Director General of the UK Offshore Operators Association.

PERSONAL

Professor James Gowans, FRS, Royal Society Research Professor in the Sir William Dunn School of Pathology, University of Oxford, has been named Secretary of the Medical Research Council to succeed Sir James Gray. Gowans will take up his appointment at the beginning of April 1977. Sir James, who has been MRC Secretary since 1968 is going to Plymouth where he will renew his former interest in neurophysiology in association with the Marine Biological Laboratory there.

On 1 October, Professor John Ashworth, Head of the Department of Biology, Essex University, was appointed for 2 years as Chief Scientist in the Central Policy Review Staff of the Cabinet Office. The creation of the new position to which Ashworth has been appointed is part of a revision within the Cabinet Office involving the merger of the Office's Science and Technology Group with the Economic

and Industrial Secretariat (see ESN 30-8:373, "New UK Science Advisory Machinery").

At the University College of Wales, Dr. F.T. Banner, Reader in Oceanography in the Department of Geology and Oceanography, has been appointed to the newly established Chair of Oceanography.

Dr. D.M. Blow, FRS, Lecturer in Crystallography and Fellow of Trinity College, Cambridge, has been appointed to the Chair of Biophysics, Imperial College from 1 October 1977.

The title of Professor of Naval Architecture has been conferred on Dr. R.K. Burcher, in respect of his post at University College London. His new title will become effective I October 1977.

Mr. Robert Chabbal, Professor at the University of Paris XI and Scientific Director of the Centre National de la Recherche Scientifique (France) has been appointed Director-General of CNRS in succession to Bernard P. Gregory. (Gregory has recently been nominated as General Delegate to the Recherche Scientifique et Technique.) Since 1974, Chabbal has been President of the Scientific Committee of the Centre National d'Etudes Spatiales (CNES) and a member of the Scientific Council of the European Space Agency. Since 1975 he has been in charge of an interdisciplinary program of R&D for solar energy. He is also President of the Solar Energy Commission of the European Community.

Gleh Frank, Professor of Biophysics, Moscow University and Head of the Institute of Biological Physics, died 14 October at the age of 71.

At Heriot-Watt University in Edinburgh, Professor A.R. Halliwell of the Department of Civil Engineering has been appointed to the Chair of Offshore Engineering and Head of the new Department of Offshore Engineering.

Mr. Gilbert Jessup has been appointed Special Professor in Occupational Psychology at the University of Nottingham for a period of 3 years to date from 1 October 1976.

Dr. F.H. Panton, Director General, Establishment Resources and Programmes B, of the Ministry of Defence, has been appointed Director of the Explosives Research and Development and the Rocket Propulsion Establishments and Head of the Rocket Motor Executive of the Ministry of Defence..

Sir James Taylor has been appointed Chairman of the Fulmer Research Institute in succession to the late Mr. J.D. Rose. Dr. B.J. Mason, Director-General of the Meteorological Office, has been appointed Director of the Institute.

ONRL REPORTS

R-8-76 MATERIALS RESEARCH IN COPENHAGEN AND ENVIRONS by H. Herman

Three materials science activities in Denmark were visited to update a report written by another liaison scientist some nine years ago. Two of the institutions are academic, The Technical University of Denmark at Lyngby, a suburb of Copenhagen, and the other directly in town, at the University of Copenhagen. A government laboratory was visited as well, The Research Establishment Risø, located north of the city. The development of science, especially materials science, in the midst of the evolving influences of social democracy, is discussed.

R-9-76 HIGHLIGHTS OF DYNAMICAL CLIMATOLOGY IN EUROPE by A.I. Barcilon

This report is divided into two main parts. The first deals very briefly with the broad questions raised by the modeling of climatic changes and should provide the non-initiated in this field with some idea of the problems involved. The second part of the report focuses on some of the work in dynamical climatology (i.e., the numerical or theoretical modeling of climate changes) as is currently found in Europe. The survey does not pretend to be exhaustive and has been limited to modeling in which the time scale considered is monthly, seasonal or yearly.

R-10-76 EUROPEAN DEVELOPMENTS IN COMPUTATIONAL FLUID DYNAMICS by R.H. Nunn

In Europe, as in the US, the use of the computer to solve complex problems in fluid dynamics is a burgeoning field of endeavor. This report briefly describes some of the current European efforts in computational fluid dynamics. The citations are intended as "leads" to the individuals and institutions involved in such activities, and recent references are given to provide guidance to the latest published information.

C-22-76 THERMOMETRY AND TEMPERATURE SCALES: THE INSTITUTE OF PHYSICS LONDON MEETING IN JUNE 1976 by T.A. Kitchens, Jr.

A review of a one-day (4 June 1976) meeting of the Low Temperature of the Institute of Physics in London on Thermometry. Discussions included mK adjustments in the near 4 K range, platinum resistance thermometry up to 273 K and fixed point superconducting thermometry.

C-23-76 4TH INTERNATIONAL CONGRESS ON MARINE CORROSION AND FOULING by H. Herman and E.C. Haderlie

This 4th International Congress on Marine Corrosion and Fouling at Juan-les-Pins, France, was attended by a wide range of specialists concerned with the behavior of materials in the sea. Broadly, two areas of concern were treated in two simultaneous sessions: (1) corrosion and corrosion-related topics, and (2) fouling. The deterioration of materials, either due to their demise electrochemically or due to their being used as a habitat for a

C-23-76 (cont'd)

variety of biota, is a central activity of the navies and maritime organizations of the world. Some 250 attendees came to the south of France during June to exchange notes on these very important topics.

C-27-76

EIGHTH INTERNATIONAL SYMPOSIUM ON THE REACTIVITY OF SOLIDS by P.J. Herley

The Eighth International Symposium on the Reactivity of Solids was held at Chalmers University of Technology, Gothenburg, Sweden 14-19 June 1976. The conference focused on six major aspects of the reactivity of solids: Reaction at surfaces and interfaces, especially at elevated temperatures; the influence of structural defects on reactivity; solid state reactions in organic materials; reactions in vitreous solids; new experimental methods for studying reactivity in solids; the role of solid state reactions in materials technology.

C-28-76

SOLID-VACUUM INTERFACES by T.A. Kitchens, Jr.

This report briefly recounts the highlights of the Fourth International Symposium on Surface Physics held at the Eindhoven University of Technology on 23-25 June 1976. The emphasis of the meeting was on solid-vacuum interfaces. Six invited papers were given, most of which were discussions of recent advances in understanding the analytical techniques used in surface science.

C-29-76

THEORETICAL POLYMERS by T.A. Kitchens, Jr.

This report summarizes the papers presented at the two-day UK Institute of Physics conference on theoretical methods in polymer physics. The meeting was held at the University of Leeds 5-7 July 1976 and about 20 papers were presented on the excluded volume model, various treatments of the entanglement problem, the glassy and collapse transition, and the use of the renormalization group methods.

C-30-76

THE 10TH INTERNATIONAL POWER SOURCES SYMPOSIUM by W.G. Soper

A summary is given of the 10th International Power Sources Symposium at which 48 papers were presented. Emphasis in the review is placed upon secondary batteries with high energy density, i.e., those most suitable for electrically-powered vehicles. An introductory discussion of the principles of batteries and measures of performance is also included.

C-31-76

INTERNATIONAL SYMPOSIUM ON WIND ENERGY SYSTEMS by R.H. Nunn

This report offers brief descriptions of the papers presented in Cambridge on 7-9 September 76. Vertical- and horizontal-axis systems were discussed both in theory and in practice. Applications ranged from "wind forms" each with hundreds of megawatt units to the use of Cretan windmills to provide water for cattle. Wing energy conversion units have been operated in several configurations and the theory of their performances is sufficiently advanced to allow design for fabrication. The trends are towards larger units for municipal power systems and smaller units

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(cont'd)

for domestic use. In the former case, the behavior of large wind turbines operating in large arrays, and the output (with and without storage) of several such arrays when geographically dispersed, has yet to be well understood. The field has reached a level of maturity characterized by such factors as economics, environmental impact and public acceptance.