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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 member of the staff of ONRL and occasionally articles are prepared by, or in cooperation with, members of the

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EUROPEAN SCIENTIFIC NOTES OFFICE OF NAVAL RESEARCH LONDON

Aubrey W. Pryce and Victoria S. Hewitson

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BIOLOGICAL SCIENCES	Biochemistry in Krakow	J.L. Wood	256
ENERGY	More UK Renewable Energy Source R&D	A.W. Pryce	257
ENGINEERING	Component Aspects of Fibre Optic Communications	D.A. Hart	259
	Heinrich Hertz Institute for Communication Technology, Berlin	N.M. Blachman	262
	Electrical Engineering in Iranian Universities	N.M. Blachman	265
MATERIAL SCIENCES	Macroscopic and Microscopic Examination of Materials: Two Views from Israel	I.M. Bernstein	269
	Organic Solids and Fibers—Strong as Steel!	C.C. Klick	271
	Indium Phosphide and Other III-V Materials Activities	H. Lessoff & J.K. Kennedy	273
MECHANICS	Aerodynamics at the Technical University of Delft	M. Lessen	276
PHYSICAL SCIENCES	First European Conference on Optical Systems and Applications (ECOSA I), Brighton, UK	V.N. Smiley	278
	Chemical Physics at the Université Libre de Bruxelles	Martin Lessen	279
PSYCHOLOGICAL SCIENCES	Training for the Diagnosis of System Malfunctions	J.A. Adams	281
	Human Factors in Command and Control Systems	J.A. Adams	282
SPACE SCIENCES	Space Activities in Greece	R.W. Rostron	283
NEWS & NOTES			285
ONRL REPORTS			288

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Herbert Solomon

HERBERT SOLOMON
Chief Scientist

P.F. GIBBER
Captain, USN
Commanding Officer

Dr. J.A. Adams	Psychology
Dr. I.M. Bernstein	Metallurgy & Materials Science
Dr. N.M. Blachman	Electronics Engineering
Dr. W.J. Gordon	Mathematics
CDR D.A. Hart	Airborne Systems
Dr. C.C. Klick	General Physics
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BIOLOGICAL SCIENCES

BIOCHEMISTRY IN KRAKOW

The ancient city of Krakow is one of the most active centers for biochemical research in Poland. I visited the Institute of Molecular Biology which was organized in 1970 at the Jagiellonian University (1364 A.D.). It includes the Departments of Biophysics, Animal Biochemistry, Plant Biochemistry, Plant Physiology, and Microbiology. Prof. Aleksander Koj, the Director, was my host. His research program has been principally involved with synthesis and turnover of glycoproteins of liver and plasma, and with the biological functions of lyosomal hydrolases and mitochondrial sulfur transferases. One of these enzymes, rhodanese, is found in mitochondria of most cells and in considerable amounts in liver and kidney, while another, mercaptopyruvate sulfur transferase is found both in mitochondria and cytoplasm. The natural biological functions of the enzymes are unknown and have presented a biochemical enigma since the 1940s. There has been considerable discussion in the US recently as to whether an absence of rhodanese in cancer cells acts in conjunction with Laetrile, an alleged anti-cancer drug. Koj's group has found rhodanese present in many types of cancer cells. Dr. J. Frendo at the Medical School has found that rhodanese develops in the chick embryo at a much slower rate than mercaptopyruvate sulfur transferase. In cooperation with biochemists at the Institute of Medicine, Koj and his associates have made some progress in producing antibodies to bovine rhodanese. Such studies should contribute to an understanding of the integration of sulfur transferases in biological systems.

In other programs of the Institute, Prof. S. Lukiewicz (Biophysics) is investigating the physical properties and functions of plant, animal, and human melanins as endogenous radioprotectors of normal and neoplastic tissues. Profs. S. Wieckowski and J. Zurzycki are working with chloroplasts and the photosynthetic apparatus. The function of pigments in the developing ovule and embryo is the project of doc. dr. Marian Ryczkowski. Prof. Maria Sarnecka-Keller is investigating the effect of diabetes mellitus on the composition and heterogenity of glycoproteins, while Prof. Zofia Porwit-Bobr and doc. dr. J. Branny are studying the variability of virus-infected animal cells and bacteria, particularly the role of cell surface antigens.

It is significant of the importance that the University and the Polish government place on biological research that, in spite of the desperate shortage of housing, construction of a new building for the Institute and allied disciplines has been announced recently.

The Institute of Medical Biochemistry at the Nickolas Kopernikus Academy of Medicine is the oldest biochemically-oriented group in Krakow. Now administratively separate from the Jagiellonian University, the Institute grew out of the Department of Physiological Chemistry which was founded in 1874. The Department was chaired by Prof. B. Skarzynski (1947-1963) when the current research projects began taking shape, i.e., metabolism of sulfur compounds and natural complexes of vitamins with protein carriers. Here T. Szczepkowski (1916-1974) made important contributions to knowledge of the nature of thiosulfate metabolism. His work on sulfur metabolism is being continued by his students and associates in close collaboration with Koj's group at the Institute of Molecular Biology.

The Director of the Institute of Medical Biochemistry is Prof. W. Ostrowski, a member of the Polish Academy of Sciences. His research projects have included the identification and isolation of the vitamin B_{12}-binding protein (transcobalamine-I), the characterization of biotin-avidin and riboflavin-protein complexes, and the properties, catalytic activity, and composition of human prostate acid phosphatase. Other enzymes under study are prostate ribonuclease P_2 and a rat-liver phosphoprotein phosphatase that acts on nuclear proteins.

Dr. J.M. Zglinczynski has found myeloperoxidase in the presence of chloride, and hydrogen peroxide can oxidize amino acids to the corresponding aldehydes, ammonia, and carbon dioxide. Biological chlorination may proceed with peptides, pyrimidine compounds, and organic acids. The process may be important to the phagocytic activity of leukocytes.

Dr. L. Konieczny has observed the appearance of a pathological excess of IgM in blood serum during autoimmunization

processes. This is accompanied by defects in the biosynthesis of the proteins. There are changes in the sugar content, and a number of polypeptides of molecular weight 10,000-20,000 appear in the serum. One of these peptides specifically binds calcium. Thiosulfate blocks the development of the polypeptides in mice.

Another group at the Institute working under doc. dr. M. Guminska is investigating the differences in carbohydrate metabolism between normal cells and cells such as Ehrlich ascites, HeLa, and polyoma-infected fibroblasts. In particular, pyruvate kinase is physicochemically and catalytically altered in the cancer cells causing an increase in energy production.

Drs. J. Naskalski and W. Pajdak of the Department of Clinical Chemistry of the Institute of Internal Medicine, at the Nickolas Kopernikus Academy of Medicine are engaged in a research program principally concerned with modifications of myeloperoxidase that occur in leukemic leukocytes. Two closely related forms of the enzyme are separable by electrophoresis. The electrophoretic mobility in acute lymphatic leukemia is remarkably increased. Naskalski and Pajdak will attempt to form anti-bodies to the normal and pathological forms for use in diagnosis and assessment of the effects of therapy. Naskalski has developed a simplified procedure for separation of the enzyme from human leukocytes which provides the enzyme in quantity.

Nearly all the biochemists at Krakow have spent time working in laboratories in the US and Western Europe, while research contacts are maintained by attendance of Polish scientists at international conferences and by collaborative projects. Significantly on the educational side, a resolution of the Sixth Congress of the Polish United Worker's Party resulted in a sweeping reorganization of national education being decreed by the Sejm (parliamentary body) in October, 1973. One effect has been a recent increase in the number of students and much greater demands on the staff for teaching duties. It will take a period of adjustment and probably more personnel to maintain the high level of research accomplishment traditional with biochemists in Krakow. (John L. Wood, Dept. of Biochemistry, Univ. of Tennesse, Memphis)

ENERGY

MORE UK RENEWABLE ENERGY SOURCE R&D

A government White Paper issued by the Department of Energy (DoE) in June on "The Development of Alternative Sources of Energy," (Cmnd 7236, HMSO, 40p) announced an increase of £6 million in the funds allocated this area, raising the total commitment to the program initiated in 1976 to £16 million ($30 million). In the main the decisions involved in this increase were a direct response to two critical Parliamentary reports issued almost a year earlier, the one dealing with alternative sources in general and the other with the possible exploitation of tidal power in the Severn Estuary, a possibility which has been in the air for more than half a century. (3rd & 4th Reports, Select Committee on Science and Technology, "Development of Alternative Sources of Energy for the UK" and "Exploitation of Tidal Power in the Severn Estuary" July 1977. HMSO £1.10 and 70p, respectively).

The first of these reports while recognizing that "renewable" energy sources—solar, wind, wave, tidal, and for purposes of discussion geothermal can make only a modest contribution toward meeting the UK's energy requirements in this century, noted their longer term potential as established fossil fuels become increasingly expensive and depleted. Comparing R&D funding allocations for renewable sources with those for nuclear R&D, it concluded that the R&D investment in renewable sources is grossly inadequate. The report suggested a complacency on the part of the DoE in this area citing as an example delay in publication of the research program for solar energy which was announced in Feb. 1977 when the work on which it was based had been completed by the DoE's Energy Technology Support Unit in July 1975, and called both for greater priority and for urgency and determination in pursuit of the development of alternative sources. Specific recommendations were made in respect of the organization for energy R&D covering policy, administration, consultation and review, and as to the R&D effort on individual source possibilities. The organizational recommendations have been accepted only in part by the Govern-

ment, although some reorganization has taken place within the UK energy hierarchy. Select Committee concerns that the membership of the Government's Advisory Council on R&D for Fuel and Power (which reflects the principal function of this body, that is of examination of the research programs of the nationalized fuel and power industries) might be inhibiting the development of new sources, and of inbalance in the membership of the Energy Commission that advises the Secretary of State for Energy were rejected. Recommendations concerning individual source possibilities faired better and are reflected in the additional support now provided (see below).

The second Select Committee report dealing in detail with Severn Estuary issues was equally critical and found

> "....the Government position on tidal power excessively timid. Although the potential of the Severn Estuary appears to be acknowledged, the Government seems unwilling to make sufficient serious effort to evaluate it. There also appears to be no encouragement from the Government to the CEGB (the Central Electricity Generating Board) to develop and assess an optimum scheme for the Severn Estuary. We find this approach regretable in view of the recent interest of the Department of Energy in wave power which, unlike tidal power, has not yet been proved on any significant scale, and lacks developed engineering techniques."

A considerable number of schemes and alignments for a Severn barrage have been proposed with predicted annual net outputs ranging up to 21,000 GWh, a figure which is substantially larger than the output from any existing UK power station complex. Since any barrage scheme would necessarily be expensive, the report called for exhaustive study before commitment of funds and recommended the establishment of a Severn Barrage Committee to supervise all future work on barrage proposals, a recommendation accepted by the Government who are establishing such a committee under the chairmanship of the DoE's Chief Scientist, Sir Herman Bondi. Further in line with the report, the Government has provisionally allocated £1.5 million, a quarter of the additional funds, to studies of the Severn barrage subject to the advice of the new committee.

Allocation of the new funds between the various renewable energy possibilities follows with notes on earlier funding commitments.

Wave Power — Total £5.4 million

£1 million (for 2 years) announced in 1976 was increased to 2.5 million in 1977 (for 2 to 3 years) and is now further increased by £2.9 million toward development of wave power devices and work on generic problems of wave power. This includes £0.3 million for collaborative work with Japan and other countries.

Geothermal Energy — Total £1.77 million

£0.84 million (for 3 years) announced in 19[illegible] assessment of the potential of geo[illegible]nergy in the UK was increased[illegible]1 million in 1977 and is now fu[illegible]creased by £0.86 million. (Ele[illegible] of this program also receive supp[illegible] from the EEC as part of the EEC's program.)

Wind Power — Total £0.97 million

During 1977, £0.17 million was committed to this area for a wind-powered generator design study and for work on a vertical-axis wind machine. These funds are increased to £0.97 to extend work on the generator for hilltop sites, and for work on medium sized aerogenerators, offshore siting studies, environmental studies, and assessment of novel concepts.

Solar Energy — Total £6.0 million

Receives no additional funding at this time, £3.6 million (for 4 years) announced in 1977 having increased Government support in this area to £6 million. Incentives to the development of solar energy have also been provided via other programs, and it also benefits from R&D in other fields particularly in regard to environmental factors.

Tidal Power — Total £1.59 million

The £1.5 million allocation announced follows earlier funding of £50 thousand for related studies in 1977 and £42,000 earlier this year to obtain wave data in the Severn Estuary.

These funding levels may seem small for an area of such potential importance, but as the UK Government argues the additional expenditure of £4.5 million on alternative source R&D

> "...will ensure that work on these sources continues to advance as quickly as possible. Most of the sources are at an early stage of development and the limitation to making faster progress is not the level of funding but the state of technology involved. While there-

> fore the Government is anxious to proceed as quickly as possible with the development of alternative sources, it does not consider it practicable at the present time to fix a target date by which the renewable sources should be making a significant contribution ...."

The later point responded to a Select Committee recommendation that aimed at providing an increased sense of purpose to the various efforts.

The real funding and program decisions lie ahead, of course, when selections between research approaches have to be made for larger scale development. In the meantime, the UK benefits from an increasing oil supply from the North Sea and basks in the prospect that this source will provide 50% of its oil demand almost immediately and 100% of it in the near future. All this to a country that only a short while ago imported almost every drop. (Aubrey W. Pryce)

ENGINEERING

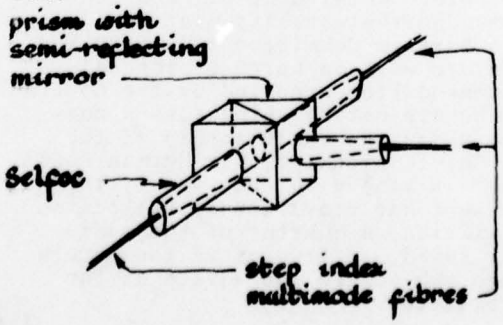
COMPONENT ASPECTS OF FIBRE OPTIC COMMUNICATION

A short but interesting conference was recently held in London dedicated to the rather narrow topic of components for fibre optic communications. Starting at a rather unusual and inconvenient time (1400 on a Friday afternoon, 14 April 1978) about 50 people nevertheless managed to show up for the 5 papers and the mandatory afternoon tea. The colloquium was sponsored by the Components and Circuits Group of the Institution of Electronic and Radio Engineers (IERE) but was held at the historic Royal Institution on Albemarle Street. It was here in 1812 that Michael Faraday attended the lecture series of Sir Humphrey Davy when Faraday was a mere apprentice bookbinder. Having heard these lectures, Faraday conceived the desire to enter into the service of science and applied to Davy for employment, sending him as evidence of his interest the notes he had made of the lectures.

Getting back to the subject at hand, the IERE Colloquium was chaired by Professor W. Gambling (Univ. of Southampton), a pioneer in fibre optics, who briefly reviewed some of the history in his opening remarks. Bringing us up to date on the present state of the art, he remarked that fibres are now available that can give attenuation as low as 0.5 dB/km, and there are several commercially available fibres providing between 0.5 dB/km and 1 dB/km. Laser sources have now demonstrated lifetimes of up to 10,000 hours and light emitting diodes (LEDs) are now available that can be modulated at rates approaching 1 GHz. Spectral ranges for sources have been extended and wavelengths up to 1.3 μm can now be attained. Strength of fibres which was a major concern in the early days is not an overriding issue now, and Gambling cited as an example a novel demonstration by Standard Telecommunications Laboratories (STL) of Harlow, Essex, that has been running for over two years. STL laid a cable across their parking lot entrance where it is driven over by about 100 cars twice a day—to date there has been no degradation in its performance.

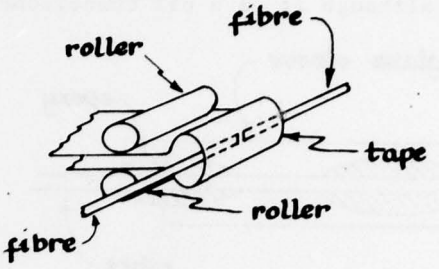
Components, the topic of the present conference, lack some of the glamour and excitement associated with fundamental studies on fibre optics, but they most certainly require ingenuity and good engineering in their design. Without progress in this field the full promise of fibre optics technology cannot be realized in marketable systems.

The first paper, presented by A.G. Cowley (Univ. of Southampton), described a new single fibre optical T-coupler. This coupler uses the properties of graded-index rods produced by the Nippon Sheet Glass Company's "Selfoc" process. These rods perform like a continuous lens in that an input image is periodically refocused on the axis of the rod. A half-period length of rod is cut in the center and a semi-reflecting mirror is inserted at this point where rays are nearly parallel to the rod axis. A sketch of the T-coupler is shown below:

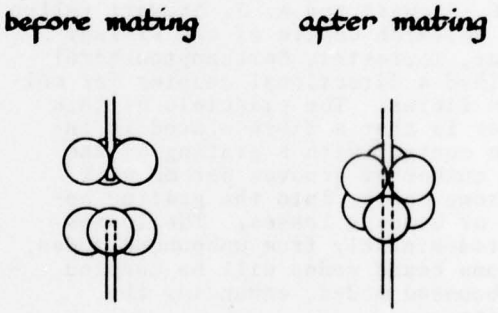


Cowley discussed some of the theoretical results which show the effect of misalignments and separations between lenses, and then went on to give actual results for two different sizes of prism cubes inserted in the center of the coupler. A coupler was constructed of Selfoc rods with a 1-mm diameter [numerical aperture (NA) of 0.3] and a 5-mm prism cube. Step index fibres of 50-μm core diameter were attached, and in this case an insertion loss of -2.39 dB was measured. With a smaller 1-mm prism cube, an insertion loss of -1.4 dB was measured with fibres having an NA of 0.15, and -2.44 dB was obtained for 0.24-NA fibres.

Dr. Paul Hensel (Post Office Research Centre, Martlsham Heath) reviewed sources of loss in optical fibre connectors and joints including the results of misalignments, separation of fibre ends, angular misalignment, mismatch in the cores (due to manufacture) and mismatch due to use of fibres with differing radial index profiles. Hensel defines joints as permanent connections in which fibre ends are joined by epoxy, etc., whereas by connectors he means "demountable" fibre connection devices. Hensel described two types of joints, one of which has been tested for several years in a Post Office experiment where optical fibres have been laid in underground ducts. This is the V-groove joint in which ends of fibre are butted together while lying in a 90° V-groove cut in a small plate of copper. The ends are then held with epoxy that also acts as an index matching medium. These joints typically have 0.2- to 0.3-dB loss. A new joint technique with which Hensel is experimenting uses a sleeve of plastic tape (actually magnetic recording tape with the oxide scraped off). The tape is formed into a loop and the ends pinched between two rollers. When the loop is slightly larger than the fibre diameter, fibre ends are slipped in from opposite ends and the loop is drawn tight around the fibres by turning the rollers. Epoxy is used to hold the fibres together and to hold the tape around the fibres. After curing, the rollers are released and the tape is cut near the fibre. This technique is producing results only slightly worse than the V-groove technique, the principal problem being the adhesive. It is difficult to find an adhesive that sticks well to both glass and plastic tape. Nevertheless, the technique looks promising as one that could be easily automated. Below is a sketch of the arrangement for this method of making joints:



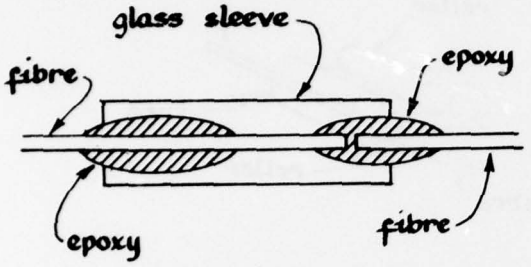
A new connector that Hensel is experimenting with is the 3-ball one. The fibre is held centered in a connector by three tungsten carbide balls (≈850 μm diameter) which fit in a precision cylindrical recess. When mated with another assembly of like design, the six balls nest together and the fibre ends are butted together to form a connection with about 0.4-dB attenuation (no matching fluid) or 0.16 dB (with matching fluid).



Three-ball Connector

J. Leach (STL) described a splicing technique and a connector developed by his company. The splicing technique for small-core single fibres was used for a prototype underground installation. This technique uses a glass sleeve of slightly larger diameter and slightly lower melting point than the fibre. One fibre is inserted in the end and the sleeve is partially melted. This collapses the sleeve to grasp the end

of the fibre. After this, the second fibre is pushed in the other end and held with epoxy. Epoxy is also used to more firmly retain the first fibre. This technique has proven quite satisfactory although it is a bit cumbersome.

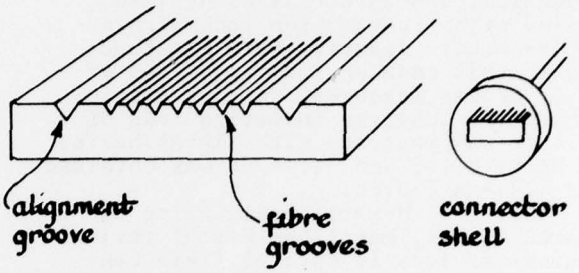


Leach described a demountable connector that is based on a standard military approved connector shell with fibre terminations used in place of the wires. Fibres are held in ferrules with epoxy after inserting the tips through the holes in watch jewels that are used for centering the fibre in the ferrule. This connector has been mated and unmated 500 times with no increase in attenuation.

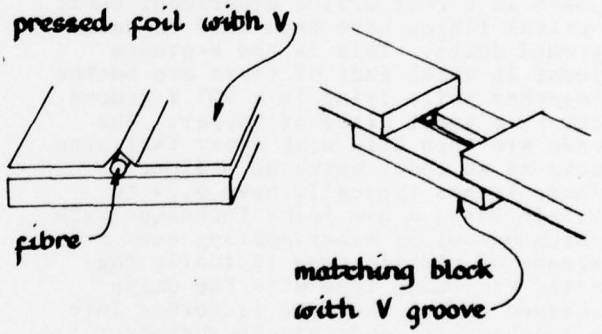
C. Stewart and W. J. Stewart (Allen Clark Research Centre of the Plessey Company, Towcester, Northamptonshire) described a directional coupler for multimode fibres. The principle of this coupler is that a fibre placed in intimate contact with a grating of the right number of grooves per mm will lose some energy into the grating because of bending losses. The losses are predominantly from unbounded modes, but some bound modes will be coupled to unbounded modes, enhancing the coupling.

A typical coupler of this type will pass about 72% of the light through the fibre and 24% to the grating thus preserving 96% of the energy. The amount of coupling is controlled by the length of grating used. Attempts are being made to improve these couplers to a point where coupled energy can be focused on the end of another fibre to produce fibre optic T-couplers.

Stewart also described Plessey developments on demountable connectors One of these, a 6-way interconnect, is already fully developed and commercially available. The 6-way connector is based on production of a precision aluminum stamping with 6 V-grooves for fibres and 2 larger V-grooves for alignment pins. After cementing and polishing the fibre ends, the stamping is held loosely inside the connector shell where it mates with a like assembly.

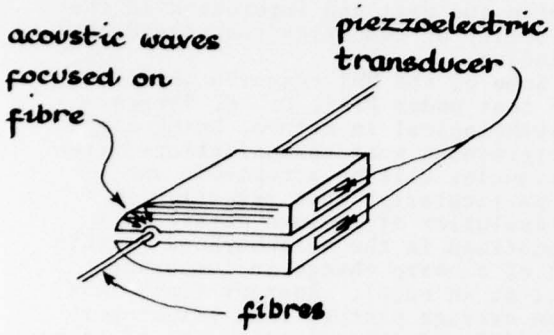


Plessey also have a foil connector for single fibres in the early stages of development. A single fibre is held on the face of a flat block with a piece of foil which has been impressed with a V-groove. The foil and fibre are cemented to the block with epoxy. To mate the ends of two fibres, the completed blocks are slid in a matching block with a V-groove. See figure.



Ms D. Howard (Univ. Coll., London) described some novel experiments on optical fibre phase modulators. If the source for a fibre optic link is a coherent laser, it is possible to use a phase modulator external to the source. If a fibre is stretched or vibrated, changes in refractive index can be produced and thus a coherent signal passing through the vibrated section is phase modulated. Acoustic transducers can be clipped on the outside of the protective coating of a fibre, and it is not even necessary

to break the fibre. A sketch of one style of such transducer is shown below.



The tranducers produce different results depending on whether single mode or multimode fibres are used. For single mode fibres highly linear phase modulation is produced. With multimode fibre multipath interference produces amplitude conversion resulting in amplitude modulation components that are subject to fading. Under proper conditions this phase modulation technique can produce reasonable signal-to-noise ratios for a narrowband signal with as little as 0.5 mW of acoustic power.

Following the papers, a short discussion was held with Gambling as moderator. The concern of the audience seemed to be that although the fibre optics field has developed significantly in the past ten years, commercial production systems are still few and far between. The field seems to be in a "chicken and egg" situation. Commercial systems are not available because there is not a large volume of users, and there is not a large volume of users because commercial systems are not available. Gambling expressed the belief that the fibre optics field is now poised to take off in a number of directions (military systems, applications for connection of computer peripherals, and telecommunications), and that in the next few years there will be a great increase in the availability of fibre optic systems.

Abstracts of papers presented at this Colloquium are available from the Institution of Electronic and Radio Engineers, 99 Gower Street, London WC1E 6AZ. The Colloquium Digest is No. C/140478. Full papers are not currently available, but the authors were encouraged to write them for publication in appropriate journals. (Cdr. D.A. Hart)

HEINRICH HERTZ INSTITUTE FOR COMMUNICATION TECHNOLOGY, BERLIN

On 18-19 May the Heinrich-Hertz-Institut für Nachrichtentechnik (HHI) held a conference and open house in celebration of its fiftieth anniversary, although its present name dates only from 1974. It had started life in 1928 as the Heinrich-Hertz-Institut für Schwingungsforschung (oscillation research) under Prof. K.W. Wagner as a part of the Technische Universität Berlin (TUB), with departments devoted to mechanical systems as well as to electrical networks, acoustics, telegraphy, telephony, and radio. The HHI's official history reports that the German government that came to power in 1933 took its toll upon the Institute, deleting (from 1936 until 1945) the name Heinrich Hertz (1857-1894) and removing a number of renowned scientists, including Wagner and some of his department heads. At the end of WWII its work came to a halt for a while, as the Institute's building had been destroyed.

In 1946 part of the Institute was moved to East Berlin, where it is now the Zentralinstitut für Solar-terrestrische Physik of the Deutsche Akademie der Wissenschaften at Rudower Chaussee 5 in Adlershof. Communication between this part and the part that remained with the Technical University in West Berlin rapidly died out, although it was not until 1961 that the wall was erected that now divides the city.

In 1968 the Institut für Schwingungsforschung moved into the present quarters, a 12-story building at Einsteinufer 37 on the corner of Marchstrasse at the north end of the campus of the Technical University, which is located in Charlottenburg in the center of West Berlin. It shares some of the lower floors of this building with the TUB's Computer Department, and nine of its senior staff members teach at the TUB; but it is now administratively independent of the University. It is primarily supported by the German Federal Ministry for Science and Technology and by the Department of Science and Research of the West Berlin government, and it also accepts support from other sources, including private industry, its 1977 budget totalling some $9 million. The Institute's research program is planned in coordination with the Federal Ministry of Posts and Telecommunications by a Council of Scientific Advisors drawn from universities, research institutes,

industry, and government agencies, and its mission since 1974 has been to investigate the full range of problems associated with new forms of communication technology. All of the work done at the Institute is open and freely published.

The present Technical Director is Dr.-Ing. Horst Ohnsorge, who joined the HHI late in 1974. Coming from AEG (Allgemeine Elektrische Gesellschaft) in Ulm, he brought a number of colleagues together with AEG's entire research program. The present scientific staff numbers 91, and there are in addition nearly 60 technical and clerical staff members as well as three dozen students. While the Fernmeldetechniches Zentralamt of the Deutsche Bundespost in Darmstadt, FRG, has extensive laboratories devoted to planning the Federal Republic's future communication systems, its mission apparently does not include long-range research, which in this field is the domain of the HHI.

Among the new means of communication to be introduced in the FRG are Teletext and Viewdata (*ESN* 31-2:72), and other applications for TV sets are being investigated at the HHI. A group under Dr. U. Haller has found that for teleconferencing it is completely adequate to have a 6-kHz voice bandwidth. They find it desirable for the TV to show not only the faces of all the people at the other end of the line but also their physical interrelationship, and for this purpose two TV screens, side by side to provide sufficient breadth of field, are considered desirable.

Simple videotelephones for home use, too, are being studied, and error-correcting codes for the high-quality digital transmission of TV programs at 30 Mbit/sec between studios and transmitters is under investigation. Here P. Stammitz and Thomas Kummerow have experimentally found that a hybrid approach to source coding involving pulse-code modulation (PCM) and differential PCM à la M.C.W. van Buul is best for reducing error propagation. This redundancy-reducing coding is followed by shortened (4095, 4035) Bose-Chaudhuri-Hocquenghem (BCH) channel coding, which adds redundant digits to aid in correcting bursts of transmission errors. Hans J. Matt has investigated the error-burst correcting ability of BCH and Fire Codes. Whenever there are more errors than can be corrected, the previous line of the TV scan is simply repeated, the coding block length being one TV line. Both Ohnsorge and Matt are interested in the possibility of combining source and channel coding.

Some of the HHI research—particularly that under Prof. Dr. G. Boerger—is psychological in nature, being aimed at determining what communication-system deficiencies will be acceptable and, more particularly, what reduction in the resolution of picture detail will go unnoticed in the neighborhood (within 0.3°) of a sharp change in luminance (i.e., at an edge). Boerger finds that for an average picture this effect permits a 20% reduction in the rate of transmission of information.

While the use of standard coaxial TV cables for two-way analogue and data transmission is being investigated by Wolfgang Krick, the Institute's major emphasis is on digital transmission over glass fibers, which will provide bandwidth for far more channels—both video (including color at 65,536 kbit/sec) and audio (64 kbit/sec) with time-division multiplexing (TDM) in place of frequency-division multiplexing (FDM). At the HHI Dr. C. Baack has built a 6-km experimental graded-index optical-fiber system, including a repeater, transmitting 1.12 Gbit/sec, which is sufficient for 15 to 30 TV channels or 15,000 telephone channels.

TDM permits a variety of approaches to the interconnection (switching) of users, and there are separate groups devoted to centralized and decentralized switching. The latter group, headed by Dr. Jens Weber, deals with the connecting of individual telephone subscribers without the need of any central office for controlling the process. This form of switching is used in the broadband optical communication system developed by another group under Matt within Haller's department. Basically the system proposed for carrying not only telephone conversations, teletype, and video telephony between subscribers but also for delivering radio and TV programs, involves the use of two fibers—one (the transmitting fiber) onto which each active subscriber puts his output in suitable uniformly spaced time slots, and the other (the receiving fiber) from which he takes the information arriving in those time slots addressed to him.

The total length of the transmission paths would be proportional to the number of subscribers in a centralized switching system, with a separate path joining each to the central office, but for the HHI decentralized system a single pair of fibers serves any number of subscribers along their length. The output at one end of the transmitting fiber is fed into the receiving fiber at that point that leads toward the desired receiver for each time slot, whether on the other fiber of the original pair or on an adjacent fiber-pair loop.

Such a system locally carrying information at 140 and 280 Mbit/sec, with higher rates over longer distances, is being built on an experimental basis with the support of and participation by several industrial firms. The time frame of the 140-Mbit/sec portion of the system consists of 2048 time slots of 34 bits each, while the 280-Mbit/sec portion has 4096 time slots, with suitable provisions for synchronization, status indication, signaling, etc. The experimental system is to be in operation in 1980 with over 150 km of optical fibers and will be used to determine the desirability of incorporating the various broadband and narrowband services by means of tests that will even include the recording of simulated tariffs. Consideration is being given to all aspects, including the smooth transition from the present telephone network to the broadband optical system.

To increase the versatility of telephone systems from another viewpoint, Dr. H.D. Höhne, Dr. P. Jesorsky, *et al.* are developing an automatic voice-recognition system which will check a caller's claimed identity in connection with access to a bank account or the like via digital telephone-line connections. He is asked to pronounce a test sentence lasting about one second. His pattern of loudness versus time is first compared with that shown in the files, and his utterance is adjusted in speed so that its loudness peaks correspond with those of the record. Short-term spectral analyses are then performed by a parallel bank of 40 filters covering the telephone baseband (0.3-3.4 kHz), and distinguishing features of their outputs as functions of time are used in forming a vector to represent the speech sample, which is compared with a stored vector obtained by similar processing of an authentic utterance.

HHI research has investigated not only what spectral features are most distinctive but also what test sentence will produce the most reliable speaker verification. For this purpose it was determined that "Mein Name ist Nemo" provides a very good assortment of phonemes for extracting the parameters of the vocal tract and the dynamics of speech production for German speakers. Details of this work are reported in English in the November and December 1977 issues of *Frequenz*.

Although ordinary analogue filters are used in the present realization of the voice verifier, digital filters are used in other applications, and an extremely fast special-purpose computer with transistor-transistor logic for Fourier and Walsh transformation is available. The latter was devised in 1972 and completed in 1974 by Weber as his Doktor-Ingenieur research for the TUB while working at the HHI. It will perform an 8192-complex-point transformation in 40 msec and a 1024-point transform in 5 msec. Weber believes his remains the fastest existing approach for the purpose and is hoping to find a commercial firm interested in exploiting it. Its high speed is achieved by splitting the computer's internal storage; there are two 2048-word internal core memories with 54-bit word length and 800-nsec cycle time.

Another project, carried out by E. Grossmann *et al.*, has sought to synthesize intelligible German speech on the basis of the smallest possible fixed digital memory for the required sounds. For intelligibility it is necessary to store not just single phonemes but also pairs of successive phonemes. It has been possible to get by with only 65,536 bytes (8 bits = 1 byte) of memory, however, by utilizing each stored pair in both the forward and backward directions. In addition, short samples of various phonemes (e.g., a single period for each vowel) are repeated in order to obtain the necessary duration for some sounds and are truncated in order to produce others. For example, a truncated *sh*, *ö*, or *e* yields a *t*, *ü*, or *i*, respectively.

Without modulation of the pitch, however, the result is very difficult to understand—even with the help of suitable variations in loudness. The introduction of pitch changes relieves the difficulty, although the result cannot be described as high-quality speech. Alterations of pitch by up to an octave

in either direction are effected by changing the rate of sampling in between a quantizer-differencer circuit and its inverse. This approach changes the fundamental frequency while leaving the formant frequencies unchanged, thus retaining the voice quality. Speech synthesis might be used for the automatic reading out of telephone-directory information, for example, if the speech-recognition problem is ever solved, as the pronounciation of German names is evidently sufficiently regular that it can nearly always be determined automatically from the spelling.

One other activity that may be mentioned before closing is the development of aids for the handicapped. The speech-synthesis work could have applications in assisting the dumb to speak and the blind to read. In addition, Boerger's group has built a device for writing and reading Braille on a magnetic-tape cassette. For writing, this approach has the advantage over audio tape recording that it achieves a much greater compression of information and, moreover, many blind people prefer to write in Braille. For playback an entire line is read into storage and is displayed by elevating the appropriate pins in a line's worth of 2 × 3 Braille matrices. It is followed by the next line when requested or, for searching, by the line at the top of the next page, for example, presented automatically in relatively rapid sequence. The use of such cassette recording can greatly reduce the size and weight of a Braille book.

West Berlin has sometimes been described as a dying city, but it seemed very much alive at the time of my visit, with a good proportion of young people at the HHI as well as elsewhere—perhaps attracted from the rest of the FRG by tax incentives. More than a tenth of its populace is employed in industry—principally producing electrical and transportation equipment. Siemens, with 35,000 employees, is West Berlin's largest private employer, and it supports some of the work of the HHI. Thus, the Institute is in no sense isolated from related activities, despite West Berlin's peculiar situation. The HHI is carrying out thorough studies and experiments with new modes of communication and, although it does not appear to be doing advanced theoretical work, it is preparing West Germany for the possible implementation of various novel concepts for communication.

An International Conference on Information Theory and System Theory in Digital Communications will be held at the HHI 18-20 September 1978 under the sponsorship of the Nachrichtentechnische Gesellschaft of the Verein Deutscher Ingenieure in cooperation with the FRG National Board of URSI, the German Section of the IEEE, and the Elektrotechnischer Verein of Berlin. Papers, to be presented in English or German, will chiefly concern models and coding for sources and channels, and the synchronization, optimization, and simulation of transmission networks. The Conference chairman is the HHI's director, Dr. Ohnsorge. (Nelson M. Blachman)

ELECTRICAL ENGINEERING IN IRANIAN UNIVERSITIES

While Iran is only beginning to set up its first doctoral program in engineering, it is importing the most advanced technology available from the US, Germany, Japan, etc., and it is engaged in training large numbers of its people to utilize and to maintain this equipment—not only in the fields of aircraft and electronics but also for medical care, dairy farming, artificial-fiber production for textiles, and in many more areas. The faculties of its universities are staffed with Iranians who have gone abroad to the US, UK, France, Germany, etc., to earn their Phds (and often their earlier degrees, too).

There are wide differences, however, in the abilities and attitudes of the various segments of Iran's population which impede the rapid modernization desired by the government and funded by revenues resulting from the 1951 nationalization of the oil industry. To aid in the absorption of modern technology, higher education is being expanded. This article, looking at progress in this direction, concentrates on the electrical engineering departments of four universities—two in the capital, one in Shiraz 440 miles to the south, and the other equally far to the east in Meshed.

Pahlavi University occupies buildings scattered throughout Shiraz, but it is eventually to be consolidated in new structures overlooking the city of 450,000 people from a hill to the

northwest. Its curriculum is based on the American system, and English is the language of instruction, thus enabling foreigners to come for lecturing or study, but there are as yet only a handful of foreign students enrolled in the Electrical Engineering Department, and no foreign lecturers were there at the time of my visit.

Its School of Engineering offers baccalaureates in chemical, civil, electrical, and mechanical engineering as well as in computer and material science. Master's degrees have been available for nearly ten years, but the doctoral program is only just getting started, with perhaps a single candidate in EE. Of Pahlavi University's 1000 engineering students 60 are women (mainly in chemical engineering and in computer science). This number is impressive in view of the tradition that women should be veiled and uneducated, a tradition which the Pahlavi dynasty has been endeavoring to eradicate.

Each year there are some 300,000 applicants for university admission in Iran out of a total population of 30 million, of whom only the 40,000 passing the national entrance examination can be accommodated (2000 to 2500 in engineering schools). Each department has a quota, which is filled according to the students' preferences and abilities, an adequate knowledge of English being an additional requirement for Pahlavi University. An easier examination is given to members of the armed forces seeking admission to universities and two-year technical schools. In Pahlavi University's Electrical Engineering Department 12 places are designated for them as compared with 40 for the others, but about half of these 12 fail to complete the curriculum, which involves 15-20 hours per week of classes and laboratories for the four years.

The Electrical Engineering Department, whose head (now Ass't Prof. M. Tavakoli with a PhD from the Univ. of Pennsylvania) is elected biennially by the 20 faculty members, has 235 undergraduates and 15 graduate students. (There are plans for nearly doubling these figures.) The students admitted for the BSEE before 1976 followed a five-year program, but the more elementary portions have been pruned to provide a four-year curriculum now, though disruptions may lengthen it. These disruptions appear to result at Pahlavi University from protests against snap quizzes given by teachers educated in the US as well as against their student's records' showing failures. The students are, in addition, very critical of the curriculum, which they sometimes see as irrelevant to the jobs they will get supervising the assembly of imported components into systems designed abroad.

Instructors handle laboratories for 2 or 3 hours 4 or 5 days a week, while assistant professors give two 3-hour courses per week, with allowance for new courses and for organizational activities. However, the atmosphere is described as not conducive to research because of the difficulty in obtaining and maintaining the necessary equipment. Good technicians and secretaries leave to take jobs in industry at much higher salaries. Assistant professors get approximately $1000 per month. Although they could get more in industry, they stay at the universities first because they are obliged to do so by the terms of their grants for previous study abroad and second because, as professors, they receive tax and other fringe benefits (housing, books, and lunches at reduced prices) as well as considerable freedom in regard to working hours.

In 1971 Pahlavi University founded the *Iranian Journal of Science and Technology*, which it continues to edit, but which is now published in London by the Pergamon Press, with contributions and editorial advice from many countries. Also in 1971, the 2500th anniversary of the founding of the Persian monarchy by Cyrus the Great, the University initiated a series of Conferences on Electrical Engineering, conducted in English, which have been attended by participants from all over the world. The Fifth Conference, held 27-30 October 1975 with the sponsorship of Shiraz's two electronic enterprises (see below) along with the Hughes Aircraft Co. and Westinghouse Electric Corp., included 113 papers with a total of 180 authors covering a wide variety of topics, from power and communication systems, electronic and electro-optic components, to system, circuit, and control theory. Its proceedings fill over 1600 pages. The Sixth of these conferences will take place there 12-15 March 1979.

Research at the University is to receive support from Iran's Ministry of Higher Education and the University Research Council as well as from the Pahlavi University School of Graduate

Studies. In addition, there is a radar project supported by Iranian Electronic Industries, which is also in Shiraz. Ultimately this new organization may utilize the services of the faculty as consultants up to a certain permissible maximum, but so far the only outside source of such work for the university staff seems to be Shiraz's two-year Technical School of Electronics, which trains technicians.

Ferdowsi University (formerly the University of Meshed, which is *Mashhad* in Farsi) is named for a famous 11th-century poet and historian, who set the foundations for the modern Farsi (Persian) literary language. Meshed, a city of 750,000 people, is noted for its beautiful shrine (begun in 1405) to Imam Reza, who died in 818. The University, which is scattered throughout the city, is about 25 years old and is still growing. Its two-year-old School of Engineering (whose dean is Dr. A. Haerian) has not yet developed an electrical engineering curriculum. Lying far from Teheran in northeastern Iran near the Turkmen SSR and Afghanistan, Meshed must attract professors largely through their obligations resulting from education abroad, as family ties are strong in Iran and people are thus attracted more and more to the capital, where an eighth of the country's population resides. Being off the beaten path (except for religious pilgrims), this university is eager to receive visitors, and I was overwhelmed by its hospitality.

During my visit the Faculty of Science had suspended teaching for a month because of student demonstrations, but its operation continued normally otherwise, apart from tight control over who was allowed to enter the premises. I was able to give a talk there for both that faculty and the School of Engineering, whose teaching was not interrupted. I was told that in this School 30% of the students are women.

The Mathematics Department, headed by Dr. B. Honari, includes 17 Phds on its faculty. Dr. R. Agahi heads both the Mechanical Engineering Department and the three-year-old Computer Center with its rented IBM 370/135, which handles the University's administrative data processing via FORTRAN by batch processing. Another computer is to be acquired with remote terminals for scientific computing, but there is so far little demand for research computation. This Center is intended to serve not only the University but also all of the governmental needs of the province of Khorasan.

When Ferdowsi University decides to set up an Electrical Engineering Department, the man likely to become its head seems to be Ass't Prof. Hossein Mousavinezhad, who joined the School of Engineering in 1977 upon return from ten years abroad—five in Taipei, where he got his bachelor's degree from the National Taiwan University, and five at Michigan State University, where he got his PhD for research on the biological effects of ultra-high-frequency radiation.

The University of Teheran with 25,000 students has a large campus in the center of the capital, and Engineering is its oldest Faculty (45 years old and headed by Dean A.M. Miri), but its Electrical Engineering Department (headed by Dr. Nili) is located a few miles to the north in the Amirabad section of the city. The Department, with 200 to 250 students enrolled in the four-year BS program and 5 in the MS program, is designated the Institute of Electrical Engineering. It seems to have well-equipped laboratories for power, microwaves, digital circuits, etc., in a large building with adequate office space.

Nearby is Iran's four-year-old Telecommunication Research Center (TRC), headed by Dr. Taba, which is operated by the Institute of Electrical Engineering as the Ministry of Post, Telephone, and Telegraph (PTT) laboratory for developing telephone equipment needed in Iran. It too occupies a large, well-equipped building, but it is seriously understaffed, having only a dozen engineers altogether for its seven divisions. In 1979 two more divisions are to be added, dealing with optical and with satellite communications, as a 12-to-14-GHz domestic satellite is planned for 1983 to serve educational needs in 65,000 remote villages as well as to carry television and telephony. Iran has about 900,000 telephone subscribers at present but expects to add two million by 1983 and another three million by 1988.

Domestic manufacturing of most telephone equipment is not yet foreseen, but the Telephone Company of Iran has two factories in Shiraz that make subscriber sets and produce spare parts for step-by-step switching systems and for frequency-division multiplexing.

Some of the equipment and personnel at the Telecommunication Research Center come from Japan as WWII reparations, but there is also assistance provided by the Bell Telephone Laboratories.

Among the devices developed at the TRC are circuitry for protecting central-office equipment from the 220 V put on the line by certain subscribers who want to shock the people they phone, a device that will keep trying a busy number every 30 seconds till the call goes through, integrated circuits for concentrating three or nine subscriber lines onto one pair of wires going to the central office, and a printed circuit for use in subscriber sets to prevent the making of long-distance calls (e.g., from a business). There is also work on the standardization of private branch exchanges for compatibility with central-office equipment.

Some undergraduate projects are carried out at the TRC, and university graduates may come to work at the TRC for a year before going off to do their two-year military service. Among its facilities the TRC has a CDC batch terminal and visual-display unit connecting it with the IBM 370 and CDC Cyber computers at the University of Teheran.

In connection with the future satellite, work is already under way to assess the fading at 12 GHz over a 36-km path and to correlate it with rain measurements. The 1.2-m fiberglass paraboloidal antenna was made at the TRC. A decision has yet to be made as to whether the satellite will be under the control of the PTT or of the National Iranian Radio and Television (NIRT), as both want it. NIRT, incidentally, offers not only the two Farsi TV networks to its viewers but also a third service, which carries educational programs during the day and news and American serials in English during the evening.

Arya Mehr University of Technology (AMUT), on the west side of Teheran toward the airport, is 10 or 12 years old, has 4000 students, and enjoys a reputation as one of the two best engineering schools in Iran (the other being Pahlavi University). It has admitted no new students since 1976, however, and in 1979 it will begin admitting military officers in its new role as the Military Science and Technology University, offering the BS, MS, and PhD in 11 fields, including physics, biochemistry, computer science, radar, and engineering, with Dr. Sekhavat coming as its chancellor. It is intended to have 2000 students and a faculty of nearly 700. In 1990 it may again become a civilian institution.

Meanwhile, the name AMUT will survive in Isfahan, 220 miles to the south, where a large new campus 7 miles north of that city is already under way. Ultimately it is to have 20 to 30 thousand students. The faculty in Teheran has been urged to move to the new campus, but few members want to leave the capital. Instead, they will be allowed to stay on at the reoriented university. The new AMUT campus is essentially a new university rather than a relocation.

AMUT's Electrical Engineering Department, headed by Ass't Prof. Djavad Saiy, has 32 faculty members and offers 52 courses for the BS and MS—the latter degree since 1975. The Department used to have 600 students when it admitted 120 per year, but it is now down to 400-500, of whom 30-40 are graduate students.

Ass't Prof. Mahmoud Tabandeh in the Department's Digital Group supervises a team of two undergraduates who have developed a 12 × 128-dot display for news in Farsi and have adapted a 7 × 7-dot matrix printer to Farsi by using two lines (14 dots high) per character. They have also introduced a simplification into the operation of a Siemens Farsi telex machine. This machine originally required the frequent use of two shift keys in order to obtain the required one of the up to four forms (initial, medial, final, or isolated) of each of the 32 letters (consonants) in the alphabet. By introducing the required logic, they are able to have the necessary shifts performed automatically as soon as the succeeding letter is typed in. Thus, the device is always one letter behind in its output, but it saves the typist a lot of work.

Altogether the Department has 14 laboratories, each providing a variety of experiments for teams of two students to work on during an academic term, and they seem to be well equipped. Other research in progress relates to the educational satellite mentioned above, and to guided-wave ultra-high-frequency transmission along a single uncoated wire, this latter work being directed by Ass't Prof. Mehdi Nouri. With all of the knowledge imported from well-known universities abroad and in many cases from employment abroad, too, by the Department's 32 faculty members,

electrical engineering at AMUT in Teheran seems to be well provided with talent and equipment. It is a shame that disruptions in its program will reduce its output of well-qualified graduates.

Conclusion. The government of Iran is endeavoring to bring about a rapid modernization of the country while the oil remains with which to fund it. Meanwhile the country continues to be interestingly different. Despite the Emperor's desire for modern dress many women still go about the streets in black tent-like *chador*s with only their eyes and noses peeping out, in accordance with Islamic tradition. Thursday and Friday are the days businesses are closed. Storm sewers are often concrete trenches running along the sides of each street, making crossing difficult. The mosques are dazzlingly beautiful. Symbols for numbers are different in Iran. Figure 1 shows the Arabic numerals used in Egypt and elsewhere (taken from

Hindu-Arabic Numerals

1 2 3 4 5 6 7 8 9 0

Arabic Numerals

١ ٢ ٣ ٤ ٥ ٦ ٧ ٨ ٩ ٠

Iranian Numerals

۱ ۲ ۳ ۴ ۵ ۶ ۷ ۸ ۹ ۰

Figure 1.

David Cheng's "Arabic Names and Arabic Numerals," *ESN* 31-9:410) along with those used in Iran. While Farsi, like Arabic, is written from right to left (though it is an Indo-European language), the numbers go from left to right.

South of Isfahan (*Esfahan* in Farsi) I saw a beautiful $500 million artificial-fiber plant being built by Dupont for the Polyacryl Iran Corporation, which will have to run continuously, on three shifts, 365 days a year, in order to avoid clogging of the pipes. It represents the latest technology for producing acrylics and polyesters, which are to be incorporated with the short-grained Iranian cotton to produce textiles. It will be interesting to see whether Iranians are able to take over the running of such plants, which require a big departure from their traditional ways of working.

Those I met in hotel lobbies and airports who are in Iran to provide training in jet-engine maintenance and other forms of advanced technology noted difficulties arising from cultural differences. There are, however, many very capable people in Iran, and they keenly feel the need to modernize before the oil runs out. (Nelson M. Blachman)

MATERIAL SCIENCES

MACROSCOPIC AND MICROSCOPIC EXAMINATION OF MATERIALS: TWO VIEWS FROM ISRAEL

A complete understanding of the behavior of materials often requires either or both detailed macroscopic and microscopic examination. The choice of viewpoint taken can yield quite conflicting results, and lively debates between the "foresters" and the "treeers" frequently provide a little sparkle to meetings. However, there are many materials and physical phenomena which are best suited to only the one level of magnification compatible with the level of detail needed. An example of each of these situations was found during visits to two Israeli universities.

In the Department of Materials Engineering of the Technion-Israel Institute of Technology, Haifa, Professor David Brandon is studying ways of imaging biological macromolecules (biopolymers), in his case the genetic information carrier DNA (deoxyribonucleic acid). Besides its obvious importance in biological studies, this material has the advantage that when extracted from the virus T4 bacteriophage, it is well characterized, easily obtained, and the strands are long enough ($\simeq 40\mu m$) so that they are not readily confused with artifacts present in the supporting material. To date there has been little success in obtaining high resolution, good contrast images of such a macromolecule, even though its size (molecular width) is well within the resolving power of modern transmis-

sion electron microscopes, which at an accelerating voltage of 100 kV is a point-to-point resolution of better than 0.2 nm (2 Å). However, it is one thing to image thin crystalline conductive metal films, and quite another to image organic materials which require staining techniques or inclined-angle shadowing by a heavy metal to enhance the molecules' inherently poor contrast. Poor contrast is not normally a problem in metallic films which are usually imaged by diffraction contrast from the regularly ordered array of atoms. In addition, staining can react with the molecule and damage it, can cause it to swell, and can be a source of many other kinds of artifacts. These effects limit resolution to not better than 1.5-2.0 nm. While the use of shadowing instead of staining can give an improvement to 0.5 nm, this technique suffers from structural irregularities in the shadowing deposit, as well as visual noise due to the granularity of the supporting substrate. In addition, with both methods, radiation damage caused by electron bombardment in the microscope is a serious practical problem.

To overcome these difficulties, Brandon and his colleagues have proposed a new specimen preparation technique, known as epitaxial sandwiching, for improved contrast-imaging of macromolecules. With this method, a DNA molecule is imbedded in a crystalline metal foil and behaves as a crystal lattice defect, whereby the contrast is now dependent on those parameters controlling crystalline diffraction, and resolutions of 0.2 nm are then in principle achievable. To produce the sandwich a 4-nm gold single-crystal support film is used. To eliminate subsequent artifacts or obscuring secondary features, this substrate should be as structurally perfect as possible. To accomplish this, it is produced by epitaxial vacuum deposition upon a 0.2-μm thick silver single crystal film, which itself was epitaxially grown on a cleaved NaCl single crystal that was first vacuum annealed and irradiated to improve its perfection. The duplex Ag/Au film is floated off the NaCl in water, and the silver film is dissolved in dilute nitric acid.

The DNA biopolymer is deposited onto the gold by a "streaking" technique that entails moving the film across the surface of a buffered DNA-containing solution in the <100> crystallographic direction of the gold lattice. The final sandwich is prepared by depositing a second epitaxial gold layer over the one containing the DNA. By the use of high vacuum, a low deposition rate, and a substrate temperature of less than 140°C, the proper combination of minimum damage to the polymer strands and a low incidence of image-obscuring randomly-oriented gold microcrystals are achieved.

In order to understand the origin of the observed images, computer-based images for the biopolymer containing sandwich were calculated assuming that the contrast from the molecule in a crystalline matrix arises both from the presence of a low electron-density void in the sandwich, whose shape is that of the molecule but whose presence does not otherwise perturb the crystal structure, and from a strain field in the vicinity of the molecule-crystal interface, due to the displacement of metal atoms in the crystal lattice from their equilibrium lattice positions. The validity of this simulation was borne out by a reasonable correlation between the computer generated image and experimental observation. Variations in the width of the molecule could be explained, by comparison of the two, as caused by strain field contrast effects.

The most striking result to date is the experimental observation of an underlying image periodicity parallel to the axis of the molecule and having a wavelength of 3.2-3.6 nm. This is an excellent agreement with x-ray data giving the pitch of the double helix structure of 3.4 nm.

Observations of these kinds are always exciting to the nonbiologist since they seem to be only a step away from revealing the secrets of life. The groups at the Technion, being more sophisticated than I and not prone to these fantasies, are continuing their careful development of the technique to obtain more reliable images and to extend the method to other biological specimens.

From looking at aggregates of atoms to a visual examination of structural instabilities is but a short trip from Haifa to Beersheva. At the time of our visit this had the added incentive of going from an area a few miles from the hostilities of the Lebanese border to the relatively safety of the Negev desert, an only slightly calming move.

Dr. Rautu Sandu, an Associate Professor in the Mechanical Engineering Department of the Ben Gurion University of the Negev at Beer Sheva, described to me chromoplasticity, a new method for investigating the behavior of structures in the elastic-plastic range by the use of small-scale plastic models. The claim of newness for the technique must be qualified in that the first paper in the field was published in 1958, Sandu then wrote a book on the subject in Romanian, published in 1963 by the Romanian Academy of Sciences and subsequently translated into Russian in 1968. He then made the "revisionist error" of applying for a visa to emigrate to Israel and was immediately relieved of all his academic and research positions, so that little work went on in the subject area until he was finally given permission to leave Romania in about 1975.

The technique utilizes the change in color of certain plastics when they begin to plastically deform. Although somewhat reluctant to describe the composition and processing variables of the materials in detail, he described them as similar to the family of polyvinylchlorides. About 20-25 materials have been shown to date to be chromoplastic and, in addition, to have the important property of not chemically or physically degrading for periods of about 6 months. Further, a material can be selected with specific mechanical properties such as elastic modulus, yield stress, and either viscous or work-hardening plastic behavior, similar to the structural metal of interest. Those developed to date have yield strengths in excess of 500 kg/cm^2, comparable to lower strength metals, and considerably in excess of other transparent plastics that display birefringence under polarized light, and which are used to study elastic stress distributions and stress concentrations.

A chromoplastic material is initially transparent. If loaded to beyond the yield stress, it will turn yellow if the resultant stress field is tensile and black if it is compressive. Thus, not only can plastic instability be monitored visually (at a magnification of 1 X) but the nature of the stress state causing plastic flow can be identified. The similarity in properties of these materials to conventional constructional materials is an important advantage, as is the fact that deformations can be easily and fairly accurately monitored, since the chromoplastic phenomena is visible after plastic strains of the order of a few tenths of a percent. Sandu identified the need to develop new chromoplastic materials and the expanded application of the phenomenon to the behavior of structures in the elasto-plastic range as major future research directions. He is also anxious to interest engineering structural analysis firms in the technique. (I.M. Bernstein)

ORGANIC SOLIDS AND FIBERS—AS STRONG AS STEEL!

This note is concerned with the various types of structures found in simple organic solids and with the wide range of mechanical properties that are found as a result of these differing atomic structures. I am indebted to two groups for telling me about this field. Professor A.J. Pennings of the Department of Polymer Chemistry at the State University of Groningen, the Netherlands showed me the work he and his students are doing in preparing and studying organic fibers grown from solution, while Professor A. Keller of the Department of Physics at the University of Bristol, UK, introduced me to the wide range of structural information about organics that now exists and to which he and his group have brought some of the most unifying concepts.

Let us first consider organic solids made in the usual way by cooling from the melt. While this is the most common kind of material, it is also the most difficult to characterize. There are regions of crystallinity and regions that are amorphous as determined by properties such as density, heat of fusion, or x-ray and neutron diffraction. The crystals are too small to be seen by straightforward microscopy. Fig. 1 shows a possible arrangement of the long chain polymers in such a solid. The large elasticity and low strength typical of organics would arise from the weak bonding between regions of high crystalline order.

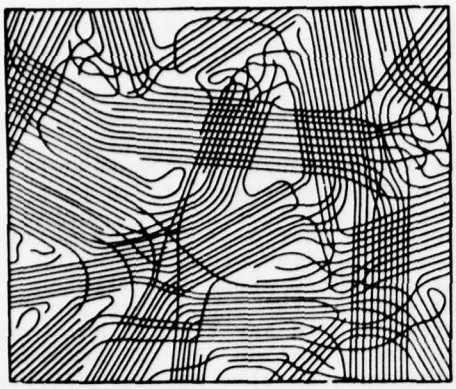


Fig. 1. Representation of normal organic solid

When crystals of polyethylene (Fig. 2) are prepared from solution, flat

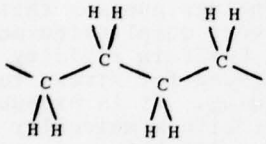


Fig. 2. Polyethylene chain

crystal sheets or lamellae are seen by electron micrography. The thickness of these lamellae is uniform and is in the region of 100 Å. It can be determined from micrographs or, when the lamellae are stacked on top of each other, by x-ray diffraction. The thickness increases with the temperature at which the crystals are grown. If a crystal is prepared at one temperature and then held at a higher temperature, the lamella thickness may increase by as much as a factor of five.

Keller and his group are among the leaders in developing the structural model for organic lamellae shown in Fig. 3. The long chains of polymers

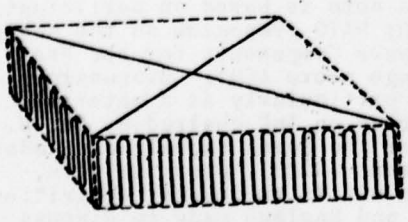


Fig. 3. Chain folding model of organic lamellae

grow for a hundred or so Å and then fold over. The folding process is thought to reduce the free energy, and thermodynamic arguments can be used to justify the stability of the crystal once it is established. However, a fibrous crystal made of long parallel chains would have even lower free energy but this structure is not obtained from normal solution growth. There are also kinetic arguments that crystallization may proceed more rapidly by chain folding. A first principles theoretical explanation of chain folding does not seem to have been made as yet. This does not alter the fact that chain folding occurs, and this is borne out by a wide variety of experiments including low-frequency Raman spectroscopy which gives independent evidence of the fold length of the chain.

The model of Fig. 3 is certainly overly idealized. The range of melting temperatures and other evidence for some amorphous character in the lamellae may mean that some disorder is present. One possibility is that the loops at the ends of the straight chain segments are of different lengths and configurations thus leading to some spread in properties.

An important question is whether these lamellae, seen so convincingly in solution-grown material, also appear in melt-grown solids. There seems to be very little hard evidence on which to base an answer.

A quite different structural form occurs frequently in natural organic materials. Plants, trees, and even bone show a strong tendency to form long fibers. Indeed, one would have guessed that this should be the natural format for long chain molecules. However, Pennings and A.M. Kiel were the first to discover how to form such fibrous polyethylene from solution. In quiescent solutions, as we have seen, the folded chain appears in lamellae growth. Pennings and Kiel showed that if the liquid streams past the solidifying material, the tendency for chains to fold may be overcome and a long fibrous material is formed. The actual shape is a complex one as seen in Fig. 4 which is drawn from a transmission electron micrograph with the dimensions of the small structures transverse to the main axis being up to 5000 Å. This is often referred to as a "Shis-kebab" structure; the name is of American origin as one might guess!

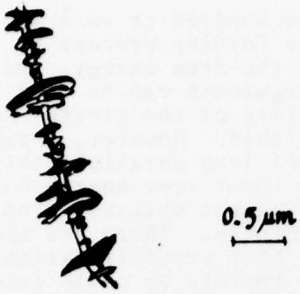


Fig. 4. "Shis-kebab" structure of organic fibers

The main core consists of straight flat fibers about 1000 Å in width. It is these long molecules that form and solidify under tension caused by the streaming liquid. The side structures simply attach themselves to this core and may have the familiar lamellar structure. When tested for mechanical properties, these Shish-kebabs showed high fracture strength and high Youngs modulus owing to the fibrous backbone; the side structures contribute very little. The ratio of core to side structures could be increased by growing the fibers at higher temperatures and was studied over the range of temperature from 105°C to 120°C. The strongest material had a fracture strength of 3×10^4 kg/cm^2 and a Youngs modulus of 10^6 kg/cm^2. These values are about the same as those for high strength steels.

Pennings and his students have been looking at various ways to produce these fibers continuously from solution. The maximum pulling speed is presently about 150 cm/min. That is hardly the kind of number to make a production engineer's pulse leap with eager anticipation, but it has allowed the group to build up a quite adequate collection of spools of fibers for future work. Pennings now wants to explore the use of the polyethylene fibers as reinforcement in cement.

In very recent work, R.G.C. Arridge, P.J. Barham, and Keller have shown that much larger samples of polyethylene can also achieve high strength and stiffness without the use of solutions. They used a tensile test specimen with dimensions of 20 mm × 4 mm × 1 mm. The specimen was drawn at 75°C to about 30 times its original length and showed a large Youngs modulus of 8×10^5 kg/cm^2. A strange sequence of events occurred on annealing. If the specimen was released after stretching and heated to 140°C, it nearly returned to its original shape and its Youngs modulus was reduced to about 8×10^4 kg/cm^2. However, over a period of hours at room temperature the modulus increased again to a value of about 6×10^5 kg/cm^2. The authors speculate that a process of melting and recrystallization occurs in which the fibers oriented along the stretch direction grow at the expense of the other material. In any case it has been shown that manipulation of bulk samples of polyethylene can also produce material with superior stiffness and strength.

Perhaps a word should be said about a comparison of the high strength polyethylene with the *Kevlar* material produced by Dupont. Not much information of a basic nature has so far been published on *Kevlar*. Pennings guesses that it consists of a more complicated molecule with perhaps a built-in rigidity that eliminates the need for stress to prevent chain folding. It is probably a shorter polymer with a molecular weight near 10^3 while polyethelene is around 10^6. However, detailed comparisons are not really possible. Both materials are enormously strong and appear to rely on the same extended chain idea.

It seems likely that we will see the continued development and application of new classes of practical organic materials having extraordinary strength. Exactly what their principal uses will be makes for interesting speculation. Will we someday perhaps have truly indestructible hosiery? Would the ladies buy it? (Clifford C. Klick)

INDIUM PHOSPHIDE AND OTHER III-V MATERIALS ACTIVITIES

This note is based on participation in a recent NATO Symposium on the subject of "Microwave Components for the Frequency Range above 6GHz," discussions there and particularly at a material working group on InP chaired by Dr. W. Bardsley of the Royal Signals and Radar Establishment (RSRE), Great Malvern, UK, and on visits to several activities in France and England made to discuss work on InP and to compare InP and GaAs material technology.

It was apparent from the Microwave Component Symposium, at which papers were presented from the UK, France, the Netherlands, US, FRG, and Canada, that materials and components for millimeter wave technology are being actively pursued, although there is some question concerning projected applications for such components. The British seem to have a considerable lead in InP materials and device technology where work is primarily concentrated on Gunn devices. Field effect transistors (FETs) are also being investigated; however, the IMPATT diodes' results are quite impressive. While the US has programs in material preparation and growth, the device technology activity is not as intense as in the UK. The major activity on InP in France is at Thomson CSF where both vapor and liquid phase epitaxial programs are on-going. The West German InP effort is at Physikalische der Universität in Stuttgart and is very limited in scope.

The working group on InP found the material extremely promising for applications in the fabrication of microwave and millimeter wave devices and that it possesses intrinsic physical, chemical, and electronic properties that make it superior to GaAs and Si for certain purposes. However, a great deal of materials and device work remains to be done even though some InP devices appear to be near the commercially available state.

As noted earlier, our visits beyond the NATO Symposium were limited to the UK and France. The Thomson CSF Laboratoire Central de Recherche, Orsay, France, (where our host was Dr. P. Moutou) is on a hill just outside the delightful village of Orsay. It was formerly an estate and some of the original buildings are still in use. There are about 700 employees with about 420 involved in R&D and the others in production activities. The Central Research Laboratory receives about 8% of the total Thomson CSF research budget and about 80% of the funds are internal. The III-V material work is on GaAs, InP, and some mixed ternary and quaternary alloys, such as GaInAs and GaAlAs. There is no bulk growth of substrate materials and very little effort on liquid phase epitaxial (LPE) growth since initial results on vapor phase epitaxial (VPE) growth have been very encouraging.

VPE growth of InP, mainly by the chloride system, has been on-going for about three years. CSF have been able to prepare very respectable layers with extremely good surface morphology via the mole fraction effect. This work has been rapidly advanced owing in part to the impressive amount of background work on GaAs and Si using the chloride processes. CSF also have a very substantial effort in organometallic VPE growth of the III-V materials. Results of this research have yielded GaAs and InP equivalent in properties to device quality material prepared by the conventional chloride process. These results are very impressive, especially since CSF use organometallic reagents from the US and appear to be producing layers superior to those prepared by the US laboratories who initiated the technique. There is also a substantial effort in molecular beam epitaxial (MBE) growth of III-V compounds, with three units in operation for InP, GaAs, and GaInAs, respectively. The majority of the activity in the three- and four-component alloys is for electro-optic applications. Overall, the work in device quality InP epitaxial growth is quite good and is state-of-the-art, or better.

The Centre National d'Etudes des Télécommunications, Lannion, France, where we were hosted by Dr. R.A. Mircea, is about the same size as the Thomson CSF one and is very well equipped. This Philips Laboratory is about 90% internally funded. Approximately one quarter of the staff is involved in solid state activities. There is no InP work, but a substantial effort is being carried out on GaAs especially for FETs, with smaller efforts on Gunn devices and integrated circuit technology. GaAs growth is by both VPE using the chloride system, and MBE. Another Philips unit is preparing high purity GaAs substrates by the Bridgman technique; however, no details of substrate preparation were available. Excellent thickness control of the VPE layers is achieved, and a significant effort is being made to determine growth mechanisms and characterization. The laboratory appears to be quite committed to research on GaAs with a substantial personnel and equipment investment.

Metals Research Ltd., located in Melbourne, Cambridge, UK, is a division of the Cambridge Instruments Corporation.

It is a major supplier of various material processing and crystal growth equipment and as such prepares various materials to demonstrate equipment capability. In the area of material growth the company via a cooperative effort with RSRE has developed into one of the larger suppliers of single crystal substrates of GaAs and InP. Here our host was Dr. R. Ware.

All the III-V material work is devoted to the growth of single crystal substrates prepared by the liquid encapsulated Czochralski (LEC) technique. The material handling and growth capability is very impressive; GaAs single crystals can be grown with diameter of nearly 3 inches, weighing in excess of 3 kg, and pulled in the (111) or (100) axis. Metals Research Ltd. use automatic diameter control for the growth process and have been able both to compound and grow in the same operation.

The InP activity includes both compounding and single crystal growth. The compounding is carried out in a carbon boat inside a thin-walled glass tube that is in a high pressure vessel. Although occasional explosions still occur, the cause is laid to faulty seals in the glass tube. The purity of the product is about $2\text{-}5 \times 10^{16}$ carriers/cm^3. Crystals of "n", "p", or semi-insulating properties are then pulled along the (111) or (100) direction in a high pressure puller by the LEC method. Twinning is a problem, especially for the (100) crystals; however, it is believed that by proper thermal controls, and especially of thermal gradients, the problem can be and is being reduced. Most III-V materials are generally double pulled with the ends of the crystals being rejected each time to reduce impurities. Overall Metals Research have an impressive bulk growth capability with very good single-crystal pulling equipment for both low- and high-pressure applications.

The material research activities at RSRE (where Bardsley was our host) have been and still are very impressive. Since 1969, this laboratory has pioneered in InP materials and device technology. The major device activity is directed towards applications below 20 GHz. Bulk single-crystal growth (see C. Click, *ESN* 31-12:494) differs from that ongoing in the US in that they purchase their polycrystalline InP for LEC growth and then double pull their crystals. (The electrical properties are quite similar to those grown in the US where compounding includes a gradient freeze followed by a single-crystal pull technique.) The semi-insulating crystals are iron doped. Automatic diameter control is widely used by both RSRE and Metals Research for InP and GaAs.

There is little or no effort at RSRE on LPE growth of InP; however, there is major work in VPE by the chloride process. Separate reactors are devoted to fabrication of specific device structures. RSRE believe that the primary material problem is obtaining high purity reproducible indium. An area now under study is the apparent discrepancy between room-temperature Hall mobility and that measured at liquid nitrogen temperature. A series of epitaxial layers may all show good and fairly uniform mobility at room temperature; whereas, at 77 K the value may vary by a factor of two. Devices made from the layers appear quite uniform. The device group under Dr. Grey has prepared InP transferred electron oscillators in the J (Ku) band with performance superior to any other solid state material. The Schottky gate is still a problem in InP and is holding back MESFET development. MBE is being used for basic surface and metallization studies in InP.

The work at Allen Clark Laboratories of Plessey Ltd., Caswell, Towcester, UK, where we were hosted by Drs. G. Gibbons and M. Cardwell, is concentrated heavily on microwave and electro-optic device investigations using both GaAs and InP binary, ternary, and quaternary alloy systems. The full range of VPE and LPE systems is utilized. GaAs and InP for microwave TED (transferred electron devices) and FET devices are fabricated in VPE chloride systems. Light emitting diode (LED) structures of GaAs and GaInAs are made in a hydride system. LPE is used for the growth of GaAs-GaAlAs and InP - GaInAsP structures for laser sources. An organometallic system capable of depositing GaAs and GaAlAs is used for FETs, solar cells and LEDs.

The only bulk growth work at the laboratories is the synthesis of GaAs source material for the chloride VPE system. The material is grown in-house, to insure reliable high purity source material for VPE, by passing three molten zones through a charge which is synthesized *in situ*.

In the VPE of InP, Plessey has found large variations in the purity of In supplied by different commercial firms

and in batch to batch purity. Their results on VPE of InP appear to support the conclusion of Clarke at RSRE that the mole fraction effects during growth are operative.

In conclusion, InP is rapidly emerging as a very important semiconductor material for electro-optic and microwave device applications. Progress in InP materials technology within the past few years has been impressive; however, compared to GaAs, materials investigations on InP are in an embryonic stage of development. Continued growth of these researches depends heavily on the demonstration of superior device performance and/or the development of devices where because of InP's intrinsic physical and chemical properties, GaAs cannot compete. Theoretically InP and alloys of InP with GaAs have this potential, especially in the electro-optics and microwave areas.

For fiber optics applications, for example, minimum absorption and dispersion in state-of-the-art fused silica fibers has been shown to occur in the 1.1- to 1.3-μm region. Double heterojunction (DH) diode lasers, operating in the CW mode at room temperature, would be ideal light sources for fiber optics communications systems, and such sources have been fabricated from several ternary and quaternary alloy systems. The long operating times, 3000-4000 h, reported for initial lasers made from the lattice-matched GaInAsP/InP system offer great promise for this application, and work is now underway to fabricate detectors using the same alloy system.

In the microwave and millimeter wave area the high peak-to-valley ratio and reduced scattering time due to the high threshold fields of InP indicate that, in TEDs, InP should be almost twice as efficient as GaAs and be able to operate with similar performance at twice the frequency. In addition, the higher avalanche field in InP indicates that FETs made from InP will be capable of yielding higher output powers than is achievable with GaAs. Equally and perhaps even more important are the unique surface properties of InP which suggest that InP is a far more attractive material for integrated circuit applications than GaAs.
(H. Lessoff, Naval Research Laboratory, Washington, DC and J.K. Kennedy, Rome Air Development Center, Bedford, MA)

MECHANICS

AERODYNAMICS AT THE TECHNICAL UNIVERSITY OF DELFT

The Technical University of Delft is the principal source of engineers for the Netherlands. Admission is determined by the level of high school certificate earned by the student. High school students in the Netherlands are generally divided into three streams, and it is the certificate that results from the highest stream that admits a student without qualification to the Technical University. In total there are some 10,000 students at the University in residence for the degree of engineer. The course of study leading to the engineer's degree is five years in length. Because of its "open admissions" policy, the dropout rate at the Technical University is generally between 40 and 50% of the entering students. There is no formal graduate program; however the doctorate is available upon presentation of a satisfactory dissertation that may be done either in residence or outside the university. Very few doctorates (Doctor of Technical Science) are given in Mechanical Engineering and Aeronautics although somewhat more are awarded in Applied Mechanics, Fluid Mechanics, Chemical Engineering, and Materials Science.

Some 500 students are enrolled in the Aeronautics program; 100 per year are admitted to the freshman class and about 50 graduate a year. Since it is very difficult for a university in the Netherlands to drop students, many students linger well over five years and some as long as eight or nine before finally giving up. The first three years of the curriculum in aeronautics are standard. The fourth year options include aerodynamics, design, stability and controls, structures, production and materials, and space technology. The fifth year is devoted to a research project.

Low-speed aerodynamics is chaired by Prof. J.L. Van Ingen, who is also in charge of the low-speed wind tunnel. The program in high-speed aerodynamics is chaired by Prof. S. Erdmann, who is also in charge of the supersonic wind tunnel. My host at the Technical University, Prof. J.A. Steketee, heads the program in theoretical aerodynamics.

An example of a report of the fifth year of research done by a candidate directed by Steketee is entitled the "Optimized Lifting Wing with Slightly Curved Subsonic Leading Edges in Linearized Supersonic Flow." The study compares drag with constant lift and wingspan for a particular class of solutions involving either straight or sonic trailing edges. The quality of work shown in this example is such that it is quite comparable with doctoral theses that I have seen in the US, and, according to Steketee, with very little extra work could be made into a doctoral dissertation at the Technical University.

In addition to his interest in the optimized wing, Steketee is involved in a number of wide ranging theoretical studies. One such is formulation of unsteady, one-dimensional nonhomentropic flows and one-dimensional unsteady gas dynamics. An example of such flows with nonuniform entropy is formulated in terms of Lagrangian coordinates which result in a formal presentation that is most elegant. This work is being performed by Dr. P. Coene and Ing. H. Bos.

In magnetofluidynamics, Steketee is studying the magnetohydrodynamic equivalent of Rayleigh's problem, that is, the problem of an infinite conducting plate surrounded by a conducting liquid where the plate is moved impulsively from rest in its plane in the presence of a transverse magnetic field. The effect of the edge of a segmented electrode is modeled by making half of the infinite plate from the origin to minus infinity perfectly conducting, whereas the other half of the plate from the origin to infinity is nonconducting. Mr. G. Schouten is studying magnetohydrodynamic flows in rectangular channels with particular reference to flows at the entrance of such a channel into a magnetic field and flow deformations at electrodes. Ing. Hansen is studying flows generated by injecting currents into a liquid metal such as an arc struck between electrodes immersed in the liquid metal. The problem of a conical electrode in an infinite fluid such that the conical electrode discharges a current to an electrode placed at great distances, is being studied with respect to the jet that is formed by the interaction of the discharge with the self-generated magnetic field.

In the area of incompressible potential flow Coene is studying slender body theory as applied to fish propulsion. A particular problem that he has investigated involves a dolphin swimming beneath the surface of water with waves passing along the surface. Under some circumstances the dolphin can extract energy from the waves to aid his propulsive effort. Coene is also studying an interesting type of windmill that consists of two disks spaced a distance from each other along a horizontal axis. The disks have a number of blades mounted between them at their periphery and oriented in an axial direction. The blades have variable pitch, much the same way as in the Voith-Schneider propeller. In this way, a wind passing through the device, which Coene calls a cyclogyro, extracts energy from the wind and, moreover, causes a large amount of air at higher altitudes than the upper extreme of the cyclogyro to dip into the cyclogyro for energy extraction before returning to a higher altitude. Thus the cyclogyro is effective in extracting energy from a greater volume of air than would normally flow by or through an ordinary windmill device. Further, in the earth's boundary layer, the upper layers of air travel at higher velocity than those close to earth, so there is more advantage to be gained in this setup than would be the case if the flow were purely potential.

In an area that is distinct but yet very similar to idealized fluid flow, Steketee is looking at the potential theory of dislocations. Some years ago he worked on geophysical problems including cracks and crack propagation in the earth. He is now working on a formulation of Navier's equations in elasticity theory which is almost analogous to that of the potential equation in potential theory. The analogs of sources, dipoles, and vortices in potential theory turn out to be centers of compression and shear in elasticity theory. Thus the Griffith's crack can be modeled as a distribution of centers or nuclei of compression in the Steketee notation, whereas geophysical and crystal dislocations are modeled as analogs of a vortex sheet.

The physical plant of the Technical University is enormous, modern, and very well equipped. I visited two large buildings, one containing the subsonic wind tunnel facility, and the other the supersonic and transonic wind tunnel

facility. The subsonic facility contains a number of wind tunnels, the largest of which is equipped with eight interchangeable half sections and balance plates upon which test models can be mounted. The various test sections can be exchanged in the tunnel in a very short time. The supersonic and transonic facility has a similar multiplicity of test sections along with a continuously variable nozzle and a perforated transonic test section.

The superb facilities and equipment I saw at the Technical University support knowledgeable, high caliber people. The outstanding shortcoming is in the scarcity of technicians; the pace of completing projects is therefore understandably slower than it might otherwise be. (Martin Lessen)

PHYSICAL SCIENCES

FIRST EUROPEAN CONFERENCE ON OPTICAL SYSTEMS AND APPLICATIONS (ECOSA I), BRIGHTON, UK

This Conference was held at the Hotel Metropole in Brighton, 4-6 April 1978, in conjunction with an Exhibition, E-O/Laser International '78 UK. The meeting was also international with more than 135 participants from the UK, most European countries, the US, Australia, Canada, Israel, and Syria.

The Conference was generally successful although marred to some extent by the nonappearance of four key invited speakers from the US, Russia, and France and a postdeadline session that probably should have been omitted. The topical coverage was extremely broad, and sessions were devoted to laser fusion, information processing and storage, various specific categories of lasers, integrated optics, surveying and measurement, photochemistry and isotope separation, communications, laser machining and materials processing, remote sensing, and spectroscopy.

Many papers were in the form of reviews. I will concentrate on a few papers in which significant results were presented. Dr. M.W. McGeoch (Science Research Council's Rutherford Laboratory, Chilton, Didcot, UK) in a paper coauthored by 6 other people from various universities and laboratories, described the first experiments on D_2 plasma production by a multi-kilojoule CO_2 laser beam. An electron beam-controlled CO_2 laser called TROJAN started operation early in 1978. This laser is capable of producing a 2.5-kJ pulse in 2 μsec and is used to irradiate 330-μm diameter, 600- to 900-μm long D_2 pellets with a peak power flux of 10^{12} W/cm^2 at the focal region. The laser is triggered automatically by an optical sensing technique that signals when the pellet is in the focal region. The reliability of proper target interception is 50%.

According to auxillary shadowgraph measurements with a ruby laser, the D_2 targets appear to be completely burnt through for energies > 1 kJ. Ionization is observed with Faraday cups. Isotropic ions with 100 to 400 eV are detected along with an anisotropic 5-eV component.

In another session Dr. M.W. Sigrist, *et al* [Solid State Physics Laboratory, Swiss Federal Institute of Technology (ETH), Hönggerberg, Switzerland] reported their work on laser-generated 60-MHz acoustic waves in liquids. This is the first report of high-frequency acoustic waves generated in a liquid directly by a single laser beam and detected by a piezoelectric transducer.

The method makes use of the thermoelastic effect induced by pulses of CO_2 laser radiation from a hybrid laser interacting with the liquid. The laser is operated in the so-called regime of longitudinal mode beating so that the output pulse is amplitude modulated at the mode separation frequency (f_o). The acoustic signal appears at f_o and can be tuned by varying the length of the cavity. The effect was detected in water and n-heptane but was not observable in CCl_4.

There is a need for tunable coherent sources of near ir radiation. G. Litfin *et al* (Institut für Angewandte Physik, Technische Universität Hannover, FRG) investigated the recently discovered cw color-center lasers. These lasers are operated at liquid nitrogen temperature and have thresholds, slope efficiencies, tuning ranges, and pump wavelengths respectively of 40 mW and 140 mW, 10% and 15%; 0.885-1 μm and 0.84-0.98 μm; and 7530 and 8560 Å for NaF and LiF.

The authors believe these lasers are comparable to dye lasers and are now trying to obtain laser action in other materials. No deterioration of the crystals at pump powers up to

5 - 6 W has been observed. In single mode operation a linewidth of 100 kHz has been achieved in F_B (II) centers in KCl:Na. In this material $dn/dT + \alpha n = 0$ at 78 K where n is the index of refraction, T the temperature and α the thermal expansion coeffient. This means that the optical cavity length is independent of temperature to the first order, therefore pump power fluctuations do not broaden the linewidth.

In another session, Professor F.P. Schäfer (Max-Planck-Institut für Biophysikalische Chemie, Göttingen, FRG) summarized recent dye laser research. He concentrated on work being done at his own laboratory on high-average power lasers, vapor-phase dye lasers and longer wavelength lasers. The first two items were covered in a recent *ESN* article (*ESN*-31-9:372). Longer wavelength operation of dye lasers is a very important area as there are no high-power, narrow-linewidth tunable sources in the near ir. There are several near ir dyes available, however they do not respond well to flashlamp pumping as their absorption spectra peak at longer wavelengths which are not optimum for flashlamps. In principle it is possible to use energy transfer from a dye that absorbs at a shorter wavelength and then fluoresces at a longer wavelength to pump the ir dye. However, when the two dyes are mixed, triplet-triplet interactions increase, reducing the efficiency. Recently it has been found that if the two dyes are linked together with a methyl group to form a new composite dye, the efficiency is increased.

Dr. D.W. Pohl (IBM Zürich Research Laboratory, Rüschlikon, Switzerland) described a new type of spectraphone capable of detecting water vapor in the sub-ppm range. An acoustically resonant tube configuration with a microphone is used as a cell containing the gases to be analyzed. Advantage is taken of a near-coincidence between an H_2O absorption line and a CO_2 vibrational laser transition near 1900 cm^{-1}. The laser beam is modulated and passed through the cell. Pressure variations at the modulation frequency occur owing to absorbed energy and produce an output in the microphone.

Pohl claims this system can detect 0.1-ppm H_2O vapor and is more sensitive than other similar systems as a result of the acoustic resonance technique. I visited Pohl's laboratory in Switzerland and will discuss the details of his technique in a later *ESN* article. The method is easily extendable to other gases.

Mr. A.J. Kearsley (Clarendon Laboratory, Parks Road, Oxford, UK) described his work on a high-power discharge XeCl laser operating at 3080 Å. Peak output powers of 8 MW in 100-mJ pulses have been obtained with 1-Hz pulse repetition rate. An important aspect of this work is that operation was achieved for a 5 hr running period on a single gas filling. This lowers the running costs over existing KrF lasers, for example. Another important factor is that the XeCl wavelength is ideal for pumping certain dye lasers.

Pulsed lasers based on dimers have been known for some time. However, only recently was cw operation achieved on the diatomic homonuclear molecule Na_2. Dr. B. Welleghausen *et al* (Institut für Angewandte Physik, Technische Universität Hannover, FRG) described their extension of this work to Li_2 and I_2. They used Ar and Kr lasers to pump the dimer systems. The I_2 system offers the largest frequency range (5830-13,430 Å) when pumped with 5150-Å Ar laser radiation. Multiline oscillation power of 250 mW and single line power of 2.5 mW has been obtained from I_2. The output power, threshold and gain of the lasers is dependent on several factors including the temperature which determines the dimer concentration and collisional relaxation processes.

Apart from the aforementioned factors, the Conference and exhibition were very worthwhile. The scope of the Conference was broader than indicated by the title, which was fortunate as some of those papers were quite important. (Vern N. Smiley)

CHEMICAL PHYSICS AT THE UNIVERSITÉ LIBRE DE BRUXELLES

Although people may argue whether or not chemical physics differs materially from physical chemistry, the program in chemical physics at the Université Libre de Bruxelles is surely one of quality and breadth. The director of the program, Prof. I. Prigogine, recently became a Nobel laureate in chemistry for his work in the field of

nonequilibrium statistical thermodynamics. Prigogine also directs a similar program at the Center for Statistical Mechanics and Thermodynamics at the University of Texas in Austin. During my visit to the Université Libre de Bruxelles I found that some 70 people of varying scientific background and from all parts of the world are working with Prigogine. Among this group are his students, as well as students of his students, thus illustrating that inbreeding can sometimes, and under the proper circumstances, be beneficial. The research program in chemical physics at Brussels was outlined to me by Prof. G. Nicolis, who has coauthored a book with Prigogine on *Self-Organization in Nonequilibrium Systems*.

In the area of statistical mechanics a large effort is underway in studying the origin of irreversibility. The idea is to demonstrate that irreversibility is a microscopic property if one formulates the problem in terms of nonunitary transformations, or smeared scattering at the outset; irreversibility will then be reflected in the dynamical equations of evolution. At present, some solvable models are being explored with sufficiently simple Hamiltonians. An additional effort is in progress in utilizing a workable generalization of the kinetic equations to obtain transport properties of fluids. Asymptotic expansions about a hard sphere model are being explored, and critical behavior at critical points for liquids, dense gases, and spin systems are being studied. Navier-Stokes type equations are being obtained from the kinetic equations in order to model viscosity, thermal conductivity, diffusion, and relaxation effects near the critical point. The group engaged in this endeavor besides Prigogine are A. Grecos, Claude George, F. Henin, P. Resivois, G. Dewell, M. DeLeemer.

In the area of plasmas, Prof. R. Balescu and L. Brenig are working on the kinetic equations for stable and unstable plasmas and in the process are extending the kinetic equations of Resivois to magnetohydrodynamics. A current interest of Balescu is laser fusion in connection with which he is studying energy transfer between a laser beam and a (hoped for) fusionable pellet. Balescu is studying interface instabilities that are ablation and radiation pressure driven. For excitation waves normally and obliquely incident on a plasma interface with property gradients in the interior of the plasma, Balescu is studying the penetration of energy into and turbulent transport within the plasma.

In the area of thermodynamics and nonlinear problems involving bifurcations of reaction systems, Nicolis and M. Hershkowitz-Kaufman are studying oscillations, waves, spatial patterns, and limit cycles. They are developing a microscopic theory of bifurcations via the theory of fluctuations in nonequilibrium systems. The work will hopefully produce a theory of nonequilibrium phase transition. This research is also being contributed to by Prof. G. Auchmuti (Univ. of Indiana).

In the area of theoretical biology R. Lefever, Mdm. A. Babloyantz, and A. Goldbeter are studying the behavior of regulatory enzymes. An example of a sustained oscillation which may occur is in the rate of cell respiration. Work in the modeling of embryonic development and morphogenesis or cell differential and organization is being pursued via methods for investigating nonequilibrium phase transitions. Also, work in modeling the immune response, and immune surveillance against cancer is in progress. The work is being done in connection with the Pasteur Institute in France, the Weizmann Institute in Israel, and the Max-Planck-Institute in Dortmund.

Since the mathematics of physicochemical systems is similar to that involved in population dynamics and social behavior, such problems are being explored by P. Allen and J.L. Deneubourg. Evolutionary problems are being studied in the following manner: one starts with a uniform population and then introduces employment opportunities that attract population to a center. The concentrated population demands further services, thus finally leading to population saturation in localized areas. The development of an urban hierarchy such as a pilot town and satellites is under study as well as the organization of colonies of social insects. The work of this group is being supported by the US Department of Transportation.

In the area of fluid mechanics, J.C. Legros and J. Platten are studying the simple Bénard instability and two-component fluid instabilities along with the thermally driven, convective motion

in closed boxes. A. Sanfeld is studying hydrodynamic instabilities and motions with membranes present. An example is a membrane in which chemical reactions take place and which separates an extracellular medium from an intracellular one. Interesting effects include transport of particles across the membrane, and vesicle formation. The study of Bénard instability and bifurcation is being pursued experimentally by J.P. Boon using light-scattering techniques. Of particular interest to Boon is the amplification of thermal fluctuations near the transition point in the Rayleigh-Bénard instability. Work in this area is proceeding also in cooperation with the Bell Laboratories. In all, I was greatly impressed with the work and the personalities that I met in Prigogine's program in Brussels. (Martin Lessen)

PSYCHOLOGICAL SCIENCES

TRAINING FOR THE DIAGNOSIS OF SYSTEM MALFUNCTIONS

Many departments of psychology in the US teach applied psychology, but in the UK they not only teach it but actually name their psychology departments in this way. The implication is that the teaching of general theory and uncommitted empiricism is downgraded, and the teaching of useful knowledge is correspondingly upgraded. Such a department is the Department of Applied Psychology at The University of Wales Institute of Science and Technology (Cardiff), with Professor Donald Wallis occupying the Chair. A US psychology student rarely acquires marketable skills without graduate training, but the undergraduate degree in Wallis's Department is aimed toward giving the student skills that will get him a job. A BSc in Occupational Psychology offers the first two years in general psychology, a third year of practical experience off campus, and a fourth year in the classroom doing advanced work in one of three options: Ergonomics, personnel psychology, or applied social psychology. There are also MA and PhD degrees that can be earned, and they are equally applied in character.

The research of the Department has the same applied direction as the classroom study. Instead of uncommitted research dedicated to the establishment of general behavioral laws and theories, it is practical and problem-oriented, as engineering research would be. The biggest project in the Department is Dr. Keith Duncan's simulation studies of training for diagnosis of malfunctions (fault-finding, as the British call it) in process control. The best examples of process control tasks are found in the chemical industry, which is Duncan's frame of reference, but there are examples elsewhere (e.g., a nuclear reactor). Process control involves a relatively slow-moving semi-automatic system, where the human operator observes and waits for the signal of a deviation from system norms, indicating a malfunction. Diagnosis of a malfunction is behaviorally distinct from the remedial action that is taken, and it is the diagnostic behavior that Duncan has under scrutiny. The importance of diagnostic behavior for process control is obvious. Failure to diagnose accurately and expeditiously can either degrade the process, stop it, or result in a dangerous situation.

Duncan uses a simple part-task simulator in his research. A malfunction is represented in realistic line drawings of the instruments on a panel display, and they are photographed and rear projected to life size. An experimental subject will study a failure pattern and say what he thinks the failure might be. Slides showing different kinds of system troubles have been made. The subject is scored on correct diagnosis or not, and diagnosis response time.

A trainee ordinarily will learn about malfunction diagnosis on the job by being alongside an experienced operator as he works, but the training is necessarily slow (a system with frequent malfunctions does not work well enough to function as a system). Because a simulator is not similarly constrained, Duncan has been concentrating on training research to optimize the value of his training device. In a recently published experiment [(*Ergonomics*, 20, 347-361 (1977)] Duncan and his associates compared three training methods. One was a control group in which the subjects were given only a brief description of the instruments on the panel. Another was a theory group who were instructed with the flow diagram of plant operation and were told how the plant worked; it is the kind of account that supervisors ordinarily would give an on-the-job trainee, and from it he is expected to

infer the meaning of failure patterns. The third was a rules group wherein the subjects were taught a set of rules for diagnosis, such as, "Locate the general area of the failure," and "Check all control loops in the affected area." There were six general rules of this kind, and, being general, it was expected they would apply to many kinds of failures.

The gist of the experiment's findings was that the rules group had higher diagnostic accuracy. They took somewhat longer to respond than the control group, however, although the responsetimes were within the limits that actual plant operation allows. Of particular interest was that the rules group performed best on failure patterns that had never been seen before, indicating the acquisition of general strategies of behavior that applied to a wide range of patterns.

In his most recent and unpublished work, Duncan is using a digital computer in conjunction with a graphics terminal and a light pen to study kinds of error feedback, or knowledge of results, after a response. Here Duncan simulates an arbitrary but realistic problem where a failure is indicated, and the operator can call up various items of information that he needs for diagnosing the failure, just as he would do with a computer-based system. Attempts at diagnosis can occur at any point in the sequence. Knowledge of results can be applied sequentially to unnecessary information, redundant information, and premature diagnosis, or it can be applied only at the end of the act when the trainee is informed of his overall success or failure. Preliminary results show that better performance occurs with sequential knowledge of results. (Jack A. Adams)

HUMAN FACTORS IN COMMAND AND CONTROL SYSTEMS

In the war of tomorrow the command of men and the control of weapons will be carried out in computerized command and control centers. Commanders will sit in semi-darkened rooms before consoles whose displays show data that are stored and processed by a digital computer. Such centers will be at the highest military levels where the plans for an entire war evolve, and they will be at lower echelons also. A command and control center will help the Army corp commander direct his divisions, the fleet commander his ships, and the Air Force commander his squadrons. The rationale for these systems is that commanders are faced with a glut of information about which they must make decisions, and they need the assistance that these systems provide. Today command and control systems are receiving most attention from the military, but tomorrow will find them in the offices of industrial executives and government managers as well.

A complex man-machine system will have uncertainties in design, and if the designers waited for research to resolve them all, the system would never become operational. The result is that an operational system often will have inadequacies, and only with expensive retrofitting can they be resolved. There would be advantages in an inherently flexible system, where the essentials are laid down in the early design stage and the rest of it defined as the knowledge becomes available and the need arises; far less specification during design would be required. In our time the general purpose digital computer has become the center of large information-processing systems, and the inherent flexibility of a digital computer can give these systems a design flexibility that pre-computer systems lacked. Command and control systems are an example of this class of system, and there are plenty of variables that cannot be preconceived years in advance at an early stage of the design process. Not the least of them is human factors. The computer information is presented to humans for decision, and the frank truth is that we know little about how to operate on this information and present it for effective human action. How should the data base be organized so that the human can best understand its contents and retrieve it rapidly? How should information be displayed at a console? Because the computer can perform many of the intellectual functions of man, what should the allocation of duties between man and machine be? How should system activities be divided into tasks and distributed among the operators? Of course, we have considerable knowledge about workplace design, such as control and display layout, but the foregoing are larger questions of system design, and they are a dark territory.

C. Metcalfe (Royal Signals and Radar Establishment, Malvern) is an advocate of the view that we no longer need to preconceive the design of a computer-based man-machine system years in advance but can continuously evolve the design throughout the life of the system. He sees this view as a solution to our lack of human factors principles. If the principles are not known, why not let the operators approximate them by defining their own tasks? They could develop comfortable modes of system operation based on their individual behavioral styles that would satisfy standards of unit proficiency. He has developed a position description language for command and control systems that allows an operator to rewrite the software and change the functions of his console position to suit him best. Consider how Metcalfe's language might work for an air defense command and control system in which an operator's task is to sit in front of a map display, overlaid with tabular information about our aircraft and the enemy's, and interact with the computer to direct our aircraft to a position where they can shoot down the invaders. With computer description language available, the operator might decide that he needs a map outline of the region but without cities shown, a tabular display of data about our aircraft in the upper left of the display, and a corresponding display about enemy aircraft in the upper right. The display need not provide information about fuel remaining for our aircraft aloft because it is obtained in voice communication with the pilots, and the operator knows from experience that he can remember it. Metcalfe and his associates have been working several years on position description language to give operators flexibility of this kind, and it is now nearing the point of operational use.

Metcalfe's language has interesting implications for system design theory. Previously, system optimization was seen as an ideal that was sought from outset of the design process. With position description language, optimization is not an explicit objective because the user puts together aspects of the system as he sees fit. While it is hoped that position description language will put the system closer to optimization than before, optimization is not a goal that is preconceived and pursued but a lucky accident, if it happens at all. Self-description of positions may be better than our present design practices that have few human factors principles to back them up, but one can ask if self-definition of tasks is an optimum definition. Unfamiliar and difficult task definitions could produce superior performance with training but never be self-selected by operators. (Jack A. Adams)

SPACE SCIENCES

SPACE ACTIVITIES IN GREECE

Historically, nearly all research in Greece has been carried out in university laboratories under the auspices of the various professors in accordance with their particular fields of interest. The field of space science is no exception with a heavy concentration on astronomy at the University of Athens and geodesy at the National Technical University. Since 1974, three courses have been offered at the University of Athens which have served to nudge Greece into the application of modern space science and technology. These courses are in the areas of applications of astronautics, remote sensing, and aerial photography and are taught by Prof. M. Moutsoulas, who heads the Astronomy Department. They are designed to acquaint students of various scientific disciplines with the potential applications of space technology to their fields of interest.

In 1976 Moutsoulas requested University funding to establish a remote sensing laboratory and a documentation center for data pertaining to astronautics and satellite applications. Apparently the request was beyond the range of the University's current budget, and Moutsoulas was referred to the Minister of Education for direct support. While in the process of writing a proposal to the Minister for support, he was visited by Dr. Les Meredith who was at that time the ONRL Liaison Scientist for Space Science and Technology. The visit culminated in Meredith accompanying Moutsoulas to the Minister of Education to substantiate the case for the proposed laboratory and documentation center.

The Minister was so impressed by the scope and ramifications of the proposal, which was heavily backed by Meredith's experience and NASA satellite photos, that he suggested the proposed facility not be limited to the University but rather be established as an independent center open to all interested parties. The center came into being late in 1977 and is known as the National Center for Space Research. Moutsoulas became its first director but still retains his professorship with the University of Athens. This dual role is of great importance as it maintains an essential tie between the university research community and the Center. Without this tie, the Center would not receive academic acknowledgement and would thus be relegated to an unworkable entity.

Interestingly enough, the Center did not end up under the administration of the Minister of Education as might be suspected since it was this office which suggested its formation, but rather the Minister of Defense through the Chief of Staff of the Air Force. This situation resulted from a number of considerations involving discussions at the highest levels of government pertaining to the availability of funds in the MoD budget and the precedence that has been set with the National Meteorological Service. For several years this Service has been equipped with a facility to receive and analyze direct satellite weather data. It is under the administration of the Air Force with a staff split equally between Air Force officers and civilian technologists. The data are utilized primarily by the civil sector (90% civil and 10% military) and are available in analyzed form to the various media that report weather forecasting. The Service is currently in the process of upgrading its facility by purchasing a European Space Agency terminal to receive METEOSAT data. In this respect the Service would participate in the EARTHNET program for European weather forcasting.

The National Center for Space Research is temporarily housed in the Meteorological Service Center, but construction is underway for an independent solar-heated laboratory destined for completion in 1979. The Center's near-term objective is to provide a documentation service for space data and information on satellite programs. It is not intended to become a national research center for space in the context of NASA, the French national center (CNES) or the German center (DFVLR). Its three current activities consist of: (1) a focal point for the deposit, documentation and reduction of satellite data; (2) a facility for persons from other government agencies, universities, and industry to come and work on their programs that can benefit from space data; and (3) a point of contact between Greece and other national and international organizations interested in space research and technology, with the idea of bringing outside expertise into Greece. It will not integrate all space stations, such as the INTELSAT station, or observatories into its fold. With regard to the third activity, the Center will continue sponsorship of international seminars such as the recent COSPAR meetings on lunar mapping and geodesy and the upcoming United Nations seminar on remote sensing to be held in 1980.

The near-term staff consists of four types of personnel. The first, permanent staff, will grow to a level of about five scientists and engineers who operate the Center on a day-to-day basis and serve to maintain records and instruct visiting personnel. They are assisted by an appropriate administrative complement. The second type are scientifically oriented Air Force officers or other MoD career or national service officers who spend up to a year at the Center learning to utilize space data. This contingent will eventually consist of two or three officers. The third type consists of up to five scientists from other government agencies wanting to utilize the application of space research in their specialized fields. Finally, the Center is open to university students and graduate assistants to help them in their university courses and research projects. This contingent consists of up to four persons. The total professional staff will therefore vary between 10 and 20 for the next few years depending upon the number of persons participating from outside organizations. The Center's budget provides the salaries of the permanent professional and support staff and pays for some student research as well as for equipment, data reduction, and computer use. The salaries of non-permanent staff members are paid for by their agencies.

A second phase in the Center's development, which is planned for implementation in the 1980s, is the installation of a satellite earth terminal for the reception of remote sensing data. The success of the Center's initial operation will be the determining factor in whether or not this second phase is implemented.

The administration of a research center by the Ministry of Defense raises some eyebrows among the academic and political communities, since historically it has been the policy in Greece for the military not to carry out research and, moreover, any high quality research has by definition been associated with the universities. The latter point can probably be rationalized by the fact that the Center will not enter into basic research, but rather serve as a training and information center, and the former by familiarizing the Greek people and the scientific community in particular with the successful operation of such organizations as the US DoD's various research offices, laboratories, and federally chartered research centers (FCRC's), and its documentation centers. In particular, Moutsoulas would like to demonstrate to the Greeks the heavy civilian participation in these organizations and their administration, and the contribution they make towards the advancement of technology of a non-military nature. (Robert W. Rostron)

NEWS & NOTES

CHANGE OF COMMAND AT ONR LONDON

In a brief but impressive ceremony on 14 July, Captain Philip F. Gibber, USN, relieved Captain L. Roy Patterson, USN, as Commanding Officer, Office of Naval Research Branch Office London. Captain Gibber, an aeronautical engineering duty officer, brings extensive Fleet and shore experience to ONR London to guide us in our mission of conducting a continuing program of scientific R&D liaison with Western Europe, Africa, and the Middle East, and of encouraging cooperative development with Allied nations. Prior to assuming his new command, Captain Gibber, whose last several assignments have been in the aeropropulsion field, established and developed the Office of the Naval Plant Representative Office at the General Electric Company, Aircraft Engine Division, Lynn, Massachusetts.

Captain Gibber will also perform collateral duties as Assistant Naval Attache for Research to the US Defense Attache in London.

Captain Patterson has reported to the Naval Air Systems Command in Washington, DC, for further assignment to the High Energy Laser Project Office. We wish him much success in his new duty.

THE SEVERN ESTUARY BARRAGE

As we go to press, it has been announced that the Severn Barrage Committee, under the chairmanship of Sir Herman Bondi, Chief Scientist, Dept. of Energy, UK, will commence its deliberations in early August. The Committee has available to it £1.5 million for study purposes, as noted in the article on pg. 257 of this issue, and will be looking at a number of schemes which might provide in the long term up to 10% of the nation's electrical requirements. (VSH & AWP)

SOVIET PHYSICIST YURI ORLOV: FRENCH SCIENTIST'S CAUSE CÉLÈBRE?

During the International Conference on Luminescence in Paris, in July, copies of a declaration concerning scientific relations with the Soviet Union were distributed to conference participants. The document was about two weeks old at the time and had circulated through the Grenoble and Paris physics communities; there were 292 names attached. The English text of the declaration follows:

"Despite protestations by the international community of scientists, the Soviet physicist Yuri ORLOV, chairman of the Moscow Group for Control of the Application of the Helsinki Agreements, has recently been condemned to 7 years of work camp followed by 5 years of forced residence in exile. The scientific community cannot limit itself to individual expression of indignation at this sentence. After a long discussion, a group of French physicists has decided that suspension of official scientific relations with a Soviet Union is an appropriate response. We realize the difficulties inherent in such a decision, but it seems to us that the condemnation of Yuri ORLOV for crime of expression of

opinion has broken the necessary mutual confidence on which scientific relations depend.

"Our action is not directed against our Soviet colleagues. We will maintain personal contacts and make them occasion of expressing our indignation.

"We refuse:

"-to attend congresses in the USSR and also conferences in our country organized through bilateral agreements:

"-to receive in our laboratories visitors who are official representatives rather than scientists:

"-to accept the arbitrary replacement of Soviet scientists invited by the organizers of a congress.

"You will receive documentation concerning the ORLOV affair. The Comité des Physiciens invites the participants of the present congress to meet at Paris VI University (where the poster sessions will be held) for a round table discussion on the ORLOV affair.

"We invite our French colleagues to sign an engagement of suspending official scientific relations. We suggest that our other colleagues consider the possibility of similar action in their countries." (Clifford C. Klick)

PERSONAL

Dr. P. Beaumont, Senior Lecturer in Geography at the Univ. of Durham, has been appointed to the Chair and Headship of the Dept. of Geography at the Univ. of Wales from 1 Oct. 1978. He succeeds Prof. David Thomas, who has been appointed Head of the Dept. of Geography at the Univ. of Birmingham.

Dr. J. Crangle, Reader in the Department of Physics, has been promoted to a personal chair in the Dept. of Biochemistry at the Univ. of Sheffield.

Mr. A.P. Dawid, Lecturer in Statistics, University College, London, has been appointed to the Chair of Statistics in the Dept. of Mathematics at the City University in London from 1 October 1978.

Dr. P.N. Harrison, Reader in Biochemistry, has been appointed to a personal chair in the Dept. of Biochemistry at the Univ. of Sheffield.

Dr. John R. Hubbuck, Fellow, Tutor, and Lecturer in Pure Mathematics at Magdalen College, Univ. of Oxford, has been appointed to one of the two Chairs of Mathematics at the Univ. of Aberdeen from a date to be arranged.

Dr. P.N. Johnson-Laird, Reader in Experimental Psychology at the Univ. of Sussex, has been promoted to a personal chair of Experimental Psychology with effect from 1 October 1978.

Dr. A.J. Leggett, Reader in Theoretical Physics at the Univ. of Sussex, has been promoted to a personal chair from 1 October 1978.

Dr. David Lloyd, Reader in the Dept. of Microbiology, has been promoted to a personal chair at the University of Wales.

Prof. E.G.S. Paige, who left the RSRE Malvern last year to accept the Professorship of Engineering at the University of Oxford and who is a recognized leader in the surface acoustic wave field, has been awarded the UK Institute of Acoustics' 1978 Rayleigh Gold Medal.

Prof. E.N. Patterson will be promoted to the senior Chair of Mathematics at the University of Aberdeen as of 1 October 1978.

Dr. A.R.S. Ponter, Univ. of Leicester, has had conferred upon him the personal title and status of Professor in the Dept. of Engineering.

Dr. Alan Pugh, Senior Lecturer in Electronic Engineering at the Univ. of Nottingham, has been appointed to the Chair of Electronic Engineering at the Univ. of Hull from 1 October 1978.

Dr. T.E. Rozzi, research scientist with Philips, Eindhoven, the Netherlands, has been appointed to the Chair of Electrical Engineering at the Univ. of Liverpool.

Dr. J.C. Scully, Dept. of Metallurgy at the Univ. of Leeds, has been awarded the Sir George Beilby Medal and Prize for 1978 jointly by the Royal Society of Chemistry, the Society of Chemical Industry, and the Metals Society.

Dr. David J. Whitehouse, currently Chief Research Engineer and Research Manager at Rank Taylor Hobson, Leicester, has been appointed to the Chair of Mechanical Engineering at the Univ. of Warwick.

Dr. Graham Williams, Reader in Chemistry at University College of Aberystwyth, Wales, has been appointed to a personal chair in Physical Chemistry.

OBITUARIES

Prof. W. Deryck Chesterman, Professor of Geophysics and Head of the School of Physics at the Univ. of Bath, died 6 July at the age of 65. Upon graduation from the Univ. of Bristol in 1934, he joined the research department of the British Thomson Houston. At the beginning of WWII he joined the Admiralty Research Establishment and worked at several of its laboratories, including the Admiralty Research Laboratory, Teddington, and HM Underwater Detection Establishment, Portland, (now the Admiralty Underwater Weapons Establishment). His research was on photography, high-speed photography, cavitation, and sonar systems for shallow water. From 1960-66 he was Professor of Physics at the Univ. of Hong Kong returning thereafter to Britain to join the staff of the newly created Univ. of Bath. He was a recognized leader in sonar research, and his side-scan sonar research team at Bath have been instrumental in developing new acoustic methods for rapid mapping of the seafloor. He was due to retire shortly, and only a few days before his death he was appointed Emeritus Professor.

Prof. Mstislav Keldysh, who died 24 June at the age of 67, was one of the Soviet Union's most distinguished scientists. As President of the Academy of Sciences of the USSR, he headed the country's vast space and science program for 14 years. He also made important contributions to the design of Soviet Aircraft. His own research in aerodynamics and mathematics is known to have played an important role in the development of space technology. He was a powerful advocate of scientific cooperation between the US and the USSR, and was an honorary member of the US National Academy of Sciences.

Prof. James Pickering Kendall, FRS, FRSE, Emeritus Professor of Chemistry, Univ. of Edinburgh, died 14 June at the age of 88. After having done research at Edinburgh, the Nobel Institute in Stockholm, and at the Technological Institute in St. Petersburg, USSR, he joined in 1913 the chemistry faculty at Columbia Univ., NY. Here he worked on addition compounds, ionization equilibria, and the separation of isotopes. In 1922 he was appointed full professor and until he joined the Washington Square College in 1926, he was mainly occupied with administration and in revising Alexander Smith's famous series of chemistry textbooks. In 1928 he returned to Edinburgh where he remained until his retirement in 1959. He was deeply interested in the history of chemistry and authored some very readable books including biographies of Michael Faraday and Humphrey Davy.

Prof. George Wallace Kenner, FRS, Heath Harrison Professor of Organic Chemistry at the Univ. of Liverpool, died tragically during the first weeks of July at the age of 55. He had gone walking in the mountains and was missing for two weeks before being found dead. Coming from a "chemical" family (both parents being chemists), he quickly showed exceptional talent with a maturity of chemical insight far beyond his young years, and the Royal Society published one of his original papers on a theoretical subject when he was only 23. His interests spanned a large area in organic chemistry from the theoretical to the experimental. His major contributions were in the structural elucidation and total synthesis of natural substances of biological importance. His most recent research was on synthetic studies on lysozyme analogues which, according to the British press, are "now on the very threshold of success... to open the way to a real understanding of the mechanism of enzyme action." He became a Fellow of the Royal Society in 1964.

ONRL REPORTS

R-3-78
(Limited)

AN ASSESSMENT OF THE TECHNOLOGY AND POTENTIAL FOR V/STOL IN EUROPE by C. Joseph Martin (Limited to US Government agencies)

A survey of advanced aircraft technology in Europe has been undertaken to highlight those activities that may be applicable to a future Naval aircraft development in the United States. A discussion of the potential for a re-emergence of V/STOL aircraft development in Europe indicates an opportunity for active collaboration in many technological areas. The European's have ongoing activities ir digital fly-by-wire control, air combat aerodynamics, and plenum chamber burning propulsion that offer significant advanced in performance. Though not as broad as the US aircraft technology program, there are many worthwhile projects that are highlighted in this report.

R-4-78

EUROPEAN TRIBOLOGICAL TECHNOLOGY: AN ASSESSMENT OF THE STATE-OF-THE-ART by Peter B. Senholzi

This report presents a technical summary of the research activities of thirty-five European organizations involved in the technological area of tribology. These activities were reviewed over a three-month period during the spring of 1978. Summary matrices have been developed which serve to outline each reviewed organization's major interest areas. Pertinent trends, conclusions, and recommendations are drawn from this summation effort.