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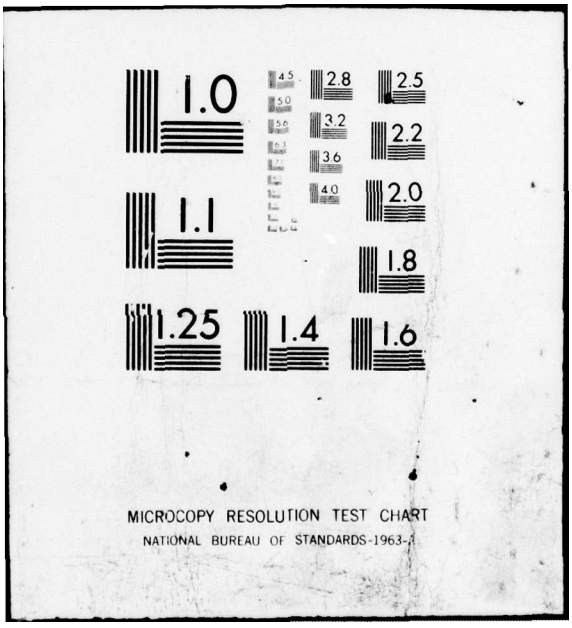
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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the scientific literature) may prove of value to American scientists by calling attention to current developments and to institutions and individuals engaged in these scientific efforts.

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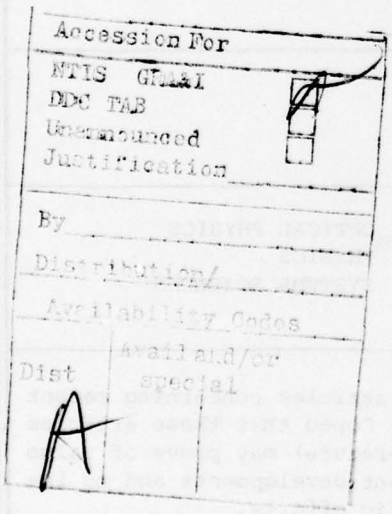

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CHEMISTRY

A REVIVAL IN COLLOID SCIENCE

The Center for Marine Research of the Rudjer Bŏskovič Institute (RBI) in Zagreb, Yugoslavia, has been conducting meetings on colloid and interface science about every other year for the past decade. These conferences are sponsored by the Croatian Chemical Society and the Union of the Chemical Society of Yugoslavia. The driving force behind these meetings is the strong colloid group at the Institute, founded by Prof. Bozo Težak. Dubbed The Summer Conference, it was held on 24 June-3 July 1979 at Cavtat near Dubrovnik in a luxury hotel overlooking the incredibly beautiful Adriatic Sea. This idyllic setting was marred only by the atypically warm weather and a total breakdown of the hotel air conditioning. Mercifully, the program was organized Gordon Research Conference style with lectures in the morning and evening. Afternoon found most of the participants on the beach.

Although the meeting brings together prominent workers in the field as lecturers, the other participants were almost all research students and teachers from the Institute, the Univ. of Zagreb, and other Yugoslavian schools. In effect, the meeting was a summer school. Besides the principal lectures, many of which were of a review nature, there were a few short presentations in the evening sessions given mostly by research students. All of the presentations were given in English, which presented some problems, especially for the younger students during discussion periods.

The Conference opened with an address by Dr. E. Matijević (Clarkson College of Technology, Potsdam, NY) who had been a student of Težak. He likened the Summer Conference to the GRCs and, in fact, called it the European Gordon Conference on Surface and Colloid Chemistry. He remarked that unlike a few years ago it is no longer necessary to justify research in colloid science. The importance of colloid phenomena in manufacturing processes, in biology and physiology, and in environmental pollution control is well recognized, and this recognition is reflected in the large increases in attendance at conferences on colloid and interface science, especially by people from industry.

Matijević devoted many of his remarks to the achievements of Težak, who was being honored by the Conference. Težak was responsible for the development of the colloid research group first at the Univ. of Zagreb and now at the Institute. He has also been a prime mover in establishing for the University a library, a museum, and a computer center, and in making the *Croatia Chemica Acta* a prestigious, internationally recognized journal.

Težak gave the first tutorial and presented a bit of his philosophy on the approach to such colloidal phenomena as precipitation, flocculation, aggregation, nucleation, and the stability of primary colloidal particles. He emphasized the relationship between the concentration in bulk solution, the structure of the emerging (or dissolving) solid, and the concentration in a "methoric" (his word) layer between the solid and the solution. Differences in the conditions and events occurring in the methoric layer determine whether flocculation, crystal growth, aggregation, or some other phenomena occur. In his lecture and throughout the meeting, Težak repeatedly made the point that experimental observation should lead the way, not the formulation of weakly supportable laws.

The ideal system for studying colloids is to have the particle sizes as uniform as possible; a monodispersed sol. Developing methods of preparing sols has been a major preoccupation throughout the history of colloid science. Matijević has been very active in this area and in his lecture described the preparation of monodispersed sols of metal oxides and hydroxides of exceptionally uniform size. The particle shapes range from spheres to regularly shaped crystals. Preparative methods include hydrothermal aging of salt solutions, slow release of metal ions by metal chelates, and the hydration of metal alkoxide aerosols. Matijević mentioned the great advantage of using the scanning electron microscope, a tool not available in years past, to monitor particle size and shape.

The characterization of a monodispersed hydrous chromium oxide, prepared

using the hydrothermal aging process of Matijević, was reported by Prof. A. Zettlemoyer (Lehigh Univ., Bethlehem). The biggest problem was obtaining enough oxide to do a reasonable job; the yield is only 10 mg/liter of solution. It took the Lehigh Chemical Engineering Department to scale up to 1000 liter batches to obtain 25 gm. Zettlemoyer found the average particle diameter was 0.4 μm with a coefficient of variation of 10-30%. As prepared, the sol is best described as a polymeric form of $Cr(OH)_3 \cdot nH_2O$ and is amorphous and hydrophylic. As the oxide is heated to 450°C the surface area increases owing to pore formation. At 450°C crystalline α-Cr_2O_3 particles are obtained, also with a narrow size distribution.

Papers on the physical chemistry of precipitation were given by Prof. A.E. Neilson (Univ. of Copenhagen) and Dr. H. Furedi-Milhofer (RBI). Neilson gave a tutorial on the analysis of precipitation data and stressed the importance of reporting the rate of particle growth ($\dot{r}$); $\dot{r}$ data should be presented as a function of concentration—too often raw data are "worked" into a special format to support some theory, making it difficult to extract the basic experimental results. In data interpretation, $\dot{r}$ may be controlled by ion transport, by convection, or diffusion, or by some step in its attachment to the surface of the growing particle, e.g., surface diffusion. He suggested that to check some assumed mechanism, the particle/solution interfacial energy should be calculated to determine whether it is consistent with values obtained by other methods, e.g., nucleation studies.

Furedi-Milhofer reviewed the value of solubility diagrams and precipitation (PPT) diagrams in describing complex multicomponent systems encountered in physiology, environmental problems, and industry. The boundary between heterogeneous and homogeneous nucleation in many PPT diagrams can be used to determine the critical supersaturation for homogeneous nucleation from which the interfacial energy and radius of the critical homogeneous nuclei can be calculated. She described her work with several PPT systems: calcium chloride/sodium phosphate, calcium chloride/sodium oxalate, and uranyl nitrate/sodium carbonate/alkaline earth salts.

The kinetics of the crystallization of calcium fluoride are pertinent to the topical application of fluoride solutions to tooth enamel. Some workers believe that transformation of hydroxyapatite to fluoroapatite occurs via a thin layer of calcium fluoride. G.H. Nancollas (State Univ. of New York, Buffalo) has developed a constant-composition method for studying crystallization. The ion concentration is maintained constant by automatic burettes controlled by a fluoride-specific ion electrode. This technique overcomes some of the difficulties of the conventional methods in accurately determining growth rates. Nancollas' results point to a surface controlled crystallization with the rate independent of changes in the flow conditions in the solution.

A key issue in much of colloid science is the electrical double layer at interfaces. Such a layer may exist for a number of reasons: the different ions in the crystal surface may dissolve unequally, there may be ionizable groups on the surface which can adsorb or reject hydrogen ions, or ions from solution may adsorb at the interface. Electrical double layers are studied primarily by potentiometric titration or electrokinetic methods. The interpretation of electrokinetic data is usually based on the Grahame model of the double layer. However, in using this model a number of assumptions must be made about the electrical and chemical potentials in the layer. Dr. D.G. Hall (Unilever Research, Port Sunlight, UK) described an alternative approach in which many of the electrostatic quantities in the Grahame model are ignored. Assumptions are also made in Hall's theory, but he claimed that they can be checked. He demonstrated its use in an electrokinetic study of adsorption from solutions with multiple ionic species.

Dr. W. Stumm (Inst. of Aquatic Sciences, Swiss Federal Inst. of Technology, Zurich) is concerned with natural water resources and the adsorption of inorganic and organic anions and weak acids on hydrous oxides. He described the adsorption in terms of surface complex formation at the oxide/water interface. Using various titration techniques and thermodynamic arguments, he obtains equilibrium

constants for ligand adsorption and from these the extent of adsorption and the surface charge on the oxide. Stumm stated that the model explains the adsorption properties of natural organic substances in fresh waters.

The electrodeposition of O or OH on noble metals can be extremely sensitive to the presence of coadsorbed anions; amounts as low as 10^{-8} moles/liter are effective. This phenomenon was the subject of the lecture by Dr. B.F. Conway (Univ. of Ottawa) who described his work on the inhibition of O and OH deposition by halide, perchlorate, and other anions. The anions appear to have a number of effects including their hydration at the electrode surface, thus disturbing the structure of the water layer and affecting changes in the electron density-of-state function of the electrode surface. He pointed out the potential of this phenomenon for trace analysis of anions.

It has long been known that the structure of the metal or metal oxide has a major effect on the double layer. However, present understanding of the double layer is based on studies with mercury, and only recently has work been done with well characterized solids. This was the topic of the lecture by Dr. R. Parsons (Laboratoire d'Electrochimie Interfaciale, CNRS, Meudon, France) who has been studying the double layer formed on different crystallographic planes of single-crystal silver. There is no question that the double layer is influenced by the atomic arrangement of the surface, and part of the effect, Parsons thinks, is the influence the crystal structure has on the orientation of the water at the metal surface.

Speaking of water at interfaces, Dr. W. Drost-Hansen (Univ. of Miami) lectured on what he calls "vicinal" water. He claims that adjacent to a solid surface the properties of water are modified over a significant distance up to 1000 Å. This vicinal water is unaffected by electrical double layers at the interface, and its properties undergo sharp changes at discrete temperatures. The principal evidence Drost-Hansen has for his theory is that some of the properties of water, both in bulk and interfacial, undergo sharp changes in narrow temperature intervals. The majority of workers dispute the existence of such long-range surface effects, and the reality of the sharp changes in the properties of water at specific temperatures has been questioned. No one will dispute Drost-Hansen's courage and persistence in his long (15 year) struggle with his critics, and it is interesting that his lecture produced more discussion than any other presentation at the Conference.

One of the most interesting talks was that given by Dr. S.S. Dukhin (Inst. of Colloid Chemistry and Water Pollution Control, Acad. of Sci. of Ukranian SSR, Kiev) on nonequilibrium surface forces. Dukhin charmed the Conference with his wit and energy. During his lecture, when he completed his presentation far short of the alloted time, the audience pressed him to continue, which he did with great exuberance. This was something of a triumph for Dukhin over the Conference organizers, who had scheduled him to be one of the last speakers. Russian scientists frequently find themselves at the end of scientific conferences held in East European countries.

Theories of the electrical double layer usually assume equilibrium conditions; they ignore the effect that the motion of the particles may have on ion distribution. Dukhin has been concerned with these kinetic effects since 1959 when he was associated with Dr. B.V. Derjaguin (Acad. of Sci. of the USSR, Moscow). Dukhin explained that any condition which causes flow disturbs the equilibrium state, even Brownian movement. A tangential flow around the particle redistributes the ions to create a dipole and thus a localized electric field, and dipole-dipole interactions occur between particles. Dukhin discussed the role of these nonequilibrium effects in flotation, filtration, electrocoagulation, and the electrodeposition of polymer films.

Colloidal phenomena in biological systems was the topic of lectures by Dr. L. Ter-Minassian-Saraga (Physico-Chimie des Surfaces et des Membranes, CNRS, Paris) and Dr. A.G. Walton (Case Western Reserve Univ., Cleveland). Ter-Minassian-Saraga described the similarity between the interaction of surfactant with polyelectrolytes and the interaction of phospholipids with proteins. In fact, surfactant/polyelectrolyte systems can serve as

models for the biological systems. She discussed the difference between the adsorption of the surfactant (phospholipid) on a polyelectrolyte (protein) and adsorption on a rigid solid. The polyelectrolyte is not an inert substrate. Unlike a solid, its molecular configuration will be altered, i.e., the degree of swelling may change. Ter-Minassian-Saraga reviewed the existing evidence that the alteration of polyelectrolytes (proteins) involves the adsorbate's screening the repulsion between charged groups and the development of dispersion forces between the nonpolar groups of the adsorbate and adsorbent.

Walton is studying protein adsorption as it relates to blood clotting on body implants and bacteria attachment to food packaging materials. He presented data that the adsorbed protein suffers conformational changes (denaturation). These changes may occur slowly so that uptake is reversible at first, but then becomes essentially irreversible as the adsorbed protein structure changes to minimize interaction energies.

In a related lecture Prof. J. Lyklema (Laboratorium voor Fysiche en Kolloidchemie, Wageningen, Netherlands) discussed some aspects of polymer adsorption: (1) its essential irreversibility, (2) the maximum in adsorption at the isoelectric point, and (3) the driving force for protein adsorption. He challenges the generally accepted explanations for these effects, which he claims do not bear close scrutiny. For example, he asserts that polymer adsorption irreversibility comes about because the high molecular weight (MW) fraction is preferentially adsorbed. Dilution of the adsorbate solution in a desorption experiment removes low MW molecules and so cannot alter the adsorption equilibrium.

The subject of emulsions, a major subarea of colloid science, was treated by only one lecture, given by Dr. L. Rydhag (The Swedish Inst. for Surface Chemistry, SISC, Stockholm). She described recent work at the Institute on emulsion stabilization which reinforces the concept put forth by Prof. S. Friberg (SISC) about ten years ago that in surfactant-stabilized emulsions a lamellar liquid-crystal structure is formed at the oil/water interface which reduces dispersion-force attractions between droplets. Rydhag and associates have expanded on the original Friberg theory by suggesting that a disjoining pressure develops as two droplets approach each other.

There has been a renewed interest in studying the hydrodynamic properties of colloid particles since the development of laser light scattering spectroscopy. Quasielastic light scattering is used to determine the translational diffusion coefficient, and photon correlation spectroscopy of scattered light to determine polydispersity. Dr. J.P. Kratohvil (Clarkson Col. of Technology, Potsdam, NY), another student of Težak, described laser light scattering applications and some of the interpretive difficulties. The applications include studies of bile salt micelles with radii as small as 20 Å, particle formation and growth during emulsion polymerization, and characterizing the haze in beer. The interpretive problems with light-scattering data discussed by Kratohvil are: (1) the assumption that particle transport behavior is independent of particle concentration (because of the cancellation of two opposite effects) is unjustified in concentrated systems, and (2) one cannot ignore the effect of the adsorption of low MW solutes onto colloid particles on the transport properties of the particle.

When liquid intrudes between two closely spaced solids, a liquid bridge forms, and rather sizable capillary forces are imposed on the solids. This capillary adhesion is important in secondary and tertiary oil recovery, printing, and liquid condensing into porous materials. Dr. E. Wolfram (Lorand Eötvös Univ., Budapest) is investigating liquid bridges by measuring the force required to separate two plates with a drop of liquid between them. As the plates separate, the liquid is pulled into a hyperboloid shaped column; eventually this column becomes unstable and breaks, leaving a droplet on each plate. In principle, the instability condition can be predicted by the theory of capillarity, but Wolfram has found that factors such as contact-angle hysteresis preclude a simple analysis. He has taken a somewhat empirical approach by first determining the events that occur during the breakup of a liquid bridge and the parameters which determine the breakup force. Currently, he is

studying systems where the liquid bridge is surrounded by a second, immiscible liquid.

Two somewhat applications-oriented lectures were given by Dr. W. Haller (National Bureau of Standards, Gaithersburg, MD), Dr. H. Leidheiser (Lehigh Univ., Bethlehem, PA) and Dr. R.M. Reeves (Laboratoire d'Electrochimie Interfaciale, CNRS, Meudon). Haller has developed silica spheres about 130-140 Å in diameter which have been surface-treated to attach specifically to virus-infected tissue. Because of their high electron density, these spheres make excellent markers for electron microscopy examination of tissue. The spheres are commercially available, and Haller first treats them with organofunctional trialkoxysilanes to put aldehyde and amine groups on the surface. The immunospecific agent, an immunoglobulin-G, is then adsorbed onto the surface via the aldehyde and amine groups.

Leidheiser described some of the electrochemical and surface-chemical processes that occur in the corrosion of paint-coated metals. He is concerned with measuring the amount of water absorbed by the coating, and has developed an electrical capacitance method for measuring water uptake. The capacitance method does not agree with gravimetric measurements, but this is probably because of the large errors inherent in the latter. (Willard D. Bascom)

BIOELECTROCHEMISTRY IN WEIMAR

The Fifth International Symposium on Bioelectrochemistry and Bioenergetics took place in Weimar, German Democratic Republic (GDR), during the first week of September. Weimar, the city of Goethe, Schiller, Liszt, and many other cultural leaders of the past, was also the home of the electrochemist and physicist, J.W. Ritter, who did some of the earliest experiments in bioelectrochemistry, shortly after those of Galvani and Volta. Prof. Hermann Berg (Jena, GDR), the organizer of the meeting, felt that Weimar was therefore an appropriate choice for the meeting, as well as an unusually attractive site.

Of the approximately 200 in attendance from 20 countries, one third were from East Germany, one third from other countries in the eastern block (primarily Czechoslovakia and USSR), and one third from the west (primarily the USA and France). English, the native language of fewer than 10% of the participants, was the official language of the conference, but the interchanges between the participants went smoothly and were enhanced by the efficient organization of the 4½-day program. To avoid the introduction of parallel sessions for the large number of contributions, there were 3 categories of presentations: synoptic lectures (30), posters (110), and formal discussion sections (4). The discussions were run in different ways, some chairmen asking for synopses of posters, others allowing a stream-of-consciousness flow or structuring the sessions around particular questions, but all catalyzed the flow of information.

The lectures and posters were grouped as follows: 1) electrochemical methodology and modern instrumentation; 2) polyelectrolytes, conformation in solution and at the surface; 3) membrane structure, transport, and excitation; 4) cell differentiation and control; 5) redox chains, energetics, and kinetics; 6) electromotor action and electrostimulation effectiveness; and 7) environmental bioelectrochemistry.

Because of the many topics, I shall be able to present some highlights only. Details can be obtained from the authors mentioned, or later in the journal *Bioelectrochemistry and Bioenergetics*, which will publish papers from this meeting (G. Milazzo, ed., Piazza G. Verdi 9, 00198-Rome, Italy).

The advantage in having such a broad range of topics at a meeting is that there tends to be interplay between subjects that would ordinarily be classified as unrelated. For example, many bioelectrochemists have studied the properties of nucleic acids and proteins at the mercury/water interface, and 7 lectures and 30 posters were devoted to this area. However, material on this subject appeared in other sections as well. Related problems were mentioned in connection with the development of parallel optical methods for determining molecular conformation and denaturation under electric fields. The sections on cell differentiation and on electrostimulation discussed the changes that occur or can occur in nucleic acids in the presence of histones (the basic proteins that pack with nucleic acids in cell nuclei) or superimposed electro-

magnetic radiation. The discussion of such a topic in 5 different but related contexts should lead to significant new insights into problems, and the experimenters were forced to consider the implications of their results for the related areas.

Another example of the interplay between different parts of the program was in connection with instrumental methods. The plenary lecturers in that section discussed chemically modified electrodes (T. Kuwana, Ohio State Univ.), optically transparent electrodes (W. Heineman, Univ. of Cincinnati) and polarography at the interface of immiscible electrolyte solutions (J. Koryta, Prague, Czechoslovakia). The posters tended to emphasize electrodes for particular applications, e.g., glucose determination, urea removal, metallic implants for stimulation, microelectrodes for measurements on cells, etc. This subject was touched on again in connection with medical applications of electrical stimulation, *viz*, bone healing, pain reduction, etc., and also in biopolymers and cells.

The plenary lectures and the posters on bioenergetics were divided between mitochondrial and photosynthetic processes. M.R. Tarasevic (Moscow, USSR) discussed biocatalysis and R. Buvet (Paris, France) presented his analysis of the fundamental types of biochemical reactions, while B.A. Kiselev (Pushchino, Moscow Region) discussed chlorophyll monolayers and G. Renger (E. Berlin, GDR) water cleavage in photosynthesis. The posters dealt with similar processes at surfaces or lipid bilayers. These subjects tended to be more self contained, as can be seen from the separate term, bioenergetics, in the title of the meeting. However, even here there were interactions with the sections on instrumentation, membranes, and cells.

The sections of the program devoted to membranes and cells produced some interesting papers on a variety of topics. Among the lectures were: Y. Chizmadjev (Moscow), breakdown in lipid bilayers; O.A. Krishtal (Kiev, USSR), noise measurements in excitable cells; I.R. Miller (Weizmann Institute, Rehovot, Israel), prothrombin and clotting mechanisms; R. Glaser (E. Berlin), the erythrocyte membrane potential; A.A. Pilla (Columbia Univ., NY), electrical stimulation of cells; and P.G. Kostyuk (Kiev), ionic channels in nerves. In the section on electrostimulation, U. Zimmerman [Kernforschungsanlage (KFA), Jülich, FRG] presented some of his recent observations on the reversible breakdown of cell membranes by short-duration high-intensity pulses, and A. Chiabrera (Genoa, Italy) discussed changes in chromatin induced by electrochemical stimulation. Here again we see the overlap between subjects and the discussion of the effects in different contexts.

The last section at the meeting dealt with environmental problems, D. Thevenot (Paris) discussing water pollution and H.W. Nurnberg (KFA, Jülich) trace-metal analysis in the ocean and in the body. Among the recently determined facts are that concentration of Pb is higher in men than in women, Cd is higher in smokers, European wines have almost 100 ppb Pb (Italian wines are at the low end). We are just beginning to get information that will enable us to establish "normal" as opposed to pathological levels and to investigate new hypotheses about disease.

Posters that caught my eye were those of G. Dryhurst (Univ. of Oklahoma) and M.Z. Wrona (Warsaw, Poland) showing that the electrochemical and enzymatic oxidations of purines proceed by the same mechanism; G. Kreishman (Univ. of Cincinnati) suggesting a higher-order phase transition in water at 42°C; A. Voight and H. Wolf (E. Berlin), indicating interactions between red blood cells and mercury electrodes leading to membrane leakage; G. Salié (E. Berlin), about oscillations in phase-boundary reactions; and H.E. Jacob, W. Forster, and H. Berg (Jena) on electrical effects on cells, including cell fusion.

Manfred von Ardenne (Dresden, GDR), who is well known in physics and electronics, addressed the meeting on changing the membranes in red blood cells by changing the pH in order to occlude the vessels going to cancerous tissues. Changing the pH from 7.4 to 6.5 causes the red cells to lose their flexibility, and this has been used as part of the cancer multistep therapy that he has developed. He also discussed a method of increasing the hemoglobin binding of oxygen by introducing inositol hexaphosphate. These two therapeutic approaches are being tried in the GDR with some success.

The last item on the program was the announcement by Milazzo of the formation of an international society to formalize and facilitate the activities of this group. Bioelectrochemists have been meeting every other year for the past decade and have been publishing a journal, now in its sixth year. (Further information about the society can be obtained from H.W. Nurnberg, KFA, Jülich.) The next meeting will be held in Israel in 1981 and is being organized by I.R. Miller, Weizmann Institute. (Martin Blank, Columbia University, New York, NY)

CHEMISTRY REVITALIZED IN GERMANY

Darmstadt

It has been more than 20 years since my last visit to the Technical University of Darmstadt which was housed, at that time, in some old buildings in the center of the city. Now most of the University has relocated to a beautiful wooded area a couple of miles east of the center, where spacious modern buildings house the chemistry institutes. The Institute of Physical Chemistry currently has four ordinary professors: Prof. K-H Homann, involved in research in various aspects of kinetics, has most recently been studying soot formation from combustion processes; Prof. E. Wölfl is a structural chemist and is involved in both X-ray diffraction and neutron scattering experiments with solids; Prof. A. Weiss specializes in NMR-NQR spectroscopy and is primarily interested in studying the electron distributions in solids; and the fourth chair (theoretical chemistry) has just recently been filled by Prof. Breckmann. In addition, the Institute is host to the monthly journal of the German Bunsen Society which is edited by Prof. K.G. Weil.

My host in Darmstadt was Dr. J. Warnatz, a junior member of the faculty in the Institute of Physical Chemistry, whose work had been called to my attention by Dr. J. Heimerl (Ballistics Research Laboratory, Aberdeen, MD). Warnatz, a former student of Prof. H.G. Wagner (Göttingen) is a combustion kineticist whose primary interest at present lies in attempting to model (by computer) all the processes that take place during combustion. For this ambitious project, he utilizes kinetic data from any reliable source, including data from the scientific literature. He is presently working on the methane-oxygen and methanol-oxygen systems; he hopes to be able to extend his approach to higher hydrocarbons and to hydrogen. His mathematical model is based on assuming a quasi-steady state during combustion.

Göttingen

It was also Heimerl's suggestion that brought me to Göttingen again, this time to visit Prof. J. Troe, a new faculty member in the Institute of Physical Chemistry of the University. Troe is a native of Göttingen, studied under Wagner, and returned there by way of the Ecole Polytechnique Fédérale de Lausanne to become one of Wagner's colleagues. While a graduate student in the sixties and later as an assistant to Wagner, Troe worked on a U.S. Air Force grant in the general area of detonations and shock tube reactions. He is a physical chemist of exceptional breadth of interests that now include studies of vapor phase reactions (including a certain amount of theory that is necessary to explain the experiments), vapor-phase photochemistry (including laser-flash studies), and the closely related area of atmospheric chemistry. He describes his present research program as kinetic studies dealing with combustion reactions (ca. 25%) and vapor-phase chemistry (75%). He has one "dozent" working with him who is doing the theoretical work. He is a collaborator on the middle atmosphere chemistry/CODATA project, and is responsible for the oxygen cycle.

In some of their work they are studying the isomerization of molecules (containing more than six carbon atoms) by means of shock tubes, laser and conventional photochemical techniques, and pyrolysis. For example, they have been studying the isomerization of cycloheptatriene to toluene by a singlet mechanism that can be followed spectroscopically. They have also studied cyclooctatetraene, the reactions of which are similar in some but not all respects. On the theoretical side they are interested in establishing the scope and limitations of the RRKM theory; they believe that it works for reactions that have well defined transition states, but not for others.

They are also studying the laser-induced chemistry of small molecules, both in the gas phase and as compressed

liquids. They are particularly interested in determining the cage effect with such diatomic molecules as the halogens. Related to this is their interest in determining the effect of pressure on the rates of recombination of halogen atoms in the presence of an inert gas; Troe says that they can handle gases at pressures up to 1 kbar easily, and they can go to higher pressures with a reasonable frequency of success. He is also involved in some collaborative work with a Danish colleague on the pulse radiolysis of toluene to give benzyl radicals. He is interested in studying energy transfer reactions that occur during the decomposition of oxygen-containing small molecules (e.g., H_2O_2, O_3 and N_2O) and has done some related theoretical work that resulted in the prediction of the rates of some of the reactions. Some of the details of the work in these areas appeared in the Proceedings of a NATO-ASI meeting on High Pressure Chemistry held in 1977, *Kinetic Phenomena in Gases at High Pressures*, 1978, Reidal, Amsterdam. He also contributed to the Chemical Society Specialist Report on gas kinetics and energy transfer that was published in 1977.

In addition to these research activities, Troe is also the coordinator of a very large "special research project" on lasers that is funded by the German equivalent of the National Science Foundation to the tune of about DM 3,000,000 per year. Troe has at his disposal a quadrupled Nd-YAG laser with a power output of 200 mJ at 265 nm, as well as a pulsed (20 Hz) Nd-YAG laser, a dyelaser that is pumped by the above, and another dyelaser that is flash-pumped. In addition he has on order a xenon fluoride excimer laser, and he now has funds to purchase a psec laser flash system and is in the process of selecting one. Troe currently has a research group of 18 people, and their laboratories in the five-year-old physical chemistry building at the edge of Göttingen have ample space and excellent facilities in every respect. Last but not least, Troe impressed me as a singularly capable and versatile scientist, and we can expect great things from him..

In the Institute of Organic Chemistry, Prof. W. Lüttke has been the senior professor since 1971, even though he is a physical chemist by training. During my sabbatical year in Göttingen (1972-3) I was in close touch with him, but this was the first time that I visited him in his new Institute. They now have excellent, greatly expanded facilities available for their work, compared to what they had six years ago. Prof. Lüttke told me that they are no longer working on indigo dyes, a field of research to which he contributed a great deal over a period of some twenty years. On the other hand, they are continuing their work on organic molecules that contain small rings, studying these systems mainly by ^{13}C NMR. The molecules that they seek to synthesize and study are designed in such a way as to contain carbon atoms with various hybridizations (sp, sp^2, and sp^3). Related to this is their interest in the synthesis of polyenes. Lüttke is using his expertise gained from their work in the indigo field to participate in a special laser project where he collaborates with his neighbor, Prof. F.-P. Schäfer (MPI for Biophysical Chemistry) on research and development on laser dyes. Schäfer, who is recognized as one of Europe's top people in the laser field, contributes the knowledge of what properties are needed from laser dyes and investigates the practical aspects of any new compounds that are synthesized by Lüttke's people, while they, in turn, are designing and synthesizing such dyes as may be promising. The first publication from this collaboration appeared in *Chemical Physics Letters* 55, 455 (1978). It should be mentioned that Lüttke has always been very much interested in correlations between the structure of organic compounds and their spectra and has made significant contributions to this field of research.

Paderborn

The university in Paderborn goes under the name of "Gesamthochschule." There is no exact translation for this term, perhaps the best approximation will be something like comprehensive institute for higher education. During the last decade five such institutes were established in Germany; their purpose is to provide post-high-school education of all sorts to students. Thus, in addition to the normal courses found in universities, they also provide opportunities for the training of technicians, engineers, and teachers. The facilities for some of these non-university activities existed when these new institutes were established;

thus they represent a consolidation of these with the newly added university curricula. (The facilities available for research and teaching in chemistry at Paderborn are truly excellent. The building is spacious and modern, instrumentation is plentiful, and Professor Stegemeyer, my host, who holds the chair of physical chemistry, is very happy in his new surroundings. (He arrived in Paderborn a few years ago from the Technical University, Berlin.)

Although I first met Stegemeyer many years ago when his research interest centered on photochemistry, during the past six to eight years he has become more and more active in the field of liquid crystals, an area to which he has made significant contributions. Now that a transparent liquid-crystal medium has become commerically available (from Merck and Company), he intends to return to the field of photochemistry by studying some photochemical reactions in liquid-crystal media. He is also involved in studies of the thermodynamics of phase transitions in liquid crystals. He has been interested in obtaining experimental verification of MacMillan's theory and finds generally good agreement. He noted that molecular structure affects the correlations between the thermodynamic quantities (ΔS, ΔH, and molecular volumes).

A second area of research in which he and his coworkers have been involved is guest-host interactions. In this work they found that optically active guest molecules can only exist in a cholesteric liquid crystal. An interesting consequence is that, if a small amount of optically active material is added to a nematic liquid crystal, the latter is rapidly converted to cholesteric mesophase. They also observed that when a solute of high optical activity was added to a liquid crystal, the pitch of the cholesteric phase was increased in proportion to the mole fraction of the guest molecule. When the guest molecule is fluorescent, the emission observed is circularly polarized.

Another line of research involves a study of the interaction between liquid crystals and surfaces. They find that the liquid crystal molecules are normally lined up parallel ("homogeneous") with a surface; however, when the surfaces are treated with lecithin monolayers, the liquid crystal molecules line up perpendicular ("homeotropic") to the surface. The homeotropy can be measured by magnetic techniques.

Stegemeyer is collaborating with Prof. Pollmann in high-pressure studies (up to five kbars) of liquid crystals, using a modified Cary 17 spectrophotometer. In this work they find that the transitions between the various mesophases can be more readily studied as a function of pressure than in the traditional way as a function of temperature. For a number of systems they have discovered new phases by this technique. The various phases show large differences in their reflection spectra, which can be readily obtained from absorption measurements. They are also equipped for measuring small-angle x-ray scattering, and they have a new dye-laser system on order that will allow them to measure lifetimes of liquid crystals. For measurements of circularly polarized fluorescence they use a suitably modified Perkin Elmer MPF-4 instrument. Stegemeyer currently has a research group of nine people.

Marburg

Just as in the other universities that I visited, chemistry at the University of Marburg moved just a few years ago to spacious, modern new buildings about five miles from the center of the city. In Prof. W. Luck's absence I stopped to talk briefly to his post-doctoral research associate, Dr. Schiöberg, about their work on membranes. They have been studying the interaction between water molecules and various membranes by means of IR spectroscopy. They find that the water structure is disturbed by this interaction,and that the stronger the interaction the less effective the membrane will be. Related to their interest in the structure of water is their study of hydrogen bonding by means of matrix isolation IR spectroscopy on oximes and alcohols in the fundamental and overtone regions. They are also using Fourier transform far IR for matrix isolation studies on water. Parallel to this are their Raman studies and they also have a diamond cell for spectroscopic measurements under high pressures.

My main purpose in visiting Marburg was to see Prof. Walter Siebert,

an associate professor in inorganic chemistry. Siebert has been a prolific publisher of papers dealing with complexes of transition metals with boron-containing heterocycles in recent years. He has had considerable success in building up double and triple-decker complexes of nickel with cyclopentadiene and the latter's analog that contains 2 B-atoms (replacing CH groups) in the 1- and 3- positions. He is a young man who is "going places"; at the time of my visit he and his American wife were getting ready for a six-month stay in Los Angeles (where he will be working with Prof. M.F. Hawthorne at UCLA), and he was considering an offer for the chair of inorganic chemistry at the Free University of Berlin. He has also recently written a review article that has appeared in the 1979 Volume of *Advances in Organo-Metallic Chemistry* entitled "Boron Heterocycles as Ligands in Transition Metal Chemistry."

Giessen

It is easy to find the chemistry building at the University of Giessen; it is the largest and tallest building in the city. My host, Prof. G. Maier, explained that this reflected the strong chemistry tradition in Giessen, where Justus Liebig lived more than a century ago. (The University is also known as the Justus Liebig University.) Maier was appointed to one of the chairs in organic chemistry a year ago from Marburg, and he still commutes from Marburg to Giessen. His prime interest at the present time is photochemical reactions of organic compounds in inert gas matrices. They have been particularly interested in studying cyclic anhydrides; in an argon matrix at 10 K, dihydrophthalic anhydride fragments to yield benzene, carbon monoxide and carbon dioxide. The broad band that they observed in the IR spectrum suggests that under these conditions a complex is formed between benzene and carbon dioxide.

Maier is interested in synthesizing some exotic organic compounds that have never been prepared before. Among these he mentioned divalent aryl-alkyl silanes, tetrahedrane, and acetylene oxide. The closest that he has come to any of these is the tetra-t-butyl derivative of tetrahedrane, which he prepared photochemically from the corresponding cyclobutadiene and which is thermally stable up to 135°C; above that temperature the compound is converted to the starting material.

Frankfurt

Here in the busiest and perhaps richest city in the Federal Republic the move of the university science institutes to the suburbs came to a premature halt after the establishment of just one building which houses the Institutes of Organic and Inorganic Chemistry in suburban Niederursel. Although this building is spacious and modern, the massive concrete structure looks strange in the midst of wheat and potato fields. The library facilities are minimal, and the location presents a considerable hardship to both students and faculty who frequently have to divide their time between here and the city center, where the Institute of Physical Chemistry and all the Physics Institutes are still situated.

My hosts for the visit were Prof. G. Quinkert, who holds the Chair of Organic Chemistry, and Associate Prof. D. Rehm, who works closely with Quinkert. (The other professor of organic chemistry is A. Kessler who is working primarily in the field of NMR spectroscopy of organic compounds.) Quinkert's main interest is synthetic organic photochemistry, with emphasis on reactions that could be used in the synthesis of natural products. According to Quinkert, one of the principal building blocks for syntheses of this type are substituted 1,3-dienones. They find that upon excitation these compounds appear to go through a ketene intermediate which, of course, is very reactive and undergoes a variety of reactions, depending on the nature of the solvent and the presence of other substances in the reaction media. Quinkert has published a series of papers in this general area, the most recent one appeared in *Chem. Ber.* this year (pp. 310-348). He also mentioned that in their work they use magnetic circular dichroism (MDC) and optical rotary dispersion (ORD) extensively and that they are hoping to develop a capability for time-resolved MCD and ORD measurements by combining these techniques with flash photolysis. This would be essentially a follow up to the original work by R. Strong and H.H. Richtol.

General Comments

At the conclusion of my third two-week swing through the Federal Republic of Germany some general comments seem to be in order. From what I have seen during these visits, coupled with what contributions I have heard at international meetings from German chemists, the inescapable conclusion is that chemistry in Germany has recovered from the effect of the war and regained its excellence completely. In the tradition of prewar German chemistry excellent synthetic work is going on in a number of universities; in addition, research in physical chemistry is on a par with the very best research one finds in other advanced countries. A new generation (35-45 years old) of very good people has been given an opportunity to carry out their own research programs by the vast expansion of the German university system during the last 15 years. Almost without exception the chemistry institutes of universities (and also the MPI's) are in modern new buildings that provide excellent facilities and instrumentation. The German chemical industry (after a slight lull) is hiring chemists again. There are not as many students as there is room for, but this is due to the tremendous expansion in the number of universities. (George Wyman, United States Army Research and Standardization Group)

8TH TRIENNIAL INTERNATIONAL MASS SPECTROMETRY CONFERENCE

The 8th Triennial International Mass Spectrometry Conference was held in Oslo, Norway, 12-18 August 1979. Formal proceedings will be published by the Institute of Petroleum; the editor, Dr. Alan Qualye, is hoping for a 1980 publication date.

This year's Conference was arranged by Dr. Olav H.J. Christie of the University of Oslo and was sponsored by the International Union of Pure and Applied Chemistry, the Federation of European Chemical Societies, and the Institute of Petroleum. Almost 600 delegates from more than 30 nations attended, with West Germany and Great Britain having the largest number. The People's Republic of China sent delegates to the meeting for the first time.

Norway is a very pleasant place for a conference. The Oslo weather was delightfully cool (especially after leaving extremely hot and muggy Washington), although the lack of sunshine was noted. Particularly pleasing were the very friendly people of the country. An excellent reception for the Conference attendees was held in Oslo's beautiful City Hall.

The Conference included 11 plenary lectures, ranging in substance from the talk by Fred McLafferty (Cornell Univ., USA) on "MS/MS: A New Separation/Identification Technique for Organic Molecules," to the talk by A. Frigerio (Mario Negri Institute, Italy) on "Mass Spectrometry and Pharmacology and Toxicology." In all there were 153 papers in 27 sessions and 115 poster papers. The poster sessions were very popular and useful. Conversations with people who use English as their second language are improved considerably in this mode of presentation. Considering that the program was packed into so few days, Christie and the organizing committee did an outstanding job arranging this meeting.

Of particular interest to the authors were the stimulating discussions in the session on secondary ion mass spectrometry (SIMS), an exciting area that holds promise for future developments. These discussions focused on the mechanism by which ions are produced when a surface is bombarded with an ion beam. Prof. J. Drowart pointed out the fascinating similarities of some compounds in SIMS and high-temperature mass spectrometry, and proposed that surface analysis techniques, such as SIMS, Auger spectroscopy, and high-temperature spectroscopy, would benefit greatly by a mutual meeting and exchange on the subject. The authors agree!

Biomedical mass spectrometry occupied more than two thirds of the meeting. Additionally, most of the papers presented in the topics called "Ion Chemistry" were biochemical or biomedical. This showing by the biochemical/biomedical community in this International Mass Spectrometry meeting is evidence of the increasing importance of mass spectrometry in medical research. This importance was predicted at the last triennial meeting in Florence by James McCloskey

(University of Utah, Salt Lake City, USA). The great sensitivity, dynamic range, and versatility of mass spectrometers make them ideal medical diagnostic instruments. The development of new, "gentle" ionization methods—such as field ionization, field desorption, and chemical ionization—that simplify the spectral interpretation (compared with the normal electron impact method), have been the principal reasons for the increased use of mass spectrometry in medical research. Chemical ionization is particularly noteworthy because this method depends on the ion-molecule reactions in the gas phase that involve well-understood chemical reactions, such as acid-base reactions. Chemical ionization spectra can be understood and interpreted more straightforwardly than those produced by electron impact.

Some of the papers that were presented in the biomedical/biochemical areas are described below to give the reader a flavor of the advances of the field. A particularly interesting paper was given by the group from the University College of Cardiff, Wales, entitled "The Mass Spectral Methods and Structural Studies of Insect Secretions." In this paper the authors pointed out that they had previously had difficulty establishing the molecular weight of insect secretions from electron impact spectra. This was caused by the low intensity or absence of ions from the secretion. The research team did an excellent job in obviating these problems and obtaining stereochemical information about these compounds by employing the newer techniques of field ionization and positive and negative chemical ionization on a series of compounds found in the secretions. In addition, they did microscale derivatization and chemical studies on the compounds in order to obtain further information. Gas chromatography coupled to a field ionization mass spectrometer proved to be the most effective method for obtaining the molecular weight when a sufficiently large sample of the secretion was available. Positive and negative chemical ionization GC/MS was also effective, but not so effective as field ionization. The derivatization studies were very effective in identification of functional groups and location of unsaturation sites.

A fascinating paper was presented by K.M. Straub and A.L. Burlingame (Univ. of California, Berkeley) entitled "Use of Field Desorption/Collision Induced Dissociation Mass Spectrometry in Sequencing Modified Polynucleotides." In this paper the authors showed that the extreme polarity and the thermolabile nature of the type of structures associated with modified polynucleotides made analysis by conventional electron impact or chemical ionization mass spectrometry techniques impractical. They used a field desorption ion source together with a gas collision cell to generate structurally characteristic fragment ions from covalently modified polynucleotides of high molecular weight (500 to 1500). The results of the study ended in a nearest-neighbor map of the nucleotide residues for the diolepoxide-modified DNA bases, and provided basic information on the short-range sequence specificity of alkaline agents. This paper was characteristic of the advances of ion chemistry needed to understand and unravel the structure of biomedical compounds.

Prof. Herman Adlercruetz (Univ. of Helsinki, Finland) reviewed the area of "Biomedical Applications of Mass Spectrometries for Steroids." He pointed out that more than 90% of all biomedical applications of mass spectrometry in the steroid field had been made with combined GC/MS instruments. The earlier studies focused primarily on identification of new steroids and various biological materials. The quantitation in these previous studies was obtained from gas chromatography data. This basic work was followed by studies of steroid hormone metabolism in various diseases or following the administration of drugs influencing metabolism. During the past few years more attention has been paid to quantitative MS methods using selected ion monitoring. In this technique, a single ion known to be produced from the compound is monitored instead of a complete mass spectrum, thus enabling the sensitivity to be enhanced greatly. For quantitation, deuterated internal standards have become prerequisites.

The new pre-purification procedures for dividing the steroids into different conjugate fractions depending on polarity or acidity

combined with capillary GC/MS were reviewed in depth. This technique, combined with high-resolution selected ion monitoring and selected metastable peak monitors, means that a further increase in the specificity of the quantitative GC/MS methods is possible. The new ionization techniques, such as field desorption, have made it possible to analyze steroid conjugates without hydrolysis. New computer programs, developed for identification of single steroids based on the fragmentation patterns, have been extended to steroid mixtures. The MS of steroids is a rapidly growing area, and the production of more versatile and stable instruments will further aid the wider use of the technique in steroid identification and quantification.

The group from Burroughs Wellcome Company (Research Triangle Park, NC) presented a paper entitled "The Use of Mass Spectrometric Data to Predict Biological Activity." The authors used the mass spectra of over 100 analogs of *trimethoprim* and performed a statistical analysis of the K nearest neighbors to group the mass spectra and predict the activity of the compounds against dihydrofolat reductase isolated from *E. Coli* or rat liver. For 70 to 80% of the samples studied, the method predicted the compounds having the greatest biological activity.

J. Ximen (People's Republic of China) presented an interesting poster paper on "First and Second Order Trajectories and Ion Optical Properties of Crossed Toroidal Electric and Inhomogeneous Fields" in which the ion trajectories were derived by means of the Fermat principle, and second-order trajectories were calculated for a crossed electric and magnetic field mass spectrometer.

Other than the biomedical papers in this meeting, the authors felt that the overall scientific quality of the meeting did not achieve the level of previous meetings. No new MS approaches or methodology were presented. The American contingent at this meeting was the lowest within memory. Whether or not this was due to the distance and cost of the meeting or some other factor(s) is not clear. We must await the next Triennial Meeting in Vienna in 1982 to find out. (F.E. Saalfeld, J.J. Decorpo, and J.R. Watt, Naval Research Laboratory, Washington, D.C. 20375)

CLIMATOLOGY

CLIMATE AND HISTORY

An International Conference on Climate and History was held at the Climate Research Unit of the University of East Anglia in Norwich, England, 8-14 July 1979. This was the first large conference where climatologists and historians met together in about equal numbers to discuss the variations of climate in the past and the effects of climate variations on history.

The 250 attendees at the Conference came from 35 countries. Over 60 individual papers were presented. The intense interest in the subject matter was shown by the fact that each session had almost 100% attendance. The usual coming and going and talking in the halls was almost nil, and even an evening session lasting until 10:20 P.M. was well attended. Most of the papers were followed by hearty discussions that invariably had to be cut off by the chairmen.

Several facts were clearly illustrated in the various papers. The most pertinent were:

(1) Relatively minor variations in climate can bring about dramatic changes in agricultural productivity in marginal areas. This is particularly true for cereal crops.

(2) Many documented and important events in history can be directly related to variations in climate.

(3) Researchers must be extremely careful in reconstructing climatic history from any single source of evidence. Wherever possible they should correlate data from as many independent sources as possible.

(4) Written and pictorial documentary evidence is rapidly coming to the fore as a rich source of information for reconstructing climatic variations in the past.

(5) There is no consensus as to what climatic trends will be in the immediate future.

Mr. M.J. Salinger (Dept. of Geography, Victoria Univ., Wellington, N.Z.) discussed instrumental records in New Zealand that suggested that

between 1950 and 1970 air temperatures have averaged 0.5°C (sic) higher than normal, and there has been an absence of droughts in many parts of the country. These two decades have been dubbed the Green Years, during which the country has enjoyed a massive growth in agricultural productivity, its main export source of income. South Island had been mainly used for pasturage because it was too cold for most crops. During the Green Years, with only a 0.5°C rise in temperature, it was found that many crops would grow, including tomatoes which would not ripen there previously.

The effects of small temperature differences can be very marked in Great Britain. My own observations have shown that the rolling hills in and near the Cotswolds have vast acreages of cereal grains at elevations of around 500 ft. On the other hand, the fertile valleys of central Wales with elevations of 1000 ft are too cold to grow grain crops and are restricted almost entirely to pasturage. The average difference in air temperature between the two elevations is about 1°C (0.65°C per 100 m elevation).

Mr. G.T.M. Beresford (Rolveden, Kent, UK) gave the last example, Dartmoor, a barren, hilly area in southwest England, that is now used solely for grazing. Bronze Age man successfully grew cereal grains there up to the 1500-ft contour line in the postglacial climate optimum, beginning in the 2nd millenium BC and lasting until about 500 BC. Then the climate became colder and Dartmoor was abandoned as a crop growing area. A second slightly less favorable climate optimum occurred between 800 and 1000 AD. During this time Dartmoor was reoccupied and cereal grains were grown up to the 1300-ft contour, only to be abandoned again when the climate became slightly cooler. Paper after paper reiterated cases of famine in western Europe caused by climatic variations, including several in the 19th century.

Prof. T. Yamamoto (4122 Nibancho, Tokuyama, Japan) discussed the effects of climate changes on historical events in Japan. There the peak frequency of riots among lower-class people against the upper-class feudal lords, court nobles, and wealthy merchants coincided with a "Little Ice Age" occurring in the 15th century. The suboptimum climate seems to have triggered a major change in social structure, the medieval feudalism being replaced by the feudalism of modern times. A second period of great social unrest in Japan occurred about 1800 AD, during a period of sustained rainy, cool climate during the summer.

Dr. W.J. Griswold (Dept. of History, Colorado State Univ., Ft. Collins) presented a similar example across the world from Japan where major revolts occurred in Anatolia in the Ottoman Empire in the late 16th and early 17th centuries at about the time of the climate suboptimum, the so-called "Little Ice Age" in Europe. Reports of travelers to Anatolia mention unseasonable storms, as well as dry spells when large areas of land became desiccated. Preliminary dendrochronological studies (tree-ring analysis) indicate that a serious period of desiccation occurred 10-15 years prior to the most important outbreak of revolts.

Perhaps the most studied and best documented relationship between historical and climatic events is that between the French Revolution and the cereal-crop failures preceding it. This relationship was discussed in several papers.

A number of speakers pointed out the pitfalls that may occur if only one source or type of data is used to reconstruct climatic events in the past. Prof. H.H. Lamb, former Director of the Climate Research Unit at the Univ. of East Anglia, UK, gave one striking example of misinterpretation that could be made. Tree-ring researchers in the future could easily determine from tree rings that the summers of 1975 and 1976 were the driest on record in southern England. He might also note that all the elm trees died in the few years after 1976. The natural interpretation would be that the dry summers were responsible for the death of the elm trees, while in truth the Dutch Elm Disease was the culprit. As many different independent types of data as possible should be correlated to be sure that errors of interpretation have not been made. One of the best received papers, given by Dr. C. Pfister (Geographic Inst., Univ. of Berne, Switzerland), illustrated the use of tree-rings, vine yields, dates of grape harvests, and

advances of glaciers to reconstruct the climate of a period of history in Switzerland.

Dr. M.J. Ingram and Mr. D.J. Underhill (Climate Research Unit, Univ. of E. Anglia, Norwich, UK) presented an invited review paper on documentary evidences of climate change. With the recent explosion of interest in research into past climates, more and more attention is being paid to the exploitation of documentary material. These sources are particularly good for studying short-term climatic fluctuations over the past thousand years. However, they are by no means limited to this time period—they extend back at least to 3000 BC in Egypt and 2500 BC in China.

Most documentary evidence is written, but a surprisingly large amount of information has been gleaned from pictorial evidence. Rock drawings, tomb reliefs, and paintings and pictorial decorations on pottery have been studied for evidence of shifts in the distribution of larger fauna of ancient Egypt and the Sahara region. These shifts in turn reflect changing wind and rainfall patterns. Many old paintings and prints, when compared with modern photographs, reveal in considerable detail movement of alpine glaciers (and hence variations in climate). The depiction of cloud cover by Dutch and English landscape artists provide an interesting record of the character of individual summer weather over the period 1550-1940. Carved stone records of the height of the Nile flood levels for a period of 500 years after about 3050 BC show evidence that the First Dark Age of Egypt was brought on by a prolonged period of intense drought.

Written sources for study of past climate are legion. These include myths, legends, fictions, ancient inscriptions, annals, chronicles and histories, records of public administration and government, private estate records including letters and diaries, early journalism, and maritime commercial and exploration records. Only a few isolated sources can be mentioned here.

Prof. A.E. Hallam [Dept. of History, Univ. of W. Australia, Nedlands (Perth)] gave some climatic records from East Anglia, England. The abbots at the priory associated with the Cathedral in Norwich (prior to the reign of Henry VIII) kept very careful records of the agricultural produce from their vast land holdings. These included daily records of cheese making. For some unknown reason, they stopped making cheese during the barley harvest and gave the milk to the harvesters; therefore we have a record of the beginning and ending of the harvest each year. Early harvests reflected good climate during the growing season while poor climate caused the harvesting to be done later than usual.

Dr. D.V. Stern (22 Basing Hill, London, UK) discussed early manorial records. Bailiffs acting for absentee landlords on estates often kept complete records, many of which tell us something about the climate. Excessive expenditures for sharpening, repairing, or replacing plows indicated drought conditions. Light seeding of grain was indicative of good growing conditions while heavy seeding indicated the opposite. Poor harvests had to be accounted for, resulting in written discussions of the bad weather that caused them. Some persistent letter writers often mentioned the weather. Dr. M.J. Freeman (School of Geography, Oxford Univ., UK) discussed climate changes that were revealed in early canal records in England. Canal traffic in England was frequently interrupted in winter by icing, and in summer by dry weather (which reduced the water available for operating the locks). One steel mill operator wrote to customers each time a canal shipment was delayed, giving a good record of the times that the canals he used were frozen or affected by drought.

Among the best and most reliable sources of historical climate were the diaries of scientifically oriented laymen. One Australian preacher left a daily weather record for 46 years, with observations several times a day. His chronicler, Mr. R.J. McAffee (School of Earth Sciences, Macquarie Univ., North Ryde, Australia), who had studied the preacher's diaries a hundred years after they were written, noted that his morning observations were uniformly good and consistent. The afternoon data deteriorated after his noontime intake of port.

Very little was said about predicting climate, probably because the subject of the conference was climate and history. However, four mutually inconsistent opinions on this subject were expressed. The simplest opinion is that variations in climate and

occurrences of extreme conditions around the world are random. A second opinion is that the climate will be warmer during the next 50 years than it has been in the recent past because of the greenhouse effect related to the increased concentration of carbon dioxide in the air from the burning of fossil fuel. Possibly the majority opinion is that the incidence of extreme conditions has recently increased, suggesting that we will have a colder climate in the future. Others have endeavored to relate some features of climate to cycles in sun-spot activity (see *ESN* 33-9:350). If such correlations exist, we may have some ability to predict some features of climate.

Although it is difficult, if not impossible, to predict climatic changes, we do know that climate could deteriorate, and history tells us the extremes that could be reached. For this reason it may be imperative that we start working on some contingency plans. To quote Lamb, "Climatic change is a harsh reality that must be taken into account in very practical terms." Often political structures have been changed materially by relatively short-term climatic changes. A question to consider is "Could our present political structures in the developed countries withstand a major climatically induced perturbation?"

I found the Conference to be one of the most provocative and stimulating ones that I have ever attended. It was encouraging that both climatologists and historians are well past the purely descriptive state and are now using modern statistical tools to reach their conclusions and test their hypotheses. (Wayne V. Burt)

EARTH SCIENCES

THE 6TH ANNUAL EUROPEAN GEOPHYSICAL SOCIETY (EGS) MEETING

The 6th Annual European Geophysical Society (EGS) Meeting was held at the Technical University in Vienna, Austria, 11-14 September 1979. Almost 500 people from 33 countries attended. Eleven different sections held symposia and other sessions, with as many as 7 different meetings running concurrently. The present article will be limited to the symposium on geophysical fluid dynamics in the oceans and the atmosphere.

A combination of gorgeous weather and a full week's sightseeing programs that had been arranged for spouses of attendees took their toll of attendance at the sessions: head counts of attendees ranged from only 23 to 42, less than the number (50) of papers presented in the symposium.

A wide range of subject matter was covered and the papers in individual sessions were not grouped according to subject matter. In contrast to the meeting the year before when the 50+ papers could be divided into only six types (*ESN* 32-12:410), only orographic effects on weather was the subject of more than four papers.

Rather than discuss each presentation, I will limit this presentation to invited review papers and some of the other highlights, and refer the readers to the abstracts and the forthcoming special publication on the symposium mentioned at the end.

The first invited speaker was Dr. T.A. McClimans (River and Harbor Laboratory, Trondheim, Norway). He gave a thorough discussion of atmospheric and oceanic fronts, ranging in size from large polar fronts to small river plumes. He classified them according to size and persistence. In his review, the processes of frontal growth (frontogenesis), frontal dynamics, frontal energetics, and frontal decay (frontolysis) were discussed in light of recent developments.

Dr. S.A. Thorpe (Institute of Oceanographic Sciences, Wormley, UK) discussed observations made with upward-looking sonar in Loch Ness, Scotland. The observations revealed clouds of acoustic targets in the near-surface mixed layer that were identified as air bubbles caused by breaking waves in deep water. He related the bubble clouds to braid-like structures in the temperature and current patterns and other features of the mixed layer. The bubbles, some of which dissolve under pressure, are an important feature in the gas-exchange budget at the water-atmospheric interface.

Dr. K. Tietze (Inst. for Geosciences and Natural Resources, Hannover, FRG) described a novel device for the

direct determination of density *in situ* in fresh or salt water. The sensor consists of a thin-walled magnetic tube with water samples running through it. The tube is electromagnetically induced to oscillate. Its resonance frequency is a function of the density of the water sample. The device has been tested in African lakes and the Mediterranean Sea in conjunction with a conductivity, temperature, pressure (CTD) probe. The prototype has a resolution of 1.5×10^{-3} kg/m^3. Tietze stated that more precise models under development should have an order of magnitude better resolution.

Dr. T. Maxworthy (USC) gave the second invited paper, on solitary waves (single independently moving waves) in nature. His diverse examples included solitary Rossby waves that are seen in photographs of the atmosphere of Jupiter, tidally induced solitary waves emanating from shallow fjord sills that become visible if glacial flour is suspended in the water, and solitary waves that are produced in the surf when two shallow-water waves cross at right angles. He discussed the formation, energetics, characteristics, and dissolution of solitary waves in the ocean.

The third invited paper, by Dr. P.G. Drazin (Univ. of Bristol, UK), was entitled "Baroclinic Instability in the Atmosphere and Oceans." He first pointed out that the term baroclinic instability had been introduced to the literature in 1947 by the chairman of the session, Prof. Jules Charney (MIT). Drazin reviewed the voluminous recent literature, theoretical and empirical, on this subject. He included a discussion of rotating-fluid models that can now simulate some of the relationships found in nature. One important phenomenon that remains to be explained is the triggering mechanism that changes the number of baroclinically unstable waves around the world in midlatitudes from the normal four to five and then back to four.

Charney discussed the very important but little understood phenomena of blocking in the atmosphere, where slowly moving or quasistationary atmospheric planetary waves are produced that have a major influence on weather. "Orography forces a baroclinic resonate instability giving rise to multiple stationary or fluctuating equilibria." Charney's paper was largely theoretical in nature. It was followed by an applied paper on blocking by Dr. A. Spiranza (Istituto di Fisica, Bologna, Italy). Cyclogenesis frequently occurs over the northern Mediterranean region. These local disturbances may deepen and remain stationary, causing a breakdown of the westerlies over Europe. The flow changes from zonal to meridional as blocking occurs. Spiranza discussed various mechanisms of instability that may bring about the blocking and prevent the disturbances from moving downstream.

Dr. F. Mesinger (Univ. of Belgrade, Yugoslavia) gave an invited paper on numerical methods used in weather forecasting. He discussed a number of methods for improving forecasting and indicated that there had been considerable improvement in the accuracy of forecasting over the past 25 years. However, the old bugaboo of accurately forecasting for more than 4 days apparently still remains with us. The general discussion that followed included a statement by the convenor of the symposium, Tibaldi, to the effect that some improvement in forecasting beyond 4 days is now taking place in his laboratory.

One of the most interesting papers in the symposium was an invited paper on "Laboratory Methods in Geophysical Fluid Dynamics" by Dr. R.A. Davis (Inst. of Lunar and Planetary Sciences, Univ. of Newcastle, UK). Laboratory experiments are used to demonstrate various mechanisms in fluid dynamics; to provide qualitative answers to questions which cannot be obtained by other means; and to carry out groups of experiments to provide ideas for studying the same phenomena in field experiments. Laboratory devices have been perfected to a surprising degree, even including stratified rotating channels that maintain laminar flow. The speaker gave Thorpe credit for a certain experimental technique; Thorpe responded by pointing out that the technique was first employed by Osborne Reynolds in 1883; and if Reynolds had had a high-speed camera available, he probably would have solved many of the modern problems in geophysical fluid dynamics.

The last invited paper, "Flow over Mountains," was given by Dr. I. Vergeiner (Univ. of Innsbruck, Austria).

Orographic effects due to the Alps dominate meteorological forecasting and climatology in Austria (see article on Meteorology at the University of Vienna in next month's issue). Although Austria is a relatively small country, it has 280 stations for observing climatological data and 50 synoptic stations. Their biggest problem is the distortion of the air pressure field brought about in the reduction of mountain-station data to sea level. Surface-pressure analysis leaves out the higher station data entirely. Equivalent potential temperature varies greatly over distances as short as 100 km.

Cold fronts take a long time to pass over the Alps. Isolines of various meteorological parameters tend to pile up on the windward side of the mountains. All meteorological distributions are distorted up to the 500-mb level. One recent development is the use of pattern-recognition techniques to interpret satellite photos of storm clouds passing over the Alps. Austria's better agricultural areas are east of the Alps, which tends to give them a better climate than other areas in Europe at the same latitude. Austria largely escaped the cold and wet years that have wrought havoc on the crops in France, England, Spain, and Germany during historical times.

The symposium was convened by Dr. S. Tibaldi (European Center for Medium Range Weather Forecasting, Reading, UK). Abstracts of most of the 50 papers that were presented were printed in the 7 August 1979 issue of *The Transactions of the American Geophysical Union* (Vol. 60, No. 32). Arrangements have been made to publish many of the papers in a special issue of "Geophysical and Astrophysical Fluid Dynamics."

The 1980 EGS meeting will be held in Budapest, Hungary, in late August or early September. US scientists who are interested in participating in next year's meeting should contact one of the convenors: Dr. John Simpson (Dept. of Physical Oceanography, Univ. College of North Wales, Bangor) or Dr. John Linden (Dept. of Applied Mathematics and Theoretical Physics, Cambridge Univ., UK).

All of the participants thoroughly enjoyed their stay in Vienna. However, if I were to schedule a scientific meeting there, I would pick a time of year with more inclement weather. (Wayne V. Burt)

ELECTRONICS

ELECTRON MICROSCOPY CENTERS PRIMARILY FOR BIOMEDICAL APPLICATIONS

I recently happened on two university centers for electron microscopy (EM) which, although geographically separated by many miles, share common features in their organization and go goals, and may serve as models for other such centers. One of these is located at the University of Bordeaux I (there are 3) in southwestern France, the other at the University of Bari, on the Adriatic coast of Italy. At both of these universities, my visits were not initially to encompass these EM centers, but laudatory comments from faculty in other parts of the university drew me to them in each case. The main similarity between these two centers is that they are both oriented strongly toward biological and medical applications of EM, although in each case they also provide service to applications in metals and ceramics. Both centers are nominally attached to other parts of the university organization, but operate more or less independently.

The center at Bordeaux I has the status of a full Department of Electron Microscopy, which I have not seen before, although there must be others somewhere. The director is Phillippe Gendre a biologist. Jean Surleve-Bazeille, Assistant Professor of Electron Microscopy, also with a background as a biologist, gave me a review of the activities of the department, created in 1962 by Dr. Cambar, again a biologist. There are now about 50 people in the Department, including about 12 faculty members and 18 research students. The department conducts its own research and offers services to other university departments and to industry. The equipment includes 4 TEMs (transmission electron microscopes), 1 SEM (scanning electron microscope), a microprobe analyzer, and many nice pieces of equipment for specimen preparation (such as for ultramicrotomy, cryofracture, evaporation, and replication) and equipment for histochemistry, cytochemistry, and

histoautoradiography. A widely used specimen preparation for organic materials that has been refined at Bordeaux is the so-called "freeze-etching" process, whereby a specimen is frozen, fractured, and a surface replica taken.

At Bari, the center is called the Center of Electron Microscopy. It is located in the medical school of the university, specifically attached to the Department of Pathology. The director is Luizi Mazzarella, a medical doctor. The center was established in 1977, and now has about 10 permanent staff, including 8 professionals. The equipment is not as extensive as at Bordeaux, but includes a Philips 400 SEM and Philips 301 TEM, and excellent facilities for preparation of organic specimens. Because of the relative shortage of funds and staff, the professionals are expert in all phases of microscopic work, from machine operation and data interpretation to specimen preparation and equipment maintenance.

In each of these centers, the emphasis is on research rather than service, and this seems to be the key to their vitality. By keeping personal research interests going, members are able to preserve their own professional integrity while at the same time being available for consultation. In fact, the term "service", which carries with it an unfortunate subordinate image, is really not appropriate. Neither of these centers is bound to do EM work for outsiders, so that the staff has to be made interested in the problem presented before work proceeds.

Regarding the specific research topics, they are mostly outside the range of familiarity of this writer. Compared to metals (about which he has some knowledge), most of the materials examined are quite soft and squishy, and this presents unique specimen-preparation problems. Metallurgists complain about the difficulties in preparing thin foils for TEM, but the reward is the capability of obtaining high contrast derived from diffraction effects, which is quite useful in interpreting the specimen structure. Organic substances are less dense and therefore more penetrable, but the inherent mechanisms for contrast formation are poor. Whereas in crystalline materials diffraction contrast is quite high, in organic materials the absorption-contrast mechanism that must be depended on in most cases is weak, and must be enhanced by appropriate specimen-preparation techniques; in this, there is significant danger of modifying the inherent specimen structure during the manipulations. Hence, although the electron microscope is basically similar for various classes of materials, the specimen-preparation methods are quite different. Normally, metallurgical electron microscopists are skilled in preparing thin foils and surface replicas, but are totally unfamiliar with methods for biological samples, and vice versa. In the two centers described in this note, both fields are encompassed, so that a much wider range of specimen-preparation skills is evidenced by the laboratory staff.

At Bordeaux, the major areas of study are medicine, biology, and pharmacology. There is also work on various applications in chemistry, physics, and metallurgy. The medical-biological applications are centered on studies of tissue morphology in human, animal, and vegetable species; both normal and diseased structures are studied, for one of the main interests is pathology. Also, histochemical and cytochemical ultrastructures are being studied. Nonorganic projects in chemistry, physics, and geology include studies of powder morphology, corrosion, diffusion in metals, mineral characterization, micropaleontology, electronics, fracture, adhesion, and friction and wear.

Since the location is Bordeaux, it was not a complete surprise that one of the activities of the Department centers around the prized local wine. The work in this regard is concerned with the study of bacteria in the wine, detection of impurities, and studies of the structure of vines and grapes. Very tasty research indeed!

At Bari, the balance of work is calculated as 30% service, 70% research. Most of the research is medically oriented, particularly in the area of pathology. To my untrained eyes and ears, much of the biomedical work seemed quite similar to that described at Bordeaux, but I was observing on a very general level. And at Bari, as at Bordeaux, geology is one of the main nonbiological disiplines which receives attention.

The nonbiomedical interest at Bari is soil science, specifically the

problem of stability of clay. In collaboration with the Applied Geology Departments at Bari and several other Italian universities, the ultrastructure of clay is being studied, relevant to problems with soil collapse, such as near river and lake beds where dredging of stones leads to erosion of the river beds. The director of this work at Bari is Mario Ricco, who has a background in physics and electronic design, which comes in handy when the EM's break down. Some special techniques for clay sectioning have been developed. The usual method of preparation of clay samples would be to make freeze-fracture sections, but because of the irregular surfaces produced by this method, resolution of microstructural features tends to be obscured. Therefore flat sectioning is preferred, but the distortion that usually accompanies slicing must be eliminated, and methods to obtain this have been developed at Bari.

Both these thriving centers are buzzing with activity. There is certainly no shortage of subscription for the kinds of services provided, and there is a wide variety of active research topics. Although the main research emphasis in both places is on biomedical applications, there is no prejudice against work on materials such as metals, ceramics, and minerals. The key ingredient to the vitality of such centers seems to be the emphasis on internally directed research rather than service-on-demand as a means to employ the skills of the staff. The Bordeaux center is older, larger, and better staffed and equipped than that at Bari, but the goals and organizations are remarkably similar. Perhaps the most impressive aspect of these centers is the range of research topics that can be accommodated. This is a assisted, of course, by the commonality of the microscopic observation techniques that can be applied, and by the common pursuit of detailed structural information. (Jeff Perkins)

ELECTROSTATICS 1979

On reading the announcement of an Institute of Physics Conference on Electrostatics, to be held at St. Catherines College, Oxford, my immediate reaction was: "Didn't Smythe solve all the electrostatics problems of interest?" (See W.R. Smythe, *Static and Dynamic Electricity*, 3rd ed. McGraw Hill, 1968). Next came visions of Oxford scholars in cap and gown demonstrating in 500-year-old buildings how to solve those difficult problems of Sir James Jeans' 1908 volume, *The Mathematical Theory of Electricity and Magnetism.* (After all, even New College at Oxford is currently celebrating its 600th anniversary.)

It was all wrong of course. St. Catherines, a brand new college, is built of glass, steel and concrete; no one wore a cap and gown; and there was very little in the way of problem solving of the Symthe-Jeans variety.

The problems that were actually considered ranged from Xerography to mining the moon, from electrostatic powder deposition to lightning. Perhaps most startling to me was the involvement of electrostatics in an accident, as follows: The brakes of a new type of airplane were being tested by accelerating the plane on the runway and then stopping quickly. After several repetitions of this procedure, the plane exploded. An electrostatics problem? Yes; investigations revealed that during the start/stop maneuvers the fuel tank had contained only a small amount of fuel. Moreover, there was no additive in the fuel for minimizing triboelectric charging, and the tanks were so large that the fuel was able to slosh around over long distances and thus acquire a high enough charge to cause electrical breakdown of the air and the explosion.

Clearly electrostatics considerations can become very practical ones.

The five formal sessions of the Conference extended over 2 1/2 days. Brief descriptions of some of the to topics treated follow.

In the session entitled Industrial Electrostatics, P. Keith Watson (Xerox Corp. Rochester, NY), who humorously called the copy machine the "ultimate electrostatic hazard," had been invited to review the scientific basis of electrophotography. He talked of two stages that characterize the electrophotographic processes: (1) The formation of a latent electrostatic image by a photoconductor (now well understood) and (2) Characterization of the development process (still in a somewhat empirical state).

He discussed what is now known about these processes and the techniques that have been used to acquire this knowledge.

Among the contributed papers of this session, Sampuran-Sing, J.F. Hughes and A.W. Bright (Department of Electrical Engineering, Univ. of Southampton, UK) discussed image-intensified photographic examinations and laser anemometry of the process of powder coating. They found that during the charging of the powder by a corona discharge only a small fraction of the corona ions actually charge the powder. The others, however, are also attracted to the work-pieces, where they may be trapped in the deposited layer. As a result, large electrostatic fields can develop in the powder that give rise to "moon craters" or pinholes or that simply modify trajectories of powder particles and therefore lead to poor transfer efficiencies.

The problem of unwanted electrical charging during manufacture of non-conducting films (e.g., photographic film) was the subject of a theoretical paper by K.L. Clum (Eastman Kodak Co., Rochester, NY) and of experimental investigations by J.F. Hughes and A.M.K. Au (Department of Electrical Engineering, Univ. of Southampton, UK) and A.R. Blythe (Imperial Chemical Industries Ltd., Welwyn Garden City, Herts, UK). The experimental results revealed that the onset point of sparking correlated well with the theoretical predictions made earlier by Horvath and Berta (T. Horvath and I. Berta, "Mathematical Simulation of Electrostatic Hazards," *Institute of Physics Conference Series*, No. 27, 1975; Chap. 4.) See sketch of Fig. 1 (a).

Electrostatic dust precipitation has been in use for many years, but only for installations that can be accompanied by a high-voltage power supply. Portable dust filters, such as those in face masks or vacuum cleaners, usually rely solely on mechanical filtration by fibrous material. Efficient filters have the disadvantage of imposing high resistance to the air passing through them. This may all be changed by the nonwoven electret fiber filters discussed by J. van Turnhout and J.H.M. Albers (TNO, Division of Technology for Society, Delft, The Netherlands) and W.H. Hoeneveld, J.W.C. Adamse, and L.M. van Rossen (N V Verto, Rotterdam, The Netherlands).

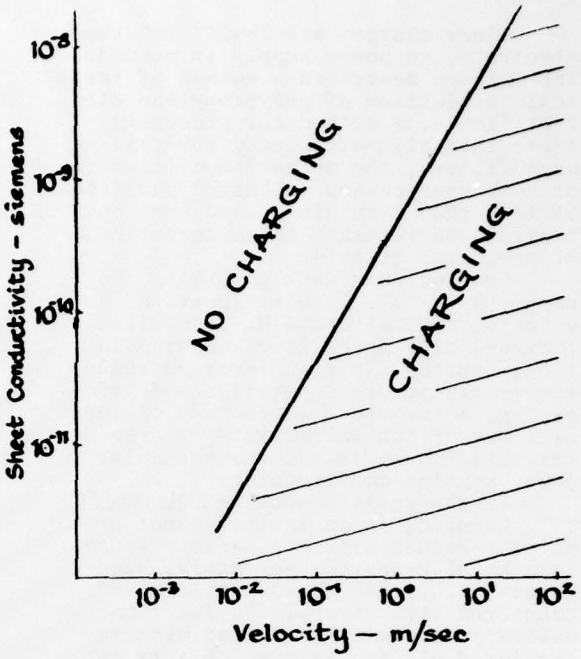


Figure 1 (a)
The conductivity of the surface and the speed of the sheet determine whether the sheet would charge or not.

In the experiments, sparking occured at the specific point shown in Figure 1 (b).

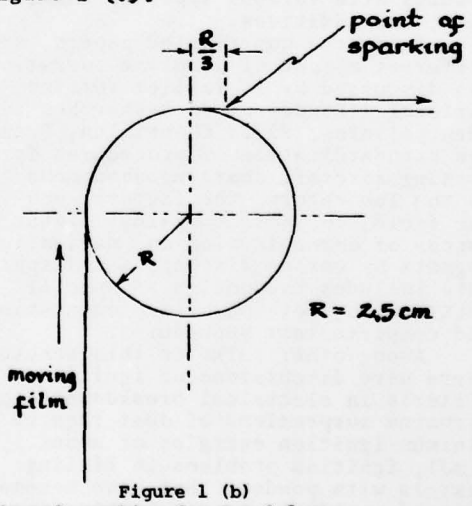


Figure 1 (b)
Location of sparking for R = 2.5 cm

Since charges are "built in" these electrets, no power supply is needed. The authors described a method of large-scale production of polypropylene electret fibres, a method for processing these into high-efficiency low-resistance filters, the mechanism of capture of both charged and uncharged particles of less than 1-μm diam., and very optimistic performance characteristics of practical filters.

From earthly dust to mining the moon: Here I.I. Inculet (Univ. of W. Ontario, Canada) and D.R. Criswell (Universities Space Research Association, Houston, Texas) discussed lunar electrostatic ore separation and processing, a technique which they claimed will have financial advantages over terrestial materials for space solar power station construction.

In the session entitled Hazards, J.T. Leonard, in an invited paper prepared together with W.A. Affens (both from Naval Research Laboratory, Washington, D.C.) discussed problems encountered with aircraft fuels. Some military aircraft are filled with reticulated plastic foam which acts as a three-dimensional flame arrestor for suppressing ignition of fuel vapor by incendiary projectiles. Although acting as a flame retarder, this foam may charge the fuel by contact electrification sufficiently to cause a spark and an explosion. Leonard presented results with various types of foam, fuel, and additives.

Among the contributed papers, a different aspect of airplane operation was discussed by J. Taillet (Office National d'Etudes et de Recherches Aérospatiales, 92320 Chantillon, France): the standardization of procedures for testing aircraft charging phenomena in the laboratory, the factory, and the field, to protect against disturbances of communication and navigation signals by corona discharges and sparks. This includes the design of special instruments, methods of implementation, and complete test procedures.

Among other talks in this session there were discussions of ignition criteria in electrical breakdown (e.g., airborne suspensions of dust require minimum ignition energies of about 5 mJ), ignition problems in filling vessels with powders that have become charged, attempts to use Fourier spectrum analysis of the pulses radiated by a discharge in a hostile environment for precise location of the discharge (because the geometry of the discharge point influences the spectrum), and theoretical and experimental studies of the mechanism of discharge formation.

The invited paper in a session dealing with fluids was by J.C. Gibbings (Department of Mechanical Engineering, Univ. of Liverpool, UK). Entitled "Interaction of electrostatics and fluid motion," it dealt with the existing knowledge and with gaps in the knowledge of this subject. His general conclusions were that a large amount of work on interactions of electrostatics and fluids remains to be done in order to understand the details of fluid flow in chargeable liquids.

Some other subjects treated in this session dealt with an electrostatic charge density monitor in a fuel line; a theoretical paper on the influence of bubbles on electrical breakdown (while in an insulating state they are innocuous, after partial breakdown they will start a catastrophic sequence of instabilities); and an interesting investigation of electrostatically assisted heat transfer. Here J. Cross (Wolfson Electrostatics Advisory Unit, Univ. of Southampton, UK) reported that the application of high electrostatic fields does indeed aid heat transfer from a metal plate through a gas because of a corona wind. At 16.5 kV and 3-cm spacing (see Fig. 2), the velocity of this corona wind was 2 m/sec.

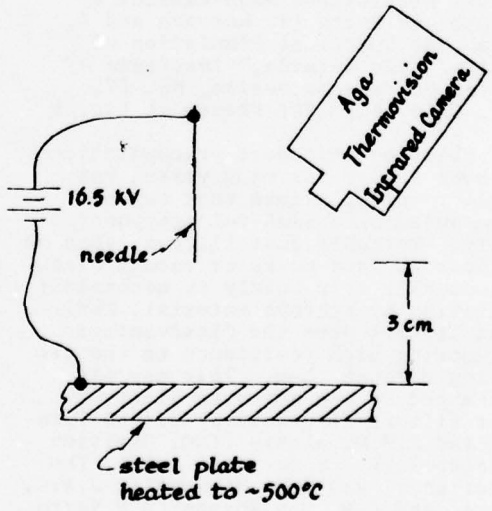


Figure 2
Experiment for observing local temperature changes in steel plate because of corona wind.

In the invited paper "The role of modern surface analysis techniques and understanding electrification phenomena," in Plastics the session entitled Solids, D. Briggs (ICI Ltd., Plastics Division, Welwyn Garden City, UK) stated that electrical breakdown at the surface of a solid can be expected to depend on both macroscopic and microscopic surface structure. He stated, for example, that since electron binding energies for a material such as germanium will be different than for its oxide, breakdown could be expected to depend upon the depth of a surface layer of oxide. Briggs then reviewed a number of surface analytic techniques (e.g., photoelectron spectroscopy, Auger electron spectroscopy, secondary ion mass spectroscopy) and the contributions that they are making to the understanding of electrification phenomena.

Other papers in this session dealt with injection and decay times of charges into polymers, studies of the charge exchange mechanism during triboelectrification, and contact potential. Two papers by the group of Prof. A.C. Rose-Innes (Univ. of Manchester Institute of Science and Technology, Manchester, UK) were of particular interest to me. In one of these, K.P. Homeward and Rose-Innes demonstrated that although the charge transferred from a metal plate pressing onto the surface of a sheet of polytetrafluoroethelene increased linearly with the logarithm of contact time, this increase of contact electrification was not due to any delay in the electron transfer but to an increase in contact area caused by the visco-elasticity of the polymer, and that in any area of contact the charge transfer takes place in a time of 0.3 seconds or less. Even more significant was the second paper, by G.A. Cottrel, C. Reed, and Rose-Innes, in which it was shown that when a metal was contacted to an insulator, contact electrification of the dielectric takes place only if there are impurity states whose energy levels are in the forbidden gap of the insulator. For "pure" dielectrics, achieved in this experiment by condensation of pure rare gases or pure rare gases doped with methane (which does not yield impurity states), there was no charge transfer into the insulator. When doped with chlorine, an electron acceptor, charge transfer occurred.

The final session, Measuring Techniques and Atmospheric Electricity, started with the invited paper "The electrification of thunder storms." This paper, delivered by J. Latham, was a status report of the Thunder Storm Research International Project. Authors were H. Christian, C.R. Holmes, and C.B. Moore (New Mexico Institute of Mining and Technology, Socorro, NM) and W. Gaskell, A.J. Lingworth and J. Latham (Univ. of Manchester, Institute of Science and Technology, Manchester, UK). The objective of this project has been to understand thunderstorms in detail. Interesting results presented were: 1) The presence of solid particles appears to be central to charge transfer. 2) Charging appears to be due to sinking of heavy particles. 3) Lightning in a thundercloud is initiated at low average fields, of only about 4 kV/cm, since the field is strongly intensified locally by the sharp edges of ice crystals. 4) A typical lightning flash neutralizes only about 20 coulombes. 5) The energy in a thundercloud is surprisingly small.

Four other papers dealt with thunderstorms or closely related phenomena. Perhaps of special interest here is a paper by J.L. Boulay (Office National d'Etudes et de Recherches Aérospatiales, Chatillon, France) which was a report of work carried out since 1975 in cooperation with the French Aeronautical Service. Special experimental sites have been set up. Among the experiments performed, rockets were sometimes used for triggering lightning strokes. The objectives were: 1) The characterization of the electric parameters of a triggered stroke discharge, 2) the comparative study of this type of discharge and of natural lightning, and 3) the analysis of strokes within clouds.

I can summarize the conference by stating that to me, personally, this meeting was a revelation. I had not envisioned that electrostatics had become such a live subject, with a number of interesting scientific and practical problems remaining to be solved.

Readers interested in a listing of the complete technical program and some additional technical information are referred to an ONRL report entitled

"Electrostatics 1979", which will shortly be available from this office. Proceedings may be purchased by writing to Mrs. Audrey Gale, The Institute of Physics, Techno House, Redcliffe Way, Bristol BS1 6NX, UK. (Irving Kaufman)

FLUID MECHANICS

AERODYNAMICS AT THE UNIVERSITY OF SALFORD

The aerodynamics program at Salford Univ. (near Manchester), under the direction of Prof. J.L. Livesey, is part of the Department of Aeronautical and Mechanical Engineering. The Department consists of 60 faculty, 60 technicians, and 12 additional personnel. The undergraduates, numbering 500 to 600, are pursuing programs in aerodynamics and mechanics, production, engineering metallurgy, and vehicle engineering. Livesey's group numbers some 15 faculty who are engaged in a variety of fluid-mechanical, combustion, heat-transfer, and biomedical problems.

Dr. Elizabeth M. Laws is investigating gauze flows, degeneration of prescribed turbulent flows, duct design for naval gas-turbine installations, and general approaches to tailoring various three-dimensional velocity profiles. In this connection Laws uses honeycombs, screens, and perforated plates to avoid collective flow oscillations and to remove flow nonuniformities. In her work, she uses a blowdown tunnel of maximum velocity 100 m/sec with a Reynolds number 6×10^6 and an area contraction ratio of 8:1, in addition to a closed-circuit tunnel of Reynolds number 4×10^6 with a contraction ratio of 16:1. Laws is concerned with gas-turbine ducting flows in connection with naval applications where the turbine inlets and outlets are connected to rather long ducts. Problems of particular interest are the distribution of flows to the compressor and minimal loss flows through the turbine.

Dr. Paul L. Wilcox is engaged in optimizing the arrangement of a tower to scrub solvent liquids from gases. The gases are admitted at the bottom through a perforated plate and water is admitted at the top to flow counter to the direction of the gases. Livesey, Wilcox, and John J. Weir are investigating use of gauzes in short wide-angled axisymmetric diffusors to keep the flow well distributed across the diffusor cross section. In addition they are using such gauzes to assist the reattachment of sudden expansion flows to the walls. Of course, the trade-off in the losses incurred with respect to the flow through the gauzes must be measured against the advantage of shorter and wider angle diffusors and more rapid reattachment of the the flow in the case of the sudden expansion.

Dr. R.A. Sawyer is studying various industrial aerodynamic problems, such as the effect of high buildings near airports on wind gusting on runways, racetrack roof overhangs, and potential failures of structures through wind loading. He is using a 14-m long wind tunnel with a 2 m × 2 m cross section. In the same tunnel, problems in wakes behind cylinders and windmills are being studied by Dr. M.M. Zdravkovich.

In another laboratory the flame propagation in a spark ignition engine is being investigated by a PhD student, Mahmoud El-Kady. The fuel being used is propane, and the combustion process data until top dead-center are in good agreement with theory. Past top dead-center, the agreement between observation and classical theory is not good; however, an 18-equation ensemble describing the chemical kinetics gives better agreement with observation. Equipment to study the transient performance of turbo-superchargers is being installed in the laboratory. The work is being directed by Wilcox.

Some interesting biomedical work is being pursued by Dr. Kenneth A. Flower. It is customary to chill a patient who is to undergo open-heart surgery (without blood circulation for extended periods of time) so that he will not sustain brain or other tissue damage. In the usual procedure, the patient is anesthetized and then chill with a cool blanket. Flower's procedure is to chill the blood passing through the heart-lung machine. In this manner the patient can be chilled more rapidly and uniformly. Flower's apparatus includes a DeBakey-type peri

static pump with bubble oxygenation in an apparatus which by-passes the heart, taking blood from the vena cava and putting it back into the aorta.

Flower has also developed an interesting apparatus to help patients suffering from cystic fibrosis, a disorder involving, among other symptoms, thick mucus in the lungs. Since there is no ciliary action to move the mucous accumulation from the lungs, it is necessary to beat patients on the back three times a day while in a head-down position to loosen the mucus which then can be expectorated. Flower has developed a pertussing appliance that beats at 16 Hz, the resonance of the lung structures, and doesn't seem to bother the heart. Such a pertusser mounted on a see-saw frame loosens the mucus, after which the patient is brought into a more optimal position for getting rid of it.

I found the program in aerodynamics at Salford both imaginative and relevant, and came away with the feeling that it will continue to be so indefinitely. (Martin Lessen)

MATERIALS SCIENCE

ADHESION AT POLYMER INTERFACES

A one-day conference was held in London on 15 May 1979 entitled "Characterization and Properties of Polymer Interfaces." This ambitious title is somewhat misleading in that all of the talks were on the adhesion of polymers to themselves and to other solids. This emphasis on polymer adhesion reflects the scientific and technical interest in the subject in general as well as the specific interests of the meeting organizers, the Polymer Properties Group of the Plastics and Rubber Institute. This article reviews the papers given at the Conference, and also some related work going on elsewhere.

Dr. K. Kendall (ICI Research & Development, Corporate Laboratory, Runcorn, Cheshire, UK) gave the first lecture and made the point that if one wished to study polymer interfaces, it is best to work with systems in which one of the phases is dispersed in the other (e.g., particulate fillers in a polymer matrix) so that there is a large interface/volume ratio. The properties of the polymer/filler interface will affect the physical behavior of the matrix polymer which, if properly analysed, will reveal information about the interface. Kendall cited the change in solvent resistance (swelling) of rubber by carbon filler that can be interpreted as an immobilization of the polymer near the carbon. Rubber chemists are quite familiar with the "bound" rubber question, and two rather distinguished members of that fraternity, Dr. A. Thomas [Malaysian Rubber Producers' Research Assn. (MRPRA), Hertford] and Dr. W. Wake (City Univ., London) took Kendall to task and reminded him of the uncertainties in interpreting swelling experiments.

Dr. Brian Briscoe (Imperial College of Science and Technology, London) described his work on the friction and adhesion of polymer fibers. In his experiments, two very thin (2-μm-diam.) monofilaments are put into crosswise contact. One is supported at both ends, the other at only one end; the latter deflects as a cantilever, and its deflection, when contact is broken, is a measure of the adhesion strength. Friction and adhesion are measured by sliding two crossed fibers and measuring the tangential force. Briscoe described work with polyethylene terephthalate fibers containing about 1% titanium dioxide filler. The filler particles protrude from the surface, and to the extent that they reduce the area of contact the interfiber adhesion is reduced. Because the area of contact is so small, it is dominated by surface asperity contact. Consequently, the friction and adhesion behavior of thin fibers does not scale up to the behavior of thick fibers or rods. This has important consequences for the processing (spooling, weaving, etc.) of the filaments and even the "feel" of the finished fabric.

Mr. S. Shaw [Propellants, Explosives and Rocket Motor Estab. (PERME), Waltham Abbey, UK] reported on the stress-corrosion cracking behavior of aluminum-epoxy bonds. He uses a double cantilever beam specimen, tapered for constant change in compliance with crack length, which means that the load on a growing crack is constant along

the length of the specimen. The tests were conducted in water at 23°C, and the time to failure (TTF) was measured for precracked specimens. Shaw reported a linear relation between applied strain-energy release rate and log TTF for both unmodified epoxy adhesives and rubber-modified (for high toughness) epoxy adhesives. The data for the rubber-modified adhesives were displaced to much higher values for a given failure time. He has also found that treatment of the aluminum with a "silane" adhesion promoter (epoxypropoxytriethoxy silane) dramatically increased TTF, by a factor of more than 10.

[Shaw and Dr. A.J. Kinloch described to me their results on the dry fracture strength of rubber-toughened adhesive bonds during a recent visit to PERME. They have found not only a strong effect of bond thickness, as has been reported by others, but also a curious dependence of the fracture energy on specimen thickness which they attribute to a transition from plane-stress to plane-strain conditions at the crack tip. If they are correct, then the usual criteria of fracture mechanics used to predict the plane-strain/plane-stress transition for monolithic specimens does not apply for adhesive bond fracture.]

Dr. M. Gettings (Atomic Energy Research Estb., Harwell, UK) reported on his work with Kinloch on the x-ray photoelectron spectroscopy (XPS) and secondary ion mass spectroscopy (SIMS) analysis of iron surfaces that had been treated with silane adhesion promoters. They find clear evidence for the formation of an iron-silane species, $FeSiO^+$, which implies the formation of a chemical bond between the silane and metal substrate. Moreover, they have been able to correlate the detection of this species with the residual strength of epoxy-iron adhesive test specimens exposed to water. Treatment of the iron with silane adhesion promoters that do not give the $FeSiO^+$ species in SIMS analysis have only marginal improvement in residual strength compared to untreated specimens. Whether convalent bonds between the silane and the metal adherend are important in their action as adhesion promoters has been a matter of controversy for many years. The results of Gettings and Kinloch are the first direct evidence in favor of convalent bonding.

The discussion of the silane adhesion promoters was continued in the talk by Wake who has been studying the properties of the polysiloxane films formed by hydrolysis of silanes. It is generally agreed that treatment of an adherend with a silane produces a polysiloxane film. Wade prepares free films by casting and hydrolyzing the silane onto polytetrafluoroethylene and then stripping it off for examination by infrared spectroscopy, solvent swelling experiments, and mechanical testing. Wake points out that, because of steric hindrance, it is unlikely that the silanes are fully hydrolyzed into 3-dimensional networks; they are more likely to be linear structures with some branching and many unreacted hydroxyl groups. Indeed, the IR spectra show a strong hydroxyl band. Surprisingly, he finds that the hydroxyl hydrogens cannot be exchanged with deuterium. The mechanical properties suggest a discontinuous network formed by particles of highly crosslinked material held together by a few tie chains. Evidently there are unreacted hydroxyls within the particles which D_2O cannot reach. This is an entirely new picture of the structure of silane films, but its significance to their action as adhesion promoters is still unclear.

Another surface treatment used to enhance adhesion, in this case of polyolefin films to themselves or to metallization coatings, is corona discharge. Dr. D. Briggs (ICI, Plastics Div., Welwyn Garden City, UK) described his study of discharge-treated polyethylene (PE) using XPS. He finds that the discharge did not alter the wettability of the film surface sufficiently to account for the improved adhesion. On the other hand, XPS showed the formation of chemical groups in the surface capable of H-bonding and more polar interactions which could account for the enhancement. Functionalizing the surface polar groups with reactants that block interfacial interactions markedly reduced the auto-adhesion of discharge-treated films.

Briggs' contribution raised the perennial question of whether adhesion strength can be enhanced by simply increasing the polarity (chemical reactivity) of the interface or whether something more is involved. In the

case of corona discharge, for instance, one might speculate that the rheological properties of the interfacial region are altered so that flow and interfacial penetration are enhanced. Dr. D. Packham (Univ. of Bath) opposed simple chemical bonding in his talk about the adhesion of melt-coated PE to copper, zinc, and steel. Essentially, he finds that a fibrous oxide growth forms on the metal surface and that improved adhesion can be explained by the PE melt penetrating the surface topology, better known as mechanical locking.

One of the very few cases where the intermolecular forces between two solids can be measured directly is the adhesion of elastomers to themselves or to other solids. One of the principal workers in this area is Dr. Alan Roberts of MRPRA, who described his recent study of the adhesion of rubbers of different polarity to themselves and to glass. The technique involves either contacting very smooth rubber hemispheres and measuring the "snap-on" force as the solids are brought into contact under zero applied load, or, if one solid is transparent, the deviation in the size of the contact area from pure Hertzian, elastic contact. Time-dependent viscoelastic effects must be eliminated in determining the equilibrium interfacial energy ($\Delta\sigma$). Roberts has measured $\Delta\sigma$ for rubber/rubber and glass/rubber contact. He obtained values of 40-60 ergs/cm^2 with a trend to increasing energies with increasing rubber polarity for both types of contacts. He has also been measuring the effect of humidity on $\Delta\sigma$ for natural rubber/glass contact. Surprisingly, he finds that $\Delta\sigma$ increases by a factor of 2 as RH increases from 10% to 70%, and then jumps another factor of 2 at 90% RH.

Dr. G.A.D. Briggs described his work with Briscoe on the effect of roughness on the adhesion of rubber. In their experiments a cylinder of very smooth silicone rubber is rolled down an inclined plane of polymethylmethacrylate (PMMA) that has been grit blasted to roughen the surface. In these experiments, like those of Roberts, the adhesion energy can be determined; in this case from the time to roll a specified distance and the angle of inclination. In earlier work by Roberts and others it was found that the adhesion energy decreases systematically with increased plate roughness, which they explained by a decrease in actual contact area. Briggs and Briscoe, however, find that at low levels of roughness, around 1 μm CLA, the measured adhesion can be as much as 2-3 times that of a smooth plate. With further increases in roughness the adhesion falls to values below that for smooth PMMA, as others have found. The explanation that Briggs and Briscoe offer for the anomalous increase in $\Delta\sigma$ is for certain size of surface asperities there is a storage of elastic energy when the rubber contacts the asperity which is lost on separation. For asperity sizes greater or less than this critical size, the effect does not occur. These results and their interpretation are highly controversial. Roberts and co-workers have suggested that low-molecular-weight silicone oils are diffusing into the surface of the rubber and are responsible for the effect. Briggs and Briscoe do not agree.

[Another worker investigating the adhesion of elastomers, but who was not at the London meeting, is Dr. D. Maugis (Laboratoire de Mécanique des Surfaces de CNRS, Meudon, France). Maugis takes a quasi-fracture mechanics approach to the analysis of the separation of elastomer contacts; and through some rather elaborate mathematics, which he supports with experimental results for the adhesion of polyurethane rubber to glass, he has developed a formalism which decouples the elastic properties and loading condition from the surface properties and viscoelastic losses. He claims that his analysis is unique in this respect.] (Willard D. Bascom)

HOW PLASTICS FAIL—THE CHURCHILL CONFERENCE

The 5th International Conference on Deformation, Yield, and Fracture of Polymers was held on 2-4 April 1979. These conferences are unofficially known as the "Churchill Conferences", since they are regularly held at Churchill College, Cambridge University. They are sponsored by the Plastics and Rubber Institute, and have been held every three years since 1970. The presentations at this conference

were largely from the UK and US, but among the attendees there was good representation from Western Europe and Scandinavia.

The papers included work on fracture, yielding, crazing, ultraoriented polymers, and composites. There were review lectures on viscoelasticity and yielding by Prof. I.M. Ward (Univ. of Leeds, UK), and on composites by Prof. D. Hull (Univ. of Liverpool, UK). Prof. E. Andrews (Queen Mary College, Univ. of London) filled in for a cancelled paper with a review lecture on his generalized theory of polymer fracture mechanics.

The Conference gave a reasonably good view of the state-of-the-art of research on polymer failure, and so a detailed account has been written on the presentations and discussion (see ONRL Report C-4-79). In this article we touch on some of the highlights of the meeting.

A number of the papers on fracture dealt with the stability of crack propagation and the microprocesses at crack tips that determine whether crack growth is stable or unstable. The outcome was more confusion on an already controversial question. Prof. J.G. Williams (Imperial College, Univ. of London) reported on a sharp increase in impact strength of high-density polyethylene and polymethylmethacrylate at very high loading rates. In the past he has dismissed the idea that this effect may be due to an isothermal-adiabatic transition, but now thinks it may indeed be due to adiabatic he heating at the crack tip.

Among the papers on polymer yielding, many were concerned with heterogeneous yielding resulting, for example, from local adiabatic heating or defects. There was an interesting paper by Dr. D.M. Shinozaki (Univ. of Manitoba, Canada) and Dr. C.M. Sargent (Univ. of Saskatchewan, Canada) on modeling inhomogeneous plastic flow. Prof. B. Escaig (Univ. de Lille I, CNRS, Villeneuve d'Ascq, France) gave a very controversial talk on a purely thermodynamic approach to polymer yielding. Fatigue failure was the subject of a number of presentations in the sessions on yielding and fracture.

The deformation of a polymer so solely by craze formation is amenable to analysis because the unit of deformation, the craze, is discrete and its pertinent properties can be measured. Craze analysis was the subject of papers by Dr. N. Brown (Univ. of Pennsylvania), Dr. N.J. Mills (Univ. of Birmingham, UK) and others. Papers by Dr. E.J. Kramer (Cornell Univ., NY) and Dr. N. Verheulpen-Heymans (Univ. Libre de Bruxelles, Belgium) presented experimental evidence for craze growth by the surface drawing mechanism.

There were two interesting papers on ultraoriented polymers. Dr. M.A. Wilding (Univ. of Leeds, UK) spoke about the irreversible creep of ultra-oriented polyethylene (UOPE) and the effectiveness of cross linking (by ionizing radiation) and chain branching in reducing creep. Dr. E.L. Thomas (Univ. of Massachusetts) described his microscopy study of UOPE and reported finding microfibrils about 250 Å in length.

Finally, in the papers on composites, Dr. G.J. Lake (Malaysian Rubber Producers Research Assn., Brickendonbury, Hertford, UK) discussed the failure mechanisms of steel cord reinforced rubber. Dr. J. Harding (Univ. of Oxford, UK) gave a paper on the compressive failure of glass and graphite composites in which he took into consideration the sinusoidal configuration of the fibers.
(Willard D. Bascom)

MEDICINE

BODY SHAPE AND PULMONARY VOLUME MEASUREMENTS

The measurement of pulmonary volumes from routine chest radiographs is not a new idea, but correlation with other types of pulmonary volume measurements was not satisfactory prior to the last two decades. Before 1960 pulmonary volume measurements taken from chest radiographs made simple assumptions about the cross-sectional shape of the chest which, it has since been learned, are not valid. Barnhard et al. in 1960 made the first reasonably successful measurements. They assumed an elliptical shape for the lungs and the heart, and considered the diaphragm as 1/8 of an ellipse. Barnhard, and others who followed him and used his method, were dependent

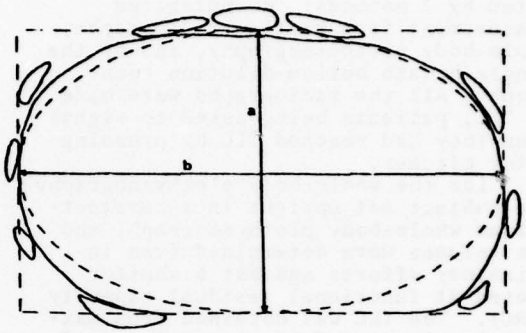
as standard tests on plethysmography and early gas dilution methods, which in themselves may not have been accurate.

A group of investigators at the lung function unit of the Brompton Hospital, London, UK, under the direction of Dr. David Denison, have refined the pulmonary volume measurements made from chest radiographs and have excellent correlation with other methods. They have, in addition, extended this work to the measurement of pulmonary lobar volumes in both normal and abnormal subjects and volume measurements of pneumothoraces and pulmonary cysts.

All modern methods of measuring pulmonary volumes from radiographs are dependent upon a digitizer and a computer. In order to write a better program, Dr. R. Pierce and the Brompton group have developed a correction for the shape of the chest. They also utilize individual magnification factors and have taken into account postural effects on thoracic gas volumes. Their results compare favorably with modern plethysmographic and helium-dilution estimates of total lung capacity (TLC).

There are four basic steps in radiographic pulmonary volume measurements. Initially, the boundaries of the chest, heart, spine, and diaphragm are identified on the posterior-anterior (PA) and lateral (lat) radiographs and traced using a digitizer. The digitizer feeds the xy coordinates of successive points of each outline directly into the computer. In the second stage the computer aligns the PA and lat views in the same vertical plane and divides them into a large number of horizontal slices. The PA and lat diameters and thickness of each slice are then determined. In the third step the computer calculates the cross-sectional area of the anatomical structures in each slice, and finally the volumes of the whole organs are reconstructed by summing the information from all the slices. The results can be presented in pictorial or digital form.

A new correction by the Brompton group for the cross-sectional shape of the chest and its contained structures was determined from post-mortem anatomical sections and from computerized axial tomographic (CT) scans in living subjects. From these studies it was determined that the average cross-sectional shape of the chest exceeds that of an ellipse but is smaller than that of a rectangle. The area was estimated to be 1/3 of the way from the ellipse to the rectangle (see figure).



ELLIPSE AREA = $\frac{\pi}{4}$ ab

RECTANGLE AREA = ab

If a and b are the length and width, respectively, the area can be described by the following equation:
$A = \pi ab/4 + (ab - \pi ab/4)/3$ which simplifies to 0.857 ab. The mean error for ten CT scans with a mean chest volume of 8.71 liters was 0.5% (45 ml). The cross-sections of the heart, spine, and sub-diaphragmatic regions were found to be very close to elliptical. The errors from both anatomical and CT data were found to be quite small (less than 50 ml), and combining all the variances for the estimation of the lung volume, an overall accuracy of ± 210 ml was found. After compiling the mean errors of chest, heart, spine, and sub-diaphragmatic volumes from the CT scan data, the total lung volume was found to be underestimated by 125 ml. As an equation therefore: lung volume = chest volume - (heart + spine + sub-diaphragm volume) + 125 ml. In addition, it was determined that the cross-sectional shape of the heart and the sub-diaphragmatic structures and the spine showed little change between TLC and residual volume (RV).

Individual magnification factors for each radiograph were estimated

from the target-film distance and half the chest diameter of the specific radiographic view. Since all the radiographs used in this particular study were taken at a specified distance, the calculation was straightforward.

The lung volumes of 18 normal males and 17 normal females were evaluated by 3 methods: computerized measurement from routine radiographs, whole-body plethysmography, and by the single-breath helium-dilution technique. All the radiographs were made at TLC, patients being asked to signal when they had reached TLC by pressing a toy clicker.

For the whole-body plethysmography, the subject sat upright in a constant-volume whole-body plethysmograph, and gas volumes were determined from inspiratory efforts against a shutter closed at functional residual capacity (FRC). The TLC was obtained from maximal inspiration following release of the shutter. A mean of at least three reproducible measurements was used.

The single-breath helium-dilution technique required the subjects to expire to RV, rapidly inspire a helium-rich mixture to TLC, hold their breaths for ten seconds, and then expire quickly back to RV. The helium concentration of the mid-expirate was measured with a PK Morgan MK IV Respirometer.

The correlation coefficient between radiographic and plethysmographic TLC data was 0.96, between radiographic and helium-dilution TLC data 0.95, and between plethysmographic and helium-dilution data 0.97. The mean value for the difference between radiographic and plethysmographic volumes in the 35 subjects was 0.72 liters. This difference is probably due to pulmonary blood and tissue volumes.

The radiographic method is very accurate for structures of known geometric shape; hence its accuracy for estimating pulmonary volumes is dependent upon how well the actual volume matches the assumed one. The overall accuracy of ± 210 ml compares very favorably with results from the literature using other methods of measuring pulmonary volumes.

The lung function unit at the Brompton Hospital has pushed these investigations into a new realm by attempting to measure lobar volumes in health and disease as well as the volumes of pneumothoraces and pulmonary cysts. Individual lung volumes are determined by programming the computer to reflect the left and right halves of the PA radiographic image about a mediastinal axis. These double left and double right lungs are then considered along with the lateral radiographs using the same cross-sectional information as for the calculation of total lung volume. The resulting volume estimates are then simply halved to give the individual lung volume. The interlobar fissures can be seen in a majority of patients on the lateral radiograph. While the whole of each thoracic structure is used in the measurement of individual lung volumes, only those parts within the boundaries of each lobe, as determined by the fissures, are used in the estimation of individual lobar volumes. The volumes of pathological spaces such as pneumothoraces and lung cysts can be estimated in the same way.

Two additional methods of determining lobar volumes were studied. One employed an isotope of Krypton (^{81m}Kr) administered through a bronchoscope, which directed a stream of radioactive gas into a lung or lobe under study. The short half life of the Krypton (13 sec) allows rapid clearing of the lobe so that anterior and lateral images can be obtained quickly. The tube carrying the radioactive gas to the bronchoscope is taped to the chest wall over easily identifiable bony landmarks. Appropriate scans can be obtained in relation to the surface markers, which also can be used to locate the position of each lobe within the whole lung scan. In this way a composite AP and lateral image of the lungs can be obtained. Pulmonary volumes can then be calculated as they are from chest radiographs.

The second method employed bronchoscopic inert gas dilution studies. In this method a bolus of pure inert gas, for example argon, is injected into a lobar bronchus during inspiration from RV to TLC. The concentration of the argon is measured in the subsequent lobar expiration by a mass spectrometer sampling probe in the same bronchus. The gas is delivered through a modified Swan-Ganz catheter, cut so that the smaller inner lumen is approximately 1 to 2 millimeters proximal to orifice of the larger distal lumen. The bolus of inert

gas is delivered to the lobar bronchus through the larger distal lumen by steady injection between the second and eighth seconds of a ten-second vital-capacity inspiration. Gas is sampled continously from the smaller proximal lumen by the mass spectrometer. If no argon is seen at the proximal tube during the inspiration, it is certain that the entire bolus has gone into the lobe without significant reflux. The volume of the lobe at TLC is calculated from the expired fractional concentration. A period of several minutes is allowed after each bolus to enable washout of the gas before another lobe is studied.

Pulmonary volume measurements can be critically important to patients with obstructive lung disease whether it be a temporary asthmatic condition or pulmonary emphysema. The pathological overexpansion of individual lobes or lung cysts may require their surgical removal. Accurate volumetric measurements can now be obtained from routine chest radiographs as well as by more sophisticated methods. Although radiographic measurements of pulmonary volumes requires a digitizer and computer, it is otherwise simple, relatively inexpensive, and of no inconvenience to the patient. The refinements developed by the lung function unit of the Brompton Hospital makes this method more reliable, more accurate and of increasing importance. (Irwin M. Freundlich)

POST-MORTEM INTRAOSSEOUS PHLEBOGRAPHY

The religious preferences of a significant segment of the Israeli population (strictly orthodox Jews and Muslims) has led to a reduction in the expected number of autopsies. Post-mortem pathological examination has been and is still one of the foundations of medical science. In order to gain some knowledge of the extent of disease and the effects of therapy following the patient's demise, when permission for autopsy cannot be obtained, an ingenious method of outlining the entire venous system of many internal organs has been developed. The procedure consists of injection of radioopaque contrast material into the marrow cavity of a bone. It is simple to carry out and provides considerable morphologic information but does not in any way represent the hemodynamic condition of the patient prior to death.

Prof. Samuel Schorr and his co-workers (Department of Radiology, Ichilov Hospital and the municipal-government medical center of Tel-Aviv/Yaffo) initially carried out post-mortem intraosseous phlebography on four dogs which were then autopsied, and the radiographic anatomy and pathology previously outlined by intraosseous phlebography confirmed. Three of them had various malignancies and one had an inflammatory soft tissue mass of the lower extremity. This preliminary animal work convinced the experimenters that further investigation on human cadavers would be worthwhile.

The cadavers are preserved at a temperature of 3 to 4°C and the radiographic post-mortem examinations performed 8-12 hours following clinical death. While most of the examinations are carried out with the cadaver in the supine position, additional injections were made with the bodies suspended in a vertical position in order to determine whether venous filling could be achieved against gravity. A 15% to 20% solution of potassium iodide (KI) is employed. Approximately 30 to 60 ml are injected into each osseous site. A needle 4 cm in length with an outer diamter of 1.5 mm and an inner diameter of 1.0 mm and a puncturing stylette is generally used. A bone is selected that contains a medullary cavity and that may be punctured without it being obvious later, such as the distal end of the fibula, the iliac crest, the manubrium, the humerus, or a rib. The needle is pushed through the compact cortical bone into the spongiosa by a rotating motion with only a moderate amount of manual pressure. After the needle is in place again only moderate manual pressure is necessary for the injection. If the distal end of the fibula is used, a tourniquet is applied in order to prevent backflow of the contrast material into the superficial venous system.

The investigators studied 90 cadavers with an average of 3 injections into different sites for each cadaver. In all cases there was good immediate passage of the contrast into the venous plexes and local veins. There was minimal diffusion within the medullary cavity and no seepage of contrast

outside of the veins was observed. Very few blood clots were seen. Excellent visualization of the entire venous system could be obtained at will with minimal hemodilution of the contrast material.

The investigators were intrigued by the ease with which the venous system could be filled by a simple hand injection into the bone marrow with only moderate pressure. However, several known factors actually can account for it: 1) In cases of sudden death cadaver blood is in a fluid state and tends to remain so. 2) The vascular system has a much greater capacity than is in use during ordinary life, and venous channels not in use but available for recruitment are open after death. 3) Arterial and arteriolar tone present during life but absent after death accounts for additional vascular space. Therefore, the vascular system has the capacity to accept considerable additional fluid in the post-mortem state.

In order to explain further the fluid dynamics involved in the experiment, Prof. S.R. Bodner (Dept. of Materials Engineering, The Technion, Haifa, Israel) was asked to join the group. Four hypotheses were evaluated as possible explanations for the movement of contrast material in the vascular system of a cadaver: 1) A pressure gradient between the intraosseous injection site and the lumen of the deep veins in conjunction with a suction effect in the partially emptied elastic venous system; 2) diffusion of contrast material, possibly because of the concentration gradient, between the injection site and the distal areas; 3) capillary and surface interaction between vessels and contrast material; and 4) a temperature gradient between a warm periphery and the still cold central parts of the refrigerated cadaver. Explanations which were initially considered but eliminated after the initial experiments were: 1) A localized pressure gradient at the stream front of the contrast medium owing to expansion of the vessels by fluid flow, 2) a squeezing effect of the venous system in the extremities because of rigor mortis, and 3) post-mortem intestinal peristalsis that might produce a milking effect on the abdominal veins.

Eleven additional cadavers were studied with pressure measurements taken in various portions of the venous system before and after intraosseous injection. For intraosseous pressure measurements, a needle was inserted into the spongiosa and immediately after the injection connected by a flexible polyethylene tube to a water manometer. Post injection intraosseous pressures were measured using a 3-way stopcock. Injection pressures in the syringe were measured with a standard spring pressure meter. Peak pressures ranging from 0.4 to 2 atm were recorded that dropped sharply as the contrast material entered the bone. Peak pressures also depended upon the rate of injection, the diameter of the needle, and the bone selected. Pressures in the deep veins were measured by catheterization and right atrial pressures were measured by an x-ray controlled transthoracic intra-cardiac needle.

In order to evaluate the intraosseous pressures during injection, two needles, 0.5 cm apart, were inserted into the distal end of the fibula (the lateral malleolus). One needle was connected to a manometer and the other used for the injection. After the injection of single bolus of 40-cc KI solution the intrasinusoidal pressure rose sharply to 36 cm of water. In the first minute after the injection, however, the pressure dropped to 18 cm H_2O and then slowly declined during a period of 2 hours to 1 cm. Although pressures rose within the veins after an intraosseous injection, a similar pressure recording in the aorta showed no change. The same study performed in a vertically suspended cadaver resulted in higher intraosseous pressures during injection that remained higher for a longer period of time. The higher pressures measured in the vertically suspended cadaver suggests a simple hydrostatic effect.

To evaluate the contribution of various parts of the venous system to the pressure gradient, pressures were measured in several parts of the cadaver without injecting contrast material. All pressures were recorded after stablization of the recording system for 30 minutes. Vascular pressures taken at several sites 5 days after death were between 0 and -1 cm H_2O. However, in cadavers examined within 24 hours of death, the venous pressures were positive, as high as + 12 cm H_2O. Schorr commented that "vascular death" may be somewhat

later than "brain death" or "heart death." The gradual decline in pressure is probably caused by hemolysis and extravasation of the blood components. Visual comparison of the veins in a cadaver immediately after death and after a few days supports this contention.

The other major hypotheses were also tested. Osmolarity measurements revealed that a gradient (hypothesis number 2) does exist but plays an insignificant role in the propagation of contrast material. The 3rd hypothesis, that of capillary and surface interaction, as well as the 4th hypothesis, that of the possible role a temperature gradient may play in diffusion of contrast material, were both tested and found to be insignificant.

The only satisfactory explanation these investigators found for the rapidly and easily filled venous system by post-mortem intraosseous phlebography is related directly to the pressure of injection, although only moderate, in an only partially filled vascular system. The pressure of injection into spongiosa of a distal bone could be measured in any portion of the venous system. The other hypotheses for the movement of contrast material within the venous system did not play a significant role.

Intraosseous phlebography has been studied extensively in Israel. These continuing efforts allow for examination in the post-mortem state when autopsy permission cannot be obtained. Morphologic demonstration, although not hemodynamically accurate, may be of considerable importance in determining the cause of death, the extent of disease, and the effect of therapy. (Irwin M. Freundlich)

OPERATIONS RESEARCH

OR AT SAS

The Operations Research Group of Scandinavian Airlines (SAS) is located at the Bromma Airport, an airport close to Stockholm for domestic flights (the international flights go from Arlanda airport, considerably further from the city). The group is headed by Sven-Eric Andersson, who has his licentiate (a degree almost like the American PhD) in applied mathematics from the Royal Institute of Technology in Stockholm. He worked for FOA, The Swedish Defense Analysis Agency, where he gained experience with large simulation models, and then with a consulting firm where he worked on long-range planning and a wide variety of operations research projects. At SAS he supervises a group of four OR professionals of whom I met three: Archie Duncanson, Catherina Fahlander, and Bengt Björklund. Duncanson is an American who has a bachelor's degree in M.E. from UC Berkeley and a master's degree in operations research from Stanford Univ. in 1968. He has married and settled in Sweden, and assures me (against my better judgment) that it is possible to learn Swedish. Fahlander and Björklund have master's degrees from the Royal Institute of Technology and considerable experience working in an operations research group there as doctoral candidates and assistants before coming to SAS a year ago. All three are highly competent professionals.

The airlines of the world all have more or less the same kind of operational problems and, as might be expected, they have an organization called IATA, the International Air Transport Association, through which they can discuss these problems. However, OR people do not usually operate through IATA but rather through their own group, AGIFORS, the Airline Group within IFORS, where IFORS is the International Federation of Operational Research Societies. Of course some studies are proprietary, but most are shared between the airlines. On the other hand each airline must have its own OR group, if only because the details of each problem are unique to a particular airline. Thus in most of the applications described below SAS has had anything from an idea to a more or less complete model from one or more of the other airlines, but it has had to do the implementation itself.

Optimal Overbooking: As long as the airlines experience a large number of no-shows (passengers who make confirmed reservations and do not appear for the flight), and as long as no penalty may be charged to them, the airlines are forced into a policy of

overbooking. This is not only from the viewpoint of airline profit, but also from that of service to the public; the latter is not being served when a prospective traveler is refused a seat that is in fact available. On the other hand, any overbooking policy leads to some probability that passengers with confirmed reservations will be denied boarding. The OR problem is of course to minimize the total expected cost—on one hand the cost of lost revenue when empty seats are flown, and on the other hand the cost of reimbursement and loss of good will when a passenger is denied boarding.

is is the first of the OR projects that was done at SAS, and has not only been accepted but has actually become what Andersson calls "an integrated model"; namely, one that has become part of the infrastructure of SAS—that is, the OR group no longer supervises its application, and it is operated by the users within the airline. The model has been reported in AGIFORS, but other than that SAS has never publicly admitted that they have an overbooking policy (though they have never denied it; they simply avoid mentioning it). Andersson told me that SAS is uncomfortable whenever they have to deny boarding, and so I suggested to him that a reimbursement policy (such as has now been introduced by US airlines through government regulations) might be a good idea; but apparently this is a marketing problem, not one that comes under the jurisdiction of the OR Department.

Manpower Planning: There are two separate models here, one for sales offices and one for handling passengers at airports. In both cases the input distributions are Poisson. In the case of sales offices the service times also tend to be Poisson, and therefore the problem can easily be handled analytically. Tables have been built up and these are used at the numerous sales offices in Sweden and around the world. Actually, Andersson told me, under the present accounting system of SAS there is little incentive for any sales office manager to reduce manpower, so these models are used primarily in the bargaining between managers concerning their manning levels; but even there they supply a set of ground rules as the basis for such bargaining, which represents a distinct advantage. In the case of serving passengers at airports, the distribution of times is quite complicated, due, for example, to passengers who are overweight and have to make supplemental payments. Hence, the problem could not be solved analytically and a simulation was made using GPSS. The output is passenger waiting times, as a function of manning levels and of the rate of passenger arrivals, during the peak hour. The model was originally developed to determine staffing levels at the new airport at Gothenborg, and subsequently was applied to the Stockholm airport.

Other Predictions: Classical time-series analysis has been applied to various routes to determine trends, seasonal, business-cycle, and random components, predicting passenger and freight demand on a long-term basis. This has been provided to users on a decentralized basis and is widely used in the airlines for budgeting and manpower planning. In addition, there is a much shorter-term scheme for predicting 24-48 hours ahead. Such forecasts are used for ordering meals and for emergency additions to the manning of check-in counters. It is an unsophisticated analysis based on statistical data: a computer routine which takes the current booking levels of particular flights and predicts the number of seats that will finally be filled.

Investment Analysis: A number of studies under this heading have been made. One of these, for a new head office building, showed that, on a net-present-value or return-on-investment basis, the new building would be a highly desirable alternative in terms of all the costs involved. In spite of this study the new building has not yet been committed, although it is in the long-range plans of the company. In addition, while the OR group has not been involved in decisions about the types of aircraft constituting the fleet, they have made an investment analysis to determine exactly when the first A-300Bs would be purchased (given the decision that they would eventually be purchased). The study was performed jointly with people from the finance department, and was a complicated model involving derived production and traffic volumes, unit costs, yields, and cost formulas.

Load Planning: Some of the 747s (designated "combi") can carry either

passengers or freight or both, with conversion time on the order of 24 hrs. This is very valuable for SAS, since they experience a greater demand for passengers in the summer and for freight in the winter. Configuration of these planes is such that there are a wide variety of ways of loading aboard the available cargo for a given flight. Some of the cargo may have large weight and small volume, or vice versa, and the plane is subject to severe weight-and-balance limitations regarding the exact location of the load. There are clearly optima involved in the large variety of ways in which the load can be inserted. The optimization model is basically heuristic, but works quickly and effectively to help the load planner, interactively, to design the location of the load.

Weight and balance is an absolutely critical factor in any aircraft. In any commercial flight there are likely to be last-minute variations in the passengers, luggage, mail, fuel, and in some cases freight that is loaded aboard. If the center of gravity of the aircraft should thereby be shifted by a few feet, the plane might not be stable and would thus be unsafe to fly. A "red cap" (a supervisor who invariably wears a red hat) supervises the departure, and one of his responsibilities is to check the actual weight aboard the plane (estimated, for example, by assuming an average weight for each passenger and each piece of luggage) against the planned weight. If on a DC-9 flight, for example, these differ by more than 200 kg, the flight may not be dispatched until something is done about it. The OR study developed a program which receives the reports of planned and actual weights and the weight-and-balance calculations, checks them for various types of errors, and does a wide variety of statistical analyses to aid in future planning of weight-and-balance considerations.

Flight Punctuality Analysis: Like all airlines, SAS collects statistics on on-time performance, but such statistical data cannot be used for forecast or to find the effect of changes of policy without an appropriate model. The model is of the convolution type, since the delay is the sum of a wide variety of stochastic delays. It was originated by American Airlines and came to SAS through AGIFORS, after which they made some modifications on it. It permits traffic planners to get a picture of the arrival delays, subject to various planning assumptions. It is also being used for part of the study of restructuring the long-haul fleet and for numerous other planning studies.

Concluding Remarks: The OR group at SAS has little input on policy planning and the like. They have had the satisfaction of seeing a number of their models not only implemented but used routinely to the point that it has almost been forgotten that the OR group originally developed them. Andersson himself is not able to devote full time to this group, since he is involved in some long-range planning studies necessitated by the conversion of SAS's accounting scheme into a profit center. He also prepared a symposium on management development for executives from 30 or more airlines, held in Lisbon in November 1979. Andersson stressed to me the difficulty of measuring passenger good will, and told me about the inevitability of alienating some passengers. The anecdote he told me concerned a Swedish SAS passenger who was denied boarding in Athens. Not only did he have a confirmed booking, but there were empty seats on the plane; there had been inexcusable errors on the part of SAS's clerks. Finally he was told that if he went very quickly to some other point he could get aboard the appropriate aircraft, but in attempting to run he fell down and broke a leg. The victim of this incredible episode was Birger Rapp, one of the leaders in Swedish operations research and a good friend of both Andersson's and mine. There is more about Rapp in a separate article in this issue. (Robert E. Machol)

OPERATIONS RESEARCH IN FINLAND, PART II: TURKU

The city which is known in Finnish as Turku is known in Swedish as Åbo. It was the ancient Finnish capital and celebrated its 750th anniversary this year. It is a beautiful little town situated at the mouth of the river Aura. It has 4 universities (which I visited), 2 art museums, and 2 legitimate theatres, all in a town of 150,000!

The Swedish-speaking institution is the Åbo Academi, consisting of the Swedish University of Åbo, with 3500 students and 40 professors, and the Åbo Swedish University School of Economics, an independent institution with 600 students. I talked with the Management Science Department at the School of Economics, whose head is C.J. Lindström. Lindström is now the acting rector of the School of Economics and inactive in that Department. This on the one hand gives the department a friendly ear in the administration, but on the other hand leaves them undermanned. There are 2 other professors in the Department, together with 1 lecturer, 4 assistant professors, and 4 research assistants (doctoral candidates). Of these 12, 4 have the PhD, 4 the licentiate, and 4 the Master's degree. This seems to be typical in Finnish universities. They graduate 100 bachelors, 25 MBAs, 1 licentiate, and 1 PhD a year.

The two professors are Aimo Törn, who took his PhD in mathematics at Åbo Academi, and Christer Carlsson, who took all his degrees at the Åbo Univ. School of Economics, typically receiving his bachelor's degree in 1970, the licentiate in 1974, and the doctorate in 1977.

Törn started working with certain multidimensional integrals that arise in the mathematics of nuclear physics and found considerable success at using Monte Carlo methods to evaluate them. He now works on Monte Carlo-like techniques for global optimization in nonlinear problems where there are numerous local optima. He has developed a powerful algorithm, with the software fully developed in Fortran IV. He picks at random a number of starting points, and for each starting point converges toward the nearest local optimum; he stops each time well before convergence is reached, and uses cluster analysis on the terminal points to determine the location of the actual optima.

He has extended this research to the determination of efficient surfaces in multicriteria decision making. The efficient surface consists of all those points that are best by at least one of the criteria—any point not on the efficient surface is dominated by some point on that surface which is at least as good by all criteria and better by at least one; hence only those points on the efficient surface need to be considered. As a mathematician, Törn is more interested in the algorithm than in its applications, but there has been one application: They have determined the direction in which to irradiate cancer patients, since this seems to be a typical nonlinear optimization problem with many local optima.

Carlsson is also working on multicriteria decision making. He is particularly interested in what is called "general systems research" and is an active member of the Society for General Systems Research. In mathematical programming he works with "interlinking models," such as linking an LP problem, a goal programming problem, and a multiobjective problem, and finding a composite optimal solution. His fourth current area of research interest is adaptive filtering. A method suggested by Makridakis and Wheelwright has been rejected by most statisticians, but they seem to have based all their tests on two series, one of airline passengers and the other of champagne sales in France. Carlsson feels that these series are inadequate to test such a technique; he has tried these filtering methods on ten other series and finds they work rather well.

At the Swedish Univ of Åbo, I talked with the people in the Institute of Automatic Control, a typical small Finnish laboratory according to its director, Prof. Kurt V. Waller. While it is called an institute, it might better be called the process control laboratory of the Chemical Engineering Department. This department has 320 students and 8 professors, and the Automatic Control Institute just one professor. In addition to Waller there are one assistant professor and 3 as assistants who are basically doctoral candidates. As noted above, a doctoral candidate in Finland is more advanced than one in the US and will typically already have had several refereed publications.

Waller and his group are interested in the relation between process modeling and process control, and in the optimal amount of accuracy in process modeling (if there is too much accuracy, the model becomes too complex). Waller is particularly interested in using the invariants in a chemical reaction in the modeling. That is, he uses a transformation of variables

in a chemical reaction system such that in the transformed system there are two state spaces, one of which is invariant with the chemical reactions. All of the problems, namely the instabilities and nonlinearities, are associated with the remaining state space. The innovative aspect of the analysis by Waller and his coworkers is that they advocate the variants be chosen nonorthogonal to the invariants. Waller and his coworkers have made two successful applications of this modeling technique, one to a cement kiln and the other to control of pH in a chemical reactor.

Turku University has almost 8000 students; from the small size of the town of Turku it is clear that students come from all over Finland to attend it. I spoke to Prof. Olavi Hellman of the Institute of Applied Mathematics in this University. This Institute has 2 professors, 2 associate professors, and 4 assistants. Hellman took his doctorate in engineering at the Technical University of Helsinki in 1955, working on a rather esoteric mathematical topic, namely the theory of thin shells. This involved him heavily in tensor analysis and he still fancies this branch of mathematics: in his spare time he is trying to generalize Einstein's force-field equations to remove singularities. He has at some time or another spent 3 years teaching at the University of California (2 in the Mathematics Department at UCLA and one in the Industrial Engineering Department at UCB) and has been in the Department of Applied Mathematics and interested in operations research since 1961. He became interested very early in optimal control theory, and may have been the first person to point out that this offspring of electrical engineering was properly part of the field of operations research.

Hellman has had a number of successful projects in application of optimal control theory. Two of these are on potatoes. In the Archipelago where he has his villa, potatoes can be harvested earlier than in the rest of Finland, and at that time the prices are extremely high; within a few weeks the prices fall by a factor of ten. During this period potatoes are increasing in size. Since the number of kilograms is increasing and the price per kilogram is decreasing, there is obviously an optimal time to pick them. This would be an elementary problem except that they cannot be picked all at once. The decision variable is the rate at which labor should be hired, and the solution of the problem is therefore one in optimal control theory. Another problem arises at the end of the season; potatoes that have not been harvested before the frost are spoiled. This is a problem in stochastic optimal control theory.

Hellman is very proud of the fact that he had some forestry training as a youth, and has several papers on forestry. The company for which he works has several wood-pulp factories all of which are fed from a single storage area. The forest is divided into rectangular sectors and each sector is cleared of lumber when it is cut; the lumber is then delivered to the storage area, the arrival of lumber being a compound Poisson process (because the interval between arrivals varies as does the size of the batches). The decision variable is the size of the sectors. While Hellman has in fact optimized this operation, he disapproves of the clear-cut method, which is ecologically disadvantageous, and is now working on an ecological approach to the same problem.

The Turku School of Economics (Business School) is an independent university with about 1200 students. They graduate about 200 MBAs a year and about one PhD. I spoke to the people in the Department of Quantitative Methods, the head of which is a distinguished scholar, Pentti Malaska. He was one of the original members of the club of Rome, although I do not think he is now a full believer in systems dynamics and the limits of growth. He has published extensively both on the applications of operations research and on its methodology, the latter under the title of "Model Epistemology." His department has excellent relations with industry and for example has done extensive studies for the State Bank of Finland on energy. He has built mathematical models for investment planning for electrical generation and input-output models for the energy field. He has also done optimization studies on how to use forests as resources, considering that they supply both energy and raw material (pulp), with the relative advantages of these competing uses depending on price.

Malaska has become very interested in the application of scenario writing to operations research. Many of his ideas come from interaction with the Shell Oil Co. in London, who use scenarios extensively. They have many models and extensive data banks but they do not use them much apparently because they do not trust them. Malaska and his coworkers are now using such scenarios extensively for Partek, a large Finnish company manufacturing building materials. As part of strategic planning, Malaska believes that combining scenario writing with quantitive methods such as forecasting and with modeling has a very important future. Such models should of course be interactive and be continuously subject to change as the decision maker interacts with them.

Another topic of interest to him is the efficiency of technosystems and their relation to ecosystems. For example, the ratio of kW hours consumed per capita to GNP per capita increases both with GNP and with time. As technology improves, this ratio should decrease; the fact that instead it increases is due to affluence. Malaska has studied this ratio and its development in many countries, western, socialist, and developing.

Malaska has also been working on problems of how to get oil to Finland in the winter. Ice breakers can keep the channels open much of the time to allow oil ships to come through, but the remainder of the demand must be satisfied by oil storage, and the amount of storage and the number of ice breakers are to be optimized.

The associate professor in this Department is Tapio Reponen who took his PhD under Malaska. Reponen, who has just received tenure, is in charge of teaching computer science to the MBAs. I was interested to note that they have rejected Fortran; they have been teaching Basic to all MBA candidates, but next year will shift to Pascal. Reponen stressed that they teach it as a course in MIS rather than on computer languages, especially in the advanced computer electives which are taken by about ten students. They are also teaching how a firm chooses a minicomputer. They use the term "systemeering" to mean analysis of data systems. Reponen's research is on the information needs of firms, using a model called PSC (for pragmatic, semantic, and constructive) that has been developed in Finland.

Ms. Hely Salomaa has her Master's degree in Mathematical Statistics from Turku University and is doing her doctoral research on "latent structures models," of which factor analysis is an example.

Eero Kasanen has his licentiate in economics and is a doctoral candidate. His thesis will be based on a wide variety of energy models, including input-output and simulation models, using optimal control theory to determine how to exploit Finland's forest resources optimally when prices fluctuate.

In conclusion, the operations research output in Finland is of high caliber and greater than might be expected from a country of its size. Industrial Operations Research is competent, with emphasis on classical optimization techniques; operations research in the public sector avoids quantitative techniques; and in both sectors they appear to be moving away from the words operations research. Operations research concepts are increasingly being taught in universities, especially to business students. Competent research work is being performed and published at the universities.

After my first visit to Finland, my admiration for the Finns is boundless. They have a fascination with design so that everything ones sees is a delight to the eye. With a population no larger than that of Chicago, the Finns have had two Nobel laureates (one in chemistry and one in literature) and one each of history's outstanding musicians (Sibelius), generals (Mannerheim), architects (Saarinen), mycologists (Karsten), and athletes (Nurmi). And withal, to make Americans more comfortable, they drive on the right, they call the ground floor the first floor, and most of them speak English with what seemed to me like a midwestern accent. (Robert E. Machol)

OPERATIONS RESEARCH AT SOME SWEDISH UNIVERSITIES

Sweden has advanced farther on the road toward egalitarianism than other capitalist countries, and this has inevitably affected both the teaching and the practice of operations research. It is now well recognized everywhere that OR without implementation is fatuous; in Sweden implementation has very special implications, since it is not possible without consulting the unions at every stage of the project. The universities are state controlled—there is only one private school left in the country (the Stockholm School of Economics, of which more below)—and this inevitably affects not only the teaching and the research, but the degree to which professors are allowed to supplement their incomes by consulting.

The state of health of the profession of OR in Sweden seems to be quite good. The country adopted OR slowly, so they never had the "LP will solve everything" syndrome that affected many other countries. They are moving to some extent away from classical optimization models and into such areas as simulation and long-range planning. The Swedish OR Society has just celebrated its 20th anniversary; unlike the Germans, the Swedes never had a problem of controversy between applied and theoretical OR people (apparently those who are interested in theoretical OR are not active in the Swedish OR Society). The OR Society has interest groups, and can therefore move rapidly into new areas such as public-sector analysis. The Society also gives courses in such areas as simulation and forecasting (being careful to avoid theoretical materials which might compete with the universities) and makes a good profit from these, which means that it is in excellent financial state.

The most recent president of the Swedish OR Society is Birger Rapp, who has just been made president of the Association of European Operational Research Societies (EURO) (see *ESN* 33-8:337). He studied math at the Royal Institute in Stockholm and then took his doctorate in economics at the University of Stockholm. He now teaches in the Department of Production Economics at the University of Linköping which is some 2-1/2 hours from Stockholm. Rapp told me that Linköping is the only school in the country where economics and engineering are combined, in the sense that there is an economics department in the Institute of Technology (in America this would not be uncommon). The Institute graduates about 700 students a year, about 50 of them majoring in production economics, which is the principal location of OR instruction. Like the British (*ESN* 32-12:427), the students in this course tend to spend an appreciable amount of time on a project, typically about 3 months in groups of 2.

Rapp's research is mostly subsidized by the government; this money is not used to increase his salary, rather it lightens his teaching load and supports his doctoral students. He is studying production control, in particular the needs for control systems in the 1980s, and is also working on two energy projects: One involves the effect of energy conservation methods in buildings and the other the economic question of how such government instruments as taxes affect the structure of energy conservation.

As indicated above, the Stockholm School of Economics (or perhaps it should be translated Business School) is the only private university left in Sweden. They graduate some 250 students a year with a degree which is equivalent to something more than our BS and something less than our MS. They also graduate an average of 6 doctorates each year. I talked to Prof. Bertil Näslund, one of the School's most distinguished scholars. He took his doctorate in economics under William Cooper at Carnegie-Mellon in 1960. His thesis constituted some of the very early work in chance-constrained programming. He has done some OR, including transportation studies for a pulp manufacturing company, and, while he was professor in Brussels during the period 1971-73, he was a council member of The Institute of Management Sciences, but his research today is largely in economics—mostly on the causes and effects of inflation. He has some students doing OR projects for theses, especially on how to operate forests optimally. He was a professor in the College of Forestry in Sweden, 1964-6, and still has a

considerable interest in this area. In general the instruction in operations research at this School is similar to what might be obtained in an undergraduate degree in business at some American universities today; in other words, with the exception of a few doctoral candidates, there is only minor instruction in this area, and that not very rigorous.

There are a number of engineering schools (called "institutes of technology") in Sweden, but very little operations research is taught there, and what there is, is mostly highly theoretical. For example, I talked to Prof. Peter Jagers at the Chalmers Institute of Technology in Gothenburg. His primary interest is stochastic processes and he teaches a little OR in his courses on those topics. Some optimization is taught in engineering physics and optimization theory is taught by some math teachers. There is a small amount of industrial engineering being taught in the mechanical engineering department, and there is a department called "Industrial Economy" teaching some case studies that we might call OR, although it has none of the quantitative techniques that we generally associate with that term in American universities. However, the board of governors has been studying a new school in "industrial administration," which might be like similarly named schools in the US at MIT or Purdue. In the interim, however, the OR that is being taught in Sweden is generally taught in business schools, and since the students there have less mathematical competence, it has quite a different flavor than the OR taught in engineering schools in America.

The University of Gothenburg has a large school of business administration. It graduates about 500 students a year with the degree of "Civilekonom," which is perhaps equivalent to something between our BS and MS, with also a handful of doctorates per year. Gothenburg on Sweden's west coast is that country's second largest city with a population of half a million. I talked to a number of professors at the University of Gothenburg, all of whom are doing OR or something closely related to it, although none of them is really a specialist in that area.

One of the most interesting of these professors is Prof. Göran Bergendahl, who took his licentiate at Lund and his doctorate at the University of Stockholm under Näslund (see above) before the latter moved to the Stockholm Business School. Bergendahl received his PhD in 1970 and obtained a chair at Gothenburg in 1971. This chair is somewhere between economics and operations research, and is perhaps closest to the Department of Managerial Economics and Decision Sciences in Northwestern University.

Bergendahl explained to me the difficult language problem for a Swedish scholar. If he wishes to get attention in his own country for his work he must publish in Swedish; if he wishes to get attention outside of his own country he must publish in English. While Bergendahl is quite fluent in English, translation is an extremely tedious process, and general he publishes his papers in one languag or the other but not in both.

While he has in the past done wor on agriculture and transportation, his current research activities are in energy and in finance. In energy he has recently completed a study, mostly from an economic viewpoint, of the possibility of zero energy growth for Sweden. This work was done while he was a visiting professor in the Depart ment of Operations Research at Stanfor and has been published in English. He concludes that while zero energy growth is feasible if Sweden wants it badly enough, it will be extremely expensive. His work on finance concerns international cash management; some of it was described in *ESN* 33-8:340. In his most recent work, he has been devising optimal strategies for small companies that are increasingly taking up foreign loans and becoming involved in this problem. His solution is that such Swedish companies should try to work more in the term market and less in the spot market, since the latter has risk which the small companies cannot afford; nor can they afford the experts to handle hedging and the like. Large companies, on the other hand, should operate in the spot market. He points out that SKF, one of the largest Swedish companies, does this, but that Volvo, another very large Swedish company, does not. He also points out that the financial market in Sweden is highly imperfect (compared, for example, to that of London) because only the 15 Swedish banks are allowed to make foreign

transactions and because they apply a wide variety of restrictions to the considerable disadvantage of Swedish industry.

Prof. Sten Jönsson took his licentiate from the University of Gothenburg with a thesis in mathematical programming. When he attempted to apply this in industry, he found that he could not; as a result, he became "turned off" such quantitative techniques and began to become interested in organization behavior, a subject in which he took his doctorate, also at the Univ. of Gothenburg. Thus he now considers himself "soft," interested in the politics of managing systems. While Bergendahl was visiting at the Institute for Advanced Studies in Management at Brussels in 1973-75, Jönsson acted in his chair. Three years ago he was appointed to the chair in accounting and finance, with the understanding that he would do something unconventional with this chair. He is not a CPA (or the Swedish equivalent) but it turns out that hardly any academics are, since accountants must be recertified every few years and must be active in the field if they are to receive recertification. However he does teach both accounting and finance as well as organization behavior. His research interests are primarily concerned with the future of industrial democracy, as the power of unions in decision-making increases so that "there will be a political process around every system problem." He has written a book (in Swedish) entitled "Decision and Action—The Influence of Politicians on Policy" based on case studies of the planning activities of the Urban Planning Commission in Gothenburg. The conclusion is that politicians do not influence policy nearly as much as the bureaucracy does. The question is: how can you control a real democracy—that is, one in which everyone has a voice in decision-making? In fact, how can you even make a model of management decision-making if everyone cannot agree on the objectives? (Presumably the unions have different objectives than management, and both are now involved in management decision-making.) Actually, industrial democracy in Sweden works quite well, he told me, because they have achieved consensus rather than conflict.

Most of the other research in Jönsson's chair is on the design and implementation of management information systems and accounting systems. They have installed 25 computerized MISs; in particular, they have been working for 5 years on an MIS for the city of Uppsala, including such functions as the school board, social welfare, and electricity production and distribution. He pointed out the intriguing requirements: The different parties have different policies and therefore want different reports. It is necessary to educate the bureaucrats, the politicians, and the unions into the uses of such MISs.

Jönsson emphasized to me that, regardless of one's own concept, one must never brand any observed behavior as irrational. The urgent thing is that the researcher should understand the behavior.

Anders Klevmarken holds a chair in statistics at the Univ. of Gothenburg. He emphasized to me that there is less tradition of mathematics in economics in Sweden than in the US, and pointed out that most academics in Sweden don't know econometrics. In fact, he asserted that "Swedish academics are not model oriented." His doctoral thesis (for the Univ. of Stockholm) was on statistics—for the analysis of earnings data; and he has continued that research, with analysis of such things as age-earning profiles, using the approach of "investment in oneself" which he told me originated at the Univ. of Chicago. For example, he has discovered that if one uses cross-section data he finds that the earnings of an individual peak at a particular age and then decrease. If one uses longitudinal data, no such peak appears and earnings continue to increase throughout the professional life of the individual. By "cross-section" and "longitudinal" data he means what we would commonly call retrospective and prospective studies, respectively. Thus, if one compares the earnings of individuals of different age groups all in the same year, one finds that the earnings peak, but if one follows an individual through many years one does not find the peak.

At the present time Klevmarken has a grant from the Federation of Swedish Unions for Salaried Employees; part of the grant is paid by the employers, giving him great freedom in what he

studies and what kind of conclusions he can publish. The particular problem that he is studying under this grant is "wage drift." The general tendency of earnings is to increase with age, and therefore when an older person retires and a younger man is hired, the employer saves some money. Ordinarily, this would be offset by periodic raises, but during a period of wage freeze there is a net saving due to such retirements and replacements. During such a freeze, the unions argued that they should get this amount, which came to about 2%, and it was indeed granted by the employers; it has now become institutionalized. The salaried employees are interested in redistributing this 2% among their own workers; the hourly workers are interested in increasing their share of it. Klevmarken is supposed to supply some rational basis for making such decisions.

Prof. Lennart Hjalmarsson holds one of the chairs in economics at the University of Gothenburg. His doctoral thesis on the dynamic theory of production was written mostly during the several years he spent in Oslo, although the degree was actually awarded by the University of Gothenburg. His current research interests are in two areas. The first is empirical production theory, trying to find measures of "technical progress" (which is similar to measuring productivity) and to relate it to economies of scale; to what he calls "bias technical progress," which involves the exchange of labor for capital; and to "neutral technical progress," which involves learning through experience. Other factors, such as improvements in technology, are assigned by him to one of these three categories. His experience to date has been that economies of scale are most important in measuring technical progress. He is also doing some fascinating work on production functions. He uses mathematical programming to find the frontiers of a wide variety of production functions and then measures the movements of these frontiers over a period of years.

Hjalmarsson's other research interest is in energy economics. He is a member of the Swedish State Power Board, a government-owned corporation producing some 75% of the country's electricity. He is interested in substitution between energy and other factors. In the short run this is related to capacity utilization and also to equipment, since newer equipment tends to utilize more energy and less labor. Long run involves labor and energy substitutions for specific levels of output. As the level changes the substitution factors change, and there have been dramatic changes in both of these over time.

Finally, he is interested in the price elasticity of energy for houses and for industry.

I conclude that operations research has reached steady state in Sweden, and that highly competent work is being done in the area even though, as in many other countries, perhaps less and less of it will be called by that name. (Robert E. Machol)

OPTICAL PHYSICS

LASERS AND LIVING MATTER

Two exciting conferences on the interaction of laser radiation with living matter (from simple cells to the human body) were held in Florence, Italy, in early September. Lasers in Photomedicine and Photobiology concentrated on the microscopic aspects and the quest for understanding mechanisms, whereas Lasers in Bio-Medicine and Surgery dealt more with special laser techniques and the applications of lasers in the medical sciences. The conferences were held in the beautiful Villa di Poggio Imperiale (House of the Imperial Porch) which is located on a hillside on the southern outskirts of Florence. During the early history of the villa, which was built in the early 15th century, it passed through several ownerships, each adding their own particular architecture or removing some of the previous. It was at one time one of the preferred country houses of the Grand Dukes of Tuscany, including the Medicis and the Lorenzos. In the 17th century it became the private dwelling of the reigning house and received its present name. Since 1865 it has been a college, and it is now an all-girls school with an enrollment of about 300. Restoration has continued since 1972 with a large crew of artisans, artists, and laborers descending on the villa each summer.

Why use a laser? What are the differences between laser light and light from "conventional" sources? These and similar questions were raised several times throughout the conferences. Let me summarize the answers that were put forth principally by laser physicists. Only the laser can provide the experimenter with: photons in portions of the spectrum that were previously unobtainable (mainly in the UV); the ability to perform detailed wavelength dependence studies; a source of picosecond and subpicosecond pulses with which photochemical, photodissociation, and time-resolved spectroscopic experiments can be conducted; a source of photons that can be focused with a spot diameter less than 1 μm and, hence, the ability to perform a variety of experiments on selected cells, e.g., cell surgery; a high-intensity source with which two-photon effects, etc., can be performed; and an intense source of highly polarized light, (such radiation may be required in some cases for biostimulation). In addition to the above unique characteristics, the laser is often a more convenient source of light.

It was also stressed that the laser is an expensive, and indeed non-magical, source of photons, and if an experiment does not require one or more of its unique characteristics, the audience was advised to stick to the conventional sources. Most of the speakers described experiments that utilized one or more of the unique as aspects of laser radiation. A description of several of the experiments that the author found particularly exciting follows.

Optical selective action can be defined as a light-induced modification of a specific part of a complex molecule or modification of one kind of molecule in a mixture of different kinds of molecules. An investigation with the ultimate objective of modifying one type of pyrimidine base in native DNA and RNA was reported by D.N. Nikogosyan (Institute of Spectroscopy, Moscow, USSR). Two-photon selective photochemistry occurred when dilute aqueous solutions of nucleic acids were irradiated by UV pulses (266 nm, 3-15 mJ, and 20-35 psec) having an intensity of 10^9 W/cm^2. Irreversible photoproducts were generated, and the characteristic form of the difference absorption spectrum of each of the nucleic acids was measured with a double beam spectrophotometer. Their results demonstrated that it is possible to carry out selective action on uracil in an equimolar aqueous mixture uracil-adenine and on thymine in the mixture thymine-adenine.

A clever way to induce two-photon selective photochemistry has been proposed and recently demonstrated by a group at the Centre di Elettronica Quantistica, Milan, Italy. This method, described by O. Svelto, involves the absorption of two laser pulses by a suitable dye that is attached to a given biological environment. As the fluorescence lifetimes of dyes are very short (~5 nsec) and as the described approach relies on the differentiation between the lifetimes of different complexes, 2-psec pulse lasers were used. The first step of the process is the irradiation of the specimen by an N_2 laser-pumped dye laser (430 nm, 100-120 psec) that elevates the absorbing species to the first excited singlet state. At a time t_d after this excitation pulse, the specimen is irradiated with an N_2 laser pulse (337 nm, 500 psec). If $t_1<t_d<t_2$, where t_1 and t_2 are the fluorescence lifetimes of complexes 1 and 2 respectively, complex 2 will be selectively excited. This approach is very effective for selectively exciting complexes that have a high intersystem crossing rate. The excitation of such a complex results in a significant fraction of the molecules being in the lowest triplet state with lifetime t_T the phosphorescence lifetime. Since $t_T>>t_2>t_d$, the condition $t_1<t_d<t_T$ is easily satisfied. Selective action was demonstrated by Svelto et al., in the case of the acridine dye Quinacrine Mustard bound to synthetic polynucleotides with either AT or GC base pair sequences.

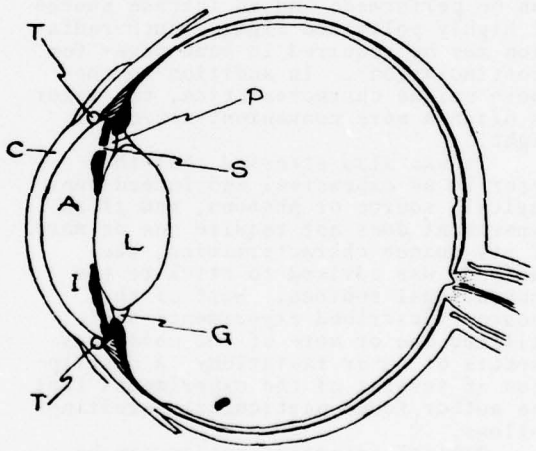
Seven papers were presented on research in which the ability to focus laser emission on living tissue was the key ingredient. The instrumentation in each case was composed of two lasers (aiming and affecting) and a slightly modified microscope. Lesion diameters as small as 0.5 μm are obtainable with this laser microbeam technique, and so the door is now open for a host of exciting experiments. Ellen Rieske (Max Planck Institute of Psychiatry, Munich, FRG) reported on an investigation of the regenerative capacity of neurons

and sensory ganglion cells. An N_2 affecting laser (λ = 337 nm) with a maximal power density of 5×10^{11} W/cm^2 (focusable to 0.75 μm) was used to perform process transection. A photomicrographic motion picture showed the two different ways that the ganglion cells react to laser transection of cell processes: no apparent change in the soma, or a typical retrograde neuronal response. In the second case, recovery takes place within several hours even if the neurons are devoid of satellite or Schwann cells.

The time dependences of the characteristic velocity, the velocity distribution, and the number density of motile human spermatozoa, and the effects of freezing and of various substances (e.g., caffeine) on these parameters, are important in the study of fertility. The use of laser Doppler heterodyne techniques and of recently developed theoretical models for the determination of these quantities was reported by two groups: R. Steiner, et al. (Klinisch Physiologie, Universität Düsseldorf, FRG) and B. Volochine et al. (Centre D'Etudes Nucléaires de Saclay, Gif-sur-Yvette, France). The modeling was required because the swimming motion of spermatozoa is complicated, being composed of rotational and translational components. Steiner reported that the addition of caffeine to two-hour-old spermatozoa caused a doubling of the velocity for a two-hour period, after which the velocity dropped sharply. Characteristic velocities of the order of tens of μm/sec (depending on the age of the spermatozoa) were reported by both groups.

Papers on the ophthalmological applications of lasers "focused" on three areas: photocoagulation for diabetic retinopathy, treatment of glaucoma, and prevention of retinal detachment. Retinal photo-coagulation appears to be the best choice of treating diabetic retinopathy and, because of its high absorption by the blood, argon-ion laser emission has been used quite extensively in such treatment. (There is no cure or recovery of diabetic retinopathy; however, treatment does slow down the development of this retinal disease.) G. Venturi (Department of Opthalmology, Univ. of Florence, Italy) reported on the results (obtained with argon-ion laser treatment of 269 patients) that were divided into groups according to the details of treatment. In one group of 70 patients (135 eyes) that had been observed over a 20-month period after treatment, 40% improved, 30% were stationary, and 30% worsened. M.L. Wolbarsht and M.B. Landers, III (Duke University Eye Center, Durham, NC) have proposed a new theory indicating that the beneficial action of photocoagulation on blood vessels is indirect through the destruction of the photoreceptor layer. This model indicates that the wavelength range of 600 to 700 nm is optimal for photocoagulation treatment of diabetic retinopathy. It will be interesting to see if experimental data support this model.

The principal cause of angle-closure glaucoma (see figure) is a fault in the valve-like action of the lens (L) and iris (I) that results in an increase in the pressure in the posterior chamber (P).



Schematic horizontal section of the human eye. C, cornea; A, anterior chamber; T, trabecular network; I, iris; S, perforation; L, lens; P, posterior chamber; and G, suspensory ligament.

This pressure increase produces a bulge in the iris that mechanically prevents the outflow of aqueous humor from the anterior chamber (A) through the trabecular drainage network (T). As there is no way for the aqueous humor to escape, the intraocular pressure increases. C.B. Wheeler (Institute of Opthalmology, London, England) reported on the use of a pulsed dye laser (λ = 590 nm, 1 μsec, 50 mJ) to perforate (S) the iris, thus equalizing the pressure between

the anterior and posterior chambers, which in turn provides for the flow of aqueous humor and normalized intraocular pressure. Perforations varied in size from 1 to 1/2 mm and shape from round to a narrow slit. A 90% success rate has been realized for the 120 laser iridectomies performed as of 1 October. Success in this case means that the intraocular pressure stabilized soon after iridectomy to the controlled pressure.

Encouraging results were presented in the endoscopic application of high-power (50-100 W) neodymium: YAG laser radiation for the treatment of a variety of internal problems, including acute gastrointestinal hemorrhage, and carcinoma of the bladder and prostate. P. Kiefhaber and K. Mority (Medizinische Klinik Innenstadt der Universität München, FRG) reported on emergency endoscopy in 570 incidents of gastrointestinal hemorrhage in 437 unselected patients. Bleeding was controlled in 94% of these incidents, which included variceal and massive arterial bleeding sites in the esophagus, stomach, duodenum, jejunum, and colon.

Three exciting papers were presented on the use of low-power cw laser radiation in therapy, two on the treatment of cutaneous ulcers and one on middle-ear inflammatory diseases. Prof. E. Mester (Surgical Clinic II, Budapest, Hungary) reported on 135 healed clinical cases in which a 25-mW He-Ne laser was used for therapy of ulcers resulting from a variety of origins including burns and amputations. Laser therapy was used only for those cases that did not respond to extended conventional therapy (up to 4 years in one case). The initiation of healing and the healing process for the cases described by Mester and Prof. F. Baldoni et al. (V. Patovogia Medica e Metodologia Clinica and Inst. Fisica-Ingegneria, Univ. Roma, Italy) were not the result of thermal effects, as the power of the lasers was too low. The first sign of healing in virtually all cases was an increase in the redness of the treated area, which is evidence of vascular development. Mester described a case in which half of an ulcer resulting from a burn received laser therapy. After several weeks, the irradiated portion of the ulcer was completely healed, while the healing process on the other half was just commencing.

A. Sciuto (I Clinica Otorinolaringoiatrica, Univ. Roma) joined Baldoni et al. in reporting a study of 10 clinical cases of chronic purulent otitis media in which a 3-mW He-Ne laser was used for therapy. The laser radiation was directed through the auditory canal and was incident near the tympanic membrane. Daily irradiation times of 4 to 8 minutes were used for 28 to 45 days. In most cases clinical healing was obtained, with acoustic gain of 30 dB at the affected frequencies. At present, the mechanisms involved in low-power laser-induced wound healing are not understood, and man's ignorance is covered by classifying the observed phenomena as a form of biostimulation. The author feels that a most interesting challenge was implicitly presented to the photobiologists attending this conference to develop an understanding of the mechanisms. (Richard S. Hughes)

OPTICAL BISTABILITY IN THE UK

In this article, a brief historical/technical background of optical bistability (OB) is followed by an overview of the research conducted in the UK in this rapidly advancing field. OB is the phenomenon demonstrated in Figure 1, where P_o is output power and P_i is input power. As P_i is increased, the curve A-B-C-D-E is followed and upon decreasing P_i the curve E-D-F-B-A is followed. Optical devices that exhibit bistability were first proposed in 1969 by H. Seidel and A. Szöke, and the first observation of hysteresis and bistability in an optical device was reported by S.L. McCall some 6 years later.

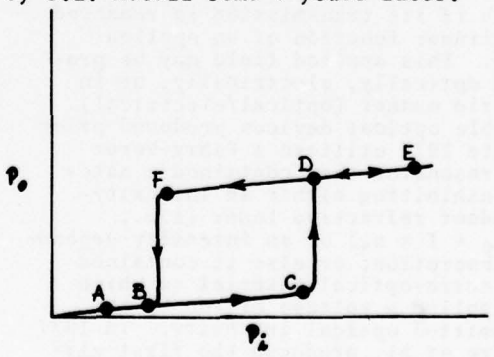


Figure 1
Representative power-out vs power-in curve for a bistable optical device.

Depending on the exact parameters of the function shown on Figure 1, and the operating range of P_i, a bistable optical device can perform a host of operations. Each of the following operations has been demonstrated. If P_i is on the lower part of C-D (near C) a small increase in P_i results in a large increase in P_o and *differential gain* is realized. Gains of ∿7× have been reported with the small increase in P_i provided by either the input laser itself or by a second laser. The latter case is analogous to transistor action, and devices operated in this mode have been referred to as *optical transistors*. By varying P_i so that P_o swings from below C to above D, optical *switching* is provided for. As in the gain case, the additional P_i can be provided by a second laser. Two *memory* states M_1 (between B & C) and M_2 (between D & F) are stable and can be addressed by increasing or decreasing P_i. If P_i is such that P_o is above D, optical *limiting* occurs and variation of P_o<4% for a 15:1 variation in P_i has been observed. If the bistability is narrow, i.e., the variation in P_i required to drive the device between B-C and D-F is small, a *discriminator* is provided for. AND-gate and OR-gate *logic operations* can be realized if two input lasers are used with a device exhibiting very narrow bistability. In addition to the above operations, phenomena including *regenerative oscillation* and a variety of types of *pulse shaping* have been demonstrated.

What conditions must be met in order to observe OB? As pointed out by Garmire [E. Garmire et al., *Appl. Phys. Lett.* 32, (1978)], a bistable device can be made from any optical switch if its transmission is rendered a nonlinear function of an applied field. This applied field may be produced optically, electrically, or in a hybrid manner (optical/electrical). Bistable optical devices produced prior to late 1977 utilized a Fabry-Perot (FP) resonator that contained a material exhibiting either an intensity-dependent refractive index (i.e., $n = n_o + I \times n_2$) or an intensity-dependent absorption; or else it contained an electro-optical material to which was applied a voltage driven by the transmitted optical intensity. In 1977 Garmire et al. produced the first mirrorless bistable optical device, based on an electro-optical polarization switch to which a transmission-dependent voltage was applied. In 1978 a miniature version of a bistable optical device was developed using a Ti indiffused optical waveguide in $LiNbO_3$ [P.W. Smith, *Appl. Phys. Lett.* 33, 24 (1978)]. This device was hybrid in two senses: in that the feedback circuitry was not integrated with the waveguide, and in that it was an electrical feedback/optical device. The observed electrical switching energy was ∿1pJ and the switching time was 200 μsec. Calculations indicate that an optical switching energy of 1.3 pJ and a switching time of 1.3 μsec should be realized in the not-too-distant future.

Until 1978, laboratories in the US had a corner on the free world's OB research market. However, the papers on OB presented by E. Abraham (Univ. of Manchester Institute of Science and Technology, UK) and D.A.B. Miller (Heriot-Watt Univ. Edinburgh, Scotland) at the Fourth National Quantum Electronics Conference are indicative of the infectious nature of the interest in this field. The balance of this report contains a brief review of Abraham's theoretical paper, and a more detailed discussion of the experimental work reported by Miller.

A number of papers treating the theoretical aspects of the temporal or spatial nature of OB have appeared in the literature. The unique feature of Abraham's theoretical work is that it treated both the time dependence of OB and the propagation effects within the FP resonator. Abraham's analysis yielded two principal results. First, for FP resonator mirrors having small transmissivity (T∿0.01), the electromagnetic fields inside the resonator are essentially constant in space. For this case, the mean field approximation (MFA) used in previous analysis is valid, and excellent agreement was obtained between this approximation and Abraham's work. For $0.01 \leq T \leq 0.15$ Abraham observed variations of the order of 10% in the plots of output versus input fields upon comparing his results with those obtained using the MFA.

The second and quite reasonable result is that under certain conditions the hysteresis cycle for CW sources can be used as a guide in describing the time-dependent behavior

of OB. In essence, if the resonator decay (including both FP and atomic resonances) is very fast compared to the input optical pulse, the resonator can "follow" the pulse. Abraham expects to complete in the near future a paper expanding on his earlier analysis of the temporal characteristics of OB including dispersive effects. The reader who is interested in obtaining detailed information on the theoretical formalism used by Abraham is referred to: [E. Abraham et al., *Opt. Comm.* 29, 109 (1979)].

A wide variety of material has been placed within FP resonators to produce devices exhibiting OB; e.g., Na or Rb vapor, ruby, Kerr media (nitrobenzene, CS_2, etc.) and the electro-optical materials KDP, $LiNbO_3$, and $LiTaO_3$. At the conference, Miller reported the observation of OB in a semiconductor. The details of this work appear in an article entitled "Optical Bistability and Signal Amplification in a Semiconductor Crystal: *Applications of New Low-Power Non-Linear Effects in InSb.*" [D.H.B. Miller et al. *Appl. Phys. Lett.* 35, 658 (1979)]. As the experimental conditions, observations, and proposed mechanisms of this work differ significantly from all previous work on OB, a somewhat detailed discussion follows.

A FP resonator was fabricated by cutting and polishing 2 parallel faces of a pure InSb crystal ($N_D - N_A \sim 10^{14}$ cm^{-3}). The final crystal thickness was 580 μm, and the interaction diameter (focused beam waist) was 180 μm. The unenhanced reflectivity of each crystal/air interface resulting from the high refractive index of InSb (∿4) was 36%. The crystal was maintained at 5 K; the bandgap of InSb at this temperature corresponds to a wavelength of 5.266 μm. The output power versus input power of this FP resonator, when irradiated by a cw CO laser operating at 5.277 μm, is presented in Figure 2.

Each "knee" in this plot corresponds to a $\lambda/2$ change in the optical thickness of the resonator and bistability was observed in 5th order. In previous work, the resonators were tuned to the incident laser wavelength and the optical thickness was varied by only a small fraction of $\lambda/2$. In contrast, no attempt was made to tune the InSb resonator, and the very large magnitude of the intensity-dependent refractive index ($n_2 \sim 1\text{-}10 \times 10^{-5}$ cm^2/W) made it possible to "scan" through $5\lambda/2$. Nonlinear transmission was observed at power densities as low as 100 W/cm^2 and an optical power density of 2 kW/cm^2 was required to scan through the 5 orders. Differential gain was obtained for orders above 2nd and a gain >6 was observed for 5th order. This differential gain (optical transistor action) was realized when two laser beams were employed, a weak beam modulating the main input beam. Also, the near-horizontal portions of the P_o vs P_i plot clearly indicate the limiting action of this InSb device.

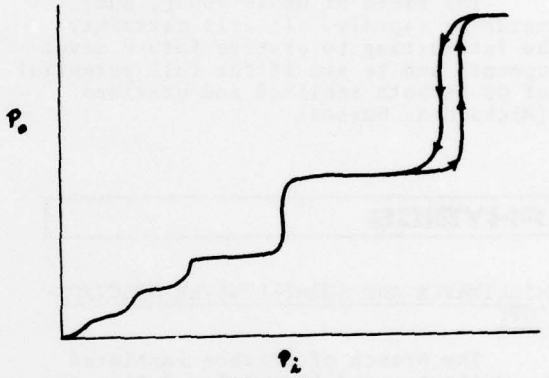


Figure 2
P_o vs P_i of an InSb FP resonator.

The physical origin of OB in FP resonator devices is the nonlinear increase in the optical path length of the material within the resonator. A bandgap resonant mechanism for the optical path length increase in InSb was proposed by Miller et al. in a paper submitted to *Phys. Rev. Lett.* in September 1979 ("The Microscopic Mechanism of Low Power Nonlinear Refraction in InSb"). Density-matrix theory was used in this work and saturation (i.e., the redistribution of electrons in the initial and final states) was accounted for by including the effects of nonradiative relaxation processes. In fact, the uniqueness of this calculation of the nonlinear refractive index in solids lies in the explicit inclusion of saturation effects. The third-order nonlinear susceptibility resulting from this model is greater than that resulting from previous models by more than 5 orders of magnitude, and is consistent in both sign (negative) and magnitude with the observed self-defocusing [D.A.B. Miller et al., *Opt. Comm.* 27, 133 (1978)].

Future research on OB at Heriot-Watt University is planned to include: determining the switching speeds of InSb devices, examining the potential for OB in semiconductors at higher temperatures, and developing a better understanding of the physics involved. Experimentally determined switch-on and switch-off times of InSb bistable devices should be available within the next six months. If the model proposed above is valid, switching times of the order of picoseconds should be realized, however, if recombination is involved, switching times will be limited to tens of nanoseconds.

The field of OB is young, but maturing rapidly. It will certainly be interesting to observe future developments and to see if the full potential of OB is both realized and utilized. (Richard S. Hughes)

PHYSICS

MILLIMETER AND SUBMILLIMETER SPECTROSCOPY

The branch of science initiated by Wollaston and Fraunhofer during the first part of the nineteenth century, spectroscopy, is concerned with the production, measurement and interpretation of electromagnetic (and other) spectra arising from either emission or absorption of radiant energy by various substances. Starting with the chemical analysis of the sun's atmosphere by Kirchhoff and Bunsen in 1861 and the subsequent discovery of the metals cesium and rubidium, spectroscopy has become an invaluable tool in science and industry.

All the techniques of spectroscopy ultimately aim at observing either the absorption or emission of energy of characteristic frequencies. In a basic laboratory experiment the information obtained is then used to determine such fundamental parameters as electronic or molecular structure, interatomic distances, atomic mass, constants expressing binding potentials, etc. The frequency range in which characteristic absorption or emission lines are observed determines the type of energy transitions and therefore the characteristic parameters associated.

In 1956, a group of individuals in Britain principally interested in radio frequency spectroscopy founded an organization known as the British Radio Frequency Group (BRFG). Completely independent of any other organization, BRFG now usually holds two meetings per year. Each meeting is completely organized by a single individual; the financial target is simply to meet expenses. There are no publications and no Proceedings, so that even tentative results can be presented. Since some organization must take place, the group is run by a small committee, which is elected more or less democratically. The present chairman of BRFG is Prof. K.J. Standley of the University of Dundee.

My acquaintance and interaction with BRFG was at the conference entitled "Spectroscopy at millimeter and submillimeter wavelengths using coherent sources," held in the spring of 1979. This meeting was organized by Dr. D.C. Lainé, (Physics Dept., Univ. of Keele, UK), and was held at the University of Keele, the first of the British post-war universities (1949), which is near Newcastle-under-Lyme and Stoke-on-Trent, roughly halfway between Birmingham and Manchester. Although the university lies in open country, it is on the edge of a large industrial area called the Potteries. The area, in fact, is the location of the famous Wedgwood potteries. On walking out of the railroad station in Stoke-on-Trent, the visitor is immediately reminded of this fact by a statue of the founder, Josiah Wedgwood.

Although the meetings of BRFG took place in the Physics Department, we also had ample opportunity to become acquainted with the social center of the University: Keele Hall, a large country manor house that, according to the inscription, was built in MDLXXX and restored in MDCCCLX.

As it turned out, BRFG shared the dining hall adjacent to Keele Hall with another group—persons from a refresher course in midwifery. The BRFG conference, with only 65 participants, was outnumbered by the midwives 3 to 1.

The lead-off talk, delivered by Prof. B.A. Thrush, FRS (Univ. of Cambridge, UK), dealt with the study of free radicals by laser magnetic resonance in the range 1-100 cm^{-1} (30 to 3000 GHz). (A free radical is a molecular fragment that has an unpaired

electron. An example is a single hydrogen atom.) Thrush reported on work performed in collaboration with the Smithsonian Laboratory at Harvard University that had the objectives of 1) defining the structure of matter, 2) determining chemical components that exist while chemical processes are in progress, and 3) examining schemes for isotope separation. Thrush has been studying rotational spectra of free radicals involved in chemical reactions by measuring the absorption in a specimen of the radiation originating from a fixed frequency source, such as an H_2O or D_2O discharge laser. (Such a laser physically is a tube 5-meters long.) To obtain absorption lines, as required for identifying species present, it would normally be necessary to have variable frequency sources. Since these were not available in the 1-100 cm^{-1} range, Thrush instead "tuned" the molecules by immersing the volume to be examined in a magnetic field of varying intensity. He found, for example, that in favorable cases changes in the magnetic field from zero to 2 tesla can change the resonant absorption frequency of triatomic radicals by as much as 1 cm^{-1} (30 GHz).

Besides the general conclusion that laser magnetic resonance spectra provide a highly sensitive method for studying chemical reactions, Thrush has obtained some interesting data of general interest. Specifically, he now predicts that instead of depleting the stratosphere of ozone, the oxides of nitrogen from Concorde and high altitude subsonic aircraft such as the Boeing 747 SP that operate at altitudes up to 18 km are now expected to enhance the ozone content slightly. Release of NO and NO_2 above 20 km is still predicted to deplete ozone somewhat. Thrush also stated that chlorofluoromethanes and other chlorocarbons (found in aerosol propellants and halogenated solvents) are expected to deplete the ozone layer by a greater amount than calculated earlier by others. (Thrush's conclusions were previously reported under *News and Notes* in *ESN* 33-5:214.)

In the second invited talk, G. Duxbury, an enthusiastic young man from the Univ. of Bristol, UK, discussed methods of using CO_2, N_2O and CO gas lasers of the 5-10 μ region for obtaining sub-Doppler resolution by various techniques of saturation spectroscopy (e.g., taking derivatives of absorption data). He discussed principles and examples of "Lamb dip" spectroscopy, nonlinear level crossing, and optical-optical double resonance and presented examples, including sideband spectroscopy with a CO_2 laser modulated by an acousto-optic device. He reported on the use of laser Stark spectroscopy (cf. J.W.C. Johns and A.R.C. McKellar, *J. Chem. Phys.*, 66, 1217; 1977) to investigate the transient species HNO, H_2CS, and CH_2NH and characterize CH_3I, CF_2CH_2, and CH_3OH, for consideration of use in optically pumped submillimeter lasers.

What was to be the third invited paper, by A. Dymanus (Katholieke Universiteit, Nijmegen, The Netherlands), was presented by abstract only and followed by a discussion. This paper described various approaches for overcoming the lack of tunability of discharge or optically pumped CW lasers in the wavelength range from 0.05 cm to 0.005 cm (6×10^{11} to 6×10^{12} GHz). The three approaches cited were laser magnetic or electric resonance (as carried out by Thrush and Duxbury), heterodyne spectroscopy, and frequency mixing. It was announced that interested individuals could obtain copies of theses on these subjects from Dymanus. Authors and titles of the dissertations mentioned were D.D. Bičanić, "Generation of tunable laser sidebands in the THz region," and B.F.J. Zuidberg, "Heterodyne detection in submillimeter spectroscopy." Bičanić's work is being continued by E. van de Heuvel in the laboratory of Dymanus.

In the invited paper "Submillimeter spectroscopy of semiconductors" Prof. R.A. Stradling (Univ. of St. Andrews, Scotland, UK) reviewed the semiconductor investigations being carried out by coherent submillimeter spectroscopy: cyclotron resonance in high magnetic fields (to measure effective mass and relative carrier density, with the high frequencies required to let a carrier "see" a number of cyles between collisions), plasmon (i.e. collective action) resonance, and phonon behavior when cyclotron and/or plasmon resonance coincide with phonon frequencies. As reported by Stradling, an interesting result obtained at Oxford just prior to the meeting, for cyclotron resonance of AgCl around 891 GHz at 1.2 K, was

a splitting of the curve that is a plot of the frequency of cyclotron resonance vs magnetic field into two curves, because of coupling of electron and phonon resonance. The shift in resonance was about 8% (around 10 to 20 linewidths) from what it would have been without coupling.

Other semiconductor topics discussed by Stradling were the quasi-two-dimensional electron gas in field effect transistors that were biased to effect channel depths of only ten lattice spacings, photoionization, time-resolved exciton studies, and the possibility that Wigner crystallization has been observed.

According to C.R. Pidgeon (Heriot-Watt Univ., Edinburgh, Scotland, UK), at the time of his invited talk on tunable and quasi-tunable infrared lasers there were 904 laser lines. He discussed four ways of laser tuning: 1) spin-flip, 2) changing the temperature of semiconductor diodes, 3) optical paramps (tuned by phase matching), and 4) hybrids, in which a fixed frequency laser is mixed with a dye laser to give a difference frequency. Pidgeon stated that perhaps the outstanding technical problem in his field at the present is to develop truly continuous tuning for middle and far infrared laser radiation.

Last in the sequence of invited papers was that by D.J.E. Knight (National Physical Laboratory, Teddington, Middlesex, UK) entitled "Techniques of laser frequency measurement for the submillimeter spectral region." This talk discussed various types of mixers and the techniques employing them for the measurement of frequency. Interested readers will find that the large amount of the material presented in this talk was published by Knight and P.T. Woods in "Applications of nonlinear devices to optical frequency measurement," *J. of Physics E: Scientific Instruments*, 9, 898-916; 1976. Knight has also recently published "Ordered list of optically-pumped laser lines (continuous, $\lambda > 9\mu m$) with frequencies," 5th issue, March—National Physical Laboratory Report No. Qu45.

In addition to the six invited talks there were ten contributed papers. These covered such subjects as double resonance (i.e., microwave pumping of a sub-mm laser), interaction of strong electromagnetic fields with a three level gas system, experimental conditions for improving detection and nonlinear mixing in the sub-mm range, free electron lasers and status of developments toward a sub-mm source, solid-state millimeter waves sources, electron spin resonance at 37 GHz, millimeter wave rotational spectra of excited vibrational states (to obtain axial rotational constants of symmetric top molecules and harmonic and anharmonic force fields), spectrometers, and millimeter wave spectroscopy of giant atoms. In the last subject mentioned, P. Goy, C. Fabre, S. Haroche, M. Gross, and J.M. Raymond (Laboratoire de Physique de L'Ecole Normale Supérieure, 75231 Paris, Cedex 05, France) described their work on the interaction of Rydberg atoms (alkali atoms excited into high states of principal quantum number n by pulsed nitrogen-laser-pumped dye-laser beams) with high frequency microwave radiation. Since, as pointed out by the authors, the radiated lifetime of an atom excited to a Rydberg n-state varies as n^3 (and is about 100 μsec for $n \approx 45$), very narrow ultimate resonance widths of transition to the next lower state ($\sim$1 meV, corresponding to a transition frequency of $\sim$250 GHz) are possible. Because of the large dipole moments of these "giant" Rydberg atoms, their transitions have extreme sensitivity to microwave radiation. The narrow line width feature makes Rydberg atoms very attractive for high resolution spectroscopy; the high sensitivity could be used advantageously to develop new types of far infrared or microwave amplifiers, masers, or superradiant systems operating with extremely low thresholds and microscopic energy levels. Goy has recently referred me to published papers on this subject as follows: C. Fabre, S. Haroche and P. Goy, "Millimeter spectroscopy in sodium Rydberg states: Quantum-defect, fine-structure and polarizability measurements," *Physical Review A*, 18, 229-237; July 1978; and S. Haroche, C. Fabre, P. Goy, M. Gross and J.M. Raimond ("Rydberg states and microwaves: High resolution spectroscopy, masers and superradiance," Proceedings of the Fourth International Conference on Laser Spectroscopy, Munich, 10-15 June 1979, to be published by M. Walter Springer-Verlag).

Of decidedly practical interest to the semiconductor technology was the paper by J.S. Thorp (Univ. of Durham, UK) entitled "Recent applications of

ESR at 8-mm wavelengths," in which the speaker reported on measuring the silicon content in bulk silicon nitride and expressed the optimistic opinion that by using similar techniques he hopes to be able to measure quickly the silicon content of the silicon nitride films used in microelectronics.

As can be seen from the brief report above, BRFG is an active little group, with enthusiasm that reaches well across the Channel. The conference was not limited to esoteric subjects, for among the papers presented there were several of significant general interest.

In conclusion, readers may find it useful to know that the July/August 1979 issue of *The Radio and Electronic Engineer*, the journal of the Institution of Electronic and Radio Engineers, is devoted in its entirety to the subject of millimeter and submillimeter waves. (Irving Kaufman)

SYSTEMS SCIENCES

INFORMATICS AND AUTOMATICS

Cracow, Poland's second largest city, with a population of 750,000, has 13 colleges and universities. One of these is Jagiellonian University, one of the 2 or 3 oldest in Europe. It was founded in 1364, and is now the largest university in Cracow with some 25,000 students. The second largest school in Cracow is the University of Mining and Metallurgy, with about 10,000 full-time students and another 8,000 part-time. While the name was originally relevant, it is now quite obsolete.

Polish universities are divided into "faculties" (translate "schools") which are in turn divided into "institutes" (translate "departments"). The name of the institute that I visited at the University of Mining and Metallurgy was given to me by one person as "Institute of Computer Science and Control" and by another as "Department of Informatics and Automatics," such being the vagaries of translation of Polish into English. At any rate, it is located in the Faculty of Electronics Computer Science, and Automation, which is about 1/3 of the whole University. The Institute represents a unique blend of computer science and systems science. The trick is to keep large groups of people in these two disciplines working productively together when there is obviously a centrifugal tendency to split off and make two separate departments. This neat balancing trick is performed by Prof. H. Górecki, who obtained both his PhD and his *habilitation* (the post-doctoral degree commonly required in many European countries of candidates for professorship) in automatic control at this university.

The Institute is composed of about 145 people, of whom about 50 have their doctorate. Górecki is the only one to hold the rank of professor, but there are 6 others with rank equivalent to assistant or associate professor. The 145 also includes a few support people and a substantial number of doctoral candidates, but not the large number of undergraduates who take courses in the department. Thus, it is somewhere between a department and a research institute.

Górecki's people are still interested in some classical automatic control problems; for example, they are working on the identification of multidimensional objects, trying to determine what are the essential data for identification and how to obtain such data. For the most part, however, they do applications of "system theory" (control theory, mathematical programming, and the like). They develop some new theory but have particular interest in applying such theory to real problems in industry. Górecki told me that they actually sell this kind of work to industry, and the funds are employed to supplement salaries.

Among the projects about which he told me was that of organizing the transport system for the Oświęcim (Auschwitz) Chemical Factory, involving an appropriate mixture of rail, truck and other transport types to carry both raw and finished materials to both the domestic and export markets. They also make hardware; namely, some specific controllers for this industry. They worked on the traffic control system in Cracow and developed a "green wave" traffic light system (we call this a "progressive" or "staggered" traffic light system). This seems to work quite well when the traffic is not

too heavy; however, Cracow is an ancient city with winding streets, many of them with trams running down the middle, and when traffic gets dense it moves rather badly.

They have also developed a new scheduling algorithm for the multi-machine/multi-product line in a factory producing electric cables. The algorithm, which was developed by a Dr. Wajs, is heuristic, and something like a branch-and-bound algorithm, but apparently reaches a near optimum very rapidly. Two fast versions have been implemented, and it has made significant improvements in the efficiency of the factory. Finally, he told me about their bioengineering efforts. They have worked with the local hospital and built both the hardware and the software for an artificial kidney. They also give undergraduate courses in bioengineering, and some 20 students major in this area each year.

The number two man in this Institute appears to be Maciej Zebrowski, who is not one of the six men holding the rank of assistant or associate professor, although he plans to take the *habilitation* with which he hopes eventually to become a professor. He did his undergraduate work in computer science at the Technical University of Warsaw, and worked for a number of years in both hardware and software aspects of computers, both with industry and research institutes, in England and Japan as well as in Poland. He came back to the University of Mining and Metallurgy a few years ago, took his doctorate under Górecki on a systems dynamics approach to maintenance problems in chemical industry, and stayed on to head a systems research group in the Institute and to teach system philosophy to undergraduates.

Zebrowski's primary interest at the present time is in what he calls GSOS, which stands for Growth Strategy Optimization System (although with tongue in cheek he says it also stands for "God Save Our System"). The basic idea of GSOS is to design a combination of models and algorithms which can be used to manage growth. He has attained a good deal of data from industry, and is building a managerial game, and also designing a highly specific problem-oriented data base for this purpose. The Institute has access to a major computer (a CDC Cyber 72) as well as some Polish-built ICL-like equipment.

Zebrowski told me that his group also works on optimization algorithms, production and distribution networks, decomposition problems, and a wide variety of other problems which involve modeling and which have some connection with industrial application of importance in Poland.

I spoke with two of Zebrowski's doctoral students, namely Marek Zabicki and Maciej Skocz, to get an idea of their research. Both are interested in optimization, decomposition, and decentralization of large-scale systems. Zebrowski has a large linear model (basically a Leontieff input-output model) of the economy, which includes 2000 variables and 10,000 equations. Zabicki was interested in checking this model theoretically, and also in simplifying it and then applying it to the chemical industry. He pointed out to me that people in the chemical industry may know economics, but they do not know control theory or optimization theory, and therefore it is very difficult to discuss with them the aggregation of variables which is central to his problem. Skocz is attempting to find "coordinating variables" to tie together the various subsystems of this large economic system. Generally we are accustomed to controlling economic systems by means of prices, but this is very difficult in Poland because of the wide variety of different prices (in the domestic and export markets, in the controlled and free markets, etc.). This is basically related to the problem of decomposition: it is essential to decompose such a large model in order to analyze it; it is necessary to have such coordinating variables if the system is to be recomposed. Neither of these young men has actually started writing his dissertation at this time. These descriptions of their research give an indication of the kind of serious-minded work going on in this Institute.
(Robert E. Machol)

NEWS & NOTES

BRAIN RESEARCH ASSOCIATION AND EXPERIMENTAL PSYCHOLOGY SOCIETY

The joint meeting of the Brain Research Association and the Experimental Psychology Society of Great Britain was held on 13 October 1979 at the School of Pharmacy, University of London. These two societies meet jointly only once every three years to discuss a topic of current interest. The topic for this meeting was "Neuropeptide-Neurotransmitter Interactions." This proved to be an international meeting with eleven speakers from Great Britain, The Netherlands, and the United States.

The meeting opened with an excellent lecture by Dr. D.G. Smyth (Laboratory of Neuropeptide Neurochemistry, National Institute for Medical Research, London) on the distribution and function of opiate peptides in pituitary and brain. This rapidly growing field has been in existence for barely five years, and ten naturally occurring peptides with opiate analgesic activity have already been identified. Their distribution is widespread; they are primarily found in the hypothalamus, the hippocampus, and the pituitary. Beta-endorphin is the most potent and most stable. Stability of these peptides is related to length. For instance, metenkephalin which has a half-life in the brain of only four to five seconds can be made more stable by linking it to insulin. It is also now becoming apparent that these compounds have actions other than analgesia. The endorphins, e.g., beta-endorphin, can produce catalepsy and hypoglycemia. Smyth left us with his impressions of the state-of-the-art in this field, namely that there are three endorphins, beta, alpha-neo, and beta-neo, which function as that neuromodulators inhibiting the action of presynaptic transmitters like Ach, and that there are two short-acting enkephalins which act as neurotransmitters.

Dr. T.B. van Wimersma Greidanus (Randolph Magnus Institute for Pharmacology, Univ. of Utrecht, The Netherlands) discussed his substantial work on neuropeptides and avoidance behavior using synthetic fragments or anit-sera to peptides of the ACTH, MSH, and vasopressin type. He has been able to show that vasopressin is involved in memory processes, particularly storage and retrieval of information in the brain. He proposed that whereas the whole structure of the peptide may be necessary for such actions as those on the kidney or adrenal, fragments of neuropeptides may be split off in the brain and are important in modulating memory and behavior.

The paper by Drs. J. Polak and S.R. Bloom (Departments of Histochemistry and Medicine, Royal Postgraduate Medical School, Hammersmith Hospital, London) discussed the peripheral neuroendocrine system and its role in pathology. They presented evidence for the widespread distribution of peptides throughout the gastrointestinal tract: in addition to gastrin, secretin, and VIP (vasoactive intestinal polypeptide), such peptides as substance P, enkephalin, bombasin, and cholecystokynin. They pointed out that in contrast to traditional thought, localisation of these and other neuropeptides is not specific to the gut. For instance, VIP is found in the pituitary. Cholecystokynin and its receptors are found in the central nervous system. These peptides have both local and distant actions and their effects range from the inhibition of gastric acid secretion by VIP to the release of insulin, glucagon, and somatostatin form the pancreas by cholecystokynin.

Three main points pervaded the meeting: 1) very minor changes in the structure of neuropeptides alter their action both qualitatively and quantitatively; 2) small fragments of neuropeptides and other hormones can act either as transmitters or as neuromodulators regulating memory, arousal, pain sensitivity, and other important behavioral functions; and 3) these neuropeptides form a diffuse neuroendocrine system both in the brain and peripherally, and hence the approach to the study of the physiology of these substances will need to be changed.
(J. Vernikos-Danellis, Visiting Scientist, Dept. of Pharmcology, Royal Free Hospital School of Medicine, London)

PHYSICAL CHEMISTRY AT NEWCASTLE UPON TYNE

The University of Newcastle upon Tyne, founded in 1851 as a branch of the University of Durham (some 15 miles distant), became a university in its own right only in 1963. My host for this visit was Prof. David H. Whiffen who holds the chair of Physical Chemistry at Newcastle. Physical Chemistry at Newcastle is best known for the research activities of the quasi-independent Electrochemisty Research Laboratory which was first established by Lord Wynn-Jones and which has been under the direction of Prof. H.R. Thirsk for the past 15 years. Thirsk, who is also editor of *Electrochimica Acta*, is scheduled to retire next year, and Dr. R.D. Armstrong will become head of the Laboratory at that time. Whiffen expects that the scope and the size (currently roughly 35) of this research group will gradually decrease after Thirsk's retirement.

In our conversation, Whiffen mentioned that his appointment to the chair of Physical Chemistry was motivated by a desire on the part of the University to give the field more balance. His own interests still revolve around molecular spectroscopy, but beginning with the next academic year he will have overall responsibility for all activities in the field of physical chemistry. In his own research, he is starting to carry out some microwave spectroscopy on small gas phase molecules. In the long run he is interested in calculating force constants and the force fields for such species. He attributes his slow start on this research to personnel limitations; very few new positions were authorized in conjunction with his appointment two years ago. Whiffen also mentioned another ongoing area of research activity in Newcastle; this involves research on carbon/graphite and is being supported by the Coal and Coke Research Association (now nationalized).

Thirsk briefly outlined to me the research activities in the Electrochemistry Research Laboratory, consisting of the following six areas: (1) metal deposition, (2) corrosion, (3) power sources, (4) a small program on organic electro chemistry (some involving water as the solvent and ilso some work in liquid ammonia), (5) studies of reference electrode systems with emphasis on the determination of pH in corrosive solutions and, (6) sutides of electrolyte solutions. (George M. Wyman, United States Army Research and Standardization Group, Europe)

NEWS

The 4th International Show and Symposium on Ocean Exploitation is scheduled to open in Bordeaux, France on 4 March 1980. Problems of maritime construction, maintenance and repairs, of ports and coastal engineering, of ways of monitoring the 200-mile economic zone, of fishing, and of preventing and controlling pollution are on the program.

OCEANOEXPO IV is expected to attract countries from all over the world, including South America, Africa, and Asia. It will be an occasion for displaying new productions or the ones still being marketed since the preceding show in 1977. Further information may be obtained from TECHNOEXPO, S.A., 8 rue de la Michodière, 75002 Paris, France.

A new university electronics department opened its doors in the UK this autumn. It is the Department of Electronics of the University of York, a university that itself is less than 20 years old. Head of the Department and its first Professor is Dr. G.G. Bloodworth, formerly of the Univ. of Southampton. His first staff member is Dr. A.C. Marvin, Lecturer.

Bloodworth's work at Southampton for many years was in the area of semiconductor devices and circuits. He is continuing this work at York with investigations of a novel magnetic field sensor that has direct digital output.

Students in the new Department will share some classes with students in the Departments of Physics and Computer Science, though there will be an emphasis on design examples and projects in the advanced parts of the program.

It has been said that it is hard to stumble on something while sitting down. If this is true, the Physics Department at Heriot-Watt University hasn't been doing much sitting. The following quote is taken from the lead paragraph of an article entitled "Speed of Light": found in the September issue of the *Economist*. "A computer that calculates a thousand time faster than the speediest of electronic machines today? Not yet. But an intriguing phenomenon that physicists have stumbled on at Heriot-Watt University in Edinburgh could offer a more practical route to the super-fast computer than either of the two main approaches being tackled at present. It would employ a laser beam to make an optical switch flip on and off in an incredible one trillionth of a seocnd." The computer switch referred to is based on the phenomenon of optical bistability and the group working on this project is led by Professor S.D. Smith.

The interested reader may want to read the article entitled "Optical Bistability in the UK" on p. 535 where optical bistability is described in considerable detail, and many applications other than computers are presented. (R.S. Hughes)

ONRL NEWS

We welcome aboard Mr. T.C. Cheston of the Applied Physics Laboratory of the Johns Hopkins University where he is a member of the Principal Staff. Prior to joining the London Branch of the Office of Naval Research in October 1979, Mr. Cheston served for three years at NATO Supreme Allied Command Atlantic Antisubmarine Warefare Research Centre, La Spezia, Italy. He will perform scientific liaison work in the areas of underwater acoustics and radar.

PERSONAL NEWS

Dr. Mario J. de Oliveria Ruivo (Portugal has been appointed Secretary of the Intergovernmental Oceanographic Commission (IOC) by the Director-General of UNESCO. Ruivo, special advisor in science and technology to the Minister of Science and Culture, has been active in marine affairs for many years in his country, internationally, and within the United Nations system. He will officially begin his duties on 1 January 1980.

OBITUARIES

Prof. Roy Markham, FRS, Director of the John Innes Institute, died on 16 November, aged 63. He is best known for his work on plant diseases, particularly on the Turnip Yellow Virus. He also provided essential data on the compostion of both DNA and RNA and was thus in at the birth of molecular biology. During his Cambridge days working in the Biochemistry Department with N.E. Pirie, he set himself the task of developing techniques for improving the quality of the information on the molecular structure of viruses provided by electron microscopy. The first step was to devise a method and the appropriate apparatus for reducing the random noise which obscured fine detail. The method, based on photographic averaging, gave greatly improved pictures, and is now referred to as the "Markham averaging technique."

ONRL REPORTS

R-4-79

RESEARCH AT THE BIDSTON BRANCH OF THE UK INSTITUTE OF OCEANOGRAPHIC SCIENCES by W.V. Burt

The background of IOS Bidston is presented along with a short history of its predecessors, the Liverpool Observatory, the Liverpool Tidal Institute, and the Institute of Coastal Oceanography and Tides. Ongoing research programs at IOS Bidston are described.

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