OFFICE OF NAVAL RESEARCH
LONDON

EUROPEAN SCIENTIFIC NOTES

ESN 35-11

30 November 1981

Distributed by the
Office of Naval Research Branch Office,
London

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
(14) ESN-35-11	AD-A109387	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EUROPEAN SCIENTIFIC NOTES, Volume 35, Number 11		5. TYPE OF REPORT & PERIOD COVERED MONTHLY PUBLICATION NOVEMBER
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) F.A. Richards, and Don J. Peters, Editors		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Office of Naval Research Branch Office London Box 39 FPO NY 09510		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE 30 November 1981
		13. NUMBER OF PAGES (12) 32
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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.

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

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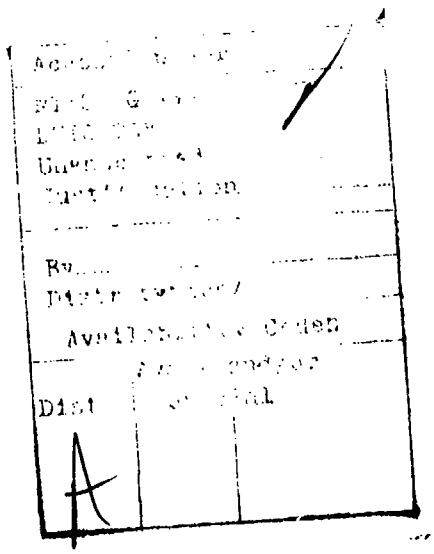
scientific staffs of the United States Air Force's European Office of Aerospace Research and Development and the United States Army Research and Standardization Group. Articles are also contributed by visiting Stateside scientists.



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OFFICE OF NAVAL RESEARCH
LONDON

edited by Francis A. Richards and Don J. Peters

30 November 1981 Volume 35, No. 11

PARTIAL CONTENTS INCLUDED:

ESN 35-11 (1981)

European Scientific Notes is a Class I Periodical prepared and distributed by the Office of Naval Research London in accordance with NAVEXOS-P-935. Prepared and submitted by the scientific and technical staff.

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BEHAVIORAL SCIENCES

ARTIFICIAL AND HUMAN INTELLIGENCE

When Alick Elithorn (Royal Free Hospital, London) organized his NATO Symposium on "Artificial and Human Intelligence," he expected that an examination of cognitive processes might contribute to the application of Artificial Intelligence (AI). To this end, specialists were invited from not strictly AI domains such as psychology, linguistics, medicine, and mathematics. The meeting was held in the Chateau de Chapeau Cornu, some 40 miles from Lyon, France, during the week 26-30 October 1981; more than 60 people were present.

A few of the papers were journal-type contributions that will be published soon in the regular literature. A good example of this kind of presentation was "Non-Standard Uses of the word *If*," by D.S. Breé and R. Smit. Starting from the Brown data base of American printed texts, a probability sample of *If* uses was analyzed. Of these, some 60 percent of the *If's* were employed with the standard conditional interpretation. To classify the remaining 31 percent (69 instances) of nonstandard *If* examples, Breé and Smit proposed a taxonomic system involving nine uses. To the AI community, a valuable contribution of this paper lies in the rather strict logical definition of each of the nine uses; an AI programmer who wanted to incorporate "if richness" into a model would have a good starting point here.

Hans Berliner (Carnegie-Mellon Univ., US) gave an up-to-date review of present game-playing programs. He stressed the necessary balance between depth of search (as expressed in number of "plies" or levels of an action tree) and the quality of knowledge (often expressed in some evaluation function carried out at each ply). There are several clear indications that knowledge can be decisive. For instance, Northwestern University's chess program BELLE won every game in a recent contest against a program that consistently searched more deeply. At present, only the very best players can beat BELLE. Some extreme cases can be formulated wherein BELLE knowledge beats a 20-ply deeper search In this context, Berliner developed the concept of projection of knowledge; thus, a bit of shrewd knowledge might be worth eight or more plies of depth. The projection ability would be reflected in the number of moves it would take to result in a recognizable advantage. BELLE, incidentally, would be a most valuable consultant to even a grand master chess player. When the program recently was given 300 standard chess problems, it got only 19.5 wrong answers (half credit is given for a partial solution). And in seven cases, the program produced answers that were correct, were not in the grand master's published analysis, and were not known before! Considering the close scrutiny such problem sets receive from chess experts, such a program achievement is most impressive. Grand masters still beat BELLE, sometimes because BELLE may be "too concerned" about the value of material on the board.

Berliner reviewed several clever tricks for reducing the size of a search effort in a game program. One technique involves a "hash table" of one's own and one's opponent's best moves; if a path through the tree produces the same best moves for each side, then one need not examine every node in both sides of the tree. Such methods can be spectacularly efficient: in one case, a 30-ply search that would require 3 years of main-frame computer time was reduced to a few minutes' run.

At least two game programs are now in the world champion class. Berliner's own backgammon program beat the human world champion in a seven-game encounter a short time ago. And for Othello, a territory game played on a board with complex edge rules, the human champion has recently declined to play the computer program again; in all likelihood, no person can beat it consistently.

Ira Pohl (Univ. of California, Santa Cruz, US) gave a plenary-style lecture on complexity theory and AI. He reviewed some of the ideas that can be used to reduce the number of computations required and still yield good results: local heuristics, probabilistic algorithms, divide-and-conquer, backtracking from known winning positions, and so forth. Complexity concepts are not necessarily manufactured from small "atoms" of arithmetic processes: Pohl mentioned the compatibility of De Groot's notion of chess-playing complexity as the "style" of class search that is done by the performer. Policy-capturing methods might elucidate this style in terms of a definite evaluation function.

Pierre Lavorel (Institut National des Sciences Applique [INSA], Lyon) showed some of his computerized displays of brain function; specific areas of the brain appear momentarily as color illuminated, and the areas change rapidly as the nature of the task changes (the blood carries a tiny amount of radioactive chemical that "travels" in accord with glucose expenditure at active sites in the brain). Two broad operating principles are often in such brain-activity charts, distributed processing

and convergent information. These capabilities permit accurate and safe outcomes of thinking despite local singularities and breakdowns. Other physiological work supports the idea that a real biological processor grows not by increasing the number of simple neurons but by increasing the number of connections, which grow by stimulation.

A few papers were rather unusual, at least for most of the audience. One of these was given by J.C. Pagés (Univ. of Paris, France), under the title "Artificial Psychology Versus Artificial Intelligence." Pagés' main point was that AI workers may focus too quickly on the final outcomes of logical and perceptual processes and may try to imitate the outputs without giving sufficient attention to real internal states and developmental necessities. To illustrate the point, he used two examples from psychology. The first was the "phi phenomenon," wherein two adjacent lamps are switched on and off in rapid succession. Under suitable timing arrangements, the successive illumination causes the lights to move (perceptually) from one place to another. In fact, an observer cannot tell the real movement of a bulb from the artificial or inferred phi movement, and if a slight barrier is placed between the two lights, the light movement is seen to "bend" up over the barrier and to go on to the other place. Such perceptions, Pagés emphasized, cannot be explained by retinal remanence of the brief exposures (remanence would only prevent the neural probes from seeing "nothing" between the illuminations).

A second illustration Pagés used is classical in experimental psychology but novel to many participants. It was the "kitten carousel" of Held and Hein, in which two kittens are born and reared by their mother in total darkness for 6 weeks. They are then placed in an illuminated carousel; one kitten is fitted with a little harness and pulls the carousel around a circular space with striped walls. The other kitten is totally restrained, with only its head protruding from the restraining box. Both cats receive exactly the same visual stimulation as the carousel moves around; but only the cat that moves will develop normal stereoscopic vision. After 6 weeks, the passive cat still has no stereoscopic acuity and its brain lacks some visual cortical layers. The implication for AI analysts is that natural systems grow not only by receiving, but by acting upon stimulus inputs. A machine or program might, then, require such activity as it "learns" to do something complex.

There were several papers on practical applications of AI systems and concepts. It was perhaps appropriate that one of these was described by A. Elithorn, the symposium organizer. Some of his patients at the Royal Free Hospital have to be tracked very closely as they shift from one medication to another; it is desirable to detect small intellectual differences caused by the different drug regimens, and Elithorn has produced special games and tests to monitor mental performance. Suppose a seizure-prone patient changes from Haloperidol to Epanutin; Elithorn uses an AI program to detect the slight performance changes caused by the drug shift. His computer program can sensitively show that something is happening intellectually to the patient, whereas graphs may not show the change in any obvious way. The technical situation resembles somewhat the automatic analysis of EEG and EKG signals, and it is already a practical procedure.

Patrick Humphreys (Brunel Univ., UK) reported on a real-world decision problem involving the settlement of certain damage claims. In designing aids for the decision maker in such a problem, Humphreys and his colleagues explored the idea that "production systems" might assist in the formulation, and possibly the solution, of such complex adjudications. After some false starts, the team concluded that production system realizations play some part in eliciting and controlling preference structures via the Brunel multi-attribute decision model (MAUD). Suppose, for example, that all of the options relating to a particular attribute $\overline{X}$ are rated about the same. A (simplified) "production" might urge that, in the circumstance, the attribute $\overline{X}$ should be deleted from the decision system, and thus some excess baggage would not have to be carried along. More complex rules derived from production systems can be applied; for example, certain decision-problem elements not only can be tagged but can be multiplied or otherwise combined and substituted, and for "housekeeping" purposes these can be gathered together and neatly stored.

Humphreys pointed out, though, that a main requirement in a decision analysis is likely to be the decision maker's (mental) representation of the problem; a proper aiding system should help to explicate the problem situation, to make views about it more consistent internally, and to assist in achieving the delicate balance between realism and abstraction. Thus, an ideal aiding machine may open up a problem, whereas the standard production-system approach yields sound

logical inferences given a data base and action criteria. In Humphreys' view, it may be better to restructure a problem radically and "blow up" the old data base and action rules operating upon it. An incidental feature of the Humphreys paper was that some of the tables and figures in the handout were copyrighted and could not be reproduced without permission of the copyright holders; this prohibition is rare in scientific meetings.

A third application came from O'Shea and his colleagues at the Open University (UK). They wanted to use artificial intelligence techniques for computer-aided teaching (thousands of students take degrees without ever meeting a live lecturer in the Open University; there are computer-aided teaching and testing centers all over Britain). The teaching situation was separated into five components: teaching administrator, student history, student model, teaching strategy, and teaching generator. Each of the components was then defined in production-system terms; to take just one example, when a student's lesson terminates, a set of production rules operates to assign values to the student's ability profile record. According to O'Shea, complex branching rules have been produced that have proved to be useful and consistent. The final set of production systems, then, is the teaching model.

The modeling of physics problems is one of the more attractive options available to the computer-aided student in this type of responsive system. The student has a video display in front of him. When a conventional inclined-plane problem is being explored, there are several significant parameters (coefficient of friction, angle of inclination, mass of blocks), and any number of these can be varied by the student (or perhaps by the system, under certain regimes). If the problem is worked satisfactorily, the little colored block slides slowly up the plane, as advertised. And if the student has not solved the problem and makes things worse as he manipulates the variables, he may be "kicked back" to an easier problem domain until he demonstrates a more thorough mastery. O'Shea and his collaborators could not yet describe any practical experience on the more elaborate total system they have in mind, but the five-component model seemed to be about as good as other teaching-machine models currently under development, and it can express most of the ideas now current in the computer-aided learning field.

C. Engelman and W. Stanton (MITRE Corp., US) gave some clear decision-making examples from their KNOBS project, an interactive system to assist the tactical air mission planner. The intersection between resources and demands can be explored in several different ways. Not only does the system point up conflicts, such as the fact that a given air base may not have some particular aircraft desired, but it also presents an "audit trail" that resembles a semantic network. The network shows the inference structure being used. The program involves both production systems and "frames." The frame representation is especially suitable for data-bases of the tactical air type, and the generic-specific relations can be maintained automatically and "inherited" between frames. The fact that the entire logic trail can be shown to the user should assist in the implementation of systems like KNOBS.

The last session of the symposium touched upon social implications of AI and associated fields. As always, such discussions promote a lot of crystal balling and controversy. Pohl, who led off this session, gave some startling examples of the complexity that is already being explored with models. A summary layout of the "US Energy Model," for instance, is simply stupefying; there are literally thousands of equations and constraints. Certain physics-simulation programs require some 300 pages to list, yet they are running every day and are producing presumably valuable results. The robots, though still rare, grow in numbers and abilities. There are ingenious schemes for identifying complex parts in a tub, picking them up, and performing rather complicated operations upon them. And in several countries interesting work is being done on stereo-imaging systems and "soft" grippers for moving delicate objects around. One "vision" program in France can recognize any of an admissible set of body stampings with nearly perfect accuracy.

Prof. Saul Amarel (Rutgers Univ., US) introduced a note of caution into some of the speculations. He noted that perhaps the two most famous products of AI, the DENDRAL and MYCIN programs, though endlessly cited, are not being used at present by anybody (certain small segments of them are being used in research projects). Also, the fascination of many AI researchers with a small set of well-structured problems may have prevented a really close association with the users. Amarel reflected that a similar meeting in 1966, with some of the same people, was full of some of the same hopes and expectations, but that AI still has realized few of them. Counter-arguments to this line of thought were urged, of course; even "failed" projects produce some worthwhile lessons and by-products, modeling capabilities do increase,

and so forth. The conflicts in viewpoint provoked enough discussion to engage the symposium well through the banquet on the final evening.

To an outside psychologist like the writer, it often appeared that the symposium might have benefited from the presence of a few more of the engineers who are now building real pseudointelligent systems. The French auto-body-part problem, for instance, uses a three-dimensional surface definition of the press stampings; each part is illuminated by the projection of a light plane (laser beam through a cylindrical lens) on the object, which produces part of some (presumably known) contour line. The intersection of the part's surface and the light plane is viewed by video, and the resulting image is analyzed by an 80-point sample-curve method and stored in a buffer. Then the software makes the identification and locates the part with high accuracy. For this application, many transformations and calculations are required, but much of the work does not, and perhaps could not, benefit from the abstract considerations of data base design that were brought up at the symposium. Another example comes from automatic ceramic sprayers, painters, and welders. These devices already do a good job and have replaced thousands of workers. But again the solutions that have been achieved are due more to ingenious engineering than to such AI considerations as complexity theory, models of belief, or linguistics.

As Heinz Von Foerster said at a similar meeting some years ago, the problem with artificial intelligence is that you don't want just a little of it—you want a lot of it. Where is a "lot of it" likely to come from? Perhaps a banal answer, but a correct one, is that progress will be uneven, and it will ensue from the intersection of differently trained and highly motivated people working under the pressure of some important practical goal. It would be interesting to follow up this symposium with an applications-oriented one, wherein AI theorists and researchers would offer their ideas more directly to applications people from fields like robotics and parallel processing. Would the AI community be able to propose things that the engineers haven't yet tried?

Nicholas A. Bond, Jr.

ONR London

ORGANIZATIONAL CHANGE IN MERCHANT SHIPPING

By almost any measure, the western European shipping fleets are undergoing a severe crisis. Within the last 6 years, for instance, the Dutch merchant fleet has moved from about 3% of the world's shipping to less than 1½%. Britain "lost" some three million tons from its registry in the 1978-1979 year alone. British cadet programs for training new maritime officers, which have served as a model for centuries, have just been drastically reduced to less than half their former size. Some of this decline in the traditional seafaring countries can be attributed to the Liberian "flag of convenience" concept; that country does not require ships registered there to be manned by Liberian citizens, and this staffing factor, along with other regulatory freedoms, is highly valued by ship operators. As a consequence, Liberian tonnage is now more than twice that of Japan, which has the next largest shipping fleet.

The Liberian administrative phenomenon is not the only thing that presses the industry. Besides the recent innovations in ship size, port operating modes, and technology, there are sweeping management changes as well. The old image of a ship commanded by western European officers but manned by dutiful non-officer ratings from Asian and Mediterranean countries is fading fast. There are still some ships with British officers and Spanish or Filipino ratings, but the owner today is more likely to engage an all Chinese, all South Korean, or all Filipino complement. The trend can be illustrated by a recent worldwide tabulation of shipping personnel. There are now 22,000 merchant crewmen afloat from Hong Kong, Taiwan, and China. These men make up more than a quarter of all the seafaring people in the world; fully 7,000 of them are officers, and a large fraction of them work in one-nation crews, with a captain and chief engineer from their native country. To round out the changing industry picture, many of the insurance and banking businesses associated with shipping have moved from London and Amsterdam to places like Hong Kong, Singapore, and Tokyo.

It was against this background that ERGOSEA '81, the Second International Conference on Human Factors at Sea, was convened at the British port of Plymouth on 5-8 October. Nearly 200 people attended, with about half from shipping

companies and most of the remainder from governments and trade associations. There was little representation from the maritime unions.

Given the present industry challenge, many of the discussions centered around the "what can be done" question. Of particular interest were certain "change projects" the European ship operators have been undertaking. The projects all start from a conviction that major changes will have to occur for the companies to stay in the shipping business, and they all use ideas from management science and organizational psychology. The progress that has been achieved so far gives an indication of what we can expect when change agents try to implement new concepts in a conservative industry.

The PROVO project is being undertaken by Nieveit Goudriaan, a Dutch consortium of companies that operates worldwide shipping and warehousing services. (PROVO stands for "Project ontwikkeling vlootoperaties," or "Project for the development of fleet operations.") PROVO was to be more than just a scheme to reduce manning costs; the idea was to conceive of the welfare of crew members and shore staff and the economic efficiency of the ship operation as interrelated factors in a system. A steering committee to get things started was set up; it consisted of seafarers, company operating and office staff, and Netherland Maritime Institute people. The goals were certainly praiseworthy:

(1) To achieve more efficient and economic operations at sea and ashore.
(2) To increase the ship's autonomy as a business unit by transferring certain responsibilities from the office to the fleet.
(3) To create a working climate in which personnel could be motivated and could work with pleasure.
(4) To ensure the safety of persons on board and the safety of the environment.

The plan was to start PROVO on two ships and eventually to implement it over the entire Nievelt Goudriaan fleet. It took 18 months to obtain all the permissions, dispensations, and the additional training for all the crew. Officers were given management training, while ratings had extensive instruction in both nautical and engineering subjects. (The ratings are now paid more because of this increased competence.)

The ship organizational structure was changed from a department model to a mixed "department-matrix" model. Thus, the previous 10 deck and engineer ratings are now 8 people who operate in one "rating matrix." Also, a 5-man circular management team was established to replace the more hierarchical management structure. Separate committees were set up on such matters as safety, recreation, and food, and general consultation meetings were scheduled in which all ranks took part. The committees had "teeth" and resources, and so they could implement decisions. Selection of people for shipboard crews was done by the management teams themselves, not by the personnel department; they could use any selection criteria they chose.

Parallel shore-based changes were also made. A special supporting group of three shore people was set up to meet directly with the ship's management team at the firm's office in Holland. Clear "profit center" accounting systems were designed to facilitate the evaluation of business performance, and the shore-based supporting group was designated as the coordinating link between the evaluations made by the ship and by the profit center. For future years, it is hoped, the matrix management idea will more fully implemented, and some further manning reductions may be possible.

How is it all working out? With less than a year of actual experience afloat, PROVO is still very much an experimental project. Some indicators are already evident:

(1) The ratings, probably because of their new training, pay, and status, report higher job satisfaction.
(2) Junior officers perceive themselves in an uncertain status in the new structure; they may have to be integrated more into the management teams in order to "bring them aboard."
(3) The majority of shipboard people favor a stable year-round crew, but some do not.
(4) The initial enthusiasm of crew members for all the meetings and committees has become tempered somewhat, as the original rearrangements were accomplished.
(5) Economic tabulations suggest that PROVO has incurred some appreciable ship and shore costs (training, higher wages, many meetings, etc.), but that it has increased shipboard efficiency.

Overall, the company expects a modest profit from the PROVO project in 1982.

Besides such specific experiences, there are some general lessons from the PROVO case. According to L.G. Bedaux and J.P. Gronenveld, who reported the case,

the standard coordinating-committee approach to a change project is not necessarily the way to go about it; it can be argued that, except for obtaining dispensations from laws and government regulations, the steering committee serves to delay the project from getting off the ground. As to the usefulness of the participative approach itself, the PROVO analysts in Rotterdam now believe that everything depends on whether the company really means to change its whole organization toward a participative mode of operation; without that commitment, a "blue-print" or design-from-above plan might be better. Many people find that participation is stressful and uncomfortable.

In another paper on change in the shipping industry, J. Roggema (Groningen, Netherlands) and M.H. Smith (consultant, US) did not concentrate on a specific change project. Rather, they considered the general prospects for change. Their thesis is pessimistic: the western European countries have vast resources and they know about organizational change ideas and possibilities, but there are powerful conservative forces that almost always prevail.

Regulation is one of the forces. Roggema and Smith compared the petrochemical and shipping industries; both are covered by complex safety and operating rules, but the refinery operator has much more room to maneuver the manning of his plant, the training and broadening of his people's skills, and the evaluation of their performance. In contrast, even the slightest shipboard manning innovation may be stalled or prevented by regulations. Also, regulations tend to be enforced by people who have been ships' officers and have gone to work for the government in middle life; these people perceive shipboard necessities against their own experience, which might be from a radically different era. If regulations are hammered out as a compromise between the three subsystems (government, unions, business and financial authorities), then this tripartite negotiating structure of "insiders" makes other kinds of inputs to the system unlikely. In their generally critical view of committees, one bright spot was observed by Roggema and Smith: when committees and regulatory authorities actually visit a ship or port facility where a change effort is under way or is being contemplated, the in-group hostility may be reduced. This corresponds well to general findings from social psychology that familiarity does not necessarily breed contempt.

The procedures for institutional response to change ideas are also very conservative. Usually special meetings are held and new proposals are delivered from governments, unions, and the front office. Everybody sees the colored slides; there are consultants and academics present to give some intellectual credibility to the proposal. The representatives present are usually not empowered to make instant commitments; they have to write up a report to their own sponsoring institutions, obtain a reaction, and bring that reaction back to a subsequent meeting. Under these circumstances, a policy of marginal or least change is often seen as prudent. The famous Pearson report on industrial relations in UK shipping was cited as an example of this. That report recommended a more decentralized approach to labor relations, with more room for innovations in manning and management. But the detailed responses that finally were accepted proved to be only minor administrative changes; the main thrust of the report was essentially lost in the small battles over forms and procedures.

Roggema and Smith think that the most likely source of change will be at the periphery of the industry, where one or a few owners can try innovations (e.g., crew families aboard a giant tanker), and where an occasional success can lead to a sharing of information and resources. In their view, considerable change can take place at the periphery before the central industry is affected.

A rather different "bottom-up" change approach was tried a few years ago in the Norwegian merchant fleet. The hopes went this way: if we can accomplish successful changes at the ship or shipfloor level, then higher levels in the organization will eventually adapt themselves to the new management ideas. A "sheltered" field experiment was actually carried out under this assumption of change percolating upward; it used some of the same ideas exemplified in PROVO, and it was pushed by an outside consultant agency, which gave novelty, energy, and direction to the project in its early stages. As top management had approved the effort, middle management could not prevent the trial, but middle management eventually managed to kill the changes. The technique was one of wearing down the innovators and making them fight the same battles over and over again.

Strong personal feelings can be aroused by a change effort. Sometimes they come from a cognitive conflict situation that is not fully revealed. When

a ship's officer is briefed by his shore management on the desirability of additional technical training for his rated men, he may agree that it is desirable to upgrade his people and to bring them into new skill and knowledge domains. After all, it is easy to say that every person should have the opportunity to develop his or her abilities. Privately, though, the prospect of a highly competent rating may conflict with the officer's stereotyped image of the ratings as less capable people; he may even resent the rating having access to what has heretofore been privileged information. In much the same way, people may intellectually agree with the general concept of equality and social integration but resist it privately; Rogema and Smith believe that this social issue is perhaps the most important and that basic perceptions of the system, and of the self, are involved. Values can change, and much is known about the factors that affect such change, but again, there are substantial grounds for pessimism regarding rapid manipulation of values.

Sometimes the new management duties are so far removed from traditional seafaring roles that even the best people will have self-doubt. One moving case history described at ERGOSEA '81 was that of a senior captain who was generally sympathetic to the change project. He believed in participatory management, work-group goal setting, profit center accounting, and so forth. He was a "natural" for a new-management ship. Under the new regime, one of his duties was to facilitate the new kinds of evaluation; in doing so, he discovered that the performance criteria derived by committees were rather unusual, and that they differed markedly from the captain's own evaluations. Confronted by this complex and rather messy situation, the captain remarked, "I used to think I was a good master; but now I wonder what I really have been doing these last few years." It was a stressful and depressing experience for him, although he continued to believe in participatory management.

When change appears imminent, junior officers are in an interesting position. For those who are technical specialists and who joined the maritime industry because of certain long-term role and status expectations, it may seem as if the industry changed the rules after the game started. Matrix management concepts may, for example, threaten the junior officer more than they do the senior people who have already reached their reasonable career goals.

Perhaps it is well to note that some change projects described at the conference did succeed. The successes were generally in technical areas about which there were no strong emotional resistances. A good illustration is the Norwegian maritime program for ship safety, which was presented by I. Johnsen (Norwegian Shipowner's Association). First, there was a thorough statistical study of the real safety problems, which, incidentally, showed that big and dramatic accidents do not account for the majority of deaths and injuries at sea. From the original data on problems, there flowed many specific projects. One of these produced a new and more flexible lifeboat design so that lifeboats can be launched more easily and quickly and are better suited to the real rescue situation. Another design embraces a detachable stern section for safety. This part of the ship is a haven to which the crew can go in case of fire or severe accident. If the ship sinks, the special compartment supposedly will separate itself and float. The concept has not been put into a ship yet, but the risk analyses indicate its promise. There are many other innovations for ship rescue equipment, portable radios, stress measurement methods for ship personnel, and shipboard medical self-help systems. The methodology has not been one of simply developing all these ideas and giving them to the fleet; more positively, the researchers and change people have actively engaged in their practical implementation. For at least this kind of technical change, then, the outlook is promising.

Nicholas A. Bond, Jr.

ONR London

BIOLOGICAL SCIENCES

UNITS OF BLOOD PRESSURE: PROTECTING THE MILLIMETER OF MERCURY

Several countries have now adopted the Système International d'Unites (SI) as the only legally acceptable system of measurement. Included is the European Economic Community (EEC). Accordingly, a 1971 directive of the EEC scheduled the removal of the mm Hg from use by December 1977. In its place, the kilopascal (kPa) was to be substituted. As of that date, it was to be illegal for physicians and others in member countries to import or use equipment calibrated in mm Hg. In May 1977, the Thirtieth World Health Assembly (WHA) confirmed that SI should be used in medicine in place of the traditional metric units.

As the full implications of these proposals became clear to biomedical scientists and medical organizations, a wave of opposition developed and a full scale controversy was under way. The result has been a seesaw, difficult to follow. The purpose of this article is to summarize recent developments concerning units used in the measurement of blood pressure, a quantity of considerable significance.

A brief review: the SI derived unit for force is the Newton (N), equal to 1 kg m/S^2. The SI derived unit for pressure is the pascal (Pa), equal to 1 N/m^2. One mm Hg is equal to 0.133 kPa and one kPa is equal to about 7.5 mm Hg. Thus, a blood pressure of 130/80 is approximately (but not exactly) 17/11 kPa. N and Pa are currently in use in high-school and college physics courses and, of course, are in increasingly common use in science, engineering, and industry.

Adoption of SI poses several other problems for physicians, for example the expression of the amount of a substance in a body fluid. The SI base unit for the amount of a substance is the mole (mol). Thus, a plasma glucose level may be expressed as 3.8 mmol/L (millimoles per liter) rather than the conventional 70 mg/dL. While these other areas are of interest and concern, it is enough to concentrate here on the blood pressure affair.

Prior to the WHA recommendations of 1977, there had already been formed, at the Cardiac Department of University College Hospital, London, the "Committee for the Protection of the Millimetre of Mercury." (The author is indebted to Dr. Arthur Hollman, the leader of that group, for numerous documents and also correspondence relating to this matter.) The group has distributed widely the arguments against adoption of units other than the mm Hg for the measurement of blood pressure. Indeed, more than kPa is involved, for the millibar has been adopted for this purpose in the Federal Republic of Germany (1 mm Hg = 1.33 mbar).

Among the arguments favoring retention of the mm Hg: it is simple; pressure measurements cannot be made directly in SI units as they can with reference to a column of fluid; pressure detecting equipment can be calibrated easily with a mercury column. A change could represent a significant disturbance in worldwide public educational programs on blood pressure levels and the control of hypertension. Generations of extensive actuarial, epidemiologic and other types of statistics would require "translation." There is no consensus on the units to be adopted and the manner in which they should be expressed. There is no gain in the accuracy or precision of measurement. In all, protectors of the mm of Hg fail to find any good reason for making any change. Were meaningful bookkeeping on the matter possible, the change would doubtless be demonstrably expensive.

The proponents of a complete and "cold turkey" switch to SI units tend to regard these arguments as reactionary. The virtues of the SI, as a whole, are that it is "coherent," meaning that no conversion factors need be employed; all derived units are formed without any mathematical factor other than unity, and all units can be expressed conveniently in suitable magnitudes by the use of prefixes. Some years ago, the editor of a British scientific journal that has adopted SI *in toto* compared the arguments of those opposing conversion to the arguments that defended the sixpence and the 10-shilling note.

In 1979, the Director of Public Health for Luxembourg wrote: "... these new units have been adopted without too much difficulty in all other fields and it is only doctors or to be more precise, the health professions which continue to be reticent...it would be regrettable that medical circles, thanks to a prolonged boycott, should allow themselves to be left behind by the rest of the scientific world."

From various sources some of the recent innings are here recorded. In the spring of 1976, an official of the UK Department of Prices and Consumer Protection wrote: "Due to the work of a British based action group (The Committee for the Protection etc.,)... all the Member States of the (European) Community have agreed to the retention of (the mm Hg) until 31 December 1979, for the measurement of blood pressure *only*."

In February 1978, the Council on Scientific Affairs of the American Medical Association assembled an advisory panel to advise the council on SI units. The panel was asked also for recommendations concerning usage in medical publications. (Until recently, the panel was chaired by Dr. William Barclay, editor of the *Journal of the American Medical Association*.) Working groups were assigned the task of preliminary recommendations on various categories of units, with special attention to pressure, radiation, and energy (the calorie is scheduled to be replaced by the joule). Other biomedical organizations and health professions were consulted.

The panel's Task Force on Units of Pressure, Flow, and Resistance has tentatively recommended that there be

no immediate change to SI units, either for blood or gas pressure measurements. The panel recognizes the theoretical advantage of SI units for the expression of resistance in dynamic systems, and for this purpose, for now, conversion factors can be applied. (These are still preliminary working proposals subject to discussion and do not represent any "official" policy.)

In November 1979, the Right Honorable Sally Oppenheim, MP, UK Minister of State for Consumer Affairs, wrote to Dr. Hollman: "The future of (mm Hg) has been reviewed... the UK is no longer a lone voice in recognizing that some provision must be made to allow the continued use of this unit. It is now agreed that the unit should be authorized until the end of 1985. The new directive also makes clear that existing equipment can continue in use after that date without any time limit. The future of the use of this unit therefore seems secured for some years to come."

At 10-to 15-year intervals, the American Heart Association publishes the expert, committee-authored "Recommendations for Human Blood Pressure Determination by Sphygmomanometers." This authoritative teaching document, now available in booklet form at local heart associations, appeared in *Circulation*, November 1980. An appendix in that version recommends "that the standard unit of pressure be maintained as mm Hg and the SI unit not be adopted." The committee goes on to say, however: "...it is now necessary for one to be able to convert mm Hg into kilopascals in order to understand pertinent literature of the medical world."

The most recent significant development occurred at the 34th WHA, May 1981. (WHA is the official policymaking body of the World Health Organization.) WHA adopted a resolution introduced by delegates of many countries, including Finland, Italy, the FRG, the UK and the US, which states that "there is no compelling need to replace the millimetre of mercury by the kilopascal in medical practice at the present time," and that both units be used simultaneously "until a future WHA considers the retention of the mm Hg unnecessary for the undisturbed delivery of health care and the interchange of scientific information." Thus, on this aspect of SI, the WHA has reversed itself.

The present situation, therefore, represents an unfortunate international rift, involving dual and combined unit systems, about which the public and the health professions are generally unaware. Several European journals have adopted SI completely and exclusively, but few American journals employ the kilopascal or require its use. I know of no physiology or medical text used by American medical students that employs kilopascals in discussions of cardiovascular physiology or clinical cardiology. The educational program that would be required for this conversion has not started in the US. This tends to support the view that "there is no compelling need" for the conversion. (In clinical laboratories, on the other hand, there is now widespread use of SI units, often exclusively in Europe, usually in combination with traditional units in the US. Blood sugar, for example, would be reported both in mmol/L and mg/dL.)

Units are merely conventions, but they can have a profound effect on health care and medical practice. Great concern has been expressed, to use another case, over the use of SI in drug dosage. Until all of the health professionals involved—nurses, pharmacists, physicians—as well as patients understand completely the system in use, there will be great room for error. There is plently of room for error now in the prescription and administration of drugs.

Medical educational institutions and physicians are obliged to maintain an acute awareness of the worldwide movement for change in biomedical units, in order better to serve the ultimate consumer, the patient.

John C. Rose

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CHEMISTRY

3RD INTERNATIONAL SYMPOSIUM ON INORGANIC RING SYSTEMS

The 3rd International Symposium on Inorganic Ring Systems (IRIS) was held at the Institute for Inorganic Chemistry of the Technical University of Graz, Austria, on August 17 to 22, 1981. The symposium has been held every 3 years and is devoted to advances in the chemistry of homo- and hetero-atomic rings of mostly main group elements (excluding carbon). There were both plenary lectures and shorter contributed papers.

The plenary lectures demonstrated something of the range of topics of current interest in the area. Profs. M. Baudler (Univ. of Cologne) and Steudel (Univ. of Berlin) discussed cyclic phosphorus and sulfur compounds; R. Keat (Univ. of Glasgow), spoke about phosphorus (III) - nitrogen rings; H. Bock (Univ. of Frankfurt) described methods associated with ring system redox chemistry; T. Chivers (Univ. of Calgary) reviewed sulfur-nitrogen chemistry; Smidt (Univ. of Würzburg) and H. Vahrenkamp (Univ. of Freiburg) gave details of various metal

containing ring systems; J.F. Labarre (Univ. of Toulouse) explored inorganic rings as anticancer agents; and R. West (Univ. of Wisconsin, Madison) treated cyclopolysilanes.

The elegant lecture of Baudler demonstrated in detail the extensive catenation ability exhibited by phosphorus atoms and in particular the wide scope of three-membered ring chemistry. Also of interest was the degenerate Cope rearrangements observed for the P_7^{3-} ion. In addition, calculations on the process were reported by R. Gleiter (Univ. of Heidelberg) in a contributed paper. The complexities of conformational properties of $P_{(III)}$-N rings were demonstrated clearly in Keat's lecture.

Chivers demonstrated that at long last one can bring some organization via simple MO models to the baroque intricacies of sulfur-nitride chemistry. The exciting potential for clinical application of aziridinophosphazenes such as $N_3P_3(N\overline{1})_6$ was discussed by Labarre. Contributed papers by the van de Grampel (Groningen) group on aziridinophosphazenes and thiaphospazenes explored the chemistry and pharmacology of these systems. Of particular interest were the mixed aziridino/amino phosphazenes and the exceptional activity demonstrated by $[NP(N\overline{1})_2]_2SON$. The contributed papers contained new chemistry in a variety of ring systems. Especially noteworthy were a number of papers on the cyclophosphazenes indicating that this area still is a fertile area of new research.

In summary, Prof. E. Hengge (Univ. of Graz) is to be congratulated for hosting a well-run meeting, and many are looking forward to the 4th IRIS, which will be hosted by Prof. J.M.E. Goldschmidt (Bar Ilan Univ.) in Israel.

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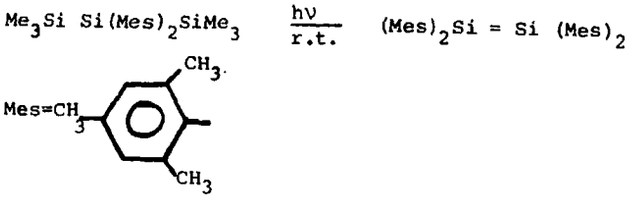
6TH INTERNATIONAL SYMPOSIUM ON ORGANOSILICON CHEMISTRY

The 6th International Symposium on Organosilicon Chemistry was held at the Research Laboratories for Natural Sciences of the Hungarian Academy of Sciences in Budapest on August 23 to 29, 1981. The meeting was divided among plenary lectures, contributed papers, and poster sessions.

Organosilicon chemistry is currently undergoing tremendous growth in a variety of directions. That growth was very much in evidence at the meeting, where topics ranged from materials exhibiting theoretically interesting bonding configurations to silicon in organic synthesis and biomedical and industrial applications of organosilicon compounds. The plenary lectures reflected these trends and developments. A survey of the Si=C species was presented by Maltsev (Moscow) with particular emphasis on vibrational spectroscopy. A contributed paper by A. Brook (Univ. of Toronto) demonstrated the occurrence of stabilized silaethylenes and their characterization by X-ray crystallography and Si-29 nmr spectroscopy. Probably the most exciting report of the conference was that of R. West (Univ. of Wisconsin, Madison) concerning the synthesis and characterization of a stable silicon-silicon double bond. A crystal structure of the material and some addition reactions of the



Si=Si bond were reported. Other plenary lectures of interest in the more inorganic area included those of E. Hengge (Tech. Univ. of Graz) on polysilanes, G. Fritz (Univ. of Karlsruhe) on carbosilane chemistry and E. Ebsworth (Univ. of Edinburgh) on silyl derivatives of the platinum metals. The applications of organopentafluorosilicates in organic synthesis were outlined by Prof. Kumada (Kyoto). Some of these processes appear to be strong rivals of the more widely studied hydroboration chemistry. The chemistry of organosilanes was reviewed by R. Benkeser (Univ. of Purdue). Industrial silicone chemistry appears to be in a healthy

state as evidenced by the lectures of Weis (Wacker-Chemis, Munich) on energy consumption improvements provided by silicones, and F. Stark (Dow Corning Corp., US) on the broad spectrum of recent advances in industrial silicones. The level of the activity is demonstrated by the granting of 2,550 patents in recent years with the concomitant development of new applications (e.g., transformer, brake, heat transfer and volatile fluids, medical applications, silylated surfaces, etc.).

Clearly, organosilicon chemistry, both at the theoretical and applied levels, is growing, and one can expect further advances to be reported at the next international symposium on organosilicon chemistry, which will be held in Japan.

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COMMUNICATION SCIENCES

ECOC IN COPENHAGEN

ECOC, the annual European Conference on Optical Communications, was first held in London in 1975. One might argue that the first meeting of two or three hundred scientists from Europe, the US, and Japan significantly hastened the transition of optical communications from the research laboratory to the commercial telecommunications system. Of course, at that time there were no fiber systems in use commercially, and most workers felt that further research was needed to improve components (fibers, sources, detectors) and to understand the characteristics of those components so that careful system design could be carried out. A minority view, forcefully argued by workers from the UK, held that commercially viable systems could (and should) be designed and built with then-existing technology.

Whatever the reason, the year or two following that first ECOC saw prototype systems field tested in several countries. Six years later there are hundreds of fiber links carrying commercial traffic in various parts of the world. Most of these systems use what is now called "first generation" technology based on graded-index multimode fiber, GaAlAs sources, and silicon detectors, a technology available in the research laboratory in 1975.

Research has, of course, continued and the proceedings of ECOC—Paris in 1976, then Munich, Genoa, Amsterdam, York, and now Copenhagen—form an annual chronicle of the advances, or a chronicle of the most important advances, since the competition to have papers accepted at ECOC has traditionally been stiff. This year only 39% of the papers submitted were selected for oral presentation; another 16% were designated for poster presentation.

"Second generation" techniques, using graded index fibers near 1.3 μm, where greater bandwidth and lower loss can be obtained, have appeared and largely moved to the development stage. "Third generation" techniques, using single-mode fibers, now dominate ECOC, and yet further advances are being considered. Still, even though new ideas continue to appear, there was a sense among participants that the field has matured technically. For example, the number of papers relating to large-scale production problems has grown as has the number of papers emphasising details of fiber characteristics and characterization.

Fiber Technology

The ultimate low-loss fiber, like a mirage, seems to move with the observer and to be always on the horizon. Fifteen years ago it was 20 dB/km. The number has fallen steadily, and since 1979, 0.2 dB/km has been achieved in several research laboratories. In two of the more forward looking papers at the conference, workers from Furukawa Electric (Japan) and Centre National d'Etudes des Telecommunications (CNET, France) described experiments with fluoride glasses that could yield fiber with losses in the 0.01 dB/km range. These mixtures of ZrF_4, BaF_2, LaF_3, and NaF, in which the ratios of constituents can be used to control the refractive index, are designed to be used in the 4 to 5 μm region. Thus, even if the predicted losses are too optimistic, the fibers may find application where long wavelength fibers are desirable for other reasons.

Another forward-looking paper, this time with a view to ultrahigh data rates, possibly to heterodyne systems, and certainly to fiber sensors, described a technique for preparing single mode fibers with ultralow birefringence. Birefringence leads to polarization mode dispersion, limiting the maximum data rates. It also causes the state of polarization at the output to be poorly defined, which leads to difficulty in many areas including interface to integrated optical components, heterodyne systems, fibergyros, and faraday current monitors. The technique consists of rotating the preform (spinning) while the fiber is pulled. This causes any birefringence due to core ellipticity

to be averaged out without introducing any twisting stress, which would lead to circular birefringence. The paper, by A.J. Barlow, D.N. Payne, M.R. Hadley, and R.J. Mansfield (Southampton Univ.), was awarded the ECOC prize for best paper.

Closer to the market place, the evolution of the Vaporphase Axial Deposition (VAD) technique of preform fabrication, developed in Japan, continues to receive a great deal of attention as the fabrication mechanisms become better understood. The VAD technique provides the highest bandwidths available in graded-index fiber, and because drying techniques can be used to remove OH ions, yields low loss values as well. The challenge at present is to find ways to control the process more completely and thus make it more reproducible.

Reproducibility was also the subject of papers from STL (UK) and British Telecommunication describing parameter variability in quantities of single-mode fiber. Both concluded that single-mode fiber could be produced in commercial quantities while holding tolerances to acceptable values.

Fiber Characteristics and Characterization

Perhaps the most important unresolved problem in the application of graded index fibers to communications systems is the interpretation of measured bandwidth data. Specifically, while it is possible to measure the bandwidth of an individual fiber with good precision (reproducibility), it is not possible then to predict with adequate certainty the bandwidth of a link consisting of several such fibers in series. Effects known as mode mixing, profile equalization, and differential attenuation lead to a nonlinear variation of bandwidth with length.

Five papers dealt with the above problem. One from Corning Glass Works (US) used a matrix transfer function focusing on three mode groups: low, intermediate, and high order. The transfer function was evaluated by exciting each mode group separately and determining how power in that group propagated and was coupled to other mode groups. In one example involving two fibers, the method worked quite well. It is probably too complex in its present form, however, to be used routinely. Another paper from Corning examined the spectral characteristics of profile equalization and found that the length dependence of bandwidth can vary widely near the wavelength where the refractive index profile is optimum. From these and other papers on the subject (from British Telecom; CSELT, Italy; and Bell Telephone Laboratories [BTL], Atlanta), and from prior work it is evident that there are no easy solutions to the length-dependence problem. The only fortunate aspect is that each of the effects mentioned generally leads to a higher than anticipated link bandwidth; therefore, systems can be designed using worst-case criteria.

The characterization of single-mode fibers is in some respects easier and in other respects more difficult than multimode. The various problems related to multimode propagation are obviously gone, but core geometry and index profile measurements are made difficult by the small size and small index differences. Measurement of bandwidth versus wavelength becomes important, as does the determination of cut-off wavelength and spot size. These problems were reviewed in a carefully documented review paper from Fujikura Cable Works (Japan).

Jointing, Coupling, Multiplexing

The shift to single mode technology puts additional pressure on connector design. Two papers from Philips (The Netherlands) described attempts to produce economical connectors. One used a ferrule-in-V-groove, the other a ball lens. Both showed promise.

Coupling light into a single mode fiber from a laser efficiently and without noise-producing reflections is another important problem. That as much as 50% of the light from an astigmatic laser diode can be launched was demonstrated in a paper from AEG-Telefunken (FRG). Isolators can sometimes be used to eliminate the spurious reflections. A Faraday isolator using a thick film of Gd:YIG was demonstrated by Nippon Electric (Japan). The device should be inexpensive to produce, but at present is hampered by a high insertion loss ($\sim$ 5 dB).

Wavelength multiplexing is receiving increased attention. A review paper from Philips pointed out that while a number of promising approaches to the demultiplexing problem have been reported, substantial work still needs to be done on multiplexers. Some guidelines for multiplexer design were suggested.

Sources and Detectors

A review paper from AEG-Telefunken put forth the idea that for most fiber systems the so-called "gain guided" lasers represent the best choice. In those systems where the greater spectral width of these devices limits bandwidth, more coherent "index guided" lasers can be used, though at a cost of greater susceptibility to modal and feedback-induced noise.

The search for more suitable detectors for the longer wavelength region continues. A room-temperature HgCdTe avalanche photodiode was described in a paper from SAT (France). The $10^{-4}cm^2$ device had a current gain of 30 at a -10V bias and a cut-off wavelength between 1.3 and 1.4 μm.

Systems

Although ECOC is primarily a research conference, papers describing advances in systems have always been included. This year, a full day was devoted to these topics.

The day began with a review paper from CSELT on the economic aspects of using fibers in the telecommunications network. The author examined several classes of applications and concluded that for high-data-rate, long-distance systems, fibers are now cost effective up to distances of 500 to 800 km. Beyond this distance satellites become a cheaper alternative. In the junction network, at 32 or 44 MB/s and distances of the order of 10km, fibers have for some time been an economical choice—witness the large number of operating systems in this area. One reason is that the use of fibers allows most links of this sort to be designed without repeaters. With coaxial cable, several repeaters would be required. In the local networks, where data rates do not exceed 1.5 or 2 MB/s, the author concluded that the current level of service can still be provided more cheaply with copper wire. However, fibers do offer the possibility of introducing wideband service (e.g., video) at a much lower cost than could be done with copper cable.

Several papers dealt with the design of long (25 to 35 km) repeaterless single-mode systems. In one paper from STL the design of a 35-km system at either 160 or 320 MB/s was considered. It was concluded that the main obstacle to the development of such systems was the control of reflection (feedback)-induced noise in the source. Techniques for minimizing these reflections, a suitable isolator, or both, will have to be developed. Another paper from STL described an FM television link using a 70 MHz carrier over 35.5 km. It was found that carrier frequencies up to 140 MHz could have been used, provided, again, that low reflection components were used. A third paper, by authors from several Japanese companies, described a 32 MB/s, 25 km, repeaterless system used in the control of an electric power system. The authors concluded that a substantially longer system could have been designed with the same components.

Papers concerning the application of fibers to the local network included one from CSELT where wavelength division multiplexing (WDM) was used to provide several video channels and remote power feeding. Others described inexpensive methods of applying WDM to the local network (Philips) the distribution of high quality VHF television (Swiss Federal Institute of Technology), and experience with an experimental local distribution system in Berlin (AEG-Telefunken). It is clear that the introduction of wideband services into the home and business will not be restricted by technical obstacles.

Finally, two papers considered the use of heterodyne techniques for high data rate systems. One, from CNET, concluded that it is possible to improve power budgets by 15 to 20 dB over direct detection.

The conference prodeedings, containing 4-page summaries of each of the 55 papers, is recommended reading for anyone in the field. It is published by Peter Peregrinus, Ltd, of Stevenage, UK, and New York.

Next year ECOC returns to France (Cannes, Sept 21-24). Switzerland and Germany have been designated as host countries in 1983 and 1984.

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SOME COMMUNICATIONS R&D IN EINDHOVEN

A commonly held misconception is the one which considers The Netherlands and Holland as synonomous, but it is as inaccurate to refer to Eindhoven as being in Holland as it would be to refer to Edinburgh as being in England. Eindhoven is in North Brabant, one of the four provinces that make up The Netherlands. The other three provinces are North and South Holland and Limburg.

Substantial communications-oriented research activities are carried on in Eindhoven; the activities are concentrated in two complexes, the Central Research Laboratory of the multinational Philips organization and the campus of the Eindhoven University of Technology. This report describes a visit to the first of those facilities.

My host at the Philips laboratory was Dr. Leo E. Zegers, head of the Digital Transmission and Speech Encoding Department, a part of the laboratory's Telecommunication Systems Division. Zeger's group of about a dozen graduate researchers and a half-dozen technicians is engaged in R&D projects in the areas of speech transmission and synthesis, video signal processing, and digital signal transmission over both radio links and local wire and cable networks. The group's current speech-related activities

fall into two areas: the hardware realization of a pair of new vocoders (an LPC design and a 10-chip channel vocoder that incorporates a DFT channelizer) and the consideration of an improved statistical representation for the speech signal. In the hardware project, an LSI version of a pitch extractor based on the harmonic "sieve" principle has been used (See *ESN* 35-9:338 [1981]). The chip set is expected to be incorporated into the two vocoder units by the end of 1981. In operation, the devices transmit pitch information every 10 ms and other spectral parameters every 30 ms. The pitch extractor was described as one especially robust for male and female voices in the presence of broadband noise, sine wave interface, or with heavy low-frequency suppression of the fundamental and low-order pitch frequency harmonics. Quantitative support for these claims may be offered if the system is described at a suitable conference in 1982.

Dr. Theo A.C.M. Claasen has been pursuing the search for a better statistical representation of the speech waveform. In the context of Zeger's departmental interests, Claasen expressed the opinion that "we've gone as far as we can go" toward bandwidth-efficient high-quality speech synthesis and transmission within the accuracy of the statistical models that are now generally used in such systems. He feels that the nonstationary characteristics of the speech signal are not adequately represented by a time-varying sequence of "short-time" stationary segments. The classical frequency-time uncertainty condition prevails: if the segment is made too short, frequency resolution suffers; if the segment is too long, "smearing" inaccuracies result throughout the interval. The approach that Claasen proposes to cope with the problem is one that was originally proposed by E. Wigner about 50 years ago in a very different context, that of quantum mechanics. The Wigner distribution, a generalized time and frequency function, has been resurrected a few times in the intervening years to help in an assortment of other problems, e.g., in the analysis of optical systems. In a three-part paper that Claasen and Dr. W.F.G. Mecklenbräuker published in the *Philips Journal of Research* in 1980 (Vol. 35, Nos. 3,4/5, and 6), the characteristics of the distribution as they relate to communication (and radar) signal processing are reviewed. Many of the function's desirable and undesirable implications (undesirable as far as hardware and software implementation are concerned), were referred to in the paper. In an attempt to cope with one particularly aggravating property of the Wigner distribution, the need to know the signal waveform for all time in order to perform the calculation, a smoothed modification ("windowed" in frequency) was described. Claasen is continuing to mull over the system implications of this newly resurrected analytical tool, and, while there is no prospect of counteracting the uncertainty limitations completely, he hopes that some of the desirable characteristics of the distribution may provide a better computational approach for speech signal handling systems of the future. In a more general discussion of speech, Zegers commented that studies relating to automatic speech and speaker recognition were being pursued in the Philips Research laboratory in Hamburg.

On the subject of local distribution of digital signals, two hardware developments were described: a one-chip analog echo equalizer for use with teletext data distribution systems and a digital adaptive echo cancellation system for use at rates up to about 100 kilobits/second in local distribution systems. The teletext equalizer compensates for short-delay echoes (≤ 1 μs) that may not be particularly bothersome, subjectively, with standard TV picture signals but can be troublesome for the binary teletext signal components. The equalizer uses a transverse filter whose six variable tap-weights are determined by attempting to restore the ideal binary waveform to the echo-distorted nonbinary received signal. The scheme thereby precludes the need for a training sequence. The chip is implemented as a nonlinear analog bipolar device, using the logarithmic characteristic of the transistors as a multiplying element.

The digital echo canceler uses a decision-feedback approach with a table look-up algorithm (possible because only short-delay loops, up to 5 km long, are being considered). This inherently fast-acting algorithm provides the system with a convergence time of about 200 ms.

Zegers' group has had a long-term interest in digital transmission over radio links. Some four years ago they developed the "tamed" frequency modulation (TFM) technique, one of a number of constant-envelope digital modulation schemes that have been proposed during the last decade to deal with the need for better spectral efficiency (or, in negative terms, to combat adjacent-channel interference), particularly in applications where the use of amplitude modulation is undesirable. (An early form of TFM was described in an article by Drs. F. de Jager and

C. B. Dekker in the May 1978 issue of the *IEEE Transactions on Communications*. Another member of this class of modulation techniques, M-ary continuous-phase frequency-shift keying [M-ary CPFSK] studied by Sundberg et al. in Lund, was noted in *ESN* 35-1:5 [1981].) In general, the methods used to reduce the level of "out-of-band" signal energy are all based on processing the binary—or, more generally, the M-ary—data waveforms so as to suppress the high-frequency components in the spectrum of the phase modulation being applied to the RF carrier. In its basic form TFM does this by a correlative technique, one that calculates a nominal discrete phase change (to be achieved during a particular signaling segment) by considering three successive digital data values, namely those occurring during the "current" time segment, and the data in the preceding and succeeding time segments. Before the resulting correlated sequence of phase changes is used as input to the RF phase modulator, a further smoothing process is applied to interpolate between the nominal discrete values of phase shift. The interpolation step, which determines the phase trajectories, can be accomplished either by analog methods (a low-pass filter) or by a digital table look-up method. Both methods have been considered, and work is now going on within the Philips organization to implement and test a digital one-chip processor that generates the TFM signal from binary input data at rates between 2.4 and 72 kbps. The chip also includes a digital-to-analog converter at its output, so a complete transmitter in a simple, low-powered configuration may be possible with the addition of an analog bandpass filter, a frequency up-converter, and a power supply.

Dr. Zengers and his group have provided significant contributions to the field of communications in the past. With the strong incentive provided by the Philips telecommunications and military systems interests and with the competent staff at the laboratory in Eindhoven, they can be expected to continue in that vein.

Philip Fire

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COMPUTER SCIENCES

RESEARCH IN SIGNAL PROCESSING AT IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (UK)

A new section was formed recently in the Department of Electrical Engineering at Imperial College, London, to pursue research in the theory, practice, and application of signal processing. At present the section, headed by Prof. A.G. Constantinides, has 4 full-time faculty members, 7 postdoctoral research assistants, several academic visitors, and 20 PhD graduate students. Many of the research projects are being carried out in collaboration with industry and government research institutions. Constantinides currently is serving as the chairman of the European Society of Digital Signal Processing and is an influential pacesetter in IEEE international activities and publications in signal processing. Some of the research projects in progress are described briefly below.

Digital Filter Structures Insensitive to Parameter Variations

Digital filter implementation requires the parameters of the algorithm to be expressed with finite precision. As a consequence, the performance of the algorithm deviates from its nominal range. Moreover, due to the finite precision arithmetic operations that are involved (rounding of products, truncations, etc.), noise and cyclic limits are generated. Design techniques are being developed for digital filtering algorithms that do not suffer from these unwanted effects. The techniques rely on simulating analog filters by means of linear transformations. The aim of the project is to examine ways and means of choosing the linear transformations (filter coefficients) necessary to subject externally imposed constraints on the above parasitic effects. For an analog prototype network having typical subsections N_i, the corresponding digital filter subalgorithm R_i is derived via linear transformations on N_i, which also produce the following interconnection strategy:

$$\begin{bmatrix} x_1 \\ y_1 \end{bmatrix}_i = R_i \begin{bmatrix} x_2 \\ y_2 \end{bmatrix}_i \quad ; \quad R_i = a_{1i} N_i a_{2i}^{-1}$$

where $$\begin{bmatrix} x_1 \\ y_1 \end{bmatrix}_i = a_{1i} \begin{bmatrix} V_1 \\ I_1 \end{bmatrix}_i \quad , \quad \begin{bmatrix} x_2 \\ y_2 \end{bmatrix}_i = a_{2i} \begin{bmatrix} V_2 \\ I_2 \end{bmatrix}_i$$

and $$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix}_i = N_i \begin{bmatrix} V_2 \\ I_2 \end{bmatrix}_i$$

V_n and I_n are voltage and current relationships of a two-terminal network. Computer simulations have been used to select filter coefficients that will approximate the theoretical filter responses.

Design of Digital Signal Processing Algorithms in a Constrained Parameter Space

The normal approach to the design of digital signal processing algorithms is to assume that the parameters (or coefficient values) from which a real model is obtained by parameter quantization and truncation are of infinite precision. Such an approach, however, may not lead to feasible solutions, particularly under stringent performance requirements for the algorithms. The purpose of the investigation is to specify a set of allowable parameters, in particular one or two combinations of the power of two from which coefficients would be selected such that the performance is within the prespecified limits. The attack taken for this problem is to use integer programming techniques to achieve a solution that would admit problems of moderate size. The formulation of the problem becomes:

Let $A(\omega) = \Sigma a(n) \cos\omega$

select $a(n)$ from a prespecified set of $\{s_1(n)2^{r_1(n)} + s_2(n)2^{r_2(n)}\}$

where $\{s_1 s_2\} \varepsilon \{-1,0,1\}$ to minimize

$$\delta - \sigma b$$

where δ is the pass band ripple and b is the filter gain subject to the constraint

$$A(\omega) - \Delta(\omega)\delta - W(\omega)b \geq 0$$

where $\Delta(\omega)$ and $W(\omega)$ are respective weighting functions.

This program is currently used for filter designs.

Two-dimensional and Three-dimensional Filtering and Signal Processing

Problems of interpolation, decimation, and general digital filtering are examined with specific reference to TV signals. Attention is focused on sampling patterns for such signals and their consequences in the frequency domain. Techniques developed for interpolation and decimation for one-dimensional signals are considered as half-band operations for the multidimensional case so that efficient realtime processing can be achieved. A spatial-temporal sampling approach for TV signals is examined to determine sampling patterns in three-dimensions that retain certain features of the spectrum. In two-dimensional signals, only the spatial domain is considered.

Partitioning of Networks

This research is conducted in collaboration with British TELECOM to divide a network of given connectivity and topology into subnetworks of specific attributes. The term network is a general one and the techniques developed are equally applicable to telephone networks or microelectronic circuits. In the latter case, attention is directed also to the problem of partitioning for integrated circuit realization. Graph theory techniques are employed to develop a given network graph with its associated link-cost matrix. Again, dynamic programming is used to determine the network partitioning to minimize the partitioning cost.

Fast Algorithms For Digital Signal Processing

Discrete Fourier transforms, number theoretic transforms, and other techniques are studied from a practical point of view to ensure that such operations are realizable within controllable hardware limits. The approach taken is to examine how these algorithms can be decomposed into a set of pipeline structures of reasonable computational complexity that are then arranged to operate in parallel on the overall input signal.

Techniques For Transmultiplexer Design

The transmultiplexer is a device to provide direct interconnections between FDM (frequency-division multiplex) and TDM (time-division multiplex) networks. A modular hardware implementation approach requires new studies that rely on preserving the simplicity of the frequency domain description for the transmultiplexing and finding a simple, efficient structure that can serve as the building block of the entire system. This project is also being done in collaboration with British TELECOM. The interpolation structures described above are used here to double the rate in two parallel branches, each fed with the same input signal and each containing a recursive all-pass section. The outputs of these branches are interwoven to achieve the higher rate. The prototype is now being constructed in the laboratory.

Signal Processing Techniques For Data Compression

The aim of this research is to investigate new techniques for data compression of a general nature that can be applied to speech and image signals. Several variable and fixed-rate schemes are under assessment. Time-domain pattern-encoding and clustering techniques have been shown to be powerful

in this context. Systems based on lexicographic principles are also under examination. Transform coding systems with memories form another approach to implement the above-mentioned techniques. Signals are segmented in discrete time and features are extracted from the segments. The feature space for a large ensemble of signals is then partitioned into disjointed classes and a typical member of each class is chosen as representative for storage, dictionary construction, and transmission.

Composite Source Coding for Image Bandwidth Compression

This new project, which is being carried out in conjunction with the General Electric Company (GEC), involves the study of the optimal decomposition of image signals into components of well-defined statistical attributes by means of which an efficient and valid encoding can take place.

The diverse activities described above represent basic technological aspects of signal processing research. Results of some projects are used extensively in biomedical applications by the Engineering in Medicine Section of the Electrical Engineering Department. The projects are surface and epicardial mapping of cardiac potentials, analysis of physiological data, and otological signals in hearing and balance disorders.

Y. S. WU

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EARTH SCIENCES

GEOTECHNOLOGY AT THE UNIVERSITY OF PERPIGNAN, FRANCE

The Centre de Researches de Sedimentology Marine de Perpignan is part of the university in the lovely old city of Perpignan, the closest city to the Spanish border on the Mediterranian coast of France. The center is comparatively small, with only 4 senior resident staff members and an average of 10 graduate students. Despite its small size, the center has a high research output. The volume of collected reprints for the center for 1979 was almost an inch thick and contained 28 papers. Unfortunately, all but a few were published in French.

Although the center has a major program in marine geotechnology (the study of the load-bearing properties of marine sediments), it was completely unknown to a marine geotechnologist with whom I discussed it with on my return to the United States. I would suggest, that, when possible, American marine geotechnologists visit the center.

The center has an unusually wide base of financial support for a French university laboratory. It receives support from the governmental ministries of Industry and Education, the French Atomic Energy Commission, the French Navy, CNEXO (Brest), and the petroleum and other marine oriented industries.

The center is in a one-story building on the new university campus. It uses the large CNEXO research vessels from other laboratories for all but close inshore research. For research close to Perpignan the center uses the 12 and 20-m long launches operated by the nearby Arago Laboratory (see Marine Science in Paradise, *ESN* 34-10:187 [1980]).

The director of the laboratory is Prof. C. Duboul-Razavet. Her research concerns the shear strength of undisturbed marine sediments. In collaboration with Dr. J.P. Longuemard, who heads the physical properties of sediments staff, she has developed empirical relationships of the same form for several areas, which allow an estimate of the mechanical strength of the sediments of a given area from a knowledge of grain size and specific gravity of the sediments. Numerical constants for the empirical relationships have to be determined for each area.

A major fraction of the building housing the center consists of machine shops where all sorts of innovative instruments for *in situ* experiments on the sea floor are under construction, maintenance, or renovation. One of the most interesting was an acoustic camera. Its frame is shaped like a triangular optical prism lying on its side with triangular ends and rectangular sides. It is used to record the interactions between various types of simulated mines and bottom sediments under the influence of various near-bottom current regimes. The simulated mines are placed on the bottom underneath the frame. Two current meters are mounted on the frame to record near-bottom currents. The actual fluctuating forces on the simulated mines are measured by six pressure transducers installed on the mines. Eight sonic transducers are equally spaced on the top bar of the prism-shaped frame. These are rotated through a 90° angle to scan the bottom and the mine on eight parallel lines. Small-scale bottom features can be contoured from the data recorded by the acoustic camera as can the horizontal and vertical movements of the mine itself.

Longuemard has done extensive research on acoustic methods for determining the physical properties of bottom sediments *in situ*. He has developed a "célerimètre"

comprised of two sound sources and two receivers mounted on the bottom corners of a square frame. The frame is weighted and constructed so that the sound heads are forced a fixed distance into the bottom sediments. The sensors measure the attenuation and speed of sound within the sediments. A hydraulically actuated penetrometer in the center of the frame measures the compressibility or resistance to deformation of the sediment. The resulting data are used to correlate the relation between the acoustic parameters and mechanical characteristics of the sediments. The center plans to continue to study the mechanical properties of the top 2 m of sediments by correlating acoustic properties with *in situ* measurements of sediment properties.

Much of the effort of the center is toward developing methods for rapid acoustic detection and assessment of manganese nodules on the deep-ocean floor. The center has worked on several types of self-propelled vehicles to move along the ocean bottom looking for nodules. In some of the areas where nodules are located the sediments are quite soft. Because vehicles with caterpillar tractor type treads they have tried do not work in very soft sediments, they have built and tested a prototype vehicle propelled by a large horizontal Archimedes screw. It has worked well in a soft-bottomed lagoon near Perpignan. At present, the center is building a working model that will be tested in deep water (to 6,000 m) on a major expedition to the Pacific in 1982. It is 5 m long, 2 m deep, and 2 m wide.

Most of the interviews at the center were concerned with geotechnology research. However, the two volumes of collected reprints indicated that personnel from the center have been engaged in a wide variety of marine geological and geophysical research projects in many places in the world's oceans, with some emphasis on the Mediterranean and areas near French possessions or ex-colonies such as Kergulan Island in the Antarctic, south of New Caledonia, off French Guiana in South America, and off former French colonies in Africa.

Perpignan is off the beaten path for tourists, but it is well worth a visit. The old walled city has not changed much since the middle ages and was the most difficult to drive in of any that I have visited.

Wayne V. Burt

Oregon State University

MATERIAL SCIENCES

NATO ADVANCED RESEARCH INSTITUTE ON SURFACE MODIFICATION AND ALLOYING OF MATERIALS BY DIRECT ENERGY PROCESSING

Attendance at this conference, held in Trevi, Italy, August 24-28, 1981, was by invitation only and limited to 50 participants, who came principally from the US, Italy, and West Germany. The objective was to review and discuss recent advances in the modification of the structure and properties of surface overlays by application of the newly developed energization techniques. These include ion implantation, ion-beam mixing, pulsed-electron or ion-beam annealing, sputtering, and laser pulsing or scanning. The sessions were long and intense; every conferee gave at least one talk.

On the whole, the wide modifications in surface structure that were described and the accompanying marked property improvements achieved with these techniques were a bit overwhelming. Research in the field is burgeoning, but much of the material is not yet fully understood and the full potentialities of the methods seem far from realization.

An excellent account of the physics of interaction of energetic ions with solids was presented by John Davies (Chalk River Nuclear Labs., Ontario). Depending on conditions carefully defined by Davies, these interactions may lead to channeling, backscattering, sputtering, implantation, defect cascades, thermal spikes, etc.

Research on alteration of the composition of surface overlays on metals by ion implantation and the attendant property effects was summarized by J. Hirvonen (Naval Research Lab.), S. Myers (Sandia Lab.), C.R. Clayton (State Univ. NY, Stony Brook), C. Draper (Western Electric), G. Wolf (Univ. of Heidelberg, FRG), and others. Implantation can lead to impressive improvements in wear and corrosion resistance, fatigue life, hardness, oxidation resistance, and catalytic efficiency. Hirvonen and Clayton reported that the fatigue life of stainless steels could be increased by factors of as much as 10 by N implantation. Clayton reported that P implants greatly improved the passivation, and Cr implants enhanced the pitting resistance of steels. Draper stressed that exploitation of surface alloying, as distinct from bulk processing, may become essential to conserve scarce strategic materials such as Cr. Draper also emphasized the advantages of annealing solid overlays by laser

scanning without melting, which generally results in undesirable surface ridges. He stated that such solid-state laser processing actually was being used by General Motors to harden steering columns. Also, it could be used to harden and improve the cavitation resistance of ship propellers.

Wolf described the preparation of catalysts with tremendously improved efficiencies for hydrogenation or oxidation reactions by ion implantation or ion beam mixing. For example, an alloy formed by implanting Pt and Fe exhibited a catalytic activity for hydrogenation that exceeded that of pure Fe by a factor of 10^3 and that of pure Pt by a factor of 10. However, these improvements are not yet competitive industrially because no method has been developed for achieving the requisite specific surface area in conjunction with the improved catalytic activity. Of more immediate practical importance may be the finding that fuel cell electrodes with greatly improved performance can be prepared by the ion beam mixing of a thin Pt overlay with a carbon substrate. It was claimed that the power output of such electrodes can be two to three orders of magnitude higher than that of the conventional fuel cell Pt electrodes.

Perhaps the most impressive report, from a scientific viewpoint, was that of C.W. White (Oak Ridge National Lab.) on diffraction studies (LEED and time-resolved X-ray using the Cornell CHESS facility) of Si surfaces in high vacuum during or after high-energy nanosecond laser pulsing. LEED examination revealed that ultrarapid epitaxial regrowth into the molten overlay on the (111) surface produced the ideal, but metastable, |x| configuration that would result from the simple termination of (111) planes at the free surface. The interlayer spacing at this surface was contracted, consistent with a bond length contraction of 0.06 Å. Annealing led to reconstruction of the surface to the equilibrium, but configurationally more complex, surface structure. Information on the temperature and thermal gradients during laser pulsing was deduced from the time-resolved X-ray diffraction studies. This information indicated that, contrary to van Vechten's model, thermal equilibration of the electron and hole plasma produced by irradiation with Si ions occurs within several nanaseconds or less. Further evidence for such short equilibration times were the findings reported by Stritzker of Jülich that the rate of evaporation of Si from laser-irradiated surfaces was of the order of the rate calculated on the basis of the thermal equilibration hypothesis.

There were a number of reports on the amorphization of metals by ion implantation or ion beam mixing. It appeared that, in general, amorphization occurs only when the compositions approach those of alloys known to form amorphous phases in rapid melt quenching. Some of the most interesting experiments in this area were reported by H. Bernas of Orsay. Transmission microscopy indicated that during implantation (e.g., of metalloid in a transition metal) distinct amorphous domains seem to appear and enlarge while grain boundaries gradually "wash out." Also, he reported that an amorphous $Pd_{.8}Si_{.2}$ alloy formed by implanting Si in Pd is made superconducting by subsequent H implantation. However, the earler state was fully restored by annealing in the range 100 to 200°C.

In summary, many of the speakers at the 3-day meeting presented information about techniques that are already proving valuable in a number of applications. A number of the new procedures, for example, ion implantation and ion-beam mixing, would seem to be worthy of special attention because of the efficiencies and economies they are capable of providing in further developments.

David Turnbull

Harvard University

SOME R&D ACTIVITIES AT BRITISH ALUMINIUM COMPANY LTD.

The British Aluminium Company Ltd. (BACO) is one of the largest producers of aluminum and aluminum products in the world. Until 1979 Reynolds Metals owned 48% of the company, but at that time Reynolds divested itself of the holdings and the concern is now wholly British owned. The company employs about 11,000, and it has primary metals plants in Scotland and a number of fabrication plants scattered throughout the UK for producing sheet metal, extrusions, tubing, wire, and other product forms. In addition, it is a supplier of alumina to refractory producers and chemical companies and of superplastic alloys for a wide range of applications.

The research activities of BACO are undertaken at its Chalfont Technological Centre about 20 miles northwest of London in the small town of Gerrards Cross. On the site are the company's Research Division, the headquarters of the Chemicals Division, and the Applications Division. This last-named division would be more commonly known in the US as a product-development division and the many aluminum greenhouses of varied design scattered about the property are indicative of the character of its activities. Recently the center's divisions

have been put under one technical director, Dr. J.W. Case.

In the Research Division, the Metallurgy Department is headed by Dr. R. Grimes. The department's activities are in four areas: liquid metal and casting research, mechanical metallurgy research, electrochemistry research, and a customer-service activity that deals with the everyday problems of aluminum users, such as mechanical testing services, welding advice, and corrosion-test services. The host for my visit was Dr. Colin Baker, who is group technical coordinator for metallurgy. Baker, a PhD from Cambridge, spent 9 years in the US in the 1960s, first as an assistant professor at Case-Western Reserve University and then as a researcher at the Reynolds Aluminum Research Laboratory in Richmond, Virginia.

Metallurgy R&D projects cover a broad range. Typical of fabrication and processing research are programs on precipitation control in 6063 alloy in order to allow easier extrusion while maintaining good surface finish and good final strength properties, research aimed at producing 2024 alloy with higher than specified mechanical properties, and investigation of the effect of processing on surface quality. The motivation for the last-named program stems from the fact that higher zinc contents are found in alumina currently being used in primary processing, and this leads to significant undesirable variations and blemishes in the surface appearance of aluminum products that are etched, anodized, or bright finished.

There is currently little activity relating to rapidly solidified Al alloys due to lack of funding, although some research has been carried out on splat-cooled Al-Fe and Al-Cr systems with various alloying additions. In addition, the metallurgy department is presently developing modifications to a commercial atomization facility to achieve higher velocity atomization and finer powders. The use of powder metallurgy is seen as a potential route for the fabrication of alloys with higher use temperatures than are possible with current alloys.

Research in superplastic Al alloys has been an area of interest for several years. Alloy development at BACO has been coupled with research on the forming process at the Tube Investments Ltd. research laboratories at Hinxton Hall. The outcome of the collaboration is a company called Superform Metals Ltd. The alloy developed by BACO has the US designation 2004 and carries the trademark SUPRAL. It is an Al-6Cu-0.35Zr alloy that can be deformed to 1,000% reduction in area at 450°C and at low flow stresses. Superform makes a wide variety of products with the alloy for nonstructural applications. A few years ago BACO developed another superplastic alloy, under a UK Ministry of Defence (MOD) contract, that was a higher strength variation of the Al-6Cu-0.35Zr alloy. Nothing came of the development, however, but the company continued the effort on its own and now can produce the alloy in production quantities. It must be heat treated to achieve its ultimate strength properties, which are similar to those of 2024. Present research in superplastic alloys is concerned with the study of grain boundary cavitation during forming of the higher strength alloy and investigation into the superplasticity of 7475 using thermomechanically treated alloy as the starting material. Baker noted that several US companies are pursuing similar research on 7475.

Perhaps the most interesting research in the Metallurgy Department deals with liquid metals and castings, and the laboratory is uniquely equipped to carry out such studies. Unlike conventional research laboratories, it has a major foundry on site for alloy casting R&D. It has three casting pits of 4, 6, and 10 ft. depths; the 10-ft. pit is capable of accommodating a 2-1/2 ton ingot. To feed its continuous casting machines, there are melting furnaces with capacities of 180 lbs, 1/2 ton, 1 ton, and 7 tons. With facilities such as these, casting research can be carried out on a scale close to that of an actual production foundry. Thus, research findings can be applied readily to production situations without the necessity of additional costly scale-up programs. In fact, in addition to the research programs, the foundry is a supplier of small quantities (100 tons or less) of specialty production alloys for outside customers. In this capacity it has supplied alloys such as 2021 (a Cu-Cd-V-Sn alloy replacement for 2219 that does not require the stretching step required by 2219 to obtain optimum properties) to a major US aerospace company; Al-B, Al-Sm, Al-Gd alloys for reactor uses; and Boral plate (a mechanical mixture of boron carbide powder with molten aluminum) for shielding spent fuel elements during transfer operations. Baker said that the center would like very much to continue in the role of specialty alloy supplier.

For the past several years, research on casting and fabrication of alloys based on Al-Li has been carried out at BACO. The interest in these alloys is based on their high strength-to-weight ratio and their high modulus, which

is of the order of 80 GPa. Al-Li alloys are not new, of course; years ago 2020 alloy, an Al-Cu alloy with additions of Li to increase strength, was used on the Vigilante aircraft. But the Li content of that all y was not high enough to produce any drastic increases in modulus or reductions in density. The current interest in higher Li alloys was stimulated by Russian work about 10 years ago on the Al-Mg-Li system, which pointed out the potential of the alloy system for aerospace applications.

BACO research on Al-Li alloys began as a subcontract to an MOD contract. The research has focused on treatment of the liquid alloy to prevent oxidation of Li, to produce lower hydrogen contents, and to minimize mold-ingot interaction in order to produce high-quality surfaces. Although MOD funding ended last year, BACO has continued its research and is currently capable of producing 140-lb ingots for rolling into 12-in.-wide sheet and 9-in.-diameter extrusion billets of Al-4Li and Al-2.2 Li-4Mg. Through a combination of proprietary fluxing and degassing techniques, BACO has been able to lower the hydrogen content to about 0.3cc H/100 g of metal, a content significantly lower than the H content of alloys recently studied in the US (about 2.2cc H/100 g of metal). Lowering the H content results in better ductility and fracture toughness values than those determined in earlier US research on this alloy system.

Currently, BACO is negotiating with US aerospace companies to produce alloys with a range of Li contents for evaluation purposes. These include the quaternary alloy Al-2-3Li-2Cu-1Mg. In addition, it has a UK Department of Industry contract to scale up from 140 to about 1,000-lb ingot size. For this work, the company will be experimenting with an alloy of the Al-Mg-Li-Cu system that has been developed at the Royal Aircraft Establishment at Farnborough. Baker said that the goal was to produce 8-ft x 4-ft sheets and 16-in. diameter extrusion billets by the end of 1982.

It will be interesting to follow the technological development of these alloys. At this writing, at least, it appears that they may play an important role in future aerospace applications.

Philip A. Clarkin

ONR London

STRESS CORROSION AT ALCAN INTERNATIONAL LTD., BANBURY, ENGLAND

The Banbury laboratory of Alcan International Ltd. is one of the company's five regional research centers throughout the world. It employs 220 people, of whom 65 are professionals, 65 are technicians, and the remainder are support staff. Presently, the company is reorganizing the functions of its regional centers, and when the reorganization is completed, the Banbury laboratory will assume a company-wide "flagship" role in materials research. At the same time, the laboratory is awaiting the arrival of its newly appointed director, Dr. J. Edington, currently a professor at the University of Delaware.

In the new organization there are three program managers: T. Thomas (Materials), M. Budd (Fabrication), and R. Wilson (Energy). The program managers are responsible for carrying out short-term projects sponsored either by the various operating components of the company (J projects) or by headquarters (G projects). The latter projects would typically be of interest to a broad group of operating components. Technical assistance programs are under the cognizance of the chief applications engineer, R. Woodward, and long-term basic programs (B projects) are handled by the chief scientific officer, A. Harding. Basic programs are proposed by the research center but are selected and supported by the company headquarters in Montreal.

Under the new scheme, basic programs on surface reactions will be handled by Dr. G. Scamans. Scamans, a very active researcher on stress corrosion of aluminum alloys, described for me his recent activities and outlined his plans in this area.

As is well known, there has been a decided shift, during the past decade, away from the earlier dissolution models proposed for stress-corrosion fracture in aluminum alloys and toward a hydrogen-induced fracture model. The shift is the result of mounting experimental evidence for the hydrogen-induced fracture model: reversibility effects, pre-exposure effects, and microscopic observation of hydrogen discharge from grain boundaries. If the hydrogen-induced failure mechanism is correct, there is a good possibility that the fracture process itself must take place by a series of discontinuous steps. For the past few years, Scamans, using a fractographic approach, has been seeking evidence for discontinuous fracture in a series of commercial aluminum alloys.

Two years ago Scamans showed that the characteristic intergranular fracture surfaces

of several stress-corroded 7000 series alloys were striated, a good indication of discontinuous crack growth (*Scripta Met.*, 1979, Vol.13:245-50). Since that time, he has conducted a number of careful experiments involving matching of opposing fracture faces to demonstrate that the striations observed were indeed crack-arrest markings rather than artifacts and to determine the factors that affect the discontinuous fracture process (*Met. Trans*, 1980, Vol. 11A:846-50; Proc. 7th Int. Light Metals Congress, Leoben, Austria 1981 [in press]). The research has led to the finding that the striation morphology is generally unaffected by factors well known to alter macroscopic crack-growth rates: applied stress, quench rate, and state of aging. As a result, Scamans concludes that these factors must control the time interval between crack jumps rather than the crack jump process itself.

Based on his observations, the sequence of events in the fracture model Scamans proposes are corrosion of the stressed grain boundary to produce atomic hydrogen, hydrogen diffusion into the grain boundary area, and brittle decohesion of the hydrogen-rich boundary. Crack arrest, he feels, occurs when the advancing crack front runs beyond the hydrogen-rich region into sound material. At this point, the cycle is repeated.

The striations observed were identified as the corrosion product, boehmite, formed by the reaction that initiates the cracking cycle. He proposes that Mg segregation at the grain boundary during heat treatment causes the boundary to be more active than the surrounding regions and is the reason corrosion starts there. To reinforce his argument, he points out that he and other investigators, notably researchers at Martin Marietta Laboratories in the US, have shown Mg grain boundary segregation in a number of alloys in the stress-corrosion susceptible condition. He finds nothing in the fracture surface morphology to support a dissolution model and little to support shear fracture based on hydrogen-enhanced dislocation movement, a model favored by some investigators.

Scamans' present research is aimed at gathering more evidence to support his model. One aspect of the research is to correlate hydrogen permeation rates with the susceptibility of an alloy for stress-corrosion failure. In the past, he conducted permeation experiments in a simple non-electrochemical cell that indicated that he could react one side of a thin (0.5 mm) aluminum alloy foil with water vapor and collect hydrogen permeating through from the other side. The experiments were criticized at the time on the grounds that they could not be duplicated by others and because the permeation rates seemed to be too high. Several critics felt that the hydrogen was not diffusing through the foil but was physically passing through via a pitting reaction. Although he has modified his experimental procedure somewhat, Scamans still feels that his original observations were valid. His modified procedure consists of using a cylindrical specimen that has been partially hollowed out from one end. The central cavity is sealed, and gas in it can be sampled from time to time by means of a syringe. The gas is analyzed with a gas chromatograph. For test purposes, the cylinders are placed in the chosen environment, water or water vapor, to react the outer surface, and any hydrogen that permeates is collected from the inner cavity. Using this technique, Scamans and his coworker, Dr. N.J.H. Holroyd, a recent PhD graduate from the University of Newcastle upon Tyne, have shown that the stress-corrosion susceptible alloy 7079 shows hydrogen permeation in as little as 6 hours. Both Scamans and Holroyd feel that the test is valid and that someday it may be widely used as a simple, inexpensive test to rank the degree of stress corrosion susceptibility of aluminum alloys.

Other research Scamans is planning is to determine how some of the well-known techniques that reduce stress-corrosion susceptibility, such as overaging, can be reconciled with the fracture model he proposes, or how the decreased susceptibility of certain alloys can be explained. He feels that, in these cases, the answers will probably lie in how the grain boundaries in the alloys are modified so as to prevent hydrogen buildup in those boundaries. He suggests that boundary modifications, compositional (e.g., composition of grain boundary precipitates) or structural (e.g., dislocation structure of the boundary), may result in lowered hydrogen diffusion rates, changes in trapping or discharge reactions, or reduction in segregation of elements such as Mg with a subsequent lowering of the chemical activity of the boundary. He points out that for hydrogen discharge reactions, for example, earlier work showed that discharge reactions differ on different types of grain boundaries. In that work, electron microscopy of hydrogen bubbles emanating from boundaries showed that while some boundaries of an alloy were very active, others did not discharge hydrogen at all. Why this was the case was not determined at

the time. Scamans hopes to be able to produce a variety of different types of boundaries by small alloying additions and by selective heat treatments in order to study this problem.

Certainly the research at Banbury is adding to our understanding of the complex phenomenon of stress corrosion of aluminum alloys. It appears that the new role of the laboratory can only increase the ability of its researchers to contribute further to this understanding.

Philip A. Clarkin

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UMIST CONFERENCE ON ION IMPLANTATION

The conference (23-26 June 1981) was the third of a series held at three-year intervals at the University of Manchester Institute of Science and Technology (UMIST) beginning in 1975. The first two concentrated on the application of ion implantation and ion beam analysis in corrosion, but since the meeting in 1978 there has been considerable development and broadening of the research areas devoted to the use of ion implantation. The 1981 meeting was therefore widened in scope to cover a greater variety of topics.

It was clear from the papers presented that the research areas currently attracting the most effort are aqueous corrosion and electrochemistry, mechanical properties, and high temperature oxidation.

In the field of aqueous corrosion, the ability of a given implant species to modify the electrochemical behavior is now being more clearly related to the influence that an implanted species has on the electrochemical reactions involved. Of major importance in aqueous corrosion, for example, is the ability of the implanted species to stimulate or impede the hydrogen and oxygen redox reactions. The most important electrocatalytical reactions in fuel cells, for example, are oxygen reduction and hydrogen oxidation, and implantation can lead to catalytic activity comparable to that of commercially available catalysts. Hydrogen embrittlement and stress corrosion cracking are often caused by the absorption of hydrogen created electrochemically, and ion implantation seems to provide a means of controlling the entry of hydrogen and its migration in metals.

Several papers showed that work in the field of high temperature oxidation continues to expand. Although high temperature oxidation usually produces an oxide scale thicker than the original implanted material, it is clear that the thin ion-implanted alloy layer has a considerable effect on oxidation. Long-lasting, significant effects can be found on oxidation kinetics and in the morphology of oxide scales. Significant reductions in oxidation rate at high temperature ($\sim$ 1000°C) and following long exposure periods have been reported.

Ion implantation is beginning to play a role as a technique for understanding oxidation mechanisms. Some topics that should receive further attention, as a result of papers presented at the conference, include the effect of ion implantation damage on oxidation, diffusion of implanted species in oxide scales, segregation of implants in oxide scales, and the relationship to normal oxidation kinetics and scale morphology.

A number of the mechanical properties of metals can be modified by ion implantation, and the present commercial interest arises from the possible industrial use of the technique. Hardness, fatigue, erosion, and wear behavior can all be modified, frequently to a high degree in ferrous alloys, usually by high-dose ion implantation of interstitial species such as nitrogen or carbon. The mechanisms responsible for such property modifications are still unclear, but the magnitude of the effects and their persistence are indicative of the production of fine, high-volume metastable precipitates that greatly influence near-surface dislocations. A number of studies are now concentrating on the characterization of the implantation-induced phases. The interrelation of wear and oxidation in ion-implanted metals is also currently attracting attention, again because of the importance of ion-implanted species in influencing dislocation behavior.

It is clear that ion implantation is still being used as a relatively simple materials fabrication technique capable of producing small quantities of novel and interesting alloys. Sometimes a dramatic new material will be found. Increasingly, however, efforts are now directed towards understanding the physical state of the materials produced by implantation and the correlation between physical state and the measured property change. Implantation is also being used for examining previously proposed mechanisms of corrosion, wear, and fatigue, in order to establish the validity of different mechanisms.

Ion implantation originated as a technique for doping semiconductors and is now routine in that industry. Research in semiconductor devices involving ion implantation no longer attracts particular attention by its novelty. One can speculate that such fields as corrosion, wear, and oxidation

will, in the near future, absorb ion implantation as a routine technique. One can further speculate that a conference devoted to all these topics and together under the combining influence of ion implantation would no longer be possible. Instead, separate meetings devoted to each discipline would be held, and these would include ion implantation as an essential, innovative, and powerful technique.

W.A. Grant

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OCEAN SCIENCES

FRAM ICE FLOE STATIONS

The last of a series of FRAM ice floe stations will be established in the spring of 1982. That year will also mark the centennial of the First International Polar Year in 1882-1883, during which the first concerted multinational and multidisciplinary scientific efforts were undertaken at the initiative of K. Weyprecht, an Austrian Arctic explorer. Scientific stations were occupied on Ellesmere and Baffin islands, Canada; and also in Greenland, Spitsbergen, northern Norway, the Kara Sea, and at the mouth of the Yenesei River in the USSR.

The FRAM-4 scientific program covers a multitude of experiments during which new avenues of research, to be based on earlier experiences, and innovative geophysical techniques will be applied for the first time. Deployment is planned at about 80°30'N, 25°E in the Eurasian Basin.

As in previous experiments in the FRAM series, FRAM-4 will be a US ice station with open participation. Norway will have a major role in the scientific program. Dr. Yngve Kristoferrsen of the Norwegian Polar Institute will be the senior Norwegian and leading scientist for the Norwegian program, which will include personnel and assets from the University of Oslo, NTNF/NORSAR (Norwegian Seismic Array) and the Norwegian Polar Institute.

The major objectives are to investigate methods of seismic multichannel and bathymetric data acquisition in a permanently ice covered ocean and to contribute towards an understanding of the geological history of the continental margin north of Svalbard. Specifically, it is planned to implement and evaluate the use of a long multichannel telemetered seismic array (1 to 2 km) of modified sonobuoys for acquisition of seismic data in the Arctic Ocean. Additionally, an integrated geophysical data set (bathymetry, aeromagnetics, gravity, and seismic reflection and refraction) will be collected to provide information about the following topics: (1) the depositional and subsidence history of the continental margin northeast of Svalbard; (2) the geophysical and geological characteristics of the transition between oceanic and continental crust along this margin; (3) the morphological characteristic of the margin northeast of Svalbard from abyssal depths to the shelf; (4) the tectonic relation between the volcanic construction of the Yermak Plateau and the adjacent oceanic crust; and (5) the scale of lateral heterogeneities in the oceanic crustal velocity structure.

In addition to the Norwegian geophysical research, a team of scientists from Massachusetts Institute of Technology (MIT), Woods Hole Oceanographic Institution, (WHOI), Lamont-Doherty Geological Observatory, Naval Research Laboratory (NRL), and Naval Underwater System Center (NUSC) will cooperate and collaborate with the Norwegian Defense Research Establishment, Horten, to carry out an active acoustic research program.

The acoustic research will primarily be in the low-frequency domain. The low-frequency propagation experiments will be coordinated closely with investigations by the geophysicists and oceanographers from Lamont-Doherty. Experiments on acoustic fluctuations in the Arctic offer an opportunity to isolate and investigate oceanographic-acoustic phenomena that are not separable in experiments in other oceans.

The major objectives will be to investigate and to determine the acoustic characteristics of the Eurasian Basin. This includes backscatter of bathymetric features as well as ice, the directional and spatial characteristics of ambient noise, and the coherence and fluctuation of acoustic signals as related to the physical environment of the eastern Arctic.

Other programs will include: (1) Biology. If feasible, up to three polar bears will be outfitted with satellite collars to determine their movements. (2) Physical Oceanography. Lamont-Doherty Geological Observatory will take daily ODEC casts to determine the characteristics of the water column. Current meters will be suspended to monitor ocean currents. Two helicopter supported lines of stations will be occupied between FRAM IV and a small satellite camp. A limited number of tritium samples will be taken to continue

to monitor tritium decay rates. (3) Meteorology. A meteorologic station will be maintained at FRAM IV. Weather data will be transmitted on a daily schedule to Station Nord, a small Danish military base in northeastern Greenland for real-time additions to the World Meteorological Organization (WMO) network.

Nord is used as the logistic base for support of the FRAM series. The Danish Defense Command allows use of its landing strip and building by the logistic team and pass-through scientists. Without this assistance from the Danish authorities, it would not be possible to support the ONR eastern Arctic research stations.

Leonard Johnson

ONR Arlington, VA

MARINE SCIENCE AT THE UNIVERSITY OF DURHAM, ENGLAND

Prof. M.H.P. Bott (head of the Dept. of Geology at the Univ. of Durham) is a marine geophysicist. His principal interests are in geophysical studies of the earth's crust, the upper mantle beneath oceanic regions and continental margins, the development of new marine seismic instrumentation, and new geophysical interpretation techniques.

Bott and his assistants use NERC (Natural Environmental Research) ships from the NERC facility in Barry (Cardiff, Wales) for their research at sea, and most of their instruments are rented from the NERC equipment pool at Barry, a system that appears to work well for small marine science research groups in Great Britain. Bott's group takes part in major deep-sea geophysical cruises with little capital invested in expensive equipment, and they are not required to have a critical mass of technicians and engineers to repair and operate the equipment.

Recently the group carried out extensive seismic surveys of the Lesser Antilles Island Arc (Guadeloupe to Granada) in the eastern Caribbean, the continental shelf west of Scotland, the Iceland Faroe Ridge, and the continental margin southeast of Greenland. They have also made a seismic survey on a line between Barra in the outer Hebrides northwest of Scotland and Ayrshire on the southwest coast of Scotland. Closely spaced shots were made with a 1000-cu.-in. air gun. A novel aspect of the experiment was the use of a large air gun as a source of sound in a sea-to-land experiment in a continental area.

In the summer of 1981 Bott took part in a major three-ship, three-country (England, Germany, and the United States) seismic survey northwest of Scotland and Northern Ireland in the region of the Rockall continental margin. In 1982 he plans to make a crustal study of the crust across England with a large number of explosive and air-gun shots at sea and a large array of recorders on land.

Bott has five graduate students carrying out research for their PhD degrees and two students working toward the MS degree in geophysics and engineering geology.

Dr. G. Westbrook is also a marine geophysicist who has concentrated his research on the Caribbean area. His main interest is in the structure of deformed sediments on the sea floor. He uses the multi-channel side-scan sonar GLORIA, which gives a picture of the sea floor, on joint projects with scientists from the UK Institute of Oceanographic Sciences. Westbrook has studied the tectonically active area of trench margins east of Barbados.

A British directory of marine sciences lists Dr. D.J. Bellamy (Dept. of Botany) as working in marine pollution and primary production. He is scientific advisor to the 20,000-member (largest in the world) Sub-Aqua Diving Club. Several years ago Bellamy marshalled a large number of amateur divers for a mass diving search around Great Britain to assess the damage of a large oil spill on marine vegetation. BBC made a television film on the project, which was so popular that Bellamy made a second film on a marine topic. His success on TV was so great that he has now made over 270 short TV programs and does almost nothing else. He is proud that his regular TV audience outnumbers that of the very popular Muppet show. He said that his British audience was 15 million and his world wide audience 150 million. His programs are concerned with various aspects of marine science and botany. Bellamy is the author of a large, beautifully illustrated book titled *Botanic Man, A Journey Through Evolution* (Hamlyn, London, New York, Sidney, and Toronto).

Drs. B. Whitton and B.A. Potts of the Botany Dept. are interested in algal physiology. They are working on the effects of heavy metals, particularly zinc, on blue-green algae. They have taken a special interest in a totally unspoiled atoll, Aldabra, one of the Seychelles north of Madagascar. The island has been saved from the usual exploitation by man because it has little soil and is inhospitable to man. It has its original pristine flora and fauna including many land tortoises and extensive mangrove swamps with their attendant communities of other organisms.

Aldabra has many different habitats ranging from fresh to brackish to salt water.

The team has studied the photosynthetic microbial communities in these habitats and has found that the different species were neatly zoned in relation to the widely ranging pH and Eh of parts of the individual habitats.

Wayne V. Burt

Oregon State University

PHYSICS

PHYSICAL ACOUSTICS IN KENT

The University of Canterbury at Kent is on a small hill outside the ancient city of Canterbury. The relatively new university, founded in 1965, has approximately 4,000 students divided administratively and operationally into several separate colleges. The major part of the teaching staff is grouped into the faculties of Humanities, Natural Sciences, and Social Sciences and a School of Mathematics. These elements and smaller units, such as the Computer Laboratory and the Language Group, are spread throughout the colleges. In effect, each member of a faculty, school or group is associated primarily with a particular college.

Teaching is of two types: a lecture system and a tutorial system that is used principally for the guidance of students. The physics faculty, which I visited, is a subset of the natural sciences faculty and has courses leading to BS degrees in Physics, Physics with Astronomy, Physics with Computing, Physics with Electronics, and Theoretical Physics as well as advanced degrees.

Dr. D. A. Jackson has recently returned from a sabbatical leave spent at the Naval Research Laboratory (NRL) where he worked with the optical fibers group. At NRL he helped to develop fiber-optic hydrophones that use Mach-Zender interferometry of single-mode fibers. Jackson intends to use the expertise he acquired at NRL to set up a laser-doppler-shift experiment in which fiber optics will be used to launch the beam.

The changing of mechanical energy into heat in a solid is known as internal friction, an effect that results in the diminution of the amplitude of a mechanical oscillation. As a function of temperature or frequency, the losses are not constant but vary according to the type of process contributing to the internal friction. In cold-worked face-centered cubic (F.C.C.) metals, a peak in the internal friction as a function of temperature was first observed by P.G. Bordoni in 1949. Now known as the Bordoni peak, this maximum in the internal friction-temperature relation shifts with frequency and is thought to be the result of the thermally activated formation of pairs of kinks on dislocations. The peak occurs when the frequency of the applied stress is comparable to the frequency of generation of the double kinks.

Dr. D.H. Niblett and his students have measured the Bordoni peak in Cu and Ag. The experiments were performed on pure metals at both low and high frequencies. In the kHz region Niblett uses the resonant-bar method in which the resonant frequency of a longitudinally vibrating bar of high Q (10^3 to 10^5) is measured. As the temperature is varied, the Q of the vibrating system changes, giving rise to peaks in the logarithmic decrement Δ ($=Q^{-1}$). For plastically deformed Ag (99.9999%) single crystals, the peak occurs near 64°K at a resonant frequency of 17.5 kHz (*J. Phys. D: Appl. Phys.* 6 1560 [1973]). For plastically deformed Cu (99.999%) polycrystals and single crystals, the peak occurs near 80°K at a resonant frequency of 10 kHz (*J. Phys. D: Appl. Phys.* 6 809 [1973]). For both, the peak temperature is independent of the crystal orientation of the sample.

In recent work (*Proceedings of Third European Conference on Internal Friction and Ultrasonic Attenuation in Solids*, C.C. Smith Ed. Pergammon Press 1980) the internal friction of cold-worked single crystals of high purity Cu (99.999%) was measured in the temperature range from 60 to 200°K at frequencies between 12 and 22 kHz. The peak was studied as a function of the magnitude of the resolved shear stress used to deform crystals of various orientation. For [110] crystals the peak was much larger than for other orientations, an effect attributed to the type of dislocation structure produced by extension in the [110] direction.

At higher frequencies, Niblett uses standard ultrasonic techniques in which the attenuation of the ultrasonic waves is measured. Measurements of longitudinal waves at 10 and 30 MHz in pure (99.999%) Cu single crystals that were plastically deformed by compression showed that the peak had moved upwards to 130°K. The position of the peak was independent of crystal orientation, but it varied about the new value slightly as a function of resolved shear stress (See *J. Phys. F: Metal Phys.* 10 773 [1980]). The measurements also showed that conditions that favor deformation by gliding give rise to a larger Bordoni peak.

Comparison of the results with the low-frequency ones gives an activation energy for Cu of approximately 0.12 eV. Niblett finds that in general the value of the activation energy is not strongly affected by the history of the material and that fact, coupled with the insensitivity of the temperature of the peak to the concentration of point defects and the dependence of the peak on plastic deformation, leads him to believe that the Bordoni peak is an intrinsic property of dislocations.

Little data exist for internal friction in hexagonal metals. Niblett and a student are beginning work on Zn but are experiencing difficulties with slip and glide in carrying out the deformations.

Low-temperature measurements of second sound (temperature oscillations) in ^{4}He crystals are being conducted by Dr. J. Rogers and his students. The crystal slabs, varying in thickness from 0.25 to 1.0 mm, were grown at constant pressure in the 25 to 100-atm range. Thin films of InSn deposited on the faces of a LiF single crystal and a glass plate also in the pressure chamber served as bolometer detectors or heaters as required. In many of the experiments, several second-sound echoes were observed. The damping varied from one crystal to another but almost always could be diminished by annealing the crystal at a temperature within a few mK° of the melting curve. Rogers finds that he can produce a sequence of different crystal densities without destroying the sample, i.e., he can release the pressure without damaging the crystal excessively as evidenced by the continued propagation of second sound. The ballistic regime has not been reached in the experiments using a ^{3}He cryostat; consequently Rogers intends to do this experiment again using a dilution refrigerator to extend the range to lower temperatures.

Rogers and Prof. J.B. Brown are collaborating in developing acoustic holography by using a starting pistol as a pseudo-delta function source and a PDP-11 minicomputer to store and process the data. In work done in air outside the physics building, the experimenters are experiencing difficulties in that the diffuse reflections they wish to measure are often overwhelmed by specular ones from nearby buildings and the earth's surface. In addition, the wind affects the sound velocity. Underground experiments can be conducted more easily, inasmuch as they are not beset by such problems. A buried pistol-type source has been developed and work is being carried out in which the Canterbury-Whitstable railway tunnel dating from 1830 is used as a target for local field use.

John R. Neighbours

ONR London

SOLID STATE PHYSICS AT THE UNIVERSITY OF KONSTANZ

Conceived as an elite university for top students, the University of Konstanz, was started on the outskirts of Konstanz, West Germany, in 1966 with the formation of the humanities departments. Science was begun in 1968 and now includes botany, biology, and biophysics departments along with the traditional ones. The university was originally designed to accommodate 3,000 students, but the population has been expanded over the years and now numbers 3,500. After having forsaken the elitist concept for a good many years, the university now is trying again to attract only the best students.

Prof. Hans Bömmel, well known to many American physicists, went to Konstanz from UCLA in 1968 as the first physics professor, and, until his retirement in 1980, he was the chairman of the Physics department. The current staff of the department numbers 65 including 6 professors and 5 associate professors.

At UCLA, Bömmel and his student, E.H. Gregory, had observed nuclear acoustic resonance (NAR) in single-crystal metallic Ta. The technique is similar to NMR except that ultrasonic waves, which can penetrate into the bulk of the metal, are used to excite the resonance. The interaction between the sound waves and the ^{181}Ta nuclei (I=7/2) is via the torque exerted on the nuclear quadrupole momen' by inhomogeneous electric fields caused by the strain associated with the sound wave. In other words the sound wave modulates the lattice, changing the cubic symmetry of the Ta sites and producing a nonuniform Zeeman splitting of the nuclear magnetic energy levels through the quadrupole interaction. Selection rules permit the acoustic excitation of $\Delta m = \pm 1$ and ± 2.

At Konstanz, Bömmel extended the work on Ta to include the effects of known amounts of hydrogen impurities (*Appl. Phys.* 9, 39 [1976]). From measurements of the $\Delta m = 2$ transition, three ranges were distinguished from the temperature dependence of the linewidth: (1) a high-temperature range in which the main contribution to linewidth is the movement of the hydrogen interstitials; (2) a low-temperature, two-phase region,

and (3) an intermediate range in which the main contributions to the linewidth are the dislocations generated by the precipitation of the second phase.

More recently (*Phys. Rev. Lett.* 45 2114 [1980]), measurements of the linewidth of samples that were hydrogenated or deuterated to higher concentrations gave values for the nearest neighbor quadrupolar interaction for each type of impurity. In both cases the value of the interaction is much larger than the Zeeman one, so that the Ta nucleus—impurity (H or D) interaction is properly defined as a group of quadrupole states with a small magnetic perturbation. The situation is thought to be unique and deserving of more theoretical attention. Bömmel plans to continue the experiments to higher temperatures and to use other metals.

Another long-term interest of Bömmel is ultrasonic attenuation in superconductors. The Bardeen-Cooper-Schrieffer (BCS) theory predicts that the ratio of α_s, the attenuation in the superconducting state, to α_n, that in the normal state, is $\alpha_s/\alpha_n = 2/[\exp(\Delta/kT) + 1]$ where $\Delta = \Delta(T)$ is the temperature-dependent energy gap. The BCS theory gives the value of the energy gap at $T = 0$ as $2\Delta(0)/kT_c = 3.53$, where T_c is the superconducting transition temperature and k is the Boltzmann constant. However, experimental results are often fitted with the zero temperature value as a parameter. At Konstanz, Bömmel has worked with several different La alloys. Early ultrasonic measurements (*Solid State Comm.* 17 241 [1975]) on unoriented pure crystals of $LaSn_3$ ($T_c = 6.628°K$) and $LaAl_2$ ($T_c = 3.273°K$) agreed with the BCS prediction, but attenuation measurements in a Gd doped $LaAl_2$ crystal showed significant deviation from the theory. Because of the low transition temperature of the doped sample ($T_c = 1.728°K$), only a small part of the superconducting region was accessible with a conventional pumped ^{4}He cryostat. Later, when the experiments were extended downward using a ^{3}He cryostat, the attenuation measurements indicated the existence of an additional term other than that resulting from the electron-phonon interaction. Further measurements at ^{3}He temperatures on an oriented [100] single crystal of pure $LaAl_2$ gave evidence of a similar behavior (*Solid State Comm.* 34 379 [1980]). At low temperatures the ultrasonic attenuation is larger than expected and exhibits a peculiar temperature dependence: below the transition temperature the normal-state attenuation rises, while the superconducting-state attenuation first falls and then rises at temperatures below 0.8°K. Another anomalous effect is the large difference that exists between the ultrasonic velocities in the normal and superconducting states. Bömmel and his colleagues believe that defect-induced two-level systems, analogous to the mechanism proposed for amorphous superconductors, are responsible for the behavior of the attenuation in $LaAl_2$. All experimental observations in this material are compatible with such a hypothesis.

An interesting, concomitant result of the above behavior is the attenuation observed in the pure and doped $LaAl_2$ crystals up to 200°K. (*Appl. Phys.* 10 81 [1976]). In both types of crystal there is only one attenuation peak, occurring near 45°K. The peak is thought to be of the Bordoni type and is so narrow that it can be described by the original Seeger model with only one activation energy and one attempt frequency.

Recoilless resonance absorption of gamma rays (the Mössbauer effect) is a tool often used to investigate the internal magnetic fields of solids. As in x-ray or neutron diffraction, the intensity of the line decreases with increasing temperature; this is a result of the increased random thermal motion of the atoms and is taken account of quantitatively in the Debye-Waller factor. In Mössbauer measurements on iron microcrystals (70 to 450 Å), Bömmel and G. von Eynatten found a much stronger temperature dependence of the Debye-Waller factor than that observed for the bulk material (*Appl. Phys.* 14 415 [1977]). The authors attributed the results either to oscillations of chains of the microcrystals or to softening of their surfaces. Von Eynatten has been at Stanford University where he collaborated with S.S. Hanna in making Mössbauer measurements on $YbBe_{13}$. The results of the work, which show strong evidence for valency fluctuation of Yb, are being readied for publication. At Konstanz, von Eynatten is preparing another Mössbauer experiment on Fe microcrystals in which a high magnetic field (14T) will be used to stiffen or lock the elementary magnets and thereby influence the Debye-Waller factor.

E. Bucher went to Konstanz as a professor in 1974; prior to that he had been with Bell Telephone Laboratories, where he had worked on low-temperature materials and metal-insulator transitions. At Konstanz, his research is related exclusively to solar cells: new materials, principally compounds, new barrier metals for amorphous Si cells, and device testing. A 1978 publication by Bucher (*Appl. Phys.* 17 1 [1978]) is a tabulation and

critical review of data to that date. More recently, he has written about the nonconventional cells developed using Be, Hf, Sc, Y, and Cr (*Fourteenth IEEE Photovoltaic Specialists Conference*, p 1360 [1980]) Bucher believes that in the future either amorphous or polycrystalline Si will become the dominant material, and he is pursuing this line of research.

John R. Neighbours

ONR London

NEWS AND NOTES

MAKING SURE THEY PICK WINNERS

Whether it is true or not, there is a common perception in Britain that the country lacks the ability to translate promising research findings into industrial successes. One hears the recurring lament of missed opportunities—penicillin and the jet engine are often cited as outstanding examples—and many reasons are offered to explain this failure. But technology transfer is a complex process and few scientific data are available to point out critical factors and how they must "mesh" for the transfer to be successful. By the same token, what causes the process to break down is also not readily apparent.

To provide hard data and conclusions related to technology transfer, a new think tank, the Technical Change Center (TCC), has recently been established in London with grants of £1.05M from the Science and Engineering Research Council and the Social Science Research Council and £2.5M from the Leverhulme trust.

The job of the TCC officially is "to conduct research on the choice, management, and acceptability of technical change relevant to the national economy." The center's director is Sir Bruce Williams and its deputy director is Dr. James Kennedy. A professional staff of up to 20 in-house researchers, together with several outside consultants from industry and academe, will carry out its programs.

Williams, who made his name as a social scientist studying the economics of industrial innovation as a Manchester University professor in the 1950s and 60's, was formerly vice-chancellor of Sydney University, Australia. Prior to that he was economic advisor to the Ministry of Technology (UK). Kennedy has more direct experience in industry, having been director of research for Delta Metals Company for the past three years. Above them is a board consisting of representatives from the research councils, industry, and government.

The activities of the TCC fall into four broad themes. One will be a series of technical studies into the introduction of new technology. The emphasis will be on Britain's older manufacturing industries that are now in decline, such as steel.

The second theme is the effect of technical change on employment. The TCC will study the balance between the jobs created and lost by new technology.

Third, TCC will assess the extent to which the British educational system is responsible for the country's technological failings.

The fourth theme will be the role of government and national policies in technical change. One project in this area, which may produce controversial conclusions, will investigate the aftermath of the reorganization of government-sponsored research following Lord Rothschild's report of 10 years ago.

In addition to its self-generated research program, the TCC aims to pick up projects commissioned and paid for by outsiders. Government departments are the most likely early sponsors, but Williams hopes that industrial companies will bring the center work after it has been operating successfully for a while.

There are two important conditions attached to sponsored research. The project must be of interest outside the commissioning organization, and the results must be published in full. So TCC will not act as a private consulting agency in the way that university research units can.

Obviously, the success of the center will depend on the sympathetic cooperation of a significant number of companies. The center's staff will need access to the more sordid details of technological innovation, including mistakes that firms would rather forget—otherwise TCC will be just another pointless prod at the raw nerve of Britain's industrial decline.

ULTRASONIC IMAGING AT IBM - TECHNION

At the Technion IBM Research Center in Israel, Dr. Israel Berger and Dr. Dov Ram are engaged in a project to develop an ultrasonic imaging system for medical application. Their system uses backscatter information generated by American-made focused transducers, with center frequency at 2.25 or 3.5 Mhz. The arrangement produces a

focused signal at 8 to 12 cm. Because the beam is focused, travel time is equivalent to normal range. Therefore, imaging does not require inversion, but display capability, in order to produce the geometry of the operating system on a screen. The system soon will be moved to a hospital.

Ram and a graduate student are carrying out direct modeling studies of the propagation from the transducers. Their method is a variant on the Born approximation, in which the elementary operator has variable coefficients and the geometrical acoustics transmitted field is used as the unperturbed field. The results look very encouraging.

Another part of the project is directed to trying all sorts of statistical formulas on "known" data sets. The objective is to determine empirically those relations, e.g., correlations or power spectra over a window of pixels, that distinguish healthy from diseased tissue.

Norman Bleistein

University of Denver

NEW UK BIOTECHNOLOGY DIRECTORATE

The UK Science and Engineering Research Council (SERC) is setting up a new biotechnology directorate in cooperation with the Department of Industry. Dr. Duncan Davies is the chief scientist of the new directorate, which will promote research and training in all areas related to biotechnology.

SERC at present spends £10 million ($20 million) a year on biotechnology, defined as "the application of biological organisms, systems, or processes to manufacturing and service industries." Dr. Geoffery Potter, head of the new directorate, expects to spend £2.25 million by 1983-84.

The major function of the directorate is to develop collaborative biotechnology projects in the public and private sectors—at universities or in industry.

AGARD SYMPOSIUM IN FLUID DYNAMICS WITH APPLICATIONS TO VSTOL

The AGARD symposium with the above title was held in Lisbon, Portugal, from 2 to 5 November 1981. Conference Proceedings and a Technical Evaluation Report will be available about 6 months from the date of the symposium. Readers who wish to obtain copies of the papers can do so by writing to the following address: NASA, ATTN: Report Distribution and Storage Unit, Lagley Field, VA 23365.

David S. Siegel

ONR Arlington, VA

ONRL STAFF CHANGES

Last month we said farewll to Mr. Theodore C. Cheston, who had been a liaison scientist at ONR London since October 1979. Mr. Cheston has accepted a position at the Naval Research Laboratory in Washington, DC.

EUROPEAN VISITORS TO THE US SUPPORTED BY ONR LONDON

Visitor	Affiliation	Navy Lab./Org. to be Visited
Lt. Yehuda Agnon	Headquarters, Israeli Navy, Tel Aviv, Israel	COMNAVOCEANCOM, NAVOCEANO, NORDA, ONR NRL, CNO (October - November 1981)
Dr. J.A. Johnson	School of Mathematics & Physics Univ. of East Anglia, Norwich, UK	NPGS, Monterey (12-17 December 1981) Oregon State Univ. (18-22 December 1981)
Dr. G.P. de Loor	Physics Laboratory TNO The Hague, Netherlands	NRL (16-19 November 1981) NASA, Goddard Space Flight Center (20 November 1981)
Dr. G. Parilla	Instituto Español de Oceanografia, Madrid, Spain	ONR (8-13 November 1981) NORDA (15-20 November 1981)
Dr. E. Pelletier	Ecole Nationale Supérieure de Physique Université de Saint Jérôme	NWC China Lake (9-10 November 1981)
Prof. P.M. Quinlan	University College, Cork, Ireland	NPGS (19-20 November 1981)
Prof. I.O. Sutherland	Dept. of Organic Chemistry, Univ. of Liverpool, UK	NRL (9 or 10 November 1981)

ONRL REPORTS

C-1-81 The Second International Conference on Antennas and Propagation, by T.C. Cheston and R. Mittra

The Second International Conference on Antennas and Propagation took place in York, England in April 1981. This report reviews some of the antenna papers.

C-6-81 4th International Topical Conference on High-Power Electron and Ion-Beam Research and Technology, J.R. Neighbours

The Fourth International Topical Conference on High-Power Electron and Ion-Beam Research and Technology was held in Palaiseau, France on 29 June - 3 July 1981. The program included electron and ion beam generators, beam transport plasma heating and free electron lasers. This report is principally about foreign research results. It also contains a list of speakers and the topics discussed.

C-10-81 Seventh Annual Congress of the European Undersea Biomedical Society and Symposium on Decompression, by Robert Goad

The Seventh Annual Congress of the European Undersea Biomedical Society and a Symposium on Decompression Sickness (the latter sponsored by the North Sea Medical Center, Great Yarmouth, England) was held at Churchill College in Cambridge, England on July 21-24, 1981. Approximately 50 presentations covered a wide

variety of topics, with an emphasis on neurological decompression sickness. There was also a session on the medical aspects of amateur diving, and the program included a visit to the British Antarctic Survey for those interested. This report contains a brief summary of each paper.

C-11-81 Ninth International Conference on Sarcoidosis, by John C. Rose

In this report on the most recent international conference on sarcoidosis, the author discusses the current status of sarcoidosis research and the latest developments in clinical treatment as they were related at the conference. He also refers to the differing opinions that were presented about diagnosis and treatment of the disease, as well as recommendations that were made as to future areas of study.