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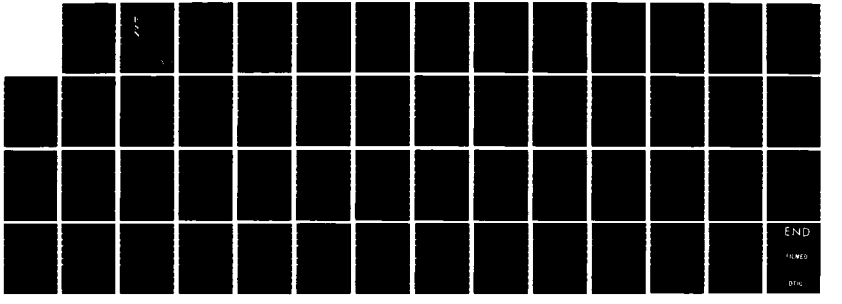

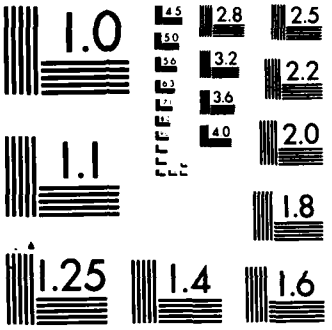

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October 1985
Volume 39
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Behavioral Sciences

The first and founding conference of the European Association for Research on Learning and Instruction (EARLI) was held at the University of Leuven, Belgium, from 10 through 13 June. This article concentrates on highlights that suggest intersections between three of the six themes of the conference: problem solving, cognition-motivation interaction, and individual differences.

Chemistry

Four conferences on electrochemistry were held in Europe and the Middle East during May and June. Fundamental Aspects of Applied Electrochemistry was held in Israel last May; this article discusses presentations on electrodeposition and energy conversion (electrodes, fuel cells, and batteries). The article briefly reviews three other meetings: Organic Electrochemistry, Two-Dimensional Surface Phenomena in Electrochemical Systems, and Journées d'Électrochimie '85.

Computer Sciences

France's Institut National de Recherche en Informatique et en Automatique has developed an impressive general-purpose modular finite element program package. US researchers and practitioners interested in using finite element procedures will find this package very important in solving various engineering problems from heat conduction, to static and dynamic elasticity problems, to fluid mechanics problems.

Material Sciences

This is the first of two articles this month focusing on the activities of Austria's Metallwerk Plansee. One of the largest privately owned companies in Europe, Plansee is a world leader in research on powder metallurgy.

NAVSO P-3624

The 11th International Plansee Seminar was held from 20 through 24 May in Reutte, Austria. This article discusses presentations on refractory metals, coating methods, and hard metals.

Ocean Sciences

The closing of the Institute for Oceanographic Sciences laboratories at Taunton has led to the complete disbandment of the sedimentation group (SG) there. This article reviews the SG's work in areas such as cohesive and noncohesive sediments and shelf sediment dynamics.

Physics

The Third International Fibre Optics conference was held in London from 29 April through 2 May. This article focuses on presentations dealing with telecommunications, local area networks, and fiber optic sensors.

New trends in integrated optics research and in fiber optics applications are vigorously pursued at the University College of London. Some highlights reviewed in this article are: innovative hybrid electro-optical logic devices, digital optic subsystems with great complexity and very short time action, fiber optic delay lines for signal processing, and a new theory of distributed optical fiber sensors.

An 800 MeV, 500 mA synchrotron light source positron storage ring is being constructed at Orsay. It is custom designed to serve as a high frequency light source, will contain six undulators, and will be specifically geared to act as an efficient vacuum ultraviolet free electron laser.

News and Notes

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ESN publishes selected letters related to developments and policy in science and technology in Europe and the Middle East or to interactions between the US and Europe and the Middle East in science and technology.

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Behavioral Sciences

THE EUROPEAN ASSOCIATION FOR RESEARCH ON LEARNING AND INSTRUCTION

by Richard E. Snow. Dr. Snow was until September the Liaison Scientist for Psychology in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is Professor of Education and Psychology at Stanford University.

The first and founding conference of the European Association for Research on Learning and Instruction (EARLI) was held at the University of Leuven, Belgium, from 10 through 13 June. The conference was supported principally by funds from the Belgian and Dutch governments and the US Office of Naval Research, London. There were approximately 140 participants representing 13 countries: Austria, Belgium, France, Germany (FRG), Greece, Italy, The Netherlands, Norway, Spain, Sweden, Switzerland, and the UK; several invited guests from the US were also present. Two expected participants from Poland were unable to attend.

The objective of EARLI is to promote empirical and theoretical research on learning, developmental, and instructional processes in, or relevant to, educational settings. Psychological, sociological, pedagogical, and other disciplinary perspectives are included so long as they aim at understanding the primary processes of concern. Activities now planned by the new association include: publication of a regular newsletter; publication of the proceedings of the first conference; a membership drive, aimed particularly at identifying interested researchers in eastern and southern Europe; organization of a second conference to be held at the University of Tübingen, West Germany, in 1987; and the development of cooperative relations with the American Educational Research Association. The chairman of the association is Professor Dr. Erik De Corte, Faculty of Psychology and Educational Research, University of Leuven, Vesaliusstraat 2, 3000 Leuven, Belgium. The Secretariat is the responsibility of Dr. Hans Lodewijks, Department of Instructional Psychology, Building S, Tilburg University, P.O. Box 90153, 5000 Le Tilburg, The Netherlands. The chairman of the 1987 EARLI Conference is Professor Dr. Heinz Mandl, German Institute for Distance-Learning, University of Tübingen, Bei der Fruchtschranne 6, 7400 Tübingen, Federal Republic of Germany.

The 1985 conference was organized around six themes, each with its own organizer-discussant, state-of-the-art lecturer, and six invited paper contributors. There were in addition three general invited addresses, two substantial poster sessions, and a panel discussion on international cooperation. The themes, papers, posters, and contributors are identified in Table 1 (pages 455-457). Although the themes were chosen to represent important streams of current activity in European research, they were not intended to be exhaustive; it is expected that the organization of future EARLI conferences will work with altered and expanded lists of topics.

The present article concentrates on a few highlights that suggest intersections between the problem-solving, cognition-motivation interaction, and individual-differences themes. The discussion relies particularly on the presentations of Elshout, Entwistle, Gustafsson, and D'Ydewalle, but mixes into the integration some of this reporter's own views. There are also references to work not explicitly represented at the conference.

The Matrix of Cognitive Psychology

The textbook view of cognitive psychology typically lays out sections pertaining to each of the basic funtions of human information processing. There are usually chapters on pattern recognition, perception and attention, learning, memory, problem solving, thinking, language comprehension and production, among others. But it is also possible to organize the subject matter of cognitive psychology according to the ecologically important cognitive activities of modern life, distinguishing reading, writing, arithmetic, problem solving in various specific domains, skillful motor performance in various everyday tasks, and discoursing in various contexts, for example. The result is a rectangular matrix with columns for the familiar basic functions and rows for the important daily activities. One can then focus on the nature and organization of cognitive functions pertaining to particular real-life activities and situations. The expansion of cognitive psychology in recent years seems increasingly to be taking this form.

Two points about this movement deserve special note, however. One is that problem solving appears as both a column and a row in the matrix; it is regarded as both one of the several basic functions and one of the several real-life

activities of importance. The implication is that problem solving, as a function, is involved in all real-life activities, and, as an activity, it in turn involves all of the basic cognitive functions. Problem solving is thus not a special domain of cognitive psychology but rather an aspect of all of its domains.

Secondly, and related to the above point, the traditional study of problem solving, as well as all other basic functions, has usually assumed that a performance model could be built to represent a modal person performing a modal task. This generalized approach has always been limited by the dual problems of task and person variation, though these problems have not usually been explicitly acknowledged. As cognitive psychological research has moved into the analysis of real-life activities, the problems of task and person variation loom especially large; they simply cannot remain ignored. The definition of problem solving expands to include the definition of intelligence. But even more is implied. There is a person-situation interaction that not only limits the generality of any particular cognitive performance model but also may introduce qualitative as well as quantitative moderating variables that reflect affective and conative, not just cognitive, process aspects of performance. So aspects of personality and motivation also come into the picture. These difficulties are now being confronted not only by Elshout and Entwistle and others at the conference, but also by researchers in other corners of the world (see, e.g., Raaheim, 1974, 1984; Raaheim and Wankowski, 1981; Rowe, 1985).

Thus, one big question now is: How do we reach a theoretical model that explicitly incorporates the implications of these two points? Another, closely related question is: How do we make this model instructionally tractable, so as to improve problem-solving processes as well as understand them?

Individual Differences and Task Characteristics

In the earlier research aimed at performance models of paradigmatic laboratory tasks, and also of the sorts of tasks that appear on cognitive ability tests, it was first assumed that individual differences could be accounted for as quantitative parameter variations within the same uniform process model. This was shown not to be possible, because individual performances differ in strategic organization, not just in parameters associated with particular performance steps. There are also within-person variations across experience with the task, as well as between-person and between-task differences, that appear to be qualitative shifts not just quantitative changes.

With the increasing interest in real-life activities, research attention has expanded from the study of knowledge-lean performance tasks and tests of earlier years to the study of knowledge-rich tasks. Here again, however, assumptions about individual differences have typically focused only on quantitative variations within a uniform process theory. Individuals may differ in their relevant knowledge base, and the availability and accessibility of the knowledge specifically required for the task. They may differ also in the amount of experience already acquired in executing the task and its various components, and thus in automaticity of performance. Similarly, they may differ in speed and effectiveness of component processes. Just as with the knowledge-lean tasks, however, there is increasing evidence that knowledge-rich tasks often involve strategic variations within and between persons as a function of experience or variations in task difficulty. Strategy shifting is particularly apparent in scientific problem solving, for example, as evidenced in recent studies in geometry and physics. Thus, a realistic model of either kind of task performance cannot be a uniform process model; it must at least provide for branching, looping, or other reorganizations of the activity flow in process.

To have explanatory power, the model must incorporate the person and task conditions that determine what particular form the flow of activity will take. Following Elshout's definition, a problem is a state of a certain person in a certain task environment such that, should the person succeed, any explanation of this event based only on previous experience in this particular environment is excluded beforehand. And people certainly do succeed, often in ways exemplary of the best of intelligence. Contemporary cognitive theory posits that people first construct mental models of task environments and then choose whatever direction of further thinking this conception of the task suggests is most sensible. But a problem-solving situation is one in which the mental model constructed presumably from past experience, is not adequate for directing a complete, successful, thinking sequence. On the person side, some kind of heuristic processing and improvising must intervene. Heuristic processing and improvising are activities that have the direction of

thought itself as the goal; when no stored strategy is available, the system switches to algorithms aimed at finding or assembling a suitable strategy. On the task side, it is impossible to say what is an easy or a difficult task, or what is a well-structured or an ill-structured problem, in the abstract. It is not the task environment, per se, that indicates difficulty or complexity or lack of structure; it is the task characteristics in relation to the performance that a particular individual can assemble. A problem is therefore a state in the interaction of a person and a task environment, and can only be identified and studied in that interaction. Individual and task differences in problem solving can only be observed and understood in this interaction.

The Algorithmic-Heuristic Threshold and Education

It may be possible, however, to think of tasks as scaled along a continuum of difficulty or complexity, at least in the abstract, for each individual. Such a scale, of course, would make sense only within types of tasks, where types are defined according to distinguishing task features not yet identified. But imagine that there is a threshold for each person along such a continuum. Below the threshold, performance follows directly from the mental model the person has in store for the task; the flow of activity is relatively automatic and algorithmic. Errors are mostly cognitive slips. Above the threshold, the person must increasingly operate in a heuristic and improvisational mode. Here, errors occur because the knowledge base is inadequate, or poorly applied, or the heuristic and improvisational devices are weak because they are not geared to the specific task type at hand. Furthermore, the farther above one's threshold one is forced to work, the more heuristic processing and improvising will degrade into helpless muddling; errors here will be more conceptual and strategic. Novices are thus to be seen as persons who must work above their thresholds in most of a task type, whereas experts are those who can work below their thresholds in that task type. The goal of education, and of any particular training enterprise too, is to move a person's threshold up, in each of the types of tasks that the society, or a particular organization, values. Raising the threshold means making more and more difficult instances of the task type nonproblematical and automatic.

Aptitude × Instructional Treatment Interaction

The preponderance of evidence now suggests strong interaction between measures of individual differences in general intelligence as aptitude and the contrast between highly structured or direct instructional treatments on the one hand, and relatively unstructured or indirect instructional treatments on the other; more able learners do better with less structure, and less able learners do better with more (Snow and Lohman, 1984). This finding is understandable as a threshold phenomenon; more able learners benefit from most of the instructional tasks presented by indirect, unstructured methods because task difficulty in this medium is either just below their threshold or only enough above threshold to be challenging. But the task in this medium is far above the threshold for less able learners; without explicitly structured teaching, they are left in a helpless muddle. Direct instruction, however, provides the extensive scaffolding needed to raise the thresholds of less able learners. But it makes the task far enough below threshold for the able learner that it becomes boring.

Rather little is learned by learners working far above their thresholds. Close examination of their performance suggests that, while working style may improve slowly, serious misconceptions and erroneous beliefs may also be strengthened. Learners working far below their thresholds may strengthen habitual automatic performance, but are not challenged to extend their heuristic or improvisational abilities.

The important target for research is to understand, for each person and each task, the zone of tolerable problematicity--the zone around the threshold that is both sufficiently structured and sufficiently challenging. Such zones are probably only identifiable within substantive task types. Direct instruction within a substantive knowledge domain, aimed at this zone, appears to be the best way to improve problem solving, and perhaps eventually, intelligence.

Higher Order Person-Situation Interaction

Although research aimed at refining aptitude or task constructs needs to focus on particular variables, in the instructional context it is clear that higher order interactions are the rule. There are few, if any, clear general relationships between particular person and task variables that hold across changes in population or subject matter or instructional context. This should be

expected, because the effects of any individual difference construct will always be mediated by differences in study methods and processes, motivation, and perception of the instructional situation, including most importantly the assessment aspect of this situation.

Entwistle, D'Ydewalle, and Gustafsson all give examples of how and why this happens. The evidence on introversion-extraversion suggests that introverts have an advantage in the sorts of instruction found at higher educational levels. But this can be attributed to the kinds of study methods they tend to adopt; extraverts with well-organized learning strategies and high motivation can be just as successful. Other evidence suggests that relatively unstructured instruction is anxiety-provoking, but the learner's level of initial attainment and motivation are now implicated in mediating this anxiety × instructional method interaction. Still other evidence shows that expectations regarding different assessment methods to be faced at the end of instructional units will moderate both motivation and learning styles and strategies.

In much of this evidence on complex interactions, the crucial importance of learners' intentions is beginning to show through. Learners intending to extract personal *meaning from* a particular instructional task or situation will process information deeply in it--they can be seen to seek deeper structure, more carefully, flexibly, and idiosyncratically organized. Learners intending to be ready to reproduce the knowledge anticipated in a subsequent test will adopt a more surface approach. Also identifiable is a strategic approach to learning involving attempts to organize time, effort, and study conditions but also to manipulate the assessment system to the learner's advantage. Independent attempts to identify these three learning styles or approaches have yielded consistent results, and one study has also related the deep approach to intrinsic motivation and a perception of interest or relevance, the surface approach to fear of failure or test anxiety, and the strategic approach to achievement motivation and vocational motives (see Marton, Hounsell, and Entwistle, 1984).

Although such learning style differences can thus be linked to relatively stable person or aptitude variables, they also vary within individuals as a function of task and situation variables. As several of the authors note, for example, the study of problem solving in instructional situations cannot be limited to a cognitive processing model of problem solving because the instructional situation includes assessment procedures. Students' perceptions of these procedures can induce a deep, surface, and strategic style regardless of problem task variables. Even the most able and interested students sensibly marshal limited time to maximize payoff--they exhibit intelligent effort avoidance.

The suggestion is that research on problem solving, cognition-motivation interaction, and individual differences in instructional learning should concentrate on the cognitive-motivational-intentional styles induced in particular person-situation combinations as the central focus for modeling. The zone of tolerable problematicity around the threshold hypothesized earlier may be equivalent to the zone of deep processing hypothesized here. But this zone will be seen to shift and change as a function of person and situation factors as well as task type and difficulty. The person factors most certainly must include student perceptions and intentions. And the situation factors must certainly include the nature of the assessments expected. Following Entwistle, it seems clear that the model sought must model the richness and variety of experience in this person-situation-problem nexus if it is to represent a recognizable reality to teachers and students.

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Snow, R.E., and D.F. Lohman, "Toward a Theory of Cognitive Aptitude for Learning From Instruction," *Journal of Educational Psychology*, 76 (1984), 347-376.

7/15/85

Table 1

Program of the EARLI Conference

Invited Addresses

Learning theory and theories of knowledge
Robert GLASER, University of Pittsburgh, US

Instruction and the cultivation of thinking
Lauren B. RESNICK, University of Pittsburgh, US

The new look in instructional psychology: teaching strategies for learning and thinking
Wilbert J. MCKEACHIE, University of Michigan, Ann Arbor, US

Theme 1: Developmental Processes

State-of-the-art: Developmental processes
Franz E. WEINERT, Max Planck Institute, München, West Germany

1. Coping with family and school problems: developmental processes
   Inge SEIFFGE-KRENKE, Technical University of Berlin
2. Operational development and individual differences
   Jacques LAUTREY, René Descartes University, Paris, France
   Laurence RIEBEN, Anik DE RIBAUPIERRE, University of Geneva, Switzerland
3. Children's rules for integrating information and how they can be changed through learning and instruction
   Friedrich WILKENING, Johann Wolfgang Goethe-University, Frankfurt, West Germany
4. Instruction and deafness
   David J. WOOD, University of Nottingham, UK
5. The use of longitudinal school achievement records for pupil evaluation
   Jean CARDINET, Institut Romand de Recherches et de Documentation Pedagogiques, Neuchatel, Switzerland
6. File-identities: some aspects of their formation and consequences for students
   Peter J. HEYMANS, University of Utrecht, The Netherlands

   Organizer Review and Discussion:
   Cees F.M. VAN LIESHOUT, Catholic University of Nijmegen, The Netherlands

Theme 2: Cognitive-Motivational Interactions

State-of-the-art: Cognitive-motivational interactions
Michael J.A. HOWE, University of Exeter, UK

1. Feedback, goals and learning
   Christian GEORGE, University of Paris VIII, France
2. Effort avoidance and learning
   Brigitte ROLLETT, University of Vienna, Austria
3. How stable is motivation by contents?
   Peter NENNINGER, University of Freiburg, West Germany
4. Situation-specific judgments of elements of the task-situation complex versus overall measures of motivational orientation
   Monique BOEKAERTS, Catholic University of Nijmegen, The Netherlands
5. Future time perspective, motivation, and achievement
   Willy LENS, Catholic University of Leuven, Belgium
6. Motivation and strategies of discourse processing
   Pietro BOSCOLO, Vanda L. ZAMMUNER, University of Padova, Italy

   Organizer Review and Discussion:
   Géry d'YDEWALLE, Catholic University of Leuven, Belgium

Theme 3: Problem Solving

State-of-the-art: Problem solving and education
Jan ELSHOUT, University of Amsterdam, The Netherlands

1. Development of mental models and heuristics for dynamic tasks
   Berndt BREHMER, University of Uppsala, Sweden
2. The role of representation in heuristic problem solving
   Rudolf GRONER, Marina GRONER, University of Bern, Switzerland
3. Learning to control systems with complex structure
   Rainer H. KLUWE, University of Hamburg, West Germany
4. Factual and procedural knowledge: learning to solve science problems
   Cees T.C.W. METTES, Twente University of Technology, Enschede, The Netherlands
5. A model of learning by solving problems with a developmental perspective
   Ahn NGUYEN-XUAN, University of Paris VIII, France
6. Children's problem-solving skills and processes with respect to elementary arithmetic word problems
   Erik DE CORTE, Lieven VERSCHAFFEL, Catholic University of Leuven, Belgium

   Organizer Review and Discussion:
   Hans SPADA, Albert Ludwigs University, Freiburg, West Germany

Table 1 (Cont'd)

Theme 4: Instructional and Social Interactions

State-of-the-art: Recent trends in research on teaching-learning processes
Neville BENNETT, University of Lancaster, UK

1. Understanding social relations in classrooms: the British and American ethnographic traditions compared
   Sara DELAMONT, University College, Cardiff, UK
2. Pupil reactions to some social influences on learning
   Peter WOODS, The Open University, Milton Keynes, UK
3. Institutional roles, partner representation, and expectational attitudes in educational interaction
   Michel GILLY, University of the Provence, Aix-en-Provence, France
4. About practices, strategies, and interactions
   Régine SIROTA, René Descartes University, Paris, France
5. Discussing for reasoning: the role of argument in knowledge construction
   Clotilde PONTECORVO, University of Rome, Italy
6. Intervention studies for social-cognitive competencies: some examples and theoretical reflections
   Jean-Luc PATRY, Fritz OSER, University of Fribourg, Switzerland

   Organizer Review and Discussion:
   Anne-Nelly PERRET-CLERMONT, University of Neuchatel, Switzerland

Theme 5: Discourse Processing

State-of-the-art: Discourse processing
Heinz MANDL, Wolfgang SCHNOTZ, University of Tübingen, West Germany

1. The effect of instruction, orientation, and acting on memory for text
   Karl F. WENDER, University of Braunschweig, West Germany
2. Please, tell me what you know, I'll tell you what you could learn
   Guy DENHIERE, University of Paris-Sud, France; Andre-Jacques DESCHENES, University of Québec, Canada
3. Metacognitive aspects of learning difficult texts
   Yvonne WAERN, University of Stockholm, Sweden
4. From "text-comprehension" to the mathematical comprehension of text
   Hans AEBLI, University of Bern, Switzerland
5. Students' regulating cognitions during learning from text
   Hans LODEWIJKS, Robertjan SIMONS, University of Tilburg, The Netherlands
6. Perceptions of text structure
   Peter WHALLEY, Robert Waller, The Open University, Milton Keynes, UK

   Organizer Review and Discussion:
   August FLAMMER, University of Bern, Switzerland

Theme 6: Individual Differences

State-of-the-art: Explaining individual differences in school learning
Noel ENTWISTLE, University of Edinburgh, UK

1. Diagnostic and instructional implications of some recent cognitive ability research within the psychometric tradition
   Johan O. UNDHEIM, University of Trondheim, Norway
2. Intelligence training with children: a new perspective to g
   Karl J. KLAUER, Technical University of Aachen, West Germany
3. On the role of classroom differences in achievement changes
   Wolfgang SCHNEIDER, Andreas HELMKE, Max Planck Institute, München, West Germany
4. Problem solving and individual differences: adaptation to and assessment of student characteristics by computer-assisted instruction
   Leen DE LEEUW, H. VAN DAALEN, Jos J. BEISHUIZEN, Free University of Amsterdam, The Netherlands.
5. Towards a determination of the dimensions and domains of individual differences in cognitive development
   Andreas DEMETRIOU, Anastasia EFKLIDES, Aristotelian University of Thessaloniki, Greece
6. A theory of antagonistic strategies: an information-processing alternative for the current ability concept
   Maarten J. IPPEL, Free University of Amsterdam, The Netherlands; A.L. BEEM, University of Leiden, The Netherlands

   Organizer Review and Discussion:
   Jan-Eric GUSTAFSSON, University of Göteborg, Sweden

Posters

1. Peer interaction in physics problem solving
   René AMIGUES, A. BLAYE, University of the Provence, Aix-en-Provence, France
2. Arithmetic problem-solving behavior in low achievers
   Janine DELORME, Jean-Francois RICHARD, University of Paris VIII, France

Table 1 (Cont'd)

3. Word problem solving in children
Marie-Claude ESCARABAJAL, University of Paris VIII, France

4. Problem-solving strategies used by young children in solving open sentences
J.A.C. SANDBERG, Y.F. BARNARD, University of Utrecht, The Netherlands

5. From parent's instructions to child's self-control
Jerzy BOBRYK, University of Warsaw, Poland

6. Development of physical constancy by 9 to 15 year-old students
Anick WEIL-BARRAIS, University of Paris VIII; Marie-Geneviéve SERE, University of Paris VII, France

7. Cognitive acceleration through science education
Philip S. ADEY, University of London, UK

8. The attrition of interests in the Swedish compulsory school
Lisbeth HEDELIN, Lennart SJOBERG, University of Göteborg, Sweden

9. The verbal communication between teacher and children in the kindergarten
Anyés FLORIN, University of Poitiers, France

10. Interpersonal processes in cooperative learning
Günter L. HUBER, University of Tübingen, West Germany

11. Individual differences among beginning writers and the variability of teachers' intervention
Laurence RIEBEN, University of Geneva, Switzerland

12. Three dimensions of "learning and instruction" as experienced by freshmen
Piet J. JANSSEN, Catholic University of Leuven, Belgium

13. Verbal reporting as a method of studying individual learning
Franz SCHOTT, Helo APPEL, University of Giessen, West Germany

14. Structuring text: the elaboration theory
Gijs BEUKHOF, Twente University of Technology, Enschede, The Netherlands

15. Scientific information in the school didactic system
Wlodzimierz GORISZOWSKI, University of Katowice, Poland

16. The effects of past experience, age and language proficiency on direct measures of prose processing
Hazel FRANCIS, F.J. TAYLOR, University of London, UK

Panel Discussion on International Cooperation

David C. BERLINER, University of Arizona, President of the American Educational Research Association

Erik DE CORTE, University of Leuven, Belgium

Noel J. ENTWISTLE, University of Edinburgh, UK

Robert GLASER, University of Pittsburgh, President of the National Academy of Education of the US

Karl J. Klauer, Technical University of Aachen, West Germany

Wilbert J. MCKEACHIE, University of Michigan, Ann Arbor, President of the Division of Educational, Instructional and School Psychology of the International Association of Applied Psychology

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Chemistry

ELECTROCHEMISTRY IN REVIEW--CONFERENCES COVER THE FIELD

by Cecil L. Yarnsky. Dr. Yarnsky is the Scientific Director of the Office of Naval Research's London Branch Office and the Liaison Scientist for Chemistry in Europe and the Middle East. He is on assignment until August 1985 from the Naval Research Laboratory, Washington, DC, where he was the head of the Inorganic and Electrochemistry Branch and Associate Superintendent of the Chemistry Division.

May and June were crammed with electrochemical meetings on Fundamental Aspects of Applied Electrochemistry, Organic Electrochemistry, Two-Dimensional Surface Phenomena in Electrochemical Systems, and the French-sponsored Journées d'Électrochimie '85. My schedule allowed me to attend only the first and last meetings, but I have promises from attendees of the other two meetings to submit summaries for publication in *ESN*. In this article I summarize the significant aspects of the meetings I attended, and leave a more detailed accounting for future ONR, London, conference reports. The topics discussed at the other meetings are listed, but more detailed reports will be left for others.

(University of California at Los Angeles) paper reviewed the current state of the development of this process. (The paper was presented by O. Knoteck, Technical University of Aachen, West Germany). The process seems to be understood and controllable for HfN, TiC, and TiN coatings. The wear properties of these coatings were claimed to be superior to similar CVD coatings due to the finer grain size of the reactive PVD coatings.

As I mentioned earlier, my general impressions of the conference include the observation that the PVD processes are only just beginning to be developed for the deposition of multilayered, multicomponent coatings. These complex coatings are needed (and available by CVD) because many different properties are required of a coating, and this is often impossible with a single-layer, single-component coating.

The characterization of the properties of thin film coatings is a difficult proposition. D.T. Quinto (Kennametal Inc., Greensburg, Pennsylvania) described a ball-wear scar technique combined with low-load microhardness testing to measure the microstructural and chemical composition effects in multilayered coatings commonly used on commercial cemented carbide cutting tools.

The technological importance of hard coatings on cutting tools is well accepted, yet the importance of interactions between the various layers affecting adhesion, fracture toughness, and the wear behavior is not understood. This is due in part to the difficulty of measuring these properties of thin coatings (10- to 20-μm thick). Quinto used a ball-wear technique to create a very shallow (low angle) sectioned cut through the coating and then used low-load (50 g) hot-microhardness measurements in vacuum and a scanning Auger microprobe to characterize the coating properties. The results of the study are providing considerable information that is needed to understand why certain coating systems work. As happens in many fields, materials are developed that work long before it is understood why.

O. Knoteck (Technical University of Aachen, West Germany) and his colleagues at Aachen are doing some fine work in developing and understanding the PVD processes. They have the knowledge of the reactions that occur during both reactive and inert magnetron sputtering to produce some very complex coatings. One such coating is Al_2O_3 with small additions of Ti and N, which is amorphous and stable up to 1000°C. Other coatings of the TiAlN type (known for high hardness and toughness) were also produced and tested. They were shown to have a better wear resistance than TiN and Ti(C,N) and are also deposited at a higher rate than these two more standard wear-resistant coatings.

H.A. Jeha (Max Planck Institute for Metals Research, Stuttgart, West Germany) also described an ultra-low-load microhardness testing technique that he showed could be used to measure the hardness of coatings only 1-μm thick. The dimensions of the indentations made by the microhardness test are measured in a scanning electron microscope. His results indicated that the actual hardness of these thin films (TiN and HfN) could be determined (unaffected by the substrate hardness) as a function of the depositing (sputtering) conditions.

Hard Materials

Hard materials are primarily those used as cutting materials for machining and also wear-resistant materials. These include: (1) high-speed steels produced by powder metallurgy techniques in order to create the required fine grain size and then coated by PVD processes (the temperature for CVD coatings is generally too high); (2) hard metals coated by CVD with a ceramic layer; (3) oxide-based cutting ceramics; (4) silicon nitride-based cutting and bearing materials; and (5) cemented carbides.

A large number of papers dealt with the potential substitution of other materials for cobalt (Co) as the binder phase for cemented carbide materials (Co is a politically sensitive material at present due to the uncertainty over the political stability of the current supplier). Most of this work has been performed by a trial and error technique. What is needed is the basic thermodynamic data to predict the phase equilibria in the potentially suitable alloy systems. H. Pastor (UGICARB-MORON, Grenoble, France) and coworkers have done this for the C-Co-W, C-Ni-W, C-Fe-W, C-Fe/Ni-W, and C-Co/Ni-W systems. Now, at last, the phase equilibria can be estimated, allowing one to estimate the temperature for liquid phase sintering and the compositions of the binders most suitable for WC-Co/Ni cemented carbides. Several previously unexplained phenomena (such as the high sintering temperature required for Ni binders) can now be satisfactorily explained. They have used these data (phase diagrams) to select replacement binders and found several with equal or better properties than the conventional WC-Co cemented carbides.

H. Sheinberg (US Los Alamos National Laboratory) presented another approach. He has developed a family of

that a residual Sn content of 4 percent produced the optimal critical current density (2.3×10^5 A/cm^2, based on the Nb_3Sn area at an external field of 7T). They show that the conductor should not exceed 0.3-mm diameter and that the reaction time in the formation of Nb_3Sn must be at least 7 days at 600°C to 650°C in order to achieve a homogeneous distribution of Sn.

Joining Methods. R. Eck (Metallwerk Plansee) gave a convincing presentation regarding the weldability of Mo and its alloys. Conventional arc welding causes severe embrittlement in the heat affected zone due to recrystallization in this region. However, high-intensity heat source welding techniques--such as laser welding for thin sheets or electron beam welding for thicker welds--work very satisfactorily. Friction welding may be successful if the surfaces to be joined can be kept clean, avoiding oxides and other impurities at the weld interface. Addition of rhenium (Re) to Mo improves the resistance to recrystallization and hence the weldability. Even small additions will effect an improvement, but 41 percent Re produces the most recrystallization resistance (1300°C for full recrystallization in 1 hour). Thus, Re not only improves weldability but will also extend the temperature range of usable strength for Mo alloys.

H.R. Konvicka (Seilstorfer GmbH, Haag-Winden, West Germany) described methods for producing powder metal composites. Samples of Cr/stainless steel, Pt/Ti, and other combinations of materials were joined using hot isostatic pressing-diffusion welding techniques.

He found that there are four critical parameters for the bonding process: (1) temperature, (2) pressure, (3) time, and (4) cooling rate (this is important when the bonded materials have different thermal expansion characteristics).

Many papers dealt with new powder processing and production methods which are intended to reduce the impurity content of the powders, and many others dealt with the effect of impurities on the mechanical properties of the compacted powder metal parts, specifically the ductility and resistance to brittle fracture. This effect of impurities on ductility and the poor oxidation resistance of the metals have been and continue to be the main limitations of these alloys. They possess excellent high-temperature strength due to their high melting temperatures, but they must be protected from oxidation. One entire day of the conference was used for the presentation of papers and the discussion of coating processes used for this and other reasons (such as corrosion and wear resistance).

Coating Methods

Composite and multilayer coatings deposited by chemical vapor deposition (CVD), physical vapor deposition (PVD), plasma spraying, and ion implantation received the most attention.

R. Henne (German Aerospace Research Establishment [DFVLR], Stuttgart, West Germany) is developing a coating system for the oxidation protection of Mo and its alloys. The coating is based on low-pressure, plasma-sprayed $MoSi_2$. The large difference in the thermal expansion coefficients of Mo and $MoSi_2$ causes cracking of the coating. Thus, an inner layer material has to be used to reduce this problem, but it has to be chemically compatible with Mo and $MoSi_2$. Crystallized mullite (Al_2O_3-SiO_2) was selected. They have not yet completed the development of this coating system, but it shows promise.

The majority of the papers on the topic of coatings dealt with surface modification or coating to improve wear and erosion resistance. There are many methods in commercial use and many others currently under development. The new processes are plasma-assisted CVD and PVD, reactive plasma-assisted PVD, and ion implantation. The CVD process is the most rapid deposition process and is the most highly developed; however, the substrate to be coated must be heated to high temperatures (500°C to 2500°C) for the process. Cemented carbides (WC-Co, for example) are ideally suited for coating by this process, but steels would lose their strength if they had to be heated to this extent for coating.

Plasma-assisted CVD allows the substrate temperature to be lower (200°C to 500°C) for coating. SiC, SiN, polymeric carbon, and amorphous Si have all been deposited by this technique, but entrapment of gases from the plasma in the deposited layer causes serious problems, and the deposition rates are lower than conventional CVD.

The PVD processes involve the same three basic steps as CVD: (1) creation of a vapor phase (by evaporation or sputtering), (2) transport of this vapor to the substrate, and (3) film growth on the substrate. For PVD processes, the material to be deposited must be dissociated and recombined on the substrate; however, the recombination does not always produce the same stoichiometry as the initial material.

The control of this step of the process is improved by using reactive vapor deposition. R.F. Bunshah's

liquid composition must be for different solid-component systems.

Grain growth is one problem that occurs during the sintering of W. At Nederlandse Philips Bedrijven in Eindhoven, The Netherlands, H. Jansen has developed a theoretical model which will predict and describe the effects of impurities on grain growth during sintering. The kinetics of grain growth are controlled by the same mechanisms that control recrystallization and creep, namely the mobility of structural defects (dislocations and grain boundaries). The model predicts the effect of impurity elements on the mobility of grain boundaries as a result of W-O impurity atom segregation processes. The ability to influence the boundary mobility depends upon the formation of W-O impurity atom complexes (due to segregation) and their effect on surface tension. The amount of segregation will be roughly inversely proportional to the solubility of the impurity elements. Oxygen has a very low solubility and so will readily segregate to grain boundaries, but due to its high diffusivity, it alone will not impede the boundary movement. However, when both oxygen and another impurity are segregated, the mobility of the boundary will be governed by the ternary W-O impurity segregation behavior. The effects of both sintering activating and retardation elements are accurately predicted by the model.

Novel Processing Methods. Since grain boundary segregation and concurrent embrittlement are problems with most of these materials, the elimination of grain boundaries should improve the ductility of these materials. However, the production of single crystals in the sizes and shapes needed for engineering components is very difficult. T. Fujii and coworkers at the Japanese National Research Institute for Metals, Tokyo, have developed a very clever way of converting conventionally processed polycrystalline material into a single crystal. Doping refractory metals with oxides has been used for years to inhibit grain growth. Fujii has used this same technique to retard grain growth of the polycrystalline Mo material by using CaO and MgO. However, if heated to at least 2300°C, the oxides which have retarded grain growth begin to dissolve by oxygen diffusion along the grain boundaries. When this happens, one grain begins to grow rapidly and consumes the entire sample (at a rate of about 200 mm/hr).

They have produced single crystal plates (10-mm × 40-mm × 200-mm), tubes (16-mm outside diameter × 9-mm inside diameter × 200-mm long) and bars (0.5-mm diameter × 200-mm long). They feel that almost any shape of single crystal could be produced by this method.

New Alloys. In another of the excellent papers presented by Japanese scientists, Y. Fukasawa (Toshiba Research and Development Center, Kawasaki) described the development of a new Mo alloy for very high temperature service. Mo alloys are generally used in a deformed condition. If they recrystallize during processing or service they become brittle at low temperatures and have poor creep resistance at high temperatures. The practical temperature limit for Mo alloys has thus been about 1200°C. The alloy developed by Fukasawa was shown to have a creep rate 100 to 1000 times slower at 1800°C than TZM (0.5 Ti, 0.08 Zr, 0.2 C, bal. Mo--the conventional Mo alloy used at high temperatures). The new alloy contains 440 ppm K and 790 ppm Si. The improvement in creep strength is due to a change in the mechanism controlling high-temperature strength. For TZM, this is grain boundary diffusion, while for the new alloy, the mechanism is controlled by the bulk diffusion rate.

Metallwerk Plansee is also involved in the development of new, higher strength Mo alloys. R. Eck and coworkers have developed a series of dispersion hardened alloys (carbide precipitates) based on the addition of Ti, Zr, Hf, and C to Mo. TZM is used to make the dies for isothermal forging of the nickel-base superalloys. Improved die life could be attained if a higher creep-strength alloy were available. The temperature range of interest in this application is 1000°C to 1200°C; thus the alloy described by Fukasawa does not offer any advantage as TZM is stronger than the new K-Si alloy at these temperatures. The use of Zr and Hf in combination with carbon as alloying elements has raised the recrystallization temperature and increased the creep strength over TZM. One of the new alloys, ZHM (0.72 Zr, 0.14 Hf, 0.05-0.1C, bal. Mo), has a recrystallization temperature of 1600°C (for complete recrystallization in 1 hour) and a tensile strength of 600 MPa at 1250°C. TZM, for comparison, recrystallizes at 1450°C and has a tensile strength of 400 MPa at 1250°C).

Several papers dealt with the development of superconducting materials based on Nb. R. Eibler (Technical University of Vienna) and W. Gätze (Plansee) described their work on Nb_3Sn superconductors. By using an external Sn diffusion process and evaluating the effect of residual Sn (after the complete formation of Nb_3Sn), they found

major contributor to the technical content of the conference. The Chinese have enormous supplies of some refractory metals (Mo, W, and Nb), but until now they have not attempted to develop the advanced production capabilities required to produce these metals. The topics that they discussed during the conference included W alloy development for the electrical industry, heavy metal alloys for radiation shielding, Mo alloy development for controlled thermal expansion alloys, high temperature furnace materials (especially for glassmaking), reprocessing methods for hard metal scrap, reduction of WO_2 in the production of W powder, W-W/Re thermocouple production, and cemented carbide materials. It is my impression that they did not present anything new or exciting, but it is obvious that they are rapidly developing a capability in these fields.

2. The Japanese are performing some very fine research (both fundamental and applied) in these fields. Some of the better papers were given by the Japanese; a few of these are reviewed below.

3. Physical vapor deposition, as a coating method, is developing rapidly, but the applications and, more importantly, the fundamental understanding of the process lag behind the chemical vapor deposition methods. This is especially true for the production of multilayered coating systems.

4. The mechanisms of liquid phase sintering are reaching an advanced level of understanding for heavy metals and cemented carbides; more research is required, however, on the mechanisms involved in liquid phase sintering of ceramics.

5. Finally, the lack of participation in the conference by people from the US (very few were present) was very disappointing to the organizers of the conference.

In the following sections I have briefly summarized a few of what I considered to be the better papers at the conference. For this purpose I have divided the papers into three topics: (1) refractory metals, (2) coating methods, and (3) hard metals.

Refractory Metals

Because of their high melting points, these metals (Mo, W, Nb and Ta) are first considered for their use at high temperatures. They are used as heating elements and as structural materials for high-temperature furnaces, hot-working tool and die materials, electrical contacts, arc welding electrodes, and of course filaments in electron tubes and incandescent light bulbs.

Processing Methods. All of these materials can be produced by both electron beam melting and powder metallurgy techniques. In both instances, the material can be further processed by forging, rolling, and drawing.

One interesting paper was presented on the high purity now attainable in commercial materials by electron beam melting. H. Stumpp (Leybold-Heraeus, West Germany) presented some data on the impurity levels in commercially produced metals that caused considerable discussion in the audience. Leybold Heraeus builds a furnace with 1500-kW beam power using six electron guns. The pumping capacity of this furnace is 300,000 L/s. As an example of the purity possible, triple remelting of Nb produced a 78-kg ingot with impurities of 20 ppm oxygen, 20 ppm nitrogen, 3 ppm hydrogen, and 7 ppm carbon. This material has a residual resistivity ratio (an indirect measure of the total impurity content) of about 135, which Stumpp claimed to be the highest purity Nb produced in a commercial furnace. One very important use of this high-purity material is for the production of superconducting material.

Several papers discussed methods of producing high-quality powders and the effects of various impurities on the sintering characteristics and postsintering properties of the materials.

R. German (Rensselaer Polytechnic Institute, Troy, New York) presented an excellent review of the factors which control the fracture properties of liquid phase sintered materials. This subject seems to be well understood. He explained how the contiguity (the amount of solid-solid rather than solid-liquid interface which exists during sintering) is a critical parameter in determining the fracture properties of these materials with a given volume fraction of liquid phase, the optimum properties occur when there is a minimum of solid-solid grain contact (minimum contiguity). The amount of contiguity depends not only on the amount of the liquid phase but on the dihedral angle formed at the solid-solid-liquid triple points; contiguity decreases as this angle decreases. The dihedral angle is controlled by a balance between the interfacial energies of the solid-solid and solid-liquid boundaries. Then, if the appropriate postsintering heat treatments are carried out to remove residual strains, eliminate hydrogen, and redistribute the impurities (away from all interfaces), the control of the composition of the liquid phase to minimize the dihedral angle will optimize the properties. The research remaining to be performed appears to be to define exactly what the

heavy metals based on W hard metals, and carbides for machine tools, and various coating systems for all of these materials. I learned that their future efforts will be on products with higher added value rather than mill products (sheet, bar, plate, etc.). Their experience in coating development makes them well qualified to develop bonding methods for the widely different materials used in advanced composite materials. Two new and exciting materials are in an advanced stage of development. Chromium and chromium-base alloys with their excellent oxidation resistance are potentially excellent materials for elevated temperature use (up to 1500°C) if the inherent problem of very brittle behavior at ambient temperatures could be overcome. Plansee has developed a processing method to remove the embrittling impurities which cause this problem. They expect to have chromium mill products for sale in the near future with a ductile-to-brittle transition temperature below room temperature. If they are successful, they will be the only supplier of this material.

The second exciting new material under development is a new class of nickel-base and iron-nickel-base superalloys for gas turbine applications. The materials are fabricated by powder-metallurgy techniques and are based on an oxide dispersion-strengthening mechanism. Coating systems for oxidation and corrosion protection will be custom designed for each alloy/application. They expect to raise the allowable operating temperature of the gas turbine by 50-100°C with these materials, a very significant increase indeed (but also very difficult to believe).

Metallwerk Plansee produces a wide variety of very special materials: cemented carbide machine tools, Mo-base plates for semiconductors, dies for isothermal forging, sputtering targets, Mo mirrors for lasers, superconducting multifilament Nb_3Sn wires, sintered steel, and refractory metal alloys--to mention only a few of their products.

Following the original ideas of Schwarzkopf, Plansee is the host for an international seminar on powder metallurgy; the next article describes the technical content of the 1985 meeting.

7/3/85

PLANSEE SEMINAR--PROGRESS IN POWDER METALLURGY

by Kenneth D. Challenger.

Although there are many international seminars in the field of powder metallurgy, the Plansee Seminars provide a focal point for those working in the specialized field of refractory metals, heavy metals, hard metals, the coating systems using these metals, and the coating materials for these metals. The 11th International Plansee Seminar was held from 20 through 24 May at Metallwerk Plansee GmbH, Reutte, Austria. These seminars have been held every 4 years since 1952. The theme of the seminars has varied and grown over the years with the expansion and growth of the related industries. The participation in the conference has also grown; the 11th was the largest ever, with over 600 participants and 150 papers from over 20 different countries.

As an example of the respect Plansee has in Austria, the President of Austria, Dr. Rudolf Kirchschläger, gave the opening address. Following this, and remarks by other government officials, the presentation of the Plansee medal was made (an award given at each seminar to recognize individuals who have made outstanding contributions to the field of powder metallurgy). Professor Hellmut Fischmeister, Director of the Max Planck Institute of Materials Sciences, Stuttgart, West Germany, was recognized for his fundamental work in this field (especially his work on Ostwald ripening theory). Fischmeister has been involved in research on many different topics in many different countries (including Austria, where he is still honorary professor at the Mining University, Leoben).

General Impressions of the Conference

Several things stood out as significant over the course of the conference:

1. The Chinese are very active in powder metallurgy research and production. There was a team of about 10 people from several different institutes in China (Central-South Institute of Mining and Metallurgy, Powder Metallurgy Research Institute, Changsha, Hunan; Central Iron and Steel Research Institute, Beijing; Zhuzhou Cemented Carbide Industries, Zhuzhou, Hunan; Shanghai Iron and Steel Research Institute, Shanghai; and the University of Iron and Steel Technology, Beijing). In terms of the number of papers presented (10), they were a

(joint work with St. Louis Hospital in Paris), computation of the heat field in the rotor of an electric engine (joint work with the French national railroad), and numerical simulation of the stresses and vibrations of arch dams constructed for hydroelectric power (joint work with Électricité de France).

On the theoretical side, one goal of the club is to investigate the performance of different finite element methods in the solution of various engineering problems. Since the data are stored in the same data structure, it is relatively simple to compare and validate different methods, such as conforming, nonconforming, and dual methods. In this article, I will only discuss the club's result for one test problem in the particular problem area of heat transfer. Laplace's equation has been solved in a polygonal-shaped region for which an explicit solution is known. Seven methods (hybrid dual triangular of degree 2, lagrangian triangular of degree 2, equilibrium triangular of degree 2, hermitian triangular of degree 3, lagrangian triangular of degree 1, hybrid primal triangular of degree 1, and lagrangian quadrilateral of degree 1) were compared with respect to accuracy, memory requirements, and computing time. For this simple problem, the results indicated that lagrangian triangular of degree 2 and equilibrium triangular of degree 2 are probably the best methods.

Conclusion

Researchers in Club Modulef have developed over the last 10 years an excellent modular and portable finite element program package. Club Modulef has benefited from the excellent combination of theoreticians, numerical analysts, and applied researchers and practitioners who have developed and experimented with the program. Considerable care has been given to validation and maintenance of the package at INRIA, resulting in a highly reliable package. US researchers and practitioners using finite element methods will likely find MODULEF worth investigation.

Reference

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7/5/85

Material Sciences

METALLWERK PLANSEE--A LEADER IN POWDER METALLURGY

by Kenneth D. Challenger. Dr. Challenger is the Liaison Scientist for Materials Science in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until May 1986 from the Naval Postgraduate School, where he is Associate Professor of Materials Science.

Austria's Metallwerk Plansee is one of the largest privately owned companies in Europe. This article briefly describes the company's research in powder metallurgy, and the next article discusses papers presented in May at the 11th seminar in a series sponsored by Plansee.

With total sales in excess of S2.1 billion ($100 million) and about 2800 employees, Plansee is the largest powder metallurgy company in Europe and is a world leader in this field. Plansee was founded by Dr. Paul Schwarzkopf in 1921. During the war, Schwarzkopf was forced to leave Austria for the US, where he founded another company which is also still in his family, Schwarzkopf Development Corporation. He stayed in the US, and Plansee became part of Thyssen during the war; later it was under the control of the French during their occupation. In 1955 the company was returned to Schwarzkopf (much bigger than when he left due to massive expansions in the war years). The company is still completely owned by the Schwarzkopf family.

It is an impressive and very progressive company, maintaining its leadership in the powder metallurgy field by continuing to improved and expand its products. Research is a major activity at Plansee (rare for a company of this size); 6 percent of the annual budget is allocated to research. Over 100 people, including 50 graduate scientists and engineers, are involved in the research activities. Plansee is also a large sponsor of research projects in the Max Planck Institutes, the Fraunhofer Institutes, and many West German, Swiss, and Austrian universities.

The range of Plansee products is well known to people in the field: molybdenum (Mo), tungsten (W), tantalum (Ta), niobium (Nb) and their alloys,

universities, as well as industrial companies, with the goal of designing and implementing a modular finite element program package. The club now has 133 members composed of 36 industrial companies (six of which are foreign), 61 French universities and laboratories, and 36 non-French universities. Only recently have US researchers participated in the club; current participation is four US universities. Exchange among members of the club is purely of a scientific (hence noncommercial) nature.

The main objectives of the club are: (1) to expand the finite element library using the latest results of theoretical and numerical research as well as industrial experience in solving large practical problems; (2) to bring together laboratories interested in the same topic to determine the optimal programs and methods; (3) to promote the sharing of information; and (4) to validate new methods and compare them with those already implemented.

These objectives are fulfilled at INRIA through standardization of the programming, portability of the programs, and full documentation and maintenance of the MODULEF library.

Additional members are welcome. The requirements for joining are an interest in and need for finite element procedures, and a desire to participate in the improvement and maintenance of a high-quality open (i.e., non-black-box) package. New members are required to add something to the package. This may either be a new module or dissemination of experience working on a particular class of problems.

The annual membership fee is small (roughly F1000, approximately $100)--to pay for mailings and report-distribution costs. For more information write to M. Bernadou at INRIA-Rocquencourt, B.P. 105-78153, Le Chesnay, France.

Capabilities

Two goals of the MODULEF system are modularity and portability. Modularity is important in that it allows the selection of various intermediate algorithms in the solution process; in addition, it allows the easy modification and updating of the package. The system is very portable. MODULEF versions are available for Burroughs, CDC, IBM, Norsk-Data, Univac, Vax, Cray, Apollo, Data General, and Hewlett-Packard computers and are adaptable to distributed computing environments like computer-aided design and computer-aided manufacturing systems. Two- and three-dimensional (2D and 3D) graphical representations are provided; in addition, 3D color display is available for the Apollo computer. I was shown a display of the color capabilities for the Apollo computer that was quite impressive. The following capabilities are provided:

1. The automatic generation and display of meshes.
2. The specification of characteristics of materials or external forces by subdomains or pieces of boundary.
3. The choice of type of the finite element method (e.g., conforming or not conforming, hybrid, mixed, etc.).
4. The finite element library, containing about 30 elements for heat transfer analysis: 2D, 3D, and axisymmetric elements. Thirty elements for linear elastic analysis are available for isotropic or anisotropic materials: 2D-plane stress or plane-strain elements, 3D axisymetric elements, and plate and shell elements. In nonlinear elasticity, five elements for hyperelastic compressible and incompressible materials are used for Mooney-Rivlin or Ogden models.
5. The solution of linear systems using a choice of several techniques for memory management, depending upon the size of the problem and that of main memory, including: (a) direct methods (Gauss, Crout, Cholesky); and (b) iterative methods (relaxation, conjugate gradient algorithms with or without preconditioning or multigrid method).
6. The computation of eigenvalues of 2D or 3D operators using a choice of subspace iteration, Lanczos, or QR methods.
7. The integration of time-dependent heat equations using multistep, Runge Kutta, or Gear methods.
8. The solution of dynamic problems by means of free vibration modes or multistep methods.
9. The determination of plastic or elastic zones of a structure.
10. The solution of thermoelastic problems.
11. The computation of velocities and pressures of a plane incompressible fluid flow (Navier Stokes equations).
12. The computation of magnetic fields.
13. The computation of the effective elastic moduli of composite materials.

Experience

The MODULEF package has been used on a variety of typical engineering problems, ranging from theoretical numerical studies to actual engineering practice. Some examples of the latter include a biomechanical problem in connection with total hip replacement

Investigation of Electrodepositon Processes Using X-ray Diffraction and Vibrational Spectroscopy, by M. Fleischmann (Southampton); Surface Enchanced Raman Scattering (SERS), by A. Otto (Dusseldorf); Analysis of Absorbed Intermediates and Determination of Surface Potential Shifts by DEMS, by J. Heitbaum (Bonn); and XPS-Examination of Passive Layers With a Specimen Transfer in a Closed System, by H.H. Strehblow (Dusseldorf).

Topics pertaining to surface properties were discussed by G. Ertl (Munich), Structure and Phase Transformation of Metal/Gas Interfaces; A.T. Hubbard (Santa Barbara, US), Electrosorption at Well-Defined Surfaces; D.H. Kolb (Berlin), *Ex-situ* Studies of Bare and Adsorbate-Covered Gold Electrode Surfaces; D. Landolt, (Lausanne), Surface and Depth Profile Analysis for the Study of Anodic Dissolution Phenomena; and E. Schmidt (Bern/Karlsruhe), Inhomogeneous Electrodes.

The largest number of presentations were made concerning electrode kinetics. Examples of topics included: Surface and Depth Profile Analysis for the Study of Anodic Dissolution Phenomena, by D. Landolt (Lausanne); Methanol Oxidation by *in-situ* and *ex-situ* Methods, by W. Vielstich (Bonn); Time and Space Distribution Statistics of 2-D Nucleation, by E. Budevski (Sofia); Models of 2-D Electrocrystallization With Couplings to Diffusion and/or Dissolution of Ions in Solutions, by R.G. Barradas (Ottawa); Kinetics of 2-D Condensation: The Case of Organic Monolayers on Mercury, by L. Gierst (Brussels); The Role of the Charge Transfer in the Adsorption of Organic Molecules at Metal Electrodes, by J.W. Schultze (Düsseldorf); Some Aspects of the Application of the Methods of Electrode Kinetics to Corrosion, by J.A. Harrison (Newcastle); and N_4-Chelates as Electrocatalyst for Cathodic Oxygen Reduction, by K. Wiesener (Dresden).

Because I did not attend this meeting, I have requested a participant to write a summary of the meeting for publication in a future *ESN*.

Summary

The four gatherings of electrochemists during May and June caused a difficult schedule for anyone wishing to attend all of the meetings. Each had a specific purpose, but one wonders if one general meeting of electrochemists--held in one location--would serve more, cost less, and increase European and Midddle Eastern interaction between electrochemists. The proposed Journées d'Électrochimie to be held in Sweden next year may serve this purpose.

7/15/85

Computer Sciences

MODULEF--A MODULAR FINITE ELEMENT PROGRAM PACKAGE

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The development of a general-purpose modular finite element program package is an impressive project centered at the Rocquencourt branch of France's Institute National de Recherche en Informatique et en Automatique (INRIA). This package, called MODULEF (for modular finite element), has been developed by members of Club Modulef, which was created by INRIA in 1974. The package, written in Fortran 77 and comprising about 2000 procedures and 200,000 cards, is maintained at INRIA and disseminated to members of the club. The capabilities of the package and the number of members in the club are continually expanding.

In this article, I will discuss the structure of the club, including requirements for joining, and the capabilities of this excellent package. US researchers and practitioners interested in using finite element procedures to solve various engineering problems from heat conduction, to static and dynamic elasticity problems, to fluid mechanics problems, are likely to find this package very important.

(For a description of INRIA's Sophia Antipolos branch, see *ESN* 39-4: 156-158 [1985].)

Club Modulef

Club Modulef was created in 1974 to bring together French and foreign

discussions, made them exciting to listen to, and ended the discussion. His absence was always noted, and his silence always made a speaker uneasy. Others may have tried, but none could equal Saveant's remarks, usually humorous, in French, English, Italian, or German.

The eight subjects covered by the conference were:

1. Physical Chemistry of Electrolytes.
2. Properties of Interphases (Membranes).
3a. Electrochemical Kinetics.
 b. Electroanalytical Chemistry.
4a. Organic Electrosyntheses and Modified Electrodes.
 b. Electroorganic Mechanisms.
5. Electrochemistry of Organometallic and Coordination Compounds.
6a. Industrial Electrochemistry, Electrochemical Engineering, and Electrodepostion.
 b. Corrosion.
7a. Energy Conversion and Semiconductors.
 b. Photoelectrochemistry and Photoelectrochemical Behavior of Semiconductors.
8. Applications in Biology and Pharmacy.

Because boundaries between the different subjects are not always sharp, some contributions should have been in other sessions. This could not have been avoided. Abstracts of the lectures and posters were distributed at the meeting. In next month's *ESN* I will report on the plenary lectures and results from the session lectures, oral communications, and posters that I consider significant. A detailed review of the meeting will be the topic of a future ONRL report.

Organic Electrochemistry

The purpose of the XII Sandbjerg Meeting (16 through 19 June) as stated by its organizer, Professor Henning Lund of Aarhus University, was "to gather a group consisting of a mixture of young and more experienced scientists under the same roof for some days under informal conditions to discuss various aspects of organic electrochemistry and to further international cooperation within the field." This year the program consisted of six main lectures and 28 short contributions, the former being surveys of the work during several years of an active group or an area in which several groups are working actively. The short contributions were unpublished works, which, after their presentation, might be influenced by the discussions. A booklet with abstracts of the communications was distributed before the meeting to give the audience a better background for a lively discussion.

The main lectures and lecturers were:

1. The Mechanism of Aromatic Nitration--Electron Transfer Mediated or Not? L. Eberson (Lund, Sweden).
2. The Interpretation of High-Precision Electroanalytical Data in Mechanism Analysis as Illustrated by the Reaction Between Anthracene Anion Radical and Phenol in N, N-Dimethylformamide, O. Hammerich (Copenhagen, Denmark).
3. The Chemistry of Electrogenerated Bases, J.H.P. Utley (London, England).
4. Electrosynthesis in the Presence of Cyclodextrin and Similar Compounds, T. Osa (Sendai, Japan).
5. Application of the SPE Method to Organic Electrochemistry, Z. Ogumi (Kyoto, Japan).
6. The Square Schemes With the Chemical or Electrochemical Reactions at Equilibrium, E. Laviron (Dijon, France).

There were 52 participants from 13 countries, including Japan and the Soviet Union.

Because I did not attend the meeting, the list above gives only the speakers and topics of the main lectures. In a future *ESN*, more information on the main lectures and short communications will be supplied by a guest writer who attended the meeting.

Two-Dimensional Surface Phenomena In Electrochemical Systems

The Third International Fischer Symposium was held from 15 through 19 June at the University of Karlsruhe, West Germany. The aim of the Fischer Symposium is to gather the specialists from all over the world who are working or interested in a specific field. This year the scientific program was "Two-Dimensional Surface Phenomena in Electrochemical Systems." The topics to be discussed included: surface investigation techniques (electrochemical methods, optical and spectroscopical techniques, UHV-surface-sensitive techniques); surface properties (thermodynamics, surface structures, nucleation and growth phenomena); and electrode kinetics (adsorption, electrocatalysis, corrosion, electrochemical noise analysis).

Thirty-one lectures were presented over the 3-day symposium. Surface investigation techniques that were reviewed included such topics as: *In-situ*

calcium/oxyhalide-SEI battery, was also discussed by Peled.

High energy density (gravimetric and volumetric), good shelf and operating life, and chemical and electrochemical stability have made the $Li/SOCl_2$ couple the most promising primary lithium system selected for commercial production. However, the thermal stability of the couple has not been established. Dr. M. Babai (Tadiran, Rehovot) reported research on the upper limit of the thermal stability of the $Li/SOCl_2$, $LiAlCl_4/C$ system at temperatures up to 200°C. He found that the system is stable on storage at 200°C (20°C above the melting point of lithium), and can be discharged at this temperature over 6 days while large portions of the available capacity are obtained. In addition, the electrochemical stability was manifested by the capability of cells to be discharged at 150°C for over 6 months.

Babai reported studies of the open circuit potential (OCV) variation with temperature. The curves show a minimum at 50°C to 80°C. At the lower branch of the curve, the decrease in the OCV with increasing temperature was explained by the increase of anode corrosion, while the OCV value per se is determined by the presence of electrolyte impurities (for example SCl_2 and SO_2Cl_2) which are more oxidizing than thionyl chloride. At the higher temperature branch, the OCV is determined mainly by Cl_2 and SO_2Cl_2 formed by a reversible decomposition of thionyl chloride:

$$4\ SOCl_2 \rightleftharpoons 2SO_2 + 3\ Cl_2 + S_2Cl_2$$
$$SO_2 + Cl_2 \rightleftharpoons SO_2Cl_2$$

The increase of the equilibrium concentration of SO_2Cl_2 and Cl_2 at higher temperatures yields a higher OCV value. Analysis of the surface characteristics of the anode as the temperature is increased showed a change from smaller crystals to more porous layers at the higher temperatures: when the cells were heated to extremes, SO_2 and Cl_2 were formed between 240°C to 260°C when thermal decomposition was observed.

Dr. J.R. Goldstein (Tadiran, Rehovot) concluded the discussion of batteries by reviewing the technology of sealed alkaline NiCd batteries, which were introduced by Les Piles Wonder, France (B. Stiker and F. Jolas, US Patent 4,169,780 [1979]). The system contains an electrodeposited cadmium negative electrode as a substitute for the conventional sintered impregnated negative electrode. The Wonder process, which Tadiran recently acquired, deposits cadmium directly--in a highly porous, adherent form--on a moving, continuous strip of foil. The deposit is calendered to give a well-defined structure with a small weight and thickness tolerance. The process results in a considerable savings in cost, weight, and thickness. In addition, the process is simpler than the corresponding sintering/impregnation process needed for a sintered negative electrode, and is virtually self-contained, free from caustic or cadmium containing effluents as is common with a sintered plate production line. Electrical characteristics of the high-current-density system and problems were described.

Summary. The UNESCO International Symposium covered the fundamental aspects of electrodeposition, electrodes, fuel cells, and batteries. More than the presentations themselves, the discussions were the focal point of the meeting, which reviewed old systems and presented results of current research in electrochemistry. The organization of the meeting, the choice of topics, and speakers resulted in a truly successful meeting.

Journées d'Électrochimie '85

The Journées d'Électrochimie is designed as a review of the electrochemical research being conducted in France. The meeting--from 28 through 31 May at the Palazzo degli Affari, Florence, Italy--was only the second not held in France. It was the first meeting held in a non-French-speaking country, with last year's gathering held in French-speaking Brussels, Belgium. Although the official language of the meeting was French, the speakers and discussers relied on English when other languages, French and Italian, failed to communicate the messages. Of the 400 to 500 attendees, the majority were from France, and the next most abundant group from Italy. On the other end of the spectrum, no participant was from the UK (B.E. Conway was from Canada via England), and only one, J. Jordan (Penn State), was from the US. The setting for the meeting and the activities arranged by the organizing committee headed by Professor Guidelli were excellent.

The meeting was divided into plenary lectures (5), session lectures (20), oral communications (49) and posters (262). A unique feature, to me, was the series of sessions at which the poster presentations were discussed. In each session I attended, the "conveners" had done their homework, and each (1 to 1½ hours) was lively, with discussion, comments, and suggestions. The most prominent figure in any of the sessions was Professor J.M. Saveant (Université de Paris VII), who generally opened

hand, if the metal anodes can be replaced, the "mechanically rechargeable" power sources are categorized as secondary sources or even fuel cells where the metal is the fuel. Metals as fuel were reviewed on the basis of their thermodynamic potential (determining the ideal energy density), kinetic properties of the anodic dissolution process (limiting the obtainable energy density and power density) and their economic potential (availability and cost of the metal). Despić concluded that Al is less expensive than Li and Zn, with Na and Mg next. He observed that the least promising from the thermodynamic point of view, the alkaline zinc/air cell, was the first to be built for the market as a reliable, large-capacity power source with seawater and freshwater activation. The favorable kinetics and low self-discharge are factors contributing to its success.

The alkaline aluminum/air high-power-density source has received considerable attention recently, but Despić believes the saline electrolyte aluminum/air battery is more promising, because of its high theoretical energy density, low cost of the metal per unit energy produced, and the safety of handling the power source by unskilled persons. Two problems remain for the battery: (1) poor kinetics of the anodic process that leads to poor energy and current efficiencies, and (2) difficulties with the reaction product that tend to limit the life of the battery far below its true capacity. Current research toward solving these problems was presented by reviewing the electrode process of an aluminum electrode based on three types of electrolytes: buffers that form barrier films on aluminum, dibasic acids that form a compact but porous layer, and halides that activate the aluminum. The absorbing properties of the oxide film and the anions in the electrolyte can change the properties of the electrode. These have stimulated solid-state studies of oxides under varying conditions of buffering and absorption.

Finally, Despić described engineering efforts to maintain a constant interelectrode spacing in consumable anode cells. The self-perpetuating wedge cells and flowing electrolyte were reviewed as means to solve problems so that an effective way of combining cells in series may be devised to form a battery. A lengthy discussion of third-world countries' needs for batteries/fuel cells emphasized the need for cheap, safe, reliable, and portable energy sources.

A reserve battery having a long, stable, shelf life--and yet rugged and highly reliable--has been sought for aerospace and ordnance applications. Thermal batteries for these applications were described and reviewed by Dr. S.C. Levy (Sandia National Laboratories, US). The electrolyte, usually an inorganic eutectic salt mixture, is stable for indefinite periods, but the cell only operates between 500°C to 600°C. Thus heat loss, short life, and low energy density make these systems applicable to very special environments. Levy presented research on the chemistry and design improvements that have led to a 1-hour battery based on $Li(Si)/FeS_2$ chemistry.

Dr. J.P. Gabano (SAFT, Poitiers, France) discussed the availability of lightweight, compact, electrochemical power sources where portability is often the prime requirement. In the search for high-performance batteries, he concluded that nonaqueous systems using lithium as the anode material offer substantial performance advantages over conventional aqueous systems. Gabano reported several combinations of lithium with a number of nonaqueous electrolytes. Some resulted in battery systems operating around 1.5 or 3 V, having long shelf life, and performing over a wide temperature range. Unfortunately, cost remains a problem, and in some cases the disposal of a spent cell requires elaborate procedures for safety reasons.

The complex electrochemistry occurring in nonaqueous lithium cells was reviewed by Professor E. Peled (Tel Aviv University). He described three groups of active metals in nonaqueous systems: Type A, solid electrolyte interphase (SEI)-free, aqueous-like, active-metal, nonaqueous systems (aluminum plating baths); Type B, metal solvent (blue) solutions or solvated electron systems; and Type C, SEI battery systems. Peled concluded that the only system that can be applied in primary and secondary lithium batteries is the Type C electrode system. The lithium/sulfur organic battery was described as having one of the highest theoretical energy densities, about 2600 Wh/kg--a value 150 percent greater than that of lithium/manganese dioxide and about 70 percent greater than the lithium/thionyl chloride cells. Using an electrolyte of 1 M lithium perchlorate in a tetrahydrofuran/toluene solution and a porous current collector loaded with sulfur, nearly 100 percent of the lithium is converted to Li_2S, but less than 100 percent is redissolved and redeposited on the anode in an amorphous form. Peled reported a shock explosion hazard in this state. Another system, the

outstanding properties: extremely high chemical stability, insolubility in aqueous and nonaqueous solvents even under extreme conditions, high water content, good permeability and selectivity for ions, and superior mechanical properties. Thus, Nafion is widely used as a separator in electrochemical processes and is being investigated as a solid polymer electrolyte. Two papers reported on the use of Nafion in electrochemical processes. Dr. Israel Rubinstein (Weizmann Institute of Science, Israel) used thin films of Nafion on electrodes to immobilize electroactive cations (primarily large complex ions) onto electrodes via a combination of ion-exchange action and hydrophobic interactions. (Research reported when Rubinstein was a postdoctoral assistant with Alan Bard, at the University of Texas). Rubinstein's current studies of electrode couples comprising neutral (reduced) and cationic (oxidized) forms in Nafion films on electrodes have led to valuable information concerning the relationship between the structure of the polymer, distribution of electroactive species between different domains of the polymer, and measured electrochemical parameters for incorporated species. Dr. Judith Rishpon (Tel Aviv University) reported on a wide frequency range AC impedance technique used as a powerful tool for investigating transport processes in Nafion polymer films on electrodes. The computerized AC system described is particularly suitable for long-term measurements of high sensitivity, especially in the low-frequency range.

Dr. J.P. Pemsler (Castle Technology Corporation, Woburn, MA) described the use of supported liquid membranes (SLM) as a new generation of electrochemical separators for alkaline batteries and possibly electrowinning of metals. The unique character of SLMs is their ability to use highly selective organic extractants as transport agents, and to compound these transport agents into organic solutions exhibiting high ionic conductivity. Requirements for an acceptable separator were stated to be specificity, resistivity, and cost.

An SLM consists of a liquid ion exchange/solvent system infused into the pores of a hydrophobic microporous membrane. Typical liquid content is 40 to 70 percent. Pemsler described the resulting membrane as consisting of two interpenetrating and largely independent phases: one component is a strong, stable resin and the other a liquid ion exchange reagent. Diffusion rates within the membrane are high, approaching those of ordinary liquid diffusion, and ionic transport proceeds rapidly. Because the membranes are hydrophobic, the organic phase is held in the microporous host by strong surface-tension forces. SLM separators are inherently low in cost, only slightly more expensive than the microporous support alone. Pemsler reviewed the testing of SLM separators as a means of eliminating the penetration of the separator by zinc dendrites that grow on the zinc electrode during the charging cycle of rechargeable nickel-zinc batteries.

Energy converters--i.e., electrochemical devices which convert the free energy change of a chemical reaction directly into electricity--were reviewed by Professor K. Kordesch (Technical University, Graz). He introduced the topic by comparing the relatively high 50- to 65-percent efficiencies of conversion for a hydrogen-air fuel cell to 15 to 25 percent of an automotive-type gasoline or diesel engine converted to operate on hydrogen as a fuel. Kordesch emphasized the merits of a new method for constructing and mass-producing alkaline fuel cells. Multilayered thin carbon electrodes having a high power output and long life can be produced by pressing, rolling and spraying methods. To significantly reduce costs, this porous carbon structure must replace the most expensive components in alkaline cells: the nickel or silver screens or porous backing plates. The use of conductive plastic materials is essential to make larger fuel cell batteries mass-producible. For low-cost production, the traditional battery plate structure with current tabs on the side or top must be changed to the "bipolar" concept being studied by Kordesch.

The importance of porous carbon electrodes for electrochemical systems was stated by Dr. A. Soffer (Nuclear Research Center, Israel). He then described how the properties of porous carbons, which are produced by pyrolyzing solid organic compounds, can be varied by changing the high temperature treatment parameters. By this preparative control of the porosity, morphology, chemical stability, and surface reactivity, the porous carbon can be tailor-made for any purpose.

Energy Conversion: Batteries. The final phase of the symposium dealt with the applied subject of batteries. This was ably introduced by Professor A. Despić (University of Belgrade, and vice president of the Yugoslavian Academy of Sciences), who reviewed the state of the art of metal-air batteries. If the battery is constructed to function on only one load of metal, it is considered a primary energy source. On the other

activity correlated with composition and morphology. Hodes reported good photovoltaic activity for close-packed, relatively smooth morphologies and poor activity for layers with many aggregates of isolated grains. Unfortunately, the photovoltaic activity varied considerably and usually irreproducibly with the preparative conditions. Quantum efficiencies up to 0.7 demonstrate the potential of the general preparative method.

A presentation by Professor J. Zahavi (Technion, Israel) appeared out of place in this symposium, except that commercial electroplating solutions of potassium gold cyanide, gold chloride, or palladium-nickel were used to immerse various test specimens. Zahavi reported results of pulsed-laser-induced plating from commercial aqueous solutions.

Highly selective gold and palladium-nickel deposit spots or lines were produced via pulsed-laser irradiation on semiconductor substrates (Si and GaAs) and on polymeric substrate (polyimide) without recourse to external electric current or masking. Zahavi reported that the metal deposition took place through a photoelectrochemical process followed by interdiffusion of metal atoms into the substrate, to give various types of compounds and better adhesion. Metal deposits showed Schottky barrier contact behavior on GaAs and Si substrates. Increase in laser energy density was followed by intensified metal deposition. The characteristics of the Q-switched Nd-YAG laser-pulse systems were reported to be 10^6 to 10^8 W/cm^2 and pulse width from 7 to 150 ns; wavelength was 0.53 μm and 1.06 μm with a repetition rate from 1 to 10 Hz and from 1 to 5 kHz.

The final paper in this part of the symposium dealt with the all-important topic of testing electrodeposits. Dr. J. Lomaniec (Tadiran, Rehovot) concluded the session by reviewing methods for evaluating the quality of electrodeposits to ensure the plater and, more importantly, the customer of a good-quality product. Thickness, porosity, adhesion, mechanical and chemical tests, and electrical conductivity were described. Actual performance tests are the most reliable and conform to the actual functionality desired. Unfortunately, functional tests are costly, usually interfere with production, and take a long time.

Energy Conversion: Electrodes and Fuel Cells. The second topic of the symposium focused on the broad area of energy conversion--progressing from electrode phenomena and fuel cells to batteries now in commercial production. The topic was introduced by Professor Ernest Yeager (Case Western Reserve University), who, in his usual superb manner, lectured on the challenging problem in electrocatalysis of identifying more effective catalysts for the reduction and generation of oxygen at low and moderate temperatures in aqueous solutions. This timely topic relates to fuel cells, metal-air batteries, industrial electrolysis, corrosion, and sensors. After a review of the three classes of catalysts and the possible reduction pathways, Yeager discussed the mechanisms of oxygen transfer at electrodes in the presence of oxygen-reducing catalysts, such as transition metal macrocycle complexes with phthalocyanines and porphyrins. He used Nafion to secure the catalysts to the electrode surfaces and characterized the species produced at the electrodes by extraction and mass spectral analysis of gases purged from the solutions with nitrogen. The macrocycle complexes as catalysts were reported to represent very promising alternatives to the high-area platinum catalysts that are frequently used now.

Professor A.C.C. Tseung (The City University, Northampton Square, London) reported results of his preliminary study on the semiconducting oxide catalysts cobalt oxide, Co_3O_4, and the effect of hydrogen peroxide on its solubility and that of cobalt hydroxide in 5N potassium hydroxide. The information is important in zinc/aluminum air batteries and oxygen cathodes for the chlor-alkali industry. Tseung discussed an *in situ* activation technique to replenish the cobalt oxides by introducing cobalt(II) ions into the solution and then relying on the hydrogen peroxide produced to convert Cu(II) to Co_3O_4. An excellent discussion followed, with Yeager leading the questioners and supplying the most comments. The major point from the discussion was that anything that can increase the solubility of oxygen in a system will be important in the overall electrochemical process.

A more precise study of structural effects in electrocatalysis was presented by Professor R. Adžić (University of Belgrade, Yugoslavia). He described the pronounced effects of crystallographic orientation of an electrode surface on kinetics and mechanism of reactions. The oxidation of formic acid, methanol, formaldehyde and ethylene glycol on the single crystal platinum electrodes with (100), (110), and (111) orientations were discussed.

Nafion, a perfluorinated sulfonated ion-exchange polymer produced by E.I. Du Pont de Nemours & Co., possesses some

Fundamental Aspects of Applied Electrochemistry

Fundamental Aspects of Applied Electrochemistry, a United Nations Scientific, Educational and Cultural Organization (UNESCO) International Symposium, was held from 6 through 8 May at Kiryat-Anavim Guest House, Israel.

The setting of this meeting at a kibbutz between Tel Aviv and Jerusalem was excellent for stimulating interaction between industrial and academic electrochemists, the objective of the symposium as stated by Mr. Y. Saphir, Director of Israel's National Council of Research and Development. Professor Joe Jazz, UNESCO's head of the Scientific Cooperation Bureau for Europe, said his goals were to stimulate cooperation in sciences and to promote the exchange of scientists and ideas. An important tool for this exchange is the symposium, where environmental concerns, energy, materials, and bioelectrochemistry can be discussed. The chairman of the local organizing committee, Professor E. Gileadi (Tel Aviv University), promised the attendees good lectures, discussions, and surroundings--he kept his promise.

Compared to the Journées d'Électrochimie the meeting was small, with only 60 to 70 attendees. However, one participant remarked that 90 to 95 percent of all the electrochemists in Israel attended. The presentations were made by experts on a given topic, and the discussions that followed were by far the most important aspect of the meeting. In general, the discussions were dominated by Professors Yeager (Case Western Reserve University), Budevski (Bulgarian Academy of Sciences) Despić (University of Belgrade, Yugoslavia) and Gileadi (Tel Aviv University). Although they dominated most discussions, many other people added their remarks to keep the meeting lively.

Electrodeposition. The plating of metals was introduced by Budevski, who reviewed the past and reported on the present status of electrocrystallization, which is the basic process of electrochemical metal deposition. He described the final deposit by roughly dividing the process of formation into two stages: (1) the initial stage, where effects connected with the crystallography of the substrate and the formation and growth of the new phase play a significant role, and (2) the bulk deposition, where interaction of the forming and growing crystallites, diffusion, electric field, additives, etc., can play an additional role. Professor Landau (Case Western Reserve University) focused on the quantitative treatment, engineering modeling, and scale-up involved in the analysis and design of modern electroplating processes. The requirements imposed by modern technology are transforming electroplating practice from largely an art into an exact engineering science with a modern system that is computer controlled. After a review of new developments in chromium plating by Dr. J. Hoare (General Motors Research Laboratories), the session focused on the simultaneous deposition of more than one element--i.e., alloys.

The fundamental aspects of pulse alloy plating were discussed by Dr. D. Lashmore (US National Bureau of Standards). He presented a theoretical model, which may help eliminate time-consuming experiments for determining the dependence of composition of the alloy on the deposition parameters. The objective is to predict the concentration of ionic species in solution under pulsed electrodeposition and hence the alloy composition. Professor J. Yahalom (Technion--Israel Institute of Technology) said that the following are the conditions for the codeposition of two metals from a common electrolyte: (1) both species are soluble in the same electrolyte, and (2) the reduction potentials of both metals are close enough to each other at the required deposition current density. Pulsed polarization, a method used in recent years, was demonstrated for electrodeposition of various binary alloys, such as silver-cadmium, cobalt-chromium, nickel-chromium, and nickel-cadmium. Details of pulse polarization and the parameters controlling the method were presented by Yahalom. He concluded that pulse plating by varying the parameters of the pulsed current is an excellent tool for alloy deposition, which enables quantitative control of alloy composition for a given plating bath.

Professor Gary Hodes (Weizmann Institute of Science, Israel) initiated a program to explore electrodeposition as a method for preparing layers of CuIn-type materials, which could be used as photovoltaic devices. $CuInS_2$ and $CuInSe_2$ (both n- and p-type) and n-$CuIn_5S_8$ films were prepared. He discussed the ternary plating of Cu, In, and S that were co-deposited from an aqueous bath onto titanium substrates. A second method was binary plating, where a Cu-In alloy was electrodeposited onto the substrate. For both methods, annealing was carried out in H_2S or H_2Se at approximately 600°C to give adherent layers of $CuInS(Se)_2$ or $CuIn_5S_8$. The layers were characterized and their photovoltaic

Co-free hard metals using a metal-boron-carbon system. He used 95W-3.5Ni-1.5Fe as the metal and up to 9 weight percent boron carbide as the source for boron and carbon. Some other materials where some of the W was replaced by Mo were also tested. Materials were fabricated by standard powder metallurgy blending followed by hot isostatic pressing and sintering in hydrogen. Hot microhardness, fracture toughness, and abrasion wear testing indicate that these materials may be suitable replacements for the Co cemented carbides.

Several other papers presented evidence that at last some of the Co can be successfully replaced by Ni+Fe. Pastor's approach seems to be one of the most logical and scientific methods.

Several investigators at the Technical University of Vienna, Austria (P. Rogl, I. Smid, J. Schuster, and H. Mowotny), are developing additional thermodynamic data needed to understand the mechanisms involved in the production of hard materials based on the metal-B-N and metal-Si-N systems. These data are necessary to understand the bonding characteristics of Si_3N_4 when joined to metals (often a necessary process when Si_3N_4 is used as a structural ceramic). Complete information about the phase equilibria for Ti-Si-N, Zr-Si-N, Hf-Si-N, V-Si-N, Nb-Si-N, Co-B-N, and Ni-B-N systems was presented.

Many papers were presented which characterized the properties of various hard materials, but to my knowledge, nothing new was included in this information.

6/10/85

Ocean Sciences

MARINE SEDIMENTATION RESEARCH SUFFERS SEVERE SETBACK IN UK

by Dr. Paul N. Boothe. Dr. Boothe is Research Associate in the Oceanography Department, Texas A&M University, College Station, Texas.

The closing of the Institute of Oceanographic Sciences (IOS) laboratories at Taunton, Somerset, has led unexpectedly to the complete disbandment of the sedimentation group (SG) there. Of the approximately 25 scientists and staff members of the SG, only two will remain within the IOS. (For background, see *ESN* 38-10:553-554 [1984].)

Since its creation in 1969, the SG had gained an international reputation for basic research into the effects which waves and currents have on both coastal and shelf sedimentation and sediment transport. The SG did at least 60 percent of the UK's basic research in this area. The SG had a unique capability in research on cohesive sediments (i.e., fluid muds) and strong programs in noncohesive sediments and large-scale processes. Especially unfortunate will be the end of the work in the Celtic Sea on the Shelf Sediment Dynamics Project (SSDP), using the unique, state-of-the-art Sediment Transport and Boundary Layer Equipment (STABLE) instrument package. Under current funding, rebuilding the SG and support staff will be a slow process taking many years. In the interim, the UK's capability for basic research in marine sedimentation and sediment dynamics will be significantly reduced.

Background

The SG at Taunton grew out of a group of scientists working on coastal sedimentation problems within the Hydrographic Department (Ministry of Defense, Navy) next to the present SG facilities. In 1969 the SG was established as a unit of the Natural Environment Research Council (NERC), which is roughly equivalent to the US National Science Foundation. In 1973 the IOS was created when the former National Institute of Oceanography at Wormley in Surrey, the Institute of Coastal Oceanography and Tides in Bidston near Liverpool, and the SG at Taunton were combined by the parent body, NERC, into a single organization. The SG had a broad focus, which included research on both coastal and offshore sedimentation and sediment dynamics. Much of the SG's success and reputation resulted from its theoretical and quantitative modeling approach to a variety of marine sedimentation problems and its capability for developing sophisticated *in situ* sensors to test and expand these models through field and laboratory experiments.

With the closing of the Taunton Laboratory, the IOS planned to keep the SG together, as a functioning unit, by transferring most group members to Bidston and the remainder to Wormley. Previous closings of NERC facilities (e.g., Institute of Geological Sciences sites) had resulted in a staff attrition rate of only 10 percent. Consequently, NERC and IOS were unprepared for the near-unanimous rejection of the Bidston and

Wormley transfer plan by SG members. They were unable to develop any alternative plans in time to avoid the complete disbandment of the group. Only the current SG director, Dr. K.R. Dyer, and one other staff member will be transferring to IOS Bidston. The others will either take early retirement or be scattered among a variety of new jobs in the public (e.g., Ministry of Defense) and private sectors (e.g., consulting firms, universities).

The majority of the UK's basic research in marine sediment dynamics was being conducted by the SG at Taunton. The remaining work is done by researchers at various universities. These efforts involve usually one or at most a few faculty members working primarily on coastal sedimentation problems. These university researchers include Dr. Vincent at East Anglia, Dr. Hamilton at Bristol, Dr. McCave at Cambridge, Dr. Collins at Swansea, Dr. O'Connor at Imperial College, Dr. Pingree at Plymouth, and some others. This university work represents a relatively small effort, which cannot compensate for the well-focused, multidisciplinary effort at Taunton. In the final analysis, offshore (shelf) sedimentation research will probably suffer the most by the loss of the SG.

An important contributor to the SG's success was the Instrument and Engineering Group (IEG) at Taunton. This group worked closely with SG researchers in developing new instruments to measure sediment movement. These include an impact sensor for measuring sand transport rate by detecting the rate at which sand grains hit the transducer. Bedform movement is detected by an acoustic bed level monitor. Another instrument measures the bedload transport by recording the self-generated noise (SGN) of sediments grains as they roll along the seabed. Over the past 2 years much of the IEG's efforts went into developing the new STABLE instrument for use in deeper water on the continental shelf and slope (page 474). The IEG enabled the SG to develop sophisticated laboratory and field experiments to complement its strong modeling effort. Unfortunately, with Taunton's closing a majority of the IEG personnel will be leaving the IOS to take generally unrelated jobs in the private sector.

Cohesive Sediments

The SG had a unique capability in marine sedimentation research. Before the work at Taunton, the field of cohesive sediments had been largely neglected, with most of the emphasis placed on sand transport. Cohesive sediments are important since their appearance in harbors and estuaries causes uncertainty in determining both navigable water depth and the need for dredging. Fluid mud also has significant ecological impact because of its high oxygen demand. Drs. R. Kirby and W.R. Parker of the SG developed an international reputation for their pioneering research on fluid muds which led to the first workable definition of navigable depth under fluid mud conditions. They conducted field research in the Bristol Channel and Severn Estuary (Kirby and Parker, 1983), the Irish Sea, The Netherlands, and elsewhere. Kirby and Parker are both now working as private consultants. Their loss as basic researchers creates a real void in this important research area.

Noncohesive Sediments

This program with the SG was characterized by a very strong theoretical and numerical modeling capability in the areas of sand and gravel transport and bedform dynamics (e.g., sand and gravel ripples and waves; see Davies, 1983; Soulsby, 1983; Langhorne, 1982). This modeling effort was aimed at improving techniques for predicting the rate of erosion and deposition of sediment under varying conditions. Physical models were developed to predict sediment transport as an interaction between surface and tidal waves and currents and the benthic boundary layer and sediment bed described in terms of stratification, bed roughness, sediment movement itself, etc. These models were verified and revised by a variety of field experiments in both coastal (e.g., Swansea Bay, Taw Estuary) and shelf environments (e.g., Celtic Sea). This field work included the use of IEG-developed impact and SGN sensors for measuring the instantaneous rates of sediment transport. Of the primary researchers in this program, A.G. Davies is moving to the University College of North Wales in Bangor. R.L. Soulsby and R.H. Wilkinson are now working for the Institute of Hydraulic Research Limited, a private consulting firm specializing in dredging and sediment management. D.N. Langhorne will be taking a position at the Admiralty Research Establishment in Portland, Dorset.

Shelf Sediment Dynamics Project

The SSDP, which started in early 1982, was a major project within the SG's large-scale processes program. The SSDP was a response to the increasing economic (e.g., hydrocarbons and minerals) and scientific importance of the continental margins. Interest in the

shelf-break regions of such marginal areas has been growing in the scientific literature due to the complex physical oceanographic processes there (e.g., eddies, edge waves, internal waves) and the enhanced biological productivity these processes can generate via upwelling. In addition, there is considerable geological interest in studying sediment transport on the outer shelf and at the shelf/slope break. Information on the rate at which sediment is lost from the continents to the deep oceans via the continental shelf/slope region is required in predictive models for the evolution of continental margins and the growth of continental crust, and has important implications for mass balances calculations in global carbon models. Also, scientists need a better understanding of the mechanisms (e.g., turbidity currents, slumping, nepheloid layers) by which sediment, after being transported across the shelf, is transferred over the shelf break to the slope and rise.

The objectives of the SSDP were to describe and quantify processes involved in the movement of sediment in the vicinity of the shelf edge and to improve our general understanding of the sedimentology and oceanography of the study area. The area chosen was the Armorican Shelf in the vicinity of La Chapelle Bank, which is on the southwestern approaches to the UK in the Celtic Sea. Sediments in the area are largely biogenic and carbonate rich (i.e., average $CaCO_3$=57 percent), with an overall mean grain size of about 500 μm. Due to anticipated delays in development of the STABLE instrument, field work was conducted using conventional oceanographic and sedimentological techniques during three cruises in 1982-84. Data were collected using moored recording current meters and thermistor chains with on-station durations of up to 30 days in water depths of 150 to 3000 m. Extensive salinity/temperature profiles were also generated using CTD and XBT equipment together with sediment sampling, underwater photography, echo sounding, and sidescan sonar surveys.

Analyses of these data have produced several major results. The importance of the shelf edge as a site for the generation of internal tides and higher frequency internal waves has been confirmed. Current pulses have been observed with amplitudes of 30 to 40 cm/s superimposed on peak spring tidal currents of 60 to 70 cm/s. The measurements have shown that these fluctuations extend, with little attenuation, throughout the bottom mixed layer within 2 m of the seabed, where they may play an important role in modifying sediment transport rates (Heathershaw, 1985). Sedimentological surveys on La Chapelle Bank reveal a field of large sand waves (i.e., heights up to 15 m and wavelengths of about 1000 m), extending to the shelf edge and within which the direction of asymmetry changes from on-shelf to off-shelf within a distance of 5 to 10 km along the shelf. Analysis suggests that these features are probably formed as a result of internal wave perturbations on a tidally driven stream of sediment transport (Heathershaw and Codd, in press). Sediment sampling has also shown that variations in grain size and carbonate content of the Bank sediments can be explained by depth-controlled variations in tidal current amplitude and enhanced winnowing of fine quartz sand and the finer shell fragments from the carbonate deposits on the top of the bank (Heathershaw and Codd, in preparation).

The STABLE Instrument and Future of the SSDP

Most of the equipment-development funds at IOS Taunton over the past 2 years went into the remote-recording STABLE instrument package. This package was developed specifically for the SSDP to monitor sediment movement under waves and currents on the continental shelf and slope at depths down to 2000 m. The instrument was designed to be used in a free-fall/pop-up mode to gain information on mean flow and turbulence characteristics near the seabed using a combination of electromagnetic flow sensor and Savonius rotors. Sediment response was monitored photographically and with sediment transport probes (i.e., SGN or impact). Water temperature and pressure sensors were also included. The recoverable (pop-up) instrument payload weight was 90 kg (in water). Bottom duration time for STABLE was expected to be typically 1 month, assuming a data sampling regime of one 15-minute burst every hour. Tank tests on STABLE were conducted in April and October 1984. The recovery system was tested at sea in November 1984. STABLE was scheduled to be used for the first time at the SSDP Celtic Sea study site in the fall of 1985. Data from STABLE would be an excellent complement to those produced by the *in situ* waveguide instrument to be used by the HEBBLE Project (High Energy Benthic Boundary Layer) this fall. This waveguide will be placed on the seafloor at a depth of 4800 m on the lower continental rise south of Halifax, Nova Scotia. This device will

permit direct observations of an enclosed portion of the seafloor under various artificially produced current regimes.

A continuing goal of the SG was to gain a more detailed understanding of the physics involved in sediment dynamics by making increasingly sophisticated *in situ* measurements of sediment transport under various field conditions. One important aspect of such measurements is their temporal resolution. It is well known that the shear stress exerted on the seabed by tidal currents is intermittent because of the turbulent bursting phenomenon. It is also well known that sediment movement at the seabed occurs in bursts. The STABLE instrument was a significant evolutionary development toward temporally resolving such phenomena in the field. Specifically, STABLE incorporated a unique, high-speed data logger, built entirely to SG/IEG specifications, capable of very rapid sensor interrogation. This logger enables STABLE to record even extreme sediment transport events using burst sampling conditions. Such high-resolution data would allow significant improvements in the physical models of sediment transport to be made.

The SSDP was set to enter a very productive phase with the completion of a successful 3-year preliminary field effort and the STABLE instrument becoming operational. The future of the SSDP and the STABLE instrument is now uncertain. Work in the project will not continue within the IOS because of a lack of personnel. Some portion of the SSDP may be continued by a university research group (e.g., University College of Swansea, Wales) but this possibility is very tentative. It is possible that the STABLE instrument will not be used at all.

Dr. A.P. Carr, leader of the large-scale processes group, is scheduled to take early retirement. Dr. A.D. Heathershaw, prime mover on the SSDP, will be taking a position at the Admiralty Research Establishment in Portland. Other staff researchers on the SSDP do not plan to remain with the IOS.

Outlook

The IOS Taunton Laboratories officially closed on 31 August, with control of the buildings being returned to the Admiralty Hydrographic Department. The NERC and IOS are understandably upset by the unexpected disbandment of the SG caused by the Taunton closing. They are committed to rebuilding the SG at IOS Bidston. However, all indications are that such a rebuilding process will be very slow. NERC is currently operating under a new corporate plan which calls for a 30-percent reduction in staff (i.e., 900 employees) over the next 5 years. This attrition will be accomplished by closing approximately 40 of the smaller NERC facilities. Also, there is a trend toward giving a larger proportion of NERC funds to universities and less to in-house NERC facilities. Personnel losses within IOS are expected to be small. However, creating new SG positions at Bidston under these conditions will be difficult. The decision to close IOS Taunton actually predates the new corporate plan. Events leading up to that decision created considerable uncertainty concerning the real commitment of NERC and IOS to support sediment dynamics research. Because of this uncertainty and current funding restrictions, it will be very difficult to hire established, experienced replacements for any new SG positions. More likely, any new positions will be filled by new researchers who will take a few years to become independently productive. The result appears to be that the level of effort and productivity in basic marine-sediment-dynamics research in the UK over the next few years will be significantly reduced (i.e., by at least 50 percent).

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7/11/85

Physics

A REVIEW OF THE PRESENT STATE OF THE ART AT "FIBRE OPTICS '85"

by Paul Roman. Dr. Roman is the Liaison Scientist for Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on assignment until September 1987.

No major breakthroughs, but an enthusiastic (albeit rather commercial) spirit, dominated the proceedings of the Third International Fibre Optics Conference in London. The meeting was organized and partly financed by SIRA Ltd., an independent leading British technology center that supplies R&D, technical services, and even some custom-made equipment for scientific and industrial advanced technology.

The meeting took place from 29 April through 2 May at the Olympia Center. The first day was a high-level tutorial session, and the conference was supplemented by an impressive fiber optics exhibition that formed part of the gigantic British Electronics Week show. There were over 300 participants at the conference, mostly from the UK; but West Germany, France, Sweden, and The Netherlands (in this order), as well as Denmark, Italy, Spain, and Switzerland were also well represented. And there was even one Yugoslav and one US delegate. The exhibitors were mainly British, German, and Scandinavian; there was also a strong showing by the Japanese.

Background

Fiber optics, now an indispensable part of optoelectronics, is the science and technology of transmitting light (mostly modulated and in the infrared, but sometimes in the visible range) through dielectric waveguides. Historically, the idea of fiber optics connections originated from the vision of transmitting audio communication over long distances via tiny fibers instead of copper wires or conventional waveguides. Trunk telecommunication traffic through fiber optics became a promising (but not necessarily economical) reality in the mid-seventies when optical fibers with less than 1 dB/km loss were first fabricated. Of course, development of efficient, cheap, high-powered, reliable light sources (light emitting diodes [LEDs] and semiconductor lasers) and also of high-gain, stable, distortion-free optical detectors (photodiodes of ever-increasing complexity as well as matched amplifiers) was a prerequisite for proliferation. By now, optical fiber communication links with low transmission loss, ultrahigh capacity (wide-band transmission of an enormous number of telephone channels), negligible crosstalk, lightweight and space-saving cables, and immunity from electric and electronic noise interference are quite commonplace. More recently, telecommunication applications have been joined by high-capacity optical data transmission of all kinds, and the ever-decreasing cost of optical communication systems now allows economical (and spectacular) applications in local data links and in so-called local area networks. In addition, optical fibers can be used for illuminating and for viewing hard-to-access areas or spaces, transmitting high laser power over short distances for industrial or medical applications, and, last but not least, for devising both active and passive sensor systems that can detect and measure a very broad variety of physical effects with never-dreamt-of accuracy and speed.

The SIRA conference covered almost all these areas of fiber optics. The major sections of the meeting were very efficiently grouped around the following topics:

- Telecommunications
- Local area networks
- Industrial and hostile environment applications
- Medical applications
- Fiber optic sensors.

Because of my personal judgment regarding direct relevance to the US Navy (and also because of my background), I shall report only on highlights in the first, second, and fifth areas. On request, I will be glad to supply copies of talks in any of the areas and also a list of delegates. Furthermore, I could copy requested sections of the *British Electronics Week Exhibition Catalogue*.

Telecommunications

Optical fiber systems are now being rapidly introduced into telecommunication networks because of such (almost unhoped-for) advantages as low attenuation, large bandwidth, immunity to electromagnetic interference, and small physical size. The trend is toward the use of single-mode fibers and single-mode sources.

I think that the most fundamental contribution in this area was the paper presented by M.R. Mathews, who reported on recent developments in the packaging of single-mode components and their potential impact on the future of single-mode technology. This talk summarized recent progress at the British Telecom Research Laboratories (BTRL). He noted that the feasibility of using single-mode technology in long-haul point-to-point transmission systems is now well established. A few years ago a major concern in the development of these systems was the manufacturability of single-mode transmitters, in which very precise alignment of a single-mode fiber tail with the laser is necessary to achieve an acceptable optical coupling efficiency. For example, even using a spherical lens at the end of a tailored fiber, an alignment of less than 1 μm is needed to achieve 40-percent coupling. Single-mode transmitters are now commercially available but expensive. Indeed, it is the fiber and the cable that dominate the cost. Further reduction of costs for videoband networks will require new packaging techniques. One important problem to solve is the automated attachment of fibers to single-mode devices. In addition, new advanced components and subsystems will have to be developed. Matthews strongly believes that the solution to these problems is the use of monolithic optical integration. Circuits so fabricated would be unaffected by thermal, mechanical, and acoustic interference. But because of possible incompatibility of the materials that are needed to fabricate the different devices required in an integrated optical circuit, BTRL is also investigating an alternative approach to optical integration that uses hybrid techniques. This philosophy makes use of the very wide range of discrete optical components that are already available (including optoelectronic, electro-optic, and purely electronic devices, fiber devices, and bulk optical components). However, hybrid optical integration is critically dependent on the development of techniques for efficient coupling of single-mode devices. As an example of successful implementation of such a program, Mathews described a packaged grating-tuned external cavity InGaAsP/I laser which his lab just developed with the use of hybrid techniques. It operates around 1.5 μm, and the precise wavelength can be selected with a 60-nm range during manufacture. Subsequent tuning is possible over 0.5 nm. The line width is better than 20 kHz, and the laser shows long-term relative frequency stability of better than 150 MHz.

Another, somewhat related paper in this session, addressing a problem of fundamental character, was delivered by Dr. T. Bricheno from the Standard Telecommuncation Laboratories Ltd., England. He talked about wavelength multiplexing by means of low-loss, single-mode fused taper couplers. In previous work he established that fused single-mode directional couplers can be used with high efficiency and stability as beam splitters. In his recent research he constructed a very strongly coupled device which allows for the multiplexing or demultiplexing of two channels located at the low-loss fiber windows at 1.3 and 1.5 μm. With such an arrangement he achieved simultaneous transmission at 140 Mb/s over 30 km of single-mode fiber with a bit error rate less than 10^{-11}. He now experiments with a single-window technique that would allow for transmittal of higher bit rates. The major problem is that no adequate theoretical treatment of the fused coupler exists.

The obvious overall trend in fiber telecommunications systems is to achieve a maximum possible span between repeaters. Apart from fiber attenuation, bandwidth limitations, splicing, and coupler losses, the main factor that limits the span is receiver theory and technology. At this conference, two fine papers dealt with detectors and receivers for fiber optic communications.

K.L. Monham, representing Plessey Research (Caswell) Ltd., UK, talked about high-speed detectors and receivers for high data rates. In his opinion, hybrid p-i-n and field effect transistor detector/receiver combinations proved to be the most promising choice, (even though photoresistor detectors may offer a competition). By now, efficient and safe detection of 680 Mb/s signals has been achieved. Current work at Plessey aims at developing integrated optics receiver circuits with a 2.4 Gb/s capability and a minimum sensitivity of -30 dB relative to the 1-mW level.

H.A. Fatmi, University of London, also talked about fiber optics receivers (his coworker was R.P. Dave, formerly at Pirelli General). Fatmi's concern is to develop a computer-aided method for

designing low/medium-speed fiber optics receivers. He and his colleagues developed a program which requires the user to specify the line rate, required maximal bit error rate, transmitted pulse rise/fall times, peak optical pulse power, extinction ratio, fiber bandwidth, photodiode responsivity, receiver bandwidth, and receiver noise. The program then can calculate items such as signal-to-noise ratio, optimum gain, effects of varying parameters on receiver sensitivity, optimal configurations, and optimal multiplication factor. It can also answer such questions as: "What is the improvement in receiver sensitivity if an avalanche photodiode is used instead of a p-i-n photodiode," or "For a given line rate and transmitter optical power, what is the maximal repeaterless span?" Clearly, the development of this program must have been not only useful for designers but also much fun for the developers.

The rest of the talks in the first day's program appeared to me much too technology-oriented to report here. They were concerned with single-mode connectors and splicing, cleaving, and fusion welding of single-mode fibers.

Local Area Networks

In spite of the evident benefits of available fiber optics technology, so far fiber optics has made relatively little impact on data communications. At the same time, the concept of the local area network (LAN)--which, based on copper transmission, evolved several years ago and promised inexpensive local data communications--had until quite recently failed to make the expected impact. But now it appears that the combination of these two technologies will make a significant contribution to the rapid expansion of LAN systems.

That was the first message well conveyed by the SIRA conference in the area of LAN development. The second message was less positive: apparently very few, if any, commercial LAN systems have been designed from scratch to match the characteristics of fiber optics. Instead, most systems have been designed around copper transmission, or at best to be semi-independent systems. This is unfortunate because the full use of fiber techniques in LANs could offer very wide bandwidths and long hops between nodes. The wide bandwidth could be used to provide integrated transmission of data, and speech and video services with a single access protocol, in contrast to most present systems, which have long packet lengths and make inefficient use of the available bandwidth.

In his impressive address entitled "High Performance Optical LANs," Dr. D.W. Faulkner (BTRL) dwelt first on some of these points and then proceeded to compare the ring and the star network topologies. In his opinion, the ring is a very attractive option because it overcomes the need for a central switch matrix--a function that is currently difficult to realize in optical technologies. Nevertheless, one should not ignore star topologies because they offer prospects of the full transmission bandwidth to each node on the network--thus enabling, for example, the inclusion of broadcast-quality video.

In the rest of this talk, Faulkner described the design and implementation of the serial transmission path (including codec, modulator, transmitter, fiber, receiver, and regenerator) of a system, but avoided details of any particular protocol realization. His group chose 1.3-μm LEDs for the transmitter because they are very cheap, easy to drive, and have proven reliability. The typical mean output power is -19 dBm (the currently popular term "dBm" is read as "decibel measure" and refers to a 1 mW level of reference). It is fed into a 50/125-μm graded index fiber; p-i-n FET and p-i-n BIP transimpedance design receivers were both evaluated, and they both achieved a sensitivity of -35 dBm for a 10^{-9} bit error ratio. The researchers found that transmission over distances of up to 10 km was possible with an adequate system margin. In fact, even the use of a single-mode fiber (with a launch penalty of 14 dB) could be used effectively. The conclusion was (no surprise here) that multimode transmission may be used for distances up to 10 km, and for longer spans single-mode transmission is necessary. A maximum transmission rate of 140 Mb/s was easily achieved; this allows for the transmission of up to 2000 voice or data channels or for a mixture of voice, data, and limited-resolution video services.

In some respects the contribution from NKT Electronik, Denmark, read by J. Maaloe, surveyed related areas. He discussed a combined digital telephone and data network based on a fully fiber optical ring topology. This ringnet has a 8 Mb/s transmission rate and interconnects simple telephone concentrators. All the data and telephone traffic can be multidropped over a large campus. Each telephone concentrator comprises a pair of optical transmitters and receivers. Both LED and laser sources can be used, and simple p-i-n detectors are employed. Here also 1.3-μm light and appropriate graded index fiber with

50/125-μm core to cladding ratio was used for longer (up to 40-km) section transmissions. The speaker emphasized the high flexibility in satisfying complex communication needs.

A third, closely related, paper by D.A.A. Roworth, representing BICC Data Networks Ltd., reviewed the use of a fiber optic inter-repeater-link for replacing the usual coaxial link by a duplex fiber optic cable and replacing standard transceivers by fiber optic transceivers in Ethernet systems. ("Ethernet" is a more-or-less standardized name for a bus-oriented LAN providing a 10 Mb/s data rate, with contention for access to the bus being resolved by a carrier-sensing, multiple access methodology with collision detection.) The design allows for interconnection of segments up to 2-km apart; each segment may be up to 500-m long. More exciting was the second part of Roworth's talk, in which he explained that his firm is now working on the development of a fully fiber-based version of Ethernet. Initial studies indicated that the physical topology of such an all-fiber Ethernet must be rather different from a conventional one. Passive star, hybrid star, and active star configurations are currently being compared.

Despite its highly specialized nature, I want to briefly take note of one more presentation in this area: the talk by Drs. J.P. Dakin and M.G. Holliday (Plessey Electronic Systems Research Ltd.), who described work toward realizing a hybrid protocol fiber databus. Most present-day optical databuses have used a ring system consisting of a large number of point-to-point optical links connected in series. Such a system is vulnerable to either mechanical damage or electronic failure, which may break the ring. This risk can be greatly reduced by using a passive optical distribution system with a fiber optic star coupler. Plessey has developed a new design approach for the electronic protocol necessary to isolate information channels on such a system. The proposed system makes use of both frequency division multiplexing and time division multiplexing. This combination was shown to have particular advantages for high speed databuses, where transit times through the system are beginning to be important. The research demonstrated that such a scheme to link 17 terminals is feasible in a star-coupled arrangement with a total bandwidth of 50 MHz.

The remaining papers in this session were essentially product promotions and will not be reported.

Fiber Optic Sensors

Fiber optic sensors offer many potential advantages for the measurement of a wide variety of physical parameters (ranging from pressure and stress through temperature, flow, level, pH, etc., to magnetic fields and minute accelerations), especially under awkward conditions familiar in military operations and in difficult or hazardous environments. Apart from high accuracy, the advantages of using fiber optic techniques include inherent safety, freedom from electric or radio frequency interference, and reduced weight and size. Interestingly enough, the conference demonstrated that currently there are only a few optical sensors which are commercially available. On the other hand, it also became clear to me that a good deal of research and development work on such sensors is at present being pursued worldwide in government establishments, leading industrial laboratories, and a small but increasing number of university departments.

Fiber optic sensors can be classed into extrinsic and intrinsic types. The former use the fiber system merely to register, transmit, and compare some change in some parameter of light that has been caused by a measurand. In contrast, intrinsic sensors take advantage of optical changes occurring directly in the fibers, whether by an effect on an applied coating (indirect sensors) or by a physical change of the fiber material itself (direct sensors).

In either type, several optical techniques can be used to register the change that indicates a measured parameter variation. These range from simple intensity modulation devices, through various types of wavelength modulation, to quite complex interferometric or polarimetric, maybe phase-modulation, sensors. Various aspects--and the pros and cons of these aspects--were discussed in a lively session, but I shall only highlight some particularly interesting talks or ideas.

In the area of intrinsic sensors the most scholarly paper came from the University of Kent (Drs. J.D.C. Jones, D.A. Jackson, A.D. Kersey, and M. Corke; it may interest readers to learn that Corke is now with Amphenol Fiber Optic Products in Illinois, and Kersey is presently associated with the Naval Research Laboratory in Washington, DC). The work was based on the fact that direct intrinsic fiber optic sensors may use either interferometric or polarimetric (differential) methods. It is well known that interferometric devices have very great measurement precision; but an unavoidable consequence of the high

resolution is the short period of its transfer function, which implies that the unambiguous dynamic range of the system is severely limited. On the other hand, the more recently developed polarometric fiber optic sensors offer much less resolution but a far greater unambiguous dynamic range.

The fascinating idea of the Kent group was to combine the advantages of the two systems. They developed novel optical configurations for a single-mode fiber optic sensor system in which the measurand-induced modulations in both the state of polarization and the overall phase are recovered. The resulting systems thus combine the wide unambiguous range of the polarimetric sensor with the high resolution of the conventional interferometer. In a particular experiment they succeeded in increasing the unambiguous range by a factor of 20 in comparison with the conventional interferometric sensor. Special signal processing schemes yielded phase sensitivities in the mrad to μrad range. (In this particular setup, 1-mrad phase resolution corresponded to a temperature change of 0.1°mK, whereas the unambiguous dynamic range was 10°K.)

The first talk on extrinsic sensors was given by Dr. J.M. Senior, who reported on the work of his group at the Manchester Polytechnic (done *in* partial cooperation with Monicelli Ltd.). He described recent developments on an extremely simple, cheap, and ragged system for pressure measurement, and I am proud to note that *ESN* reported on the first phase of Senior's experiments when the feasibility was still in doubt (see *ESN* 39-3:107-8 [1985]). Consequently there is no need to describe the system again; I only add that the improved prototype used "more frictionless" bearing arrangements, and by this simple step increased sensitivity to 0.05 psi, improved linearity to 1 percent of the full-scale deflection, and reduced the disturbing hysteresis to less than 2 percent. Two hundred new prototypes have already been commissioned by industry.

Another interesting and simple extrinsic sensor, a fiber optic pressure transducer using a wavelength modulation sensor, was described by Dr. J.D. Place from Delta Controls Ltd. This system has, as the displacement sensor, a zone plate with 1800 lines/nm. The operation range is 10 mm when illuminated with a simple white light source (wavelength range: 500 to 1000 nm.) An LED with a 5-nm bandwidth gives, naturally, higher accuracies but a working range of only 1 mm. (The wavelength modulating action of the zone plate arises, of course, from the fact that its focal length is inversely proportional to the wavelength.)

The last paper read in the sensor session reported on quite general and potentially crucial work of Dr. I.P. Giles and his colleagues at the University of Strathclyde. The talk dealt with self-compensating techniques for remote fiber optic intensity modulated sensing. To make a precise measurement, it must be assumed that the variations in the optical intensity perceived by the detector are introduced solely by the measurand. However, this is not always the case, and intensity changes due to aging effects in the source and detector, electronic variations, and optical path changes produce errors. The required stability usually cannot be maintained without employing a calibration technique. Two methods can be used: either continuously recalibrating (by sweeping through the full dynamical range), or providing a reference signal with which to compare the sensing signal. For remote systems, clearly, the latter method is more suitable. The paper discussed a technique to stabilize the system against attenuation effects anywhere in the system, except at the sensor head itself. The experimental results showed a 1-percent stability in measurement for up to 20-dB attenuation in transmitter power.

Conclusion

I think the SIRA conference gave a fair, broad, well-organized view of the rapidly maturing (and commercializing) field of fiber optics. The presentations were a fine combination of basic research, theory, and already well-established technical developments. Discussions were always possible and often they were quite lively. The technical management of the meeting was exemplary.

While an almost panoramic picture was presented, I was surprised to note the conspicuous absence of any discussion of non-silica-based fibers (such as halide fibers) or other, more unconventional fibers (for example, chalcogenide glass or other constructions that are suitable to transmit at longer wavelengths and/or high powers).

5/13/85

OPTOELECTRONICS AT UNIVERSITY COLLEGE, LONDON

by Paul Roman.

The Department of Electronic and Electrical Engineering of University

College, London, is investing most of its resources in the following areas: integrated optics, electro-optical logic devices, Fabry-Perot devices for fast switching, digital optic subsystems with extreme complexity and minimal time-frame action, optical wiring techniques, integrated optic techniques and fiber optic delay lines for signal processing, and distributed optical fiber sensors. This 100-year-old department is in a state of rapid development. Not only has it been receiving, for quite a time, regular external support from the Science and Engineering Research Council, the Royal Society, the Ministry of Defense, the National Physics Laboratory, British Telecom, and the University Grants Committee, but recently it secured a major industrial donation of about £1 million. This will be used to build an entire new floor on top of its current location, housing convenient facilities and possibly including a new clean-room.

Perhaps even more significant is the receipt of an endowment from British Telecom that enabled the establishment of a chair in optoelectronics. Its first holder is Professor J.E. Midwinter (the fifth Fellow of the Royal Society on the current faculty), who is now busy building up a new research group focusing on logic devices based on optical processes. Currently they have three permanent faculty, several visiting scientists, and four graduate students, and they are on the way to adding two postdoctoral research fellows. Capital equipment is also rapidly growing.

Another notable research group in the department is led by Professor D.E.N. Davies and is involved in fiber optics applications, especially in using fiber techniques for signal processing and for sensors. This group is closely associated with the Wolfson Unit of Optical Fibre Instrumentation Systems, which was set up in the department in 1983 to conduct short-term R&D work, involving industrial consultancy, in the area of optical fiber sensors and instrumentation.

This article reviews some highlights of the research in the integrated optics and fiber optics groups.

Integrated Optics Group

Traditionally, optical data and information transmission is governed, at least on the receiving end, by electronics. Hence, while picosecond pulses can be now transmitted without much difficulty, they cannot be used, due to the limitations of traditional electronics. Therefore a trend has developed, both in the US and in some European countries (especially Germany), to extend optical processing as far down the line as possible. It is now well established that integrated optics can be effectively used in devices such as modulators, demodulators, and waveguides. Optical elements also appear suitable for building high-speed logical devices and memories.

There has been much discussion of optical bistable and logic elements both as possible accessories or replacements for digital electronic components or as leading eventually to all-optical computers. Midwinter is somewhat skeptical about this last item. He is particularly concerned about the high power levels associated, for example, with the ZnSe or ZnS bistable devices that are to be used in the first demonstration of an optical computer in an all-European effort. He also wonders about the somewhat long recovery time of these devices and fears that industry will be reluctant to build devices which must be fabricated so differently from the now-customary Si- and GaAs-based technologies. Actually, to characterize the work of his group, he wishes to avoid the term "optical computing" (that tends to generate misleading images, since one cannot see a close analogy to electronic computing). Instead, he established the term "digital optics," pointing out that "it equates well" with "digital electronics."

The digital optics program of Midwinter's group has two major goals:

1. To identify materials, devices, and structures suitable for systems applications.
2. To demonstrate subsystem concepts and establish design criteria for the key devices needed to implement them.

Elaborating on these goals, Midwinter explained to me that digital optic subsystems offer three potential attributes, of which only two are probably of real engineering value.

Firstly, they will operate directly on light signals, thus avoiding optical-electronic-optical interfacing when the remainder of the system is optical, such as in optical sensors or optical fiber transmission. But this is already a well-known trend, and he thinks that, in itself, it is only a minor advantage.

More importantly, however, digital optics promises greater operating speeds in complex system environments. Discrete electronic gates become increasingly difficult to interconnect at switching times under 1 ns and seem unlikely to go

below 1-ps switching speeds--not because of the fundamental properties of the devices themselves, but because of the attenuation, dispersion, and cross-talk properties of electrical wiring at these frequencies. Optical gates can be expected to operate at rates well below 1 ps, and optical interconnect and fan-out with a time skew of subpicosecond magnitude is entirely possible.

The third potential advantage of digital optics lies in the possibility of exploiting "space wiring" rather than "planar wiring." Wideband optical communication can occur through space along intersecting paths with zero cross-talk and huge bandwidth. The challenge is to implement this in a real subsystem environment and to gain some of the promise from "optical parallelism."

A further factor that Midwinter believes to be of great importance in the implementation of digital optic subsystems is an ability to smoothly interface with digital electronics, so spreading the processing function freely between the two, as optimum system design dictates. This implies that an intimate involvement with electronics should be regarded as an advantage rather than a hindrance.

Personally, as far as I can tell, this last statement is a rather unique position and runs counter to early hopes of "all-optical" systems.

In conformity with this general outline of the group's goals, both their theoretical and experimental programs are based upon a number of distinct yet interlocking topics. Midwinter lists them in six groups.

1. His current focal point is the study of GaAs multiple quantum well (MQW) hybrid electro-optical logic devices which, similarly to "self-electro-optic-devices," exploit the phenomena of electroabsorption and of photodetection in active arrays operating at room temperature. Electronic intervention and control is used via electrical coupling between the electroabsorption modulator and the (isolated) photodetector parts of a "cell." Figure 1 shows one unit of a possible (longitudinal) array. The optical output-input graph of this hybrid arrangement is expected to show a sharp hysteresis pattern, where the loop and the levels are electrically controlled, and a large on/off contrast ratio may be thus achieved. These systems would serve as logic, bistable, and electro-optical interface devices. Midwinter aims at optimization for only 100-fJ switching energy at 10- to 100-ps switching speeds. (This would imply only a 10-W power level in an entire logic

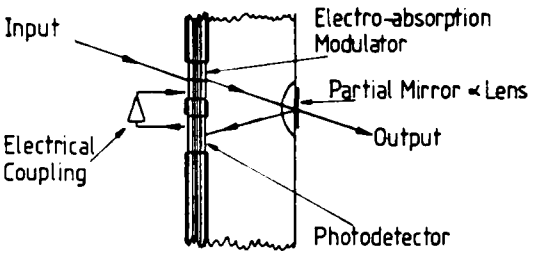

Figure 1. Hybrid electro-optic logic unit.

circuit, as opposed to the kilowatt-to-megawatt dissipation expected if purely optical bistable elements were used.)

2. A second related project is the study of GaAs MQW Fabry-Perot devices for fast switching applications, with particular reference to obtaining fast recovery (10 to 100 ps). Here also electronic control will be used.

3. Additional studies will be conducted of materials with natural response times for the intensity-dependent refractive-index effect in the time frame of 10 to 100 ps. Initially, semiconductor-doped optical glasses will be explored.

4. A more ambitious part of the program is the eventual design of digital optic subsystems with complexities of 1000 or more active optical gates in array formats, and with cycle times in the 10- to 100-ps time frame. Special emphasis will be put on optical shift registers, serial to parallel converters, and fast Fourier transform and sorting algorithms (based upon the optical analog of the electronic "perfect shuffle" method). Application to packet switching and high-speed multiplexing will be explored.

5. Study of space wiring techniques for simple, hard-wired, optical logic arrays is yet another, distinct area to be explored.

6. Demonstration of basic subsystem concepts and experimental study of static and dynamic power-speed optimization for devices, stabilization, and control of device arrays, establishment of a complete and comprehensive digital optic design methodology (based on the experiences gained with the preceding topical studies) is the long-range project of Midwinter's research group.

The Fiber Optics Group

Fiber Optics Signal Processing. One of Davies' primary concerns is a nonstandard application of fiber optics for signal processing. This research is not

concerned with the well-known distribution of signal data flow between subsystems of an extended system (such as a phased array radar), but rather it aims at employing optical fiber delay lines directly to construct, by appropriate configuring, transversal filters, beamforming networks for antenna arrays, radio frequency multiplexing filters for microwave spectral analysis, and pulse repetition frequency selection filters for electronic-warfare-support-measures radar analysis. The basis of his research project is the observation that optical fibers can act as a wide bandwidth time-delay medium. This concept leads to modest time delays (tens of microseconds) but very large (gigahertz) bandwidth. At the heart of the signal processing system is a tapped delay line whose outputs are weighted and combined together to form a transversal filter. The signal taps are achieved without introducing couplers into the fiber--for example, by the use of external piezoelectric phase modulators located along the single-mode fiber. Eventually, the system will operate as a coherent processor with many attractive features, which include reduced optical losses, increased dynamic range, and capability for electronic control of fiber taps. For the reader who wishes to learn more about this research of much relevance to electronic warfare, I recommend Davies' article in *Conference Proceedings, Military Microwaves, MM (84)*, London, pages 269-275, which discusses both the principles and the possible multifaceted applications.

Signal Processing for Fiber Optic Sensors. Another, unconventional, research line of Davies is concerned with signal processing necessary for extracting information from optical fiber sensor measurements, especially in the case of distributed sensors. He demonstrated that these fiber optic sensors can be studied in terms analogous to guided-wave radar systems. His brilliant analysis shows that all optical fiber sensor measurements can be represented as four basic types of measurement, corresponding to time and frequency derivatives of the transmission or reflection coefficient of the fiber transmission line. Davies then used this approach to explain and illuminate the theory of both distributed optical fiber sensors and of passive multiplexing of many fiber sensors. The analysis also indicates the relations between some of the crucial parameters that are involved, including source coherence, range resolution, and the bandwidth-to-repetition rate ratio of the associated optical modulation. The approach can be extended to various fiber network configurations, and it is applicable to both single-mode and multimode systems. A very clear exposition of these fascinating results may be found on pages 285-295 of the recent *Conference Proceedings of the Second International Conference on Optical Fibre Sensors* (Stuttgart, 1985).

Davies told me that his long-range research plans include: (1) multiplexing signals on single-mode fibers, and (2) further advances in distributed fiber sensors, especially time domain reflectometry in an integrated optical system, with 1-mm resolution.

Conclusion

This article demonstrates that the scientists involved in optoelectronics research at London's University College are not following the beaten path. The rapidly developing research activities are boldly embracing stimulating, truly novel ideas and viewpoints that are leading the field.

6/6/85

SUPER-ACO CONSTRUCTION AT ORSAY

by Paul Roman.

Construction of Super-ACO, a dedicated 800-MeV, 500-mA synchrotron light source storage ring, is proceeding essentially according to schedule in Orsay, France. Completion is expected by the fall of 1986. Super-ACO is specifically aimed at operating primarily as a coherent vacuum ultraviolet (VUV) source (very-short-wavelength free electron laser [FEL]).

The ring is being built at the Laboratoire de l'Utilisation du Rayonment Electromagnetique (LURE), a Centre National de la Recherche Scientifique institute of the Université de Paris XI, in Orsay, a southern suburb of Paris.

Background

The LURE synchrotron laboratory originated 13 years ago, when the first local electron storage ring--ACO (short for Anneau de Collision d'Orsay), built in 1965 for high energy particle physics experiments and having a maximum energy of 540 MeV--was converted into a radiation source. In the early seventies a larger ring, with maximum energy 1.85 GeV was added (it is called DCI, short for Dispositif de Collisions dans l'Igloo, a reference to the shape of the

hall which houses it). And that too was used for high energy particle work until early 1985. Now it functions as a synchotron source with stored positron current intensity of about 250 mA and a 40-hour lifetime. Next winter a superconducting wiggler will be installed which will reduce the critical wavelength from 3.4 angstroms to 1 angstrom. Eventually, this ring, like ACO, will be shut down, for with the opening of the large European Synchotron Radiation Facility (probably to be located at Grenoble), it will become redundant. But for a while the site will have three active rings: the historic ACO, the DCI, and the Super-ACO. The layout of the plant is sketched in Figure 1.

The historic achievement of ACO was to produce, for the first time, effective FEL action with very short wavelength. (FEL principles were reviewed in *ESN* 38-4:206-211 [1984] and, from another viewpoint, in *ESN* 39-9:430-435 [1985].) When using a storage ring for FEL, one must insert a straight section which houses a wiggler (or a related insertion device called an undulator; see below). The bunching of the electrons arises here not from the ponderomotive force but from the entire operational mode of the ring, and thus it is steerable. If the bunches arrive in the straight section at the right intervals, the light pulses emitted with the synchrotron radiation peak power's frequency will gradually increase in strength until the gain becomes large enough to overcome the losses. These losses arise mainly at the mirrors placed at the ends of the straight section, turning it into a resonant cavity. Since it is difficult to fabricate low-loss mirrors for VUV radiation, and since, in addition, the gain is proportional to $\lambda^{3/2}$, it is clear that the construction of very short wavelength FELs is not easy. The LURE researchers were successful with ACO because the undulator configuration and the use of an "optical clystron" arrangement permitted the generation of several high order harmonics with an emission brilliance curve envelope that peaked at around the eighth harmonic. (An optical clystron is an arrangement where the undulator consists of two sections interrupted by a gap in which a strong magnetic field, perpendicular to the beam plane, acts.) With the current ACO a gain of value 0.25 could be achieved, which is just marginally suitable for effective performance. But having learned the trade on ACO, the researchers decided to build a machine *specifically* designed for VUV-FEL-work: this is how Super-ACO originated.

Technical Characteristics of Super-ACO

Super-ACO will be optimized for FEL operation. It will have eight straight sections, six of them filled with undulators. An "undulator" is a wiggler using a lower magnetic field so arranged that the maximum deflection angle caused by it is smaller than the natural angular spread of the cone of synchrotron radiation. Under these conditions, strong interference effects may result in a spectrum consisting of a set of narrow harmonic lines. The fundamental harmonic has (in the first approximation) the wavelength $(\lambda_w/2)\ (mc^2/E)^2$, where λ_w is the wiggler spatial periodicity, m the charged-particle rest mass, and E the beam energy. Figure 2a

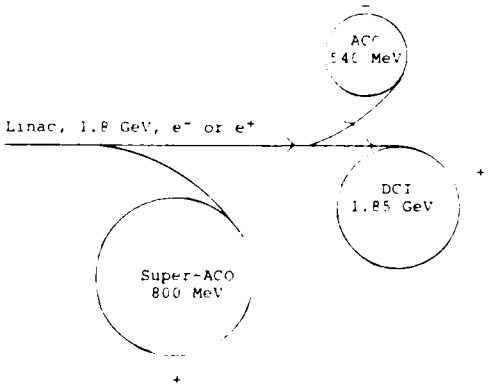

Figure 1. LURE storage rings' layout.

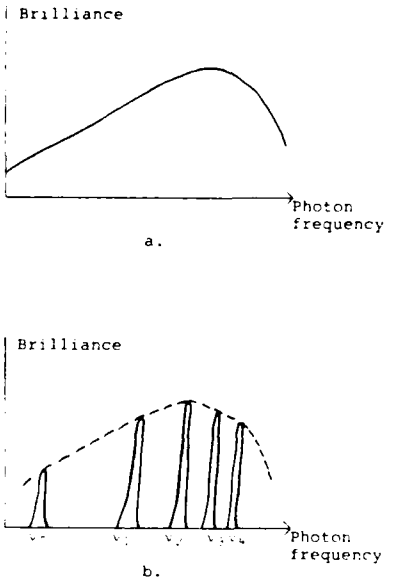

Figure 2. Brilliance spectrum: (a) with no interference effects, (b) with interference.

shows the brilliance spectrum of the synchrotron radiation when no interference effects are at play, and Figure 2b shows the spectrum when an undulator is used and so arranged that harmonics are generated by interference. (The frequency and brillance scales are essentially logarithmic.)

Two of the undulators will be 2-m long, two 2.4-m long, and two 3-m long. Super-ACO will use positrons (rather than electrons), which will be obtained from the presently existing linac. The advantage of using positrons rather than electrons is that there is no emittance growth (most residual ions, which cause trouble for electron beams, are positively charged), and a current lifetime of 50 hours is expected. This is an order of magnitude higher than for the ACO. Super-ACO will have a better brilliance and a 10-times-shorter critical wavelength (hopefully, 0.4 angstroms, as compared to ACO's 4 angstroms). It will have 13 light ports from the bends and six from the undulators (Figure 3), and its circumference will be 72 m. As already stated, the maximum operational energy is scheduled to be 800 MeV and the maximum current 500 mA. The maximum radiated power will be 10 kW. The radio-frequency (RF) system to be installed initially will work on the 24th harmonic of the rotational frequency, which comes to about 100 MHz. The aluminum cavity has an internal diameter of 1.46 m. Plans are ready to replace this system by one working at the 120th harmonic (approximately 500 MHz).

An idea of the magnitude of the entire enterprise can be gained from considering the vacuum system. The stainless steel chamber (equipped with copper absorbers) will be pumped out by seventeen 600 L/s titanium sublimation pumps, eight 500 L/s integrated ion pumps in the bends, and sixteen 400 L/s lumped ion pumps--amounting to a total pumping speed of over 20,000 L/s, evenly distributed around the ring. After the initial *in situ* bakeout at 250°C, the static pressure is expected to be less than 1×10^{-10} Torr.

In normal (800 MeV) operation the horizontal and vertical emittances (product of spatial and angular spread in each plane) will be 3.7×10^{-8} mrad and 3.7×10^{-9} mrad, respectively. The energy spread is expected to be about 5.3×10^{-4}. In another optical configuration, at 400 MeV, the emittances should be 2.8×10^{-8} and 2.8×10^{-9} mrad, while the energy spread reduces to 2.6×10^{-4}. An additional feature of this mode of operation is that, after the 500 MHz RF system is installed, the bunch length will be no more than 1 mm (with a possible factor 4 shortening from potential well effects). But with the initial 100 MHz RF system, in both optical configurations the bunch length will be about 42 mm (with a possible considerable lengthening expected because of turbulent instability).

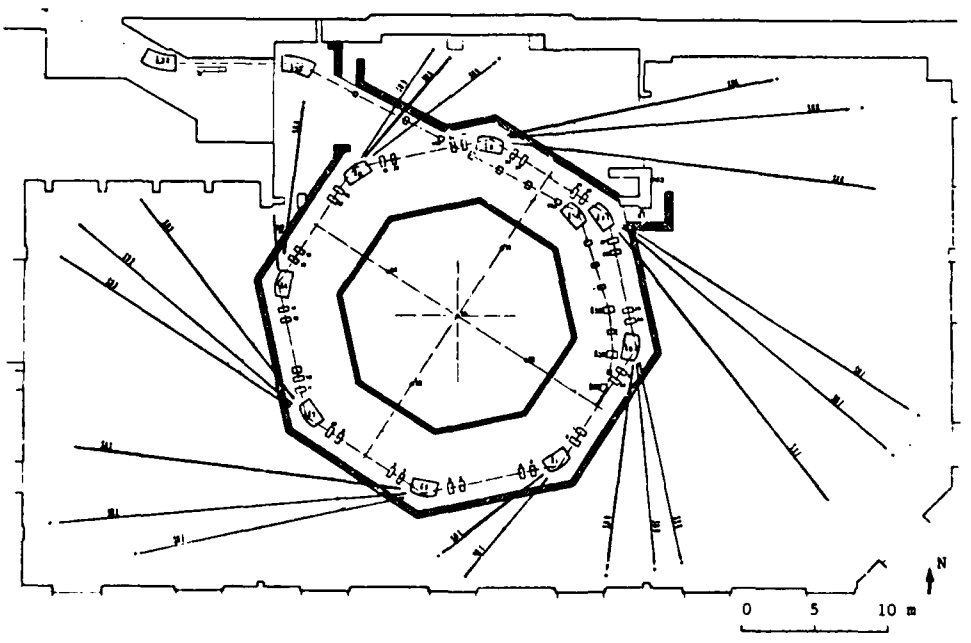

Figure 3. General layout of Super-ACO.

Outlook

The 2000-m^2 hall, which is to house Super-ACO, and the ancillary buildings have already been completed, even though the foundation concrete floor was defective and had to be torn up recently. The bending magnets of the ring have been delivered and are now being tested. The remaining magnets and the beam transport line are still under construction. Delivery of the power supplies will start next summer. Hardware components of the vacuum system are ready and will undergo testing; the construction of the vacuum chamber has also started. The computer system component modules are being tested, as is the model of the interconnecting local area network. But other crucial elements, such as the RF system, the pulsed injection magnets, and the beam diagnostic equipment have not arrived yet.

By the time Super-ACO becomes operational, the personnel will consist of 170 engineers, technicians, and administrators; 30 permanent staff scientists; and 45 scientists associated with other institutions--a total of 245 people, to be contrasted with the tiny staff of five when LURE started in 1972. The total annual budget (including salaries) will be about F70 million (approximately $7.8 million). Of course, these figures include not only the FEL group but also all other staff--which, incidentally, is quite multidisciplinary: solid state physicists, chemists, biologists work well with the electromagnetic radiation physicists and electrical engineers.

The institute's energetic director, Professor Yves Petroff, told me that long-range plans include the construction of a small 800-MeV linac FEL, and eventually the construction of a large superconducting cavity linac, with multiple application areas.

6/5/85

News and Notes

VDTs NO RISK, SAYS SWEDISH MEDICAL STUDY GROUP

Recently, there have been several claims for higher-than-normal rates of birth defects and other pregnancy problems among groups of US and Canadian workers who use video display terminals (VDTs). As a result, there is increased concern on the part of the general public, labor unions, and scientists. However, according to a major study just completed in Sweden, pregnant women who work with VDTs do not run a higher risk of miscarriages or delivering babies with birth defects. The study was conducted by the National Board of Occupational Safety and Health with the support of the Board of Health and Welfare. The results of the study--which appeared in a recent issue of *Lakartidningen*, the Swedish medical journal--do, however, indicate that the total work situation in which these women find themselves is often more stressful than normal (B. Knave et al., *Lakartidningen*, Vol 82, No. 9 [1985], 689-712).

The investigators felt that on the basis of what is known today, there is no medical reason to recommend that pregnant women be exempted from working with display units. One of the leaders of the study, Dr. Ricardo Edström, said that if a woman is worried, particularly is she has had difficulties with a previous pregnancy, that is sufficient reason to comply with her request for a transfer to other duties.

The study looked at 10,000 pregnancies in 1976-77 and 1980-81 among three groups of women whose exposure to VDTs was deemed to be low, medium, or high. There appeared to be no significant difference between the outcome of pregnancies for the two periods, despite a large increase in the use of office computers and VDTs during the interval. The first group included such categories as bank tellers and librarians; the second, insurance secretaries; and the third, employees at travel agencies and computer centers. The groups were selected to be as similar as possible from the socioeconomic point of view.

There was no difference found in the pregnancies that could be correlated to how much the women worked with computers. Among the 10,000, a total of 552 problem pregnancies were found. This included all miscarriages, stillbirths, and births in which the infant weighed less than 1500 g.

The data for the study were taken from detailed questionnaires, sent to the women, concerning their working environment and general state of health during pregnancy. There was a 93-percent response. In studying the responses, the investigators noted an apparent connection between problem pregnancies and those women reporting high exposure to VDTs, more than 40 hours per week. It was decided that this was a highly unlikely frequency, and this was deemed to be evidence of a psychological mechanism

based on the premise that women who have miscarriages or unsuccessful childbirths are eager to find a cause for their misfortune, and tend to exaggerate their exposure to presumed risk factors (sic). It was also noted that frequency of smoking, a known threat to the fetus, was higher among VDT workers.

I spoke recently with an official of the Board of Occupational Safety and Health, which has conducted another study of the exposure to VDTs on human health. That study concluded that it is difficult to make any connection between subjective complaints and fields that can be measured, or physical symptoms that can be diagnosed by a physician. One exception to this might be eye strain. This sometimes does occur when a long time is spent reading a poorly illuminated screen or one in which there is poor contrast between the characters and the background. This situation can be improved through the use of better designed displays and has nothing to do with other effects.

Thomas C. Rozzell
7/5/85

MEAT-SPOILING BACTERIA IDENTIFIED

Two scientists at the Swedish Meat Research Institute in Kävlinge claim to have identified the bacteria that cause meat to spoil. If their discovery is substantiated, it could lead to improved methods for the handling and processing of foodstuffs and to longer shelf life for packaged meat.

Over the last 5 years, Drs. Molin and Ternström studied and described 250 strains of the bacterial family *Psychrotrophic pseudomonas*. They used 174 biochemical and physiological tests and found a cluster which they say could represent a new species of bacteria. They have named the species *Pseudomonas lundensis*, after the nearby university town of Lund.

The newly described bacteria are, in fact, two strains, although the name of the second, *Pseudomonas fragi*, has been used for a long time without scientific justification. Both strains of bacteria thrive on meat and other organic substances, which they break down into carbon dioxide and other products. The bacteria apparently find the energy they require for this process in lactic acid, glucose, and amino acids in meat. They become active at 12°C, a temperature commonly found in household refrigerators.

Molin and Ternström have published their findings in the *Journal of General Microbiology* (Vol 129 [1983], 285-291). They acknowledge that other scientists abroad have carried out similar research, but the Swedes maintain that they have actually succeeded in identifying for the first time the bacteria responsible for the decay of meat.

Thomas C. Rozzell
7/5/85

YET ANOTHER BREAKTHROUGH IN OPTICAL TELECOMMUNICATIONS

Recently I reported an impressive, and already commissioned, technical breakthrough by Siemens in optical communication (see *ESN* 39-8:397 [1985]). Now news has reached me from Plessey Research (Caswell) Ltd., UK, about yet another "first," this time still in the laboratory environmental framework.

The Plessey scientists succeeded in transmitting data at the rate of 1.3 Gb/s, error-free (they say), without a repeater, to a distance exceeding 107 km. This data rate corresponds to about 16,000 simultaneous telephone channels.

In addition to the high data rate and long-range characteristics of the transmission, the significance of this result is that, in contrast to other experimental systems of this kind, no "single-frequency" laser was needed. Unlike the conventional laser source Plessey used, single-frequency lasers are still at the research stage.

Apparently, the secret of success lies in the use of a new, very high quality, dispersion-shifted, single-mode fiber. This particular fiber was developed by Corning Glass Works. Another collaborator in the experiment was the UK firm BICC, which tubed and spliced the 5-km fiber lengths into the full 107-km transmission line.

Paul Komar
6/21/85

"AQUALLOY POLYMERS"--A NEW CLASS OF HYDROGELS WITH MANY USES

In delivery systems for the controlled release of bioactive substances, such as drugs and pesticides, hydrogels--i.e., polymers which can absorb

water in large quantities--are increasingly being considered adequate materials for rate controlling matrices or membranes. The June newsletter of the TNO, The Netherlands Organization for Applied Scientific Research, reported new hydrophilic polymer alloys, or "Aqualloy polymers," which overcome most of the common drawbacks of other polymer systems--such as high cost, inability to be thermoplastically processed, and only a small number of parameters available for adjusting the release profile. (For information about work on hydrogels in Scotland, see *ESN* 39-5:187-190 [1985].)

The Aqualloy polymers are homogeneous mixtures of hydrophilic, maleic-anhydride copolymers (mostly a copolymer of styrene and maleic-anhydride-PSMA) and hydrophobic polymers such as polyvinyl acetate (PVA), cellulose acetate (CA), or polymethylmethacrylate (PMMA). The alloy forms when the solvent used to dissolve the constituent components is evaporated at an elevated temperature.

The maleic-anhydride groups, which are hydrolyzed, in the PSMA copolymer are responsible for the molecular interaction between the alloy components. The nonhydrolyzed groups remain inactive in the alloy till they are activated by contact with water and subsequently during the final use cause the alloy to swell. The number of maleic-anhydride molecules in the alloy determines the hydrophilicity, which can be altered by a change in the mixing ratio. In addition, a time lag, varying from seconds to weeks, can be built into the alloy by regulating the rate of activating the maleic-anhydride groups toward water absorption.

The hydrophilicity also can be increased or reduced significantly by chemically reacting the maleic-anhydride groups of the bulk or surfaces of Aqualloy polymers with suitable polar molecules. This type of modification may be an essential step in the formulation of, for instance, loaded Aqualloy polymers for controlled-release applications in their final morphology.

The physical properties of the alloy are determined by those of the original alloy components, and by such additives as plasticizers and fillers. This results in another unique property of Aqualloy polymers: thermoplasticity, which allows the material to be extruded, blown, or spun into such physical shapes as granules, foams, foils, and fibers. Moreover, Aqualloy polymer granules can be ground to powders (down to 50 microns) by means of cryogenic grinding techniques.

Aqualloy polymers appear to have a wide variety of applications. Of special interest are the applications in controlled-release systems. Bioactive materials that are incorporated into an Aqualloy polymer matrix can be delivered at a controlled rate. Release of these materials is basically water-activated. Thus, the bioactive material is not released until the product makes contact with water: body water, rain, dew, or soil moisture cause swelling and propagate the release. If necessary, the swelling process can be delayed.

The controlled-release properties find several important applications. For example, improved protection against attack by microorganisms in timber constructions is achieved by putting fungicide-containing alloy granules in those places--e.g., at the junctions of frames, where water penetration may occur. Fungicide is released when and where water penetrates. The water, which usually conditions the wood for fungi attack, now transports the fungicide. When the wood dries, the release is stopped, and the fungicide is left in those places in the wood where it has been deposited.

Another application is in integrated pest control, where beneficial insects or predators have to survive, whereas harmful insects have to be killed. Matrix formulations have been developed which remain inactive under conditions normally encountered on humid leaves. After spraying the micronized formulation on leaves, one finds minimum contact toxicity to predators. Caterpillars eating these leaves are killed because the elevated pH in their stomachs causes the formulation to swell rapidly (Figure 1). During swelling, the pesticide is released from the polymer at sufficiently high rates to kill the caterpillar.

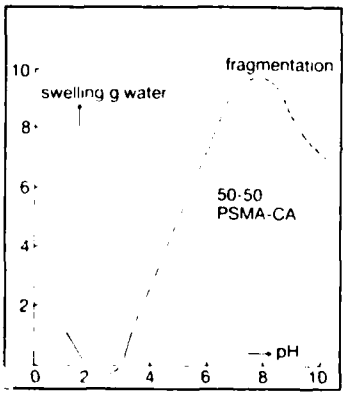

Figure 1. Degrees of swelling of PSMA-CA (50-50) Aqualloy polymers in water at different pH.

The exclusive rights of the Hydrophilic Polymer Alloys are owned by Aqualloy B.V., The Netherlands. In 40 countries, patents have been obtained or are pending.

David L. Venezky
7/11/85

ISRAELIS USE HUMAN HYBRIDOMAS TO SHED LIGHT ON AUTOIMMUNE DISEASES

Autoimmune diseases are mysterious ailments that cause the body literally to attack itself. Their cause is unknown, but recent research by a Tel Aviv University scientist has shown how an infecting agent, such as bacteria, may trigger the condition.

Found mainly in young women of childbearing age, autoimmune diseases break down the immune system. Instead of producing antibodies to fight infection, victims of autoimmune disease produce "autoantibodies," which attack healthy tissues--the skin, the joints, the central nervous system, or the kidneys. Hundreds of autoimmune diseases have been identified, but one of the most serious is systemic lupus erythematosus (SLE), which affects the kidneys and may lead to renal failure and death.

Now Dr. Yehuda Shoenfeld, professor of medicine at Tel Aviv University's Sackler Faculty of Medicine, working with Dr. Robert S. Schwartz and Dr. David Stollar of the New England Medical Center in Boston, has used the hybridoma technique to demonstrate the mechanism of binding of autoantibodies to normal tissues.

Hybridomas were first developed in the mid-1970s by Dr. Cesar Milstein and Dr. Georges Kohler, winners of this year's Nobel Prize in medicine. The technique involves three steps. A mouse is stimulated to produce a particular antibody. Then the mouse lymphocytes are fused with malignant mouse cells. The cells resulting from the fusion, called hybridomas, have the characteristics of both parent cells; the malignant cells make them capable of reproducing infinitely, and they are able to generate the specific antibody desired. These antibodies, called monoclonal antibodies, or MCAs, are used extensively today in immunology research and diagnosis.

Shoenfeld and his colleagues were among the first to produce human hybridomas, using lymphocytes from patients with SLE, who are, so to speak, already immunized--against themselves. The two scientists used the MCAs produced by these hybridomas, as well as autoantibodies from the SLE patients, in experiments with tuberculosis bacteria.

Previous research had shown that tuberculosis was associated with autoimmune disease. Autoantibodies had been found in TB patients, and a vaccine used against TB caused autoimmune symptoms. Shoenfeld and his colleagues showed that the association was valid, and helped to define the mechanism used by invading agents to trigger autoimmune disease.

Shoenfeld hopes these discoveries will one day lead to treatments for SLE and other autoimmune afflictions. He also wants to apply the hybridoma technique to cancer research. "We have succeeded in producing a hybridoma using cells from a woman with breast cancer, which secretes monoclonal antibodies against breast cancer antigens," he said. Working with Professor Iafa Keydar, dean of the George S. Wise Faculty of Life Sciences, and Dr. Amnon Hizi of the Sackler Faculty of Medicine Department of Histology and Cell Biology, Shoenfeld demonstrated that the antibodies from this hybridoma react with the antigen from a mammary tumor virus from mice.

"This could mean that there is a human counterpart with characteristics similar to that of the mouse antigen. If this is so, we will someday be able to diagnose breast cancer more efficiently and develop more effective treatments for it."

Larry E. Shaffer
7/9/85

THIRD WORLD TO SET UP MAJOR BIOTECHNOLOGY RESEARCH PROGRAM

This year third-world countries are initiating a major program of genetic research to overcome hunger, disease, and energy problems. The world's first International Center for Genetic Engineering and Biotechnology devoted to the needs of developing countries will be based at two locations: New Delhi, India, and Trieste, Italy.

A special United Nations Industrial Development Organization (UNIDO) committee has discussed a plan of work as well as financing for the center, establishment of affiliated countries, and appointment of a project leader to supervise setting up of the center. As envisaged in a UNIDO secretariat paper, the

work plan will consist of three phases. The first focuses on preparation for constructing provisional and permanent facilities in New Delhi and Trieste. The second consists of preparatory activities before the center's operations can begin. The third marks the commencement of operations in the provisional facilities.

Affiliated centers will be established to participate in the main center's training, research, and development activities. Thus far, offers have been made by Algeria, the Andean group of countries, Argentina, Bulgaria, China, Cuba, Egypt, Indonesia, Mexico, Tunisia, Yugoslavia, and Zaire. Besides research and development, training of scientific and technological personnel from developing countries--both at the center and elsewhere--will be one of the project's chief functions. Advisory services will be provided to members to develop national technological capabilities. A program of bioinformatics is planned as well as collection and dissemination of information.

Claire Zomzely-Neurath
7/12/85

EEC TARGETS BIOTECHNOLOGY "CONCERTATION"

The Council of Ministers of the member states of the European Economic Community (EEC) has agreed on a 4-year research program in biotechnology for 1985-89. The price tag, $35 million, is about half of what the EEC Committee asked for in its six-point, April 1984 proposal. The money covers just two projects: a program for research and training, and a "concertation" of policies and actions. It is not yet clear how the funding reduction will affect the plan.

The proposal's other points, not yet approved, are: (1) a plea for new regimes on agricultural outputs for industrial use, (2) an agreement on regulation, (3) a program to achieve agreement on intellectual property rights (harmonizations of patent law), and (4) a program to start demonstration projects.

The new research program follows a 1982-86 initiative on biomolecular engineering, which emphasized research on enzyme technology and plant genetic engineering. The recent program has a wider scope. In addition to research projects, it aims to promote transnational cooperation among the members of the EEC and the transfer of biotechnology from universities to industry and agriculture.

Fernand van Hoeck, director of the program, says that the EEC fears that if it does not stimulate cooperation in biotechnology, Europe will soon lag further behind the US and Japan. "In the analysis of the US Office of Technology Assessment (OTA)," he says, "the US sees Japan as its main competition in the field. Europe isn't seen as a serious player in the biotechnology game." According to van Hoeck, the problem is that the efforts of individual EEC member states are fragmented. "You can't compete," he says, "if your home market is as small as most home markets of the member states are."

The official document underlying the Council of Ministers' decision states that a cooperative European home market is needed for the EEC to be competitive. The report leans heavily on US Office of Science and Technology Policy and OTA strategic information to describe Europe's position.

Under the EEC program, the staff will monitor developments in biotechnology and related fields like environmental affairs and Europe's cooperation with third-world countries. It will also assess the social dimensions of biotechnology--at a cost of about $4 million over the next 4 years.

The research and training program is divided into two subprograms called "contextual" and "basic." The basic subprogram will receive the main part of the money, $27 million; the contextual subprogram gets $4 million. Both have begun, following the official go-ahead in March. Some other program points (regulation, patent harmonization, and demonstration projects) have made a small start.

The basic subprogram is to a large extent a continuation of the biomolecular engineering program. Later, attention (and money) will be paid to research and training in cell and tissue culture, and developments of test methods and scientific assessment of the risks associated with certain modern biotechnologies--e.g., recombinant DNA.

The contextual subprogram is meant to build up a European infrastructure in bio-information (programs, databases) and culture collections. (For information on the CUBE subprogram, see next page.) This infrastructure, partly based on already existing institutes, must be accessible to European industries and research institutes.

An important aim of the EEC program is to keep young researchers from relocating to the US. In support of this

goal, apart from grants for contract research, much of the funding will be put into long- and short-term training grants for scientists. Researchers will work for varying periods--a few weeks to a few years--in institutions outside their home countries.

One of the main problem areas remains the new regime on agricultural products for industrial use. Europe sets the prices of agricultural commodities--higher than world levels. These products are then too expensive to serve as feedstocks for biotechnological industry. Proposals for new regimes for sugar and starch have met with resistance from growers. A European strategic-forecasting group is studying this problem--whatever it recommends is bound to be met with more dispute.

As for the two approved points of the program, one question overshadows all others: will $35 million prove enough to strengthen the EEC's position in world biotechnology? The general view is that Europe plays an important role in the scientific aspect of biotechnology, but that it lacks an infrastructure for commercialization and, historically, a mechanism for harmonization. However, it is hoped that the relatively small amount of funds will be enough to serve as a catalyst.

Claire Zomzely-Neurath
7/15/85

EEC BACKS BIOMASS

The European Economic Community (EEC) will extend its research into the most effective routes for generating ethyl alcohol from biomass. The basis is the 1989 target date for lead-free petroleum in Europe and stricter emission controls starting in 1988.

The anticipated need for blended fuel meshes well with the increasingly embarrassing question of how the EEC should deal with its agricultural surpluses. Now gasohol will form a major target of the Community's biomass policy, which has been allocated 20 million ECU over the next 4 years (1 European Currency Unit is about $0.78). Speakers at a recent conference in Vienna, Austria, estimated that 32 million tons of ethanol could be produced each year from the 900 million acres of EEC land that currently generate surpluses.

EEC member countries also agreed recently on a 4-year program of research and training in biotechnology (see preceding page). Some 55 million ECU will be spent during the period up to 1989. As well as biomass studies on topics such as lignocellulose conversion, the program will embrace protein engineering, artificial enzymes, and industrial applications of gene transfer. However, a redirection in the budget below the figures originally discussed means that investigations into the genetics of higher plants have been dropped from the program of research.

Claire Zomzely-Neurath
7/15/85

EUROPEAN BIOTECHNOLOGY SERVICES

Europe is setting up new services to improve information exchange in biotechnology.

CUBE

CUBE, the Commission of the European Communities' Concertation Unit for Biotechnology in Europe, provides a focal point for European activity in biotechnology. It comes under DGX11, the commission's directorate general for science, research, and development. Its role, briefly stated, is to monitor strategic developments in biotechnology worldwide and to make recommendations in community strategy, to promote collaboration and the exchange of information between member countries, and to facilitate the coordination of activities within the commission itself. CUBE was formally set up in February 1984 to help implement recommendations from the Forecasting and Assessment in Science and Technology team. Some of CUBE's specific activities include providing the secretariat for the commission's task force on biotechnology information, providing representation and advice in international forum's and for conferences, and commissioning study contracts. For all this, CUBE has just three principal staff members: Mark Cantley, Ken Sargent, and Albert Saint-Remy. CUBE can be contacted at DBX11, rue de la Loi, 200, 1049 Brussels, Belgium. A particular interest of CUBE has been the application of computing to biotechnology. Together with the commission's information technologies and telecommunications task force a program of work on bioinformation has been set up. Ten contacts have been arranged so far.

Data Banks in Europe

A move to coordinate European activities in nucleic acids and protein sequence data was made at a European

Economic Community (EEC)-sponsored workshop held in Rome, Italy, from 23 through 26 May, with participants from all EEC member states, the US, and Japan. It seems that the future lies with networks of national systems, rather than large central facilities. Attention will also have to be given to software portability, user training, and easy communication via electronic bulletin boards.

CODATA, the EEC's commission on data banks, has already established a task force to stimulate international collaboration in the use of protein data banks.

Claire Zomzely-Neurath
7/12/85

EUROPEAN BIOTECHNOLOGY INFORMATION PROJECT

The European Biotechnology Information Project (EBIP) offers an information service in biotechnology to industry and research workers. EBIP has been set up with the help of funds from the Commission of the European Communities and will be collaborating with other European information centers. Information is vital for the progress of industry and research, but in biotechnology it is often fragmented and difficult to find. EBIP draws together and exploits the publications, on-line computer services, and other sources that cover biotechnology, including scientific and technical information, business, news, patents, culture collections, and regulatory affairs.

The following are information services provided by EBIP:

1. Enquiry service--the EBIP staff uses the resources of the British Science Reference Library to deal with queries on all aspects of biotechnology.
2. Publications--information guides to key sources and topics appear regularly; new publications are announced in the EBIP newslettter sent to all members of the mailing list.
3. Seminars--1-day courses for business users and research workers are held several times a year.

The EBIP newsletter and information about EBIP guides and services can be obtained by writing to the following address: EBIP, British Library Science Reference Library (Aldwych), 9 Kean Street, London SC2B 4AT, England.

Claire Zomzely-Neurath
7/12/85

BIOTECHNOLOGY FIRMS BACK "CLUB" NAMED BIOSEP

BIOSEP, the new "technology-transfer club" for biotechnology industries, was launched recently by the Harwell and Warren Spring Laboratories, UK. BIOSEP has been set up to develop the large-scale biotechnology separation technology (downstream processing) which is essential for the industrial application of major advances in biotechnology.

BIOSEP already has 38 members, including some of the world's largest biotechnology, food, and chemical engineering companies. The club provides the mechanism for transferring the results of downstream processing research and development. Its aim is to provide information rapidly and in a form which can be easily used.

BIOSEP's services include design studies, design data, and state-of-the-art reports which can be used immediately in the design, construction, and operation of separation plants. The club's activities are based on major research and development programs funded by the Department of Trade and Industry and carried out at Harwell and Warren Spring. Both laboratories have been designated by the Department of Trade and Industry as UK centers of expertise in biotechnology.

Research priorities for the technology transfer program have been agreed upon by the members of the club. Key BIOSEP research topics include membrane separation processes, absorption and chromatography, and primary solid-liquid separation, including a downstream processing database. This will be used to provide specialist literature searches for members and to produce a regular BIOSEP information bulletin.

BIOSEP membership fees are linked to company turnover, with overseas-based companies paying a surcharge determined by the degree of their involvement in the UK economy.

For further information, contact Mr. Martin Lewis, Commercial Manager BIOSEP, Bldg 329, Harwell Laboratory, Didcot, Oxon OX11 ORA, UK.

Claire Zomzely-Neurath
7/12/85

NEW BIOTECHNOLOGY CENTERS IN THE UK

Work at the Leicester Biocentre and Cranfield Biotechnology Centre is part of a recent initiative in the UK to stimulate biotechnology research (see *ESN* 39-7:347 [1985]).

Leicester Biocentre

In response to an identified and growing need for cooperation between the industrial and academic sectors, Leicester University--with support from several industrial sponsors and the Biotechnology Directorate of the Science and Engineering Research Council--has recently established a unique type of research center, the Leicester Biocentre. The Biocentre is seeking a rapid transfer of ideas and high technological developments in biology from university to industry. In addition, it aims to guide academic research into areas of commercial significance.

Taking advantage of the expertise available at Leicester University in recombinant DNA technology, the Biocentre is concentrating initially on a number of themes, such as studies of the mechanism of DNA replication and gene expression in yeast and higher plants. The research areas will be expanded to include surface protein biogenesis, mammalian virology, and the control of gene expression in mammals, including primates.

The Biocentre will also offer facilities for contract research which will be undertaken in areas where the expertise from the basic research program--i.e., gene cloning, expression, and transfer--can be expected to make a significant contribution to the goals of contract projects. The Biocentre, which has close links with several university departments, intends to provide opportunities for the training of both industrial and academic personnel in the techniques of *in vitro* gene manipulation. The Biocentre will also provide consultancy services as well as courses and seminars.

Professor I.J. Higgins, Director of the Cranfield Biotechnology Center and Leverhulme Professor of Biotechnology at Cranfield Institute of Technology, was appointed director of the Leicester Biocentre in December 1984. He is forming a new association to take full advantage of the strengths of Leicester Biocentre and Cranfield Biotechnology Centre in the development of biotechnology in Britain, and he is building on the strong links already established with industrial organization.

Cranfield Biotechnology Centre

This center was created in 1981 under the directorship of Britain's first Professor of Biotechnology, I.J. Higgins. This chair was established and financed by the Leverhulme Trust.

Cranfield Biotechnology Centre is a contract research organization which also provides advanced training facilities for postdoctoral fellows. It is housed in well-equipped modern laboratories attached to a suite of offices. The next phase of development will extend work in several key areas and entails provisions of accommodation for a staffing level of over 100. The center has been developed with assistance from industry to relate its activities closely to industrial needs, and from academic and technological institutions to provide industrially oriented postdoctoral training in biotechnology. The center has also adopted a deliberate policy of collaborative research with both industry and academia.

The current research interests include:

1. Biofuel cells, electrocatalysis, biosensors for clinical research, environmental monitoring systems, fermentation and process monitoring, and biosensors for the food industry in the Bioelectrochemistry Division.
2. Investigation of microbial transformations to devise industrially viable biocatalytic processes for chemical conversions. In addition to specific transformations, they are also studying the fundamental physiology and biochemistry of carbon-one oxidizing bacteria. Bacterial strains with a high capacity for biosurfactant production for uses in oil recovery are being developed.
3. A contract research and testing service to industry and government as well as long-term fundamental studies in environmental microbiology are provided by the Biodeterioration Division.
4. Genetic manipulation techniques are being applied to improving industrially important microorganisms; and research into applied aspects, such as factors affecting plasmid stability, is in progress.
5. The Fermentation Technology Division is perfecting large-scale methods for producing a range of microorganisms, and projects include the development of computer control of fermentation processes. Novel techniques for separating particles and proteins applicable to downstream processing are being developed.

Cranfield Biotechnology Centre has the capacity to undertake all types of innovative industrial research programs, ranging from long-term basic research to one-time projects. The work is carried out by key personnel with substantial specialist expertise.

The scope and effectiveness of the center's operation has been strengthened considerably by the recent appointment of Higgins as joint director of the

Cranfield Biotechnology Centre and Leicester Biocentre. This association extends the commitment to the multidisciplinary, collaborative approach, bringing together the world-leading expertise in genetic manipulation techniques of Leicester Biocentre and the many strengths, in particular those in fermentation technology and downstream processing, of the Cranfield Biotechnology Centre.

For further information about the two biotechnology centers, contact: Dr. Jennifer Jones, Cranfield Biotechnology Centre, Cranfield Institute of Technology, Cranfield, Bedford MK43 0A2, UK; Professor I.J. Higgins, Director, Leicester Biocentre, Medical Sciences Building, University Road, Leicester LE1 7RH, UK.

Claire Zomzely-Neurath
7/12/85

GMIDC--A NEW BIOTECHNOLOGY CENTER IN THE UK SUBSIDIZED BY INDUSTRY

The Grand Metropolitan Innovation Development Centre (GMIDC) is a unique new venture which combines the extensive research and development facilities of the University of Surrey with the commercial and financial expertise of Grand Metropolitan PLC, one of Britain's largest companies. The primary aim of the Innovation Development Centre is to help inventions from British universities, research institutes, and other sources of original thinking to become marketable products which can form the basis of new British industries in the field of high technology.

Through the Innovation Development Centre, Grand Metropolitan Biotechnology Limited, a subsidiary of Grand Metropolitan PLC, will be providing successful applicants with space and technical and administrative services, supported by a full evaluation and business development service using the international resources and management strength of the Grand Metropolitan Group. In addition, the University of Surrey offers some of the best technical research and reference facilities in Britain, backed by top technological academic expertise within the university itself and a highly attractive location convenient to all types of transport.

What makes the Grand Metropolitan Innovation Centre unique? The answer is the involvement of a major multinational company. With a consultancy agreement, the resources and commitment to assist in realizing the full market potential of any invention successfully developed at the Innovation Development Centre can be achieved with or without the full-time involvement of the inventor.

Why was the GMIDC developed? Grand Metropolitan PLC has been committed to the principle of research and development to create growth and employment. The company decided that a major seedbed of British inventiveness--the universities and technical research institutes--were not being provided with sufficient facilities to develop new ideas to the advantage of British industry. Unfortunately this has been true. This lack of coordination between academia and industry has also been recognized by the government, which is supporting in part the new biotechnology centers at Leicester and Cranfield (see preceding note).

The GMIDC development is located in a new 70-acre research park adjacent to the University of Surrey. All the resources and services of the university are available to the occupiers of the GMIDC through automatic membership in the Surrey Network for Industrial Collaboration. This network involves the entire university--no faculty or department is exempt--offering a formidable intellectual resource as well as superbly equipped research facilities.

There are many research groups, units, and departments whose services, facilities, and expertise will be available to companies and organizations at the research park (GMIDC). The following are a few examples: (1) biochemical engineering and downstream processing; (2) biotechnology unit; (3) computerized data bank on drug diagnostic test interaction; (4) computer-assisted learning; (5) environmental research groups; (6) microstructural studies unit; (7) nuclear magnetic resonance imaging in biological materials; (8) particle technology; (9) structural plastics unit; (10) surface analysis group; (11) facilities for mechanical testing of materials; (12) medical and environmental physics groups; and (13) Guildhay antisera.

Additional information can be obtained from: Grand Metropolitan Innovation Development Centre, Research Park, University of Surrey, Guildford, Surrey, UK.

Claire Zomzely-Neurath
7/12/85

NOVO PLANS LARGE-SCALE DNA HUMAN INSULIN PRODUCTION PLANT IN DENMARK

NOVO has applied to the Danish Environmental Authorities for approval to build commercial-scale plants for the production of human insulin from genetically engineered microorganisms. The company has indicated that pilot plant upscaling of its fermentation and purification processed are in progress. However, the new plant's targeted completion and start-up have not been specified.

The planned facilities have been designed to the specification of the US National Institutes of Health and will also be usable for the production of other peptide hormones and enzymes based on microorganisms classified as suitable for industrial applications of genetic engineering.

In 1982, NOVO was the first company in the world to market a human insulin identical to that produced by the human body, based on an enzymatic conversion of porcine insulin.

Claire Somzely-Neurath
7/12/85

INTEPNATIONAL STUDY ASSOCIATION ON TEACHER THINKING

With the growth of cognitive psychology and its application to research on student learning, thinking, and problem solving in instruction, a natural next step is the cognitive analysis of teaching. Research on teaching has long been concerned with teaching acts in classroom discourse. But the new emphasis also studies teacher thinking and planning, and its linkage to classroom action on the one side, and teacher training on the other. There has been rapid development of this field in US educational research in recent years. There is also now a rapidly developing international perspective, represented by the International Study Association on Teacher Thinking (ISATT).

ISATT was formed at a symposium held at Tilburg University, The Netherlands, in late 1983. It held its second conference at Tilburg from 28 through 31 May 1985. There were about 70 participants at this second meeting, coming from Australia, Austria, Belgium, Canada, West Germany, Indonesia, Israel, The Netherlands, Spain, Sweden, Switzerland, the UK, and the US. Program presentations concerned such topics as: teaching as problem solving, as clinical information processing, as technical expertise, and as reflective professional practice; information technology and teacher routines; teacher perceptions and expectations regarding student achievement and motivation; teacher thinking within particular curriculum domains; teacher strategies for understanding and managing classroom dilemmas, including justifying teacher actions and decisions; individual and contextual influences on the relationships between teacher beliefs and classroom behavior; cognitive comparisons of more and less effective teachers; teacher understanding of student assessments; reflections of teachers on a variety of instructional tasks and situations; improvements in teacher training related to research on teacher thinking; and conceptual and methodological issues for future research.

The proceedings from the first conference, edited by A.R.J. Halkes and J.K. Olson and titled *Teacher Thinking: A New Perspective on Persisting Problems in Education*, were published by Swets and Zeitlinger, Lisse, The Netherlands, in 1984. Proceedings of the second conference, also edited by A.R.J. Halkes and others, and titled *Teacher Thinking: Interface Between Theory and Practice*, will be available from the same publisher next year. For information about ISATT, contact A.R.J. Halkes, Tilburg University, P.O. Box 90153, 5000LE Tilburg, The Netherlands.

Richard E. Snow
7/9/85

INTELLIGENT DECISION AIDS IN PROCESS ENVIRONMENTS

A North Atlantic Treaty Organization Advanced Study Institute, held at San Miniato, Italy, from 16 through 27 September 1985, brought together recent developments in intelligent computer systems and theories of human decision making, cognition, and performance in dynamic work environments to establish the basis for improved cooperation between human and artificial cognitive systems. Lectures and discussions featured: B. Fischoff (US), Principles of Human Decision Making and Decision Theory; P. Garbolino (Italy), Decision Complexity and Information Measures; H. Prade (France), Uncertainty and Imprecision in Decision Making; W. Wagenaar (Netherlands), Decision Making in Dynamic Environments; G. Johannsen (West

Germany), Man-Machine Architectures; H. Stassen (Netherlands), Decision Demands and Task Requirements; G. Volta (Italy), Time and Decision Making; N. Moray (Canada), Modeling Cognitive Activities; J. Rasmussen (Denmark), Analysis and Allocation of Cognitive Tasks; G. Mancini (Italy), Modeling Humans and Machines; J. Reason (UK), Loss of Control and Failures; E. Hollnager (Norway), Measuring System Performance; D. Woods (US), Joint Cognitive Systems in Decision Support; A. Stevens (US), Human and Machine Knowledge; G. Guida (Italy), Expert Systems and Decision Support in Dynamic Environments; M. Coombs (UK), Artificial Intelligence and Cognitive Technology; D. Norman (US), New Views of Information Processing, Artificial Intelligence, and Expertise; J. Leplat (France), Knowledge Elicitation and Mental Models.

Richard E. Snow
7/1/85

SUBJECTIVE PROBABILITY, UTILITY, AND DECISION MAKING

The European Research Conference on Subjective Probability, Utility, and Decision Making (SPUDM) will now publish a quarterly bulletin to carry research summaries and information on new relevant books and activities, as well as announcements of upcoming conferences. The first issue gives reference to all previous conference publications. For information, write to Professor Dr. Helmut Jungermann, Institut für Psychologie, Technische Universität Berlin, Dovestrasse 1-5, D-1000 Berlin 10, West Germany.

SPUDM has existed as an interdisciplinary association since 1968 and now has a membership of about 400. It is aimed at improving the theory and practice of decision making and is open to anyone who believes that models prescribing how human beings should make decisions need to incorporate knowledge about the ways human beings actually do make decisions. The 10th SPUDM Conference was held in Helsinki, Finland, from 26 through 29 August 1985. The organizing committee was chaired by Guje Sevon, Swedish School of Economics, Arkadiagatan 22, 00100 Helsinki, Finland, who has detailed information about the proceedings.

Richard E. Snow
7/11/85

EUROPEAN MONOGRAPHS IN SOCIAL PSYCHOLOGY

A new series of monographs has been organized under the sponsorship of the European Association of Experimental Social Psychology. It is an amalgamation of a previous series published by Academic Press and one published by Cambridge University Press in collaboration with the Laboratoire Européen de Psychologie Sociale, Maison des Sciences de l'Homme of France. The aim is to promote the best of European research in different fields of social psychology. Executive editors are Richard Eiser (University of Exeter, UK); Jos Jaspers (University of Leiden, The Netherlands); and Klaus Scherer (University of Geneva, Switzerland).

National Characteristics

A monograph in the above series, by Dean Peabody, is a comparative study of psychological characteristics associated with different nationalities. The study focuses on France, Germany, Italy, the UK, the US, and the USSR, and demonstrates that the psychological characteristics of different nationalities do differ in fundamental ways.

Richard E. Snow
6/27/85

PSYCHOMETRICS AND CLASSIFICATION SOCIETIES

The Fourth European Joint Meeting of the Psychometric Society and the Classification Society took place from 2 through 5 July in Cambridge, UK. For information on program and proceedings contact Dr. Ian Nimmo-Smith, MRC-APU, 15 Chaucer Road, Cambridge, CB2 2EF, UK.

Richard E. Snow
6/27/85

BRITISH JOURNALS ON EDUCATION

The British Educational Research Association has now published "British Journals Concerning Education: A List for Research Workers and Others," authored by J.G. Vaughan. It is a unique source of information on all British periodicals relevant to educational research. The cost is 95 pence. Write to J.E. Vaughan, Library, School of Education, University of Liverpool P.O. Box 147 Liverpool, L69 3BX, UK.

Richard E. Snow
7/11/85

EUROPEAN INTERESTS IN THE STUDY OF SOCIAL INTERACTION, COGNITIVE-SOCIAL DEVELOPMENT, AND SCHOOL LEARNING

A European Special Interest Group for the Study of Social Interaction, Cognitive and Social Development, and School Learning has been founded. The group aims to publish a newsletter with abstracts of recent research on this topic, to organize workshops and conferences to bring related research together, and to promote research and publication in international journals and books. A first conference will be held near the end of 1985 in The Netherlands. For information, write to Dr. Paul Roeders, Hoogveld Instituut, Center for Youth Studies, Stikke Hezelstraat 1-3, NL-6511 JV, Nijmegen, The Netherlands.

Richard E. Snow
7/11/85

THE SECOND SEMINAR ON LASER PHYSICS, OBERGURGL, AUSTRIA

The University of Innsbruck's Institute of Theoretical Physics held its second week-long Seminar on Laser Physics last February. There were participants and key lecturers from laboratories in a number of countries, including Austria, West Germany, France, Italy, Belgium, The Netherlands, Finland, Hungary, Denmark, and the US.

The four main subjects of discussion were: (1) scattering processes in the presence of intense laser fields; (2) multiphoton ionization and multiple-electron production by absorption above the first ionization threshold; (3) advances in selected areas of laser spectroscopy; and (4) electron-photon correlations in atomic physics. A round-table session at the end of the week was led by four rapporteurs: C. Joachain (Brussels), M. Gavrila (Amsterdam), K. Welge (Bielefeld), and P. Zoller (Innsbruck).

Readers interested in the specific developments described by each of the seminar's lecturers can obtain the proceedings from Springer-Verlag; summaries of the rapporteurs' remarks are to be published in the journal *Comments on Atomic and Molecular Physics* in late 1985.

Joseph H. Eberly
7/15/85

NEW BOOK ON MOLECULAR NEUROBIOLOGY PUBLISHED

A new book, *Gene Expression in Brain*, deals with molecular approaches to the analysis of the nervous system.

The scope of the chapters, each written by different investigators, ranges from studies on the bag cell neurons of *Aplysia* to the molecular biology of human brain. All the authors combine cellular and molecular biology.

According to the editors, Claire Zomzely-Neurath and William A. Walker, "The exciting area of molecular approaches to the study of gene expression in brain has enormous research potential and should make this volume of interest not only to neuroscientists but also to molecular biologists contemplating the study of molecular genetics in complex systems such as the brain. The purpose of this volume is to show what has been accomplished, the various approaches that can be used, and to promote research efforts in this area."

Dr. Neurath is the Liaison Scientist for Biochemistry, Neurosciences, and Molecular Biology for ONR, London. She is on leave until July 1986 from her position as Director of Research, the Queen's Medical Center, Honolulu, Hawaii, and Professor of Biochemistry, University of Hawaii School of Medicine. Dr. Walker is Assistant Director of Research at the Queen's Medical Center.

The book costs $42.50 and is published by Wiley Professional Books, John Wiley & Sons, Inc., Dept. 6005, Somerset, NJ 08873.

Larry E. Shaffer
7/10/85

ONRL COSPONSORED CONFERENCES

ONR, London, can nominate two registration-free participants in the conferences it supports. Readers who are interested in attending a conference should write to the Scientific Director, ONRL, Box 39, FPO New York 09510.

The Third Israel Materials Engineering Conference, Technion City, Haifa, Israel, 10-11 December 1985.

New Technological Applications of Phospholipid Bilayers, Films, and Vesicles, Puerto de la Cruz (Tenerife), Canary Islands, 6-9 January 1986.

SCIENCE NEWSBRIEFS FOR JUNE AND JULY

The following issues of *Science Newsbrief* were published by the ONR, London, Scientific Liaison Division during June and July. *Science Newsbrief* provides concise accounts of scientific developments or science policy in Europe and the Middle East. Please request copies, by number, from ONR, London.

Science Newsbrief Number	Title
3-37	Chemist Coming Your Way, by David L. Venezky.
3-38	Unique Monodisperse Polymer Particles Developed by Norwegian Firm, by Claire Zomzely-Neurath.
3-39	Plessey Scores Breakthrough in Optical Telecommunications, by Paul Roman.
3-40	Materials Engineering Conference to be Held in Israel, by Kenneth D. Challenger.

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JUNE AND JULY MAS BULLETINS

The following *Military Applications Summary (MAS) Bulletins* were published by the ONR, London, Military Applications Division during June and July. The *MAS Bulletin* is an account of naval developments in European research, development, test, and evaluation. Its distribution is limited to offices with the US Department of Defense. DoD organizations should request copies of the *Bulletins*, by number, from ONR, London.

MASB Number	Title
64-85	Remotely Operated NDT Surveying Device
65-85	New German Model for Forecasting Ocean Waves
66-85	Three Oceanographic Devices From the UK
67-85	Second Quarterly Index 1985
68-85	NAUTIS--Naval Autonomous Information System
69-85	Sea Giraffe--A Third Generation Surveillance Radar for Small/Medium Sized Warships
70-85	High Speed MCM Route Surveillance
71-85	NAUTIS-M and the UK Single Roll Mine Hunter
72-85	Mine Countermeasures Vessel (MCMV)
73-85	Archimedes II: Remote Sensing of Oil Slicks
74-85	Second International Marine Systems Design Conference--Theory and Practice of Marine Design
75-85	Electric Power Generation Using a Fuel Cell System
76-85	A Radar Evaluation System from FFV in Sweden
77-85	International Symposium on the Air Threat at Sea
78-85	Gravity Measurements by UK Group
79-85	Underwater Power Sources--UEG Pub UR32
80-85	HMS ARK Royal--The Newest Royal Navy Aircraft Carrier
81-85	Remote Sensing Applications: Short Course in Scotland in Fall 1986
82-85	UK Submarine Communications Mast
83-85	Satellite Data/Applications in Scotland

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