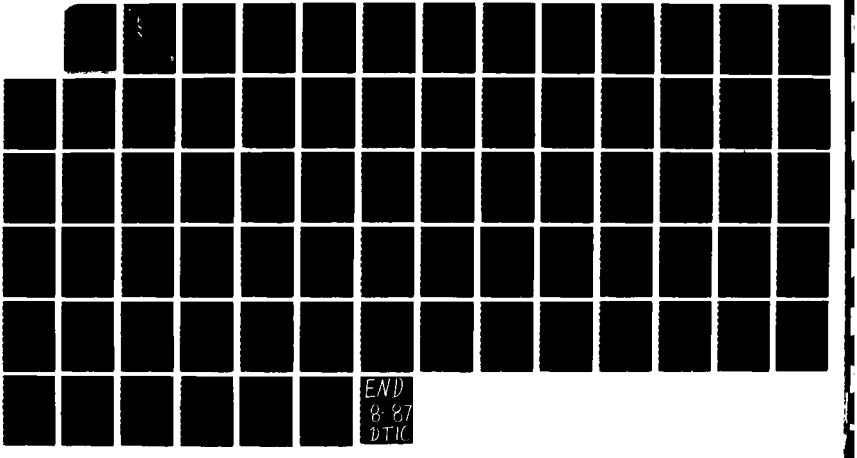

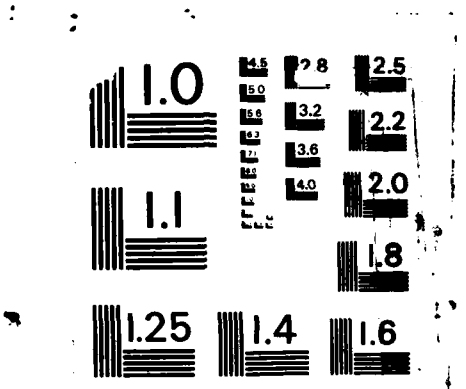

U.S. Office of Naval Research, London
Vol 41 No. 7 July 1987

European Science Notes

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

AD-A182 036

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) 41-7	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION US Office of Naval Research Branch Office, London 6b. OFFICE SYMBOL (If applicable) ONRL	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Box 39 FPO, NY 09510	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) European Science Notes--(UNCLASSIFIED)	
12. PERSONAL AUTHOR(S) C.J. Fox, Editor	
13a. TYPE OF REPORT Monthly 13b. TIME COVERED FROM _____ TO _____ 14. DATE OF REPORT (Year, Month, Day) July 1987 15. PAGE COUNT 66	
16. SUPPLEMENTARY NOTATION	

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	

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

European Science Notes (ESN) is a monthly publication with brief articles on recent developments in European scientific research. The publication is not intended to be part of the scientific literature. The value of ESN articles to Americans is to call attention to current developments in European science and technology and to the institutions and people responsible for these efforts. ESN authors are primarily ONRL staff members. Occasionally articles are prepared by or in cooperation with staff members of the USAF European Office of Aerospace Research and Development or the US Army Research, Development and Standardization Group. Qualified US scientists travelling in Europe may also be invited to write an ESN article.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL C.J. Fox	22b TELEPHONE (Include Area Code) (44-1) 409-4340 22c OFFICE SYMBOL 11

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

European Science Notes

US Office of Naval Research, London

Commanding Officer ..... CAPT Terry J. McCloskey, USN
Scientific Director ..... David L. Venezky
Editor ..... C.J. Fox

July 1987
Volume 41
Number 7

Acoustics

This article reviews the invited papers presented at the Conference on Fluctuation Phenomena in Underwater Acoustics. The invited papers covered four major subject areas: the mathematical basis, effects on system performance, contributions from nonacoustic fields, and oceanographic and acoustical measurements.

The subjects of the presentations reviewed here include probability distribution for scattered acoustic intensity, numerical simulations of ray statistics, use of the Dyson equations to calculate the mean field in a random medium, simulation of scattering by rough Dirichlet surfaces, and use of lasers to gather bathymetric data.

Behavioral Sciences

Psychological research in eastern Switzerland is primarily geared to the needs of this industrialized section. This becomes apparent in the author's review of the work of the psychology faculties of the University of Zurich, the Work and Organizational Psychology Institute of the Federal Institute of Psychology, and the business school at St. Gallen.

Biological Sciences

This conference, held in London in January 1987, was concerned exclusively with current UK research in biotransformation--the conversion of one chemical to another by use of whole cells, extracts from cells, or enzymes. Evidence is given that the UK is engaged in extensive efforts to foster liaison between academia and industry in this area. The presentations by representatives of many UK academic institutions are discussed.

This report deals with some of the research projects in the life sciences in different institutions and departments at Aarhus University. The topics include cell differentiation, evolution of human repetitive DNA sequences, antibody-dependent cell-mediated cytotoxicity, chromosomal leghemoglobin gene from soybean, and pathenogenesis of *M. hominsus* in humans.

Computer Sciences

This overview of France's Institut National de Recherche en Informatique et en Automatic (INRIA) includes comment on INRIA's facilities, research in networking, and its high-speed network research project. Collaboration between INRIA and the US's National Science Foundation on high-speed network research is expected soon.

Two researchers at Institut National de Recherche have designed a new method for the recognition and positioning of two-dimensionl objects. The method uses segmented descriptions of the object contours to generate and recursively evaluate a number of selected hypotheses. This article discusses the method in detail.

This article focuses on the presentations concerning languages and software for control systems simulation, and looks in a more general sense at the contributions from Western Europe, Eastern Block countries, and Japan.

Material Sciences

Several electron spectroscopic and optical techniques are described and their use in qualitative, quantitative, and spatial examination of electronic devices discussed. The methods include laser microprobe and laser scan mass spectrometry, pulsed laser atom probe, x-ray photoelectron spectroscopy, Auger electron spectroscopy, and ion beam crystallography.

Mechanics

Significant work in fluid dynamics at the Technical University of Berlin's Herman Föttinger Institute and Institute für Mechanics, 2 is discussed. The work concerns boundary layer separation, turbulence structure in shear layers, aeroacoustics, and vortex shedding.

Ocean Sciences

Physics

The annual Chelsea Conference on Amorphous and Liquid Semiconductors took place in London, 15 through 17 December 1986. This article focuses on general studies concerning amorphous (a)-Si, specific works on a-Si:H, a-As-S, a-As_2Se_3, and conducting polymers.

News and Notes

* * *

European Science Notes is a Class I Periodical prepared and distributed by the Office of Naval Research, London, in accordance with NAVSO P-35.

Acoustics

CONFERENCE ON FLUCTUATION PHENOMENA IN UNDERWATER ACOUSTICS

ONRL was fortunate to receive two reports from guest authors on the Conference on Fluctuation Phenomena in Underwater Acoustics, which was held on 9 and 10 December 1986 at Weymouth, UK. One, written by Dr. Hassan B. Ali, covers the papers of the four invited speakers. The other, by Dr. David H. Berman, complements the Ali report by reviewing some of the contributed papers. The proceedings, containing all the presentations, are available from Mr. J.R. Dunn, Department of Electronic and Electrical Engineering, University of Birmingham, PO Box 363, Birmingham B15 2TT, UK. (Cost: ~$25.00, including postage.)

THE FOUR INVITED PAPERS--FLUCTUATION PHENOMENA IN UNDERWATER ACOUSTICS

by Hassan B. Ali. Dr. Ali is a research scientist in the Array Effects Branch, Acoustics and Technology Directorate, the Naval Ocean Research and Development Activity, NSTL, Mississippi.

The conference was organized by the Underwater Acoustics Group of the Institute of Acoustics, UK, and hosted by British Aerospace. Although the Underwater Acoustics Group has been organizing academic meetings regularly since its formation in 1975, the Weymouth Conference is only the second to be hosted by industry.

Perhaps it may come as a surprise to some, but British Aerospace is actively involved in various aspects of underwater acoustics. It is a major supplier of underwater warfare equipment to the UK Ministry of Defense (UK MoD) and is well established as a "preferred contractor" for mines, mine countermeasures, and associated activities. These "associated activities" include studies in sonar performance, digital signal processing, underwater communication systems, sonar image processing equipment, etc.

That British Aerospace is not interested solely in equipment development is evidenced by their hosting of the conference on the somewhat erudite topic of propagation in a random medium. In practice, interest in the subject, far from being merely academic, rests on the very real concerns for the effects of random inhomogeneities on wave propagation and the concomitant degradation of system performance. These effects, generally manifested by fluctuations in acoustic intensity (scintillations), are of particular concern in underwater acoustics and have been the subject of increasing attention in recent years. In underwater acoustics these fluctuations are manifestations not only of the changing patterns of interaction with the ocean bottom and surface, but also passages of the acoustic wave through time-varying inhomogeneities in the ocean medium. These acoustic fluctuations are analogous to the twinkling of stars arising from multiple scattering of lightwaves in the irregular layers of the upper atmosphere.

Not surprisingly, the conference brought together workers whose interests in fluctuations range from underwater acoustics to fields such as atmospheric propagation of laser and radio waves. The conference was well attended, with 115 delegates, mainly from the UK (96), but also from the US (5), the Netherlands (4), France (3), Italy/SACLANT Centre (3), Denmark (1), Norway (1), Australia (1), and Poland (1). Seventeen papers were presented--18 if one includes the unscheduled "postscript" paper by David Weston of the Admiralty Research Establishment (ARE), Portland, UK. Four of the 17 papers were invited keynote papers in each of the four major subject areas: The Mathematical Basis, Effects on System Performance, Contributions from Non-Acoustic Fields, and Oceanographic and Acoustical Measurements.

The Invited Papers

The first invited paper was presented by B.J. Uscinski of the Department of Applied Mathematics and Theoretical Physics (DAMTP), University of Cambridge, UK. The paper, "Successes and Failures of Multiple-Scatter Theory," sketched the theoretical basis of propagation in a random medium. The only medium descriptor needed in such a theory is the correlation function of the fluctuations (index of refraction) or its equivalent (structure function, spectrum). Because the pertinent stochastic wave equation cannot be solved deterministically, solutions are obtained in terms of statistical moments of the acoustic pressure, such as the expected value (ensemble average), various correlation functions, and higher order moments. The fourth moment is of particular interest since this gives the intensity fluctuations.

Earlier theories of intensity fluctuations were based on either the Born approximation or the Rytov Method of Small Perturbations. These approaches

are valid for the weak or single scattering cases, which are adequate for high frequencies and short ranges. In particular, the Born approximation is valid only for small fluctuations in both the intensity and the phases; the Rytov method is valid for small intensity fluctuations, but has less stringent requirements in phase.

Much of the new work in extending the range of validity to large intensity fluctuations rising from multiple scattering is based on the parabolic equation (PE) method. The PE method is a simplification of the wave equation for the case of scattering that is mostly in the forward direction. The two main methods of solving the PE are the Feynman path integral (used by Dashen et al., 1979) and the moment-equation (used by Uscinski et al.). Both methods have had some recent success in attributing measured intensity fluctuations to the action of internal waves. This has been possible because of the availability of the required statistical description of the stochastic medium, viz., the Garrett-Munk empirical model.

Apart from these analytical developments, some advances have been made in numerical simulations of random wave propagation. The work at DAMTP was described by Uscinski, who considers this method equal in importance to the purely analytical approaches. Impressive though developments are in these two areas, some important problems are still unsolved. In particular, the cross-correlation of intensity fluctuations at different wave-frequencies cannot be satisfactorily described, nor can the probability distribution of the intensity fluctuations be derived theoretically.

The second invited paper was presented by R.J. Urick of the Catholic University of America, Washington, DC. The paper, "Fluctuations of Signals and Noise in the Sea and Their Effect on Sonar Target Detection," provided an overview of the practical effects of the fluctuations of transmitted acoustic signals on sonar system performance, particularly detection. Examples from field exercises were used to demonstrate the effect on transmitted single frequency (CW) signals of such things as tides, sea-surface motion, interference between bottom and surface-reflected signals, etc. Further, Urick considered models for the fluctuation of narrow-band signals and ambient noise. The fluctuations of transmitted sound were found to have a Rician distribution with the "randomicity" (the fraction of received power that is random) as a parameter, while those of stationary Gaussian ambient noise were found to have a Chi-square distribution with twice the bandwidth-time product as a parameter. However, all the other quantities that affect the detection of a target also fluctuate. The result is a log-normal distribution with a standard deviation of 6 to 8 dB for the probability of detection against signal excess, and therefore against range--a distribution that is most convenient in practical calculations. Urick's presentation followed closely his previously published work in his books and reports from the Naval Surface Weapons Center.

The third invited paper was presented by A. Hewish of the Cavendish Laboratory, Cambridge, UK. The paper, "Remote Sensing of Astrophysical Plasmas by Radio Scintillation Methods," provided a broad outline of some applications of scintillation methods in astronomy and space research, with the emphasis on the extraction of useful information.

The scattering of radiation by inhomogeneous media along the line of sight to a distant source degrades the image and leads to a loss of information in many observations. At the same time the fluctuations in phase and amplitude of the received signals in space, time, and wave frequency can be used as a plasma-diagnostic to reveal some properties of the source and of the intervening media. Such methods can be particularly valuable in astrophysics where the media and the sources are usually inaccessible to more direct observation. Plasmas along the line of sight include the ionosphere, the heliosphere, the interstellar gas, and intergalactic medium. All these regions, save the latter, are known to modulate incoming signals, and it is fortunate that the characteristic scales of the fluctuations in time, space, and wave frequency are usually distinct so that effects due to the different media are not confused. Applications of the scintillation method include: remote sensing of ionospheric irregularies using radiation from celestial radio sources; probing of the interplanetary solar wind; mapping and tracking of large-scale interplanetary disturbances associated with geomagnetic storms at the earth; observation of interstellar plasmas and pulsars, etc.

The presentation by Hewish was so fascinating that some acousticians muttered that they had chosen the wrong field of endeavor!

The fourth invited paper was presented by Terry E. Ewart of the Applied Physics Laboratory and the School of Oceanography, University of Washington, Seattle. The paper, "Acoustic Propagation, Internal Waves, and Fine-Structure," concentrated on the comparison between the fluctuation results of a

well-known Ewart experiment, Mid-Ocean Acoustic Transmission Experiment (MATE), and predictions based on Uscinski's development of the theory (the 4th Moment Method). This is no· the first paper by Ewart on the subject, but rather represents the latest in a series, based on the long-term collaborative effort (since 1980) between the group under Ewart at the Applied Physics Laboratory, Washington, and the group under Uscinski at DAMTP, Cambridge. Two noteworthy papers resulting from this effort appear in the November 1983 issue of the *Journal of the Acoustical Society of America*. The joint effort (supported by MoD, UK) has led to success in the comparison of the predictions based on the solution to the fourth moment equation for the scattered acoustic field, with measurements made by Ewart in 1971 (COBB) and 1977 (MATE) at Cobb Seamount. In the experiments, short pulses were transmitted over distances of 17 km (1971) and 18 km (1977) using frequencies of 4 and 8 kHz in 1971 and 2, 4, 8, and 13 kHz in 1977. Both source and receiver were fixed at a depth of about 1000 m, almost at the center of the SOFAR channel, virtually excluding surface and bottom effects. Great care was taken to ensure that the resulting phase and amplitude time series represented a single, wholly refracted path. The MATE measurements are considered to be one of the few experiments where scattering theories can be properly tested, since complex acoustic amplitudes were measured simultaneously with sufficient environmental measurements to allow the experimental determination of the space-time correlation function of the medium. For the oceanography of the Cobb Seamount area the effects of internal waves, fine-structure, and tides turned out to be of foremost importance.

Apart from reviewing some of the results from the MATE, Ewart discussed models of the acoustic index of refraction correlations. He also discussed the inverse problem, viz., the use of the scattering equations and the acoustic data to obtain the stochastic ocean correlation function as an inverse. Naturally, good agreement was obtained between the MATE data and both the 4th Moment and inverse theories. However, a significant limitation of the theories is the neglect of the mean sound speed profile. That is, a linear sound speed profile is assumed, thereby precluding curved raypaths. In the Cobb Seamount experiments the sound speed was quite linear over the depth range of the transmission path and the ray angle was always small (<3.5°); thus, ray effects were negligible. This is not true for most ocean acoustic scattering conditions. Hence the theoretical approach requires modification to include these effects.

Additional experiments, under other ocean conditions, are being planned to both test the Uscinski et al. theories and to obtain further information on acoustic transmission fluctuations. In particular, a collaborative effort between DAMTP, Cambridge, and the SACLANT Centre, La Spezia, Italy, was begun (by Hassan B. Ali) in 1984. A joint experiment in the Mediterranean has already been conducted and more are planned. Preliminary results were presented by the SACLANT Centre speaker (J.R. Potter).

The three contributed US papers were presented by the Naval Ocean Research and Development Activity (NORDA). They were as follows:

1. Sea Surface Wave Height Effects on Shallow Water Matched Field Processing, by D.R. Del Balzo, C. Feuillade, and M.M. Rowe.
2. Fluctuations in Acoustic Transmission Loss: Comparisons Between Measured Data and the Predictions of the SAFARI/Parabolic Equation Numerical Models, by H.B. Ali, J.V. Soileau, R.P. Wooten, and G.J. Tango.
3. Amplitude Fluctuations of High Frequency Acoustic Signals in the Marginal Ice Zone, by J.W. Posey and M.A. Wilson.

Reference

Dashen et al., *Sound Transmission Through a Fluctuating Ocean* (Cambridge: Cambridge University Press, 1979).

2/17/87

THE CONTRIBUTED PAPERS--FLUCTUATION PHENOMENA IN UNDERWATER ACOUSTICS

by David H. Berman. Dr. Berman is a researcher in the Large Aperture Acoustics Branch of the Acoustics Division, Naval Research Laboratory, Washington, DC.

This was a well-organized, comfortably sized meeting. Most attendees that I talked with thought the meeting successful, in part because of the specialized nature of the topic and because of the leisurely pace: invited talks were allotted 45 minutes and contributed talks 25. It helped, of course, too, that the people from British Aerospace were gracious hosts.

The Papers

The primary success of the work described by E. Jakeman of the UK Royal

Signals and Radar Establishment (RSRE) is a calculation of the full probability distribution for the scattered acoustic intensity. Although this is done for a very simplified model of a phase screen which only redirects rays according to a local stochastic slope, it is probably the only first-principles calculation of an intensity probability distribution based on details of the statistics of the propagation medium. Jakeman showed the effects of finite apertures and outer scales of the slope-slope correlation function. The objective of his work is to produce noise and clutter models using a few parameters which describe the non-Gaussian statistics observed when small inhomogeneities are modulated by a few large features. Jakeman indicated that the subfractal phase screen model is sufficiently complex as to be physically interesting, and sufficiently simple to yield analytic results for probability distributions.

Two talks were given in the afternoon session by J.H. Jefferson and R.J.A. Tough, who work with Jakeman at RSRE. Jefferson described numerical simulations of ray statistics, which were undertaken with an eye toward extending the analytic results of Jakeman. Tough described schemes for generating non-Gaussian slope statistics from stochastic differential equations. He presented a Fokker-Planck equation which had a K-distribution as its equilibrium solution.

There was only one talk which used the Dyson equation to calculate the mean field in a random medium. This was by E. Soczkiewicz of the Silesian Technical University, Poland, (who presented the paper) and R.C. Chivers of the University of Surrey, UK. I confess to not understanding the relationship between field theoretic methods, such as they presented, and path integral and moment equation methods. It seems that the former is at best able to describe second moments of scattered fields and may be limited to a weak scattering regime. In addition, I suspect that field theoretic methods are limited to Gaussian media.

C. Macaskill of the University of Sydney, Australia, described simulations of scattering by rough Dirichlet surfaces. He used the integral equation described by Holford for the surface field. His work is at a preliminary stage and his talk mainly concerned details of the solution of single realizations.

Following the invited paper by A. Hewish of the Cavendish Laboratory, Cambridge, UK, were talks about underwater laser propagation. Apparently there is something of a window in seawater at frequencies corresponding roughly to blue-green light. This allows lasers to be used to gather bathymetric data rapidly to a depth of about 40 meters, depending on the type of water. Ocean fluctuations determine the effective rate of absorption and scattering, and hence the depth limitations of laser measurements.

There were a number of talks which were only peripherally concerned with fluctuation phenomena. These, instead, dealt with the performance of deterministic models when the model parameters were not only unknown, but whose statistics were unknown. The aim of this research is to see how well a deterministic model can be made to work, rather than to predict fluctuation statistics from ocean statistics.

The last talk was given by A. Plaisant and S. Leroy, Thomson Sintra ASM, France. By using optimum beamforming I believe they were attempting to separate out multipath effects sufficiently to measure coherence degradation on a long acoustic array. Unfortunately they did not present corresponding environmental measurements, or try to compare with theoretical predictions of coherence loss.

Conclusions

Although there are a number of theoretical approaches to the problem of inferring field fluctuations from ocean fluctuations, there seems to be little systematic experimental work. It also seems that experiments are often carried out without suitable environmental measurements and without considerations of theories that might be tested. The work of T. Ewart of the University of Washington [reviewed in the preceding article] is a notable exception.

2/17/87

Behavioral Sciences

BASIC RESEARCH AND APPLIED PSYCHOLOGY IN EASTERN SWITZERLAND

by William Crano. Dr. Crano is the Liaison Scientist for Psychology in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until June 1988 from Texas

A&M University, where he is a Professor of Psychology.

Introduction

Of the many and distinguished universities in Switzerland, only one, the Swiss Federal Institute of Technology in Zurich (Eidgenossische Technische Hochschule Zurich), is funded by the federal government. The other institutes of higher education in Switzerland are supported by their respective cantons (with, of course, additional support obtained from federally supported research grants). In many ways, these sources of support are reflected in the orientation of the psychological research that is undertaken in the various universities.

Given their dependence upon the communities in which they are located, researchers in canton-supported institutes seem to feel very keenly that their work should contribute to the life of the community. These contributions appear to differ as a function of the needs of the canton in which they are produced. In the eastern part of the country, probably because of the powerful industrial presence of Zurich, there is a strong emphasis on leadership research, industrial and organizational psychology, etc. The psychology faculties of the University of Zurich, the Work and Organizational Psychology Institute of the Federal Institute of Technology, and the business school at St. Gallen all appear geared to meet the needs of this industrialized section of the country.

Psychology in the French-speaking western side of the country appears to be dominated by the Universities of Geneva and of Neuchatel, where research is likely to be more laboratory-oriented (vs. the eastern side's field emphasis) and more concerned with social and educational issues. In almost all cases, however, the application or, better, the *utility* of the research for the community is given more than just a nod. Researchers in Switzerland feel the need to discuss and demonstrate the practical relevance of their work not only in situations involving clearly applied issues (e.g., better ways to boost children's mathematics skills, new organizational models to enhance productivity), but even in such basic and fundamental areas as the influence of minority or outgroup members on the attitudes and perceptions of the majority.

In this report, I will focus on one section of German-speaking Switzerland, specifically on the work of researchers in Zurich and St. Gallen. This review is meant to provide a flavor of the psychological research that is characteristic of this beautiful area of a beautiful country. In a subsequent report, I will discuss some of the work of psychologists from the western, French-speaking side of the country.

The St. Gallen Graduate School of Economics, Law, Business, and Public Administration

Another Look at Hawthorne. An intriguing example of the integration of "pure" research with applied concerns is exemplified in the work of Emil Walter-Busch (University of St. Gallen), whose reexamination of the original interview data on which the classic Hawthorne study was based has the potential to still the continuing interpretive debate surrounding this study. The meaning of the "Hawthorne Effect" is commonly understood by psychologists. This term summarizes the results of a classic study focused on the effects of various social and contextual interventions on workers' productivity (Mayo, 1933; Roethlisberger and Dickson, 1939). Many interventions were undertaken in this work--raising the level of illumination in the plant, lowering it, instituting work breaks, etc.--but no matter what the intervention, the end result usually was the same: productivity increased spectacularly. In the case of clearly antithetical interventions, (e.g., raising vs. lowering the illumination levels in the work area), this finding could not be attributed persuasively to the manipulations themselves.

The "standard" interpretation of the productivity results is that the workers' knowledge that they were part of a study was sufficient to influence their behavior; subjects' knowledge that they were under scientific scrutiny was sufficient to boost output. This reaction occurred despite a central premise of the study, that workers could, and should, work in a normal fashion, and neither force higher output nor fear that higher output would influence their pay (workers in the plant were paid on a piece-work basis). For some (see Crano and Messe, 1982), the Hawthorne findings form the foundation for later theory and research on the self-fulfilling prophecy (Jones, 1977; Merton, 1957) and the experimenter expectancy effect (Rosenthal and Jacobson, 1968).

A radical reinterpretation of the Hawthorne findings, however, attributes the enhanced productivity to a systematic selection bias which operated through the management's callous removal of two RATR workers who refused to "play ball" by increasing their rate of output (Bramel and Friend, 1981; Carey, 1967; Franke, 1979, 1980; Franke and Kaul, 1978). In

fact, two of the five female operators in the work group under study were replaced over the course of the investigation. Obviously, removing slower workers from the study and replacing them with more productive ones would result in Hawthorne-like findings without the need of resorting to Hawthorne-like explanations.

The controversy focuses on the cause of the dismissals. The "revisionist" school holds that the underlying reason for the dismissals was political. The operators had become disillusioned with the capitalist system, felt they were being exploited by the bosses, and refused to allow this to continue. Some documentary evidence in favor of this interpretation is available in a letter written by Mayo (cf. Mulherin, 1979, p. 162): "One girl, formerly in the test group, was reported to have 'gone Bolshevik' and had been dropped." On the other hand, in his published work Mayo observed this same operator had been suffering from anemia at the time of her dismissal from the study, and after treatment had disavowed her earlier criticisms of company and experiment.

It is not possible here to describe the investigative steps necessary to come to a definitive conclusion of the controversy, but Walter-Busch (1986) has demonstrated that careful scholarship can defuse the polemics surrounding this issue. By cross-validating numerous available data sources, he showed that both interviewers and interviewees slanted information and withheld evidence, usually as a consequence of their own particular theories of how the world worked; however, it was possible, objectively, to come to a conclusion about the reality of the Hawthorne effect, and Walter-Busch appears to have found in favor of the phenomenon, independent of selection artifacts. Those interested in this issue, or in the general issue of the utility of scholarship in the solution of important questions, should consult his recent work on this topic (Walter-Busch, 1986).

Quality of Life. How people view the quality of their lives and how these attitudes correspond with objective measures of environmental quality are issues that have stimulated considerable controversy. Indeed, of all the work on social indicators, quality of life research is perhaps the most problematic. One of the central problems of this area is the weak relationship typically found between subjective and objective measures of quality. Unfortunately, much of the research demonstrating weak subjective/objective quality of life relationships has made use of samples characterized by low variability or, when disaggregated, startlingly few respondents. For example, Schneider's (1975) influential quality of life study was based on respondents from 15 large cities in the US. An attenuated relationship between subjective and objective indicators might be expected in such a situation, given the probable restriction on the range of values of the objective quality of life criteria. Wasserman and Chua's (1980) influential study employed a sample of communities much more variable than that of Schneider, but suffers from the complementary problem of restricted sample size. For example, in the Wasserman and Chua investigation, the subjective data representing the communities of Miami, Bridgeport, Tulsa, and Washington DC were based on the responses of no more than nine respondents per community. While social science is highly dependent upon the principle of randomization, the principal itself is dependent upon the "rule of large numbers" (cf. Crano and Brewer, 1986). To make use of nine respondents, no matter how well chosen, to represent the subjective quality of life attitudes of the citizens of Washington DC is to make a charade of the entire enterprise of social research.

Walter-Busch recognized the shortcomings of earlier quality of life research, and took advantage of Switzerland's tradition of universal military conscription (of males) to remedy them. In his work, he obtained access to the entire cohort of 20-year-olds who were undergoing their initial "basic training" in the Swiss Army, all 33,512 of them. This figure represented 96.7 percent of all the 20-year old males in Switzerland at the time of the research. To this population he administered a 69-item questionnaire which posed questions to respondents about their career problems, regional provenance and preferences, and the quality of life of their home region. Recruits' motivation seemed high: only 0.4 percent of the questionnaires were discarded as untrustworthy. For the objective indicators, Walter-Busch took advantage of a Swiss data bank which contained 500 objective quality of life indices for more than 3000 communities in Switzerland. From the indicators, 24 variables were chosen as most informative with respect to objective living conditions.

With this sufficiency of data, Walter-Busch could disaggregate his information by canton, region, and even village. In so doing, he produced a very interesting picture of regional quality of life profiles. The specific findings obtained within villages, regions, or cantons are not important for present purposes, but the overall result is, since it suggests a remarkably powerful

association between subjective and objective measures of quality of life, contrary to suggestions of previous research which had been flawed by the sampling problems noted earlier: "...among the 665 correlations that can be computed from the [objective and subjective] indicators of regional quality of life, 344 or 51.7 percent are significant at the 0.001 level, and 406 or 61.1 percent are significant at the 0.01 level. More importantly, not one of these significant correlations is in the wrong direction."

Differential patterns of strength of subjective/objective quality of life associations also were discovered. The weakest results involved subjective measures which assessed respondents' views concerning personal housing conditions, level of taxes, job security, proficiency of local government, and facilities for children. Strongest quality of life relationships were found among the subjective indicators that tapped respondents' evaluations of schools, public transportation, job opportunities, career opportunities, shopping facilities, and the unrest of daily life.

On the basis of his findings, Walter-Busch suggested that subjective measures of life quality were not necessarily invalid indicators of reality. Indeed, under certain conditions, strong relationships could be expected between subjective and objective quality of life indicators. These include:

- The subjective measures must focus on simple evaluative judgments about concrete aspects of the respondents' living conditions
- Sample size must be sufficient
- Range of variation among living contexts (i.e., communities, states, cantons) must be sufficient to allow for a reasonable disaggregation of data.

Support for Walter-Busch's first qualification is available in recent research of Schwarz et al. (1987), who found that transitory mood states corresponded with respondents' ratings of *general* life states, but not with more *specific* quality of life ratings. This suggests that evaluative questions about specific aspects of respondents' lives are more likely than general questions to elicit answers that are independent of momentary feelings, and (from Walter-Busch's findings) more closely related to objective reality. No substantive support for the second and third qualifications is needed--from the perspective of proper research practice, they are self-evident.

Leadership. In his classic discussion of the nature of progress in science, Kuhn (1970) asserted that a massive data base was necessary before an organizing principle could be imposed on a field of scientific endeavor, thereby allowing for revolutionary advance in knowledge and understanding. Few areas in the social sciences have the history that is necessary for this type of accumulation and consequent advancement. The "preparadigmatic" aspect of the social sciences (to borrow Kuhn's phrasing) fosters the collection of information rather than its theoretical integration. Arguably, one area of social research that approximates the level of data saturation necessary for the imposition of an organizing principle is that of leadership. For many years, research on leadership has been intense and continuous, yet the field seems no closer to theoretical integration and consequent advance than it was a decade ago.

Dissatisfaction with this state of affairs may be inferred from the various attempts at restructuring the field of leadership research. One such attempt has been made by Professor Peter Dachler (University of St. Gallen), whose recent work is focused directly on the state of leadership science. Dachler's evaluation is far from comforting (e.g., see Dachler, 1986). Briefly, his position is that precious little in the way of emerging vistas can be discerned in the field and that, given a "business as usual" approach, little of any consequence can be expected to emerge.

I learned from Dachler that in his view, the field of leadership research has for too long been stuck in a descriptive rut, characterized by an approach in which various traits are combined to form the picture of "what a leader is." Perhaps not surprisingly, the traits that most often emerge to form the picture of the leader are the very traits that describe, perhaps caricature, the "dominating, competitive, aggressive, manipulating, and achievement-driven males" who do leadership research.

Dachler argues that we must discard traditional research perspectives in our search for a new approach to understanding leadership. We must reject the view that leadership is a property or quality that an individual can possess, and rather adopt the position that leadership is a complex set of social processes that define attributes of the system in which they occur. People are leaders, Dachler argues, when they consistently make effective contributions to a process, and when they are both expected and perceived to do so by fellow participants in the process. As such, leadership is an emergent phenomenon, rather than a definition of a set of qualities inherent in a

specific actor. The research implications of this revised view are important, and suggest approaches that are quite different from those employed in the standard leadership laboratory.

It is too early to know whether Dachler's view will prove influential and, following that, useful. Much remains to be specified before it is clear that the social constructionist view, as he describes it, offers anything more than a set of problems different from those encountered in the standard approaches to the study of leadership. However, it is clear that progress in leadership research has stagnated, and the standard operating procedures have not proved sufficient to break into new territory. If the process-oriented views exemplified in Dachler's orientation take hold, it is conceivable that leadership research could regain its lost momentum.

Zurich: The University and the Swiss Federal Institute of Technology

Social Class and Educational Opportunity. A bridge between the laboratory-oriented educational research programs undertaken in the Universities of Neuchatel and Geneva, and the more field-dependent orientation of eastern Switzerland, is provided in the survey research of Professor Francoise Stoll (University of Zurich). Stoll's research, elegant in its simplicity, is focused on the influence of socioeconomic factors on equality of educational opportunity.

It is an article of faith in Switzerland that social class, wealth, parental status, etc., have nothing to do with access to the educational resources of the community. This theory also holds in the US and England, among other places, despite compelling evidence to the contrary (cf. Brophy & Good, 1974; Crano and Mellon, 1978; Rist, 1970). Stoll has chosen to investigate this issue by following cohorts of children throughout their educational careers. To address the issue of socioeconomic influences, he first divides children into various strata on the basis of sex, parental income and education, and nationality (Swiss vs. immigrant). Under conditions of complete (theoretical) equality of educational opportunity, these factors should have little relationship with the distribution of children from the various substrata that attend the vocational vs. college preparatory tracks in the schools, and who go into the unskilled labor market, the skilled trades, or on to advanced university degrees. Such, however, is far from the case.

Stoll has found that socioeconomic status is a very telling predictor of who enters the college preparatory streams in the lower schools, and it is from this group, almost exclusively, that the pool of university attendees is chosen. The probability of entering the universities from one or another of the "nonacademic" tracks is miniscule, as is the likelihood that the child of immigrant parents will make it into the college preparatory group. (Chances are only slightly better for the Swiss-born offspring of parents of lower socioeconomic status.)

Interpretations of these figures are quite easy to put forward. We might see in these results the deliberate and malevolent operation of an aristocratic class system, in which one's own, and no others, are allowed access to the means of becoming successful. Equally reasonable is the interpretation that the wealthy understand what it takes to succeed in the game of life, and can better prepare their children for the contest. No matter which interpretation is preferred, if we let the data speak for themselves it is evident that the Swiss child who is not blessed with the right set of parents will not be privy to all that the society has to offer by way of education.

Reaction Time in Real Settings. Measures of reaction time are used widely in psychology, in very diverse areas of study. Just as fundamental studies of motor coordination could not do without reaction time measures, neither could cognitive psychology or research directed toward understanding the human memory. In general, we think of reaction time as a laboratory measure, dependent as it is on complex measurement devices. However, Amos Cohen (Swiss Federal Institute of Technology, Zurich) has adapted this "laboratory" measure in studying a very practical problem, the reasonable response-time limits of automobile drivers under different conditions of car speed, road conditions, etc.

Cohen has observed that typical government-sponsored tests of drivers' reaction times in Germany and Switzerland are overly and unreasonably generous, in that they allow subjects to concentrate upon the presentation of a simple stimulus and to respond as soon as the stimulus is detected. Focused concentration of this type is not typical when driving a car, which involves navigation, vehicle guidance, control, monitoring, and anticipation. Accordingly, he adapted the usual procedure by mounting 32 tiny red diodes on the windshield of a test vehicle, which subjects drove on major highways, rural roads, or urban streets. Speed, too, was varied in his study, with subjects driving at 80 km/h in one test and 130 km/h in the next (of course, local speed regulations were obeyed).

Both experienced (police) and inexperienced drivers were used in the study. The subject's task was to press a ring mounted on the steering wheel whenever a diode was lit. The particular diode, and the time at which it was activated, was computer controlled and randomized. The computer also was used to measure latency of response.

Cohen's results extended and corrected the typical findings. Among his results were the following:

- Stationary reaction times averaged 0.3-0.5 seconds, almost identical to those found in earlier equivalent research sponsored by the German government.
- The reaction times of subjects taken when they actually were driving were not nearly as good as when the car was stationary and subjects merely had to focus on the onset of the stimulus.
- Angular deviation of the signal influenced reaction time drastically. The more peripheral the signal, the greater the latency of response.
- Experienced drivers failed to detect 27 percent of all signals; inexperienced drivers missed 47 percent.
- Road conditions mattered, with shorter latencies on highways.
- Speed might possibly have made a difference, but drivers were unable to keep to the prescribed figures, given variations in local conditions; thus, the effect of this variable could not be assessed unambiguously.

The practical aspects of Cohen's use of laboratory measures are important. For example, Enke (1979) observed that approximately 50 percent of all automobile accidents could be avoided if the involved drivers responded 0.5-1.0 seconds earlier. Cohen's data suggest that this conclusion must be moderated by a consideration of relevant conditions, and he has detailed some of these. His work also suggests that the laws of many countries regarding drivers' responsibilities are simply unrealistic. In Israel, for example, drivers are legally responsible for accidents that occur before they can possibly respond to their cause. Cohen's findings suggest that laws which fail to take into account limits of fundamental human response latency be modified. This is especially obvious when we consider that Cohen's measure involved only a simple reaction--a finger movement from steering wheel to response ring. We know that complex reactions involve considerably greater latencies.

Conclusion

As noted at the beginning of this report, most institutions of higher education in Switzerland are supported by their respective cantons. Swiss psychologists clearly recognize their obligation to their communities, and this recognition is evident in the orientation of their work. This is not to suggest that the particular topics of study are dictated, or even influenced, by this orientation, but rather that there exists an informal norm that psychological research have utility for the citizenry. This applications orientation is proper, and has resulted in a unique approach. Most of the psychological researchers I encountered in Switzerland seemed to have been trained as "ivory tower" laboratory scientists. Over time, however, their felt obligation to the communities that support them appears to have extended their views about the nature of the scientific enterprise. The extended orientation still includes a healthy respect for basic scientific values--indeed, the quality of psychological research in Switzerland is as least as good as I have encountered anywhere. In addition, the eye toward utility of research findings renders Swiss work a model of science in the service of the community. The Swiss provide an example of an approach that many of us might adopt with great profit to ourselves, our field, and to the society at large.

References

Bramel, D., and D. Friend, "Hawthorn the Myth of the Docile Worker, and Class Bias in Psychology," *American Psychologist*, 36 (1981), 867-878.

Brophy, G.E., and T.L. Good, *Teacher-Student Relationships: Causes and Consequences* (New York: Holt, Rinehart and Winston, 1974).

Carey, A. "The Hawthorne Studies: A radical criticism," *American Sociological Review*, 32 (1967), 403-416.

Crano, W.D., and M.B. Brewer, *Principles and Methods of Social Research*, (Boston: Allyn and Bacon, 1986).

Crano, W.D., and P.M. Mellon, "Causal Influence of Teachers' Expectations of Children's Academic Performance: A Cross-Lagged Panel Analysis," *Journal of Educational Psychology*, 70 (1978), 39-49.

Crano, W.D., and L.A. Messe, *Social Psychology: Principles and Themes of Interpersonal Behavior* (Homewood, Illinois: Dorsey Press, 1982).

Dachler, H.P., "Constraints on the Emergence of New Vistas in Leadership and Management Research: An Epistemological Overview," *Emerging Leadership Vistas*, eds. J.G. Hunt, B.R. Baliga, H.P. Dachler, and C.A. Schriesheim (Boston: Lexington, 1986).

Enke, K., "Moglichkeiten zur Verbesserung der Aktiven Sicherheit Innerhalb des Regelkreises Fahrer-Fahrzeug-Umwelt," *Paper presented at the 7th Conference on Safety Vehicles* (Paris, June 1979).

Franke, R., "The Hawthorne Experiments: Review," *American Sociological Review*, 44 (1979), 861-867.

Franke, R., "Worker Productivity at Hawthorne," *American Sociological Review*, 45 (1980), 1006-1027.

Franke, R., and J. Kaul, "The Hawthorne Experiments: First Statistical Interpretation," *American Sociological Review*, 43 (1978), 623-643.

Jones, R.A., *Self-Fulfilling Prophecies: Social, Psychological, and Physiological Effects of Expectancies* (Hillsdale, New Jersey: Erlbaum, 1977).

Kuhn, T.S., *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 2nd ed., 1970).

Mayo, E., *The Human Problems of an Industrial Civilization* (New York: Viking Press, 1933, 2nd ed., 1960).

Merton, R.L., *Social Theory and Social Structure* (New York: Free Press, Revised ed., 1957).

Mulherin, J.P., "The Sociology of Work and Organizations: Historical Context and Pattern of Development," *Ph.D. Dissertation* (University of California: Berkeley, 1979).

Rist, R., "Student Social Class and Teacher Expectation: The Self-Fulfilling Prophecy in Ghetto Education," *Harvard Educational Review*, 40 (1970), 411-421.

Roethlisberger, F.J., and W.J. Dickson, *Management and the Worker* (Cambridge, Massachussetts: Harvard University Press, 1939).

Rosenthal, R., and L. Jacobson, *Pygmalion in the Classroom* (New York: Holt, Rinehart, and Winston, 1968).

Schneider, M., "The Quality of Life in Large American Cities: Objective and Subjective Social Indicators," *Social Indicators Research*, 1 (1975), 495-509.

Schwarz, N., F. Strack, D. Kommer, and D. Wagner, "Soccer, Rooms and the Quality of Your Life: Mood Effects on Judgments of Satisfaction with Life in General and with Specific Domains," *European Journal of Social Psychology*, 17 (1987), 69-80.

Walter-Busch, E., "Subjective and Objective Indicators of Regional Quality of Life in Switzerland," *Social Indicators Research*, 12 (1983), 337-391

_____, "The Sudden Restlessness of Relay Assembly Operator 2A," *Paper Read at the Convention of the Academy of Management*, (Chicago, 1986).

Wasserman, I., and L.A. Chua, "Objective and Subjective Social Indicators of the Quality of Life in American SMSA's: A Reanalysis," *Social Indicators Research*, 8 (1980), 365-381.

4/9/87

Biological Sciences

BIOTECHNOLOGY: "BIOEXCHANGE '87," A CONFERENCE ON UK RESEARCH IN BIOTRANSFORMATIONS

by Claire E. Zomzely-Neurath. Dr. Zomzely-Neurath is the Liaison Scientist for Biochemistry, Neurosciences, and Molecular Biology in Europe and the Middle East for the Office of Naval Research's London Branch Office. She is on leave until July 1988 from her position as Director of Research, the Queen's Medical Center, Honolulu, Hawaii, and Professor of Biochemistry, University of Hawaii School of Medicine.

Introduction

A 1-day conference aimed at providing a forum for the transfer of biotechnology from research programs in biotransformations at universities, polytechnical, and other research institutes to industry in the UK was held at the Park Lane Hotel, London, UK, on 15 January 1987. The conference was sponsored by the Laboratory of the Government Chemist (LGC) and the Royal Society of Chemistry. There were 174 attendees--63 percent from industrial organizations and 37 percent from universities, government laboratories (such as the LGC), and polytechnical institutes.

The presentations included an overview of current research emphasis in biotransformations as well as discussions of various topics by university scientists including biotransformations of synthetic organic compounds and by naturally immobilized cells, aerobic biotransformations, use of microorganisms as biocatalysts, oxygenases, etc. In addition, representatives from the Laboratory of the Government Chemist (LGC) and the Scientific and Engineering Council (SERC) spoke about their programs to stimulate university-industry collaborations.

Although the conference was entitled "Bioexchange '87," only the area of biotransformations was addressed. Biotransformation is the conversion of one chemical to another by use of whole cells, by

extracts from cells, or by enzymes. The source of the cells or enzymes for a particular biotransformation may be animal, plant, or microbial. These cells may or may not be immobilized. The potential to industry through the use of the technique of biotransformation is considerable. It may provide novel routes to specialty chemicals or key intermediates or enable the more efficient use of costly starting materials. Other applications cover the specific detoxification of troublesome effluents to protect the environment and the development of specific and cost-effective bioanalytical procedures.

Role of the LGC

In a brief introduction, R.F. Coleman (LGC) summarized the functions of the LGC, which was founded in 1842. In addition to wide-ranging programs in analytical chemistry supporting government policies for the protection of the environment and the consumer as well as the improvement of human and animal health, the LGC is currently engaged in research and development projects of industrial relevance in areas as diverse as biotransformation, laboratory robotics, and materials development. Consulting and advisory services, originally developed for the LGC's own programs are now available to public and private-sector customers. The LGC also operates a sponsorship scheme for the commercial application of biotechnology in UK industry. The LGC sponsors three "CLUBS": (1) Biotransformations, (2) Chemical sensors, and (3) Laboratory Robotics. Members of these CLUBS pay an annual fee, which is matched by the Department of Trade and Industry to ensure that CLUB members get increased value for their money. The aims of these CLUBS are to:

- Provide a means for the exchange of information about new developments in their respective areas and their applications
- Facilitate the formation of consortia to carry out projects with defined commercial objectives
- Encourage UK manufacturers to develop and exploit specific university-based research
- Identify and encourage private and public funding for the research.

Animal Cell Biotechnology at the University of Surrey, UK

Animal cell technology is concerned with the growth of animal and human cells on an industrial scale for the production of unique products. During the past few years a combination of advances in immunology, biochemistry, microbiology, biochemical and genetic engineering, and computer technology has resulted in the discovery and production of a number of important new medical and industrial products. A.D. Murdin (Animal Cell Research Group, Department of Microbiology, University of Surrey, Guildford) spoke about some of the research being carried out in this area at the University of Surrey. He emphasized the eagerness of his department to attract additional industrial collaborators, either to commission contract research making use of his group's capabilities or to become involved in the development of projects initiated in the department.

Murdin stated that the animal cell research group has expanded rapidly since its formation 3 years ago and thinks that they are one of the leading research groups in this field in the UK. The group comprises over 20 scientific staff with expertise in many aspects of animal cell technology including genetic manipulations, immobilization, viral vaccine production, bioreactor development, scale-up, and monitoring and control systems. A new laboratory block will be completed soon, and future expansion is anticipated. Murdin mentioned that they have developed a packed-bed bioreactor suitable for the culture of nonadherent animal cells including hybridomas (for monoclonal antibody production). The bioreactor has considerable potential but requires further studies, and scale-up work has to be undertaken. Also, a serum-replacing growth factor has been obtained from cultures of a human carcinoma cell line. There is much current interest in replacing serum as a tissue culture reagent and they would like to undertake further studies of this growth factor. An improved host vector system for the expression of recombinant proteins in animal cells is also being developed by the Animal Cell Research Group. The vector is based on bovine papilloma virus which exists in high numbers in mouse fibroblast cell lines. This means that recombinant proteins can be produced in large amounts within a cell, in some cases in quantities equivalent to those found naturally for secreted molecules such as immunoglobulins.

Among the most exciting of the products produced by animal cells are monoclonal antibodies (Mabs) which can now be produced at high purity and on a large scale by growing animal or human cells outside the body in bioreactors. Mabs are also finding widespread use in the diagnosis of disease, testing of the environment and food products, and in the industrial purification of biological substances. In addition, there is a great deal of interest in the use of Mabs for the treatment of cancer and other

diseases, and medical trials are now starting in the UK. According to Murdin, these developments will result in a dramatic increase in demand and a requirement for technological advances which will allow the production of Mabs on a larger scale, at higher cell densities, and at a lower cost. Other animal cell products of commercial interest include viral vaccines, hormones, interferon, antiviral drugs, and Factor VIII. The Animal Cell Biotechnology Group's work is concerned with the development of technologies which allow the intensification of production of Mabs and other products.

The Animal Cell Research Group, headed by R.E. Spier, has already attracted substantial funding for contract research. The members of the research group have expertise in the attachment of cells to surfaces, the immobilization of cells which produce Mabs, the optimization of the nutrient medium used to culture animal cells, the design of microcomputer hardware and software for the monitoring and control of bioreactors, the development of novel bioreactors, the development of new sensors for bioreactors, viral vaccine production, and the genetic engineering of animal cells. In addition to the research facilities for laboratory-scale cell culture, the group has a pilot plant for scale-up studies, and a purpose-built cytotechnology laboratory is under construction.

Biotransformations of Synthetic Organic Compounds

D.W. Ribbons (Center for Biotechnology, Imperial College of Science and Technology, London) has a large group working in biotransformations of synthetic organic compounds. He emphasized that their main objective is to produce new fine chemicals using microorganisms--principally, bacteria and yeasts. Microorganisms are uniquely able to react with molecular oxygen under mild conditions (room temperature and atmospheric pressure) and insert the oxygen into compounds in highly specific reactions and in excellent yields (sometimes approaching 100 percent conversion). Usually, genetically altered microbial strains are needed for the high yields. Many of these reactions cannot yet be done chemically under the mild conditions necessary for unstable starting materials and products. Another advantage of microbial hydroxylation reactions is that some of the products are chiral in high optical purity, whereas chemical syntheses invariably yield mixtures of these optically active products which require extra separation processes to resolve the mixture and give only 50 percent yield, at best, of the required compounds. Speciality fluorochemicals are of great interest in medical and agricultural research. It is evident from the number of fluorochemicals commercially available (about 1500 in 1985) that this is a growth area for new compounds with novel biological activities. Although fluorochemicals are very rare in biological work, synthetic fluorochemicals are frequently and readily biotransformed by microorganisms to previously undescribed fluorochemicals. According to Ribbons, chemists have an interest in using the novel biotransformations as aids in organic synthesis.

Bioconversions at Strathclyde

Work on bioconversion processes has been carried out at Strathclyde University for over 15 years. P. Halling (Department of Bioscience and Biotechnology, University of Strathclyde, Glasgow) discussed the various projects emphasized in his department. They have a variety of projects on both enzyme and whole-cell catalysts with active collaborative involvement of staff from three departments: Bioscience and Biotechnology, Chemical and Process Engineering, and Pure and Applied Chemistry.

An area of special emphasis is the use of biocatalysts in predominately organic reaction mixtures with low content of water (for example, containing 99 percent of an organic solvent and 1 percent water). These offer considerable industrial advantages, notably higher solubilities for many reactants of interest and the use of readily available hydrolytic enzymes to catalyze the reverse, synthetic reactions. Some of the earliest work on these reaction systems was done at Strathclyde over 10 years ago, and particular studies have been made of peptide synthesis with proteases and of ester synthesis catalyzed by lipases and other esterases. Halling and his coworkers are now extending their investigations to cover redox catalysts. He thinks that it seems likely that the application of biocatalysts in these reaction mixtures must offer commercial opportunities. Other areas of research on bioconversions include fermentation process improvement, isolation of microbes with novel transformation activities and reaction of redox enzymes with electrodes.

Biotransformation Group, Trent Polytechnic

A brief report about the biotechnology group was given by M. Griffin (Department of Life Sciences, Biotransformation Group, Trent Polytechnic, Nottingham). The department has well-recognized expertise in the area of microbial physiology; recently, a group consisting of both microbiologists and biochemists have

applied this expertise to investigating the potential use of microorganisms as biocatalysts. Work in this area, which presently encompasses three major areas of study, has received external funding from both the public sector and industrial concerns. The three areas of study include:

- The microbial oxidation of cycloalkanes and simple cyclic terpenes, the use of the microorganisms concerned in the production of chemicals having application in the petrochemical, fragrance, and flavor industries
- The use of microbial esterases for the optical resolution of commercially important racemic terpene esters
- Microbial dehalogenases, their genetics and biochemistry, and their stereoselectivity in the production of useful optical isomers of organic acids.

Biotransformations Research at Sunderland Polytechnic

The North East Biotechnology Center (NEBC) comprises the Biology and Pharmaceutical Chemistry Departments at Sunderland Polytechnic together with the Chemical Engineering Department at Teeside Polytechnic. Staff at the Center are engaged in research projects in biocatalysis, fermentation, downstream processing, health care biotechnology, molecular genetics, and plant biotechnology. J. Colby of NEBC outlined three specific research projects involving important biotransformations:

1. Applications of co-oxidizing microbes. Carbon monoxide (CO) is a highly poisonous gas; it is also colorless, odorless, and tasteless. Human exposure arises principally from the incomplete combustion of fossil fuels in the home or workplace. Contact can also be a consequence of working in enclosed conditions, for example, in coal mines, garages, and sewage treatment plants. Microorganisms or enzymes that specifically bind CO can be used in the construction of cheap and sensitive devices to detect and measure CO in hazardous environments, or to remove CO (CO biosensors and CO biofilters). Colby and his group are currently developing such devices based on CO dehydrogenase produced by one of their Co-oxidizing microorganisms (*Pseudomonas thermocarboxydorvorans*). A prototype biosensor has been constructed and tested. Currently, the researchers are concentrating on attempts to immobilize and stabilize the catalyst.

2. Microbial synthesis of chiral compounds. The ability of biological systems to distinguish between steroisomers is based on the sterospecificity exhibited by many enzymes, enabling the systems to specifically synthesize the required isomer or selectively to remove the unwanted isomer from a racemic mixture. This property of biologically-based processes makes them very attractive for the production of chiral feedstocks that are not amenable to chemical synthesis. Such feedstock chemicals are required in the production of many nigh-value products such as pharmaceuticals and agricultural chemicals. The bioconversion of a racemic mixture of D- and L 1-2-chloropropanoic acids into the L-isomer, a system of some commercial importance, is being used as a model biotransformation system. The aim of the research is to purify and characterize the enzyme responsible for this bioconversion with a view to improving the efficiency of the process. Methods for the immobilization and stabilization of the enzyme catalysts are now under investigation.

3. Selective hydrolysis of natural lipids. Commercial processes for the isolation of fatty acids use conventional hydrolysis followed by distillation or crystallization; these are not applicable to the particular fatty acid being studied by Colby and his group. They utilize a lipase with unique stereospecificity that will hydrolyze the methyl esters of most fatty acids but leaves the desired product intact. Immobilization techniques for the lipase are being developed and the kinetic behavior of the system evaluated with a view to establishing the preferred configuration for any enzyme reactor.

Biotransformations at the University of Bath

The interest in biotransformations at Bath has resulted from the close association between the university and the pharmaceutical industry and has consequently focused on the application of microbial and mammalian transformations to the synthesis of pharmaceuticals and fine chemicals. C.J. Soper (School of Pharmacy and Pharmacology, University of Bath) described the strong interdisciplinary approach to biotransformations that is maintained at Bath. The systematic development of a commercial process for the N-dealkylation of drug molecules from the initial enquiry via feasibility assessment to scale-up was used by Soper to illustrate this approach.

The industrial enquiry concerned the problem of the N-dealkylation of cyclic amines in drug synthesis. This reaction can be carried out chemically but requires toxic agents. Therefore, the staff at Bath was asked to find a milder procedure utilizing microorganisms. The research group was able to find a

microorganism which could carry out the N-dealkylation better than could be done chemically. It was then necessary to ascertain if scale-up could be carried out efficiently and cheaply. It was found that immobilization of whole cells on alginate gels and the use of an airlift reactor gave the best results. The yield of the commercial product, for example, was 30 percent--six times better than any chemical process.

Soper emphasized that optimization of the transformation process needs the participation of pharmaceutical microbiologists and genetic engineers in the screening and development of suitable microorganisms, and the involvement of biochemists in characterizing the enzymes that catalyze the transformation reaction. The concurrent involvement of medical and analytical chemists in the design and development of techniques for the detection and separation of the required transformation product from the chemically similar drug or fine chemical substrate in complex growth media permits assessment of the overall feasibility of the biotransformation. The cooperation of chemists, microbiologists, and biochemists enables biochemical engineers to scale up the fermentation and selective separation techniques for downstream processing, culminating in the design of the commercially viable process. In addition, the existence of other facilities such as molecular graphics, and pharmacological and toxicological testing as well as pharmaceutical formulation and development enables the university to provide a complete service for a company that wishes to explore the possible uses of biotransformation.

Biotransformations at the University of Kent at Canterbury

Significant research effort at the University of Kent has been expended for many years in the study of commercially applicable transformation systems. Some of the programs at Kent were discussed by D.J. Hardman (Institute for Biotechnological Studies, Research and Development Center, University of Kent). One area of emphasis includes both the bioconversion of substrates to value-added products and the biotransformation or biodegradation of potent environmental pollutants. Some examples are the conversion of nitriles into value-added sterospecific amino acids or nontoxic compounds. Such commercially desirable conversions are often of limited use due to the properties of the substrates or products. In particular, poisoning of the biocatalyst often occurs. The group at Kent uses membrane reactors to overcome important problems intrinsic to this area of biotechnology. The desirable properties of a good bioreactor are: (1) high volumetric productivity; (2) stability; (3) ease of control, such as temperature change; and (4) reduction of downstream processing burden. Hardman and his group use hollow filter membranes in their membrane reactors. Bioreactors are used for the conversion of glucose to lactate by yeast cells (*S. cerevisiae* or *Zynamonus mobilis*). The group has also developed systems to degrade or detoxify halogenated compounds by specific enzyme-catalyzed removal of halosubstituents. For example, *Pseudomonas aeriginosa* is used for the degradation of dichlorohexane. The environmental application is the removal of vinyl chloride.

Biotransformations at the University of Warwick

A brief presentation of the research activities at the university was given by H. Dalton (Department of Biological Sciences, University of Warwick, Coventry, UK). In Dalton's department the research group's activities center principally on the exploitation of oxygenases to effect the production of a variety of oxychemicals from simple aromatic and aliphatic substrates. Although fundamental studies on the mechanism of action of the enzymes are undertaken on purified enzymes, their exploitation in the production of oxychemicals is done using whole cells. There are two approaches being used to transform these substrates. One is the use of mutant organisms in which products accumulate in culture due to a lesion in the enzyme which would normally transform the product into central metabolites. The other makes use of the cometabolic activities of the oxygenase. The oxygenases, generally, have broad substrate specificities and are able to insert oxygen into substrates to produce products that are not further metabolized by the organism and hence accumulate in the culture medium. The group has developed strategies for producing alcohols, diols, and epoxides.

In the Department of Chemistry, biotransformations are being studied using esterases and lipases, decarboxylases, dehydrogenases, and oxygenases. These enzymes are being investigated for their ability to catalyze chemo- and enantioselective transformations of meso or racemic substrates. The objective is to produce chiral building blocks of value in the synthesis of fine chemicals in optically pure form. Technical aspects of the research include the study of enzymatic reactions in organic solvents, immobilization procedures, and flow-through reactor systems. The products of biotransformations are being included

with chemical transformations in the development of procedures for the synthesis of biologically active compounds. In parallel with the synthetic program, studies are being made of the fundamental properties of enzymes with applications in biotransformations.

Microbial Transformation Groups, University College of Wales

The activities of the aerobic biotransformation group were presented briefly by D.J. Hopper (Department of Biochemistry and Agricultural Biochemistry, University College of Wales, Aberystwyth). Studies are directed towards:

- Understanding the enzymology and reaction sequences by which microorganisms transform both natural products and xenobiotic compounds containing alicyclic or aromatic rings in readiness for ring cleavage
- The range of oxygenative and other ring fission systems available and the structural features that dictate the particular mechanism used
- Elucidation of pathways for the conversion of ring-fission products into central metabolites
- The application of these enzymes and reaction sequences in the production of novel molecules with industrial relevance.

The studies of the aerobic biotransformation group were outlined by J.G. Morris of the Department of Botany and Microbiology. The research is concentrated upon: (1) understanding the physiological basis for the control of enzymic and metabolic activities by a variety of anerobic microorganisms, particularly those of the genus *Clostridium;* (2) the analysis of novel enzymic biotransformations exploited by these anerobes; (3) the exploitation of electrochemical methods for biosynthetic purposes; and (4) the development of host/vector systems for such organisms to permit the enhancement of the selective expression of clostridial genes and the expression of heterologous DNA in clostridial hosts.

Biotransformations of Naturally Immobilized Cell Systems (NICS)

The development of large-scale growth of cultured plant cells has been carried out by K.W. Fuller at the Department of Plant Sciences, University of Oxford. Plants produce a vast array of chemical compounds--some very complex such as vincristine from *Catharanthus roseus*. Moreover, the variety within any one species may also be large; thus *C. roseus* does not produce only vincristine but also something near 100 alkaloids and Digitalis purpurea as well as 20 or more cardenolides and a similar number of anthraquinones. Many of these are synthesized by standard hydroxylations, oxidation, dehydrations, etc., but some also involve special transformations such as the coupling of the two halves of the complex alkaloids from *Catharanthus*. With the development of suitable techniques, these enzymic processes should be of value to the synthetic chemist--particularly where chiral centers are involved.

By manipulating the growth medium and conditions, Fuller and his group have been able to produce surfaced, roughly spherical aggregates of uniform plant cells from a number of species. These aggregates are robust enough to withstand stirring in bioreactors or use in columns. Being green, their metabolism more nearly resembles that of cells *in vivo*, and they are responsive to the many environmental triggers and controls which regulate chemical production in the plant.

As an example of the use of these aggregates, Fuller and his group have studied the formation of glucosides of various compounds--both those known to occur *in vivo* and some to which the plant has not previously been exposed. High rates of transformation were obtained, giving likely rates per cubic meter of 1 ton per year. Fuller stated that glycosylation itself might be useful to improve the pharmacodynamics of various drugs, to separate chiral forms, and to provide easy selective blocking of groups in intermediates used in further bio- or chemical synthesis.

Fuller stated that he and his group seek collaboration with organizations interested in the use of their immobilized cell systems for any of the multifarious reactions which exist in plant cells. In particular, they are interested in talking with anyone who thinks the glycosylation reaction could be of use to them.

Biotechnology Directorate, SERC

This organization was established by the Science and Engineering Research Council (SERC) in 1981 to provide stimulus and coordination as well as a focus for research and postgraduate training in biotechnology in SERC and on a national scale in the universities. It is particularly charged with encouraging the academic/university interface. The mechanisms of SERC support for biotransformation research in academia were discussed by M. Lex (Biotechnology Directorate, SERC, Swindon) with particular emphasis on schemes to encourage collaboration with industry. The priority sectors identified as being of key importance to the development of UK biotechnology,

and therefore meriting special support, are:

- Process engineering; for example, fermentation technology and downstream processing
- Bioconversions; for example, microbial physiology and enzyme biocatalysis
- Animal cell culture
- Plant cell culture
- Whole plant biotechnology
- Host/vector systems
- Biosensors and bioelectronics
- Protein engineering.

It is impossible within the scope of this report to outline SERC's many programs and methods of support. Detailed information can be obtained by writing to: Dr. Maurice Lex, Biotechnology Directorate, SERC, Polaris House, North Star Avenue, Swindon SN2 1ET, UK. The Directorate has an extensive and effective system of support. The question is whether it was started too late to enable the UK to catch up with Japan, the US, and West Germany, which today are leaders in the area of biotechnology.

Conclusion

It is evident from the presentations at this conference that the UK is engaged in extensive efforts to foster liaisons between academia and industry in the area of biotechnology. Many universities and polytechnical institutes, some of which were represented among the speakers at this conference, are already engaged in collaborative efforts with industry. However, many more collaborative projects are required, and the recent increase in support funds to SERC as well as meetings such as this conference are geared towards increased collaborative efforts. Although basic research in the UK is excellent, the transfer of basic research information to industry has lagged behind that of other European countries such as West Germany, The Netherlands, and Sweden and certainly far behind the US and Japan.

4/23/87

LIFE SCIENCE RESEARCH AT AARHUS UNIVERSITY, DENMARK

by Claire E. Zomzely-Neurath.

Introduction

Aarhus University was founded in 1928 as an organization under the name of "University Education in Jutland." It was the first Danish university to be established outside of Copenhagen, the capital of Denmark. Private donations and a grant from the city of Aarhus formed the economic basis for the first years of its existence. The university was a private institution until 1970 when it became a state university. From its founding, Aarhus University was planned as a "full" university in the European university tradition with the five faculties of arts, medicine, social sciences, theology, and natural sciences.

Today, Aarhus University is located in a university park covering 350,000 square meters in a beautiful campus setting. All the buildings of the university have the same architectural design. C.F. Møller has been the sole architect for the design of the attractive buildings.

This report deals with some of the research projects in the life sciences in different institutes and departments at Aarhus University. The information was obtained from interviews with scientists during an initial liaison visit to the university. The topics include cell differentiation, evolution of human repetitive DNA sequences, antibody-dependent cell-mediated cytotoxicity, chromosomal leghemoglobin gene from soybean, and pathogenesis of *M. hominus* in humans.

Cell Differentiation

Differentiation of human epidermal cells in culture and factors affecting this parameter are being studied by L. Bolund (Institute of Human Genetics). Cell kinetic studies on cultured human epidermal cells have indicated that cycling basal cells may be divided into at least two subpopulations that seem to differ with respect to the rate of DNA replication. In a recent study, Bolund and his group carried out experiments to elucidate the biological significance of these subpopulations. They found that the proliferation characteristics of cultured basal cells were changed by the addition of epidermal growth factor (EGF) and cholera toxin to the culture medium. They showed that EGF and cholera toxin stimulated the growth of epidermal cells in culture. Simultaneously, the terminal differentiation of the cells was inhibited, resulting in a reduced multilayering and a reduced formation of the cornified envelope. However, only minor differences in the protein synthesis pattern were observed between cultures maintained in the presence or absence of the growth stimulators.

The effect of EGF and cholera toxin on the basal cell populations was investigated after labeling with tritiated thymidine followed by cell sorting and autoradiography. In the presence of EGF and cholera toxin dramatic changes were

induced in the labeling pattern of sorted S-phase cells, indicating significant alterations in the balance between the subpopulations of cycling basal cells. Bolund thinks that his results with these substances indicate that the observed cell kinetic subpopulations may be related to regeneration or early events in the differentiation process of the keratinocyte.

In another study, Bolund and his group investigated changes in proliferating cell subpopulations and mitotic activity in human epidermal cultures treated with epithelial growth inhibitors. They used an epidermal growth inhibitor purified from an epidermis extract and a kidney epithelial growth inhibitor obtained from conditioned medium of BSC1 cell cultures. Both agents were shown to cause a dramatic decrease in mitotic activity in the epidermal cultures and also to diminish the proportion of S-phase cells with a strong thymidine incorporation (high rate of DNA replication). The effect of the BSC1 growth inhibitor was furthermore shown to be counteracted by epidermal growth factor and cholera toxin.

Evolution of Human Repetitive DNA Sequences

One of the models for genomic change which mediates the evolution of new species or generates changes within a species involves periodic reorganizations of the genome accompanied by amplification of different families of repetitive DNA. The alphoid family of repetitive DNA is found exclusively in primates and has been studied in human and in several monkey and ape species. It is believed that different families of this repeat arose prior to the emergence of several of these species, after which the alphoid families have remained relatively unchanged. Although the separation of the branches leading to the great apes and man took place about 6 to 8 million years ago, the most significant evolution of man has probably taken place within the last few million years. One might expect, therefore, to find within the human genome families of the alphoid repeat which have been amplified relatively recently, and evidence for one such family has already been reported. Recent studies by A.L. Bak (Institute of Medical Microbiology) and other investigators indicate that human alphoid DNA is organized into chromosome-specific subfamilies, formed by the amplification of segments composed of tandemly arranged related copies of the 170 base pair (monomeric) or 340 base pair (dimeric) repeat units. Chromosome-specific subfamilies within human alphoid repetitive DNA is being studied by Bak.

Chromosome specificity of subfamilies of alphoid DNA implies that transfer of sequences between nonhomologous human chromosomes occurs very rarely. However, one group of chromosomes, the nucleolus organizing (NOR) chromosomes appear to undergo recombination between nonhomologues more frequently than do other chromosomes, as found by Bak and others. Thus some alphoid families might be expected to be held in common between the NOR chromosomes. Recently Bak and his group have carried out studies on the alphoid repetitive DNA in three different NOR chromosomes; i.e., 13, 21 and 22. These chromosomes hold in common a related subfamily of alphoid sequences which has diverged about 25 percent from the average sequence of alphoid repeats.

Bak and his group analyzed the hybridization of alphoid DNA probes to Southern transfers of restriction enzyme-digested DNA fragments from hybrid cells containing single human chromosomes. They found that chromosomes 13 and 21 share one subfamily of alphoid repeats, whereas a different subfamily may be held in common by chromosomes 13 and 22. The sequences of cloned 680 base pair (bp) EcoRI fragments of the alphoid DNA from chromosomes 13 and 21 showed that the basic unit of this subfamily is indistinguishable on each chromosome. The sequence of cloned 1020 bp XbaI fragments from chromosome 22 was related to, but distinguishable from that of the 680 bp EcoRI alphoid subfamily of chromosomes 13 and 21. These results suggested to Bak that at some point after they originated and were homogenized, different subfamilies of alphoid sequences must have exchanged between chromosomes 13 and 21, and separately between chromosomes 13 and 22.

Cell-Mediated Cytotoxicity

Humoral and cell-mediated immunity to herpes simplex virus (HSV) has been studied by A. Møller-Larsen (Institute of Medical Microbiology). In one study, she and her group investigated the development of humoral and cell-mediated immune parameters in relation to the acute primary attack of gingivostomatitis in children aged 1 to 15 years. Most individuals are infected with HSV type 1 (HSV-1) during the first few years of life with the greatest frequency of the infection between the ages of 1 and 3 years. Most of the infections are subclinical, conveying immunity to the infected individual and implying latent infection with the risk of later development of recurrent herpes eruptions. About 15 percent of the primary infections appear as an acute gingivostomatitis which is the most common form of a symptomatic manifestation of

the primary infection with HSV-1. The role of humoral and cell-mediated immunity in the recovery from the primary infection and in controlling recrudescence of subsequent latent infection has still not been resolved.

In the above study, Møller-Larsen and her group performed virus isolations to ensure the diagnosis. Humoral immunity was measured by a complement-fixation (CF) test and by an antibody-dependent cell-mediated cytotoxicity (ADCC) test. Cell-mediated immunity was measured by blast transformation assays with specific antigen or phytohemaglutinin (PHA) and by measuring interferon production in HSV-1 stimulated lymphocyte cultures. The clinical response was compared with immune parameters. The results showed that an increase in immune parameters was seen in all patients with herpes stomatitis. From results in blast transformation and antibody-dependent cell-mediated cytotoxicity experiments it was observed that cell-mediated and humoral immunity can be found at the same time during recovery from this type of infection. Møller-Larsen thinks that it is important in future investigations to pay attention to ADCC not only in recovery but also in the control of latent infections.

In another study, Møller-Larsen and her group studied healthy individuals with different reactions in humoral and cell-mediated immunity to HSV as found in complement-fixation, neutralization, and blast transformation assays. These individuals were investigated using ADCC as a serological test. The purpose of the study was to ascertain whether the ADCC assay was more sensitive than the other assays mentioned above in detecting HSV positives. Sera from all individuals were absorbed on HSV-infected varicella zoster virus (VZV)-infected or uninfected cell monolayers before they were used in ADCC with HSV-infected cells as target. The results with absorbed sera were compared with the results from unabsorbed sera. Fresh inactivated sera were also used in some of the experiments. The results of this study revealed a group of individuals who were HSV-positive in ADCC, but negative in all other above-mentioned tests. Because of these reactions they are proposed to be HSV-positives without a latent infection.

Møller-Larsen and her group have also recently investigated the influence of human allergic encephalitogenic peptide (HEAP) on cell-mediated cytotoxity reactions in patients with multiple sclerosis. A clear understanding of the course of multiple sclerosis is still lacking. Abnormal humoral and/or cellular immune reactions to viral and brain antigens have been suspected, but conflicting reports make the significance of these reactions unclear. Møller-Larsen and coworkers assayed multiple sclerosis patients and normal control persons for cell-mediated cytotoxicity against target cells coated with human allergic encephalitogenic peptide. Coating of different types of target cells resulted in increased cytotoxicity, most clearly seen against homologous lymphocytes and virus-infected fibroblasts. Both the patients and controls showed reactivity against coated targets. Although Møller-Larsen was not able to explain the mechanisms of the reactions, she thinks that her findings provide new information about the pathogenesis of multiple sclerosis. During periods of relapse, where new plaques are formed or older ones enlarged, the possible release or presentations of HAEP to the immune system may aggravate an ongoing process of damage through an increase of cytotoxic reactions. Most probably, the damaging process is started by other agents, perhaps viruses.

Studies of Leghemoglobin Genes from Soybean

Investigation of the genes coding for leghemoglobins using molecular biological methods has been carried out by K.A. Marcker (Department of Molecular Biology and Plant Physiology. Leghemoglobins (Lb's) are synthesized exclusively in the nitrogen-fixing root nodules that develop owing to the symbiotic association of Rhizobia with legumes. Soybean nodules contain four major species of Lb's called Lba, Lbc-1, Lbc-2 and Lbc-3, respectively. The Lb's are encoded in the plant genome by a small family of genes. Marcker and his group have so far isolated six separate Lb genes from soybean and have determined the nucleotide sequences of these genes. Recently, these investigators have studied the nodule-specific expression of a chimeric soybean Lb gene in transgenic *Lotus corniculatus*. When a chimeric Lb gene was introduced into the genome of another legume species, *L. corniculatus*, nodule-specific expression of the chimeric gene was found in root nodules formed on fully regenerated plants inoculated with the *Lotus microsymbiont, Rhizibium loti*. Expression under control of the 5' upstream region of the soybean gene was regulated at the level of RNA and followed the correct developmental timing. This indicates a conserved induction mechanism for Lb genes in legumes.

Pathogenesis of Mycoplasma Hominus

There are 12 species of the class *Mollicutes* currently recognized as

occurring in man, four of which are associated with the genital tract--*Mycoplasma hominus, M. fermentans, M. genitalium*, and *Ureaplasma urealyticum*. *M. hominus* is commonly found in the female genital tract, and several epidemiological, microbiological, serological, and animal model studies have shown that it is potentially pathogenic and may be involved, for example, in pelvic inflammatory disease, acute pyelonephritis, and postpartum fever. However, assessment of the pathogenic potential of *M. hominus* is complicated by the fact that this species constitutes a relatively heterogeneous group of organisms. Extensive studies of the various strains of *M. hominus* have been carried out by G. Christiansen (Institute of Medical Microbiology, with the objective of the present study to determine whether this interspecific heterogeneity of *M. hominus* is valid.

The protein patterns of 14 strains using sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE), two-dimensional (2D) gel electrophoresis and immunoblotting were examined. The strains examined included the *M. hominus* type strain PG21 and 13 others isolated from the genital tract, mouth, blood, upper urinary tract, and a wound. These 14 strains were found by Christiansen and her group to share 76 to 99 percent of proteins in SDS-gradient gel analysis and 41 to 72 percent in the 2D gels. The immunoblot likewise revealed the existence of an extensive common protein pattern in *M. hominus*, in addition to a number of antigens shared only by some strains. Thus, the results of this comparative assay of 14 selected strains of *M. hominus* showed a relatively high degree of intraspecific heterogeneity. The finding of apparently more pronounced similarities between the strains when tested by SDS-PAGE (range of congruence 76-99 percent) as compared to the results of 2D gel electrophoresis (calculated homology 41-72 percent) is not surprising since the latter method separates individual bands according to both their isoelectric point and their molecular weight and thus provides a higher degree of resolution.

Conclusion

The University of Aarhus has extensive research programs in all areas of the life sciences. Many of the scientists are using the latest techniques of molecular biology to investigate problems in plant genetics, cell differentiation, and human disease states. These are illustrated in the small sampling of research projects described in this report. These projects are of high quality. Although the research groups are quite small, especially as compared with those in the US, the researchers at Aarhus University are productive and innovative.

4/23/87

Computer Sciences

NETWORK COMMUNICATIONS FACILITIES AND COMMUNICATIONS RESEARCH AT INRIA---AN OVERVIEW

by J.F. Blackburn. Dr. Blackburn is the London representative of the Commerce Department for industrial assessment in computer science and telecommunications.

Facilities

The eight main buildings at France's Institute Nationale de Recherche en Informatique et en Automatic (INRIA), Racquencourt, are well equipped for both local and worldwide communications. The local area network uses the X.25 protocol for communication other than data. There are about 200 terminals on this network. Ethernet is used for the local computer network.

Several possibilities exist for communication with other institutions. There is a hyperchannel for connection to a CRAY 2 computer at Ecole Polytechnique, Paris. The French node on CSNET, a 9600 baud computer science network, is at INRIA. This network has nodes at the US National Science Foundation (NSF) and many other institutes and universities in the US.

FNET is a high-speed computer network providing Unix-to-Unix communication with connection to US NET and Japan NET.

Aristote Network serves an Association of French research institutes including the atomic energy agency, Commission à l'Energie Atomique (CEA), the space agency, Centre National d'Etudes Spatial (CNES), the PTT Research Institute, Centre National d'Etude des Telecommunications (CNET), Electricité de France (EDF), Ecole Polytechnique, and INRIA. The network uses X.400 and file transfer access method (FTAM) protocols.

Research in Networking

Possibly in collaboration with the NSF, INRIA will be testing FTAM for file transfer and X.400 for electronic mail in an open systems interconnection (OSI) environment. A transport converter will

have to be implemented to accommodate the different choices made at the transport level.

An objective of the high-speed networks research at INRIA is to produce an interface compiler, so that if a service, described by an abstract interface, is available on a machine, the calling package can be automatically generated on a remote client machine. A first and reduced version could be a remote procedure interface, built upon a standard remote operation protocol (X.410), which would be generalized by using the OSI presentation protocol. This interface compiler would enable users to define their applications and to experiment with them on the network.

Considerable work will be required in preparation for OSI network management. INRIA plans to investigate the use of a directory service to map the OSI addresses onto subnetwork addresses, and to perform efficient routing. The plan is to also study real-time routing protocols within the OSI network.

Since the current connectionless and connection-oriented X.25 network protocols are based on queuing models, there are no means to request a particular bandwidth for a given application or to request that a packet be forwarded in a limited time. INRIA plans to experiment with a new category of protocols in which a connection phase is used to reserve resources, with no flow control protocol applied during the connection. This will enable real-time applications to be developed after a proper definition of the upper layers of protocols is available.

The High-Speed Network Research Project

This project is based on research previously conducted in the NADIR Project (ESN 36-11:286-288) and the GIPSI-SM90, a joint initiative of INRIA; Honeywell BULL, SA; and CNET to develop a workstation software and hardware based on the SM-90 machine designed by CNET.

The NADIR Project, beginning in 1980, was a 5-year study and experimentation on the use of satellites for communication between computers. A bulk transfer protocol was developed for copying large volumes of data at Mbit/s through point-to-point and point-to-multipoint satellite links, the interconnection of local area networks, and high-speed and multipoint links.

Through NADIR, INRIA participated in HELIOS, a project launched by CEA and INRIA to experiment with high-speed, bulk data transmission between the Paris area and the European high-energy research center (CERN) in Geneva. HELIOS will provide high-speed file transfer for institutions in Europe using hyperchannel to TELECOM I interconnections.

The GIPSI-SM90 implemented the ETHERNET version of X.25 in the Unix system for the SM90 and SPS-7. Ethernet networks can be connected with 64-kbit/s X.25 links. Plans are underway to provide a throughput of up to 2 Mbit/s.

The GIPSI-SM90 integrated the OSI transport and session layers within Unix, and realized an X.400 protocol implementation. A first use of the interactive "remote operation service" was developed within the European information technology program (ESPRIT) THORN project, which will provide a directory service for the ESPRIT community.

The current state of the art in high-speed networks is to connect Mbit/s local nets (Ethernets) of work stations, terminal concentrators, and general purpose mainframes through low- or medium-speed links (typically 64 kbit/s). However, computer networks of the future will include:

- Supercomputers of the Cray class, which may easily generate several 100 Mbit/s of data
- General purpose mainframes or minicomputers
- Clusters of work stations, connected through standard local networks, such as Ethernet
- Very-high-speed "backbone" networks, using fiber optics to provide a throughput of several 100 Mbit/s, to interconnect the local networks and the supercomputers
- Terrestrial or satellite long distance links.

INRIA research will investigate new applications that will use these future networks including:

- Testing new applications at the current high speeds (Mbit/s) using existing networks
- Study of new communications protocols for the upper layers of the OSI architecture
- Study of network protocols for the very-high-speed network
- Building the gateways between the existing networks and the future high-speed backbone (this will be particularly useful for connecting clusters of workstations to the backbone network)
- Building direct interfaces between the supercomputers and the backbone
- Optimizing the applications to take advantage of the available throughput
- Eventually, designing VLSI chips for interfacing the new high-speed networks. Then, it will be possible to

directly connect the new generation of work stations to the high-speed network.

INRIA Interest in High-Speed Networks. INRIA needs an operational high-speed network to upgrade its network which links workstations, minicomputers, and mainframe computers at INRIA sites in Rocquencourt (near Paris), Rennes, and Sophia Antipolis (near Nice). At each site an Ethernet local network serves workstations and minicomputers; terminals and mainframe computers are connected to a local X.25 network which is also connected to the Ethernet and to Transpac. The main use of the X.25 network is terminal access, but it is also used for some file transfers or message exchanges using X.400 protocol. Transpac is used to interconnect the three sites. The Multics mainframe computer in Rocquencourt is connected through a high-speed hyperchannel to a Cray 2 at Ecole Polytechnique.

The configuration of one Ethernet per site is expected to be insufficient for traffic within the next year. A more complex structure will be required, with local Ethernet connected to a campuswide backbone. Higher speed connections will be installed between the three INRIA locations.

Plan for Transatlantic Collaboration. A public virtual circuit can be used but the throughput of the X.25 connection will be low. A 64-kbit/s leased circuit can be acquired from "Satellite Business Service." This service is commercialized for INTELSAT by France Cables et Radio and in the US by authorized carriers. France Cables et Radio sells service terminating in mid-Atlantic and the remainder is purchased from a carrier in the US.

An ISO relay can be established by INRIA over this circuit in the first half of 1987, and the link can be available for the testing of new OSI applications. Work stations to super communication could begin right after the ISO relay was established. Real-time applications such as the real-time generation of images from a supercomputer for visualization on a transatlantic workstation would require defining and implementing new network level protocols on NSF NET, INRIA NET, and the transatlantic link.

Comments

The possible collaboration between INRIA and NSF on high-speed network research is still pending as of mid-March, 1987. However, Mr. Georges Nissen, Director of Industrial and International Relations at INRIA is optimistic that it will be agreed upon within a few weeks.

The work at INRIA in this field has been underway at least since the beginning of the NADIR Project in 1980. The quality of the research appears to be high and certainly the communications facilities are excellent and continued improvement is in prospect.

4/20/87

A NEW APPROACH FOR THE RECOGNITION AND POSITIONING OF TWO-DIMENSIONAL OBJECTS

by J.F. Blackburn.

Introduction

Two researchers at France's Institut National de Recherche en Informatique et en Automatique (INRIA), Nicholas Ayache and Olivier Faugeras, have proposed a new method designed to identify and locate objects lying on a flat surface. They refer to the method by the name Hypothesis Predicted and Evaluated Recursively (Hyper). The method has been implemented in a vision system coupled to an industrial robot arm to provide automatic picking and repositioning of partially overlapping industrial parts.

In computer vision, sensor output is used to construct a symbolic description where the information necessary to solve the problem at hand is explicitly represented. Then a priori knowledge is represented in an "environmental model," which is a very complex problem. Finally these two structures, the symbolic description and the environmental model, are used to achieve the task of recognition and positioning. The first of these activities is mainly a signal processing problem, the second is a knowledge representation problem, and the third is a control strategy problem. The complexity of the total task depends on parameters like signal quality of the sensor output.

The approach used by Ayache and Faugeras was to fix one or more of the parameters and have the others vary in a controlled manner. Specifically, the method is used to analyze scenes with randomly oriented and partially occluded industrial parts, in which the parts are essentially flat--one dimension is small compared to the other two.

The approach used is one of hypothesis generation and verification coupled with a recursive estimation of the model of scene transformation. It has the advantage of ease of extension to three-dimensional problems.

Building Models and Scene Descriptions

The sensing device is a standard vidicon camera connected to an image memory. The video signal is quantized, using 256 gray levels, and the image size is either 256×256 or 512×512. Models and scenes are represented in the same way.

To build either a model or a scene description the following steps are applied:

- If contrast is high enough, threshold the image and smooth the resulting binary picture using erosions and dilations.
- If the contrast is not high enough, find the edges by combining gradient and second-order derivative information. This is done by thresholding to find the major intensity discontinuities and then the use of low-pass filters to get an accurate detection of intensity discontinuities. Edges of width 1 pixel are then connected.
- Find the list of connected border points.
- Approximate the connected components with polygons.

This description of two-dimensional object shapes with polygonal approximation of their borders has several advantages:

- Different parts of the object are described independently, allowing for independent identification.
- Most objects can be described using a small number of line segments.
- It can be applied to any planar shape.
- It is sensitive to variations in the position and orientation of the objects, and these parameters can be accurately recovered.
- The operations used to go from the image to the description are straightforward and fast.

In the following discussion it is assumed that both the model and the scene descriptions are given by a set of linear segments, respectively, of the form: $Mi=(x_i, y_i, l_i, a_i)$ and $Sj=(x'_j, y'_j, l'_j, a'_j)$ where x and y are the coordinates of the segment midpoint, l is the segment length, and a is the segment orientation relative to the horizontal axis.

The model description will also include a certain number of privileged segments.

Matching Models and Scene Description

The prediction of the position of the model in the scene is made by matching a privileged segment in the model description with a segment in the scene description by comparing local intrinsic features. Hypotheses are generated and ranked on the basis of a local criterion of merit. Using the predicted position of the model, additional segments between the two descriptions are used to evaluate a hypothesis and to refine the predicted positions of the model. The matching stops when a sufficient number of hypotheses has been evaluated or when a very high-quality measure is reached. The hypothesis with the highest quality score is then reexamined before being validated or rejected.

Generating Hypotheses

The model position is defined by a transformation T which is described by a parameter vector $V=(k\cdot\cos\theta, k\cdot\sin\theta, tx, ty)$ such that the image (x^*, y^*) of an arbitrary point (x,y) of the model description is given by the equations:

$$x^* = tx + x\cdot k\cdot\cos\theta - y\cdot k\cdot\sin\theta \quad (1)$$

$$y^* = ty + x\cdot k\cdot\sin\theta + y\cdot k\cdot\cos\theta \quad (2)$$

A hypothesis is generated by matching a privileged segment of the model description to a compatible segment of the scene description.

If M_o is a privileged segment of the model description, a segment S_{jo} of the scene description is compatible with M_o if and only if:

1. The angle A between M_o and its preceding neighbor is close to the angle A' between S_{jo} and its preceding neighbor. (Close means lower than a given threshold.)
2. The ratio r between the lengths of S_{jo} and M_o is close to the a priori estimate k_o of the scale factor, when available. (Close means $r-k_o$ is below a threshold.)

If no a priori estimate k_o of the scale factor is available, the parameter vector $v_o = (k_o\cos\theta_o, k_o\sin\theta_o, tx_o, ty_o)^T$ of To is computed by resolving the equations (1) and (2) for the two pairs of corresponding end points of M_o and S_{jo}. If a good a priori estimate k_o of the scale factor k is available the parameters θ_o, tx_o, and ty_o of To are computed by equations (4)-(6) only:

$$k_o = l(S_{jo})/l(M_o) \quad (3)$$

$$\theta_o = a(S_{jo}) - a(M_o) \quad (4)$$

$$tx_o = x'_o - k_o\cdot(x_o\cdot\cos\theta_o - y_o\cdot\sin\theta_o) \quad (5)$$

$$ty_o = y'_o - k_o(x_o\cdot\sin\theta_o + y_o\cdot\cos\theta_o) \quad (6)$$

Where $l(S_{jo})$, $l(M_o)$, $a(S_{jo})$, and $a(M_o)$ denote, respectively, the lengths and orientations relative to the horizontal

axis of S_{j_o} and M_o and where (x'_o, y'_o) are the coordinates of the midpoints of the segments S_{j_o} and M_o, respectively.

A measure of the error in the estimate T_o of T is given by:

$$S_o = E[(v_o - v) \cdot (v_o - v)^t]$$

where v and v_o are the parameter vectors of the unknown transformation T and of its estimate T_o. In practice, S_o is initialized for each hypothesis with respect to the error variance s_k^2, s_a^2, s_x^2, and s_y^2 attached to the initial estimates k_o, θ_o, tx_o, and ty_o. These variances may be heuristically estimated. If s_k^2 and s_a^2 are small compared to 1, the elements of S_o are approximately:

$$S_o(1,1) = k_o^2 \sin^2(\theta_o) \cdot s_a^2 + \cos^2(\theta_o) \cdot s_k^2 \quad (8)$$

$$S_o(2,2) = k_o^2 \cos^2(\theta_o) \cdot s_a^2 + \sin^2(\theta_o) \cdot s_k^2 \quad (9)$$

$$S_o(1,2) = S_o(2,1) = \sin(\theta_o)\cos(\theta_o) \cdot (s_k^2 - k_o^2 \cdot s_a^2) \quad (10)$$

$$S_o(3,3) = s_x^2 \quad (11)$$

$$S_o(4,4) = s_y^2 \quad (12)$$

the other terms of S_{j_o} are equal to zero.

When the hypotheses are ranked by measuring the compatibility between the pairs of matched segments the best hypotheses are evaluated.

Evaluating Hypotheses

After having identified M_o with S_{j_o} the program matches the other segments of the model by an iterative algorithm. At iteration i the program selects a not yet examined segment M_i which is closest to M_o; thus, if the initial estimate T_o of T is inaccurate then the error in position between the estimated image $T_o(M_i)$ of $T(M_i)$ increases with the distance $||M_o M_i||$. The segment M_i is transformed into a segment M_i^* by the current estimate T_{i-1} of the transformation T. Following this, a dissimilarity measure d_{ij} is computed between the image segment M_i^* and every segment S_j of the scene description. This measure is a weighted sum of three positive quantities which account for the following:

1. a_{ij} = the absolute value of the difference between orientations of M_i^* and S_j,
2. D_{ij} = the Euclidean distance between the midpoints of M_i^* and S_j, and
3. l_{ij} = the absolute value of the relative difference between lengths of M_i^* and S_j: $l_{ij} = (l_i^* - l_j)/l_j$.

Each of these quantities has an upper bound a_{max}, D_{max}, and l_{max} and d_{ij} is computed as follows:

If a_{ij} or D_{ij} or l_{ij} is above its corresponding upper bound, the $d_{ij} = 1$

Otherwise,

$$d_{ij} = p \cdot a_{ij}/a_{max} + q \cdot D_{ij}/D_{max} + r \cdot l_{ij}/l_{max} \quad (13)$$

where p, q, and r are associated positive weighting factors adding up to 1.

d_{ij} takes a minimum value of zero when M_i^* and S_j are just superimposed, and increases when the discrepancy between M_i^* and S_j increases and the maximum value of d_{ij} is 1, and reaches maximum value if and only if one of the quantities a_{ij}/a_{max}, D_{ij}/D_{max} or l_{ij}/l_{max} is greater than or equal to 1. M_i is matched with the segment S_j of the scene description such that d_{ij} is minimum and less than 1. Otherwise M_i has no homologue in the scene description with respect to the current hypothesis.

When a segment M_i is matched with a segment S_{j_i} a recursive least squares technique is used to update the estimate T_{i-1} of T. The new value of the parameter vector V_i is computed as follows: Given a set of matches $[(M_i, S_{j_i})]$ a transformation T is sought which minimizes the quantity:

$$R = \sum_i \frac{li}{K} \Delta^2(T(m_i), S_{ji}) \quad (14)$$

Where m_i and s_{j_i} are the midpoints of segments M_i and S_{j_i}, Δ is the usual Euclidean distance, and l_i is the length of M_i. The term li/K is present to emphasize the role of long segments which are less sensitive to noise. K is a constant whose value depends on the quality of the observed images.

If the transformation T is represented by the vector V = (k Cos θ, k sin θ, tx, ty)^t, and the point s_{j_i} of coordinates x'_i, y'_i is represented by the vector $Y_i = (x'_i, y'_i)^t$ then (14) can be rewritten

$$R = \sum_i (Y_i - C_i v)^t W_i^{-1} (Y_i - C_i v) \quad (15)$$

Matrix C_i is given by:

$$C_i = \begin{pmatrix} x_i & -y_i & 1 & 0 \\ y_i & x_i & 0 & 1 \end{pmatrix}$$

Where x_i and y_i are the coordinates of point m_i. Matrix W_i is given by

$$W_i = \begin{pmatrix} w_i^2 & 0 \\ 0 & w_i^2 \end{pmatrix} \quad \text{with } w_i = K/l_i$$

Control of the variation of some of the parameters of the transformation T can be achieved by adding to R an extra term of the form $(v-v_o)^T S_o^{-1} (v-v_o)$ where v_o corresponds to the initial hypothesis and S_o is as described under the section

above on Generating Hypotheses. Finally R is written:

$$R = \sum_i (Y_i - C_i V)^t W_i^{-1} (Y_i - C_i V)^t + (v - v_o)^t S_o^{-1} (v - v_o) \quad (16)$$

R is a quadratic criterion which can be minimized recursively by the following equations:

$$v_i = v_{i-1} + K_i [y_i - C_i \cdot v_{i-1}] \quad (17)$$

$$K_i = S_{i-1} \cdot C_i^T \cdot [W_i + C_i \cdot S_{i-1} \cdot C_i^T]^{-1} \quad (18)$$

$$S_i = [I - K_i \cdot C_i] \cdot S_{i-1} \quad (19)$$

These equations are initialized for a new hypothesis by S_o and v_o computed in the section on Generating Hypotheses, and are recursively updated after each new match (M_i, S_{ji}).

A refined method gives more accurate results in which, instead of updating the transformation T by trying to superimpose the centers of the matched segments, the center of each identified model segment is superimposed on the straight line supporting its homologous scene segment. The T is less sensitive to variation in segment lengths since the position of the supporting straight lines is not modified. In this case

$$R' = \sum_i \frac{l_i}{k} \Delta^2 (T(m_i), S_{ji}) \quad (14')$$

where $\Delta(T(M_i), S_{ji})$ is the distance of the point $T(m_i)$ from the infinite line containing S_{ji}. If its orientation is a_i' and if the coordinates of S_{ji} are (x_i', y_i') then R' can be written

$$R' = \sum_i \frac{l_i}{k} ([-\sin(a_i')\cos(a_i')] C_i V + \delta_i')^2 \quad (15)$$

where $\delta_i' = x_i' \sin(a_i') - y_i' \cos(a_i')$

The matching stops when the number of hypotheses which have been evaluated is large enough (this is typically 10 to 20) or when a very high-quality measure is reached by an hypothesis.

After each iteration i, the quality measure Q(i) measures the length of the identified model segment as a percentage of the total model length. Q=Q(N) where N, the number of model segments, has an upper bound of 1, which maximum is reached for a perfect match between the model and the scene.

Remarks

Ayache and Faugeras have designed a new method for the recognition and positioning of two-dimensional objects. The method uses segmented descriptions of the object contours to generate and recursively evaluate a number of selected hypotheses. The advantages claimed by the authors over other methods previously known are its ability to work under poor lighting conditions and with up to 60 percent occlusions in the scene, its accuracy in locating objects, its high degree of parallelism, and its smaller storage requirements.

The recognition method which they have developed has been integrated within a vision system and tested on a large number of scenes. The vision system has also been coupled to an industrial robot arm and used for picking and repositioning of nonoriented, partially overlapping parts. The performance of the system was satisfactory.

References

Ayache, N., and O.D. Faugeras, "Hyper: A New Approach for the Recognition and Positioning of Two-Dimensional Objects," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Vol PAMI-8, No. 1 (January 1986).

4/20/87

INTERNATIONAL SYMPOSIUM ON SIMULATION OF CONTROL SYSTEMS

by Daniel J. Collins. Dr. Collins is the Liaison Scientist for Aeronautics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until June 1988 from the Naval Postgraduate School where he is a Professor of Aeronautical Engineering.

The International Symposium on Simulation of Control Systems, held in Vienna, Austria, from 22 through 26 September 1986 at the Technical University of Vienna, was sponsored by the International Federation of Automatic Control (IFAC) in association with the International Association for Mathematics and Computers in Simulation. Some 28 countries were represented by about 110 participants. Approximately 70 papers were presented in 20 sessions. There were also eight invited papers.

The American perception of IFAC is that it is essentially a European organization. There were no representatives from the US in the organizational committee of the symposium and, in fact, only two Americans other than myself were

present at the meeting. The largest national contingent was from Germany with England also well represented. Ten other Western European countries were represented plus Japan, Turkey, Egypt, Australia, and South Africa.

Some idea of the breadth and coverage of the conference can be obtained from the topics of the different sessions. Three sessions were held on languages and software for control systems simulation. Two sessions each were held on:

- Adaptive control
- Engineering applications
- Analysis and design of control systems
- Electrical systems and power plants.

Other sessions concerned:

- Robotics
- Optimal control and applications
- Discrete and sampled-data systems
- Nonlinear systems and applications-distributed parameters and time-delay systems
- Time-varying and multivariable systems
- Management and decision support systems modeling
- Educational aspects
- Nonengineering applications.

Since double sessions were conducted I could not attend all the presentations. Table 1 lists some of the papers from the presentations I was able to attend. The papers are listed by country and affiliation of author in order to provide some sense, via the titles, of the state of the science in the countries involved--particularly of the Eastern Block countries. I will consider only the sessions on languages and software from a technical viewpoint since this was an important aspect of the conference. My further comments are directed at the contributions from individual countries. The complete agenda and list of the participants may be obtained by writing me.

Languages and Software for Control Systems Simulation

An excellent overview in this area of simulation was obtained in the invited paper by A. Fischlin (Switzerland). This paper documented the rather extensive experience that the Swiss Federal Institute of Technology has had in the use of computers in the teaching of control system design and simulation. Their approach to the problem of using computers in an academic environment is well thought out, and they have used a variety of commercially available programs as well as some developed at the institute. They reported their experience with programs bearing such acronyms as ACSL, DSL, CTRL-C, Matlab, etc.

Many presentations in the same area documented experience with specific computer codes developed at different universities. These can perhaps be characterized by the names of the programs: CAEBEL, SIMCOS, MICOSS, DASP, and LINSY. There are some two dozen commercial programs available in the controls and simulation area at this time. While one could ask whether we need more, each of the programs presented at the conference had some special feature, such as ease of graphical inputs, that merited consideration.

The CAEBEL program (Hullender et al., US [see Table 1 for coauthors and title]) was well conceived. It involved the ability to have graphical inputs in terms of block diagrams. As with almost all of the other programs, it could generate Bode diagrams, root locus plots, transfer functions, and transient response with CAEBEL. Several nonlinearities such as dead zone, limiters, hysteresis, etc. could also be included in the block diagram input. From the block diagram input a state/space representation of the system could be developed.

SIMCOS (by Hesenjaiger and Niederhause, West Germany) is applicable to the simulation of multivariable control systems. It is, as are all the computer programs, interactive, and it is said to be user friendly. The input, in terms of matrices, handles symbolic input of subsystems. MICOSS (Bonvivento et al., Italy) on the other hand, is a module that permits the development of an applications-oriented environment in a given work station. It is structured to provide easy interfaces with a variety of programs such as CTRL-C. For a discussion of DASP and LINSY on control theory in Austria see *ESN* 41-1:47-50 (1987). Other papers in this area were directed at development of PC-oriented control packages, other specific computer systems, and some specialized simulations.

Contributions from Western Europe

There were some 12 papers presented from Germany. The papers were of excellent quality and I will refer only to some of the more interesting ones. (Note also the previous discussion under languages and software.) Several papers dealt with industrial processes involving air conditioning, turbofan control systems, and hydraulic servos.

Sölter's analysis of the design and simulation of a turbofan control system was typical of the excellent quality of the West German papers. Essentially, Sölter is interested in linear control concepts adapted to a nonlinear simulation

Table 1

Presentations at the Symposium

Austria

Gausch, F. (Graz Technische Universität), "DASP" "Simulation Studies Using the Program"

Hofer, A. (Graz Technishe Universität), "Linsy" "A Program for the Analysis and the Design of Control Systems"

Belgium

Vansteenkiste, G.C. (University of Ghent), "Process Control of Large Scale Systems"

Bulgaria

Tomov, I.I., and K.I. Kolev, (Higher Institute for Electrical and Machine Engineering), "Microcomputer Simulation of Robust Model Reference Adaptive Control System"

Czechoslovakia

Kvasnica, M., et al. (Institute of Technical Cybernetics, Slovak Academy of Science, Bratslavia), Simulation of Accuracy of Positioning of the Torch in Adaptive Robotic Welding System"

Voros, J. (VUNAR-Tool Research Institute, Nove Zanky), "On Modeling and Simulation of Discrete Event Dynamic Systems"

France

Bertrand, M. (ENSAM), "Control of Transient Responses Using Shape Descriptors"

Rotella, F., I. Zambettakis, G. Dauphin-Taguy, and P. Borne (Laboratoire d'Automatique et d'Informatique Industrielle), "Modeling and Simulation of Non-Linear Systems on Infinite Bilinear Realizations"

Greece

Tzafestas, S.G. (Control and Robotics Group, National Technical University, Athens), "Knowledge Engineering Approach to System Modeling, Diagnosis, Supervision, and Control"

Hungary

Bencsik, I., Z. Feher, G. Michaletzky, and L. Bencsik (Hungarian Hydrocarbon Institute), "Realization Algorithm for Time Varying Systems"

Haber, R., J. Hetthessy, and M. Hilger (Computer and Automation Institute Hungarian Academy of Sciences, Budapest), "Modeling, Identification, Design and Simulation of the Control of a Spray Drier"

Habermayer, M. (Technical University of Budapest), "Quality Investigations of an Adaptive Smith Predictor"

Javor, A., M. Benko (Central Research Institute for Physics), "Automatic Knowledge Based Decision Feedback Control of Simulation Experiments"

Kováts, J. (Research Institute for Telecommunication), "A Simulation Program for Higher Order, Nonlinear PLL"

Vajta, M., and L. Tikasz (Department of Automation, Technical University of Budapest), "Adaptive Prediction of Anode Effects in Aluminum Reduction Cells"

Italy

Bonivento, C., C. Melchiorri, and A. Tonielli (University of Bologna), "The Micoss Package for Simulation of Computer Controlled Systems and its Integration in a CACSD Workstation"

Japan

Furuta, K., M. Sapei, Y. Nakamura, and K. Asaka (Department of Control Engineering, Tokyo Institute of Technology), "Application Examples of Advanced Digital Control in Wire Industry"

Poland

Banasyak, Z. (Institute of Technical Cybernetics, Technical University of Wroclaw), "Computer Simulation Oriented Models of Concurrently Flowing Processes"

Deskur, J., K. Zawirski, B. Glajcher (Department of Electric Engineering, Pozna's Technical University), "Application of Simulation Technique for Microprocessor Speed Control Systems Testing"

Sapinski, B.L. (Department of Mining and Automation, University of Nunig and Nethadurg, Kwakow), "Investigation of Parametric Vibrations via Solution of Eigen Value Problems"

Szejko, S. (Institute of Computer Sciences, Technical University of Gdansk), "Structural Model of Real-Time Systems"

Szmidt, E. (Institute of Control, Technical University of Wroclaw), "Controlling a Telecommunication Network by Simulation"

Romania

Meghesan, V., and M. Rosu (Department of Engineering, Research Institute for Computer, Bucharest), "Aspects Concerning the Achievement of a Nuclear Power Plant Simulation and of the Software"

Sweden

Ljung, L. (Division of Automatic Control, Linköping University), "Building Models for Specified Purpose using System Identification"

Table 1 (cont'd)

Switzerland

Fischlin, A., M. Manson, M. Rinvall, and W. Schlaufelberge (ETH-Zürich), "Simulation and Computer Aided Control System Design in Engineering Education"

The Netherlands

Bruijn, P.M., J. Cser, and A.R.M. Soeterboek (Institut Industriel du Nord), "Simulation and Realization of In Line Control Algorithms"

UK

Atherton, D.P. (School of Engineering, University of Sussex, Brighton), "Simulation in Control System Design"

Pang, G.K.H., and A.G.J. McFarlane (Engineering Department, Cambridge University), "A Systematic Approach to Control System Design Using a Reverse Frame Alignment Design Technique"

US

Hullender, D.A., C.C. Blackwell, K.L. Lawrence, A.L. Blackwell, J.K. Nisbett and C.C. Ku (University of Texas at Arlington), "CAEBEL A Computer-Aided Control Systems Synthesis and Analysis System"

USSR

Asmykovich, I.K. (Department of Mathematics, Kirov Byelorussian Institute of Technology, Minsk), "Model Control and Decoupling for Linear Time Delay Systems"

Korbicz, J., and M.Z. Zgurovsky (Kiev Polytechnical Institute), "Computer Aided Design of the Distributed Parameter Control System"

Nechval, N.A. (Department of Control System, Civil Aviation Engineer Institute, Riga), A New Technique of Sequential Sampling and Its Application to Simulation of Airplanes Rescheduling System"

West Germany

Ameling, W. (Department of Electrical Engineering, Aachen Technical University), "Optimization of Computer Structures"

Diekmann, K., and R. Dreibholz (Institute of Automotive Control, Ruhr University), "A Simulation and Analysis Program for the Education in Automatic Control"

Hasenjaiger, E., and A. Niederhause (University of Siegen), "Simulation of Multivariable Control Systems with Sincos"

Korte, R., and H. Rake (Institut für Regelungstechnik), "Design and Test of Adaptive State Feedback Controls for Hydraulic Servo Drives by Digital Simulation"

Munack, A. (Institute for Control and System Dynamics, Technical University of Hamburg), "Application of Recording Horizon Adaptive Control to Underfloor Heating System"

Sölter, H. (Institut für Flugführung der TU Braunschweig), "Concept Design and Simulation of a Turbofan Control System"

and optimization process. The control of a turbofan engine so that it can operate nearer to the surge limit is a difficult nonlinear process that is engine specific. Depending on the speed range two different cost functionals are used. There are demands on speed and safety which are sometimes conflicting so that one must go through an optimization process. Further improvement in the design as suggested by Sölter could be obtained by introduction of other control variables such as bleeding of compressor air and guide vane adjustment. The problem is difficult, but the paper approaches the solution in a systematic and logical fashion.

The RASP computer code (Diekmann and Dreibholz, West Germany) directed at control education at the PC level was another computer package of some merit in that it could be implemented on an inexpensive computer readily available in Germany. The invited paper by Ameling, although of a tutorial nature, was quite interesting on the simulation of computer systems. The running of a large computer system is complicated and simulation permits rapid investigations of the effect of new configurations.

I was impressed by four papers from the UK. The invited paper by Atherton was an excellent tutorial on CAD. Perhaps the most interesting paper in the entire conference from a theoretical viewpoint was that of Pang and McFarlane. A new technique was given for the design of multivariable feedback control systems in the frequency domain. The technique uses the singular value decomposition and establishes stability, performance, and robustness for the system. It is a two-stage frequency-response design technique, and since it is based on the singular value decomposition method it automatically produces robust designs. The singular value decomposition method is a generalization of classical frequency-response approach. As indicated by Pang and McFarlane, this results in fairly simple controllers. The technique is intuitively appealing and is directly related to well-established classical methods. The design of the controller is separated into two parts. In the high-frequency domain one obtains good phase properties while in the low-frequency domain one seeks good gain properties. The main design variables are the characteristic gains and phases, and principal gains of

the system. The characteristic gains and phases are related to the stability of the system while the principal gains give an indication of the performance of the system. The divergence between the two criteria is related to the robustness of the system. A detailed design example of a 12-state gas turbine system with two inputs and two outputs was presented. This was most helpful in explaining the method.

The Japanese Contributions

The invited article by Furuta et al.--an excellent example of development of process controllers--concerned applications of advanced digital control in the wire industry. The processes were that of enamelling wires and of making foamed insulated wires. For the enamelling process an optimal digital cost-function based on the error in the thickness of the coating and on the input energy was chosen for the problem. An industrial furnace was modeled by a state-variable representation with a 5×5 plant matrix. Control variables included five damper settings, and there was also a feed-forward control loop. The foaming process was similarly modeled. The control resulted in a halving of the start-up time and temperature control within 1 degree in the furnace and a considerable reduction in waste material. The speed of the process was increased from 10 to 20 percent. It was somewhat surprising to me that the speed of the wire was not included in the state variables.

Contributions from the Eastern Block Countries

A very interesting aspect of the conference was the relatively large representation from Eastern Europe. There were a total of six papers from Hungary. Two of the papers (Vajta and Tikasz; Haber et al.) were connected with industrial process control. The paper by Vajta and Tikasg described a two-parameter adaptive prediction algorithm applied to an aluminum reduction cell. The process model predicts the anode-effect so that the controller can avoid a deleterious effect. The paper by Haber, et al. presented the modeling identification, design, and control of a spray drier. The aim of the control is to keep the moisture of the compact powder which is used to form tiles at a given value. The paper by Habermayer was directed at a specialized technique of an adaptive Smith predictor. The paper presented some simulation results illustrating the effect of a time delay estimation in an adaptive Smith prediction algorithm. For fairly accurately modeled time-delays and system parameters the system has advantages. The last two papers (Javor and Benko; Bencsik et al.) were more theoretically oriented. In particular, the paper by Bencsik et al. considered the problem of modeling discrete-time, multivariable time-varying systems applying the results of stochastic realization theory for real data. Properties of the adaptive mean were discussed and tested.

There were nine papers listed from Poland, but quite a few of these were not presented due to the absence of the authors. The papers that were presented were typically of a somewhat specialized nature connected with simulation, eigenvalue solutions, and modeling. The technical level of some of the presentations could have been higher.

The paper from Bulgaria was involved essentially with the development of software for microcomputer simulation of a robust model reference adaptive control system. The paper studied approaches for decreasing the effect of the unmodeled dynamics in the plant's model. Although well written the paper did not contain new algorithms. The Romanian paper considered a simulator for training personnel in a nuclear power plant. Of the two papers from Czechoslovakia, one considered the modeling of the torch position in a robotic welder, the other the modeling of discrete event dynamic systems. This latter paper had more to do with algebra than control theory.

There were five Russian papers, but as far as I could tell none of them were presented by the authors. Of the three papers available from the preprints, the first was a theoretical investigation of sequential sampling, the second considered computer-aided design of distributed parameter control systems, and the last was somewhat mathematical in that it was concerned with existence theorems for solutions to linear time delay systems.

The strongest technical presentations from the Eastern Block (both in technical content and in breath of material covered) was from Hungary. Many of the presentations from the other Eastern Block countries were of limited interest and focused on a particular aspect of a problem which might have some historical value. Also, the individual scientists in these other countries, at least as revealed at this meeting, appear to me to be working by themselves or in isolation.

Conclusion

There were some other fine papers presented during the conference, notably from France. The invited papers were all of high quality and provided good introductions to different sessions of the conference. Of the invited papers not previously mentioned that of L. Ljung

(Sweden) on building models based on system identification was excellent. A book by him on this subject is soon to appear and it should be worthwhile reading. Other invited lectures were by S. Tzafestas (Greece), G. Vansteenkiste (Belgium), and P.M. Bruijn et al. (the Netherlands). Clearly these lecturers are also a point of contact in their respective countries.

In general, the technical level of the conference was quite good, and there were some excellent presentations. From my observations at this gathering, it would also appear necessary to accept some degree of disparity in the technical papers if these conferences are to maintain a truly international character. There is a volume of preprints which is available from Professor I. Troch Wien, ARGE, "Industrial Robots and Manipulators," c/o Institute für Mechanik/Mechanik I (114), Karesplatz 13, A-1040, Vienna, Austria.

4/14/87

Material Sciences

MATERIALS ANALYSIS FOR ELECTRONIC DEVICES A UK MEETING

by Louis Cartz. Dr. Cartz 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 June 1988 from Marquette University, College of Engineering, Milwaukee, Wisconsin.

The 1-day meeting on Materials Analysis for Electronic Devices was held in London on 28 January 1987. It was organized by the UK's Institute of Physics. About 120 UK scientists attended the meeting held in the headquarters of the Society of Chemical Industry, Belgrave Square, London. The proceedings were very well organized, useful, and interesting. Since I was only able to attend the afternoon session, my coverage cannot be complete but I will describe some of the papers in detail which both interested and impressed me.

The talks and discussions covered the wide range of analytical systems available for the study of the several aspects of semiconductor integrated circuit systems. These analytical methods, and the speakers who addressed them included:

- Scanning tunnelling microscopy (STM), M. E. Welland and T.D. Bestwich, University of Cambridge, UK.
- Reflection high-energy electron diffraction (RHEED), P.J. Dobson, Philips Research Laboratories, UK.
- High-Resolution Rutherford backscattering (RBS), P.L.F. Hemment et al., University of Surrey, UK.
- Polarizing optical systems in the visible and the infrared to 2 μm, B.T. Meggitt, SIRA Ltd., UK.
- Secondary ion mass spectroscopy (SIMS), W.G. Dowsett, City of London Polytechnic, UK.
- Laser microprobe mass spectrometer (LAMMS), E.R. Wallach, Cambridge University, UK.
- Laser scan mass spectrometry (LSMS), F. Grainger and J.A. Roberts, Philips Research Laboratories, UK.
- Pulsed laser atom probe (PLAD), C.R.M. Grovenor, Oxford University, UK.
- X-ray photoelectron spectroscopy (XPS), I. Sutherland, Loughborough Consultants, UK.
- Auger electron spectroscopy (AES), D.K. Skinner, Plessey Research Caswell Ltd., UK.
- Ion beam crystallography, J.M. Cole et al., University of Birmingham, UK.
- Transmission electron microscopy (TEM), P.D. Augustus, Plessey Research Caswell Ltd., UK.

LAMMS

A fascinating talk about the LAMMS technique was given by E.R. Wallach of Cambridge University. (This technique is also known as LIMA; the term LAMMS avoids using a trade name.) He discussed the LAMMS techniques for quantitative analysis, depth profiling, and postradiation processes. He deliberately presented examples from outside the field of semiconductor materials to show that LAMMS is a very versatile technique.

The laser can be used at the low power of 10^7 W/cm^2 to the high power of 10^{12} W/cm^2. The depth of the crater created depends on the power of the laser pulse and can be 2 to 3 μm at low power to 5 μm at the high power; this results in lower spatial resolution for the higher power pulse. Material is vaporized and then examined by mass spectroscopy. The advantage of LAMMS, even though it is less sensitive than SIMS, is that all elements can be examined in both nonconducting and conducting materials. The lateral resolution can be of the order of 5 μm and the depth resolution of the order of 1 μm. The analysis is extremely rapid and no specimen preparation needs

to be carried out so there can be an extremely rapid turnover for qualitative analysis. Quantitative analysis can be performed, and it is usual to set up calibration curves. There has been some modeling to explain these calibration curves, and while the models make assumptions based on the temperature of the plasma and its electron density, they are not easy to apply universally. Depth profiling can be undertaken by repeated firing of the laser, which increases crater depth.

Wallach described the post ionization process. For this, the incident laser beam is used at reduced power, which removes--but not necessarily completely ionizes--the material. A second laser beam, used perpendicular to the primary incident beam and parallel to the surface, is the beam which ionizes the evaporated material. This has been shown to be quite successful, giving good results, for example, in the case of gallium arsenide. Gallium requires 6 eV to ionize and arsenic 9 eV so that at lower laser beam energies the gallium signal is observed though not necessarily the arsenic. The arsenic signal only appears when a laser beam of high energy is used. On the other hand, when postionization is used, both the gallium and the arsenic signals are immediately observed in the correct composition proportions without resorting to the use of a very-high-energy incident laser beam. In the case of mercury cadmium telluride very good results have been obtained. Some workers have disputed some of these findings and work is still continuing on postionization measurements.

Laser Scan Mass Spectrometry

F. Grainger described the use of laser scan mass spectrometry (LSMS), which is essentially the same as LAMMS, and he compared results obtained with those using radio frequency (RF) sparks. Using an electron microscope he examined craters that are formed by the laser beam and was able to show that the ionization yield efficiency is increased by a factor of 10^4 compared to the RF spark method. In general, LSMS is much more efficient and much more convenient than RF spark methods.

Pulsed Laser Atom Probe

C.R.M. Grovenor described the use of the pulsed laser atom probe (PLAP), based on the field emission electron microscope to which has been added a time-of-flight mass spectrometer. A DC voltage of the order of 10,000 volts is applied under cryogenic cooling to the specimen through a very fine tip of radius of the order of 10 nm. Gas molecules are ejected from the tip surface in straight lines and set up a projection pattern of the atomic structure on a fluorescent screen. To this system, one can now add laser beam heating of the tip so that the temperature at the tip rises almost instantaneously to 300 K. The surface layer of atoms is ejected, and it is these atoms that give rise to the pattern rather than the gas molecules. By arranging a suitable hole in the fluorescent screen or the image plane, one series of atoms can be allowed to go through the aperture, and it is these atoms that are examined in the time-of-flight mass spectrometer.

A commercial system is being developed by the English firm, V.G., in collaboration with the workers at Oxford University. With laser excitation of the field emission in this mode--the so-called "Atom Probe"--a vacuum of 10^{-11} to 10^{-12} torr is required. This system permits the removal of one layer of atoms at a time, giving rise to an extreme sensitivity. Indeed, one can separate and identify the isotopic abundances with great clarity. One problem of the system is that it is essential to have the material in the form of a needle and it is not evident how to obtain this from a planar structure. Another problem is that the statistics are not good enough for quantitative analysis.

Grovenor gave a very interesting example of an aluminum layer on a silicon [100] needle; a layer about 10 Å thick of aluminum had been evaporated onto the silicon tip and the interface examined by suitable orientation of the tip. One could follow the composition across the tip from the aluminum metal through the interface to the silicon substrate. Across the interface, hydrogen and oxygen could be observed as the composition of aluminum decreased and that of the silicon increased. The amounts of hydrogen and oxygen present were observed to decrease when lower temperatures were used in the evaporation of the Al onto the silicon tip in the formation of the interface. In principle, each atomic layer should come off entirely before the next atomic layer. In the case of gallium aluminum arsenide, the correct chemical composition is, in fact, observed; all of the gallium aluminum arsenide atoms of one layer come off before the next layer starts to evaporate.

Another interesting study was that of the native oxide on silicon; this can be shown to consist of a silicon monoxide layer at room temperature. If the silicon tip is taken to 400 or 500°C before being examined in the atom probe, one can determine that no native oxide layer has formed and that subsequently the formation of the silicon monoxide surface

layer can be very slow, taking several hours at room temperature. Grovenor described the examination of a tip in which a series of gallium aluminum arsenide epitaxial layers had been evaporated and where the different compositions across the bands could be followed.

Oxide Layers

J. Sutherland described the study of oxide layers on gallium arsenide, on indium phosphide, and on 3-5 compounds by XPS and by LAMMS/LIMA where oxide layers had been introduced by wet etching. On gallium arsenide, 15-Å layer thicknesses of As_2O_3 can be observed. When the oxide layer from gallium arsenide has been removed using the LAMMS process, one can follow the regrowth of the oxide layers by XPS, and these regrowth processes are very slow. Sutherland described the observation of successive removal of layers by LAMMS using the minimum laser power when one can very nearly observe individual surface atomic layers. In the case of gallium arsenide one observes by LAMMS a whole range of chemical constituents such as OH, CN, Cl, As, GaO, AsO, AsO_2, and As_2, and the sensitivity is much better than that which is possible by XPS. When the surface has been cleaned by successive laser pulses, one observes just arsenic, gallium oxide, and As_2 from the lower, cleaner surfaces. In the case of indium phosphide, the first pulse of the laser beam will show P, PO_2, PO_3, and P_3, whereas at the second pulse all the oxides have already gone.

Sutherland also described an interesting study of the effect of ozone on indium phosphide. With pulse 1, it was possible to identify PO_2 and PO_3. With pulse 2, it was possible to identify P, P_2, and PO_2. With pulse 3, P and P_2 and by pulse 4, no oxides whatsoever. For these studies, laser beams of low power--10^7 W/cm^2--are used, which is just about the minimum of the system. It is believed that by successive pulses one is removing 10-Å-layer steps from the surface.

Change of Composition with Depth by AES

Skinner described the use of AES and how it does, in fact, examine the surface layer 5-10 Å deep. In general, one is identifying the atoms that are present, but because the electron energy peaks are slightly displaced or broadened one can get some information on the type of bonding present in the surface. It is not possible to observe hydrogen or helium, and a minimum of 0.1 atomic percent is needed for an identification of an element. Quantitative analysis is possible to about 3 percent accuracy and, using the latest equipment models, areas down to 500 Å can be achieved. Skinner described three methods of determining the change of composition with depth. The first involves the use of ion beam sputtering to remove surface steps of about 2000 Å. A second method involves angular lapping using a diamond polish, and the third method uses the crater edge profile. It is this last method that is under development. For the crater edge profile, a laser beam produces a crater ideally of smooth sides so that when examining the composition down the side, one is in fact going down in depth through the material. Since the angle of the side is very small, the lateral magnification is very large--of the order of 2×10^4.

Skinner described several cases of crater edge profiling. One concerned the examination of layers of $Ga_{0.68}$ $Al_{0.32}As$ alternating with GaAs. This is a four-layer superlattice. The crater was formed by using Xenon ions at 700 eV to induce ion beam sputtering. It was possible to show that ion beam mixing of the lightweight aluminum atoms had occurred; the analytical results are improved when the aluminum content is very low. In another example, the workers examined specimens of arsenic implanted into silicon at 40 keV with 10^{16} ions per cc, and compared the composition profile to calculations. The effect of annealing could be carried out, and while in the original profile of the unannealed implanted arsenic there is a distinct peak at ∿500 Å below the surface, after annealing this changes markedly--the arsenic concentration is now approximately uniform down to about 2000 Å . This can be related to the existence of polycrystalline silicon about 2000 Å thick on the silicon surface; on annealing, the implanted arsenic penetrates rather uniformly into the polycrystalline silicon layer. Further studies have been able to show that while penetrating into the polycrystalline silicon the arsenic is held up at the oxide barrier between the polycrystalline silicon and the single-crystal silicon.

Ion Beam Crystallography

J.M. Cole described the investigation of an indium gallium arsenide interface with indium phosphide by ion beam crystallography aided by TEM. This is a system using Rutherford Back Scattering to identify channelling and dechannelling due to strains within the crystal structure. Using several different crystal orientations it is possible to identify the type and orientation of the strains. The dechannelling is observed to be smaller along the [001] growth direction.

Interfacial Arrangements

P.D. Augustus described the use of SEM, TEM, and scanning transmission

electron microscopy (STEM) to examine different interfacial arrangements of polycrystalline and single-crystal Si, amorphous SiO_2, and silicon nitrides. The integrated circuit on the silicon chip has to be sliced very thin so that it can be examined in the electron microscope. One can observe the different orientations in the polycrystalline silicon at the interface with the single-crystal silicon where dislocations can be observed by diffraction contrast. This permits the explanation of many of the electrical breakdown phenomena which can be related to the presence of dislocations in undesirable positions within the silicon structure. Augustus gave examples of metal silicon contacts where metal spikes can be observed to penetrate into the silicon, causing difficulties. This method of cross-sectional TEM is highly efficient in showing all of the defects present in the material, though the effort required to prepare the specimens for examination in the TEM is considerable.

Conclusion

This meeting was very successful in bringing together people from different disciplines, from university and industry, and especially people using the different analytical techniques--electron, optical as well as x-ray methods--for the examination of semiconductor systems and electronic devices. Almost all present were from the UK. The proceedings of meetings of this type, as organized by the UK's Institute of Physics, are not normally published. I believe that this type of meeting was highly appreciated and found to be most useful by all the people present.

4/22/87

Mechanics

FLUID MECHANICS RESEARCH AT THE TECHNICAL UNIVERSITY OF BERLIN

by Eugene F. Brown. Dr. Brown is the Liaison Scientist for Fluid Mechanics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until September 1987 from the Virginia Polytechnic Institute and State University, where he is a Professor of Mechanical Engineering.

Fluid mechanics research at the Technical University of Berlin (TUB) is centered in the Herman-Föttinger-Institut für Thermo-und Fluiddynamik (HFI) where experiments, and, to a much lesser extent, computations on boundary layer separation, turbulence structure in shear layers, aeroacoustics, and vortex shedding are being carried out. Computational work is being done in the Institute for Mechanics, 2, which will be described at the end of this article.

Herman Föttinger Institute

Herman-Föttinger, the first professor of fluid mechanics at the TUB (and the inventor of the hydraulic torque converter) established HFI in the 1950's. Originally having strong links with the shipbuilding industry, HFI now performs work for a broad spectrum of chemical and manufacturing industries. HFI is collocated and has close research connections with the Turbulence Research Unit of the Deutsche Forschung und Versuchanstalt für Luft und Raumfahrt (DFVLR). (See companion article following.) HFI receives strong support from the Deutsche Forschungsgemeinschaft (DFG) from which it receives from 70 to 80 percent of its research support. HFI's staff consists of five senior professors, five scientific staff members, 25 Ph.D. candidates, and 25 undergraduate assistants. It is an extremely prolific group, producing more than 75 papers in an average year and having strong contacts with many research organizations in the US. My host during my visit was Professor H. Fiedler. Fiedler's current interests are in the formation of coherent structures in inhomogenous flows, the far-field (x/d greater than 100) coherent structures of jets, and the transverse stability of lateral vortices in homogeneous shear layers.

For the inhomogeneous flow work Fiedler is in the process of constructing a channel of modest dimensions (40×20 cm^2) in which gases of different densities (such as Freon and air) can be admitted using separate blowers. In this facility he hopes to reach a density ratio of 7 and to examine the relative amplitude of turbulence amplification in the two fluids. In this facility he intends to measure local density (from which the amount of local mixing will then be determined) with an aspirating hot-wire probe. The far-field jet experiments will be conducted in a 50-m/s, 2.5-cm (approximately) diameter jet in what appeared to be a recently completed

facility. Finally, for the vortex stability experiments, Fiedler will modify his $0.5 \times 0.5\text{-m}^2$ induction wind tunnel to accept laterally converging and diverging test sections. Fiedler expects that vortices will be stabilized in the diverging test section and randomized in the converging one.

Institute for Mechanics, 2

TUB's Institute for Mechanics, 2 is headed by Professor R. Trostel. For several years he has been working on a field theory of turbulence containing a nonlinear stress-strain relationship based on modern continuum mechanics theory. This approach is equivalent to the postulation of a new constitutive equation which includes the kinematics of the turbulence as a new physical property. The governing equations are solved in terms of a set of variables which include so-called "directors," offering, in effect, an expanded number of degrees of freedom. Trostel is now studying the proper treatment of the flow at the wall. A striking feature of this approach is that the familiar no-slip condition and the vanishing of the vertical component of the turbulence velocity at the wall will not be enforced. Trostel hopes that use of this more generalized stress-strain model will reduce the level of empiricism and allow turbulence models to be extended to a broader range of flows than is currently the case.

In an unrelated, but equally important piece of work, Dr. H. Wirz is examining fast methods for the calculation of three-dimensional flows and Eulerian methods for tracking contact discontinuities. Fast methods for the calculation of two- and three-dimensional inviscid subsonic (elliptic) flows often employ multigrid (MG) methods. The problem with MG, Wirz feels, is that it destroys low-frequency errors by creating high-frequency errors. Wirz's approach is to work directly on the low-frequency error. He does this by introducing a second density which obeys a pseudo-continuity-like equation. Unlike the actual continuity equation, however, the equation for the second density contains a source of dissipation which, in fact, is the mechanism by which the damping of the low-frequency error is obtained. The resulting set of equations, which he calls a "relaxing evolution" system, can either be used alone or in conjunction with MG methods. It has the advantage that, unlike MG, it can be used both on elliptic and hyperbolic problems and the advantage that it can be shown to converge regardless of the accuracy of the initial solution. Wirz has developed a rigorous theory to support this method. He showed a calculation which he had done on a two-dimensional wave propagation problem which appeared to be far superior to the results obtained with the conventional Lax-Wendroff method.

Special procedures are needed for the problems containing contact discontinuities (such as surface wave problems) because conventional methods disperse the discontinuity. To retain the discrete nature of the discontinuity, a Lagrangian formulation of the problem is frequently used. However, the large gradients which characterize the physics of such flows ultimately lead to the severe kinematic distortions necessitating repetitive rezoning of the computational region. Besides presenting a computational inconvenience, this rezoning process introduces interpolation errors. Wirz's approach is to retain the Eulerian formulation but guarantee the preservation of the interface by giving the interface a shock-like form in the vicinity of the discontinuity. He does this by introducing a third-order production term which imitates the effect of so-called artificial compressibility. Wirz calls this technique "interface tracking" and showed an example of its application to a shock tube problem. After initially smearing the discontinuity over no more than three mesh points, the solution preserved the discontinuity without further dispersion.

Conclusions

TUB is justifiably well known for the outstanding turbulent flow experiments conducted at the HFI. Not well known, but of equal quality, is the computational work of the Institute for Mechanics, 2. There, new and promising developments are taking place in the calculation of three-dimensional hyperbolic flows and in the calculation of contact discontinuities which should be of considerable Navy interest.

3/11/87

TURBULENCE, DRAG REDUCTION, AND ACOUSTICS RESEARCH AT THE MAX PLANCK INSTITUTE AND DFVLR-BERLIN

by Eugene F. Brown.

Organizational Profiles

Research in turbulence, drag reduction, and acoustics is taking place at the Max Planck Institute and the Turbulence Research Station of the Deutsche

Forschung und Versuchanstalt für Luft und Raumfahrt (DFVLR) in Berlin.

The Max Planck Institute (MPI) for Flow Research is located in Göttingen, West Germany, alongside the facilities of the DFVLR. It was founded in 1925 by Ludwig Prandtl and is now part of the Max Planck Gesellschaft (MPG), a public-funded (federal and state) research organization which has 10,000 full-time employees at 50 institutes throughout Germany. The MPG is the successor to the Kaiser-Wilhelm-Gesellschaft, which was founded in 1911. MPI carries on the original philosophy of providing outstanding scientists with an opportunity to conduct their research programs in an academic-like environment.

The Max Planck Institute for Flow Research is one of 17 MPG institutes comprising the Chemistry, Physics, and Technology Sections. At the present time the Max Planck Institute for Flow Research has a scientific staff of approximately 300. These are supported by undergraduate and graduate students conducting research in connection with their studies at the University of Göttingen.

The areas in which research is currently being carried out at the Institute are the dynamics of compressible media, atomic and molecular physics, molecular interactions, and reaction kinetics. Each of these topical areas constitutes a department and each department has a director. My visit was to the Department of the Dynamics of Compressible Media where the director is Professor Dr. E.-A. Müller. My host during my visit was Dr. A. Dinkelacker, who is a senior member of the scientific staff.

The Turbulence Research Station of the DFVLR in Berlin was founded in 1953. It is a small research organization comprising only 10 scientists and an equal number of technicians. It is collocated and has close research ties with the Hermann Föttinger Institute für Thermo-und Fluiddynamik. My host during my visit was Dr. D. Bechert, whose interests include turbulence noise and, more recently, turbulent drag reduction methods.

Turbulence

At the MPI, Dr. Dinkelacker has been interested in the structure of turbulence for more than 20 years. His conception of turbulence, based in equal measure upon detailed measurements and scientific intuition, has led him to a longitudinal-vortex/low-and-high-speed-streak model similar to that of Kline (Kline, 1967). According to Dinkelacker, hairpin vortices naturally accompany these patterns. His conclusion is based on interferometric measurements of the instantaneous pressure measured by approximately 200 small, circular membranes located in the floor of the test section of a specially designed, low-noise, subsonic, induction wind tunnel.

Dinkelacker has also studied the generation of turbulence noise and its relationship to the near-wall turbulence structure. In these experiments, he measured the velocity and pressure fluctuations produced by the flow of air in a circular pipe using a hot-wire anemometer and a small surface-mounted microphone. By conditionally averaging the velocity measurements so that they were synchronized with the detection of high static pressure at the wall, he found that high wall-pressure events were associated with the passage of a high-velocity front. Conversely, regions of low wall static pressure were found to be associated with the passage of a low-speed front. In more recent work (Dinkelacker and Sieber, 1986) he found that the appearance of a high-speed front at one wall of the pipe was associated with the arrival of a low-speed front at the pipe centerline and the arrival of a high-speed front at the opposite wall. These measurements seemed to suggest a ringlike turbulence structure in the pipe. This conjecture was supported by subsequent measurements in which such structures were identified and found to persist over large distances even into the jet formed at the pipe exit. In the future, Dinkelacker plans to make additional pressure measurements in the pipe in order to gather more information about the turbulence structure.

Dr. H. Eckelmann directs MPI's famous oil channel facility in which detailed measurements of turbulent boundary layers have been made since 1951. Besides his interest in near-wall turbulence structure, Eckelmann has more recently become interested in vortex shedding and microgravity problems. However, once again the limited time of my visit precluded detailed discussion of these latter topics.

The unique characteristic of the oil channel is that, because of the oil's high viscosity, the boundary layer is extremely thick (on the order of a centimeter) and thus, using hot-film probes, Eckelmann is able to obtain extremely high-resolution measurements of the turbulence structure in the boundary layer. The advantage of using an oil channel for such measurements can be seen by comparing the size of a miniature hot-film probe in the oil channel boundary layer with its size in a wind tunnel boundary layer. In the oil channel, the dimensions of a typical hot-film probe are approximately 2 wall units. In a wind tunnel it is 20 wall units. Thus an order of

magnitude better resolution of the flow in the near-wall region can be obtained in the oil channel compared with the wind tunnel. The oil channel is 8.5 m long, 0.22 m wide, and 0.79 m deep and is filled with a pure paraffin-based oil having a kinematic viscosity of 0.06 cm^2/s. The maximum (centerline) velocity is 21 cm/s.

Eckelmann's measurements of the spacing and energy content associated with the longitudinal vortices, conventionally held responsible for the high-speed streaks (Kastrinakis, and Eckelmann, 1983), has led him to discard the conventional hairpin vortex description of turbulence structure. Instead he believes that the low-speed streaks are nothing more than the wakes caused by the passage of the inclined front of rapidly moving fluid which is pushed ahead by the action of the freestream flow at instants when the local turbulent shear stress vanishes due to the intermittency of the flow.

Drag Reduction

At the MPI, Dinkelacker has also had a longtime interest in the scales of fast-swimming sharks. Early studies done in collaboration with biologist W.-E. Reif (Reif and Dinkelacker, 1982) have shown that shark scales have a riblike structure with smooth ridges and narrow peaks oriented more or less in the flow direction. Looking toward the ribbed surface of the shark from a point outside the boundary layer, one recognizes that the fluid is brought to rest over a shorter distance at the crest than in the valleys between the crests. Consequently, the velocity gradient is higher at the crest than it is in the valleys, but since the crests are narrower than the valleys, an overall drag reduction is produced. Looking at the spacing of the ribs, Dinkelacker found that the ribs were approximately 25 wall units apart, compared with 100 wall units between the low-speed streaks in a flat-plate boundary layer. His conclusion was that the ribs on the scales of fast-swimming sharks serve to break up the streaky structures (longitudinal vortices) observed in a normal turbulent boundary layer, and since these smaller structures are less effective in promoting mixing, the drag is reduced.

In a recent study, Dinkelacker performed experiments in an internally-ribbed pipe (Dinkelacker, et al, 1987) and found a drag reduction of approximately 3 percent. In this same reference, he reported on some interesting local anomalies in the streamwise orientation of shark riblets. He found, for example, in regions near the shark's "ear," that there was a local divergence in the riblet pattern. His contention is that the effect of this divergence may be to divert the turbulence structures away from the ear in order to lessen the background flow noise. Conversely, in regions near what Dinkelacker contends may be direction sensors, the ribs appear to converge, resulting in a pressure differential effect which Dinkelacker thinks the shark may use to adjust the position of his scales or perhaps the shape of his skin.

D. F. Bechert, at the DFVLR-Berlin, has, since 1982, also been working on the drag-reducing characteristics of ribbed surfaces. At the Lausanne drag-reduction workshop (see *ESN* 41-2:87-91 [1987]) Bechert announced his intention to study the effect of placing short crescent-shaped riblets in a staggered three-dimensional pattern such as shown in Figure 1. He has recently completed this study and and has concluded that three-dimensional riblets offer no advantageous drag-reduction properties. This was quite surprising since Bechert had anticipated (Bechert, et al., 1986) that three-dimensional riblets should have an increased protrusion height and therefore an enhanced capability to break up the formation of longitudinal vortices and thus to reduce drag. Bechert's experiments did not bear this out. The question is why? Bechert believes that the problem lies in a misunderstanding of the role which riblets play in affecting the turbulence structure. He feels that the riblets, rather than break up the longitudinal vortices, break up the turbulent bursts. It was unreasonable, Bechert contends, to speculate that riblets interact with the longitudinal vortices in the first place. This is because regardless of whether conventional or three-dimensional riblets are used, their protrusion height buries them deep in the laminar sublayer where they can exercise at best a minimal effect on the streamwise vortices. What is much more likely, Bechert contends, is that they interact with the turbulent

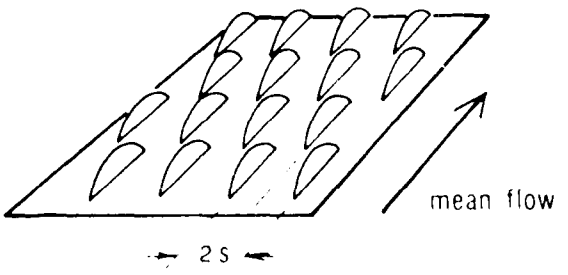

Figure 1. Short three-dimensional riblets in a staggered array.

bursts which sporadically uncover the riblets by sweeping away the boundary layer with a packet of high-speed fluid. This being the case, the increased protrusion height of three-dimensional riblet would be of no benefit since the protrusion height of conventional riblet surfaces would already be sufficient to interact with the turbulent bursts. Bechert's measurements of the drag-reducing qualities of three-dimensional riblets tend to support this contention since they were found to be no more effective than a conventional riblet surface of equivalent (increased) lateral spacing.

Bechert is planning a new study of large eddy breakup (LEBU) devices in which he will measure both surface and manipulator drag. LEBU's are thin horizontal plates (termed manipulators)--usually having an airfoil cross-section--mounted above the surface (but within the boundary layer) on which a drag reduction is sought. Bechert plans to carry out these experiments in a 2.0×1.5 m^2 wind tunnel which has a maximum airspeed of 45 m/s and a capacity to accommodate a manipulator of 600-mm span. In this facility, previously used for the riblet studies described by Leehey (see *ESN* 39-2:60-61 [1985]), plates of up to 750 mm long can be mounted downstream of the LEBU to optimize the drag-reducing effect. This is important since recent investigations have shown that if the plate is too short the full drag-producing potential of the LEBU will not be realized, and if it is too long it may well extend into a region where shear stresses in excess of those in the unmanipulated boundary layer may be present.

His intention is to resolve the controversy which now surrounds the drag-reducing potential of such devices. Bechert feels that the equivocal nature of the results obtained to date are due either to the failure to properly secure the LEBU so that it does not vibrate or the use of an insufficiently long test section downstream of the manipulator. By rigidly mounting the manipulator (in this case a NACA 0009 profile) Bechert hopes to eliminate vibration effects. He will verify this by making measurements of the manipulator vibration, if any, with a proximity sensor. To make sure that he uses the proper plate length, he intends to vary the length of the plate until a maximum drag-reducing effect has been achieved. In addition to making drag measurements, Bechert will also measure the velocity profiles (as have many others) downstream of the LEBU with either a Pitot probe or a hot wire.

If he is unsuccessful in demonstrating a drag reduction with LEBU's, Bechert intends to return to his riblet work, where, despite the failure of his three-dimensional experiments, he still hopes to do better than the 8-percent drag reduction offered by conventional riblets. Even though such a study offers almost an overwhelming degree of complexity Bechert will proceed to examine the effect of what until now had been regarded as secondary effects. For example, on the skin of sharks, which many people believe to represent a biological application of riblets, the mobility of the riblet-containing scales seems to offer the possibility of longitudinal fluid injection. The rib scales and the interconnected subsurface cavities are shown in Figure 2. Some sort of streak cancellation mechanism might be at work here in which the longitudinal injection might compensate for the velocity defect in the low-speed streaks. Crosswise injection, for whatever benefit that might be, is another possibility. In any event, there is a distinct possibility of some active boundary layer control mechanism, and Bechert intends to examine the influence of these secondary effects.

Acoustics

The acoustics work at DFVLR-Berlin is directed by Dr. E. Pfizenmaier and Dr. W. King. Since the late 1970's they have been working on a combined theoretical and experimental program directed toward the prediction and measurement of the aerodynamic noise on Germany's new 350-km/hr, intercity experimental (ICE) high-speed train. At these speeds, aerodynamic (boundary layer) noise tends to predominate over wheel noise, and careful consideration needs to be given to the nose shape of the locomotive to minimize the sideline noise. Assuming that the noise generated is that which would result from turbulent flow over a smooth, flat, rigid surface, King developed a prediction method using dipole and quadrupole acoustic sources which agreed within 3 dB with the experimental measurements of sideline noise taken with a directional 15-microphone array during an actual test of a prototype locomotive.

When attempting to make measurements of wall-generated turbulence noise with a microphone located in the flow, a problem arises due to the fact that the noise resulting from the flow over the microphone needs to be excluded from the measurements. Pfizenmaier is working on an interesting method by which boundary layer noise can be measured external to the boundary layer without the use of a microphone. This employs laser-induced florescence (LIF) which is a popular diagnostic tool in low-density, high-temperature flows. In a pilot experiment,

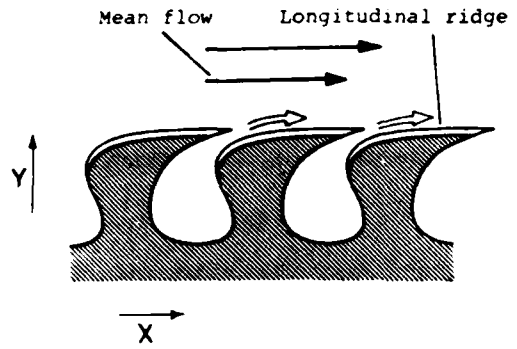

Figure 2. Shark scales and subsurface cavities.

Pfizenmaier is using a 3-watt argon-ion laser to make pressure measurements in an acoustically driven cavity filled with iodine-doped air at low pressure in which the LIF pressure measurements will be compared with those obtained with a microphone mounted in the wall.

At the MPI, Dinkelacker's colleague, Dr. G.E.A. Meier, is also involved in a number of acoustic and wave propagation projects. Since the time which I was able to spend with Dr. Meier was quite limited, I will just list topics which his research group is working on:

- An acoustic sound source utilizing the water hammer effect for geological prospecting
- Acoustic cavitation
- Application of vortical flows to reduce valve noise
- Wave propagation (including evaporation and condensation) in retrograde media
- Blade vortex interaction and noise generation (helicopter applications).

Conclusions

Research in the areas of turbulence, drag reduction, and acoustics at the MPI and the DFVLR-Berlin are mature and productive activities. The turbulence research at the MPI has made fundamental contributions to the understanding of coherent turbulence structures. The LEBU experiments being planned at the DFVLR-Berlin promise at last to clarify the drag-reducing potential of such devices. Finally, the acoustic research programs at the MPI and the DFVLR-Berlin are producing some innovative developments in the field of applied acoustics and measuring techniques.

References

Bechert, D.W., M. Bartenwerfer, and G. Hoppe, "Drag Reduction Mechanisms Derived from Shark Skin," *Proceedings of the 15th Congress, International Council of the Aeronautical Sciences* (London, September 1986, published by American Institute of Aeronautics and Astronautics, Inc., 1633 Broadway, New York 10019), 1044-1068.

Dinkelacker, A., P. Nitschke-Kowsky, and W.-E. Reif, "On the Possibility of Drag Reduction with the Help of Longitudinal Ridges in the Walls," *Proceedings of the IUTAM Symposium on Turbulence Management and Relaminization* (Bangalore, India, 1987, to be published by Springer-Verlag, Berlin/Heidelberg, West Germany).

Dinkelacker, A., and M. Sieber, "Coherent Structures in Turbulent Pipe Flow," *Proceedings of the European Turbulence Conference* (Lyon, France: July, 1986, to be published by Springer-Verlag, Berlin/Heidelberg, West Germany).

Kline, S.J., W.C. Reynolds, F.A. Schraub, and P.W. Runstadler, "The Structure of Turbulent Boundary Layers," *Journal of Fluid Mechanics*, 30 (1967), 741-773.

Kastrinakis, E.G., and H. Eckelmann, "Measurement of Streamwise Vorticity Fluctuations in a Turbulent Channel Flow," *Journal of Fluid Mechanics*, 137, (1983), 165-186.

Reif, W.-E., and A. Dinkelacker, "Hydrodynamics of the Squamation in Fast Swimming Sharks," *N. Jahrbuch F. Geologie u. Paläontologie, Abhandlungen*, 164 (1982), 184-187.

3/9/87

FLUID MECHANICS AT THE NATIONAL TECHNICAL UNIVERSITY OF ATHENS

by Daniel J. Collins. Dr. Collins is the Liaison Scientist for Aeronautics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until June 1988 from the Naval Postgraduate School where he is a Professor of Aeronautical Engineering.

The National Technical University (NTUA) occupies a new campus (6 to 7 years old) overlooking Athens. It is a stimulating atmosphere and there are some new experimental facilities that should further the research effort. Support for the university comes principally from the Ministry of Education with extra funding sources consisting of the EEC and the Greek Ministry of Defense.

NTUA has about 6000 students and 10 academic departments. As in Italy a department rather than institute structure was recently introduced into the

university organization. I spoke with Professor Athanasiadis, who is head of the Fluid Mechanics Section which, in turn, is a part of the Mechanical Engineering Department. The Fluid Mechanics Section is further divided into turbomachinery, aerodynamics, and naval architecture. About 150 students a year enter the 5-year fluid mechanics program leading to what could be called a diplome engineer.

As a bridge over the apparent gap between research and its industrial application, Greece has a Department for Research and Development, which falls under the Ministry for Industrial Development. The general secretary for the Department of Research and Development, which is charged with advancing research in selected areas in Greece, is Professor Papailiou, who was my original contact with the university. I believe that the real problem in the research configuration is the essentially total lack of interaction between private industry and the universities. My impression is that there is an element of traditional separation of the university and industry activities.

Perhaps a program similar to that of Portugal, which forces industry-university interaction by a series of grants to industry that require university support, would be fruitful. (*Reviews of National Science Policy, Greece* 1984.)

NTUA's Fluid Mechanics Section. The research activities at NTUA are very analagous to those conducted in Portugal (*ESN* 40-11/12:436-440 [1986]) but at a more advanced level. The Fluid Mechanics Section is designing windmills for power generation in conjunction with the Public Power Corporation (PPC), which recently installed two small windmills (100 kilowatts) on a Greek island. This work has been in cooperation with the national laboratory of Denmark at Riso. Computer codes for the design were obtained from the US. Other research is in the area of atmospheric pollution and wind patterns around buildings. There is also some activity on helicopter landings for the Ministry of Defense.

Professor Athanasiadis has designed a very innovative subsonic wind tunnel which contains three test sections. It has a standard test section with a cross section of 1.8×1.4 m and a velocity capability of 70 m/s. The return loop has an atmospheric test section which has been used for investigations on a scale model of the terrain for a proposed, small windmill farm. Just prior to the tunnel's convergent section is the third test section, which permitted the helicopter tests mentioned before. Although there are clearly constraints on this three-part design that separate facilities would not have, it is nevertheless an efficient use of Greece's scarce resources. Most of the test equipment for the tunnel is conventional, but the tunnel has a computer for control and data reduction.

Another interesting development area that concerns the Fluid Mechanics Section is the use of pumps as turbines for power generation. Greece has many small waterfalls, and the pumps which are manufactured in Greece are being adapted for power generation from this source.

I next talked to Professor G. Bergeles in the aerodynamics laboratory. Bergeles is a graduate of Imperial College, London, where he worked with B. Launder and J. Whitelaw in studies of combustion. He has been a visiting professor at Imperial and has also had an Eisenhower fellowship in environmental pollution, as a result of which, he has visited selected laboratories in the US. He recently published a paper on the application of the Navier-Stokes equations to the flow around two-dimensional hills and has been working on the development of codes for numerical solution of the transport equations for passive contaminants in three-dimensional complex terrain. These calculations complement the group's activity in the atmospheric tunnel. His principal current activity is concerned with adaptive grids orthogonal in three dimensions. One of his previous papers considered orthogonal grid generation in two-dimensional space (Bergeles, 1985). His three-dimensional work is concerned with a three-dimensional wing with a spoiler process. I believe his work is of high order, but he is hampered by the lack of computer capacity. Although Bergeles has an IBM PC AT on his desk (there are five in the group), the central computer is limited (prime 450) and he must use (by American standards) a sparse set of grid points.

Professor Loukakis, who is in charge of the new tow tank of the department, is interested in marine hydrodynamics, free-surface theory, ship maneuvering, and cable dynamics. Loukakis spent 8 years at Massachusetts Institute of Technology, from which he has his Ph.D. He has excellent contacts in the US and indicated to me that 11 of his students are now professors at American universities. The towing tank, although somewhat small, 91×4.6×3 m, is now the official tow tank of Greece. The tank is controlled by a series of HP computers--5000, 9845, and 310.

Dr. Chaviaropoulos showed me the turbomachinery laboratory of Professor K.D. Papailiou, who was unable to meet with me because of a last-minute

government meeting. I regretted this since we had become acquainted when he worked at the Naval Postgraduate School turbomachinery laboratory a number of years ago. Papailou has 10 diplome engineers working with him for their doctorates. The complete laboratory is to be enclosed in a new building which is essentially ready. A small low-speed facility is now in operation; it includes a calibration tunnel for three-dimensional probes, a ventilator test rig (4000 rpm, 5 kW), and a small, computerized automatic measurement system. An axial/radial compressor test rig is being installed. This will have 750-kW installed power and 24,000 rpm output. A radial compressor of 19,000 rpm, 7 kg/s mass flow and a 3.2 pressure ratio is connected with the compressor test rig. A Sage microcomputer will be used for computational purposes and for monitoring the compressor test rig. A Microvax II is on order. Upon completion, the laboratory should be an excellent facility.

The turbomachinery laboratory has a wide range of research activities and interacts with several outside agencies. Thus, for Avions Marcel Dassault-Breguet Aviation (AMD) laboratory personnel have developed computer codes for two-dimensional transonic, inviscid, strongly rotational flows (Giannakoglou et al., 1985) and three-dimensional subsonic, inviscid, strongly rotational flows (Chaviaropoulos et al., 1984). Other work, which is partly funded by Société Nationale d'Etude Construction Moteurs d'Aviation (SNECMA), concerns shear layer approximations with viscous-inviscid interaction and shock/boundary-layer interaction (Assasse and Papailiou, 1979;). Some of the current projects include an investigation of air inlets for AMD and a study of windmills for the EEC . In this latter investigation emphasis is on diagnostics, particularly acoustics, and on the Navier-Stokes calculations in a blade-to-blade geometry. For the Greek organization of small- and medium-size industries (EOMMEH) Papailiou's group is analysing two existing ventilators (one radial and the other axial). From this analysis two new ventilators will be designed and constructed and then tested. An important feature of this project is the matching of numerical methods and machine design.

For the Greek Ministry of Technology (YET) the laboratory has under development an advanced calculation system for the design of small hydraulic machines. The work is in cooperation with another research group which specializes in material and manufacturing procedures. This is in connection with the small waterfall work mentioned earlier. A complete axial device is now available so the work is directed at a radial turbine about 1 m in diameter with a height of 3 m generating 120 kW. In a joint program with the University of Patras, YET is sponsoring the development of a diagnostic program for powerplants which will help in preventive maintenance. Following an idea patented by Electricité de France, (EDF) the turbomachinery laboratory has designed a small, wet-steam separator for EDF. This design is being sold commercially in the US, and further detailed tests, sponsored by EDF, are being made at the laboratory.

Conclusion

I was particularly impressed at NTUA by the turbomachinery laboratory, which should have excellent facilities upon completion of the new building. The group has good contract support and interaction with industry--which appears to be rare in Greece. The turbomachinery laboratory would be a credit to any large state university in the US.

The facilities of the Fluid Mechanics Section appear on the whole to be quite good. Some more modern diagnostic equipment on the subsonic tunnel might be helpful. They do have a low-power, single-color laser Doppler anenometer which could be useful in their water channel.

The professors in the section have good contacts with colleagues in the US and UK. I have found that such contacts for countries such as Portugal and Greece are essential if good research work is to be accomplished there. The NTUA work appears to be ahead of the local technology base, a fact which presents difficulties both for industry and the academic communities *(Reviews of National Science Policy, Greece, 1984.)*

References

Assassa, G. M., and K.D. Papailiou, "An Integral Method for Calculating Turbulent Boundary Layer With Separation," *Journal of Fluids Engineering*, 100 (March 1979).

Bergeles, G.C., "Numerical Calculation of Turbulent Flow Around Two-Dimensional Hills," *Journal of Wind Engineering and Industrial Aerodynamics*, 21 (1985), 307-321.

Chaviaropoulos, P., K. Giannakoglou, and K.D. Papailiou, "Numerical Computation of Two-Dimensional Rotational Inviscid Compressible Subsonic Flows Using the Decomposition of the Flow Field Into a Potential and a Rotational Part," *ISABE 85-7050* (National Technical University of Athens, 1984).

Giannakoglou, K., P. Chaviaropoulos, and K.D. Papailiou, "Numerical Computation of Two Dimensional Rotational Inviscid

Transonic Flows, Using the Decomposition of the Flow Field Into a Potential and a Rotational Part," *ISABE 85-7050* (1985).

4/14/87

AGARD'S 68TH PROPULSION AND ENERGETICS MEETING

by Daniel J. Collins.

The AGARD 68th Propulsion and Energetics Meeting was held from 8 through 12 September 1986 in Munich, West Germany. It comprised two specialist meetings: "Transonic and Supersonic Phenomena in Turbomachines," and "Engine Response to Distorted Inflow Conditions". Both meetings were well attended with perhaps 175 people present at any given time. The proceedings are available as an AGARD conference proceeding (CP400 and 401).

Transonic and Supersonic Phenomena in Turbomachines

A total of 27 papers were given in the four sessions of this meeting. Eight of the papers were from Germany, six each from the UK and France, three each from Italy and the US, and one from Turkey. Following is a brief review of some of the papers in those sessions.

Experimental Data and Shock Structures. An experimental and theoretical program to develop essentially a data base on shock-wave/boundary-layer interaction in 3-dimensional (3-D) flows was detailed by R. Benan, T. Pot, and J. Delery (Office National d'Etudes et de Recherches Aerospatiales [ONERA], France) The experiment consisted of a 3-D transonic channel with a hump in the lower wall. The 3-D flow pattern involving a boundary layer and shock interaction was extensively measured by a three-color laser doppler anemometer (LDA) system. The detailed measurements of the flow field were complemented also by oil streak patterns on the walls. This type of experiment depends on the nonintrusive nature of the laser measurements. The precise data developed in the experiment can also be used to validate numerical models of the flow.

Schultz et al. (University of Oxford, UK) investigated wake and shock interactions in a transonic turbine. Strong trailing-edge shock waves in a transonic turbine originating from the inlet guide vanes can cause interactions with the downstream motor that can be more severe than in lower pressure ratio stages. The guide vanes were simulated by an array of rotating bars and the effect determined on a stationary rotor. This simulated the effect of upstream guide vanes on a moving rotor. Detailed heat-transfer-ratio measurements made with rapid-response guages permit separation of wake and shock phenomena.

Another paper of interest in this session--given by H. Hoheisel (Deutsche Forschungs and Versuchsan und Versuchanstalt für Luft und Raumfahrt [DFVLR], Braunschweig, West Germany) and N. Seyb (Rolls-Royce, UK)--dealt with the boundary layer behavior of highly loaded blades at transonic conditions. The experiments were conducted in the Braunschweig high-speed, cascade wind tunnel of DFVLR which is now at Munich (see *ESN* 41-3:161-163). A two-finger probe was used in measuring the boundary layer profile. Corrections to the calibration of the probe were made by comparisons with flat-plate experiments and some LDA measurements.

Shock-Induced Losses Including Shock/Boundary-Layer Interaction. The paper by A. Fourmaux and A. LeMeur (ONERA) contained a detailed analysis of the losses introduced in turbomachinery by shock waves. In advanced turbomachines the reduction of aerodynamic losses is of serious concern to the designer. These losses were attributed to three origins:

- Losses due to leading edge shocks
- Losses due to the main-compression shock
- Friction losses due to the evolution of the boundary layer.

All the analysis and experimental work in the paper was confined to two dimensions, contrary to the ONERA paper by Benay et al. Although the detached shock region can in principle be determined by flow field analysis based on the Euler equations, the grid system in supersonic cascade flows is often not fine enough for such analysis. Thus there is the tendency to calculate the losses from the detached shock separately from the flow field. The paper dealt primarily with the losses due to the initial detached shock in front of the blade.

Another paper from ONERA this one by J. LeBalleur and D. Blaise, presented a calculation method for internal transonic separated flows and for shock-wave/boundary-layer interaction. The approach is a generalization of a method originally proposed for external detached flows on airfoils. It is based on "indirect" numerical solvers with viscous-inviscid splitting. The theoretical calculations are compared with several experimental measurements involving transonic flows in

symmetric and asymmetric canals, supersonic ramp flows, and the reflection of a shock wave. Finally, some preliminary calculations are given for flow in a supersonic cascade. The results are reasonably encouraging but with some problems--as might be expected in detachment and reattachment points--and, of course, the results depend on the selected turbulence model.

The paper by Epstein et al. (Massachusetts Institute of Technology [MIT], Cambridge) considered the wakes of highly loaded axial compressors. Hitherto, such wakes were considered to be turbulent, unstructured flows. Recent work has indicated that the wakes of the blades may be dominated by coherent structures that are like vortex sheets. The paper reviewed the work on wake structure at MIT and presented results of viscous numerical simulation of cylinder wakes. The numerical calculations were compared with experimented data obtained by LDA and high-frequency probes. The implications of wake structure on compressor performance were discussed.

The two UK papers in this session were primarily experimental and treated in the one case (J. Edward and L. Squire, Cambridge University) a somewhat idealized version of a shock/boundary-layer interaction. The experiment was well thought out and consisted of a 2-D shock wave undergoing oscillation at imposed frequencies. One conclusion of the experiment was that at reduced frequencies of 0.75 or less the flow could be considered as quasi-steady. The other paper (W. Dawes, J. Camus, and L. Xu, also from Cambridge) had excellent agreement between predicted and measured blade surface pressure in transonic turbine blades. This is perhaps not too surprising since, unlike compressor blading, there is weak coupling between the inviscid and boundary layer flows in a turbine. This fact makes the prediction process for th losses by numerical calculation also somewhat easier. As indicated by the authors, trends are well predicted in a consistent manner but the levels are not correct.

Computational Results. There were nine papers given in the session on computational results. A full 3-D code for turbomachinery is clearly not available at the present time and the authors of most of the papers tried in one manner or another to fill this gap. Detailed flow fields were presented with some comparisons between experimental measurements and predictions. Since the actual experimental comparisons are limited, it is difficult to judge the accuracy of some of the codes. The predictive value of the algorithms in the off-design conditions are even more difficult to evaluate. For more limited investigations such as that of H. Dietrichs, H. Happel, and K. Lehmann (Motoren und Turbinens-Union [MTU], West Germany) which was confined to 2-D transonic cascade flow, good agreement was obtained between experiment and theory when frictional effects are weak and the boundary layer is not separated. This session's nine papers gave as a whole an excellent overview of the present state of the art, and the calculations can provide some insight to particular physical phenomena in a turbomachine--for example, the article by W. Dawes (Whittle Laboratory, Cambridge), which presents an excellent discussion and analysis of tip flow. It is further clear that considerable work is still needed in 3-D turbomachinery calculation.

Blade Design Methods. The last session on blade design methods consisted of five papers, of which three were from West Germany. The paper by Carrahar and Kingston (Rolls-Royce) explained the time-marching method whose development began at Rolls-Royce in the mid-1970's. Future developments are aimed at predicting losses accurately and investigating vortex shedding and incoming wakes. Some minimal comparisons with experimental measurements were given. The paper by G. Meuzé (ONERA) was concerned with characterization of the flow incident to what could be termed a generalized cascade. Some rules were developed for the optimization of the entrance part of a supersonic cascade.

The first German paper--by Reiss et al. of Hannover--considered turbine cascades at subsonic and supersonic conditions. Essentially, the paper made a comparison between so-called simplified methods (sine law) and numerical calculations for determining the downsteam flow angle. With appropriate thickening of the wake (empirical methods) of the trailing edge of the turbine blade good predictions ($\sim$0.2 deg) of the outlet flow angle could be obtained. The simplified methods were found to be inadequate. The paper by R. Dunker (DFLVR) was concerned with development of shock models for incorporation in off-design performance predictions of transonic axial flow compressors. The mathematical treatment of the shock models was somewhat lengthy and no extensive comparisons with experiments were given. Such comparisons are to be contained in a future publication by DFVLR at which time a better understanding of the validity of the models can be made. M. Horsmann and J. Schmidt (KHD Engineering) in the last of the German papers made a comparison of inverse design airfoils and standard series airfoils in high-loaded axial turbine

nozzle applications. They conclude that improvements can be made but that the method is time consuming and there is therefore at present a lack of experience using the method.

The meeting on blade design methods--transonic and supersonic phenomena in turbomachinery propulsion and energetics panel (PEP)--provided an excellent review of the state of the art. The presentations in themselves gave a good survey of the European actors in this area.

Engine Response to Distorted Inflow Conditions

This meeting consisted of 17 papers (five from the USA, four from Germany, four from France, three from England, and one from Italy). The four sessions were:

- Unsteady flow and validation of empirical distortion parameters
- Computations technique for engine/compressor performance predictions of distorted inflow
- Distorted inflow detection
- Experimental investigations of engine instability and response to flow distortion.

The meeting was opened with an excellent review paper by D.D. Williams of Rolls-Royce. Essentially all aspects of engine distortion swirl, temperature distortions, etc. and engine response were covered. At the conclusion of the conference Williams, as technical advisor to the meeting, also gave a detailed summary of the accomplishments of the meeting and areas for future investigation. His critique is to be published with the conference proceedings. For this reason and also because of the large number of American contributions, I have limited my comments on this meeting.

The following institutions were involved in engine research: Germany's Messerschmitt-Bölkow-Blohm (MBB), the Technical University of Aachen, DFVLR, Industricanlagen-Betriebsgesellschatt [IABG], the Federal University of Munich; the Société Nationale d'Etude et Construction de Moteurs d'Aviation [SNECMA], ONERA, Société Bertin, and Cie; England's Rolls-Royce and Royal Aircraft Establishment; and Italy's Alfa Romeo. It is interesting to note the technical participation of universities in Germany in this type of research--it shows the close connections between industry and the universities in Germany.

One further observation here: The paper by Billet, Chevalier, and Laval (ONERA) was a numerical study of the transmission of a distortion through an axial compressor. From the numerical calculations a motion picture was composed with colors showing the different levels of distortion and their change with time. This was an excellent way to present a considerable quantity of data in an efficient manner. Such numerical flow-field presentations are, I believe, essential to an understanding of complex flow fields.

I found this meeting to be of very high quality, and one that provided many comparisons between measurements and theory. The original review of engine distortion and the final critique of the meeting by Williams were most helpful in obtaining a perspective of the field.

4/13/87

FLUID DYNAMICS AND CONTROL THEORY RESEARCH IN DENMARK

by Daniel J. Collins.

Denmark is a highly developed country with a population of a little more than 5 million. Its technical emphasis is focused on such areas as sophisticated scientific instruments and advanced technical devices--research for labor-intensive industry is avoided. The small population also means that there are few people engaged in a single activity. For example, in both Denmark's technical universities there are perhaps only a few more than a couple of dozen people who are involved in the application of control theory to modern technology. This equates to essentially three groups, each headed by a senior professor. From this viewpoint it is then relatively easy to characterize the entire national effort in the areas I am concerned with. This report includes both the fluid dynamics and control theory activities because I believe that will give a better indication of the overall research activity in Denmark than would separate reports.

The Danish Council of Research (DCC) is one of the principal research institutions in Denmark. It is similar in function to the NSF in the US but also has some functions that in the US would fall under the Departments of Education and Commerce. DCC has two subcouncils, one concerned with basic research, the other with technological developments. In this latter subcouncil is a group concerned with electronic developments and communications. Since emphasis is on high technology the subcouncil encourages

and supports small businesses in scientific and medical research.

In my visit to Denmark I talked to a small scientific instrumentation manufacturer (Dantec), visited the Technical University at Lyngby, visited the Riso National Laboratory, and talked to a professor from Denmark's second technical university (at Aalborg).

Dantec manufactures precision equipment for laser Doppler anemometry (LDA). It has of necessity a relatively large volume of foreign sales. The Riso National Laboratory was originally founded as a nuclear research laboratory. Since the present national sentiment appears rather strongly to reject nuclear power for Denmark, the laboratory broadened its mission and has become a national laboratory with a wide spectrum of research activities. Of the two technical universities in Denmark the first, the Technical University of Denmark, was founded in 1829 and intended to be in close collaboration with the University of Copenhagen. Beginning in 1961 a completely new campus for the technical university was created at Lyngby, a suburb of Copenhagen. Thus the university has very modern and adequate facilities. The Technical University at Aalborg was establish 10 years ago. My visit to Denmark gave me an opportunity to judge in some sense how the interfaces between industry, university, and the national laboratory are handled in Denmark.

Fluid Dynamics

Dantec. Dantec (previously known as DISA) has two divisions, electromedical and scientific research. My visit was confined to the scientific division; my host was Dr. L. Larsen, manager of the R&D department. Larsen has spent a number of years working with Riso in the area of fluid mechanics and laser measurements (Lading and Jensen, 1980). As with many of the Danish scientists that I talked to he has also spent some time in America at Case Western Reserve (Lading, 1983). Dantec (owned by a completely private venture company) develops scientific instruments for fluid mechanics measurements. Their facility is modern and has extensive computer support at the minicomputer and PC level.

In addition to LDA instrumentation Dantec also manufactures hot-wire equipment and associated auxiliary devices. About 45 percent of the laser anemometry generated in the world comes from Dantec with another 45 percent from the American firm, TSI. The rest is split between a Japanese and a German firm. Having supplied several thousand LDA systems in France and Germany, Dantec is now emphasizing fiber optic systems. They have also developed a new particle dynamics analyzer which simultaneously measures size, velocity, and concentration of spherical particles in a fluid. They have a further emphasis on the development of equipment that will simultaneously measure other quantities such as temperature and density. Although we did not discuss it, I believe Dantec is making a strong effort to introduce holographic methods or devices in optical equipment. Since their customers are principally scientific investigators Dantec publishes a magazine, *Dantec Information*, which reports results of complex measurements using Dantec apparatus. In addition, their own researchers publish articles in the open literature (Saffman and Buchave, 1984).

The Technical University of Denmark. My next visit was to the Technical University of Denmark at Lyngby. The student population is about 4500 with a technical and administrative staff of around 750. The first technical university degree requires 5 years and is essentially that of a Diploma Engineer, which is equivalent to the Master's degree in America. The Danish Ph.D. requires another 3 years.

The first part of my visit was hosted by Dr. P. Larson of the Fluid Mechanics Department, which has 12 scientific staff members and normally three doctoral candidates. The curriculum in fluid mechanics is similar to many given in the United States. The research activities are concerned with instrumentation systems for fluids with LDA measurements, computation and measurement of laminar and turbulent flows, and aerotechnology involving wind turbine design and aeroelasticity experiments.

The principle LDA experiments conducted by Larson are concerned with characterizing the fluid flow in electrostatic precipitators and in cyclones. (Larson and Christensen, 1986). The research is supported by the Danish Technical Research Council and also has close ties with industry. Almost all the research that I had an opportunity to review was connected to some immediate technical need in industry or related to improving technical competence in the export market.

In one of the experiments, the department used a Dantec two-color system to obtain detailed velocity and turbulence data measured in a negative corona barbed-wire plate precipitator. The results indicated a secondary flow pattern consisting of rolls of axial vorticity. At values of the electrical Froude number above 30 the flow was shown to be stable and of low turbulence. The experiment was very well

designed and has been used in a Ph.D. research effort.

I talked further to Mr. H. Saustrup Kristensen (a doctoral student), who is using the Cebeci-Smith turbulence model to calculate three-dimensional flows. He is considering separation effects based on some flows measured at Office National d'Etudes et de Recherches Aérospatiales (ONERA).

The fluid dynamics laboratory has two small, subsonic wind tunnels and is also developing a five-hole spherical probe. The research effort in fluid mechanics is limited by the small number of people involved but the areas being investigated are very competently handled.

I next talked to Dr. B. M. Pedersen on wind turbines (Pedersen, 1986)--a large-scale export activity conducted by about five small companies in Denmark. Pedersen told me that Denmark itself is presently using some 1400 small (∿100 kW) wind turbines, and it is estimated that up to 10 percent of the country's electrical consumption could be covered by wind energy. An excellent publication outlining research in this area has been prepared by the Danish Ministry of Energy (*Wind Energy*, 1986). Denmark has a long tradition of research in windmills going back to Paul la Cour at the turn of the century. In the latter half of the 19th century with 3000 commercial windmills and over 30,000 farm-mills the working capacity of the windmills was between 150 to 200 MW. Interestingly enough, the installed wind turbine capacity in 1990 is expected to be in the range of 150 MW.

Recent export as well as domestic activity was originally motivated by the energy crisis. Of the windmills used in California, 30 to 40 percent are of Danish origin. The smaller Danish windmills are perhaps third- or fourth-generation machines and although not particularly innovative or advanced in design are noted for their reliability. Large megawatt machines, which are probably beyond the technical capacity of the small Danish firms, are being developed by Danish utilities and by the research at the Riso National Laboratory. At Riso is the National Test Station for Windmills which certifies windmills.

Denmark's Windmill Program Future. Future trends are to larger power windmills (100-300 kW) and the further development of MW wind turbines. Wind turbine technology in Denmark has a strong traditional foundation and a strong climatology foundation. One can expect that Danish research will continue to make heavy contributions in this area. In the area of large windmills (1 MW) American technology is in all likelihood ahead of Denmark.

It is interesting to compare Denmark's research effort with respect to wind turbines to that of Portugal. In my recent visit to Portugal (*ESN* 40-11/12:436-440 [1986]) many of the people in fluid mechanics, motivated by memory of the energy crisis in the mid-1970's, talked about research in the area of wind turbines as an alternate source of energy for the country. Their emphasis was on developing reliable windmills for energy production in the country. Some small activities were devoted to airfoil design and development of machines. In the same time frame Denmark has developed a world-competitive industry and has installed over 1400 windmills in its own territory. This illustrates the importance of Denmark's previous experience with windmills and also the ability of a fully developed country to allocate the needed fiscal and manpower resources to an area of national need.

Riso National Laboratory. The Riso National Laboratory is primarily concerned with energy utilization; thus the National Wind Turbine Testing Facility is located here. The laboratory employs some 1000 people of whom about 300 are professionally qualified. They produce about 700 articles, reports, and conference presentations each year.

My main interest at Riso was in holography, and my host for this part of the visit was Dr. Skov Jensen. His group's main project is the development of a robot vision systems, an ESPRIT project in a cooperative program with, among others, Dantec. (It was my impression that Dantec had a particular interest in the development of holographic optical elements.) The vision system must recognize shapes, positions, orientations, and sizes of a collection of objects. Involved is the ordering and sorting of parts, quality inspection and precision measurement, and the assembly of parts. The corresponding enabling techniques are computer-generated holograms, filter recording techniques, and spatial light modulators.

A typical vision system is shown in Figure 1. The system must perform at least four functions:

- Detect the positions of objects
- Detect the size of objects
- Detect the orientations of objects
- Detect the shapes of objects.

Optical implementation of these goals is the purpose of Riso's robot vision effort. Most of the techniques used in development of the system are fairly well established. What makes the project interesting is the effort to obtain a sophisticated application of

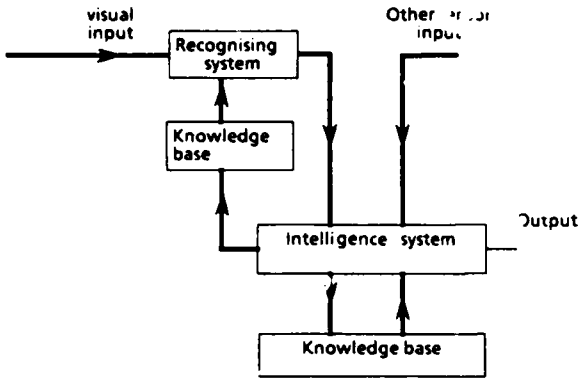

Figure 1. General consideration of vision system.

these techniques. Computer-generation of holograms has been a field of research for some 20 years. Riso now has the capability of generating a complete hologram in somewhat less than 20 hours. Holographic optical elements (HOE) use diffraction to bend light rays rather than refraction and reflection, as in conventional optical elements. In the special case of coherent light illumination such as is the case with LDA, HOE's may have particular advantages. HOE's may be manufactured by computer-generated holograms. It is possible for a given HOE to combine the effect of several optical elements such as a set of lenses, a beam splitter, and an optical filter. The hologram plates can be manufactured inexpensively and offer the further advantage of being light in weight and compact. One can easily see an application of the holographic technique in the design of LDA equipment. HOE's can be used in optical processing for Fourier transforming holographic lenses, matched spatial filters, erasable spatial filters, and geometrical mapping filters.

Perhaps the area which is technically the most demanding in this field is that of spatial light modulators (SLM). This is particularly true in the area of computer utilization of light processing. Riso has developed a SLM which can identify four objects: a washer, a hex nut, a bolt, and a micrometer screw. The optical setup for the SLM is given in Figure 2, where a correlation function is used in the identification.

The work on the robot vision project is perhaps precompetitive in nature but the group impressed me with their knowledge of the current state of the art and I believe interesting results will come from the activity.

Riso personnel are well acquainted with research in optical processing in America. Representatives attended the SPIE International Symposium On Optical Processing in April 1986 at Orlando, Florida. Many of the papers at this conference were concerned with optical target finders and silhouette recognition for military purposes. They have talked to Professor David Casasent (one of the sponsors of the conference) at Carnegie Mellon University and have invited one of his recent doctoral students for a 2-week visit in order to exchange information.

Some of the experimental work at Riso on holographic optical elements was shown to me. One fascinating hologram depicted an optical element that produces a pattern of 12 focal points.

Another very interesting project that I had an opportunity to discuss may have some impact on the SDI program. I talked to Dr. Harold Yura, who is on leave for a year from the Aerospace Corporation, Los Angeles, California. He has been working on the effect of the finite size of optical elements on the transmission of laser signals over a fairly large distance. This might involve a mirror in space illuminated from the earth. His analysis is linear and does not cover the effect, for example, of thermal blooming. Finite size effects are very significant with axis intensity reduced by as much as one-fourth. Jitter effects are particularly bad. A report on this method of calculation, which may be unique, is to be shortly published and can be obtained by writing Yura at Riso.

Riso also has a strong ongoing effort in human factors (Rasmussen, 1984). This interest extends to office automation and, in more general terms, to what can be termed cognitive physiology, which leads to large-scale processes control. In his discussion with me, Dr. Rasmussen, head of the Electronics Department, also expressed strong interest in C^3 activities.

Rasmussen talked to me about the nature of Riso's approach to research. The Riso people try to concentrate their activities in an area where a small number of researchers can be effective. This requires some shrewd forecasting as to the direction of research and analysis of how that fits in with the ability of the people available. Such an approach is not too much different from that of any other active research unit in the world, but it is particularly critical for Denmark because very few researchers are involved and there is little room for mistakes.

Controls Research

Professor Morton Lind is head of the controls group at the Technical University of Aalborg. I talked to him at Riso,

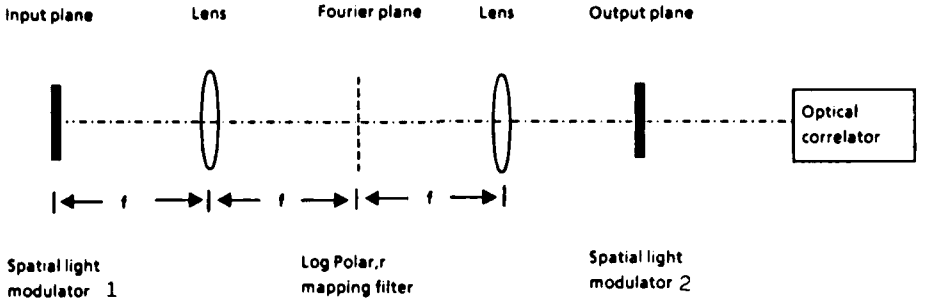

Figure 2. Setup for making geometrical mapping.

where he was employed and is now a consultant in the Electronics Department--another example of the close professional ties between the universities and Riso.

The University of Aalborg was founded about 10 years ago and now has some 8000 students and a technology and science staff of about 500. The Institute of Electronic Systems, headed by Lind, has 15 faculty. The research interests of the institute are in the area of computer-based control systems. Lind's own interests are in the area of artificial intelligence (AI); he is concerned with the modeling of AI within the process control area and in man-machine interactions (Lind, 1983). The central question he addresses is how to describe control problems in large systems. His activities are thus complementary to the human factors cognitive task analysis mentioned by Rasmussen (1984). Lind uses what he terms a multilevel-flow modeling technique to describe complex systems, such as power plants, in terms of mass and energy flows. Out of the description come specific plant control requirements, needed plant information, and the relationship to knowledge-based expert systems for the design of man-machine interfaces. Thus the analysis is concern with a hierarchical abstraction of the system and a corresponding hierarchical control of the system. Some of this analysis has formed the basis for work on an ESPRIT program concerned with expert systems. Several utilities are using the software in their plants. From what I have seen of the method the approach is not confined to powerplants but could be applied to any large-scale system.

The other two control groups I visited were located at the Technical University of Denmark. First was the Servo Laboratory, which was established in 1956. The head of the laboratory, Jens R. Jensen, was in the process of retiring so I talked to K. Andersen.

The Servo Laboratory, much as the name implies, puts great emphasis on classical methods and the designing of electrical motors and power amplifiers. Many of the staff of about 10 have half-time work in industry. The laboratory's research efforts are directed at five areas:

- Automatic control of ships (autopilots)
- Adaptive control
- Real-time monitoring systems in process control
- Optimization of control of the climate in TV studios
- Control of power plant boilers.

Andersen is starting on half-time industrial work involving the pitch control of wind turbines. The research activity is hardware-oriented and not directed at publication in the open literature. Thus most of the activity appears to be in connection with practical problems arising from consultation with industry. My detailed review of the teaching program in control theory revealed an excellent program that could have been found at any first-rate American school.

The other control group I visited was the Control Engineering Institute, founded about 4 years ago, and now headed by Professor Erik Trostmann. The institute had invited me to give a lecture on some of my current research on eigenstructure assignment. One of their recent doctoral candidates, Per Sogaard-Andersen, has also been working in this same area. His paper (1986), which concerns a singular value sensitivity approach to robust eigenstructure assignment, is of very high quality and indicates a solid foundation in this presently active area of research.

Comparing the institute's work to that in America, I find it theoretically competitive but it does not as yet have as many practical applications of eigenstructure assignment as the work by Americans.

The institute has a great interest in robotics and computer-integrated

manufacturing. The researchers are using CAD as a tool to real-time programing of machines. They are using offline programing in which one has a given instructional set for a machine and then one models and simulates the response of the system; the final test of the system would be in the actual control of the system with a robot. A large part of their effort is in welding programing. They are also active in an ESPRIT program KFK initiative in which robotic geometric information is used in the control of the system.

Conclusion

Danish research is characterized by close interaction between universities, industry, and the government laboratory. The small number of people involved essentially requires this type of interaction in order to obtain a synergistic effect. There are close ties to American research institutes both in the exchange of information and in the exchange of people. It would be a mistake to consider research at universities as separate from that of industry or the national laboratory. To me all research activities appear to be a team effort directed at making Denmark competitive in highly specialized advanced research efforts. Since modern technology has perhaps a half-life of 5 years, facilities for retraining engineers and scientists must be part of the educational system if Danish research is to maintain its competitive edge. In this regard it is interesting to note that some 25 percent of the students in higher education in Denmark are over the age of 30. Although limited by the small number of people engaged in research, the quality and competency is of very high order indeed.

References

Lading, L., "Estimating Time and Time Lag in Time-of-Flight Velocimetry," *Applied Optics*, 22 (1983), 3637.

Lading, L., and A. Jensen, "Estimating the Spectral Width of a Narrow Band Optical Signal," *Applied Optics*, Vol 19, No. 16 (1980).

Larsen, P.S., and E. Christensen, "Secondary Flow and Turbulence in Electrostatic Precipitation," *Proceeding of the Third International Symposium on Application of Laser Anemometry to Fluid Mechanics*, (Lisbon, July 1986).

Lind, M., "A Systems Modeling Framework for the Design of Integrated Process Control Systems," *Riso Report M2409* (December 1983).

Rasmussen, Jens, "Strategies for State Identification and Diagnosis in Supervisory Control Tasks and Design of Computer-Based Support Systems," *Advances in Man-Machine Systems Research*, 1 (JAI Press, Inc., 1984), 139-193.

Pedersen, B.M., "Wind Energy in Denmark," *Wind Energy in Denmark, Research and Technological Development* (Danish Ministry of Energy, 1986).

Saffnan, M., P. Buchhave, and H. Tanger, "Simultaneous Measurements of Size, Concentration and Velocity of Spherical Particles by a Laser Doppler Method," *Proceeding of Second International Symposium on Applications of Laser Anemometry to Fluid Mechanics* (Lisbon, July 1984).

Sogaard-Andersen, P., "A Singluar Value Sensitiviey Approach to Robust Eigenstructure Assignment," *25th IEEE Conference on Decision and Control* (Athens, 10-12 December 1986).

Ocean Sciences

YUGOSLAVIAN MARINE SCIENCE INSTITUTIONS

by Jerome Williams. Professor Williams is the Liaison Scientist for Oceanography in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until December 1987 from the US Naval Academy, where he is Associate Chairman of the Oceanography Department.

In March of 1987 I visited four Yugoslavian institutions in Zagreb, Split, and Dubrovnik. These included the Ruder Boskovic Institute and Geophysical Institute of the University of Zagreb, in Zagreb, The Institute of Oceanography and Fisheries in Split, and the Biological Institute in Dubrovnik.

Ruder Boskovic Institute

This Institute is an independent institution engaged in pure and applied research in physical, chemical, biochemical, biomedical, marine, and environmental sciences, with additional units in nuclear, solar, optical, and chemical technology. The Institute staff totals about 750; of these about 300 have graduate degrees in science, while the remainder provide technical or administrative support. The Institute was founded in 1950 as a center for advanced research of the Yugoslavia Academy of Sciences and Arts. Gradually its base was broadened to encompass mathematics and other

branches of natural sciences as well as engineering and technological research and development. It was named after the eighteenth century Croatian scientist and philosopher Ruder Josip Boskovic, who achieved a certain amount of international fame and a number of honors during his lifetime including a membership in the Royal Society.

The Institute serves as the graduate school of the University of Zagreb, offering specialized courses in physics, chemistry, biology, experimental medicine, and marine science. Funding is accomplished through national science funding agencies, industrial contracts, and international scientific organizations such as The World Health Organization, The Food and Agriculture Organization, The International Atomic Energy Agency, and The Intergovernmental Oceanographic Commission. In addition, the Institute has various collaboration agreements with other nations. US organizations involved include the National Institutes of Health, The National Science Foundation, the Environmental Protection Agency, and The National Bureau of Standards.

I visited the Institute's Center for Marine Research, which has a staff of approximately 100. The primary activities of this center appear to be in support of fisheries and pollution studies--both within the confines of the Adriatic Sea. The mission-oriented research deals with the properties of the Adriatic Sea and includes applied biology and biopopulation dynamics, aquaculture, classical taxonomy, and ecological research. Physical and chemical oceanography are both used to support the study of primary productivity. Pollution research includes the distribution and toxicology of trace heavy metals, chlorinated hydrocarbons and other biocides, bacteriology and sanitary conditions of coastal waters, and radioecology.

The Physical Oceanography Group within the center is primarily concerned with modeling the circulation of the Adriatic Sea, which apparently is driven by a number of factors including seasonal atmospheric disturbances and the wind. One of the investigators within this group is Milivoj Kuzmic, a numerical modeler who is working on a circulation model of the Adriatic Sea. One of the unique features of this modeling activity is the fact that relatively large amounts of data are available. The local winds (Bura, in particular) are strong enough to affect the entire country, so that wind data are accumulated on a regular basis, and time series current data from a few moorings are also available. His work has been well accepted by others in the modeling community who usually do not enjoy the luxury of viable data sets, but he is very limited in the amount of modeling he can do by the relatively small computer facilities available to him.

The Geophysical Institute of The University of Zagreb

Contiguous with the Boskovic Institute, but separated by a wire mesh fence, is the Geophysical Institute of The University of Zagreb. Here I spoke with Mirko Orlic, who is a research scientist with the Geophysical Institute and a member of the Faculty of Science of the University. Orlic is also working on the numerical modeling problem and has published a number of papers in this area, some of them as a coauthor with Kuzmic (mentioned above) from the Boskovic Institute. This team is able to supply both geophysical fluid dynamics and numerical modeling input to their study. At the present time they are trying to evaluate the relationship of wind curl to the production of the Adriatic current system and bottom topography to the dissipation of this energy. The oceanographic thrust of the Geophysical Institute appears to be minimal with only one or two oceanographers on the staff. Nevertheless, in conjunction with the Boskovic Institute some reasonably important work in modeling of the Adriatic, especially the northern regions, has been accomplished.

The Aquaculture Laboratory

This branch of the Institute was formed in 1980 and has a field laboratory near Dubrovnik. It has a staff of 14, nine at the professional level, who are investigating various aspects of aquaculture. They are not only involved with rearing and maintaining of various species, but they are also concerned with fish diseases and water quality analyses. Rainbow trout have been raised in brackish water where they grow about three times as fast as they do in a freshwater environment. The staff has also done experiments with coho salmon using eggs obtained from Seattle, Washington. After being hatched, the fry are placed in Adriatic water at a temperature of 10-12°C; they seem to survive to market size quite well. So far these experimenters have not been able to repeat the experiment using local salmon eggs but they are hoping to accomplish this in the near future.

The physical chemistry laboratory is also doing a lot of work associated with the marine environment, especially in the areas of heavy metals and hydrocarbon monitoring and measurement. Since these materials are adsorbed on suspended particulates, there is some ongoing work in modeling of sediment transport.

The Institute of Oceanography and Fisheries

This Institute is located in Split in a waterfront environment that looks extremely conducive to conducting marine research. In addition to a dedicated research facility the Institute boasts a research vessel about 25 meters in length. The total staff of the Institute is about 80, with 30 having graduate training. Of these, about five specialize in the area of physical oceanography. Again, the emphasis seems to be on fisheries and pollution problems, and the physical oceanography effort is primarily designed to support these other activities. The Institute was founded in 1930 and recently celebrated its 50th anniversary. During these 50 years a total of about 1200 papers have been published by the staff, split about 50-50 between in-house reports and papers published in refereed scientific journals. For a group this small that is not a bad record.

The research in physical oceanography at the present time seems to be divided into four areas. There is some work proceeding in the area of oceanic climatology of the Adriatic, along with some additional modeling and dynamic studies of Adriatic waters. In addition, one investigator, Mira Morovic, is using classical methods to study the optical properties of the Adriatic in an attempt to develop some methodology for using optical properties, either as tracers for Adriatic water masses, or as indicators of various phenomena of interest such as productivity indices or pollutant pathways.

Here again financing is partly derived from the Yugoslavian Government and partly from local industry and international oceanography groups; there are also funds from some US agencies such as EPA and NSF.

I believe the level of expertise at this field-laboratory-type installation is first-rate as far as personal competence is concerned. However, as I examined the physical facilities, including instrumentation and other resources such as computers, I found the laboratory quite wanting. The level of research possible under these conditions certainly is not the same as at institutions where facilities allow work of a highly technical nature to be accomplished.

The Biological Institute

The last facility I visited in Yugoslavia was the Biological Institute, located on the waterfront in Dubrovnik. This facility has been around since 1951, but the present site has been occupied only in the past 3 years. The Institute is a branch of the Oceanogrpahy and Fisheries Institute in Split, but seems to operate fairly independently. It has its own sea-going vessel--about 24 meters long--and a staff of about 15 professionals and 30 support personnel. The new facility is located within the confines of an ancient fortress; the renovation has been remarkably successful in maintaining the old appearance and charm while providing for modern laboratories, offices, and storage facilities. A rather complete public aquarium, stocking species indigenous to the local area, is an integral part of this operation.

In addition to the marine biological activity there is also some activity in terrestrial botany and ornithology. The major effort, though, is directed toward plankton studies, with some work going on in shellfish aquaculture. In addition, they do some environmental monitoring in cooperation with the Split and Zagreb facilities, along with an occasional environmental impact study. The Director of the Institute, Adam Benovic, showed me around, pointing out the fact that the walls of the fortress, and therefore of the Biological Institute, were more than 15 feet thick. With this sort of construction it is easy to have a constant temperature laboratory, since the thermal inertia of a massive structure like this is extremely high. The salt water flow tanks and plankton culture areas are both well designed and well instrumented.

An interesting aspect of this laboratory is that it owns a part of Lokrum Island, which is close enough to Dubrovnik to boast of a regular ferry service. On this island is an old monastery which is being renovated by the Biological Institute to be a field laboratory suitable for visiting scientists and classes, especially those given during the summer. The laboratory had planned for this facility to be open in 1985 but problems arose when some ancient ruins were uncovered at the site during renovation. Archeological studies have now stopped any further work and it is unknown at this time when the work can proceed. When the field laboratory is finished, it would appear that this would be an ideal place not only to study marine biology, but also to enjoy the beautiful Adriatic. It is hoped that the facility will be completed in time for the summer of 1988, but even now there is some space available for visiting scientists at the shore-side facility. Interested scientists should write to Dr. Benovic at the Biological Institute, 50001 Dubrovnik, Yugoslavia.

General Comments

The people I met in Yugoslavia were extremely warm and friendly and at the

same time exhibited a high degree of technical competence in their particular fields. Almost without exception they were very limited in what they could do by the resources available to them. Equipment is either nonexistent or grossly outdated, especially the computer facilities. The modelers are forced to model only a small portion of the Adriatic at one time, since that is all their computer system can handle.

It would appear, however, that perhaps an effort of the present size may very well be adequate to support the limited aims and objectives of Yugoslavian oceanography: to support the small Adriatic fishery and to monitor, as well as model, pollution in the Adriatic.

4/22/87

Physics

A LARGE GATHERING OF SOLID-STATE PHYSICISTS

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.

The 23rd convention of the annual Solid-State Physics Conference series of the UK's Institute of Physics was held in London, and hosted (for the first time) by Imperial College. It took place on December 17 through 19, 1986. A number of industrial companies provided financial support and the UK Department for Trade and Industry gave grants to allow for the attendance of young research scientists from industry. A small exhibition provided additional funds.

Over 550 scientists attended the meetings. The majority was from the UK; foreign visitors, 8.5 percent of attendees, came mainly from Ireland, Germany, France, and the US.

The highlights of the conference were eight special plenary sessions, presented in a festive atmosphere. The rest of the program, consisting of 94 talks (31 of them invited contributions), had to be held, of course, in four parallel sessions. To make the huge program manageable, the topics were presented in the framework of "symposia." These each had three parts (sessions), and encompassed the following areas:

1. Low-temperature transport in bulk and low-dimensional metals and semiconductors
2. Disordered solids
3. Surface physics
4. Materials-physics of phase diagrams
5. Advanced semiconductor materials
6. Magnetism
7. Microfocused ion beams
8. Minitalks on general topics.

There were also 245 poster contributions (certainly too many; but special, nonconflicting showing-times were set up for these).

The majority of oral presentations were given in the symposia numbered 1 and 3, closely followed by 5 and 7.

I report below only on some of the great plenary session talks. But I have a complete list of presentations (including the posters), a 250-page book of abstracts, and a list of participants (with addresses), and will be glad to send xerox copies of selected items to interested colleagues. No proceedings will be published.

Some Special Lectures

The opening address to the conference was given by the "grand old man" of British atomic and solid-state physics: Sir Nevill Mott. Despite his advanced age, he regaled the audience with an impressive, witty, and vigorously presented lecture on the history and present status of research concerning the mobility edge. This concept was first mentioned in 1964 and became popular after 1967; it was originally defined as the energy in the conduction band of a noncrystalline semiconductor which separates the localized states from the extended states. Mott reviewed both older and current work in amorphous semiconductors and more recent work that includes mobility edge studies in metals. In this respect he emphasized that, in a-semiconductors there is no sharp edge (because phonon collisions play a dominant role), but in metals there will be a sharp edge, since electron-electron collisions become very important (and complicate the understanding). Special attention was paid to a-Si:H and the metallic a-$Nb_{1-x}Si_x$ alloys. Impurities in compensated semiconductors were also discussed. The talk ended with a brief discussion of conductivity and the mobility edge in liquid semiconductors such as Te_{1-x} Tl_{2+x} and Mn-T_e systems.

Old glory must be followed by newly acquired fame. Indeed, the second plenary

talk was given by Dr. H. Rohrer (IBM Research Division, Zurich, Switzerland), one of the 1986 Nobel Laureates in physics, the inventor of the scanning tunneling microscope (STM). He first reviewed, very clearly and impressively, the physical foundations of STM. Then he pointed out that STM has, or potentially has, three major fields of application:

- Imaging (nondestructive, reversible)
- Displacement monitoring and control (local displacement sensing)
- Materials modification (effecting selected individual atoms or molecules).

In the rest of his talk, Rohrer concentrated on the first application, imaging. He reviewed, and illustrated on beautiful slides, the now "classical" applications of STM that deal with structural, electronic, and chemical imaging of semiconductor or metal surfaces, and special studies on graphite, including new local elastic-response investigations. Next, he noted that STM imaging has a new feature if one uses it in the time domain: it allows then for diffusion studies and observation of traps. Furthermore, if the tip (which can now be fabricated to the precision of single-atom accuracy) is used as an injector, STM can be applied for local resistance measurements or for potentiometry. In general, the single-atom tips may be used as true electron and ion point-sources. Yet another possibility is the construction of an "atomic force microscope." This consists of two STM's operating back to back. In his summary, Rohrer emphasized that we can now experiment on scales so small that they are less than most relevant lengths in surface-physics and, more generally, in solid-state physics. We can work under predetermined, well-defined, chosen conditions (in air, vacuum, under water, or in electrolyte solutions) which surely are relevant not only for branches of technology such as electrochemistry but also for biology. Finally, STM allows experiments to be done exactly in locations of the materials where we want to see or do something: suitable or specific locations can be selected at will.

The lecture was delivered brilliantly and with a good sense of modesty and humor. I was touched, for example, by Rohrer's observation: "Success in research often depends on good luck alone, but we notice this only after the experiment has been done."

I must confess that Rohrer's lecture very much dispelled the doubts of those who are tempted to ask: isn't STM only one more, however superior, tool in the study of structures? Is there also "real physics" involved? Yes, there is--although it will depend on the users' ingenuity to *employ* (not only *use*) STM for frontier discoveries in physics, biology, materials science. As Professor E.A. Ash, Rector of Imperial College, remarked: with STM methodology we can "really" do things that, in the past, would have been considered "Gedanken experiments."

The third festive occasion of the conference was the bestowing of the biannual Simon Prize to Professor Ym.V. Sharvin (Academy of Sciences, Moscow, USSR). This prize was established in commemoration of Sir Francis Simon, the pioneering British low-temperature physicist, and it was first given in 1956. Interestingly enough, Sharvin, who received the prize from the hands of Lady Simon, is the third Soviet physicist who merited this international award for outstanding research in low-temperature physics. (Lifschitz and Kapitza were the two others before him.) The Simon Memorial Lecture given by Sharvin concerned itself with magnetic flux effects in disordered conductors. This choice of topic is somewhat surprising because Sharvin spent most of his rich career on low-temperature behavior of crystalline substances and turned his attention to the action of enclosed magnetic flux on the electrons in multiconnected conductors with various conductance mechanisms only about 2 years ago. He first gave a detailed historical account of the Aharonov-Bohm effect and its role in leading to quantum oscillations of the magnetoresistance. Subsequently he described the crucial experiments done at his laboratory, during which these oscillations were first observed. (Actually, earlier experiments at other laboratories, done in a different context, did also show effects of these oscillations, but were incorrectly interpreted.) In Sharvin's very simple experiments a quartz wire was coated with metal (Cd, Mg, and Li were used), suspended in a Dewar cooled to around 1 K, and placed in a longitudinal magnetic field; the variation of the magnetoresistance was then observed.

In the last part of his presentation, Sharvin talked about a quite new, recently established effect: quantum oscillations of the Mott conduction with variable range-hopping. While the theory of this phenomenon and some experimental underpinnings have been done by a variety of Western and Soviet researchers, Sharvin and coworkers observed it unambiguously in late 1986. They used a rather large network built from fully oxidized PbTe, and made the first measurements at 1.12 K.

I wish next to report on a fascinating discussion of optical nonlinearities in multiple quantum well structures (MQWS), which was given by D.A.B. Miller (AT&T Bell Laboratories, Holmdel, New Jersey). He reminded the audience of one of the most important aspects of such systems: they enable us to observe at room temperature nonlinear and electro-optic effects previously seen only at low temperatures. In addition, a new electro-absorptive effect can be studied: the so-called quantum confined Stark effect (QCSE). This has no analog in bulk semiconductors. Miller explained that QCSE can be used in self-electro-optic effect devices, which show optical bistability, linearized modulation, optical self-oscillation, and optical level shifting. Using QCSE, arrays of bistable devices have recently been constructed. More generally, Miller told the practical-minded members of the audience, MQWS's have low operating energies and are compatible with both laser diodes and with semiconductor electronics, so that they are ideal for integrated or hybrid systems of broad future potential.

Finally, I cannot refrain from referring to a not strictly scientific talk which, however, drew good attendance because of the vital societal problem it addressed. It was given by D.H. Roberts, FRS (General Electric Company plc., UK) and had the amusing title, "The Physics Industry--or Tunnelling for Profit." He discussed the role of solid-state physics in stimulating the expansion of electronics over the last 25 years and drew attention to the important relationship between physics and engineering design skill and attitudes. He promulgated the following thesis: Industrial progress is maintained by first understanding the intrinsic nature of particular performance limits and then by finding ways of climbing over--"or tunneling through such potential barriers."

Concluding Comments

Despite its distressing size, the Solid-State Physics Conference was a clear success. This was brought about by the heroic and self-sacrificing organizational work of members of the Physics and the Mathematics Departments at Imperial College, and the Solid-State Subcommittee of the Institute of Physics. I am tempted to say that English calm and custom was the seal of success. Equally surprising was the fact that very few external fiscal resources were mobilized. The fine conference center of Imperial College and the good amenities in the Physics and Mathematics Departments contributed significantly to a sense of calm and orderliness; they also allowed for good personal interactions. The interesting Kensington neighborhood of the site provided necessary relaxation in the breaks.

The next conference will be in December 1987, at Bristol.

4/20/87

A SMALL EUROPEAN WORKING-CONFERENCE ON AMORPHOUS SEMICONDUCTORS

by Paul Roman.

While the crystalline state of both inorganic and organic materials has been the subject of extensive theoretical and experimental studies for many decades, the same can not be said about an in-depth exploration of optical, electrical, and optoelectronic properties of amorphous or liquid systems. This is regrettable because it is widely acknowledged that amorphous systems may have properties for electronic and optical applications as interesting as have crystalline materials. In fact, there are indications that amorphous materials may have surprising properties that endow them with high value.

It is, perhaps, the relatively neglected area of amorphous semiconductor research which led the organizers of the annual Solid-State Conference series in the UK to have, each year, a separate, satellite meeting on amorphous semiconductors. In 1986, both the general solid-state meeting (preceding article) and the meeting on amorphous materials took place in London, permitting participants of one to also attend the other.

Here I report on the prestigious, annual meeting, "Amorphous and Liquid Semiconductors," convened from 15 through 17 December 1986 at its traditional venue, the King's College campus at Chelsea, London, Uk (formerly: Chelsea College). There were about 75 participants (including many graduate students) and 29 talks were given (five of them were invited). Most participants came from the UK (gathering virtually all experts in the field); there were also several German speakers, and even a couple from the US. The meetings were extremely informal but quite well organized and orderly. No abstracts or list of participants were made available, nor will there be a specially published proceedings book. But I have a list of all talks given (with affiliation of the speakers noted) which I would be glad to share with colleagues.

The title of the meeting was somewhat misleading, inasmuch as there was no mention of liquid semiconductors at all (save perhaps a couple of talks on glasslike structures). Otherwise, a rather broad variety of topics was addressed and I restrict my review only to mention some typical talks in a few selected areas.

Amorphous Silicon (a-Si) (General Studies)

There was overwhelming interest in this area of both undoped and doped a-Si research. The Dundee University (UK) group was represented by two contributions. In his invited paper W.E. Spear discussed the still vexing problem of transport phenomena in the electron tail states of a-Si, while F. Djami spoke about attempts to understand the conductivity prefactor in a-Si as a function of the Fermi level position.

The invited talk by W. Fuhs reported on interesting new work of the Marburg University (West Germany) researchers on recombination in a-Si.

Hydrogenated Amorphous Silicon Studies

Several additional talks on a-Si concerned more specific experiments related to both undoped and p- or n-doped a-Si:H. for example, P. Thomas (University of Marburg) elaborated on a particularly important aspect of the previous presentation given by Fuhs: he concentrated on field-effect measurements and their interpretation in relation to the conductivity prefactor in a-Si:H.

The Max Planck Institute for Solid-State Research (Stuttgart, West Germany) was represented by two talks: K. Winer reported on the investigation of band gap states in a-Si:H, while M. Stutzmann talked about reversible changes of the density of states in doped a-Si:H.

M. Hopkinson (University of Sheffield, UK) presented evidence for his conclusion that two slow radiative processes take place side by side in a-Si: H-based materials--this conclusion was based on recombination experiments.

Finally, I call attention to the presentation of J.M. Marshal (Dundee College of Technology, UK, in cooperation with the Xerox Palo Alto Research Center, California). Marshall described a study of conduction band tails in a-Si:H from drift mobility measurements. During the discussion, a sharp controversy developed between the speaker and R. Vanderhaghen (Ecole Polytechnique, Palaiseau, Paris), who earlier in the day had given a talk on a related subject.

Amorphous Arsenic Chalcogenide Systems

Another significant group of talks centered on As-S alloys, and As_2Se_3 and Si-Cd-As was also mentioned.

Metal-photodissolution kinetics (from Ag or Ag-Cu) into As-S metal/glass amorphous phases was carefully studied, with an interesting application of optical reflectivity observations. This work, done at the University of Edinburgh, UK, was presented by P.J.S. Ewen (see *ESN* 41-4:192-197 for a full article on microelectronics at the university). The photodissolution process may have important practical applications for creating negative photoresists.

A University of Glasgow-Dundee College of Technology cooperative effort chose to reinvestigate several open questions in the field of AC-conductivity of chalcogenides. In particular, the talk read by A.R. Long concerned the behavior of a-As_2Se_3 films. The so-called Dyre model of conductivity appeared to be ruled out by the measurements.

D. Wolverson, on behalf of the University of Exeter, UK, presented a study of transient photocurrents in a-As_2Se_3 under repetitive pulsed excitation. The talk described the simple experiments, developed a simple but convincing theoretical model, and pointed out good agreement. This shows, primarily, that the discretized density of states technique which the researchers employed, is useful and flexible.

Conducting Polymers

I would like to conclude this selective review by calling attention to an invited talk by S. Roth (Max Planck Institute for Solid-State Physics, Stuttgart) who fascinated the audience with his discussion of a topic that, strictly speaking, did not fit in the framework of the meeting. Roth gave an exciting general introduction in which he familiarized the audience with the basic structures and mechanisms that lead to conductivity in polymers with conjugated bonds. He described both the effects of defects in intact chains and hopping phenomena between neighboring chain-ends, as well as across "fibers" made up of a multitude of chains. The speaker also indicated already existing examples of using conductive ("metalic" as well as "semiconducting") polymers in practical devices, such as solar cells or batteries. In the second half of his talk Roth described his laboratory's experiments regarding conductivity of a variety of polymeric materials. To me, the most interesting conclusions concerned the relevance of these studies to the controversial issue of solitons in conductive polymers. He found that dark conductivity measurements

do not support the surmized presence of solitons. On the other hand, photoconductivity experiments may show some evidence; however, the drift-distance is too short for testing the crucial property of nondispersive propagation, but it is long enough to allow for soliton-switching in presumably forthcoming molecular electronics devices.

Remarks

This was a fine, civilized, and useful conference for experts in a well-circumscribed subfield of modern solid-state physics. I hope the tradition of topical meetings of this kind will stay alive.

4/20/87

News and Notes

THE EUROPEAN JOURNAL OF PERSONALITY

The European Journal of Personality, the official journal of the European Association of Personality Psychology, has just assembled its first volume. The journal, in English with German and French summaries, is published quarterly. It emphasizes studies on human individuality (as manifested in cognitive processes and motivational functioning), individual differences in personality structure, and intelligence. Research notes and book reviews also will be published. Editor is G. Van Heck of Tilburg University. Subscription information may be obtained from John Wiley & Sons, Subscription Department "C", 605 Third Avenue, New York 10158. Individual price for Volume I (1987) is $45.

William D. Crano
5/1/87

ANNOUNCING A SPECIAL CONFERENCE SESSION--HIGH-TEMPERATURE SUPERCONDUCTORS

A special session on High Temperature Superconducting Materials will be held on Friday, 25 September 1987 at the University of Warwick, Coventry, UK. It is being organized by Dr. David Dew-Hughes, Department of Engineering Sciences, Parks Road, Oxford University, Oxford OX1 3PJ, England, from whom further details can be obtained.

This session is part of the conference titled "New Materials and their Applications" being organized by the UK Institute of Physics, which will be held from 22 through 25 September 1987. However, in order to accommodate the rapid advances taking place in high temperature superconductor research, the details and format of session will be determined later than for the rest of the meeting.

Further details can be obtained from Dr. Louis Cartz, Office of Naval Research Branch Office, London, P.O. Box 39, FPO NY 09510.

Louis Cartz
5/6/87

NONDESTRUCTIVE TESTING CENTER, HARWELL, UK

The testing by a nondestructive method (NDT) of a solid to locate possible defects or to observe its microstructure needs to be undertaken by first trying a range of different techniques to find the most appropriate NDT for that particular problem. This is the great advantage of centers such as the NDT Center at Harwell (NDT Harwell) where an extensive range of techniques is available. It is this fact which makes the NDT Harwell Center so useful.

The UK National Center for nondestructive testing is located at the Harwell Atomic Energy Research Establishment (AERE). Over the past 20 years, Harwell (AERE) has diversified into nonnuclear technologies and work is now being carried out in a range of subjects:

- Environmental science and technology
- Materials science and technology
- Inspection, analysis, and characterization of materials
- Chemistry and chemical technology
- Engineering science and process technology
- Computer science and services
- Marine technology.

The nonnuclear research at Harwell is organized as a series of business centers, one of which is the NDT Center.

The NDT Center is also concerned with materials evaluation and has been very successful in working closely with a wide range of industries. The center manager is R.S. Sharpe; J.W. Sheppard is responsible for collaboration with industry. The Center's main fields of

specialization in materials evaluation and NDT (and the responsible individuals) are:

- Radiography, R. Parish
- Ultrasonics, M.G. Silk
- Magnetics, D.H. Sandersson
- Eddy current (flux exclusion scanning), C.C. Holt
- Thermography, P. Carter
- Laser technology, F.A. Wedgwood
- Acoustic emission, C.B. Scruby
- Positron annihilation, A.J. Allen.

These persons may be contacted for further information about their specialties at Harwell (AERE), Harwell, Oxfordshire, OX11 ORA, UK, Telephone No.: 0235-24141.

Some examples and methods developed at NDT-Harwell, particularly in neutron radiography and positron annihilation, are described below.

Neutron Radiography

Neutron absorption characteristics in solids are very different from those of x-rays; the mass absorption coefficients of x-rays vary smoothly with atomic number, while neutron absorption coefficients do not. This can give rise to contrast differences in neutron radiographs where none would be observed using x-rays. For example, H, Cd, Gd have very high neutron absorption coefficients and those elements such as Fe, Cr, Ni (i.e., neighbors on the Periodic Table) are sufficiently different to give contrast effects. Neutron radiography requires a neutron-absorbing fluorescent screen which is used to transfer the image onto photographic film (static method of neutron radiography) or which can be observed by a TV camera (dynamic method of neutron radiography). The use of several types of screen, including ZnS/LiF and gadolinium oxysulphide, have been tested and developed at NDT-Harwell, and this work is described by Cocking and Harris (1986). Neutron beams derived from atomic piles have high γ-ray content which can interfere with the neutron radiography; the Dido reactor at Harwell uses a filter to reduce the γ-ray content by passing the beam through a long, single-crystal filter (215-mm-long Bi). A cold neutron flux of 7×10^6 n $cm^{-2}s^{-1}$, which is found to give favorable radiographic conditions, is available at this site. NDT-Harwell has also applied image enhancement methods to aid in the interpretation of the radiographs.

The Static Method. The static method of neutron radiography with a fluorescent screen-film combination can resolve 10-μm features. Several examples of work at NDT-Harwell are given (Anderson and Harris 1979):

1. Cooling Tubes in Metals. Cooling tubes may contain residues of glues, resins, molding materials, beeswax, or other hydrogenous materials used in their production. Neutron radiography can display such residues very clearly since H has a very large mass absorption coefficient compared to most metals. Alternatively, a solution containing a Gd salt has also been used to help display the location of any blockages in the tubes.
2. Neoprene or rubber vacuum seals can be observed very clearly inside metal containers; for example, neoprene seals have been observed behind 1 m of Al.
3. Diesel oil thickness measurements with an accuracy of the order of 100 μm have been made from the absorption of the neutrons.

The Dynamic Method. In the dynamic method of neutron radiography--dynamic neutron fluoroscopy--the fluorescent screen is viewed by a TV camera (Cocking and Harris 1986; Harris and Seymour 1986). The radiographic image of a moving part can be recorded on a video recorder. NDT-Harwell uses an imaging tube with a silicon intensifier target (SIT) with a gadolinium oxysulphide-based screen. Several examples of real-time dynamic neutron fluoroscopy at NDT Harwell are given:

1. Quenching Patterns in a Cooling Tube. The inside of a red-hot tube is observed as it is slowly quenched by H_2O. The tube is of stainless steel, o.d. 12.2 mm, i.d. 9.25 mm, and preheated to 600°C. The water-steam patterns can be observed; instead of a narrow quench front as had been assumed, the front is spread over a relatively long distance along the tube and this can be seen to arise from the generated steam entraining water along the tube with the formation of water droplets over a large region of the tube.
2. Contents of Metal Boxes. In some archeological studies of metal caskets found near Saxon graves, seeds and plants are known to have been placed inside the caskets. Rotating and viewing by dynamic neutron fluoroscopy of the metal caskets has permitted the building up of a three-dimensional view of the seeds inside the boxes. The seeds stand out clear in contrast by neutron radiography; this is not feasible by x-radiography.
3. Slow and Fast Moving Changes. A plant taking up water can be studied by time-lapse neutron fluoroscopy revealing the details of the H_2O movements. The oil droplets from an oil injector in a

working engine can be observed, and the movement can be clarified by judicious use of stroboscopic effects.

In a different application involving neutron diffraction methods, Allen et al. (1985) have measured residual stresses in steel bars and steel tubes.

Positron Annihilation (PA)

The trapping of positrons at defects in crystalline materials has been studied extensively, and the physics of the phenomena is well understood. The application of PA as a NDT method to study defects in metals has been undertaken by various workers but the technique, its measurement, and interpretation are still under development. (Coleman, 1977, Hughes 1980; Corbel et al. 1984). The NDT center is investigating the application of PA for the measurement of defect densities in materials and their relationship to fatigue and failure in metals. Positron lifetime can indicate the defect cluster type, and the buildup of certain defect clusters can lead to failure of the metal specimens. NDT Harwell has been working for several years on the development and use of positron annihilation lineshape techniques to characterize and quantify plastic damage in alloys and steels. The lineshape of a positron annihilation gamma ray spectrum is sensitive to plastic damage in metals and alloys within which the annihilations have taken place.

The NDT-Harwell center has been developing a transportable system so that measurements can be made in the field. The system can measure plastic damage to $\sim$1.5 mm below the surface of most metals and alloys, and the use of a small, compact source allows a spatial resolution of $\sim$1 mm to be obtained in a survey of plastic damage variation over the surface of a component, (Allen et al., to be published). Harwell's A.J. Allen is measuring both the plastic damage and residual stress in steels to assess the service life of metal components.

Other NDT Methods

Other special activities at the NDT center at Harwell include an ultrasonic scanning and processing system (Carter, 1986) and video thermography (Reynolds and Wells, 1984). A multiclient program is being set up at Harwell for the assessment of thermal pulse video thermography for the rapid nondestructive testing of composite materials. Methods based on ultrasonic C-scan or soft x-radiography only have limited success in detecting defects in laminates or composites while thermography can reveal such defects very clearly in certain cases though the method needs further development.

Summary

The NDT center is a very active and successful operation with many fine developments in progress. The center produces a reference handbook on NDT methods, sources, and applications in the UK and this handbook is continually upgraded and reissued (Sharpe, 1985).

If further information is needed on any of these NDT techniques mentioned above, I will be pleased to respond to requests and to supply pertinent references or obtain further information.

References

Allen, A.J., C.F. Coleman, M.T. Hutchings, and F.A. Smith, "Plastic Damage in Metals by Positron annihilation Techniques," *4th European Conference on Non-destructive Testing, Sept 1987*, (to be published).

Allen, A.J., M.T. Hutchings, C.G. Windsor, and C. Andrean, "Neutron Diffraction Methods for the study of Residual Stress Fields," *Advanced Physics*, 34 (1985), 445-473.

Anderson, M.R. and D.H.C. Harris, "Engineering Application of Cold Neutron Radiography," 2 (Engineering Design Council, 1979), 387-394.

Carter, P. "The Development of Zipscan," 5 (Report National NDT Center AERE: Harwell, UK, 1986).

Cocking, S.J. and D.H.C. Harris, "Robust Equipment for Dynamic Neutron Fluoroscopy," Harwell Report MPD/NBS/304, *2nd World Conference on Neutron Radiography*, (Paris 1986).

Coleman, C.F. "Positron Annihilation--a Potential NDT Technique," *NDT International*, (Oct 1977), 227-239.

Corbel, C., P. Moser, and R. Paulin, "Annihilation de Positons-Application a l'Etude des interactions lacunes-solutes," *Annales de chimie, Science des Matériaux*, 9 (1984), 351-366.

Harris, D.H.C. and W.A.J. Seymour, "Applications of Real Time Neutron Radiography at Harwell," *2nd World Conference on Neutron Radiography*, Harwell Report MPD/NBS/305 (1986).

Hughes, A.E., "Probing Materials with Positrons," *Materials in Engineering*, 2 (Sept 1980).

Reynolds, W.N. and G.M. Wells, "Video-Compatible Thermography," *British Journal of Non-Destructive Testing*, 26 (1984), 40-45.

Sharpe, R.S. (Editor) "Quality Technical Handbook", (NDT Center, Harwell) 1985.

Louis Cartz
4/21/87

ELECTROCERAMICS--A MEETING ANNOUNCEMENT AND CALL FOR PAPERS

A meeting on electroceramics will be held from 16 through 18 December 1987 at King's College, London, UK. It is being organized by the basic science section of the Institute of Ceramics (Shelton House, Shelton, Stoke-on-Trent, UK). The topics to be covered are:

- Preparation of materials--mixed oxide and organo-metallic routes, multilayer structures, sol-gel, sputtering, and CVD preparation of thin films
- Capacitor dielectrics
- Microwave ceramics--both dielectric and magnetic
- Sensors and transducers--including pyroelectric, piezoelectric and electro-optic ceramics, thermistors, varistors, and ceramic gas sensors
- Conducting ceramics--particularly solid electrolytes.

Deadline for the submission of papers is 15 September 1987. Further information can be obtained from Dr. J.G.P. Binner, Department of Ceramics, The University of Leeds, Leeds LS2 9JT, UK, or from Dr. Louis Cartz, Office of Naval Research Branch Office, London, P.O. Box 39, FPO NY 09510.

Louis Cartz
5/6/87

INSTITUTE OF DESIGN AERODYNAMICS AT DFVLR BRAUNSCHWEIG

DFVLR (Deutsche Forschung und Versuchanstalt für Luft und Raumfahrt)-Braunschweig is located in Braunschweig, West Germany, which is approximately 100 km east of the city of Hannover near the East German border. Due to a rationalization of the activities at the DFVLR centers in the early 1970's, the "official activity" of the institute is flight mechanics although there are important activities in other areas directed from other DFVLR centers. For example, the computational fluid dynamics activity at Braunschweig takes its direction from the Institute for Theoretical Fluid Mechanics at DFVLR-Göttingen.

DFVLR-Braunschweig had its origins in the Luftfahrt Forschungsanstalt (LFA) which was founded in 1936 by Field Marshall Göring to provide technological support for the buildup of the German air force prior to the beginning of the second world war. After the end of the hostilities, Braunschweig was part of the zone of British occupation and LFA was, in fact, run as a British research establishment from the end of the war until 1948. In 1948 the British left, carrying with them what they could. In 1954 a new aerodynamics research facility was begun in Braunschweig which was called the Deutsche Forschunganstalt für Luftfahrt (DFL); in 1969 it became DFVLR-Braunschweig.

Today, 650 people are employed at DFVLR-Braunschweig in five institutes: flight mechanics, navigation and control, flight tests, structures, and design aerodynamics. My visit was to the Institute of Design Aerodynamics and in particular to the Department of Computational Fluid Dynamics, which is headed by Professor A. Das, who was my host during my visit.

The Department of Computational Fluid Dynamics consists of five scientists and four Ph.D. students from the University of Braunschweig, where Professor Das holds a joint appointment. Typical of the heads of many departments at Braunschweig, Das has close contacts with other European and US aerodynamics research organizations. In Das's case this includes NASA (Lewis and Langley), the US Army Aeromechanics Laboratory at Moffett Field, California, and the University of California, Berkeley. Das's interests are in the development of a unified, linearized theory for flow fields and acoustics and in the use of nonlinear numerical methods for the prediction of transonic flows.

In the first area, Das and his coworkers have examined the detailed kinetics of the pressure disturbances which govern both the acoustics and the aerodynamic flow fields and have derived universal relationships which describe the spatial and temporal stretching rising from the motion of the singularities. This has provided him a unifying interpretation of the behavior of distributive singularities for several classical aerodynamic and acoustics problems (Das, 1984).

In the aerodynamics area, his group has developed a new panel method based on the pressure potential formulation which simplifies the treatment of the wake in propeller flows. In both helicopter and prop-fan applications he has found this theory to give excellent agreement with experiments. For these same problems he has developed a three-dimensional Euler code which, unlike conventional panel methods, allows the effect of nonlinearities to be included. For the prop-fan problem the results of the Euler solution at subsonic Mach numbers (approximately 0.5) agreed well with a linearized theory. Das has also applied his Euler

solver to the problems of vortex generation and bursting in the flow field around slender delta wings. He reported the results at the recent Stockholm workshop, see (*ESN* 41-1:20-24 [1987]). With the assistance of Mr. Steven Sherr, an American participating in the US/German Scientist and Engineer Exchange Program, he will apply the three-dimensional Euler solver to the flow field about a complete aircraft such as the Shuttle or Hermes, or a generic fighter configuration.

References:

Das, A., "Wave Progapation from Moving Singularities and a Unified Exposition of the Linearized Theory for Aerodynamics and Acoustics," *DFVLR-FB*, Vol 84, No. 17 (1984).

Eugene F. Brown
3/9/87

PROGRESS IN THE UK LOW-DIMENSIONAL STRUCTURES INITIATIVE

About 2 years ago I reported (see *Science Newsbrief* Vol 3, No. 13, 21 March 1985) that the UK's Science and Engineering Research Council (SERC) had launched a concentrated and centrally directed effort to support the universities in the planned development of studies in low-dimensional structures (LDS Initiative--LDSI). This development program is directed by the Science Board.

In an open meeting on 16 December 1986 at Imperial College, London, Professor J.L. Beeby (Leicester University) summarized progress made so far and commented on future plans. He began by proudly pointing out that LDSI has made good progress, has an excellent international standing, and is well subscribed by industry. Since the program's beginning (about three fiscal periods ago) SERC committed over £350,000 ($600,000 at current exchange rate). For 1986-1987, the SERC contribution alone was £3.9 million ($6.6 million) (but part of this was taken off to maintain UK participation in CERN); in the next 3 fiscal years the SERC moneys put into LDSI will be £3.85, 3.75, and 3.75 million, respectively. Unfortunately, it has not yet been decided whether and how the Initiative will be continued after 1990.

There are currently over 100 scientists and advanced students in academia who receive support. In addition, the Universities of Nottingham, Cambridge, Hull, Warwick, Oxford, and Imperial College have been designated as "growth centers." Heavy equipment programs assist these centers. Oxford received a full metal-organic chemical vapor deposition facility (MOCVD); the other five centers either already have, or are to put into operation in the near future, well-equipped molecular beam epitaxy (MBE) laboratories.

The LDSI also organized a number of topical conferences for academia and industry; these were oversubscribed.

The importance SERC attributes to LDSI can also be gauged from the fact that this program receives far higher support from the Science Board than any other of the Board's programs. (For example, in 1986-1987 the computer science effort was given £1 million as contrasted with the £3.9 million for LDSI.) In fact, Beeby claimed that the LDSI's framework of funding structure is superior to those used in this area by Germany, France, or even the US--but he admitted that these other countries have considerably shorter timescales of acting upon proposals (and, often, more money, in absolute terms, for support).

The next 2 years will bring ever-widening horizons to LDSI. The new approaches will include:

- New materials-systems (IV-VI compounds, metals, dielectrics, insulators)
- More complex structures (quantum dots, pillar arrays)
- More sophisticated device concepts.

Beeby also announced that the Engineering Board is in the process of setting up a low-dimensional devices initiative (LDDI) to supplement the Science Board's LDSI. The Universities of Sheffield and Glasgow, as well as the University of Manchester Institute of Technology (UMIST) act as growth centers. Sheffield received £500,00 ($850,000) and has both MOCVD and MBE facilities; Glasgow and UMIST have MBE's. Two or three additional centers are planned. Individual research grants so far paid out amount to £500,000. It is proposed that in the next 4 years the Engineering Board will invest a total of £15 million ($25.5 million) into LDDI. Eventually, at some not yet defined time, LDSI and LDDI will merge.

The presentation was followed by an hour-long question-and-answer period from the audience of about 50 people. Enquiries were made regarding the motivation and wisdom of including (or omitting) specific topics in the LDSI framework. Further questions expressed concern regarding the distribution pattern of funds.

Paul Roman
4/20/87

THE PHYSICS COMMITTEE OF SERC REVIEWS PHYSICS ACTIVITIES IN THE UNITED KINGDOM

On December 18, 1986, Professor L.J. Challis (Nottingham University), chairman of the Physics Committee of the Science and Engineering Research Council of the UK (SERC) gave a public address in London in which he surveyed selected areas of concern as well as future development plans in the area of university physics.

He began by noting that the average age of SERC-supported physicists in academia is now 45.5 years and is still rising: by 1990 it is expected to be over 50 years. Clearly, new influx of high-quality young physicists is needed. The situation is aggravated by the fact that, according to recent government studies, 45 percent of physics departments are rated "below average" -- the worst ratio among all fields. This must lead to cuts in budgets and even closures of physics departments, which will further endanger the supply of new physicists. It must be noted at this point that SERC policy does not permit taking into account the rating of a department when a research grant is given: the only criterion is the quality of the proposal on hand. But then, if a "poor" department receives a grant via a good research proposal, SERC must guarantee that the research has proper facility and resource support. This often necessitates the allowance of extremely high (40 percent) overhead expenses. Unfortunately, fiscal forecasts indicate that this "method" can not be maintained for long.

Challis then commented on SERC's financial position in comparison with other European countries. He welcomed the fact that the number of "research studentships" (SERC national graduate student stipends) increased rapidly: it stands now at about 190 and is still rising. However, a grave problem arose: despite increased SERC budgets, less went last year into domestic physics support because $34 million more than a year ago had to go into international contributions (including CERN). (The reason for this increase was simply the substantial drop of the pound versus the leading (German and French) European currencies.) Actually, physics in the UK is now run on 40 percent less support (relative to other sciences) as it is in France and Germany. Also, UK physics output (measured by a mixture of indicators, including the number of publications) is relatively lower in relation to the output of other sciences than it is in Europe. Specifically, the number of papers published in physics is on a steady decline in the UK, whereas it is rising on the continent.

SERC believes that the remedy to these difficulties lies in the establishment of "special initiative programs." The so-far most successful of these, called Low Dimensional Systems Initiative, received $5.6 million support in 1986-1987; next comes the Molecular Recognition Initiative ($2.4 million) and then the Computer Science Initiative ($1.7 million). The next special initiative program to be started will be in "smart optics"--i.e., quantum optics, nonlinear optics, and solid-state optics. As a curiosity I want to mention that the already existing (but modest) initiative program in molecular electronics is expected to grow considerably and reach a $4.3 million SERC budget support by 1991-1992.

Challis concluded his outlook on the future by calling attention to a special development plan in the area of high magnetic fields. Cooperative efforts are now under negotiation between Oxford, Grenoble, Nijmegen, and some German centers. It is planned that Oxford will eventually have a 20-23 T facility, and several other UK universities 15-16 T facilities. A new idea is to build extremely-high-field machines which operate in a quasi-stationary mode. It appears that a UK-Grenoble cooperative effort will be launched to build a quasi-stationary machine that can produce a 100-T field for 1 s, or 60 T for 10 s. The first step will be construction of pulsed-field coils. In addition to these "dc" machines, SERC wants to assist the development of high-field NMR machines: the ideal would be a 23.5-T field at 1-GHz frequency.

I can not tell if Challis' presentation was fully representative of the directions which British physics will take in the next few years, but it certainly fascinated the 150-strong audience.

Paul Roman
4/22/87

ONRL COSPONSORED CONFERENCES

ONR, London, can nominate two DOD employees for registration-free participants in the conferences ONRL supports. Readers who are DOD employees and are interested in a free registration to one of these conferences should write to the Scientific Director, ONRL, Box 39, FPO New York 09510.

5th International Conference on Phase Partitioning, Oxford University, UK, 23-28 August 1987.

7th International Conference on Erosion by Liquid and Solid Impact, Cambridge, UK, 6-10 September 1987.

International Symposium on Turbulent Shear Flow, Toulouse, France, 7-9 September 1987.

International Digital Signal Processing Conference, Florence, Italy, 7-10 September.

7th GAMM Conference on Numerical Modeling in Fluid Mechanics, Louvain-la-Neuve, France, 9-11 September 1987.

Engineering Materials for Very High Temperatures, Coventry, UK, 22 September.

ONRL COSPONSORED WORKSHOPS

ONR, London, can nominate two DOD registration-free participants in the workshops it supports. Readers who are DOD employees and are interested in a free registration to one of these workshops should write to the Scientific Director, ONRL, Box 39, FPO New York 09510.

Workshop on Optical Stability, Lucca, Italy, 7 August 1987.

Workshop on Turbulent Flow, Rouen, France, 11 August 1987.

* * *

ONRL REPORTS

To request reports, indicate the report number (in parentheses after the title and author's name) on the self-addressed mailer and return it to ONR, London.

Ocean Sciences

The International Symposium on Microwave Signatures and Remote Sensing, by Jerome Williams. (7-010-C) Held in January 1987 at Gothenburg, Sweden, this symposium was attended by participants from 16 countries. Discussions covered signatures from snow and ice, solid ground, ocean surfaces, and vegetation and considered systems and radar altimetry, interactions and modeling, and new methods.

Physics

German Quantum Optics Research in the Mirror of the Annual Physical Society Meeting, by Paul Roman. (7-011-C) The 51st annual convention of the (West) German Physical Society, on 30 March through 4 April, in Berlin, hosted the very large meetings of the West German Quantum Optics Association. About 130 talks were presented. Nonlinear optics, nonlinear spectroscopy, lasers, laser applications, laser spectroscopy, ultrashort laser pulses, ultrashort phenomena, quantum-effects, bistability, and chaos were the session headings. This report covers selected topics from most of these areas. The conference reflected well the work currently done in the academia of the Federal Republic.

OVERSEAS TRAVELERS

Notes on trip reports to locations in Europe and the Middle East which have been received by ONRL are reported below. For details, contact the traveler directly.

Material Sciences

Traveler: Mr. Michael M. Swisdak, Jr., Explosion Dynamics Branch, Naval Surface Weapons Center, Silver Springs, Maryland 20905-5000.

Mr. Swisdak attended the Third International Symposium on the Interaction of Conventional Munitions with Protective Structures held in Mannheim, West Germany, in March 1987. The sessions covered the following topics: soil-structure interaction, local effects, ground shock/cratering, reaction/effects, penetration/perforation, material/materials, design, shaped charges/small calibers, probabilistic methods, fragment/blast, shock, modeling/testing, modeling/blast values, mechanics of structural elements, and hardening/design.

Further information about this symposium may be obtained from the US Coordinator for the symposium: Mr. John R. Hayes, Jr., Senior Scientist, HQ AFESC/RDC, Tyndall Air Force Base, Florida 32403-6001.

Physics

Traveler: Dr. A.E. Robson, Experimental Plasma Physics Branch, Plasma Physics Division, Naval Research Laboratory, Washington, DC 20375.

Dr. Robson visited Imperial College (IC), London, in March 1987 to attend a meeting of scientists involved in a European collaborative program on z-pinch research, and to see and discuss z-pinch work at IC--in particular, to review the progress in z-pinch research at IC since his sabbatical year there ended in October 1986.

IC is the principal partner (or lead lab) in a collaborative research program on dense z-pinches funded by the European Economic Community. Other institutes involved are: Ecole Polytechnique (Paris), University of Düsseldorf, and University of Stuttgart. The program is not connected with the EEC fusion effort, and is primarily intended to foster collaboration between university laboratories in different European countries. This meeting was to review work on numerical simulation and ion-beam formation in pinches.

Of the 14 papers given at this meeting, nine were concerned with theory and five with experiment. Robson found the meeting very worthwhile, and reports that "there seems to be a number of very competent people in Europe enthusiastically engaged in z-pinch research, with the emphasis moving away from the plasma focus towards the dense linear pinch, which of course coincides with our interests at NRL."

REPORTS ON EUROPEAN SCIENCE AND TECHNOLOGY FROM OTHER COMMANDS

Information on each of the reports listed below was furnished by the activity identified by the abbreviations for that office. Requests for copies of or information about the document should be addressed to the appropriate office:

USARDSG--US Army Research Development and Standardization Group, Box 15/65, FPO New York, 09510-1500

EOARD--European Office of Aerospace Research and Development, Box 14, FPO, New York, 09510

Chemistry

Supercritical Fluid Chromatography Research, by MAJ Scott A Shackelford, EOARD. (1 p) [Report No. EOARD-LR-87-36.]

Professor Tyge Greibrokk, University of Oslo, Norway, is researching a new high-resolution separation technique called supercritical fluid chromatography (SCFC) which provides an important bridge between conventional high-pressure liquid chromatography (HPLC) and gas liquid partition chromatography (GLPC). His research seeks to define SCFC's scope of capability and to determine its potentially unique applications. SCFC uses a liquid mobile phase which is a gas liquified beyond its critical point (e.g., CO_2). SCFC can be used on organic compounds with moderate polarity and has the inherent advantage of using a mobile phase at low temperature (30°C) which provides fast transport with minimum diffusion. Pressure rather than temperature is the parametric variable used for a given liquid carrier "gas."

Progress Report on Decomposition Reactions of Laser-Initiated Explosives, an interim report by Dr. B.J. van der Meer and Dr. M.W. Leeuw, Prins Maurits Laboratory of the TNO, the Netherlands, under contract AFOSR-86-0348. (27 pp) [Report No. (none assigned); refer inquiries to MAJ Scott A. Shackelford, EOARD.]

In this progress report emission spectra of the primary explosives lead azide (LA), silver azide (SA), lead styphnate (LS) and mercury fulminate (MF) are presented. The metal atom, freed in the decomposition process, is the predominant emitting species. In the emission spectrum of MF the radicals CN, OH, and C_2 have been identified too. No influence of the two laser wavelengths used (193 nm and 248 nm) on the presence of reaction intermediates has been observed. In the case of MF the total (time-integrated) emission intensity of CN and of C_2 as a function of the distance z between the sampling volume and the sample surface does not show a competition effect. For LS, lead particles have been detected as far as 100 mm from the surface of the sample; the total emission intensity is most intense at z=60 mm. The time-resolved intensity of the Pb-emission in LS is shown not to be "bell-shaped," but to have structure which might give information about the history of the explosion. Finally, the influence of the laser wavelength on the induction time has been examined, as have the change in the induction time as a function of the energy of the laser pulse and of the pressing force applied to the samples before initiation.

RARDE/Waltham Abbey Reorganization and Propellant Research Activities, by MAJ Scott A Shackelford, EOARD. (7 pp with 7 attachments) [Report No. EOARD-LR-87-38/LRC (distribution limited to US agencies only).]

The UK's Royal Armaments R&D Establishment (RARDE), Waltham Abbey (called PERME until 1977) was drastically reorganized in 1984. RARDE/Waltham Abbey and some Westcott personnel are now combined into one group of two divisions and continue R&D activities in propellants, energetic materials chemistry, and combustion. Work is being conducted in the development of an electrolytic cell gas generator, in evaluating a new synthetic technique for the novel simultaneous introduction of $-NO_2$ and $-ONO_2$ groups into aliphatic organic compounds, and in composite rocket casing concepts.

Synthetic and NMR Spectroscopic Investigations of Fulvenes and Fulvalenes, by MAJ Scott A. Shackelford, EOARD. (4 pp) [Report-LR-87-03/LRC.]

Solid polymerization of a special "push-pull" diacetylene monomer compound class is proposed by Professor Markus Neuenschwander, Head, Institute for Organic Chemistry, University of Bern, Switzerland. Neuenschwander and his group have extensive experience in the study of highly conjugated aliphatic compounds, especially with the cyclic fulvene and fulvalene compounds. He and his group were also the first to synthesize a special class of electronic "push-pull" eynamine-type diacetylene monomers several years ago. He plans to use past experience with these conjugated systems to synthesize properly oriented, stacked "push-pull" diacetylene crystals for subsequent solid-state polymerization. This could produce a highly oriented conjugated solid polymeric network which may possess a low activation energy in optical absorption and electron transport processes. The fundamental molecular parameters necessary to produce the appropriately oriented diacetylene stacked crystal orientation as a function of optical absorption and electron transport properties will be characterized.

Tailored Monodispersed Particles and Sizes, information gathered by MAJ Scott A. Shackelford, EOARD. [There is no report for this abstract. Additional information can be obtained by contacting MAJ Shackelford.]

A faculty member at the Norwegian Institute of Technology, University of Trondheim, Norway reports that a colleague has developed a unique capability for producing monodispersed particles in a terrestial environment. Professor John Ugelstad has developed a very precise technique for producing monodispersed particles of any size in his Industrial Chemistry Institute Laboratory at Trondheim. While NASA claims a zero-gravity environment is needed for accomplishing this, Ugelstad's method reportedly produces monodispersed particles of various sizes as good as those made in a zero-G space environment.

Material Sciences

Wide-Span Lightweight Space Frames, by LTC James G.R. Hansen, EOARD. (5 pp) [Report No. EOARD-87-23.]

An infinite polyhedral lattice (IPL) concept has been devised by the Architecture Department of Technion, Israel Institute of Technology, for design and construction of wide-span, lightweight space frames. IPL space frames, consisting of a series of hyperbolic envelopes, have a very low density of edge bars and vertex joints. Used as roofs in aircraft hangers, free space three to four times today's conventional structures are attainable. Large SDI space structures utilizing IPL frames could be made significantly lighter and stiffer than conventional structures.

Protective Structures Research, by LTC James G.R. Hansen, EOARD. (3 pp) [Report No. EOARD-LR-87-06/LDS.]

Protective structures R&D in Norway occurs at the Norwegian Defense Construction Service (NDCS) and the Norwegian Defense Research Establishment (NDRE). NDCS is similar in function to the US Army Corps of Engineers. Very-small-scale blast tests are performed in-house, while larger scale and full-scale tests are performed on the contract under the supervision of NDCS. NDRE, Norway's in-house R&D Center for the entire Ministry of Defense, performs additional research.

Fortified Structure Testing in Sweden, by LTC James G.R. Hansen, EOARD. (4 pp) [Report No. EOARD-LR-87-18/LDS.]

The Research Department of The Royal Swedish Fortifications Administration is performing tests to evaluate effects of mechanical weapons effects on fortified structures. Test facilities include a uniquely capable long-duration, large-pressure shock tube for nuclear weapons effects simulation. Test programs include testing and evaluation of mobile C^3 shelters, doorless aircraft shelters, underground personnel shelters, protective doors and steel-fiber-reinforced shotcrete.

Deformation and Strain Measurements at Very High Temperature, by LTC James G.R. Hansen, EOARD. (3 pp) [Report No. EOARD-LR-87-19/LDS.]

Electronic speckle pattern interferometry (ESPI) and moire interferometry have been used at the Norwegian Institute of Technology to measure the deformations of white-hot objects. To date, moire measurements of in-plane deformations, that can be used to determine stresses, have been made up to 1300°C. ESPI measurements of out-of-plane deformation have been made beyond 2000°C. Air currents due to the high temperatures were not found to be a considerable problem. To go to higher temperatures with ESPI, a YAG pulsed laser is now being incorporated into the experiments. Cracks in ceramic objects have been measured at room temperature, but will be made at higher temperatures in the future.

Ceramic Components Research in Sweden, by LTC James G.R. Hansen, EOARD. (4 pp) [Report No. EOARD-LR-87-07/LDS.]

The Swedish Institute for Silicate Research (SISR) has been cited by the Swedish National Board for Technical Development as the leader in Swedish R&D in ceramic composites. The modest, 3-man-year effort at SISR is mainly concerned with whisker-reinforced ceramics. Very little work has been done on continucus-fiber-reinforced ceramics. SISR research concentrates on fabrication techniques required by industry. Two patented SISR-developed processes (rate-controlled extraction for injection moulding and nitriding pressureless sintering) developed for monolithic ceramics have been applied to whisker-reinforced ceramics.

High-Strength Concrete Research at the Norwegian Institute, by LTC James G.R. Hansen, EOARD. (4 pp) [Report No. EOARD-LR-87-05/LDS.]

Research within the Cement and Concrete Research Institute at NTH has led to development of high-strength concrete (cube strength of 115 MPa) that is now processed in bulk quantities (1 to 3 m^3 mixes). A new, multimillion dollar research effort concentrates on developing design procedures for high-strength concrete and on further strength increases. Research has also led to wet shotcreting with steel-fiber-reinforced concrete. Within the Road Technology Division, laboratory and field tests of asphalt with an advanced binder (Novophalt) have recently been concluded for the Norwegian Defense Construction Service.

Meteorology

The Morphology of Broken Cloud Fields Over Ocean and Land Surfaces Using LANDSAT 4, by Joachim H. Joseph, Tel Aviv University, Israel, under contract AFOSR-86-0174. (25 pp) [Report No. EOARD-87-3.]

Forty-one LANDSAT 4 quarter scenes have been checked in detail as to their suitability for cloud field analysis. Three scenes have been returned for exchange, and in the case of two "scrounge-type" scenes (early data), additional software has to be written before analysis is possible. All programs developed for analysis of LANDSAT 3 scenery have been transcribed to the new applications. In addition, new programs have been developed for analysis of the IR band (Band 6). Results in the visible bands are almost identical to what was presented in the final report on the previous grant (Joseph, 1986 AFOSR-83-0239). Results in the new IR band are different. Clouds are smoother, with less small detail. When images are compared with the visible bands, small clouds tend to be either joined to larger ones or to have disappeared. This general result affects all others as outlined in the report. The determination of height using the IR band has been attempted and depends crucially on the calibration. A study is underway to develop a multispectral scheme for the determination of the height. All 41 available LANDSAT 4 scenes will be analysed in the next 6 months. It is not expected that the final conclusions will be much different from those reported here.

Mechanics

Turbomachinery Research at Oxford, by LTC Robert C. Winn, EOARD. (2 pp, with attached 8-page report) [Report No. EOARD-LR-87-28.]

One of the best turbomachinery research groups in the world is working at Oxford University. Under the direction of Professor Don Schultz, they have published prolifically on experimental turbine aerodynamics and heat transfer. Highlighted in this report are their superb turbine blade construction facilities, a technique for determining temperature distribution on a blade using liquid crystals, and a description of their new rotating cascade test facility. In addition, a paper recently released for publication describing work done over the last 5 years on turbulence scale effects is attached.

CFD at Brussels Free University, by LTC Robert C. Winn, EOARD. (1 p, with two attached reports--6 pp and 8 pp) [Report No. EOARD-LR-87-29.]

Professor C.R. Hirsch from Brussels Free University is one of the world's leaders in the development of fast code for 3-D Navier-Stokes solutions. He has developed a method of diagonalizing the problems along pressure gradients and shear stress tensors which yields much greater accuracy and faster convergence. This report consists of a brief discussion of his work and copies of two recent papers on the method.

Physics

Research on Silicon Technology in Italy, by Dr. D. Eirug Davies, EOARD. (3 pp) [Report No. EOARD-LRE-87-20.]

Investigations pertinent to the scaling of silicon device technology are being pursued both at the University of Catania and the Lamel Institute, Bologna. A defective region often found beyond implantation-created amorphous layers can now be understood in terms of partial recrystallization induced by the dopant ion beam itself. In a study of shallow boron implants, which are notoriously prone to channeling with corresponding deeper junctions, chlorine is being used for pre-amorphizing implants. A rather unusual investigation of low-dose gold implantation is being conducted for lifetime control in power devices. Carrier mobilities also appear to be less than anticipated in very heavily doped arsenic layers.

New Laser Institute in Stuttgart, by Dr. S.S. Lazdinis, EOARD. (2 pp) [Report No. EOARD-LR-87-13/LRL.]

Institut für Strahlwerkzeuge is the new industrial laser applications institute recently established in Stuttgart. It is a joint venture between the University of Stuttgart and DFVLR and will be physically located on the University's campus in Pfaffenwaldring.

Changes at DFVLR Stuttgart, by S.S. Lazdinis, EOARD. (4 pp) [Report No. EOARD-87-14.]

DFVLR Stuttgart is reorienting its laser R&D work. It has terminated or is phasing out most of its long-standing pure research in CO and CO_2 gas dynamic laser systems. In the future the institute will stress the manufacturing, materials processing, and industrial applications aspects of laser development.

Fluoride-Based Color Center Lasers, by S.S. Lazdinis, EOARD. (2 pp) [Report No. EOARD-LRL-87-16.]

Professor Hans Paus of the 2. Physikalisches Institut of the University of Stuttgart specializes in fluoride-based color center lasers. He has recently demonstrated tunable laser action between 855 and 965 nm using KMgF doped with Pb^{2+}.

Vg Semicon UK Oxygen Implanter, information gathered by Dr. D. Eirug Davies, EOARD. [There is no report for this abstract. Additional information can be obtained by contacting Dr. Davies.]

Dielectrically isolated silicon is required in preference to bulk silicon for radiation hardening. Buried oxide formation through implanting oxygen into silicon is considered one of the more promising approaches for providing the desired material. Several orders of magnitude more ions have to be implanted than is presently done by doping implanters, and Vg Semicon of East Grinstead, UK, is one of the two companies currently developing high-current oxygen machines. The use of an r.f. ion source, long abandoned in doping implanters, circumvents the problem of oxidizing filaments, and the oxygen ions are extracted as seven adjacent beams. Up to 80 percent of the beam is singly ionized oxygen, and to date 55 percent of the extracted beam reaches the silicon target. Sputtering from the nontransmitted beam is significant and requires the use of internal quartz or silicon coating to prevent contamination. The prototype machine is designed as a test vehicle with features beyond the requirements of a commercial system, and the huge 2.5-meter target chamber is yet to be retrofitted with an automated wafer loader. It is currently being operated up to 150 MA with the wafers provided for evaluation as part of the UK Alvey Program.

TECHNOLOGY ROUNDUP--ITALY

The items below were received from the American Embassy in Rome. For further information, contact Dr. Gerald Whitman, Office of the Science Counselor, American Embassy, Rome, APO New York 09794-0007.

Italy Encouraging Research. Minister for scientific research, Luigi Granelli, told the chamber of deputies that the 1987 financial law provides L15,000 billion (about $11.5 billion) for research, a 30-percent increase over 1986. About L1200 billion will go for national research projects on biotechnology, new materials, fine chemicals, and for participation in international projects such as EUREKA. Granelli said that Italy aims to allocate 3 percent of its GNP to research by 1992. In other developments:

- The minister of treasury is offering a 1-percent discount on the interest rate on government "easy term" loans to industry for scientific research. The interest rate drops from 5.5 percent to 4.5 percent.
- The government approved 170 applications from industry totalling L5.7 billion to purchase high-technology machinery worth L22 billion. Thus far the government has provided a total of L457.7 billion to industry under the 1983 program to facilitate the acquisition of high-technology machinery.

Mapping the Human Genoma. Nobel Laureate Renato Dulbecco has accepted the offer of the Italian National Research Council to coordinate Italian research on the mapping of the human genoma. Dulbecco estimates the project will require 10 years and cost $1 billion. The Italian national research council has established a "strategic project" for the research and is allocating initially L20 billion (about $5.3 million) and 75 to 100 man-years.

New Center for Theoretical Biology. A new international center for theoretical biology has been inaugurated in Venice. The center will apply mathematical models to experimental biology results, utilizing computerized techniques to study gene and protein molecule structures.

Research in Bioengineering. Several universities in Italy have initiated research in bioengineering with a total investment of L35 billion per year (about $2.8 million). Bioengineers are studying the functions of the pancreas in Padua, human mobility in Milan, and researchers in the robotic division of the University of Pisa are employing molecular bionics to develop synthetic skin to supply robots with the sense of touch. They are also developing artificial tissues with a gel made with synthetic polyelectrolites to be employed in the simulation of contractions and functions of the human muscles in robots.

Research for Superconductivity. The Italian National Research Council's Institute for Nontraditional Metal Materials Technology and The Department of Physics of the University of Genoa are conducting experiments on the superconductivity of "YBCO," a compound of yttrium, barium, and copper oxides. The researchers hope to obtain at room temperatures superconducting qualities equal to those at very low temperatures. The results of the research will be presented in Pisa later this year.

"Bipol" for Biodegradable Packaging. Government experts this year will formulate the technical parameters for a 1984 government decree requiring that all commercial wrappings for products will be made out of biodegradable substances. The decree will enter into effect on January 1991. Italy produces about 92,000 tons of plastic bags and containers per year. While researchers thus far have not found a completely biodegradable plastic which does not decompose into toxic substances, the Research Center for Technological Innovation (CERIT) believes the chemical "biopol" may be a solution. Biopol is a polymer used in medicine: it is biodegradable in a period of about 1 year and does not produce toxic substances.

New Center for Information Technologies. The Regional Administration of Sicily has created a center for study and applications of informatics technologies to promote electronics development in the region. The center, named CSATI, will provide technological and scientific support to the manufacturing industry and will develop research programs in the fields of informatics, telecommunications, and electronics systems for technological innovation of the island's industry. Numerous national industries are underwriting the creation of CSATI.

Recording and Duplication Holograms. The Center for Information Studies and Experiences (CISE) of Milan has developed an industrial system for duplicating and recording optical holograms. The resulting quality of the images and the number of copies obtained is high, making possible a decrease in printing costs.

R&D in Gallium Arsenide. CISE and the Italian Factory for Radioelectric Appliances (FIAR) concluded a 3-year agreement for the research and development of gallium arsenide photovoltaic cells produced by CISE for space applications. The Italian National Space Plan will finance the project, which is aimed to define a pilot line for the manufacturing of the cells on an industrial basis.

A Laser System for China. In 1986 CISE supplied to the China Nuclear Energy Corporation a laser system developed by CISE with technical support from the Italian Agency for Nuclear Energy (ENEA) and participation of Chinese technicians. The laser system is employed for diagnostic measurements of the plasma generated by a Tokamak in tests for controlled nuclear fusion. The laser system was provided under the agreement for scientific and technological cooperation between ENEA and the Chinese Ministry of Nuclear Industry.

MARCH AND APRIL MAS BULLETINS

The following *Military Applications Summary (MAS) Bulletins* were published by the ONR, London, Military Applications Division during March and April. The *MAS Bulletin* is and account of accomplishments in European naval research, development, test, and evaluation. Request copies of the *Bulletins*, by number, from ONR, London.

Number	Title
11-87	Aircraft Laser Warning Receiver
12-87	Submarine Automatic Cathodic Protection System
13-87	First Quarterly Index 1987
14-87	A Cost-Effective NOAA Satellite Imager Receiving and Processing System
15-87	Office of Naval Research, London (ONRL) Branch Office--More Than Just Pink Sheets
16-87	Compact Towed Array Sonar System (COMTASS)
17-87	SPRITE--A Remotely Piloted Helicopter
18-87	Highlights and Papers of the Sixth International Conference on Remotely Piloted Vehicles (RPV)

CHANGE REQUEST
NAVEUR-ONR-5605/1 (Rev. 3-85)

FOR YOUR CONVENIENCE . . .

Government regulations require up-to-date distribution lists for all periodicals. This form is provided for your convenience to indicate changes or corrections. If a change in our mailing lists should be made, or if you want any of the ONRL publications abstracted in this issue and listed below, please check the appropriate boxes. Fold on dotted lines, being sure our address is on the outside, tape or staple the lower edge together, and mail.

1. ☐ CHANGE OR CORRECT MY ADDRESS EFFECTIVE IMMEDIATELY OR (date)
2. ☐ DELETE MY NAME FROM DISTRIBUTION LIST
3. ☐ PLEASE SEND ME THE FOLLOWING ONRL PUBLICATIONS

Corrected or New Address

☐ 7-010-C
☐ 7-011-C
☐ 5-5
☐ 11-87
☐ 12-87
☐ 13-87

☐ 14-87
☐ 15-87
☐ 16-87
☐ 17-87
☐
☐

Fold Here

Fold Here

FROM:

_____

_____

_____

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO 12503 WASHINGTON DC

POSTAGE WILL BE PAID BY DEPARTMENT OF THE NAVY

Commanding Officer
Office of Naval Research, Branch Office
Box 39
FPO New York 09510-0700

DEPARTMENT OF THE NAVY

OFFICE OF NAVAL RESEARCH
BRANCH OFFICE
BOX 39
FPO NEW YORK 09510-0700

OFFICAL BUSINESS
Penalty for Private Use, $300

APPLICATION TO MAIL
AT SECOND-CLASS
RATES PENDING

L IN

END

8-87

DTIC