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The European Science Notes Information Bulletin (ESNIB) is a compilation of reports on recent developments in European science of specific interest to the US R&D community, and is issued in support of the mission of the Office of Naval Research Branch Office, London. It is not intended to be part of the scientific literature. The value of the Bulletin to Americans is to call attention to current activity in European science and technology and to identify the institutions and people responsible for these efforts. ESNIB authors are primarily ONRL staff members; other reports 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. US scientists travelling in Europe may also be invited to submit reports.

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ESN INFORMATION BULLETIN

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This publication is approved for official dissemination of technical and scientific information of interest to the Defense research community and the scientific community at large

Commanding Officer ..... CAPT Terry J. McCloskey, USN
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ACOUSTICS

Research at the Bruel and Kjaer company and at the Technical University of Denmark is reviewed. B&K's work includes refinement on the measurement system – the Spatial Transformation of Sound Field System – and applications of that system. The university's Industrial Acoustics Laboratory studies in machinery-generated noise, medical applications, and underwater sound are also discussed.

BIOLOGICAL SCIENCES

The author discusses the work of Fritz Strack and Norbert Schwarz of West Germany's University of Mannheim in which they have striven to understand the reasons behind the lack of correspondence in survey results between objective and subjective quality of life indicators. He then discusses the more general consideration of the ways in which the outcome of a survey can be unfairly influenced by extraneous factors.

INFORMATION SCIENCES

The 8th Avignon International Workshop on Expert Systems and their Applications is reviewed. In particular, selected contributions in the area of Artificial Intelligence applications, presented within a specialized conference "AI and Defense," are described.

MATHEMATICS

Work in three research centers – units of the Ecole Nationale Supérieure des Mines de Paris (ENSMP) – is discussed. Studies at the Center for Applied Mathematics include work for flexible structures, real-time control and robotics, and informatics. The Energetics Center has developed a large series of computer codes for use in energy conservation. The Materials Formation Center is working on application of finite element methods to metal forming, and development of software for practical applications of artificial intelligence.

OCEAN SCIENCES

A brief review is given of the Greenland Sea Project (GSP) with particular attention to participation of Professor Preban Gudmansen from the Electromagnetic Institute at the Technical University of Denmark. A synopsis is given of the scientific objectives of GSP with an outline of the international scope of the project from a funding and participation perspective.

A short synopsis of the 1988 International Geoscience and Remote Sensing Symposium (IGARSS) held in Edinburgh, UK, is given. Particular attention is given to synthetic aperture radar (SAR) projects in the Arctic. The symposium title was "Remote Sensing – Moving Towards the 21st Century."

PHYSICS

The 15th annual conference on plasma physics was held in July 1988 at the University of Manchester Institute of Science and Technology. Topics included magnetic fusion, inertial fusion, basic plasma physics, and astrophysical plasmas. The papers, 37 in all, are briefly summarized.

CIRP4 was a huge, well-organized, broadbase international conference on practically all basic (and some applied) aspects of infrared science. Apart from a general overview, this article gives a review of papers in the area of nonlinear optics.

At an international symposium on symmetries, near Bregenz, Austria, a special 1-day session was dedicated to nonlinear phenomena, especially to the use of algebraic methods and symmetry considerations suitable for dealing with nonlinear systems.

The Rutherford-Appleton Laboratory is the host establishment of the UK's Central Laser Facility, a nationwide center for advanced research and research facilities. The facilities and ongoing research at this world-class laboratory are briefly reviewed.

SENSORS

The presentations given at the Second European Workshop on Low-Temperature Devices for Detection of Low Energy Neutrino and Dark Matter are discussed. The topics are: the motivating experimental needs and theory for low-temperature detectors, superconducting tunneling junctions, superheated superconducting granules, low-temperature bolometers, and other detectors and topics.

This report focuses on and briefly discusses Siemen's main line of sensor research – intelligent MOS-sensitive sensors and chemical sensors for liquids and gases.

SUPERCONDUCTIVITY

The presentations at this conference, held in February 1988 at Mauterndorf, Austria, are discussed. The topics include: materials-structures, mechanisms, critical fields and currents, and films-wires. The meeting was devoted to recent developments in ceramic superconductors.

NEWS, NOTES, AND ABSTRACTS

ACOUSTICS

Acoustic Research Activity in Denmark

by David Feit. Dr. Feit is the Liaison Scientist for Acoustics and Mechanics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He is on leave until January 1990 from the David Taylor Research Center, where he is a research scientist in the Ship Acoustics Department.

Introduction

Despite its small size and population Denmark has a relatively large amount of research activity going on in the field of acoustics. This is due in no small part to the presence of two institutions of worldwide fame, Bruel and Kjaer Instruments, Inc. (B&K), and the Industrial Acoustics Laboratory (IAL) of the Technical University of Denmark (TUD), both of which I visited in May 1987. There are, of course, other activities engaged in acoustics research in Denmark, but these were not visited during this trip – I will report on them after I have visited their facilities. Information on B&K and the TUD facilities has already been given in earlier editions of this publication. Therefore the information in this article can be considered as an update to that previously reported information (*ESN* 34-11:311-312 [1980]); *ESN* 38-6:325-327 [1984]).

Bruel & Kjaer (Manufacturers of Acoustic Instrumentation)

B&K is a world-famous manufacturer and distributor of precision acoustic measurement, recording, and analysis equipment. The company was founded shortly after World War II by three individuals, two of whom, Per V. Bruel and Viggo Kjaer, still participate very actively in the operation of the company. P.V. Bruel, a fellow and member of the Acoustical Society of America, attends society meetings and continues to direct the worldwide sales operations, while Kjaer plays a large role in formulating company policy and directing plant production. The company is located in Naerum, Denmark, which is about 15 miles north of Copenhagen, and has a work force of more than 2200 employees, most of whom work in Naerum. The company has offices in 20 countries and representatives in more than 50 others.

During the first part of my visit, I was given a tour of their extensive manufacturing facility. Essentially the plant produces all the necessary parts that go into their products, from the circuit boards controlling the recording and analysis equipment, to the mounting of the thin-film members forming the active part of their microphones. These parts are then assembled into the final products, calibrated, and individually quality control tested before the product leaves the factory. It is interesting to note that during the tour I saw a batch of One-Third Octave Filter Analyzers and the associated Graphic Level Recorders being assembled. This system is probably one of the original and most successful of the company's products. More than 98 percent of the company's production is for export, and, according to a company spokesman, B&K's foreign sales contribute significantly to Denmark's balance of trade.

Spatial Transformation of Sound Field System. In recent years B&K has moved into the digital signal analysis field. In fact the primary purpose of my visit was to learn about and help to assist colleagues at the David Taylor Research Center (DTRC) evaluate the utility of a new sound measurement system that is being promoted by B&K. This tool, the Spatial Transformation of Sound Field System (STSF), has been developed in response to research and development engineers in the automotive industry who desire to make measurements close to the source, and from these measurements project the sound field to points further removed as well as closer to the body. B&K already produces measurement systems that can determine the acoustic intensity map corresponding to a particular source configuration. But since intensity represents the net energy flux at any point averaged over the period of a time cycle, phase information between measurement points is lost and the possibility of projecting the information to other points becomes difficult.

The present system measures the pressure or velocity over a set of points in a planar surface. From these measurements one can determine the cross-power spectral density matrix between the measurement points and a set of reference points. This information contains both amplitude and phase information between the measurement points, assuming stationarity of the controlling sources at least within the total time interval of the measurements. If the number of uncorrelated sources is small, at least less than the number of reference measurement points, the cross power-spectral density matrix previously determined is rank deficient. This means that the required cross-power spectral density matrix can be constructed from a relatively small number of linearly independent columns. The Helmholtz integral representation of the radiated pressure is then used to calculate the far field sound pressure field from the above

information. With some slight modifications the measurement data can also be used for acoustic holography reconstructions using the Maynard-Williams approach (Williams and Maynard, 1980). The system improves upon the usual holographic reconstruction in that it can be used not only for broadband sources, but uncorrelated sources as well.

The instrumentation required to make measurements of the above type include the following: transducers, a two-channel cross-spectrum analyzer, controller for automated scanning, and a mini- or microcomputer for data storage, processing and graphical and numerical output. Currently the software has been developed for the HP 1000 and the VAX/microVax computers.

Applications of the STSF System. Up to the present time the principal applications and uses have been made by the automotive industry. In principle the system can also be used for measurements in water, although no such applications have been reported. The David Taylor Research Center is currently considering the purchase of such a system. This system, like some other measurement tools, offers promise of providing another visualization of the sound fields generated by complicated source configurations. Further experience with a variety of visualization techniques will inevitably lead to the development of improved noise control techniques.

Technical University of Denmark

From the B&K factory in Naerum it is only a short ride (less than 5 miles) to the Technical University of Denmark (TUD), a large modern campus in Lyngby, another suburb of Copenhagen. This campus was constructed in the 1960's and now accommodates close to 5000 students in a variety of technical disciplines. Students enter at about the age of 19 and embark upon an education program that takes from 5 to 7 years. The university offers the M.Sc. degree and to a small number of candidates moving on, the Ph.D., which usually takes 3 more years to complete. There are 70 full professors and a total staff of about 1400. Most of the funding for the university comes from the Ministry of Education (about 90 percent), with the remaining funds coming from grants and contracts from private industry, the European Economic Community, and the Ministry of Defense.

Industrial Acoustics Laboratory. The university's Industrial Acoustics Laboratory, headed by Professor Leif Bjorno, is part of the Institute of Manufacturing Engineering, which was organized and founded in 1984 as a separate entity within TUD. Besides Professor Bjorno there are two other professors in the institute and a faculty of 120 members. The institute is devoted to education and research and is organized into three groups: one considers the mechanical aspects of the manufacturing process, such as milling and shaping; the second, to laser processing and cutting using computer-integrated manufacturing to improve production and processing; while the third stresses the application of acoustics to the manufacturing process.

My visit to TUD was spent with Bjorno and several members of his staff. There are currently nine students pursuing degrees in acoustics; six seeking the M.Sc. degree and three the Ph.D. The staff of the Acoustics Laboratory is 25, about half of whom are degreed professionals. Because of involvement of the laboratory with other research institutes in cooperative projects, the effective staff is even larger, making for a highly leveraged acoustic research and development effort in Denmark. The acoustic research activities generally fall within four categories. These are: machinery noise, medical applications, sensor development, and underwater sound.

Machinery-Generated Noise. One of the more active areas is that of machinery-generated noise and vibration. This is particularly important in maintaining the contact with industry which is so vital to the economic well-being of the Institute of Manufacturing Engineering. This institute, in contrast to the remainder of the university, receives the majority of its funding from private industry. Peter Nohr Larsen is Bjorno's principal assistant in this area. He teaches the basic courses in machinery noise radiation and supervises graduate students doing thesis work in this area. In fact he has just completed a two-volume set of notes on this subject. Some of the projects in this area are: noise from machine tools, vibration monitoring of machine tools, hydraulic pumps as noise sources, and flow noise generated by windmills.

For the project on hydraulic pump noise a student is doing measurements to determine which of the pump components are the primary noise makers. At the present time the student is trying to determine whether the noise is transmitted to the enclosure walls by the waterborne path or by the structural path connecting the pump to the walls. In parallel with experiments the student has generated a statistical energy analysis (SEA) model of the pump and the coupling of structureborne and waterborne noise to the walls of the enclosure to help diagnose the noise problem.

Medical Applications. The medical applications of acoustics is another area in which there is much activity. Bjorno had just returned from the US where he had presented an invited talk at the Seattle meeting of the Acoustical Society of America on the use of lithotripsy in the treatment of kidney stones (Bjorno, 1988). The lithotripter is a device that makes use of the deleterious effects of acoustic energy in a medically useful manner. The cavitation region produced by a focused shockwave causes the breakdown of kidney stones. The debris is then removed through a syringe, thus providing a noninvasive treatment of kidney stones.

There are two mechanisms in use to generate the focused sound fields. One is generated by the discharge of an electric field across a spark gap focused by an ellipsoidal reflector while the other is based on the field created by piezoelectric disks situated on a hemispherical or ellipsoidal surface, which focuses the sound field. The latter mechanism is being researched and developed for a second generation of lithotripters, and is being conducted as a cooperative venture with NITEK, a Danish institute for product development. Prototypes of the devices are tested at nearby research and teaching hospitals and the Danish Institute of Biomedical Engineering.

In another medically related project, the medical ultrasonics group is studying the use of ultrasound to discriminate between healthy and diseased tissues. This is done by measuring the nonlinearity parameter of the tissue. This parameter is related to the sound speed and the attenuation factor of the material, and is thought to be different for different states of the tissue. When a high-intensity sound wave is passed through tissue, the sound wave becomes distorted as a result of the generation of harmonics and subharmonics of the wave by the nonlinearities in the propagation process. These measurements, to be useful, must be made both *in vivo* as well as *in vitro*. This same group in the past has developed a number of specialized transducers to make such measurements, with sizes ranging from 0.5 mm to 15 mm in diameter.

Fiber Optic Sensors. Currently, there is some work going on in the development of fiber optic sensors. In particular, Michael Mikkelsen is developing accelerometers that use the fiber as a cantilever beam which vibrates with the body being measured and looks at the intensity modulation of the light with that from an undeformed fiber. In another design Mikkelsen employs a photoelastic material which when stressed changes the polarization of light passing through it as a detector. The advantage of such devices is that they do not generate or use electric or magnetic fields in their operation so they can potentially be used in those environments where such fields would be precluded by other considerations such as danger of explosion, etc.

Underwater Sound. The last major area of endeavor is that of underwater sound, a field which has attracted the attention of Bjorno himself for many years. Bjorno has been associated for many years with the NATO SACLANT Research Center in La Spezia, Italy, as the Danish representative to the Defense Research Board. One of his first doctoral students, F. Jensen, is a leading research scientist at this institute. Over the years Bjorno has organized a number of NATO Advanced Study Institutes. He is currently helping to organize one to be held in Cesine, Turkey, in September 1990, the subject being the "Diagnosis of Mechanical Systems Using Sound and Vibration Signals." Some recent research conducted by Bjorno in collaboration with L. Crum of the National Center for Physical Acoustics, Oxford, Mississippi, examines the noise-generating mechanism of rain as it impacts with the sea. (Incidentally, Bjorno is also on the Advisory Board to this Center.) From physical observation they have observed raindrops as they impact the sea surface and have measured the ensuing bubble sizes, which, they found, range from 0.9 mm to 1.1 mm in diameter. This correlates with the peak in the noise spectrum at 14 to 16 kHz.

There are a number of other research topics being pursued, and these are all listed, together with a short description, in an annual report issued by the institute, a copy of which I have and could make available to anyone interested.

Conclusion

Although Denmark is a relatively small country in both size and population it certainly has made its presence felt in the world of acoustics. There is probably no laboratory or institute in the world devoted to acoustics or vibration research that does not make use of B&K equipment. In addition to the analog measurement systems, B&K is now moving rather vigorously into the digital signal analysis field and no doubt the high quality and precision of its new products will help to maintain its position as a leading supplier of acoustic research measurement systems.

The TUD activities in acoustics under the leadership of Professor Bjorno continue to provide new ideas and uses of acoustic principles, but, more importantly, educates the future acousticians of Denmark in an academic department dedicated to acoustics.

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7/22/88

BEHAVIORAL SCIENCES

Asking Questions: West German Research on the Social Survey

by William Crano. Dr. Crano was the Liaison Scientist for Psychology in Europe and the Middle East for the Office of Naval Research's London Branch Office. He completed his tour and has returned to Texas A&M University, where he is a Professor of Psychology.

The survey is one of the social sciences' most powerful research tools. It is versatile, capable of being used in many contexts and, when used properly, can produce predictions of startling precision. The multibillion dollar industry that surrounds the prediction of election outcomes, supported by all the major news media and political parties, gives some indication of the power of this technique to see into the future. Of course, there have been noteworthy failures of the social survey to get it right. Probably the most famous of these, and without doubt the most heavily studied in academic circles, was the fiasco involving the *Literary Digest's* prediction, based on the responses of 10 million respondents, that Alf Landon would defeat Franklin Roosevelt by a landslide in the presidential election of 1936. He did not. In fact, Landon won 3 electoral votes to Roosevelt's 523.

It is obvious on the basis of examples of this sort that the social survey is far from infallible – but remember that this example of failure occurred more than a half century ago. Today's polls are much more likely to hit the bullseye, and to do so with the use of considerably smaller respondent samples. Failures still occur, of course, but are usually the result of an improper utilization of the technique. When samples are drawn "by the book," the survey can allow predictions of future outcomes with very little margin of error. (To learn how such margins are estimated, and the factors that determine their magnitude, see Kalton, 1983, or Crano & Brewer, 1986.)

Many people do not realize that surveys involving even national issues (e.g., presidential elections) typically make use of samples of fewer than 1000 respondents. The predictive power of the survey is thus all the more impressive. Precision is not dependent on large numbers of respondents, but upon the quality of the sampling procedures used to select them. The sampling procedures themselves are based on fundamental laws of statistical probability, and it is this foundation that provides the survey with its predictive power.

Unfortunately, the predictive potential of the social survey is maximized in relatively simple choice settings. The presidential election is a good example of one such setting, in which, in most election years, the voter realistically has to choose between one of only two viable candidates. In this circumstance, the predictive precision of the survey can be breathtaking. However, there are many situations involving social issues that do not admit to simple two-choice alternatives. One of the most interesting of these situations occurs in research focused on people's subjective estimates of their well-being, or quality of life. Issues of this sort have been commonplace in survey research for decades, at least for two reasons:

- First, social scientists have long been interested in perceptions of the members of the general population regarding the quality of their lives. How people feel, what social forces affect their lives, in short, their subjectively perceived well-being, are the stuff of which the social sciences are made. The US Federal Government, recognizing the importance of quality of life, has spent considerable sums of money in developing "social indicators" to monitor this important aspect of societal function.
- Second, there is a paradoxical lack of relationship in the research literature between subjective and objective indicators of quality of life. It is not surprising that social researchers would be intrigued with this issue, given the social importance of the issue and the lack of expected correspondence between economic indicators and subjective reports. As nature abhors a vacuum, social science is captivated by paradox.

Fritz Strack and Norbert Schwarz, from West Germany's University of Mannheim, have mounted a concerted research effort to try to understand the reasons behind the lack of correspondence between objective and subjective quality of life indicators. Not incidentally, in so doing they have also uncovered a host of interesting findings regarding the means by which survey results can be biased – or un-biased. In this report, I will discuss first the quality of life research of Strack and Schwarz, and then move to a more general consideration of the ways in which the outcome of a survey can be unfairly influenced by extraneous factors, or biased, to use the more common phrasing. Since survey research plays so ubiquitous a role in contemporary life, often serving as the basis for new legislation, changes in work environments and procedures, modifications in educational practices, etc., it is hoped that the relevance of the following discussion will

rise above that of a simple methodological tract on what is right and what is wrong with the survey approach to compiling information of social import.

Traits and Social Judgments

When economists think of national well-being, they typically focus on income, employment, and other "objective" measures of this sort. Social scientists are more likely to consider subjective reports of people's perceptions of their current status. When these two types of indicators are considered in tandem, their correlation usually is not great.

Considering the subjective measures gives some indication of why this is so. First, subjective measures of well-being usually have very low test-retest reliabilities (typically on the order of 0.40 [see Campbell et al., 1976]). Indeed, when Glatzer (1984) presented the same subjective measure twice in the same interview (an approach almost guaranteed to enhance the reliability coefficient), the test-retest correlation was improved only marginally ($r = 0.60$).

Results of this type explain the low correlation between subjective and objective measures of quality of life, since it is well established that correlations involving unreliable measures will be attenuated even if only one, not necessarily both, of the measures is flawed.

But perhaps there is more to it than mere unreliability (which in most circumstances is relatively easy to correct). When we correlate objective and subjective quality of life measures, we make the implicit assumption that the subjective measure is tapping a stable inner trait, more or less "writ in stone." But subjective measures of well-being might better be considered as belonging to the category of constructs we call *social judgments*. The distinction between social judgments and enduring traits is important. A trait is conceptualized as a stable individual characteristic, whereas social judgments are viewed as being subject to a host of transient influences. Social judgments do not "reside in the head," as do traits, but rather are created in response to specific questions -- "How well-off are you relative to 5 years ago?" As such, the circumstances surrounding the question session will influence social judgments, but not traits.

The conceptualization of subjective quality of life measures as social judgments leads to certain testable predictions, which Strack and Schwarz have developed in an ingenious program of research. One obvious "circumstance" surrounding a respondent's reaction to a question is his mood. If subjective measures are influenced by respondents' mood, then this finding provides support for the view of subjective quality of life measures as social judgments. And this view, in turn, suggests certain research caveats that must be honored when using such measures.

There is some indirect, nonexperimental evidence for the social judgment view of subjective quality of life measures. For example, Schwarz (1983) found that general life satisfaction was higher when respondents were interviewed on sunny, as opposed to rainy days. He also found during the World Cup soccer competition that reported quality of life was much higher in his sample of German respondents when Germany had won, rather than tied or lost, their match (Schwartz et al., 1984). Logically, sun or rain, and the outcome of Germany's national team, should have little to do with the quality of one's life, unless the quality of life question is taken to mean, "Tell me, in general, how you feel right now, in light of everything (and anything) that is impinging on your life." If subjective quality of life measures are taken to mean this, then it is reasonable that one would report more positive feelings on sunny days, and when one's beloved national team had achieved an important victory. And it is equally clear why such measures would not necessarily correspond with the more robust measures of GNP and unemployment, which we would not expect to be influenced by such semi-random fluctuations.

A Model

In part, measures of general life satisfaction are doomed to predictive failure because of the simple enormity of the question they pose. To ask a respondent to sammarize his life as a whole calls for the consideration of a host of comparisons along an almost innumerable set of dimensions, with poorly defined criteria (Well-off as compared with whom? With respect to what?), and the ultimate collation of "" of these comparisons into a summary score. This is not easy. However, suppose instead that the life domain was specified clearly and precisely – that is, the respondent knows exactly what part of his life we want to know about, and the particular dimensions we wish him to use when forming his judgment. We are still dealing with a social judgment, but in this circumstance, the social judgment is in some ways insulated from transient factors that reduce its reliability, and consequent validity. Two questions immediately arise in such a circumstance:

- Would such an approach enhance the reliability of the survey?
- Would the outcome of such a process relate more strongly with objective quality of life measures?

An affirmative answer seems a reasonable guess in both instances. Let's reconsider the weather-mood-quality of life research reported by Schwarz (1983). This study suggested that weather influenced mood which, presumably, influenced respondents' reports of their subjective well-being. We assume that the respondents were not aware of the weather-mood influence, and if this were brought subtly to their attention, it would attenuate the

observed weather-quality of life relationship. In a follow-up study to test this possibility, Schwartz's interviewers called their respondents, presumably from out of town, and asked before the start of the formal interview, "By the way, how's the weather down there?" When this was done, the negative effects of rainy weather on respondents' reported quality of life were eliminated. This result suggests that respondents use their current mood as an indicant of their quality of life unless the information value of the mood is called into question. Thus, asking about the weather helps to preclude the respondent's use of mood as an indicator of well-being, since in this circumstance mood is attributed to the weather instead of general life circumstances (see Schwarz & Clore, 1983).

Specificity of Comparison Dimension

Does the specificity of the dimension along which we wish the respondent to compare himself influence response quality? Again, an affirmative answer would appear to be indicated. To return to the German national soccer team, Schwarz and his colleagues (1984) found, as reported, that people reported higher quality of life scores when the team had won. However, the team's performance did not influence these same respondents' answers when they were asked more specific questions regarding their satisfaction with their work and income. In this circumstance, the general mood state was uninformative, and hence was not used by the respondents in framing their answer.

To make sense of this finding is relatively simple. Consider the difference in difficulty of answering the following questions:

- Compare your life as a whole with that of your boss, vs.:
- Compare your income with that of your boss.

The second question is much easier to handle because the dimension of comparison is clearly articulated. Schwarz and Strack argue that it is therefore much less prone to influence by external circumstances such as mood.

Cognition and the Social Survey

Such a conceptualization leads to a consideration of the mental factors that might influence the subjective report of well-being, the most obvious of these being the cognitive accessibility of the information needed to answer the question.

When we are asked a question, we do not retrieve from memory all possible relevant information. Rather, we settle on the information that comes most readily to mind, i.e., on information that is cognitively accessible. In instances involving questions that are very broad, general (and generally irrelevant) information is not only accessible, but acceptable. So, it is possible that subjective mood state will seem to the respondent to provide a reasonable indicator of overall quality of life. However, when asked to provide a more delimited judgment (of, say, income or job satisfaction), such information, while accessible, does not fill the bill, and the cognitive search is continued until more relevant data are uncovered.

Assimilation and Contrast

This theory regarding the accessibility of information and its effect on the outcome of surveys suggests that we might be able to influence responses to general quality of life issues by systematically impinging upon the mood state of our respondents; but such treatments should have no influence on more general satisfaction questions. So, the theory would hold that if we could somehow make people happy in the course of an interview, they would report greater satisfaction with their general quality of life than if we made them sad. Research has provided good support for this expectation, but it is important to understand the limits of this result, not only to enable a more clear understanding of the dynamics of the social survey, but also to obtain a better picture of the way that the human cognitive system operates.

If people are made happy *within the context of the interview*, they will report greater satisfaction on general quality of life queries. If they are made sad, they will report less satisfaction with quality of life. It is as if the quality of life response is assimilated to the good or the bad feelings induced by the mood manipulation.

However, if respondents are asked to focus on *past* events (provoking either happy or sad memories), the opposite result can be expected. That is, respondents asked to concentrate on their most glorious day will report lower satisfaction with quality of life than those asked to remember their most embarrassing moment. The comparison between those wonderful days of yesteryear and today's acceptable (but perhaps far from exhilarating) status quo seems almost bound to suffer. Such "contrast effects" are common in research on attitude change, and it now appears that they have made their presence felt in survey research as well. While perhaps troublesome from a methodological point of view, assimilation and contrast help us understand more precisely the workings of the human cognitive system, and it is this understanding, ultimately, that provides the impetus for the work of Schwarz and Strack.

The model that Schwarz and Strack have developed to detail their hypotheses, and to organize the findings in this field of research, is represented in Figure 1. As can be seen, they hypothesize that the respondent will activate one of two distinct cognitive processes as a consequence of the form of the question that is addressed to him. If the respondent is asked to make a quality of life judgment,

he will first determine whether affective information is relevant. If it is, he will equate global well-being with mood. Then, the respondent will consider whether social circumstances should be considered when reporting the judgment. If not, the global response will be a direct function of mood. If social circumstances should be considered – e.g., if good mood is a consequence of reminiscences of the good old days – then the judgment will be "corrected," and reported.

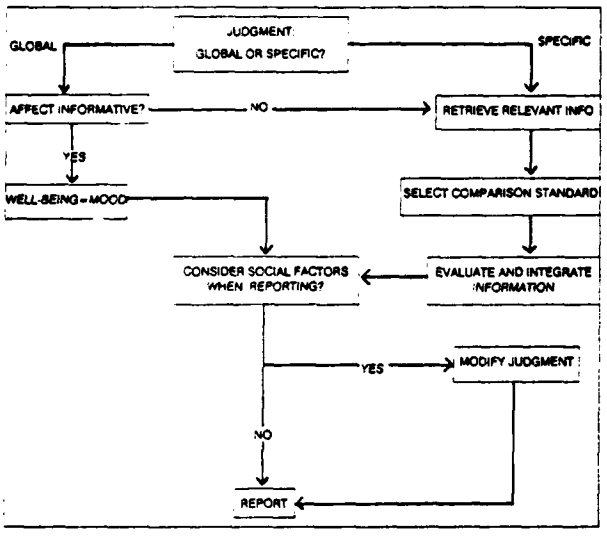

Figure 1. A model of the response process to general or specific quality of life queries.

In the case of a question that is focused on a specific quality of life feature (e.g., How does your job stack-up with that of your former college roommate?), a very different search strategy is employed. In this circumstance, the respondent will search for information that is relevant on the basis of the specific dimension requested. Evaluation will be made on the basis of this comparison, and a tentative judgment will be formed. Then, the respondent will determine whether social circumstances should be considered in modifying the judgment. If not (the usual conclusion), the judgment will be reported. If so, the judgment will be modified accordingly, and reported.

This model accords well with the research of Strack and Schwarz, and with the literature on subjective quality of life indicators in general. It is useful in that it can be employed as a springboard for future study of survey methodology, and is amenable to modification and change as the need arises. It is based on well-established findings in the literature of cognitive psychology, and as such, will expand as knowledge in this very active field continues to grow.

Cognitive Research and Survey Research

In this paper, I have outlined in a very global manner the way in which some ideas from cognitive psychology have been absorbed and used in research on the methodology of the social survey. In some ways, cognitive psychology is an unexpected helpmate for the survey researcher, because the concerns of the two fields are so widely divergent. The social survey researcher is interested in finding out what people believe, or how they (think they) feel. It is the content of their cognitions that is of principal importance. The cognitive psychologist, on the other hand, is rarely concerned with the content of cognitions, but rather with the process of cognition itself – with how people think, rather than with what they think. Despite these divergent concerns, it is clear that the application of findings from cognitive psychology can improve the precision of what is, arguably, one of the social sciences' most important methodologies.

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7/14/88

INFORMATION SCIENCES

An International Workshop on Artificial Intelligence

by Paul Roman. Dr. Roman was the Liaison Scientist for Physics in Europe and the Middle East for the Office of Naval Research's London Branch Office from September 1984 to September 1988.

For the past 8 years the one-time Papal Court seat Avignon (France) has been the locus of a late-spring convention on expert systems (ES) and related artificial intelligence (AI) topics. The "Avignon International Workshop on Expert Systems and their Applications" has become probably the largest industrial event devoted to AI applications to be held in Europe.

As were the previous get-togethers, Avignon '88 was held May 30 through June 3 with the support of the European Coordinating Committee for Artificial Intelligence (ECCAI) and the French Association de Recherche Cognitive (ARC). It consisted of a main technical conference and three, partly parallel-running specialized conferences focusing on "AI and Defense," "ES and Maintenance," and "ES and Medicine," respectively. The conferences were accompanied by a high-level commercial exhibition (over 130 exhibitors) and an "Authors' Fair." Finally, 11 tutorials preceded the congresses. All told, there were about 1900 participants from 30 or so countries – nevertheless, there was a vastly overwhelming presence of French authors and participants. Perhaps significantly, the only Communist countries represented were Bulgaria and Hungary (not counting Yugoslavia.)

The main conference consisted of 40 sessions, at each time four sessions running in parallel. (A few hour-long invited lectures and panel discussions were presented in joint plenary sessions.) The contributed papers were leisurely presented and discussed (half an hour was allotted for each). There were a total of 109 talks given in the frame of the general conference. I will not attempt to report on the entire meeting; rather, also to the exclusion of the specialized conferences on maintenance and on medical topics, I will briefly review what to me appeared to be the most interesting talks at the specialized "Conference on AI and Defense."

Artificial Intelligence and Defense

The special-topics conference on AI and Defense was attended by about 200 participants. The importance of the gathering was outwardly emphasized by the fact that, in the course of the opening session, the keynote address to the conference was given by General H. Conze, an engineer of the French Ministry of Defense, and the invited lecture ("Artificial Intelligence and Defense in the World") by Colonel J. P. Bansard of the Secretariat Général de la Défense (Paris). Among other review materials, Bansard gave a fine review of European centers involved in AI work that has defense-related aspects (i.e., almost all AI research except financial, legal, and business applications.)

The rest of the conference consisted of seven sessions in which 19 talks (of 1/2-hour duration each) were presented. The session-headings were as follows:

1. General examples of AI applications in defense
2. AI tools for defense
3. Infrared vision image interpretation
4. Pilot aids
5. C^3I (two sessions)
6. Identification problems.

To illustrate the tone of the conference, I have selected some talks from areas 1, 2, 5, and 6.

Two Examples of Naval AI Applications. P. Lloret (Aeronautics Department, SAGEM, Paris, France) talked about navigation and mission preparation/planning aids. He emphasized that even onboard tasks now use 1 Mips-class processors with the capability to process the algorithms for inertial navigation, its hybridization in Kalman filters with radio aids (such as radar and terrain contour matching), optoelectronic devices (including infrared), and image processing for landmarks; also, these new data processing systems are involved in the mission plan itself (determination of targets, obstacles, protected areas). Because of the ever-increasing sophistication of these requirements, introducing AI methodology and tools into the data processing becomes mandatory, explained Lloret. After this general analysis he presented some AI solutions for the "navigation of the future" developed at his firm. Most examples referred to aircraft and land-mobile robot navigation.

J. Bruin and J.J.C.R. Rutten (TNO-FEL, The Hague, the Netherlands) discussed intelligent decision support for warship damage control (DC). DC involves a C^2-cycle: status maintenance, damage assessment, planning of damage control activities, tasking, and evaluation. Bruin showed how complex the involved decision making processes are; they are also ill-defined, suffer from incomplete information, and depend on the DC-officer's experience. The total DC-organization can be made more effective if the quality of decision-making is facilitated by providing automated decision aids to be used along with the customary information processing and

presentation facilities. The AI tools and techniques (which are able to effectively use the knowledge about the ship, and can accept, combine, and fuse data from sensors and reports) will be particularly useful to the subtasks of damage-assessment and planning. The talk concluded with brief descriptions of intelligent knowledge-based-systems which are currently developed for assisting the DC officer.

AI Tools for Battle Management and Command Systems. An Italian group of researchers from Selenia S.p.A. (Rome), Delphi S.p.A. (Viareggio), and the Department of Informatics (University of Pisa) described an expert system for data fusion which is based on a blackboard architecture. A. Brogi (Selenia), who presented the talk, briefly summarized first how AI techniques can be used for data fusion. He then chose as a prototype a system which was designed to merge reports received from a radar and a jammer-strobe with a priority information. This system is built upon a general blackboard architecture, which has been built on top of Prolog. The blackboard architecture permits the partitioning of all domain-knowledge into cooperating modules, and keeps it separated from control-knowledge. The handling of probabilistic reasoning has been approached with the so-called Dempster-Shafer theory of evidence.

On a more general level than data-fusion, AI use in command systems presents a formidable task. D. Loye (Graphaël, Compiègne, France) pointed out that the development of large AI systems in object-oriented programing has been slowed down by the fact that so far the data had to be loaded in virtual memory. However, Graphael recently developed an object-oriented deductive database which circumvents the difficulties. This commercially available product, called G-Base, merges an object-approach (allowing for an efficient and secure storage of thousands of objects within a multiuser environment), and various logic-mechanisms (including Prolog). (The latter are used for data-access.) G-Base is available in various LISP dialects. Interestingly, the various realizations of G-Base have been developed with using symbolic machines.

Decision Support, Threat Analysis, Tactics. Several enthusiastic talks in the C^3I domain caught my attention.

The opening talk was a report of the principal investigators, M. Maleval and Ph. Oziard (Department of Informatics, Issy les Moulineaux, France, and Department of Systems Information Research, Evry, France, respectively), on the impact of AI techniques on decision support systems. The authors first clearly identified and characterized the decision aid problems met at (hypothetical) headquarters, identified the limits of current techniques, and then described the general structure of knowledge bases and ES's that can properly take into account the relevant problems. Corresponding to this mapping-out of the task, the researchers next described an architecture for building the knowledge base (they named it Arcade), and then they surveyed a special ES which supervises distributed activity (this is called Arpege). Next they discussed their command-applications-oriented man-machine interface (Armonie). Finally, they formalized proposals for a development strategy based on an incremental approach, and expanded the application of an analysis-methodology (appropriately, this they call Meta-Arcade.)

SIAM is the nickname (and, I believe, the tradename) of an intelligent system that analyzes chemical warfare risks. The research on SIAM was done on behalf of DRET by scientists at GSI-Tecsi (Paris-la-Défense, France), although two of the three principal investigators have since moved to other labs. The presenter, F. Momal explained that the SIAM expert system was developed using the AI tool called Knowledge Craft (KC) (Carnegie-Group Inc.). SIAM's end-user interface applies intensively the KC graphics package. One interesting result of using SIAM was that it demonstrated the complementarity of ES's and classical battlefield management systems. In fact, the assessment of chemical-agent risks has no classical algorithms to rely on; moreover, rules describing the use of chemical weapons cannot be easily modeled. This is why the use of advanced AI techniques becomes mandatory. To sum up SIAM's effectiveness: it was found capable to determine not only the areas of possible chemical weapon deployment, but also the type of agent used by the enemy. It may be worthwhile mentioning that SIAM was developed on the Symbolics 3620 machine, and its realization took only 17.5 man-months. Yet another acronym (like SIAM, also "derived" from the French language) was introduced by P. Bessière (Industrie et Technologie de la Machine Intelligente, Meylan, France), who called the real-time ES used for assisting the preparation and the control of air-sea missions "SEXTANT." The talk briefly described the software used for SEXTANT, and described both the difficulties of the problems involved and how they were solved. Particular emphasis was given to aspects of distributed intelligence, reasoning on large knowledge bases, and user-friendly interfaces.

Sonar Pulse Classification and Identification. A. Fron (Thomson Sintra Asm., Cagnes sur Mer, France) analyzed the difficulties that bedevil complex object classification: knowledge representation of structures and relationships, deductive processes, and data-base accesses. The system described in the talk uses the new description language OMEGA to cope with these problems. It incorporates the expressiveness of frames, power of logic-inference, and use of queries for data bases. While the primary purpose of the system was the identification of sonar pulses with the use of a data base, it clearly can be modified for solving a wide variety of identification tasks by AI techniques.

Concluding Remarks

The complete set of Conference Proceedings (including, both the general conference and the three specialized conferences, three big volumes altogether), as well as the rather detailed Exhibition Catalog may be requested from the commercial organization "EC2", attn. M.-M. Sainflou, 269-287 rue de la Garenne, F-92000 Nanterre, France. (Most of the texts are in French, with an English abstract.) On a less complete level, I have the entire program and a list of all participants (giving affiliations but not addresses). These may be requested from the editor of ESNIB by interested readers on a "need-to-know" basis. He could also send copies of the texts of talks that I referred to in this article. Moreover, provided the request is sufficiently specific, he could also copy well-defined sections from the exhibition catalog.

To conclude, I wish to point out that the Avignon workshop and the exhibition was first class and colleagues would benefit much from attending future meetings – provided they can put up with a certain degree of organizational chaos...and the exorbitant registration fee.

8/30/88

MATHEMATICS

Applied Mathematics, Energetics, and Material Forming at Three ENSMP Centers in Sophia-Antipolis, France

by Daniel J. Collins. Dr. Collins was the Liaison Scientist for Aeronautics in Europe and the Middle East for the Office of Naval Research's London Branch Office. He has returned to the Naval Postgraduate School where he is a Professor of Aeronautical Engineering.

France's National Superior School of Mines – the Ecole Nationale Supérieure des Mines de Paris (ENSMP) – is one of the Grandes Ecoles de France. Within the past 20 years some 17 research centers of the School of Mines, with some teaching functions, have been established throughout France as part of a decentralization process and also with the purpose of fostering research. Four of these research centers are located at Sophia-Antipolis in the south of France. I visited two of these centers – the Center for Applied Mathematics (CMA) and the Energetics Center. A further visit to the Material Formation Center concentrated on the finite element work and some interesting artificial intelligence (AI) work being done there. Perhaps the most interesting work that I encountered was at the CMA. I shall begin with CMA and then discuss the Energetics Center and finish with a review of the finite element and AI work at the Material Formation Center.

Center for Applied Mathematics–CMA

The Center for Applied Mathematics, directed by Dr. J. Rigault, has 17 scientific personnel, eight of whom are working for their doctorates. Within the past year five doctoral degrees were awarded to personnel at the center.

Dr. Y. Rouchaleau, the scientific counselor of the center, was my host for the visit. Rouchaleau obtained his Ph.D. in the US under the direction of R. E. Kalman, who is listed as an advisor to CMA. CMA is well supplied with computer equipment, which includes four Sun work stations and a Gould PN 9800. Further computer connections are to a Cray in Paris. Research activity is divided into two groups, the Control Group (led by Dr. Jean-Paul Marmorat), and the Informatics Group (headed by Dr. Gerard Berry). My review will consider each group in turn.

Control Group. Research in the Control Group is directed at process automatization, control of flexible structures, stochastic equations, real-time control, and robotics. Process automatization requires the modeling, identification, and control of the process. Most of this work is done under contract either directly for the industry involved or for other ENSMP centers. Typical applications include the modeling of the thermal exchanges of a building in different climatic conditions. This work, for the Energetics Center, also includes on-line simulation with recursive identification of building complexes from measured data. The modeling of the building is done by means of finite element theory, and an effort is made to use reduced-order modeling in order to save computational time. Another application has been to the modeling and analysis of a group of windmill-diesel electrical

generation machines. The first part of the study is to determine the stability of the system while the second part of the study is directed at the optimal utilization of the system under varying demand and changing wind conditions with a view to minimizing the diesel fuel used. The last system discussed is that of multivariable control of a cold rolling mill. The control problems are particularly difficult since the system is almost singular (Humpich, 1987). Interestingly enough, the French researcher on this project feels that the technical competition in this area comes from the Japanese and not from the US.

Flexible Structures. The study of flexible systems is a joint project with the University of Montreal, Canada. The project is concerned with the controllability and observability of a large structure whose movement is governed by the hyperbolic equations of elasticity. One wishes to synthesize a controller with a finite number of sensors and a finite number of actuators (Marmorat, 1987).

Real-Time Control and Robotics. The real-time control is done in collaboration with the informatics group and will be discussed below. In the robotics work a formal calculus is being developed to describe the motion of a robot arm to which will be applied a nonlinear controller. This work is mainly instructional in nature at the present time.

Informatics Group. The main effort of the Informatics Group is in parallel programing and distributed programing. Some of this work is in cooperation with INRIA. There are three aspects to the research – mathematical modeling of parallelism, verification of correct parallel programing, and development and utilization of real-time and parallel programing languages. Mathematical modeling of parallelism is based on the work of R. Milner at Edinburgh University (UK). The mathematical modeling aids in one of the key problems in software development – that of verification of the correctness (or, perhaps more formally put, proof of the correctness) of the code. G. Boudol has developed a calculus called MEIJE which is used in program verification or proving. This has led to theories of process observation and process equivalences. Another program, ECRINS, is also used in verification. The program verification is hierarchical and can involve complex and rich structures. The MEIJE system has been incorporated in another computer program, AUTO, which has a graphics interface and facilitates on-line program interaction and verification. Future work will include an extension of this system to include communication protocols. Research is now being directed to the study of true concurrence and automaticity in a program. A new experimental parallel language is being developed which reflects the underlying mathematics of parallelism and simultaneous verification.

Considerable work has been done both in the Informatics Group and INRIA on the development of ESTEREL, a computer language directed at reactive systems. By reactive systems one means systems that react to an input or inputs with a given output. Reactive systems include real-time process controllers and all types of control automata. One of the key concepts in the ESTEREL language is the idea that the response to the input is instantaneous (also termed "synchrony hypothesis"). As such, the system is completely deterministic and thus it is easier to verify or prove the correctness of programing modules. The language is capable of using parallel construction in the code, and the instantaneous concept helps in the parallel programing. By combining ESTEREL with the AUTO code simultaneous verification of the code is possible as the code is written. The advent of parallel computing has created a need for a new computer language that will help the programer in handling parallel systems. It will be interesting to see which of the languages, such as OCCAM, ESTEREL, ADA, or others, wins the competition.

Energetics Center – CE

The Energetics Center has two geographic locations – Paris and Sophia-Antipolis. Dr. R. Gicquel is the director of the Sophia-Antipolis center, which has about 20 scientific personnel, nine of whom are working on the doctoral degree. The work of the center is directed at the analysis and simulation of low-energy systems typified by factories and domestic buildings. Although there might be a tendency to consider such research as unexciting, this is indeed a mistake since minor savings at the domestic level can have a considerable impact on the national energy budget.

A large series of computer codes have been developed as a result of the Center's research. A list of these codes in the given research area indicates the emphasis that CE puts on code development and on the transfer of these codes to industry. In the area of solar energy CE has developed three computer codes which involve the simulation of the heat balance of a building as a function of climatological conditions (note above). These codes can be used on a microcomputer. One code is concerned with simulation of photovoltaic devices. Several codes are directed at thermal control of buildings and at simulation of refrigeration cycles and energy producing devices in a building such as wood fires. Thus, almost any energy effect in or on a building is the subject of investigation. This type of applied research can be very effective but it is difficult for me to judge the effectiveness since essentially the object of the work is to achieve long-term improvements in energy use at the national level. The effectiveness of the codes generated by the center will de-

pend on whether (or who in) industry uses them to create more effective buildings.

Material Formation Center

Finite Element Analysis. The Material Formation Center has a relatively large staff of 70, of whom about 15 work on the application of finite element methods to metal forming. Dr. C. Chantil discussed the activities of the finite element group with me. Hot rolled steel is analyzed by the code FORGE 2, which, after a 4-year development time, became commercially available in 1984. This code has automatic grid generation and considers the metal to be two-dimensional with superplasticity. No elasticity of the elements is allowed. Some 15 examples of this code have been sold and it is now in its second generation. An extension to this code, FORGE 3-D, which includes elasticity effects and three dimensions, is now being tested in industry. Two three-dimensional codes devoted specifically to hot rolling of steel – CALIB3 and TOLE3 – are also to be commercialized.

Since the task of the group is to describe metal forming, other codes directed at deep drawing or sheet forming, powder metallurgy, and aluminum and tantanum alloys are being developed or have already been sold. Future work of a technical nature will be directed at further application of multigrid methods in the codes. Other technical regions of metal forming such as foundry work, continuous casting, and extension to polymer castings are to be considered in the future.

Artificial Intelligence. Dr. J. Wybo heads a small group of people doing work in artificial intelligence (AI). What I found fascinating in the AI work of the group was the practical application of their expert system to fire fighting in Provence. Before describing that system I would like to mention some of the tools developed by the group. The first tool is called EXPERTPLAN, which is a computer program for the generation and development of an expert system. This facilitates the expert in creating or modifying his own system. Using EXPERTPLAN a machine fault diagnostic expert system has been installed for a company in France. The machines are very expensive and downtime is to be avoided. Another part of the problem is that highly paid specialists on the machine were spending an inordinate amount of time on fault corrections, before the introduction of the expert system. The cost effectiveness of an AI machine usually depends on factors such as these. The final tool is EXPERTGRAPH which manipulates and synthesizes graphical information at a very sophisticated level.

The graphics for the fire fighting system are what make the system interesting. Each fire station has a graphics terminal which can produce a complete map of the region showing roads, vegetation, wind conditions, and water resources. If a fire develops in the mountains, suggested road access is presented and an estimate of the fire-spread based on meteorological conditions is given. Suggestions on the number of fire-fighting engines required and whether helicopters should be used are also detailed. Whether or not the fire chief follows the suggestions, the map display should be an invaluable aid. In the case of a city fire, location of hazardous material (such as in a paint store near the fire) are displayed as well as the closest fire hydrant. This particular expert system is one of the neatest examples of practical AI that I have encountered in Europe.

Conclusion

The Center for Applied Mathematics is conducting some interesting work in multi-input/multi-output problems. Their work in parallel computation appears particularly strong. The Energetics Center concentrates on applied research by whose nature the results become evident only over a number of years. In the Material Forming Center the finite element work in the metal forming is of a high order, and the AI in fire fighting should be of particular interest to fire fighters in California, as well as those in other forested regions.

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7/26/88

OCEAN SCIENCES

The Greenland Sea Project and the Technical University of Denmark

by Captain Tony Clark, USNR. Captain Clark is a member of the OCNR Technology Mobilization Reserve Program. He was assigned to ONRL for a short period as a Technology Liaison Officer. As a civilian, he is a Senior Scientist in industry.

Introduction

In early September I visited Professor Preban Gudmansen at the Electromagnetics Institute (EMI) at the Technical University of Denmark in Lyngby, Denmark. The Electromagnetics Institute is a part of the Electrical and Electronics Department. The Institute's research and development work is in the field of applied electromagnetics theory and related topics. The Institute offers over 17 graduate courses on subjects closely related to its research topics. Many of the courses have a strong element of systems engineering. Recently, new courses in digital image processing and in optical communications systems have been introduced. EMI has a faculty and staff of about 76.

Professor Gudmansen heads the Remote Sensing Department at EMI. He has had a long and distinguished background in airborne and satellite remote sensing and has pioneered techniques in the field of advanced very-high-resolution radiometry (AVHRR). His research interests have been confined primarily to studies of the Greenland Ice Cap and other regions of the Arctic. At present, Professor Gudmansen is one of the principal investigators in a study called the Greenland Sea Project (GSP).

GSP is an ongoing scientific study of the meteorologic, oceanographic, glaciologic, and biologic processes in the Greenland Sea between Svalbard and Jan Mayen. The GSP, which began in 1987, is a 5-year program of observation and modeling with an overall goal of understanding the large-scale, long-term interactions of the air, sea, and ice in the area. The planning for GSP builds on other programs such as the Global Atmospheric Research Program (GARP), the World Climate Research Program (WCRP) and the ongoing Danish East Greenland Current (EGC) project.GSP has five major elements:

- A study of air/sea/ice interaction including ice motion in the Arctic to the north and to Iceland in the south. This element will include observations of the atmospheric boundary layer and the mixed layer of the ocean and its interaction with the ice.
- The measurement of the development processes for the formation of the Greenland Sea Deep Water.
- A study of the ocean circulation and mixing, and ice and heat transport in the Fram Strait and the area between Jan Mayen and Greenland.
- A study of atmospheric processes.
- A study of biological processes, including the distribution of planktonic biomass and the synoptic scale distribution of chlorophyll.

In the GSP, studies will be supported by remote sensing (airborne and satellite), moored and drifting buoys, acoustic tomography, and surface measurements. There will be numerical modeling of ice kinematics as well as the atmosphere and ocean. Although GSP is planned for a 5-year program beginning in 1987, suggestions have been made that it be extended 5 additional years to permit further satellite coverage and data analysis to understand long-term variability.

GSP is a coordinated international study with participation by Polar scientists from Denmark, Canada, France, Germany, Iceland, Norway, Holland, the UK, and the US. As part of the study, current meters, upward-looking sonars, and pressure guages will be placed around the perimeter of the Greenland Sea. Drifting buoys and SOFAR floats will be used. Hydrographic sections and frontal zone mixing studies of deep connection will be done. Included in this will be an experiment by US scientists with a tomographic array. Extensive use will be made of remote sensing data from satellites and aircraft. Numerical models will be developed to describe oceanographic and meteorological phenomena and ice kinematics.

Guidance for the Greenland Sea Project comes from the Arctic Ocean Science Board, which is an international steering group composed of representatives from each country participating in the project. Funding in varying amounts in terms of money and equipment has come from research foundations in all participating countries. GSP has been very successful in dovetailing its scientific objectives with existing Arctic research programs on an international scale. This has facilitated, in many cases, the use of scientific equipment and resources when actual monetary support has not been available. Staff support for the steering group comes from a project office established in Canada's Department of Fisheries and Ocean.

Specifically, EMI will play a key role in the use of Remote Sensing in research elements 1 and 3. The main objectives of EMI's effort are to:

- Monitor the seasonal and interannual variability of the extent of sea ice in the Greenland Sea and adjacent areas such as the Arctic Ocean north of the Fram Strait
- Monitor the amount of ice crossing the north and south boundaries of the Greenland Sea
- Monitor atmospheric parameters that drive the physical processes in the region, and retrieve ocean and ice parameters important to these processes.

The plans are to use data as it becomes available from the ERS-1 satellite. This will include SAR and imaging microwave radiometer data. Some of the research will be tied to the Program for International Polar Ocean Research (PIPOR) and its evaluation and use of the ERS-1 data. Visual and infrared sensor data will also be used from the NOAA AVHRR to determine ice drift velocities and floe size distribution on a daily basis in cloud free periods. The ice drift velocities will be used to expand the area coverage of data from buoys drifting through the area. Inputs for meteorological modeling will include temperature and water vapor profiles from the TIROS satellite. Passive microwave data will also be used as inputs. In addition to the many scientific objectives, detailed ice charts will be prepared to assist in the planning of the field experiments. To support the field work a data base of historical and present remote sensing data and observations has been established. As a result of the large amount of data available and to be acquired, an integrated Geo-Information System will be established to provide easy access by modelers and forecasters.

Conclusion

In conclusion, the Greenland Sea Project is a large international, multidisciplinary undertaking. The Electromagnetic Institute at the Technical University of Denmark, which has played a key role in organizing GSP, is one of many different participants, and will, in particular, make a great deal of use of remote sensing techniques and data. The scientific objectives of GSP are technically sound, are built upon the scientific work previously done in the Greenland Sea area, and have a lot of potential in contributing to a better understanding of the long-term variability of oceanographic and meteorological processes in the Polar regions.

It is important that the US Arctic scientific community be aware of the existence of GSP and the potential usefulness of its products and data. Greater usefulness could be attached to GSP if the results and data sets were well known among US investigators and program managers.

9/23/88

Remote Sensing – Moving Towards the 21st Century; The 1988 International Geoscience and Remote Sensing Symposium

by Captain Tony Clark.

The 1988 International Geoscience and Remote Sensing Symposium (IGARSS 88) was held at the University of Edinburgh, UK, from 12 through 16 September 1988. The symposium, entitled "Remote Sensing – Moving Towards the 21st Century," was sponsored by the Remote Sensing Society (RSS), the Geoscience and Remote Sensing Society (GRS) of the Institute of Electrical and Electronics Engineers (IEEE), and by the International Union of Radio Science (URSI). Among the many cosponsors was the Office of Naval Research. The symposium was multidisciplinary and over 600 papers were presented in airborne remote sensing techniques such as radiometry and synthetic aperture radar, as well as in below-ground sensing and data and image processing. Additionally, there were a few nontechnical presentations given on legal/commercial and the political consequences of remote sensing. For the purpose of this review the focus is on selected key presentations related to future space systems, sea ice, and marine oceanographic applications. Following are summaries of the presentations under these topics.

Future Space Systems

The keynote address on future space systems was given by G. Duchossois, European Space Agency (ESA) Headquarters, Paris, France, on the development of ERS-1. There are 12 member nations participating in the ERS-1 project. Although the US is not a major participant many of its scientist will have access to the

ERS-1 products. ERS-1 is scheduled for launch in May 1990 in a near polar orbit at an altitude of 780 km. The ERS-1 is to be an end-to-end system with a space and ground segment to provide global oceanic and regional ice/land coverage. Every 3 hours it will deliver standard products that will be used be support scientific objectives related to open ocean/coastal zone processes, polar ice regions, global, climate, and satellite data processing techniques. It is anticipated that after 2 years of orbit all of the global and regional mission objectives of ERS-1 will have been met. A great deal of confidence was expressed in the operational capabilities of the system. A comprehensive ground segment is being set up to provide a full-scale preoperational demonstration. Plans are being made for an ERS-2 to supersede ERS-1.

An additional presentation of interest on future systems was given by R.M. Jenkins and E.P.L. Windsor of the British Aerospace, Space and Communications Division in Filton Bristol, UK. The title was "The Performance of the European Polar Platform." In the presentation it was pointed out that the European Space Agencies (ESA) began the Columbus Program in response to President Reagan's invitation in 1984 for the industrialized Western world to join the US in an International Space Station. The Columbus Program contains provisions for a free-flying polar platform, a pressurized module to be attached permanently to the space station and a man-tended free-flyer.

The development program began in January 1988 with British Aerospace responsible for the development of the polar platform. The platform exploits the unique advantages of a sun-synchronous polar orbit to give a daily view of the entire globe. The polar platform will be one of an international set of earth-observing space craft. These facilities will be operated as complementary parts to address the temporal, spatial, and spectral coverage of the user community. The presentation gave the evaluation of the European Polar Platform from conception to performance capability. The authors also described as alternate concepts the need for a permanent polar orbiting facility in the form of a generic family of unserviced platforms with lifetimes of about twice that of existing polar orbiting space craft.

Sea Ice Studies Using SAR

There were numerous papers on sea ice investigations with synthetic aperture radar (SAR). B.A. Bruns from ERIM, Ann Arbor, Michigan, and A. Wegner, Institute for Polar and Marine Research, Bremerhaven, West Germany, demonstrated how SAR sensitivity to surface roughness can be exploited to obtain indicators of atmospheric drag variations over sea ice. Their analysis demonstrated how SAR imagery can be used to produce real maps of ice concentration and ice flow deformation. M. Fily, Laboratoire de Glaciologie et Geophysique de l'Environment, St. Martin-d'Heres CEDEX, France, and D.A. Rothrock, Polar Science Center, APL, University of Washington, Seattle, demonstrated an algorithm for measuring the opening and closing of leads by comparing two sequential digital images. The algorithm requires that displacement data be supplied on a regular grid and lead identification in two images. Ideal displacement input is obtained from automated ice tracking routines. When compared with estimates of manually digitized lead boundaries an error of about 10 percent was noted.

J. Askne and R. Johansson from Chalmers University of Technology, Göteborg, Sweden, discussed ice ridge observations by means of SAR. The practical implications of the properties of ice ridges is the effect on ship routing. Their conclusion is that ice ridges can only be studied in a statistical way because of the variability of the individual properties. To characterize the SAR scattering from ridges they suggest a model with tilt modulation due to the ridge response angle together with a specular contribution due to randomly orientated blocks. A look angle dependence may be used to characterize these two different contributions to ice ridge scattering.

P. Wadhams, Scott Polar Research Institute Cambridge, UK, gave an interesting presentation on measurements made on the underside of arctic ice with upward looking sidescan sonar from two different British submarines in the spring of 1987 and 1988. Little is known about the three-dimensional morphology of the ice underside. Most studies of the underside are done with a linear profile from which the distributions of ice features are derived. This type of one-dimensional data gives no information about spatial morphology or the appearance of the underice surface. In contrast, the upper surface of the ice has been well documented from SAR, passive microwave, infrared, and visual imaging. With the sidescan data Wadhams is able to show a clean distinction between first-year and multiyear ice. This distinction will enable submarine-mounted upward looking sidescan sonar to be used as a means of validating airborne passive microwave data.

An additional paper suggesting schemes for differentiating between first-year and multiyear ice was given by C. Garrity, York University, UK. According to Garrity, if a large number of measurements are averaged for a particular month, multiyear, first-year , and thinner ice types may be classified from their polarization using a dual-polarized 37-GHz radiometer. Brightness temperature was measured from a research ship in the Arctic. Experimental results suggest that brightness temperature for first-year and multiyear ice approaches each other in the spring. By the end of June however, multiyear ice exhibits a higher degree of polarization than first-year ice. In midspring even though the brightness temperature of first-year ice is significantly higher than for multiyear ice

the polarization can be similar. During this time the ice can be classified based on brightness temperature irrespective of their polarization. The question of ice classification during summer using the 37-GHz radiometer still needs additional research.

Marine and Oceanographic Applications

A presentation of an applied nature describing an airborne nonacoustic bathymetric system was given by S.P Haimbach, K. Smith, and G.D. Hickman, NORDA, Mississippi. The Airborne Bathymetric System (ABS) is composed of a laser sounder and multispectral scanner, used respectively as active and passive optical sensors. Electromagnetic techniques are used to obtain hydrographic data and comprise the airborne electromagnetic (AEM) system. Deployed from a helicopter the system operates at 95,385 and 7,200 Hz. The two nonacoustic systems are close to becoming operational. The ABS can measure bathymetry to International Hydrographic Organization standards over a wide swath in clear, shallow coastal waters.

The ABS, when development is complete, will not cover as wide a path, but will be able to operate over a wider range of environmental conditions. ABS will provide a fast and inexpensive means of resolving the backlog in coastal survey requirements. A constraint on both systems is their limitation to clear waters and a depth of 30 meters or less. With additional R&D effort it is felt that operating depths of up to 150 meters can be obtained.

Summary

In summary, the magnitude of a conference of this size tends to overwhelm one's imagination in terms of the technology delivered in the many disciplines represented. However, when I considered the conference in its total context – with particular attention to the keynote presentations – several revelations became evident. Remote sensing, for example, offers a great deal of glamour in its basic hardware such as the satellites, the launchers that carry them into space, the down-links, the receiving station and, ultimately, the big computers needed to handle the data. Once past the glamour phase a lot needs to be done with techniques such as use of artificial intelligence for data compression to circumvent problems with the floods of data produced by remote sensing. One of the real challenges ahead is to turn remote sensing data into useful knowledge.

It also became evident that the overwhelming majority of the speakers at the conference are of the opinion that one of the unique contributions of remote sensing is in the study of the oceans. The message was that this alone justifies the staggering cost associated with remote sensing. From the standpoint of naval applications this is certainly true. Better understanding of the oceans and their driving mechanisms will ensure better understanding of a wide range of naval-related problems. There will be better ship routing, clearer understanding of the environmental effects on weapons and sensor platforms, and an overall better meshing of naval systems with the environment.

The conference, in my opinion, met its objectives in defining the technical, legal, and economic role that remote sensing should have in the 21st century. It provided an excellent overview of budding technologies in various disciplines. The symposium proceedings, in three volumes containing almost 2000 pages, would make an excellent addition to any professional library. They are available from ESA Publications Division, ESTEC, P.O. Box 299, 2200 AG Noordwijk, the Netherlands.

9/23/88

PHYSICS

The UK's Institute of Physics Annual Conference on Plasma Physics

by Stephen E. Bodner. Dr. Bodner is the Head of the Laser Plasma Branch at the Naval Research Laboratory, Washington, D.C.

The 15th Annual Conference on Plasma Physics, sponsored by the Institute of Physics, was held from 6 through 8 July 1988 at the University of Manchester Institute of Science and Technology (UMIST). These annual meetings serve as the focal point for plasma physicists in the United Kingdom to meet and share their

research results. The approximately 50 attendees were from universities, from Culham Laboratory Abington, and the Joint European Torus (JET) project Abington, along with a few invitees from the European continent and the US. During the 3-day meeting there were 10 invited papers and 27 contributed papers, with topics including magnetic fusion, inertial fusion, basic plasma physics, and astrophysical plasmas. Because of the small size of the meeting, the atmosphere was relaxed, with ample time for in-depth conversations.

Tokamaks

The tokamak session began with an invited paper by Professor Bruno Coppi from MIT, Cambridge, Massachussetts. In addition to his high reputation and distinguished research in fusion and space plasmas, Coppi has for many years been a major critic of the mainline tokamak programs in the world, and a proponent of compact, high-density tokamaks. He maintained his reputation at this meeting by asserting that the large, low-density, tokamaks provide us with an excellent way to uncover basic plasma physics phenomena, but that they would not form the basis for a reactor. The detailed technical reasons for his view were not presented at this conference. (I asked him if he had any preference for a fusion reactor; he proposes the use of D-He_3 in a high-density, high-magnetic-field, compact tokamak.) Coppi used his invited talk to discuss the commonality of plasma physics phenomena in laboratory fusion plasmas, geomagnetism, solar flares, and the first few seconds of the universe's expansion. From tokamaks to space plasmas, the density variation is 17 orders of magnitude, but he showed that many of the physical phenomena are the same.

The next day Dr. R.S. Pease (retired) outlined the results of a British committee that has been meeting to evaluate non-tokamak fusion concepts. They considered each concept in terms of physics status, achievements and key problems, the interaction of the physics with other components of the system, reactor engineering and development needs, the potential for new ideas, suggestions for a role for the UK Atomic Energy Research Establishment, and items for further study. The committee included a large number of scientists, and their conclusions were (unusual for a committee) clearly and decisively stated. The written report will be completed soon; I am sure that it will be widely read. In summary, toroidal systems were found to be best. Mirrors were, surprisingly, found to have no inherent advantage over tokamaks; this British view would support the US decision a few years ago to slow and then to cancel the large US mirror program. All alternate concepts were found to have basic physical uncertainties and not ready for major investment, but some of the alternates had very attractive features. Z-pinches were very interesting for their plasma physics; the spheromaks pleased the engineers and the committee recommended an in-depth review if there were further technical advances; the empirical scaling laws for stellarators were very attractive but the committee believed that tokamaks may be sufficiently successful so that stellarators are not necessary.

A series of papers from Culham and JET described recent advances in the JET tokamak. Dr. F. Pegoraro of JET presented recent measurements of the sawteeth oscillations, including the fact that the on-axis q value is significantly less than one in the center of the machine. During high power injection the sawtooth oscillations are suppressed. This phenomenon had not been fully understood. Dr. Pegoraro and colleagues now have a theory based upon an $m = 1$ internal resistive kink mode that explains this stabilization by energetic particles that are formed during the high-power heating. Dr. D. Start of JET discussed the ion cyclotron resonance heating (ICRH) results with the JET tokamak: the detailed energy dynamics of how the ICRH energy is coupled to the plasma, new eigenmodes of oscillation, energetic electron generation, and the so-called "monster sawteeth." Results in JET have been very successful, with 6 megawatts of ICRH energy coupled to the plasma in thermal heating.

Several presentations dealt with fundamental design limitations on an ignition tokamak. Dr. M.F.Turner of Culham described numerical simulations of the Murakami limit; this limit gives the maximum density that can be achieved in a tokamak without disruptions. It was suggested that the final catastrophic temperature drop is caused after an island touches the limiter and promotes an influx of impurities. Dr. G. Apruzzese of JET then evaluated the impact of his density limit upon the design of an ignited tokamak plasma such as the Next European Tokamak (NET). There was only a narrow parameter region in density and temperature that produced a stable ignition. One possible solution is to go to the high-magnetic-field, compact tokamaks proposed by Professor Coppi. Another possible solution is to increase the current in the machine. In this presentation, Dr. Aprezzese proposed a third idea – that a fast feedback in plasma current could broaden the regime of stable operation.

Dr. C.N. Lashmore-Davies of Culham presented a major advance in gyrokinetic theory for tokamaks. This is a technique for solving the Vlasov equation in arbitrary, strong magnetic fields to all orders in the larmor radius. Dr. Lashmore-Davies and Dr. Dendy (also of Culham) have extended the theory to high-frequency perturbations in order to study the case of fast magnetosonic waves propagating perpendicularly to the magnetic field in a two-ion species plasma. Strong absorption of the waves was found where previous theory found zero damping.

Alternate Magnetic Fusion Concepts

Alternate magnetic fusion experimental research in the United Kingdom is centered at UMIST, Imperial College, and Culham. Research papers included z-pinches, reversed field pinches, spheromaks, and the small aspect ratio torus concept. Imperial College has proposed a new z-pinch machine that could produce a radioactive collapse and a very dense plasma. At this conference Professor M. Haines of Imperial College presented the detailed theory behind the proposal. There was a great deal of formal and informal discussion, and no one could demonstrate any weaknesses in his concept. UMIST has begun operation of a spheromak. The meeting included a tour of the facilities, and the general view of the meeting attendees was that the machine was especially well designed and well built, and that it would make substantial contributions to spheromak physics.

Inertial Fusion

In inertial fusion, I was invited to present the work of the US Naval Research Laboratory that has shown how to produce symmetric illumination of a laser fusion pellet. Techniques invented at NRL, called ISI and echelon-free ISI, can take a high-power laser beam with aberration and turn it into a laser beam with nearly perfect textbook beam quality. The technique trades off focal spot size for beam quality by breaking the laser beam into thousands of small, statistically independent beamlets, each of which is nearly perfect, and then recombining these beamlets. In addition to meeting the symmetry requirements of direct-drive laser fusion, NRL has shown that ISI also strongly quenches all known laser-plasma instabilities.

My paper was followed by one from Dr. R. Sigel of West Germany's Max-Planck Institute, Garching, (see also *ESNIB* 88-03:64-68 [1988]). Dr. Sigel's group fires a high-power iodine laser into a cavity to produce thermal x-rays. The group plans to use these x-rays for a variety of fundamental atomic and plasma physics studies. At this conference, Dr. Sigel presented a basic tutorial on radiation flow in cavities, summarizing the research at his laboratory over the past few years. (In the US, the Department of Energy nuclear weapons labs use related techniques in their approach to inertial fusion.)

There were several interesting papers on space plasmas. Professor S.J. Schwarz of Queen Mary College, London, gave an overview on collisionless shocks. He pointed out that space plasmas are the perfect system for basic plasma physics studies because the debye length is on the order of a meter, easing diagnostic problems. Shocks in space are also of interest, he said, because they are ubiquitous, collisionless, thermalizers, nonthermalizers, full of kinetic physics, and not the standard toroidal geometry. Dr. Schwarz analyzed the bow shock between the earth and the sun to try to explain why the shock has a width that is much less than the mean free path of a particle. The explanation, including a variety of two-dimensional computer simulations, was based upon the branching of ions in velocity-space at the interface where the magnetic field increases. Professor P.F. Browne of UMIST then discussed magnetic vortex tubes that are ubiquitous in astrophysics, on stars, between stars, and in plasma focus machines and homopolar plasma rotators.

Basic Plasma Physics

There were a number of papers presented on basic plasma physics, including Langmuir probes, discharges, electon-cyclotron masers, and beat-wave accelerators. In addition to these usual papers, Professor J.E. Allen of the University of Oxford gave a talk on railgun recoil and relativity. There have been a series of articles in scientific journals that have suggested that there was a basic problem with the theory of relativity as applied to rail guns. Professor Allen spent the time to refute these papers and to show that there are no such problems

8/30/88

Infrared Scientists Gather in Zurich

by Paul Roman.

Nearly 450 researchers, from all over the world, gathered in Zurich, Switzerland, to attend a remarkably rich and successful meeting (August 22 through 26, 1988) on basic (and to some extent, applied) infrared (IR) science. This meeting, the International Conference on Infrared Physics (CIRP4, for short), was the fourth in a series that originated in 1975. As were its predecessors, this meeting, intended to present a lively forum for presentation and discussion of the state-of-the-art and the future development of IR physics and techniques, was organized and enthusiastically directed by Professor Dr. F.K. Kneubühl. The major sponsor was the Federal Technical University (Eidgenössische Technische Hochschule [ETH]), assisted by the Swiss Science Foundation, the

federal Swiss government, Swissair, and a number of industrial firms. The meetings (held under the auspices of the Swiss Physical Society) took place in the attractive, modern facilities of the new ETH campus. Despite the crowded and amazingly diverse program, there was ample opportunity for mixing and informal contact. There were 30 invited review papers (45 minutes long), and about 200 contributed papers (each lasting 15 minutes, discussions included).

General Program. The early mornings and the late afternoons were reserved for two or three plenary session invited talks; additional invited papers were read during all the rest of the day, simultaneously with three streams of contributed papers. This organizational arrangement was most successful.

The topics covered by the contributed papers were as follows:

- Laser spectroscopy (two sessions)
- Nonlinear optics (two sessions)
- Semiconductors (two sessions)
- Detectors (two sessions)
- Devices (including mixers), and components (three sessions)
- Remote sensing and imaging
- Astrophysics and astrophysical instrumentation (two sessions)
- FIR gas lasers (two sessions)
- IR gas lasers (two sessions)
- Semiconductor lasers
- Solid- and liquid-state lasers
- Laser interactions and laser chemistry (three sessions)
- Spectroscopy of gases
- Solid-state spectroscopy (three sessions)
- Photoacoustics (two sessions)
- Thermal emission
- Fibers
- Building-physics

Because of my major interest (and a variety of limitations) I will briefly review only selected papers in the area of nonlinear optics.

Nonlinear Optics

R.J.M. Bonnie, on behalf of W.J. Witteman's research group at Twente University (Enschede, the Netherlands) described an elegant method which measured sub-nanosecond infrared pulses by means of noncollinear second harmonic generation in tellurium. The phase matching condition was easily satisfied by simply rotating the Te crystal around the optical axis.

The effect of input modulation on an optical bistable device was studied at Jilin University, Changchun, China, and the report was read by Gao Jin Yue. The input intensity was sinusoidally modulated, and there was a delay in the feedback loop. Resonance, frequency locking, and modulation-induced chaos have been observed.

Far infrared (FIR) frequency shifting by optically induced gratings in semiconductors was the topic of a submission by G. Dodel (Institute for Plasmaresearch, Stuttgart University, West Germany). A 300 mW, 488 nm Ar^+ laser was used for optical excitation of a moving refractive index grating in a Si wafer. The 119-μm beam of a CH_3OH laser could be then partly diffracted and frequency shifted on this grating. Frequency-shifts up to 80 MHz were observed.

Din Van Hoang (University of Hanoi, Vietnam) analyzed the appearance of optical bistability and the influence of inhomogeneous broadening on bistability in a molecular gas laser containing a saturable absorber. A four level scheme was used for the traditional model calculation, and the problem was solved both for the single mode and the multimode regimes.

In addition to the strictly research-oriented papers, the first session on nonlinear optics featured also a presentation that described the new European Laboratory for Nonlinear Spectroscopy (LENS). The review was submitted by M. Inguscio, one of the organizing directors of LENS (his permanent address: Physics Department, University of Naples, Italy), who described the IR and FIR equipment of LENS. The laboratory, located in Florence, Italy, features a coherent spectrometer which is continuously tunable from 1 mm to 50 μm, with a frequency uncertainty of about 35 kHz. In addition, the lab has a high-quality commercial Fourier transform interferometer, with a spectral range from 10 cm^{-1} to 4800 cm^{-1} and a resolution of 0.004 cm^{-1}. Finally, the microwave spectroscopy accessories deserve special mention: they include a synthetized sweeper which is continuously tunable in the 10 MHz to 22 GHz range. There is also a spectrum analyzer covering the same spectral range. (For more information on LENS and the possibility of cooperative research please contact directly the President of LENS, Professor S. Califano, Dip. di Chimica, Laboratorio di Spettroscopia Molecolare, via G. Capponi 9, I-50121 Firenze, Italy. Telephone: 011-39-55- 247-6961.)

Nonlinear Wave Mixing. A substantial portion of papers in the nonlinear optics sessions related to various aspects of wave mixing phenomena.

Optical parametric amplification (OPA) and optical parametric oscillators (OPO) were considered by a Soviet and a Chinese contributor, respectively. T. Usmanov, on behalf of the Usbek Institute of Electronics, Academgorodok, Tashkent, USSR, demonstrated theoretically the possibility of full parametric conversion of a modulated pump wave for the use of certain input wave modulation profiles. Experimental results in the IR region were compared with the calculations. Subsequently, Wu Lusbeng, representing researchers from the Institute of Optics and Fine Mechanics, Hefei, China, described ex-

periments with a tunable OPO (operating between 1.3 and 2.0 μm). At a wavelength of 1.9 μm and with a repetition rate of 10 Hz, the output energy per pulse was found to be 0.3 mJ.

A group of four papers on four-wave mixing (FWM) and phase conjugation (PC) was impressively put into a coherent perspective (no pun intended) by V.I. Kovalev (from the famous "Basov Group" of the Lebedev Physics Institute, Moscow, USSR) – even though this invited lecture was scheduled for the day *following* the nonlinear optics sessions. Kovalev reviewed the state of the art of PC and stimulated backscattering, with an emphasis on the mid-IR region. He also paid attention to the appropriate nonlinear media and to the design of PC mirrors.

The contribution of A.K. Popov (Institute of Physics, Krasnoyarsk, Siberia, USSR) described both theoretical and experimental studies relating to degenerate FWM and upconversion with a mid-IR (10.58 μm) beam in an absorbing Cs vapor medium. It appears that the efficiency depends strongly on both the total absorption and on the absorption dispersion. Optimal conditions were suggested by the author.

In a related second contribution Popov described work on nondegenerate FWM and upconversion of a near-IR (CO_2 laser) beam in Cs vapor, with resonant enhancement. (The beam required for the enhancement was generated in the cell by stimulated electronic Raman scattering [SERS]). The characteristics of the mixing show a strong dependence on the conditions of SERS. Recommendations for achieving optimal conditions for effective mixing were presented.

In a third work, Popov related research in his institute on PC of CO_2 laser radiation by a three-beam interaction. Forward resonant parametric scattering in gaseous SF_6, followed by a retrace after retroflection from a mirror, was used to study the distortion correction of a CO_2 laser radiation wavefront; i.e., the experiment was concerned with wavefront restoration.

Finally, there was also a Western contribution on PC. P.A. Krug (University of Sidney, Australia) presented a progress report regarding cooperative research with the Plasma Physics Laboratory of Princeton University, New Jersey. This research involves the study of PC in the FIR region, occurring in an "artificial Kerr medium" – i.e., in a suspension of dielectric particles in a transparent liquid.

Concluding Comments

This was a truly excellent international meeting, and I hope the "CIRP series" will continue.

A 768-page Conference Proceedings is now available and can be purchased for SF75.00 (about $50.00) directly from the CIRP4 Conference Secretariat, c/o Professor Dr. F.K. Kneubühl, Infrared Physics Laboratory, ETH Hönggerberg, CH-8093 Zürich, Switzerland. In addition, a special issue of *Infrared Physics* (Pergamon Press, Oxford) will be devoted to CIRP4. It is expected that this issue will come off the press by early 1989.

8/31/88

An ONR-London Sponsored Symposium Session on Nonlinear Phenomena

by Paul Roman.

Schloss Hofen, a modernized renaissance castle in Lochau/ Bregenz, Austria, was the seat of the international Symposium on Symmetries in Science, the third in a recurring sequence of similar multidisciplinary meetings since 1979. This was the first occasion that the symposium took place in Europe. It was held from 25 through 29 July 1988 and was directed by Professor Bruno Gruber, an international mathematical physicist who divides his time between American, German, and Austrian universities. The symposium was cosponsored by the Land (State) of Vorarlberg, IBM of Austria, Southern Illinois University at Carbondale, and the US Office of Naval Research Branch Office, London.

The symposium, attended by about 65 invited participants (mainly from Western Europe and the Middle East, but also with a good show of communist country scientists, including the USSR and China) featured the following program:

- Symmetry applications (five sessions)
- Nonlinear phenomena (three sessions)
- Algebraic structures, representation theory, and computational methods (three sessions)
- Workshop and poster session.

In particular, ONRL sponsored the three sessions (filling a whole day of the meeting) on nonlinear phenomena. The major motivation for supporting these pres-

entations was to create a forum for open discussion of the use of symmetry principles and algebraic methods in the exploration of nonlinear dynamics. This is a not-well-explored area, and indeed it was difficult to focus the talks to that particular aspect of nonlinear phenomena. The program of the ONRL-sponsored sessions was as follows:

- H. Fröhlich, FRS, The University of Liverpool, England, "Coherence in Biology"
- R. Friedrich, Universität Stuttgart, Germany, "Symmetries and Symmetry Breaking Instabilities in Synergetic Systems"
- R. Kerner, Université de Paris VI, France, "Symmetry and Scale: from Local to Global Symmetries"
- G. Vitiello, Universita di Salerno, Italy, "Symmetry Breaking and Self-organization in Living Matter 1"
- E. Del Giudice, INFN Milano, Italy, "Symmetry Breaking and Self-Organization in Living Matter 2"
- M. Rasetti, Politecnico di Torino, Italy, "The Group of Mapping Classes and the Braid Group in the Statistical Mechanics of Spin Lattice Systems"
- L. Vasquez, Universidad Complutense de Madrid, Spain, "Some Dynamical Aspects of the Solitary Waves: Stability under Space-Time Stochastic Perturbations"
- S. Wojciechowski, Linköpings University, Sweden, "A New Method of Finding Integrals for Dynamical Systems"
- P. Santini, Universita di Roma, Italy, "Algebraic Properties and Symmetries of Integrable Evolution Equations"
- A.B. Shabat, Academy of Sciences, USSR, "Symmetry Approach to the Problem of Integrability"
- E. Sorace, INFN Firenze, Italy, "Energy of Skyrmionic Configurations"
- Y. Dothan, Tel Aviv University, Israel, "Nuclear Quantum Numbers in the Skyrm Model"
- W. Blau, Trinity College, Dublin, Ireland, "Nonlinear Optics in Quantum-Confined Semiconductors"

One-page abstracts of some of these presentations are available from the Editor of ESNIB on request. So is a list of invited participants. The proceedings of the entire symposium will be published by Plenum Press ("Symmetries in Science III", editor B. Gruber), and should be available by the end of 1988.

8/30/88

The Central Laser Facility of the United Kingdom

by Paul Roman.

About 3 years ago I visited the Rutherford-Appleton Laboratory (Chilton, Didcot, Oxfordshire) and wrote an article (ESN 39-5:209 [1985]) which, among other related issues, dealt with the substantial laser laboratory. Since then, both the organizational framework and the hardware, as well as research done with it, have been developed appreciably. This article describes the current status.

Actually, the laser division of the laboratory is now the host establishment of the nationwide Central Laser Facility (CLF). The CLF is financed and controlled by the Science and Engineering Research Council (SERC) of the UK, and it provides advanced research facilities for use by UK academic researchers and invited foreign visiting scientists. The day-to-day management of the CLF is in the hands of a Laser Facility Committee which represents university staff and other non-SERC experts, to ensure that the scope of the research and development programs reflect the interests of the user community. A competitive peer review process is used to determine the schedule of approved experiments. In 1987, the total expenditures for running the CLF amounted to £2.6 million (about $4.9 million).

The Hardware

There are three, very different laser facilities with unique features.

VULCAN. This is a highly versatile multibeam, multiwavelength near-IR high-power neodymium/glass laser. It can irradiate small targets at power densities up to 10^{16} Wcm^{-2}. VULCAN can be used in two major modes: long pulses (1 ns) with more than 2-TW power, and short pulses (variable 20-100 ps) with over 5-TW power. Synchronization of pulses is better than a few picoseconds. Four experimental areas are provided; one uses 12 beams for symmetric irradiation, another has a line-focus irradiation system, a third has six independent beams available, and the fourth target area has a small single-beam chamber. Independent synchronized high-power probing beams are available in each of the first three target areas.

SPRITE. This is an electron-beam-pumped krypton fluoride UV excimer laser. It produces over 200-J energy in 50-ns pulses. Novel multiplexing techniques permit this to be compressed into pulses an order of magnitude shorter. It is expected that, by July 1988, the short-pulse energy will be as high as 10 J in 2- to 3-ps pulses.

Laser Support Facility. This, the third resource, is not a single piece of equipment, but rather a collection of a variety of pulsed tunable dye laser systems, high-energy excimer lasers, continuous-wave ion laser systems, and a special, complete picosecond laser system. (The dye lasers are pumped by additional excimer- or solid-state-lasers.) A streak camera and various diagnostic equipment is also available. This pool of up-to-date equipments may be utilized either on-site, or loaned to the users' home laboratories.

Current Research

Ongoing research can be grouped under three main headings.

Plasma Physics. Focal areas of work are:

- Laser-generated implosion for the creation of dense plasmas and inertial confinement fusion research
- Study of ultradense nonclassical plasmas
- Nonlinear interactions of high-intensity laser beams with matter
- Energy transport in plasmas
- Laser plasma beatwave studies
- Plasma emission- and absorption-spectroscopy.

X-ray Lasers. Schemes for achieving population inversion in laser-generated plasmas, leading to x-ray laser action, include recombination processes as well as intense x-ray pumping from another laser source.

Other Applications of Laser-Produced Plasmas. Mainly the following areas in other applications are pursued:

- Laser plasmas as sources for both line and continuum intense pulsed x-ray sources
- Laser plasmas as sources of charged particles
- Laser plasmas as sources of pressure pulses.

Particular examples from this area are: use of pulsed x-rays for surface science and EXAFS studies on nanosecond timescales; and *in vivo* x-ray microscopy of biological specimens.

Research with the Laser Support Facility. The utilization of this equipment collection involves multidisciplinary applications of repetitively pulsed and frequency-tunable lasers in chemistry, biology, physics, and materials processing. It covers the frequency range from the VUV to the near-IR. Specific examples are:

- Raman spectroscopy
- Two-photon spectroscopy
- Gas phase kinetics
- Picosecond kinetics in liquid and in solid state
- Scanning x-ray microscopy
- Lineshape studies in nonclassical plasmas
- Luminescence on picosecond timescales
- *In vivo* DNA repair mechanism studies
- Photosynthesis on nanosecond and picosecond scales.

Plans for the Future

The VULCAN laser will continue to operate for the next 6 or 7 years at the ouput level reached in 1988, but the target areas and the operational facilities will be developed to cater for the increasingly sophisticated user research program. As far as the SPRITE is concerned, a major capital development program is proposed to raise its output to 7.5 kJ in 1-ns UV pulses, and to provide full multibeam target areas. This will result in SPRITE taking over from VULCAN the role of the major high-power laser facility. It is expected that this will occur in the mid-1990's. Another capital investment program will ensure the updating of the Laser Support Facility equipment.

Concluding Remarks

It seems to me that the CLF is probably the biggest high-energy laser establishment in Western Europe. As far as I know, only the iodine vapor laser at the Max Planck Institute at Garching can compete with it. And worldwide (not counting the Soviets), Livermore's NOVA is probably the only superior facility. In any case, the CLF is surely a prize piece of British science and technology.

5/9/88

SENSORS

European Workshop on Low-Temperature Detectors

by Steven E. King and Gilbert G. Fritz. Mr. Fritz is the head of the X-Ray Astronomy Branch at the U.S. Naval Research Laboratory (NRL) and Dr. King is a nuclear physicist in the Radiation Detection Section at NRL.

The Second European Workshop on Low-Temperature Devices for the Detection of Low Energy Neutrinos and Dark Matter was held from 2 through 6 May 1988 at Laboratoire d'Annecy-le-Vieux de Physique des Particules (LAPP) in Annecy, France. This is the second annual workshop designed to foster communication within a diverse group of scientists working on the use of low-temperature devices for particle and radiation detection. While the central theme of the workshop, as indicated in the title, was the use of these devices for dark matter and neutrino detection, participants also considered other potential applications. This is a new field attracting a growing number of researchers as the need for high sensitivity, low energy threshold, and high spatial and spectral resolution detectors increases. As an indication of the growing interest, the current meeting – with 85 registered participants from 12 countries, and 48 talks – was twice as large as the first meeting, held in 1987. The participants represent a broad range of specialities including low-temperature physics, condensed matter physics, particle physics, nuclear physics, astrophysics, and materials engineering. Theoretical, basic, and applied researchers were all represented.

The conference was organized by Drs. L. Gonzalez-Mestres and D. Perret-Gallix of LAPP. LAPP is an experimental particle physics laboratory situated in the hills overlooking Lake Annecy; its approximately 150 personnel primarily work on collaborations at CERN.

The talks presented at the conference were divided into five areas:

- The motivating experimental needs and theory for low-temperature detectors
- Superconducting tunneling junctions (STJ)
- Superheated superconducting granules (SSG)
- Low-temperature bolometers
- Sundry detectors and topics.

Presentations in each of these topics are discussed below.

The proceedings of the conference will be published later this year. Inquiries about the proceedings or the conference itself should be directed to either Dr. Gonzalez-Mestres or Dr. Perret-Gallix at LAPP, B.P. 909, 74019 Annecy-le-Vieux Cedex, FRANCE, or via E-Mail to PERRETG%CERNVM.BITNET.

Motivating Experimental Requirements

The meeting began with introductory talks given by Gonzalez-Mestres, R. Flores (CERN, Switzerland), P. Sikivie (University of Florida), and A. Drukier (Applied Research Corporation, Landover, Maryland) on the needs of neutrino and dark matter physics for new detectors. The principal motivation behind research to develop cryogenic detectors is the inability of current or anticipated state-of-the-art radiation or particle detectors to even approach the requirements of the fundamental problem of detecting weakly interacting particles. The principle attraction of superconducting devices is the fact that the superconductor energy gap is on the order of 1 meV compared to the semiconductor energy gap of approximately 1 eV. The energy resolution could be improved by a factor of 30 to 100 for some detector designs. Also many of the potential applications require energy thresholds of 100 eV or less. Another important consideration in detector design is the background rejection requirements for searches of what are often very rare events.

Two fundamental problems in neutrino physics could be addressed by these detectors. First, there is a disagreement between experiment and theory on the solar neutrino flux. However, the current generation of neutrino detectors can only measure the most energetic neutrinos from the ^{8}B reaction. The next generation of detectors must be sensitive to the predominant flux of lower energy neutrinos (100 keV), operate in real time, and if possible provide some spectroscopic capability or a reduction in detector size. The proposed cryogenic methods to detect neutrinos are to use neutrino-electron scattering reactions, nuclear recoil from coherent neutrino scattering, or inverse β reactions (in In or Tl). The other fundamental neutrino problems include the determination of the neutrino mass and the detection of υ-oscillations. F. Cardone (Institute Nazionale di Fisica Nucléare [INFN-LNI], Frascati, Italy) said that with the possibility of high-energy resolution (< 10 eV) the neutrino mass could be measured more accurately in double β-decay experiments or tritium β-decay.

Superconducting detectors are also viewed as the best, and possibly the only, means of finding cold dark matter in the universe. The underlying problem is that

the masses of both our own galaxy and the universe as a whole, as estimated from the luminosities of objects, fall far short of providing the mass needed to account for the observed gravitational effects. Extensive efforts have been made to search for cold baryonic mass without success. Alternative proposals attribute the so-called missing mass to undiscovered weakly interacting particles. The candidates include a heavy neutrino, the lightest supersymmetric particle such as a photino, higgsino, zino or neutrino, axions, cosmions, magninos, or other more exotic particles. Possible methods of detection are the observation of recoil energy of coherent scattering from nuclei or the formation of excited nuclear states. Drukier said that the counting rate for galactic axions could be as high as 10^4 event/kg/day. Flores showed the difficulties in super symmetric dark matter detection using inelastic scattering resulting from the extremely low count rate ($< 10^{-5}$ events/kg/day).

Superconducting Tunneling Junctions. The research in superconducting tunneling junctions (STJ's) was reviewed by D. Twerenbold (IP, Neuchatel, Switzerland). In these devices incoming radiation breaks Cooper pairs, creating excess quasi-particles that tunnel through an insulating layer; the resulting charge pulse is measured. A principal attraction of these devices is the high energy resolution resulting from the few meV energy gap for the creation of quasi-particles. Theoretical limits on the energy resolution of STJ detectors are < 10 eV. W. Rothmund (Schweizterisches Institut für Nuklearforschung [PSI], Villigen, Switzerland) gave the best resolution results of 41 eV for 5.9 keV x-rays. One of the major problems with STJ's was the limitation of size resulting from the device capacitance and quasi-particle tunneling times. A proposed solution, by Twerenbold, is to use a bulk crystal to absorb particles and to focus the phonons produced onto a STJ device.

Much of the STJ research was concerned with the search for good candidate materials (K. H. Grundlach, IRAM, Grenoble, France), the development of high-quality devices (R. Bayer, Karlsruhe, West Germany and Sachail, ENS, Paris, France), and modeling efforts (A. Khalil, Sachs/Freeman Associates, Maryland, and Dr. Rothmund, PSI, Villigen). D. Goldie (University of Oxford, UK) reported on recent preliminary results on development of indium junctions as well as efforts to solve the inherent STJ size problem by using one relatively thick superconducting layer as the particle absorber and a second layer as a quasi-particle trap. Dr. Gross (Tubingen, West Germany) presented a unique approach of studying the structure of STJ's using a low-temperature scanning electron microscope (LTSEM). The LTSEM serves as a controllable radiation source for high-resolution studies for position, for beam energy, and for time. This technique provides a valuable tool to study the quasi-particle and phonon interactions in the STJ devices such as phonon escape and quasi-particle diffusion. F. Peterreins (Technical University of Munich, West Germany) presented results using STJ devices as ballistic phonon detectors. Other uses of STJ's in radio astronomy electronics and as optical and IR detectors (J. C. Villegier, LETI, Grenoble, France) were presented.

Superheated Superconducting Granules

Perrer-Gallix gave a review talk on the SSG devices. These devices are microscopic (1 to 50) granules of Type I superconductors that are in a superheated metastable state in the presence of a weak magnetic field. The deposition of even a small amount of energy (υ, axion, x-ray, etc.) will cause a granule to "flip" to the normal state. The flipping can be detected by measuring a change in magnetic flux. The technical challenges include:

- Production of smaller, more uniform granules
- Selection of materials, granule preparation, and granule fill density
- Improvement of readout such as use of dc superconducting quantum interference devices (SQUID's)
- Development of position readout.

The so-called avalanche effect was discussed in detail. This effect is the cascade of grain flips that could possibly be triggered in very small granules at $T \ll T_c$. The number of grain flips may be proportional to the energy of the incident particle. M. Le Gross (University of British Columbia, Canada) demonstrated a significant signal-to-noise improvement of RF SQUID readout of SSG's using 6000 5-μgrains. The radiation hardness of these detectors and the superconducting detectors in general was discussed with the proposal by Drukier to use these devices in hostile radiation environments. Also, ongoing theoretical efforts into the understanding of the radiation/superheating transition phenomena were presented.

Bolometers

The most successful cryogenic detector technology to date uses bolometers to measure the calorimetric effect of the particle absorption. Several groups are working on development of both μ-bolometers, needed for high energy and spatial resolution, and larger bolometers, needed for higher efficiency. A large effort, which covers all aspects of detector development, is underway at the INFN, Milan, Italy, to develop large germanium bolometers. S. Read, Rutherford-Appleton Laboratories, UK, said that efforts are also underway in the UK Dark Matter Collaboration.

Other Detectors

P. O. Caldwell (University of Santa Barbara, California) discussed a search for dark matter, using low-background germanium detectors, establishing new upper

limits on the mass and interaction strength of dark matter candidates including an upper limit on the solar axion mass of less than 10 eV. The limits are based on a comparison of the low energy spectrum of these detectors and calculations of the predicted count rate assuming a particle flux sufficient to account for the missing mass.

Another ongoing experiment is the search for cosmic axions, reported by S. de Panfilis (University of Rochester, New York). His detector uses a microwave cavity placed in a strong magnetic field. The axion decays to two photons in the presence of the magnetic field. Cosmological arguments and Supernova 1987a have set the search limits of the axion mass to between 10^{-5} and 10^{-3} eV. The expected local flux is 10^{12}/s/cm^2. The search looks for a very narrow resonance between 1 and 6 GHz with a search rate of 200 Hz/s. The current detector is only a prototype as the sensitivity is only 1 percent of that needed to detect the predicted flux of axions.

Another original proposal, this one by G. Picket (University of Lancaster, UK) for a sensitive cryogenic detector is the use of superfluid ^{3}He at a temperature of 100 μK. The quasi-particle density is essentially zero and the energy gap is only 10^{-7} eV, which could make this system a very sensitive detector. In discussion of this proposal the difficulty of a fast readout device for small energy deposition was indicated.

S. E. King (NRL, Washington) proposed a granular thin film detector using the disruption of superconductive phase coherence in NbN/BN thin films as a means to detect radiation with moderately high energy resolution with a simple and rugged device. In another unique experiment (by T. O. Niinikoski of CERN, Geneva, Switzerland), a limit on galactic dark matter was determined by the limit set in the heat load of Cu nuclear magnetic refrigerators. If the entire heat load is attributed to coherent 1-phonon scattering of dark matter a maximum limit can be set in terms of mass versus interaction strength. Currently, the sensitivity of this experiment is several orders of magnitude below that needed to eliminate any of the dark matter candidates.

The current status of the magnetic monopole search using SQUID detectors was discussed by J. Incandela, CERN. The current limit on monopole flux combining all experiments is $9.9\text{x}10^{-13}$/cm^2/sr/s.

Other topics discussed include the metallurgical and solid-state engineering techniques for the preparation of these detector devices, such as a new μ-fabrication technique for etching silicon, x-ray astrophysics applications, and an update on high T_c superconductivity.

Summary

The workshop was concluded by K. Pretzel (Max Planck Institute for Physics and Astrophysics, Munich, West Germany) with a comprehensive summary and discussion. Clearly there is a growing interest in the development of low-temperature devices for neutrino and dark matter detectors. Other applications are spectroscopic ultrahigh spatial resolution x-ray imaging, optical and IR radiation detectors, cold neuron, and other low energy particle detectors, and phonon detectors. However, it is also clear that the fundamental experiments that were the original motivation of this research are a long way from realization. Slow but steady progress is being made on all fronts. In the process, this research is enhancing an understanding of the particle/radiation interactions and revealing important phenomena in cryogenic devices. Each of the technologies under development has individual strengths and weaknesses, so no single device is expected to solve all the detection problems. The state of the current research is still exploratory. It appears that at least 2 to 3 years of research will be required to demonstrate the viability of one or more of these ideas. At that point, hopefully, full-scale development of one or more detector systems will begin to address the many fundamental problems posed at this workshop.

7/22/88

Advanced Sensor Research at Siemens

by Paul Roman.

In 1986 West Germany cornered 45 percent of Europe's market in semiconductor-based sensors. No wonder then that the largest German electrical, electronics, dataprocessing, and telecommunications firm, Siemens A.G., recently accelerated its research and prototyping of novel sensors, which also include on one chip important parts of the processing microelectronics. Two main lines are reviewed here.

Intelligent MOS-Transistor Sensors

Siemens developed a class of miniaturized metal oxide semiconductor (MOS) devices suitable for the modern, normalized and self-calibrated measurement of mechanical entities such as pressure, flow, vibration, and acceleration. They are based on the well-known pressure-dependence of the MOS-transistors' channel-conductivity. Actually, the sensor system determines the detuning of a ring-oscillator circuit which contains several field effect transistors (MOSFET's). The transistors and resistances, capacitances, etc. are carefully arranged on a thin-film membrane. Additional built-in microelectronic circuits provide on-chip correction of temperature effects. Of course, the output is an easily digitized frequency.

While well-developed methods of silicon technology make the fabrication of such sensors feasible, there are also a number of unusual micromechanical fabrication steps involved. Research toward these problems has been completed in the Erlangen laboratories of Siemens, where also a new clean room fabrication facility was opened up for production.

Chemical Sensors for Liquids and Gases

Ion-sensitive field-effect transistor sensors, ISFET's (a subclass of more general, chemically sensitive field-effect transistors, ChemFET's) are a focal effort of Siemens. In such devices, the gate-electrode of the well-known MOSFET is replaced by a chemically sensitive (in the present case, ion-sensitive) membrane. When the concentration of a specifically defined ion in a liquid (or gas) changes, the charge distribution on the surface of the membrane will change. The resulting potential difference then controls the channel resistivity.

In the Siemens devices for liquids, the crucial part of the sensor consists of a flow cell with a sandwich-like structure. This contains two ISFET's with identical membranes. For calibration of the zero level, both are moistened with some liquid. In the course of the actual measurement, one of the ISFET's stays in contact with the calibrating liquid, the other with liquid to be tested. The ensuing voltage differential depends on the sample's ion concentration.

On the other hand, for gaseous samples Siemens developed an entirely new methodology. Here the researchers used a phototransistor which is preceeded with an optical filter so devised that it changes its transparency in the presence of certain gases or vapors. Such devices turned out to be particularly superior to other chemical sensors when the measurand is a polar molecule, such as alcohol or ammonia. Sensitivities down to a few thousandths of a percent (i.e., 10^{-5}) have been recently achieved.

These sensors have been produced also with a gas-transmitting encapsulation. These devices may be inserted into liquids for measuring gas concentrations of dissolved agents.

All chemical sensors developed at Siemens are strictly specific for only one chemical. By developing suitable membranes, current work focuses on extending the range of measurands.

The chemical sensor research at Siemens is done in cooperation with the Technical University of Munich.

For further information please contact directly Dr. H. Runge, Director, Information Services, Siemens A.G., Wittelsbacherplatz 2, D-8 Munich 2, West Germany. Telephone: (011-49-89) 636-46673 or 234-3690.

7/21/88

SUPERCONDUCTIVITY

International Discussion Meeting on High T_c Superconductors, Mauterndorf, Austria

by Robert J. Soulen, Jr. Dr. Soulen has recently been appointed as Head of the Superconducting Materials Section at the Naval Research Laboratory.

This meeting, held from 6 through 12 February 1988 at Mauterndorf, Austria, was devoted to a timely discussion of the most recent developments in the rapidly changing field of ceramic superconductors. The meeting drew approximately 100 attendees from Austria, France, the US, the Netherlands, Germany, Canada, the USSR, Japan, Yugoslavia, Sweden, Finland, Poland, Switzerland, Hungary, and Italy. The presentations were organized into the following topics:

- Overview
- Materials-Structure
- Mechanisms

- Critical Fields and Currents
- Films-Wires

Each topic was opened with presentations by two invited speakers. Except for the first and last, each topic then included a poster session with several (15-30) contributors. A wrap-up session led by a discussion leaders followed the posters. This format provided ample time for structured as well as unstructured discussions – clearly one of the special features of this conference. The conference proceedings will be published this fall (*High T_c Superconductors*, ed. H. W. Weber; being published by Plenum Publishing Corp., 233 Spring St., New York).

Overview

This conference was devoted to preparation of ceramic superconductors and to theoretical explanations for the observed properties. Clearly, the ceramic superconductors of greatest interest are those of the composition $REBa_2Cu_3O_7$, where RE stands for a rare earth element. These materials occupy center stage in contemporary superconductivity research by virtue of their very high superconducting transition temperatures, T_c (under best condition $T_c = 90$ K), and the strength of other superconducting properties, such as critical magnetic field, H_c, and critical current density, J_c. These compounds are referred to in shorthand notation as 123 compounds.

B. Raveau (University of Caen, France) discussed details critical to the synthesis of these materials. He reviewed the profound effect of O_2 content on the structure and the related valency state of the copper. Raveau reported that the effect of partial substitution of iron for copper was to convert YBaCuFeO into the tetragonal lattice structure which was still superconducting (albeit at a somewhat reduced $T_c = 60$ K) yet free of twins – a problem which may limit transport properties in these materials. Raveau also discussed the many types of lattice imperfection which can occur in these compounds. C.M. Varma (AT&T Bell Laboratories) then addressed the status of theoretical explanations of high-temperature superconductivity. After reviewing the salient experimental facts known about these systems, Varma outlined some of the attempts at theoretical explanation. It appears that the BCS theory, so successful in accounting for the properties of "conventional" superconductors (i.e., $T_c < 25$ K), and depending on an electron-lattice interaction as the basic mechanism for superconductivity, has not been successfully applied to ceramic superconductors. Other proposed theories are both ingenious and numerous, but not one was capable of explaining all of the facts. Development of a successful theory remains as one of the major goals of this field.

Materials-Structure

The session on materials-structures drew together the impressive body of information amassed in a very short time on the physical properties, structure, composition, preparation, and effects of substitution in the 123 compounds. As a class they exhibit anomalies in the resistance above T_c, and anomalies in the specific heat below T_c. These materials display extreme Type 2 superconducting behavior in which the lower critical magnetic field H_{c1} (i.e., the value at which magnetic field penetrates the sample) is rather small while the upper critical magnetic field H_{c2} (i.e., the magnetic field at which all traces of superconductivity disappear) becomes immeasurably large (estimated to be 100 T at absolute zero). Experiments demonstrated that $T_c = 91$-95 K for all materials independent of what is chosen for RE, but that T_c is strongly depressed by other substitutions (e.g., Fe and especially Zn). The structure of the 123 superconductors is composed of layers repeated in the following sequence along the c axis: one-dimensional CuO chains are arranged along the b axis of the crystal, a Ba layer, a CuO plane, a RE plane, a CuO plane, a Ba layer, and the CuO chains.

A special session was devoted to perhaps the most exciting development in this young field: Barely 2 weeks before the conference was held, the discovery of a new superconducting system BiSrCaCuO, with T_c greater than 100 K was announced! At the conference, presentations by representatives from the Argonne National Laboratory and the Naval Research Laboratory, from Japan, and from Leiden (the Netherlands), and Gottingen (West Germany) showed data confirming these results. Prospects for this material appear particularly exciting.

Mechanisms

Two invited speakers returned the attention of the conference to theoretical explanations of superconductivity. The first, J.P. Carbotte (McMaster University, Hamilton, Canada) studied the feasibility of embellishing the BCS theory with some add-ons (anisotropy, strong coupling) to see if it could encompass the properties of the new superconductors. It was a bit of a stretch, but wide tolerances in the available data – especially tunneling – allowed for optimism. W. Weber (Karlsruhe, West Germany) studied the problem from a different viewpoint, and concluded that strong correlations among the conduction electrons almost demand the consideration of additional mechanisms to account for high T_c superconductivity.

The poster sessions for the day devoted to mechanisms were concerned mainly with experimental studies designed to determine the nature of the mechanism responsible for superconductivity. A wide variety of tech-

niques were used (isotope effect; tunneling; pressure; EPR; x-ray, optical, electronic spectroscopy) but a consensus as to the basic mechanism responsible for superconductivity in these systems did not emerge.

Critical Fields and Currents and Films-Wires

Experimental evidence presented in the invited papers on this topic and in the poster session concur in the view that the critical magnetic fields of the 123 materials are quite anisotropic. The critical magnetic fields are roughly 5 to 10 times smaller when they are applied perpendicular to the c axis than when they are parallel. The experimental data is reasonably consistent with the Ginsberg-Landau phenomenological theory, and the (anisotropic) parameters have been determined. The picture of an extreme and anisotropic Type 2 superconducting behavior for the 123 materials emerges from the data and analysis.

Many of the important technical applications envisioned for these new superconductors hinge on the success of simultaneously increasing all three critical parameters – T_c, H_{c2}, and J_c. Considerable progress has been made in increasing the first two, but the critical current density has not yet been increased to the level needed for many applications. R.B. Laibowitz (IBM) did report that great strides have been made in producing thin films of 123 materials on a variety of substrates and that the J_c values were high enough for technical applications. These results at least prove the feasibility of using 123 superconductors for a wide variety of electronic applications including Josephson devices, mixers, and transformers. How quickly devices appear will depend on the success in solving a myriad of problems associated with optimizing the superconductive properties of the films, in configuring them to specific geometries, and combining them with other thin film layers. O. Horigami (the Toshiba Company, Japan) reviewed the status of J_c for 123 in wire form. Progress has not been as rapid here as in thin films: the critical current density is roughly 1000 times smaller in the best wires than in the best films. The applications awaiting superconductivity in bulk form are far from feasible at this time.

Conclusion

Well-justified excitement attends the field of high-temperature superconductivy. The phenomenon challenges our understanding of its fundamentals – without a basic theory it is impossible for instance to envision how high we may push T_c. Certainly the dramatic discoveries thus far have revived the hope for room-temperature superconductivity. Much has also been made of the potential applications of high-temperature superconductivity, but the conferees learned that many barriers yet remain. This conference did much to capture a snapshot of the dynamic evolution of a field, the endpoint of which cannot be envisioned by its participants.

7/22/88

NEWS, NOTES, AND ABSTRACTS

Technical Research Center of Finland (VTT)

During late September 1988 I visited the Technical Research Center (VTT) of Finland. This national research "center" features laboratories in the largest Finnish cities with a major facility in Helsinki. In 1984, the National Science Council approved a plan to provide a research expenditure of 2 percent of the gross national product by 1990. VTT's 2440 man-years of science in 1987 is soundly based and features significant new facilities in a wide spectrum of science and industrial research in energy, information, and manufacturing technology. The general breakdown of budget source and committment is provided in the pie charts, Figures 1 and 2.

International Interactions. The national technology programs financed by the Technology Development Center (TEKES) are an important form of research cooperation in Finland. VTT is involved in most of the 14 technology programs at present underway. In 1987 VTT received FIM38 million (about $9.1 million) from TEKES to finance these programs, and VTT also used some of its own funds for this purpose.

International cooperation in technology has been going through an active stage of development at VTT. This has been affected by Finland's participation in EUREKA as well as admission into vari-

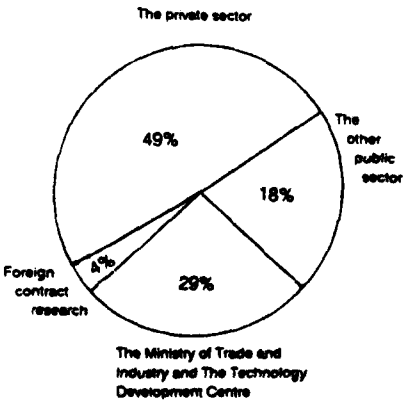

Figure 1. Income from contract research 1987 FIM 342 million.

ous EEC research programs. Moreover, there has been a clear increase in international cooperation started at VTT's own initiative.

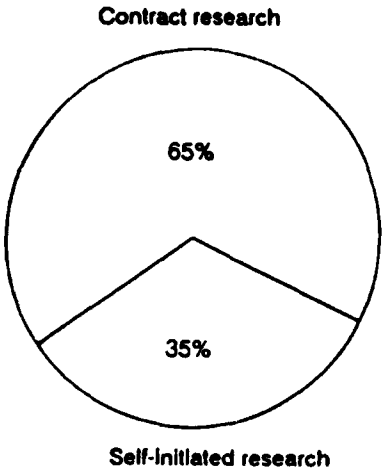

Figure 2. Operating expenditure 1987 FIM 443 million.

The project proposal "Advanced Simulator for Chemical Plants" produced by VTT and VTT Technology Oy was accepted as a EUREKA project. In addition, VTT has acted as a subcontractor for various companies in certain Finnish EUREKA projects. VTT is among the first to participate in the EEC's EURAM material program and RACE telecommunications program. In connection with the EURAM program, work is underway at VTT to investigate the environmental factors leading to failure of titanium alloys in offshore structures, to develop and evaluate new tribological ceramic coatings in the engineering industry, and to develop optical data transmission components.

Specific Programs and Two Superior Facilities. Some specific programs of general interest include radiotherapy medicine for rheumatoid arthritis, infrared electronic door locks, robot vision, optical data transmission, purification of biotechnical products, and electrochemistry of conductive polymers, to name but a few. I concentrated on visiting the VTT Ship Laboratory group, which features a major national towing tank, a small wind tunnel, and a world-unique, world-class 40-m x 40-m ice-modeling/towing basin and a most impressive shiphandling simulator. The ice-modeling basin was so impressive that I will document it as a separate *ESNIB* report. The shiphandling simulator is a computer-generated imagery system in a full-size bridge capable of training an entire bridge team. Different ship types can be simulated. The towing tank, which is 125 m in length, can handle models of up to 6 m long; it is a superior facility though similar to most national tow tanks. The wind tunnels are small by international standards and designed more for testing small devices or systems, but certainly not aircraft.

Conclusion

Finland is a relatively small country which is very advanced in several areas of science and technology. While maintaining the highest standards it has made a major commitment to science and technology. The educational standard is high and the populace well educated. Flawless English is common in the major industrial areas. The commitment to excellence is seen by the number and quality of the new facilities which seem to be everywhere. Any American company or university would be proud to own the facilities that I saw. I believe that Finland is a real comer.

T.J. McCloskey
10/6/88

Sediment Characterization Using a Standard Echo Sounder

Accurate knowledge of the physical structure of the seabed is a vital requirement for many scientific, commercial, and military applications. Sophisticated hydroacoustics have been the preferred technique for remote sensing of the seabed, with mechanical devices often used for establishing "ground truth." Most of the hydroacoustic/electronic remote sensing devices have in common the fact that their output requires a subjective, expert interpretation of a high-definition visual image. Though there are computer expert systems and image processing techniques to aid and supplement human expertise for deep marine geophysics, positive and precise identification of the surface of the seabed has not been accomplished in a particularly straightforward manner. However, Marine Microsystems Ltd., of Ireland, has developed an ultrasonic signal processing system (USP) whose unique feature is its patented ability to process selected features of reflected hydroacoustic signals from standard echo sounders and thus convert the physical structure of the surface of the seabed into a numerical format.

Marine surveyors have for some time been aware of the potential of the hydrographic echo sounder as a source of information on the consistency of the sea bottom. It is possible to glean some knowledge of the so-called "hardness" of the seabed from visual interpretation of the graphical recordings displayed on the sounder, the guideline being "the longer the echo the softer the material." The lower impedance of silt or soft clay enables the acoustic wave to achieve greater penetration. Similarly, the length of the echoes decreases when the survey craft is passing over a harder area. The USP system capitalizes on the presence of the "second echo," visible on most standard echo-sounding readouts. The basic USP model provides two main digital readouts, E1 (ground roughness) and E2 (ground hardness), from analyses of the ship's echo-sounder signals. These readouts refer respectively to quantified and averaged values for the first and second echo returns. It has been customary for hydroacoustic experts to dismiss the second echo return as "irrelevant" and to presume that the echo is merely specular. However, the company's research has shown that while the value of E1 is obviously important, the E2 return is even more valuable, containing, in essence, a square function of bottom information.

The USP operating system includes a signal processing unit with data storage, an operating keyboard, and a color video display. Data is acquired from the vessel's echo sounder, then processed and stored in the integrated computer. The USP primary processing unit fits into most PC-type computers. Its patented techniques transform selected elements of the echo-sounder signals into raw outputs of ground roughness and ground hardness. According to the manufacturer, the USP system has been successfully tried with over 40 different echo sounders of varying

quality, complexity, frequency, and beam width.

J.P. Simpson
11/7/88

New Method for Treating Mercury and Lead Poisoning Discovered by Technion Researchers

According to a Technion news release, grave dissatisfaction with conventional methods of treating people poisoned by toxic metals like mercury, lead, cadmium, and arsenic has led researchers at Israel's Technion-Israel Institute of Technology to come up with a unique new method to restore poison victims to health.

Professor Samuel Yanai and his colleagues at the Technion's Department of Food Engineering and Biotechnology have found a way of clearing the blood of toxic metals by the use of hemodialysis, which involves cleaning the blood outside of the patient's body. The Technion team worked in cooperation with Dr. Uri Taitelman, head of the National Poison Information Center at the Rambam Medical Center in Haifa.

Toxic metals enter and accumulate in the body by various means. Arsenic is used in many dyes, in insecticides, and in the production of polymers, and cadmium is used in the electronic and metallurgic industries. Lead exists in many colors added to toys and in industry in general. Most common are cases of mercury poisoning caused by ingesting contaminated food. In the early 1960's, hundreds of people in Japan were poisoned after consuming fish with high mercury levels.

In Israel, doctors see cases of poisoning among the rural and nomad populations who continue to mill wheat for flour with grinding devices containing lead. And mercury poisoning cases can occur when these populations eat tainted wheat grains not meant for human consumption. A person can tolerate small amounts of toxic metals in the body, Yanai said. However, when there is repeated exposure, the danger level is exceeded, the person is poisoned, and death can result.

Professor Yanai pointed out that in the conventional method of treatment, specialized drugs are administered which attach themselves to the toxic metals and carry them from the body. But it was found that in many cases the drugs also linked with valuable substances essential for good health, like iron, magnesium, and calcium and removed them from the patient's system. "This method sometimes caused more damage to the patient than the poisoning itself," he said.

Doctors also noted that the drug-metal complex could enter the central nervous system, especially the brain, causing a different set of medical problems.

Another drawback to the conventional method was that drugs taken orally were often not completely effective. This led doctors to prescribe increasing amounts of medication, in itself a situation to be avoided. A single treatment took between 24 and 48 hours, and in many cases, had to be repeated.

The procedure devised at the Technion avoids all these problems because the blood is cleaned outside of the body by hemodialysis. With the new method, which takes only 3 to 5 hours, medication is administered to the poison victim's blood as it passes through the dialysis machine, and then the blood is returned to the patient essentially free of both medication and dangerous metal substances.

The efficiency of the new procedure was proven after an Arabic family, poisoned as a result of eating bread baked from flour tainted with mercury, was successfully treated by hemodialysis. When the results of the case became known, the Ministry of Health also approved the use of Professor Yanai's method for lead poisoning.

C.J. Fox
11/9/88

New German Mid-Infrared Diode Lasers are Commercially Available

As the result of an extensive R&D program concluded recently at the Fraunhofer Institute for Physical Measurement Technology (Freiburg), the firm Mütek now supplies off the shelf five models of very efficient, stable, inexpensive lead chalcogenide lasers; others, with customized specifications, may be ordered with rather short delivery times. The five standard models cover (contiguously) the range from 3.3 μm to 25 μm. They are all tunable (via temperature control) and the tuning-ranges vary between 35 to 250 cm^{-1}, depending on the model and on whether pulsed or c.w. operation is employed. The total outputs range from 0.1 mW to 1.5 mW. The mean operating temperatures vary between 35 K and 250 K. Threshold currents are of the order of 100 to 300 mA.

More technical details are given in MASB 62-88. For any further information please contact directly the Technical Director, Mütek GmbH, Arzerbergerstrasse 10, D 8036 Herrsching, West Germany. Telephone (011 49 8152) 2046.

Paul Roman
9/2/88

A "Glasnost" Potpourri from US-USSR Symposium on Strongly Interacting Electron Systems

A US-USSR Condensed Matter Theory Symposium on Strongly Interacting Electron Systems was held from 30 September through 4 October 1988 at Tblisi, Georgia, USSR. This resumes the series following the last such US-USSR symposium held at the University of California, Santa Barbara 10 years ago. As reported by Professor Piers Coleman of Rutgers University, this small (70 people) workshop drew together some of the best theoreticians in the US and USSR to discuss a variety of topics including models for high T_c superconductivity, the quantum Hall effect, and heavy Fermion systems.

In extensive discussions of various high T_c models involving spin, one band, two bands, etc. the workshop concluded that the hybrid nature of the electronic states would have to account for a wide range of experimental results. Some of these results, such as electron energy loss

(EELS), indicate that it is solely the oxygen p states that carry the charge; some, like nuclear magnetic resonance, indicate the copper d spins are strongly involved; and photoemission shows both. Strong thermally activated flux creep was also shown to be readily modeled with a characteristic energy of 100 to 1000 K. It was also observed that an "irreversible critical field" frequently masks a true upper critical field and would result in even smaller coherence lengths.

Little work appears to be in progress in the USSR on fractional quantum Hall effect (FQHE), but in this area of investigation the UK's N. Read, reported that a local order parameter creating a small quantum region with 1, 2, 3, ... flux quanta plus a particle can explain some of the results. Mineev of the Landau Institute showed that only two possible allowed Landau-Ginsburg symmetries in the heavy Fermion U-Th-Be system predicts the three phases. Vulovic, also at Landau, showed that the equivalent of the FQHE should be observable in thin liquid helium 3 films.

Some of the more intriguing results noted come from the first visit by Westerners to the USSR's Institute of Physical Problems at Chernogolovka. Among these were: a new low pressure of 10^{-13} bar obtained by cryopumping with LHe_3; precisely shaped, single crystal sapphire nuts and bolts that were "designer" grown and not machined; single crystal Nb and Mo films that were obtained by "rolling" larger single crystals and were flexible and had resistivity ratios of 10^5; and zone refined single crystals of YBCO where the zone could be traversed reversibly by electromigration by reversing the current.

Finally, there were several indications of a much more relaxed policy of Soviet scientists being permitted extended stays in the West, including Dr. K. B. Efetov from Chernogolovka, who will become an acting director of the Max Planck Institute at Stuttgart. Dr. Efetov will be head of the Condensed Matter Theory Group, a position recently vacated by the death of Dr. Henry Bilz.

Alan F. Clark
11/7/88

SQUID Applications Focal Point at the University of Strathclyde

In an excellent example of one of Europe's many "pockets of excellence," Professor Gordon Donaldson and Dr. Colin Pegrum have created in the Department of Physics and Applied Physics at the UK's University of Strathclyde a very strong program in superconducting quantum interference device (SQUID) applications. Located in central Glasgow and drawing mostly from the excellent Scottish educational system, the university provides quality students for this broad-based program which is supported by the ministries of health and defense as well as British industries.

Although not brimming with the latest in high-tech facilities, the department's carefully built and maintained clean room has produced some of the world's lowest noise SQUID's. Devices and circuits are made using mostly Nb-Pb and Nb-Nb technology assisted by a Rutherford Laboratory computer link for mask production. The applications studies fall in the three general categories of medical, gravity, and nondestructive evaluation (NDE).

The group – and Professor Donaldson – are the world's leaders in applying SQUID technology to NDE and were the first to demonstrate its feasibility. With an awareness of offshore oil rig problems, the group has demonstrated crack and corrosion pit detection from as far as 10 cm away. On a more fundamental basis, they can observe not only crack propagation but also changes in the nature of the strained material preceding the crack growth. This could well have application to fundamental fatigue studies.

In medical applications, the principle focus, is on magnetoencephalography (MEG) in collaboration with a Glasgow hospital. With a vertical plane detector array perpendicular to the brain surface instead of the usual parallel configuration, the investigators hope to be able to use a 16 parallel-loop detector for lower noise and still maintain spatial resolution and be able to monitor signal changes in multiple sclerosis and Alzheimer patients. They are also studying the use of SQUID's as detectors for low-field magnetic resonance imaging (MRI) where detector signals are necessarily much lower. Low-field MRI has the apparent advantage of tracking biological processes more closely.

Accuracy in inertial guidance accelerometers requires a knowledge of the changes in the gravity gradient. A clever design of two SQUID circuits in series where Nb diaphragms are moving walls in parts of each circuit permits an integration of the gravity gradient detectable as the SQUID current. Coupled with some of their low-noise SQUID's, such circuits readily provide the needed accuracy and are typical of the group's abilities for innovative superconducting electronics applications.

Alan F. Clark
11/7/88

European Project Achieves Temperatures Ten Times Hotter than the Sun

Thermonuclear plasmas, nearly 10 times hotter than in the center of the sun have been achieved in the Joint European Torus (JET), the Director of the Project, Dr. P.H. Rebut recently announced. JET now routinely produces plasmas with temperatures well over 10^8°C for several seconds. Describing the impressive progress made in JET in recent months, Rebut said "the knowledge gained at this stage of our experimental program enables us to define confidently the parameters of a fusion reactor."

JET, the "flagship" of Europe's coordinated fusion research program, was set up in Culham, Oxfordshire, as a Joint Undertaking in 1978. Earlier this year the Council of Ministers approved the extension of the JET program up to the end of 1992 with an annual budget of a little over 100 million ECU (about $116 million). The staff and funds for the project come from Euratom and 14 European countries (the 12 member countries of the EEC together with Sweden and Switzerland).

At the halfway stage of the scheduled experimental program JET has not only reached plasma temperatures greater than 10^7°C but has also achieved the required plasma density and the necessary confinement time for a reactor, but not all

at the same time. JET is the only machine to have achieved a confinement time greater than 1 second, Dr. Rebut told the press conference. The record plasma heating current of 7 million Amperes is more than twice that of any other fusion experiment.

Rebut pointed out that when the proposal for JET was first made the best combined plasma parameter that any fusion experiment had reached was 25,000 times lower than the required reactor value. Today JET is only a factor of 20 lower than the reactor value. The results are very significant for the proposed experimental fusion reactors to follow JET. These include NET (Next European Torus) and ITER (International Thermonuclear Experimental Reactor). The ITER design team consists of scientists and engineers from the US, the Soviet Union, Japan, and Europe. "Both the NET and ITER teams are adopting the same design philosophy as JET; that is, a large noncircular cross section and a large plasma current," said Dr. Rebut.

C.J. Fox
11/9/88

A Collective Search Initiated for New Superconducting Materials

With the direct aim of seeking new superconducting materials, a collective research program is being coordinated by the Harwell Laboratory of the UK Atomic Energy Authority. Industrial laboratories throughout Europe have been invited to participate following the format of a similar and successful program addressing electrical ceramics in the early 1980's. This new program's aim is "to test a sufficient number of materials in the main classes of ceramics so that it will become clear how widespread the phenomenon of superconductivity is. This will assist greatly with the development of theory by providing data for a statistical correlation of properties with structural features and composition and in turn will lead to an advanced capability for the prediction of new superconducting materials. The identification of new materials with improved critical temperature, T_c, or critical current, J_c, will obviously be of great value, opening the way to new applications. Even the identification of new materials with similar superconducting properties to those already known is likely to be of benefit in respect of patent circumvention or of providing materials fabrication options."

For a small fee (£9000, about $16,000) an industrial member will participate in the program planning, have access to all the results as they emerge, and share in the arising intellectual property rights. It is anticipated that a large number (many hundreds) of materials will be prepared and characterized by the program's members as best fits their capabilities but following strict purity and procedure guidelines. Target materials will range from simple oxides, complex oxides, doped oxides, to even nonoxide ceramics in the following structural groups: perovskites, pyrochlors, bronzes, spinels, and magnetoplumbites. All materials will be tested from 4 to 293 K for conductivity and magnetic susceptibility using an automated system in place at Harwell.

The program is being coordinated by Dr. P.T. Moseley, Materials Development Division, Harewell Laboratory, UKAEA, Oxfordshire OX11 – 0RA, United Kingdom.

Alan F. Clark
11/7/88

ONRL REPORTS AND MAS BULLETINS

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.

Aviation

Workshop Proceedings on Composite Aircraft Certification and Airworthiness, by CDR Dennis R. Sadowski. **(8-017-R)** This report contains a summary of the workshop, a list of attendees, a prepaper entitled "Some Areas for Discussion Suggested by RAE," and the presentations of Composite Aircraft Structures, Civil Aviation Concerns, Impact Damage, RAE Composite Certification, and the Effect of Observed Climatic Conditions on the Moisture Equilibrium Level of Fiber-Reinforced Plastics.

Behavioral Science

The Twenty-Fourth International Applied Military Psychology Symposium, by William D. Crano. **(8-018-C)** The papers given at this symposium, held in July 1988 in Toronto, Canada, are reviewed under five general categories: manpower (emphasis on retention), tests and selection, performance and morale, treatment (primarily of psychological problems), and organizational development.

Computer Science

European Seminar on Neural Computing, by Claire E. Zomzely-Neurath. **(8-010-C)** The presentations given at this seminar, held in February 1988 in London, UK, are reviewed in depth. Topics range from neural systems and models through languages and architectures to the respective European and American perspectives on neurocomputing.

The RACE Program of the European Communities, by Dr. J.F. Blackburn. **(8-014-R)** The background of RACE – the program for R&D in advanced communications technologies for Europe – and progress in the technologies it embra-ces are discussed.

Those technologies include: switching, transmission, customer access, terminal and display, and coding.

Fluid Mechanics

Research in Fluid Mechanics, Control Theory and Such in Yugoslavia, by Dr. Daniel J. Collins. **(8-013-R)** The author visited Yugoslavia's Universities of Belgrade and Sarajevo, the Institute for Control and Computer Sciences of the Energoinvest company, and two research institutes – Steffan Institute and Rudger Boskovic Institute. He reports on the control theory, fluid mechanics, and other research being done there.

Materials Science

Sixth International Conference on Composite Materials (ICCM-VI), by Drs. S.G. Fishman and Y.D. Rajapakse. **(8-015-C)** Selected papers presented in five of the six sessions held at this meeting in London, UK, are discussed. The areas covered in the sessions these papers were given are: metal matrix composites, ceramic matrix composites, mechanical characterization, impact, and nondestructive testing.

Engineering Materials for Very High Temperatures – an ONRL Workshop, by Dr. Louis Cartz. **(8-016-R)** The limitations of present-day materials at very high temperatures are reviewed: silicon-nitride-based ceramics, silicon carbide, and carbon materials. Near-term and long-term studies are described to improve the performance at temperatures above 1400°C of monolithic ceramics, composites, and ceramic coatings. The full texts of the papers given at the workshop are included.

MAS Bulletins

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

- 65-88 Handheld Electronic Laser Rangefinder
- 66-88 New System for Measuring Hull Roughness
- 67-88 Oceanographic Equipment from a West German Firm
- 68-88 Ice Model Basin – Helsinki University
- 69-88 Two European Multibeam Echosounders
- 70-88 New Welding Glass
- 71-88 Sediment Characterization Using Standard Echosounder
- 72-88 WETOS 625 Automatic Ship Weather Station
- 73-88 French and Finnish Multibeam Survey Systems
- 74-88 Syntactic Foam from Finland
- 75-88 Soviet Submersible Built in Finland

REPORTS ON EUROPEAN SCIENCE AND TECHNOLOGY FROM OTHER COMMANDS

Reports

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

Aeronautics

The Fourteenth European Rotorcraft Forum, 20-23 September 1988, by Dr. R.E. Reichenbach, USARDSG. [Address inquiries to Dr. Reichenbach]

I attended the Fourteenth European Rotorcraft Forum which was held at the Museo Nazionale della Scienza e della Tecnica Leonardo da Vinci in Milan, Italy. The forum is held annually and had approximately 400 attendees, mainly from the UK, West Germany, France, Italy, and the Netherlands. The international organizing committee is composed of members from these five countries. Other countries with attendees present included the US, China, and Japan.

The contributed papers, primarily on R&D efforts, were organized into five dynamics sessions, three flight mechanics sessions, three aerodynamics sessions, two ground and flight test sessions, two structure and materials sessions, three avionics sessions, and airworthiness, quality and health control, and acoustics sessions. Most sessions appeared to be well attended. The Fifteenth European Rotorcraft Forum is to be held in Amsterdam, the Netherlands, from 12 through 15 September 1989.

Ballistics

Liaison Visit to Fraunhofer-Institut für Kurzzeitdynamik, Weil am Rhein, West Germany, by Dr. R.E. Reichenbach, USARDSG. [Address inquiries to Dr. Reichenbach]

On 14 September 1988, Dr. Fritz H. Oertel, US Army Research Office, and I reviewed the progress on BRL-funded European Research Office (ERO) contracts relative to interior ballistics. The objective of the task relative to solid propellant guns is to provide new insight into and detailed technical information on ballistic flow processes that occur in realistic, simulated gun environments to assist in the development of combustion submodels. The other research effort is in-

vestigating and optimizing the electrical ignition of hydroxyl-ammonium nitrate (HAN)-based liquid monopropellants for use as a propellant charge in the regenerative liquid propellant gun (RLPG). Excellent progress is being made on both contracts. The visit provided the opportunity to view the Institute's excellent experimental facilities, to meet Dr. Schroeder, Mr. Klingenberg and their research associate, and to receive briefings on other ongoing research efforts at the Institute.

Liaison Visit with Professor J. Whitelaw, Imperial College, London, by Dr. R.E. Reichenbach, USARDSG. [Address inquiries to Dr. Reichenbach]

Dr. Fritz Oertel, US Army Research Office, and I visited Professor Whitelaw and his research associates on 15 September 1988 to review their progress on the ERO-funded research effort to develop instrumentation and ballistic flow simulators for (1) measuring flow characteristics in the space vacated by a projectile in a gun barrel configuration and (2) assisting in the development of computational methods for simulating the two-phase reacting flow in a gun barrel. The research results from their laboratory simulation system will prove valuable for correlation with the results of the research on realistic, simulated gun environments using combusting drivers at the Fraunhofer Institute mentioned above.

Biological Sciences

Central Andrenergic Recepter as Mediators of Central Response to Stress; Study with Positive Emission Tomography, by Dr. Andre Goffinet, University of Louvain-la-Neuve, Belgium. (7 pp) [EOARD-TR-88-01; available through the Defense Technical Information Center (DTIC)]

This report describes initial studies designed to investigate the effects of a high degree of neurological alertness on brain metabolism. Positron emission tomography (PET) was used to quantitate brain metabolism using fluorodeoxyglucose (FDG) as an indicator of glucose uptake during mental stimulation provided by playing a video game (Mooncrash) for 30 minutes. Brain metabolism in 22 regions during neurological alertness was compared with the resting state. In most subjects there was a marked increase in brain metabolism with stimulation, however there was tremendous variability in brain metabolism in the eight subjects. Consistent patterns of activation were found with maximal activation in primary visual cortex, followed by parieto-occipital cortex, cerebellum and thalamus.

Chemistry

Physical Chemistry at the University of Turin, by LTC LaRell Smith, EOARD. (12 pp) [EOARD-LR-88-44]

The theoretical group of Professor Cesare Pisani is doing significant work on *ab-initio Hartree-Fock calculations.* They have worked in this area for 10 years and have improved the Hartree-Fock treatment to the point where it is seriously competitive with other calculations methods. The report contains additional information about the group's research and a book they have recently published. Also at Turin is a large group (30 people) under the direction of Professor Enzo Borello who work on various aspects of surface and cluster chemistry. Most of their efforts center around IR spectroscopy and the absorption of CO and CO_2 on oxide surfaces. The effort is directed primarily at catalysis.

Optical Bistability Conference, by LTC LaRell Smith, EOARD. (16 pp) [EOARD-LR-88-56]

The "Optical Bistability IV" topical meeting was held in Aussois, France, from 23 through 25 March 1988. There were approximately 200 papers presented with 14 countries represented. The meeting covered not just optical bistability, but also most areas of optical nonlinearity – particularly those relevant to optical communication and optical computing. This report covers significant papers dealing with ultrafast serial switching, data processing based on fiber optics, and massive parallel processing through optics.

Fluid Dynamics

Hypersonic CFD in Italy, by LTC Bob Winn, EOARD. (35 pp) [EOARD-LR-88-46]

The computational fluid dynamics (CFD) research in Italy is comparable to the best in the world. The most significant work is in the proper modeling of hypersonic flows. In particular, the chemistry which occurs at very high Mach numbers is carefully and correctly included in their CFD codes. This report covers the work of Dr. Claudio Bruno of the Consiglio Nazionale delle Ricerche in Milan and Professor Maurizio Pandolfi of the Polytechnic University of Turin.

Materials Science

Changing the Face of Materials: From Coal to Diamond, by Dr. W. Simmons, USARDSG. [Address inquiries to Dr. Simmons]

The common theme of several conferences sponsored by ERO this summer has been the modification or complete *reconstruction of the surface structure/properties.* Two such conferences were attended by Dr. W.C. Simmons, Chief of the Materials Science Branch, this month. A NATO-Advanced Study Institute near Luca, Italy, 1 through 9 September 1988, entitled "Ion Beam Surface-Modified Ceramics" dealt with the whole range of ion energies from a few eV to 10 MeV from many ion sources. The depth of modification can be adjusted from a few atomic layers to as much as several micrometers. Diamond-like coatings with high hardness, abrasion resistance, and altered electrical and optical properties can be applied on many substrate materials. If thicker coatings are desired, simultaneous ion bombardment and vapor deposition is performed to alter atomic structure and density as the material is built up. In this way, graded coatings and interfaces are possible. The "First International Conference on Surface Plasma Engineering" at Garmish-Partenkirchen, West Germany, from 19 through 23 September 1988, dealt primarily with lower energy ions and atoms hitting the surface. DARPA, which has a significant program interest in this area, supplied funds to the conference through ERO and has other present and pending contracts through our office on surface modification. The fundamental process is generic in nature and applies to the mechanical, electrical, optical, chemical, and magnetic properties of virtually every solid material, be it metal, ceramic, polymer, or composite. Army applications are legion!

Conference on Electrically Charged Interfaces, by Dr. R.J. Campbell, USARDSG. [Address inquiries to Dr. Campbell]

With partial funding from USARDSG-UK Research Division, representing joint support by the Electronics,

Physics, and Chemistry Branches, a multidisciplinary "International Conference on the Chemistry and Physics of Electrified Interfaces" was held from 29 August through 2 September in Bologna, Italy. More than 200 scientists from 26 countries participated in discussions on topics such as experimental approaches for surface electronic structure and properties; single crystal electrochemistry; charge carriers at electrode interfaces; membrane electric fields; and double layer structure theory and modeling. In representing the US Army research community at this conference, I noted that the expectations for a number of developments to arise were fully met. These included: advancement of our understanding of the charged interface; communication of novel approaches to double layer modeling on a molecular basis; useful attempts at unifying concepts and languages; stimulated implementation, in electrochemistry and membrane biophysics, of the most recent and powerful techniques developed for study of the solid/gas interface; insight into investigation of nonhomogenous areas of interest encompassing surface studies, and including corrosion processes, optics, semiconductors, chemical and biological detection, energy conversion, and new materials. A number of contacts were made with distinguished investigators whose research activities offer potential feed-in to these areas, and follow-up is underway.

Ceramic and Metal Matrix Composites at Two British Institutes, by LTC Jim Hansen, EOARD. (8 pp) [EOARD-LR-88-52]

Dr. McCartney heads current research at the British National Physical Laboratories in modeling and experimentation of both ceramic matrix and metal matrix composites. He has extended the Aveston-Cooper-Kelly model (1971) to cracks of finite width in brittle matrix composites, and he is experimenting with model material systems. Metal matrix composite programs are intended to develop a basic scientific understanding in order to improve material property control. At Cambridge University, Dr. Clyne is researching metal matrix composites. Titanium is plasma sprayed onto SiC monofilaments to study interfacial effects. Aluminum reinforced with whiskers and short fibers is extruded in carefully controlled experiments to develop a process minimizing fiber breakage and inhomogeneities.

1988 European MRS Conference, by Dr. Eirug Davies, EOARD. (3 pp) [EOARD-LR-88-54]

The 1988 European Materials Research Society Meeting was held at its customary Strasbourg, France, location and attracted an attendance of around 600. Symposia included were on ceramics, photon/plasma processing, deep implants, and metastable alloys. The Society in its 7 years of existence has established what has become one of Europe's foremost conferences on materials science.

Microelectronics

National Microelectronics Research Center, Ireland, by Dr. Eirug Davies, EOARD. (3 pp) [EOARD-LR-88-53]

The National Microelectronics Research Center, Ireland, is located in Cork, adjacent to the city's University College. It provides excellent student training in microelectronics and has become a successful participant in European collaborative research. It is currently undergoing expansion that will nearly double the size of its present facility.

Multidiscipline

Research Work at Ben Gurion University of the Negev, by LTC LaRell Smith, EOARD. (5 pp) [EOARD-LR-88-55]

Ben Gurion University of the Negev is one of the premier institutions in the world for research in magnetohydrodynamics. They are completing a new 10-kW pilot plant and are working on almost every aspect of magnetohydrodynamics. Another area of excellence is that of theory and calculation of shock waves. Professors Igra and Ben-Dor are world leaders in this field. Finally, a third area of excellence is the work of Professor Shlomo Efrima in Raman activity on surfaces and in the area of a newly discovered liquid-like silver film. This report gives more details about the above projects.

Physics

Recent Progress in Surface and Volume Scattering – a USARDSG-Sponsored Workshop, by Dr. J. Zavada, USARDSG. [Address inquiries to Dr. Zavada]

The European Research Office sponsored an international workshop entitled "Recent Progress in Surface and Volume Scattering" which was held in Madrid, Spain, from 14 through 16 September 1988. The workshop was organized by Dr. M. Nieto-Vesperinas from the Instituto de Optica in Madrid, and the sessions took place on the campus of the Consejo Superior de Investigaciones Cientificas. Nearly 30 invited scientists, representing 13 different countries, participated in the workshop and presented papers dealing with novel aspects of light scattering from surfaces and volumes.

On the first day there were eight talks centered on electromagnetic scattering from rough surfaces, including experimental and theoretical studies. Talks on the second day involved a number of related topics, such as second harmonic generation at rough surfaces and phonon scattering from interfaces. The third day concluded with papers dealing with enhanced backscattering of radiation from particles suspended in a fluid medium. In general, the presentations at the workshop were of a very high quality and most participants mentioned that they had a better understanding of these scattering phenomena due to the 3-day meeting.

Visit with Professors M. Casati, and H. Guarneri at the University of Milan, by Dr. J.M. Zavada. [Address inquiries to Dr. Zavada]

Professor Casati (University of Milan) and Professor Guarneri (University of Pavia) are investigators on a European Research Office contract (R&D 5653-PH-01) entitled "Chaotic Behavior in Quantum Mechanics." Dr. Andersen and I met with Professors Casati and Guarneri to discuss progress on their research. This research is generally devoted to the investigation of the relevance of classical chaos to quantum mechanics, especially when the quantum systems are subjected to time periodic perturbations. The professors' theoretical and numerical computations for the excitation of hydrogen atoms under a monochromatic microwave field show a suppression of chaotic excitation produced by quantum mechanics in an upper part of the frequency range; within this range, the quantum thresholds rise significantly above classically predicted thresholds. Ex-

perimental verification of these predictions have been obtained, within the last month, from Stony Brook Laboratories in the US.

Structures

Independent Suspension Heavy Vehicles, by LTC Jim Hansen, EOARD. (11 pp) [EOARD-LR-88-62]

The Timoney Technology Group in Dublin, Ireland, has developed an independent suspension system for heavy vehicles. They have incorporated it in a design of a 3000-gallon Crash Fire Rescue Truck offered to the US Air Force. Their heavy vehicles incorporate a rigid chassis mounted relatively low to the ground, resulting in unprecedented maneuverability and mobility on paved and rough surfaces.

Hotol Loads, Structures, and Materials, by LTC Jim Hansen, EOARD. (24 pp) [EOARD-LR-88-62]

This report documents a short presentation by the Chief of Materials and Structures for the British hypersonic vehicle Hotol, a competing vehicle to NASP. The presentation, entitled "Noise and Vibration Problems Associated with Hotol," deals briefly and generally with the materials and structures in Hotol and proceeds to outline major dynamic loads acting on the structure. The report includes hard copies of 18 presentation slides.

THE EMBASSIES: TECHNOLOGY ROUNDUP

Belgium

For further information on Belgian items, contact Mr. Niel Oberlin, Office of the American Consulate, American Embassy, APO New York 09667-1050.

EC Commission Proposes EC Involvement in Space Activities. The EC Commission has proposed that the Community play a greater role in space endeavors, through activities in research and technological development, telecommunications, remote sensing, industrial development, legal studies, and training. Herbert Allgeier, the EC Commission official who spearheaded the proposal, was in Washington in October, during which time he met with State, Commerce, and Defense officials to discuss the Commission's proposal on aeronautical research and development.

In July the EC Commission adopted for transmittal to the EC Council of (research) Ministers a proposal that the Community (as an institution) play a larger role in space affairs. The proposal includes an analysis of the Community's potential for improvements in space research and outlines possible future actions. The Commission requests only that the Council accept the proposal's analysis, acknowledge the need for the Community to play a wider and more active role in space matters, and approve the indicated areas of possible future actions. This is not a research approval for specific programs or for funding. Such requests would be submitted at a later date, following approval of the present proposal by the Council of Ministers. It is unclear when the Council formally will discuss the proposal.

The proposal lists six areas of possible future actions: (1) research and technological development (R&TD), to promote greater complementarity and synergy between EC R&TD and the various space programs (of the European Space Agency [ESA]); (2) telecommunications, to ensure and optimize the use of satellite technology in the development of terrestrial networks; (3) earth observation, to intensify the use of satellite information in various Community policy areas such as agriculture, environment, regional development, and development aid; (4) industrial development, to anticipate the effects of the 1992 single market in the sectors which involve space research; (5) legal aspects, to study questions such as the protection of satellite data with commercial value, civil and penal law concerning actions in space, and protection of the atmosphere from space trash; and (6) training, to encourage the development of advanced training programs related to space science and technology.

According to EC Commission officials, the proposal is designed to emphasize that space is no longer "just for pioneers," that it touches on many aspects of economic activity. Therefore, there may be a role for the EC in space activities. Various relevant EC policies should be examined; e.g., the accelerated push for a fully integrated single European market by 1992, R&D priorities, environment issues. The EC should attempt to support European space programs where it can. "This is just to put an EC dimension into space technology," one official said. "We are not going to build a shuttle."

Israel

For further information on Israeli items, contact Mr. Anthony (Bud) Rock, Office of the Science Counselor, American Embassy, Tel Aviv, APO New York 09672-9700.

Lasers and Optics in Israel. The following is one of a series of reports in preparation on centers of basic research excellence in Israel. The Science Attaché has been reviewing these activities in conjunction with Ministry of Science and Development (MOSD) plans to define (and hopefully offer financial assistance to) areas (or centers) of particular research strength. A separate initiative is underway by the Ministry of Industry and Trade (MOIT) to find a linkage between some of these centers and local industries for commercial opportunities.

The following list of centers for excellence in lasers and optics in Israel includes both centers and informal groups where a critical mass of academic excellence in a particular field has been attained in a particular location. The list is by no means complete, and in many centers only part of the information can be given. In addition, there are many excellent individual scientists who are not associated with any identified center or group.

- The Planned Institute for Laser Medicine; Beilinson Hospital (Center of

Excellence) – Professor Isaac Kaplan, Dr. I. Giller, Dr. Yona Tadir. This is the oldest and the most active group of medical scientist involved in the medical applications of lasers in Israel. The leader of the group, Professor I. Kaplan, is a pioneer in the field, having developed the first successful CO_2 surgical laser. He is also Honorary Chairman of the International Society for Laser Medicine and Surgery. The center is involved in clinical research, development of new applications for lasers in medicine, education, and laser tissue interaction.

The center is in the initial stage of acquiring a free electron laser from Professor Medy's group in Stanford University. This laser is an ideal investigative tool for laser tissue interaction. In addition, Professor Kaplan believes that novel treatments can be found with the free electron laser.

- Electro-optic Research Center, Physics; Technion – Professors Steve Lipson and Uri Openheimer. The center was set up in 1976 in the Physics Department as the infrared radiation laboratory and has continued to serve as an all-purpose consulting facility to solve problems of infrared radiometry and spectroscopy in Israel. Lately, a thermal imaging unit has been set up. The staff consists of six Ph.D. physicists. The center also offers a graduate and postgraduate program in electro-optics.
- Center of Excellence for Electro-optics, Electrical Engineering; Technion – Professor Joseph Shamir and Dr. Baruch Fischer. The scientists at this center concentrate on the subjects of digital and optical computing. Fischer is one of the leading scientists in the world in the applications of phase conjugation.
- Center of Excellence for Electro-optics, Engineering; Tel Aviv University (Planned to be set up as an official center) – Professors Emmanuel Merom, Amion Yariv [honorary, from Caltech], Amos Hardy, Avram Gover, N. Croitoru, and Moshe Tur, and Drs. M. Jassby, Shlomo Rushin, and David Peri. This group is probably the largest concentration of eminent scientists involved in academic research in the field. Some 40 scientists are involved in optics-related research work here – not including the many part-time scientists or engineers, who also work in industry. There is an ongoing graduate and postgraduate program going on in electro-optics and lasers. Research is being done in a wide range of fields: electro-optics, atmospheric optics, solar energy, nondestructive evaluation, optical computing, integrated optics, lasers in medicine, etc.
- Center of Excellence for Solid-State and Solar-Pumped Lasers, and for Isotope Research; Weizmann Institute – Professors Amnion Yofeb, I. Dostrovsky, and Joseph Schwartz, and Drs. Meir Weksler and Moshe Oron. This group of scientists have succeeded in developing the solar-pumped laser with the highest output in the world – 150 watt. The center enjoys the use of a 10-kW solar furnace. The group deals with solid-state lasers, in particular, tunable ones. (This subject has turned out to be of major interest overseas, especially for applications in space). Weizmann scientists are also now actively engaged in free electron laser development and applications, and discussions are underway for further collaboration in this area with US firms.
- Technology Center for Electronic Materials; Israel Institute for Metals, Technion – Dr. Joseph Zehavi. This center deals with laser application in material processing, in particular, laser-induced metal deposition, annealing, and removal of materials for a wide span of applications, such as microelectronics production and production of integrated circuits and in the metallurgy industry. The center recently opened an excimer laser laboratory. The center also has several scientists from industry involved in research projects.
- Research Laboratory for Laser Application in Cardiology; Tel Hashomer Hospital (Center of Excellence, no formal organization) – Professor Michael Belkin. This center is involved in both clinical research and the development of novel applications of lasers to ophthalmology. The center has recently acquired an excimer laser for its research.
- Center of Excellence for Chemical Lasers, Physics; Ben Gurion University – Professor Zalman Rozenwaks. This center is involved in the development of novel chemical lasers. It has a grant in the framework of the strategic defense initiative.
- Center of Excellence in Optical Engineering; Jerusalem College of Technology (JCT) – Professor Leo Levy, Professor Joseph Bodenheimer. The JCT is Israel's leading school for undergraduate optical engineers. The school has some eight Ph.D. physicists on its staff, not including several part-time scientists and engineers from industry. The school is involved in research in optical engineering, solar energy, photolithography, robotics, and image processing. The school is very applications-oriented and has been directly involved in the establishment of a dozen optics-related companies.
- Center of Excellence in Holography and Optical Computing, Electronics; Weizmann Institute – Professors Asher Friessem and I. Glaser. This group of scientists has some 10 Ph.D. scientists and engineers involved in study of holography, nonlinear optical effects, and optical computing.

Israel has about 35 firms engaged in electro-optics and laser research and production. Other firms are peripherally involved in this activity. Examples of these firms include:

- Alumor Laser Ltd. – research, development, and production of CO_2 lasers.
- Aryt Optical Industries, Ltd. – R&D in the field of diamond-turning optical elements.
- C.I. Ltd. – infrared and heat infrared remote sensing equipment.
- El-De Electro-optic Developments, Ltd. – electronic access control systems, including an analog electro-optic system which compares a "live" fingerprint with the image of the same fingerprint contained within a laminated plastic card.
- Elop-Electro-Optics Industries, Ltd. – optical, electro-optical, electromagnetic, and electronic systems and instruments for defense, industrial and scientific applications, optical components, and solid-state and gaseous lasers. Employees: 1300, of whom 300 are engaged in R&D.
- Fibronics, Ltd. – fiber optic and other high-speed data transmission and distribution systems.
- Galai Laboratories, Ltd. – electro-optical inspection and diagnostic systems

for particle analysis, image analyzers, infrared detecting and control systems.

- Kerem Optronics, Ltd. – concerned with advanced crystal technologies (growing, processing, components, and devices).
- Kidron Digital Systems, Ltd. – development of an advanced laser printing system.
- J. Kramer Electronics, Ltd. – R&D on video-image processing.
- Laser Industries, Ltd. – laser systems for industrial use. Employees: 350, of whom 80 are engaged in R&D.
- Liacom, Ltd. – computerized graphic systems and display generators; industrial high-power lasers. The company has developed and sold a high-performance 8-kW laser and is currently developing 5-kW and 4-kW lasers.
- Ophir Optics Jerusalem, Ltd. – R&D in laser power monitors, optical coatings (visible and infrared), precision reticles.
- Oprotech, Ltd. – electro-optic systems for the printed circuit board industry; employees: 268, of whom 70 are engaged in R&D.
- Robomatix, Ltd. – provides a robot-laser system for the metal industry.
- Scitex Corporation, Ltd. – turnkey graphic systems.
- Tadiran, Ltd. – Image enhancement; servo-control systems for stabilizing line of sight; holographic imaging; and improvement of heat transfer systems for lasers.

Electro-optics and laser research is also conducted by Israel's defense industries, particularly Rafael-Armament Development Authority (E.W. and Elint Electro-optics) and Israel military industries (laser communication equipment).

The Netherlands

For further information on this release, contact CDR Donald Dahl, US, Office of Defense Cooperation, American Embassy, APO New York 09159-5770.

US and the Netherlands Sign a Memorandum of Understanding (MOU) on Good Laboratory Practice. On 18 October 1988 the Netherlands and the United States signed a memorandum of understanding on good laboratory practice (GLP). Lee Thomas, Administrator of the Environmental Protection Agency (EPA) signed for the US and J. Van Londen, Director General for Public Health of the Ministry of Welfare, Public Health and Culture, signed for the Netherlands. This MOU on GLP is the fourth concluded by EPA. The other three MOU's are with Japan, the UK, and Switzerland.

Norway

For further information on Norwegian items, contact COL Daniel L. Konopatzke, USAF, Office of Defense Cooperation, American Embassy, APO New York 09085-5460.

Norway to Participate in EC Science Program. The Norwegian government has officially announced that it will apply for membership in the EC "Science" R&D program. The government's proposed 1990 budget allocates NKR5.3 million (about $0.8 million) for "Science"-related expenditures, 1.94 percent of the program's total budget.

Research spokesmen caution that while the European Parliament is expected to approve the Norwegians' applications, final action on this front is not likely before next spring. Sweden and Finland find themselves in roughly the same situation, they add, with the other EFTA nations trailing a bit behind in their "science" efforts. Once Norway actually does enter "science," this will represent the first time ever that the country has become a full member of a community research program. In any event, officials admit that a lot of work remains to be done before the government will be in a position to start arranging contracts.

Apparently, the Norwegians decided to seek membership last spring, although no formal move could be made until budget planners determined whether they could spare the extra funds. Officials emphasize that joining "science" constitutes the next natural step in their efforts to strengthen the country's R&D ties with Europe. While the issue of Norwegian membership in the EC remains controversial, they point out, the prospect of scientific and technical cooperation generates no political heat. Accordingly, the government hopes to release before year's end a study detailing further steps that might be taken to cement links between Norway and the rest of Europe.

United Kingdom

For further information of British items, contact James Devine, Office of the Science Counselor, American Embassy, London, APO New York 09509.

UK Work on New Materials for Civil and Military Aircraft. Hotol, for space enthusiasts, is the space plane that could put Britain in the vanguard of cut-price satellite launching sometime early in the next century. But for the realists in the British Aerospace Industry it has a more down-to-earth role. It is a test-bed which could help to pull through much advanced materials technology and associated manufacture, in readiness for new generations of military and civil aircraft.

Hotol is a hydrogen-fuelled rocket which aims to burn air for the first few minutes of flight to minimize the amount of liquid oxygen it needs to carry. To do this some difficult engineering problems must be solved that arise with an atmospheric oxygen intake that grows thinner and colder as Hotol increases in altitude, but hotter as it accelerates.

Rolls-Royce, which has acquired the patents from the inventor, Mr. Alan Bond, and has designed the engine (the RB-545), says it has never considered the engine as anything but a propulsion system for space launches. Nevertheless, the engine technology will advance its experience of high-speed propulsion in the regime from Mach 2 to Mach 8. But operating temperatures envisaged for the RB-545 are little different from those it expects to meet in military engines in the next 20 years. Rolls-Royce engineers believe bigger advances in materials technology will be demanded of the airframe engineers, who must seek to minimize the weight. Hotol, although expected to improve on the poor payload-to-weight ratio of current satellite launchers (with only about 1 percent of their launch weight as payload) is still rated at best only at 3.0 to 3.5 percent. It is expected to take the best endeavors of the materials technologists of British Aerospace to achieve such a figure – still only half what Concorde achieves. To achieve the target payload-to-weight ratio, much of the airframe would be made of either carbon-fiber composites or metal matrix composites, with nickel alloys needed to withstand temperatures exceeding 1700°C expected to be found at the vehicle's fin. "In an engineering company, the main concern is the acquisition of sufficient knowledge about the materials to enable the designer to form them into artifacts with high confidence in the ultimate performance,"

says Dr.Robin McEwan, Head of Materials Science Research at BAe's Sowerby Research Center, near Bristol. Dr. McEwan says his company has responded to reductions in the R&D effort on new materials by the Defense Research Establishment in Britain, by establishing Sowerby as a corporate research laboratory "to address long-term basic issues in materials and other research." BAe is a big customer for advanced materials spending about £100 million (approximately $178 million) per year on top-quality materials, including £20 million (about $35.6 million) apiece on aluminum alloys and nonmetallic materials such as resin-bonded composites. Structural composites are already deeply entrenched in BAe's thinking, especially for military aircraft. Use of carbon fiber, established with the Jaguar and Tornado aircraft, has been increasing to the point where the company believes 40 percent by weight and 60 percent of the operational surface area of the next operational airframe (for the European Fighter Aircraft) could be made from carbon fiber composites (CFC).

Reinforced metals, also known as metal matrix composites (MMC), have improved to a point where they now offer airframe designers dramatic enhancement of strength compared with unreinforced metals.

Dr. McEwan says: "Many components of the current range of civil airliners have been identified as suitable for MMC." In the case of the Airbus, these include body skins, slat (flap) tracks, and wing and engine struts. Such conclusions have led British Petroleum (BP) to believe that advanced engineering materials are destined to become what Dr. Robert Malpas, its technical director, calls a megabusiness of the next century. BP has mounted a major R&D effort into MMC's.

Dr. Malpas says a Hotol project could provide an excellent focus for companies to collaborate in the development of advanced aerospace materials. Dr. Stephen Bold, manager of BP's Advanced Materials R&D at Sunbury-on-Thames, identifies four types of MMC:

- Melt-infiltrated refractory fiber – which can be used to make modest improvements in the high-temperature strength of aluminum alloys, by die-casting them round a preform of refractory wool (such as BP's own fiberfax)
- Particle-reinforced composites – which can be used to make modest improvements in strength but big improvements in the stiffness of aluminum alloys, by adding silicon carbide grit to the cast or powder-formed metal
- Whisker-reinforced composites – which are similar to particle-reinforced composites but are more difficult and therefore more costly to make
- Continuous-fiber composites – which can greatly enhance strength, stiffness and high-temperature properties of titanium as well as aluminum alloys, but are costly, currently exceeding $1800 per kilogram.

Dr. Bold says the continuous-fiber MMC's will find markets in the least price-sensitive sectors such as space and defense. Reinforced aluminum will be used as struts and stiffeners in airframes while titanium MMC will be used for blades, discs, and shrouds in aeroengine gas turbines.

BP is making monofilament reinforcement and developing composites, but Bold believes that AVCO in the US is the front runner in the field today.

A small start-up company which has spotted a niche in the aerospace market for reinforced thermoplastics is Shrinemark, with its uncrushable tubes made from braided fibers of carbon, Kevlar, or glass. Its process combines time-honored textile practice with polymer science to make small-bore tubing for aircraft cooling ducts – lighter than aluminum ducts and more easily installed, the company claims. The material also resists slopped Coca-Cola which can wreak corrosive havoc with aluminum fittings in aircraft galleys. Dr. Bob Jeal, Chief of Materials and Mechanical Technology at Rolls-Royce, forecasts that military demands will lead to an engine built largely on nonmetallic materials by the year 2010. He suggests that nearly 60 percent of the engine would consist of two types of ceramic composite – either MMC or ceramic-matrix composites (CMC's).

"Continuing development of metal alloys cannot provide the properties needed for the major performance advances required beyond the year 2000," Dr. Jeal says. He believes changes in design, materials, and manufacturing technology will all be required to make the next leap ahead in performance. His targets include a thrust-to-weight ratio of 20:1 and a reduction in mission fuel burn, in first cost, and in maintenance cost by 25 percent through better design, and 50 percent by better materials. The new materials on which he is pinning his faith are composites containing ceramics either as reinforcement or as the matrix, or both. They cannot be directly substituted for current alloys because they will behave differently. "They will demand radical changes in the way engine components are designed and manufactured." He believes there will have to be a much closer integration of design and manufacture. Silicon nitride and silicon carbide seem to offer the greatest potential for use in the gas turbine. Above 1000°C they are stronger than nickel superalloys, more creep-resistant, less subject to corrosion, and potentially cheaper. They are also much lighter – less than half as dense. Unfortunately, they are also brittle, sensitive to flaws and, hence, unreliable. "The plastic flow which occurs with ductile materials is not possible," Dr. Jeal acknowledges. Nevertheless, he is sufficiently confident that these disadvantages can be circumvented to forecast that the military jet engine of 2010 will have a composite compressor and a ceramic turbine. It will be, in effect, a nonmetal engine.

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.

Acoustics

Traveler: Professor David T. Blackstock, Applied Research Laboratories and the Department of Mechanical Engineering, University of Texas at Austin.

In the UK, Professor Blackstock visited the Physics Department at the University of Bath, the Medical Physics Department at St. Thomas' Hospital, London, and the Radiation Science and Acoustics Division of the Natural Physical Laboratory at Teddington.

Blackstock's interest at the University of Bath was particularly taken with work being done in experimental measurements of the nonlinear acoustical nearfield of plane and focused pistons. The work, being done under the supervision of Dr. Victor Humphrey, involves use of a tank, about which Blackstock says: "Baker's [the lead student in the work] tank is long and narrow (1.3 m x 0.3 m x 0.3 m). One novel feature of the tank is that the water surface is covered with styrofoam packing pellets. The purpose is to cut down on evaporation, but the random surface also prevents coherent reflection from the surface. The covering is three or four pellets thick. Another novel feature is that the tank is simply a fish tank purchased for about $55, much less cost and bother than if it has been constructed in the laboratory. The plane piston projector is a 2.25 MHz parametrics piston (ka = 181, Rayleigh distance $1/2\ ka^2 = 1.7$ m), and the receiver is a Marconi PVDF membrane hydrophone. The positioning apparatus for the receiver is computer controlled (as is the signal processing of the received signal), but the projector drive signal is not. The measurements are quite reproducible. The experiment was running and was demonstrated to me. It is a beautiful piece of work. Baker demonstrated how he converts his projector into a focusing source simply by fitting a lens over the Parametrics piston. The procedure takes only a little coupling gel and is done in a minute or so with the projector in place in its holder in the water.

"Another of Humphrey's experimental projects is a very impressive schlieren system set up to investigate scattering of sound from underwater objects. The object I saw demonstrated was a water-filled cylindrical shell. Several years ago when I saw Werner Neubauer's schleiren system set up for this purpose at NRL, I marveled at the clarity with which the wave field could be demonstrated. However, the Bath schlieren visualization is even an order of magnitude clearer. Not only the scattered wave, but also the wave transmitted into the interior of the cylinder, could be followed in minute detail. For example, the wave bounced back and forth across the cylindrical interior creating focus after focus. The system could be operated either pulsed or CW. In pulse mode the time history of the incident, scattered, and transmitted fields could be seen. The CW mode showed the modal structure inside the cylinder, changing from mode to mode as the frequency was slowly swept through its range, which was, I believe, in the low MHz region. Humphrey wants to eventually move down well into the kHz region.

At St. Thomas' Hospital Blackstock visited Andrew J. Coleman, whose work so far has been a real contribution to lithotripsy research, and was allowed to observe the hospital's lithotripter in use. Blackstock discusses Coleman's current work and describes the lithotripter Coleman is constructing for laboratory use.

At the National Physical Laboratory, Blackstock focused his visit on Roy C. Preston, head of the ultrasonics section. Blackstock, who says that a large part of the section's efforts have been and are devoted to calibration methods for the frequency range 0.5 to 15 MHz and above, was much impressed by the detail and sophistication of the many tanks used for calibration and other measurements.

Blackstock also visited the Laboratoire de Mécanique Physique of the Université de Bordeaux I, where he was hosted by the Director, José Roux. Blackstock say: "Almost all the research has to do with sound waves in solids. The project with which Roux seemed most occupied currently has to do with finding behavioral laws of solids. He makes use of ultrasonic measurements of refraction through a plate of given material in a water bath. The frequency range is 0.8-10 MHz. Measurements of sound velocity and attenuation for both shear and longitudinal waves allow Roux to compute all the mechanical properties of the material. Many of the materials being studied are of interest to the French aerospace industry, for example, carbon fiber composites and a titanium alloy containing boron fibers. The latter is very light and very strong; Roux said that its sound velocity is about 15,000 m/s. Special facilities have been constructed to allow the properties to be measured under strong tension and at high temperatures (up to 2000°C). Special transducers have been made to generate shear waves in specimens."

Blackstock continued, saying that the laboratory has developed "a device to measure ultrasonic absorption *in situ* to determine silt concentration in river harbors. Silt concentration up to 400 g/l can be measured; for reference, ships stop when the concentration reaches 320 g/l. The device is used to map out silt concentration in a harbor and identify the parts of the harbor that need dredging. Since dredging is expensive, use of the device saves lots of money.

"A Doppler shift system is being developed to measure flow rates of gases in pipes. The application is to industry. A wide range of temperatures and pressures must be accommodated. In some cases the gases are corrosive. The requirements lead to tough transducer design problems."

Blackstock concluded his comments about the laboratory, saying, "Several facilities to measure shock waves in solids, both compressional and torsional, were shown. Hopkinson bars are used. The means of initiating the shocks are ingenious. Of particular interest at the moment are ceramic materials. Also of interest are fracture characteristics of composite materials."

Traveler: Dr. B.E. McDonald, Naval Ocean Research and Development Activity, NSTL, Mississippi 39529-5004.

Dr. McDonald attended the 1988 European Geophysical Society Convention in Bologna, Italy. His report concentrates on the invited paper by Walter Munk, who, in McDonald's words, re-examined results of a 1960 long-range acoustic propagation experiment in which an explosive source was detonated near Perth, Australia. The signal was picked up approximately 13,000 seconds later by hydrophones near Bermuda. Until recently, results were interpreted by a model by Shockley, et al. based on propagation along a great circle in an ocean of constant sound speed. In this model, the great circle ray (presumed to carry the acoustic energy) passed comfortably south of the Cape of Good Hope on its way into south Atlantic waters.

The re-examination of the experiment by Munk, et al. ["Australia-Bermuda Sound Transmission-Experiment (1960) Revisited," *Journal of Physical Oceanography,* in press (1988)] corrected the great circle model for two effects previously neglected: the rotational flattening of the earth (small, but important in the determination of the shortest path), and refraction due to the horizontal temperature gradient (lower sound speed near Antarctica). Alas, the corrected rays put Bermuda into the shadow of the Cape of Good Hope. A mechanism is needed to bend the principal ray 3° north at the Cape. Blunt knife-edge diffraction and scattering from internal waves were considered, but a more compelling mechanism if left wanting.

Private discussions at the meeting and afterward provoked consideration of the following candidate mechanism to explain significant shoreward deflection of an acoustic beam propagating tangent to a cape. Consider trapped acoustic waves propagating to the west just south of a cape. There is a wide region in which the continental shelf gradually cuts off the sound channel, with acoustic energy propagating roughly parallel to isobaths. If the variation of the sound speed with depth is sufficiently weak, simple waveguide theory predicts that horizontal group speeds will be greater where the sound channel is undisturbed than where it is partially cut off by the bottom. Thus energy propagates to the west with a speed that decrease to the north. The result is a retardation of wave packet arrivals to the north, and an effective northward refraction near the cape.

Fluid Dynamics

Traveler: Dr. Chiang C. Mei, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

Dr. Mei attended the first part of the Naval Hydrodynamics Symposium held in Den Haag, the Netherlands, and the second part of Euromech 240 on Dispersive Waves in Dissipative Fluids, held in Bologna, Italy.

Mei gives brief overviews of the sessions he was able to attend, commenting on presentations of particular interest, and lists the topics of both meetings. In the Naval Hydrodynamics Symposium, the topics were:

- Free surface effects, wakes, and viscous flows associated with ships and propellers. Ship wakes, propeller wakes, and vortex wakes near the free surface; bow and stern flows
- Nonlinear waves including breaking; solitons in two-layered fluids and their effects on floating and moving bodies
- Propeller/hull/appendage interaction; three-dimensional flow separation
- Two-phase flows: cavitation and bubble flows, and hydroacoustic effects
- Sea-keeping: nonlinear motion; chaos.

In the Euromech conference, the topics were:

- Boundary effects
- Waves in a tube
- Waves in porous media
- Waves with negative energy
- Nonlinear evolution equations
- Waves and instability in non-Newtonian fluid
- Atmospheric and water waves.

Oceanography

Traveler: Dr. Paul LaViolette, Naval Ocean Research and Development Activity, NSTS, Mississippi 39529-5004.

Dr. LaViolette served for 3 months as a visiting professor at the Universitat de les Illes Balears, Palma de Mallorca, and for 1 month as a coinvestigator at the Institute de Ciencies del Mar, Barcelona.

LaViolette says of the University's Department of Physics that it has about 12 professors, four of whom have meteorology or oceanography degrees. The school is trying to expand its meteorology and oceanography programs, but is limited by lack of experience.

Of the Institute, he says that it is an old, established marine laboratory which is trying to break away from fisheries-only marine science, and that with rather extensive funding, it is purchasing new computers and moving to new facilities. Their biggest drawback, he says, is the lack of strong physical oceanographic inputs into their mostly biological programs.

Along with many other highly productive results, several papers by Spanish investigators – either coauthored by or in collaboration with LaViolette – were written as an outcome of this 4-month visit.