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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.

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Scientific Director . . . . . James E. Andrews

Editor . . . . . Ms. Connie R. Orendorf

## ACOUSTICS

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**Wave Propagation Research at the Technical University of Delft . . . . . David Feit 2**

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## COMPUTER SCIENCE

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This week-long conference is the annual world event in electromagnetism. The author summarizes papers in General (Direct) Scattering, Inverse Scattering, Transient Boundary Value Problems and Geophysical Applications, Various Types of Media, Mathematical Methods, Electromagnetic Theory - Linear and Nonlinear, Antennas, and Waveguides and Periodic Structures.

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# ACOUSTICS

## Acoustics at the Technical University of Delft

*by David Feit, the Liaison Scientist for Acoustics and Mechanics in Europe and the Middle East for the Office of Naval Research European Office. Dr. Feit is on leave from the David Taylor Research Center, Bethesda, Maryland, where he is a research scientist in the Ship Acoustics Department.*

### Introduction

Acoustics is among the main areas of research in the Faculty of Applied Physics of the Technical University of Delft (TUD), the Netherlands. The other principal fields of concentration are particle optics, solid-state physics, instrumentation, and physical technology. Applied Physics is one of twelve faculties within the university serving about 12,000 students.

This article reviews the acoustics programs within this faculty and is based on discussions held with Dr. ir. Diemer de Vries. Dr. de Vries stood in for Professor dr. ir. A.J. Berkhout, head of the Laboratory for Acoustics and Seismic Technologies (my translation from an organization chart written in Dutch), who was not present during my visit. Berkhout assumed his position at TUD in 1976 and his primary fields of interest are architectural acoustics, seismic inversion, and architectural acoustics.

### Laboratory for Acoustics and Seismic Technologies

The Laboratory for Acoustics and Seismic Technologies' research concentrates on the physical and numerical aspects of three-dimensional forward and inverse wavefield extrapolation. The waves propagate in media that are characterized as fluids and/or solids, homogeneous or inhomogeneous, and may be bounded or unbounded. As can be seen from my article on the TUD Laboratory of Electromagnetic Research in the Faculty of Electrical Engineering (see following article), there is considerable overlap and collaboration in the work of the two laboratories. This is also true with regard to the Laboratory of Geophysics which is part of the Mining Faculty. Besides cooperation within the university, there are strong connections to the TNO Institute of Applied Physics (ESNIB-90-01).

In this laboratory, the work is concentrated in four main programs: measurement systems, measurement

preprocessing, forward and inverse wave field extrapolation, and extrapolation results postprocessing.

Professor Berkhout is assisted by three senior faculty members. Dr. de Vries specializes in room acoustics and electroacoustics; Ir. G. Faber takes care of the transducer research, while Dr. ir. M.M. Boone is in charge of the noise control research. In addition, there are some 20 other researchers associated with the department; most are graduate engineers, some have doctorates in engineering, while the remainder are student assistants.

Some of the work in the laboratory is funded by individual oil companies and the Royal Dutch Academy of Sciences, but a greater part of the funding comes from the Foundation for Technical Sciences. This is a consortium of oil companies contributing a fixed amount of money each year allowing them to reap the benefits of the applied research conducted in the laboratory.

### Acoustical Control System

The Acoustical Control System (ACS), a recent development within the laboratory, and supported by the TNO-TPD, has received much publicity within the European Community, the public press, and popular science television programming. Supposedly, the system can reconstruct within wide ranges perfect sound fields in acoustically "defective" spaces (Applied Research, 1988).

Architects designing multipurpose auditoria and studios according to their own artistic and functional principles, oftentimes design halls which, although aesthetically satisfactory, may not be acoustically suitable for some purposes. The ACS can control and alter the important acoustical parameters of a hall, such as reverberation time, early-to-late energy ratio, and lateral-to-frontal energy ratio, producing the ideal acoustical environment for a range of purposes.

The ACS works using the principles of "acoustical holography" to reconstruct the ideal sound field for the actual hall (Berkhout, 1988). The direct source signals, be they voices or musical instruments, are measured using

arrays of microphones. These signals are convolved with predetermined transfer functions designed to produce the signals of an imaginary hall with optimum acoustical properties, and then rebroadcast to the audience by other strategically located loudspeaker arrays.

Previous systems were based on acoustical feedback, which can cause now and undesirable coloration of the sound. To prevent such effects, the level of feedback must be greatly reduced, and this limits the older systems' abilities to increase the reverberation time to perhaps a factor of two. Because acoustical feedback is not an essential aspect of this system, it can be reduced to any safe level. Experience with ACS has shown reverberation time increases by as much as a factor of six. The ACS has been installed and used in several small halls as well as the auditorium of the TUD and in McLaughlin Hall, York University, Toronto, Canada.

### Echo-Acoustics

The other strong area of research performed in this laboratory is in the field of echo-acoustics, and its application to seismic exploration, acoustic microscopy, and medical imaging. For these applications, they have developed specialized measurement systems including sources and detectors configured in arrays to perform spatial filtering and migration imaging (Berkhout, 1981).

In seismic exploration, the major application area, sources to generate signals and detectors to acquire data are developed. Research is also being performed in the

development of measurement preprocessing techniques. Some of these are the separation of P and S waves (for elastic solids), the elimination of source-detector limitations and the influence of inhomogeneous surfaces, and the estimation of macro subsurface models. Furthermore, after eliminating propagation effects, they are investigating the postprocessing of reflectivity information to develop estimates of elastic and lithologic parameters.

### Summary

This laboratory, together with its sister laboratory, the Laboratory for Electromagnetic Research, combine to form a most powerful educational and research capability in the fields of acoustical and elastic wave propagation. With other institutions in Delft such as TNO-TPD, the Netherlands continues to make significant contributions to the scientific and technological knowledge base of the international acoustical and seismological communities.

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- Berkhout, A.J., *Seismic Migration Imaging of Acoustic Energy by Wave Field Extrapolation*, (Elsevier, N.Y., 1981).

## Wave Propagation Research at the Technical University of Delft

by David Feit

### Introduction

On a visit to Delft, the Netherlands, I met with Professor A.T. de Hoop, Technical University of Delft (TUD). His name is very familiar to investigators in the field of elastic wave propagation for his work on the modification of the Cagniard method for solving seismic pulse problems (de Hoop). Professor de Hoop is currently with the Laboratory for Electromagnetic Research (Laboratory) in the Faculty of Engineering. In 1970, this Laboratory was established in its present form, having as its main focus the mathematical and computational modeling of acoustic, electromagnetic, and elastodynamic field and wave problems with particular emphasis on industrial

applicability. Close links between the Laboratory and industry is characteristic of all the departments of the university. Both de Hoop and another professor in the Laboratory, Dr. H. Blok, have spent leaves of absence at the Schlumberger-Doll Research Center in Ridgefield, Connecticut. Royal Dutch Shell Exploration and Production Laboratories and other oil exploration companies have also sponsored research projects at the Laboratory.

### Teaching Activities

The staff of the Laboratory is responsible for the following courses with the School of Electrical Engineering.

- Signal Theory - second year
- Electromagnetic Field Theory - introductory
- Excitation, Propagation and Scattering of Electromagnetic, Acoustic, and Elastic Waves - advanced
- Quantum Electronics - introductory
- Avionics Electromagnetic Wave Propagation - advanced

As described by Professor de Hoop, the advanced courses emphasize fundamental methods of analysis; e.g., analytical, computational, or combined approaches, with surveys of particular current international research applications. In many cases, there is a close connection between the advanced courses and the research projects carried out at the Laboratory.

### Research Activities

The differing research projects conducted within the Laboratory generally fall into the following categories:

- Modeling of Electromagnetic Field and Wave Problems
- Optical Electromagnetics
- Biomedical Electromagnetics
- Modeling of Acoustic and Elastodynamic Field and Wave Problems.

Computations associated with the research projects are executed on a VAX 8250, which is housed in and operated by the Laboratory. Professor de Hoop and I discussed several ongoing projects. Here I will discuss some of the research projects that I found to be most relevant to structural acoustics.

The project, "Global Optimization in the Computation of Electromagnetic Fields," has been directed toward the development of iterative techniques for the computation of radiating or scattered electromagnetic fields for a bounded contrasting domain that is embedded in a homogeneous medium. The approaches developed can, with slight variation, be used effectively in structural acoustic problems.

The approach, like other computational schemes, uses expansions of the field quantities in terms of comparatively simple functions or in some cases source type integral representations. These expansions are then substituted into error expressions that are squared and minimized over the domain of the problem (global optimization). This ultimately leads to the problem of fairly large systems of linear algebraic equations. The difficulties inherent in the direct solution of such systems can be eased by using suitable iterative techniques. The essential features of Neumann series, over-relaxation methods, and conjugate gradient techniques have been investigated in this project, which has been going on since 1979. These methods have been applied to the planar problem of scattering by

a strip where an integral equation of the second kind is obtained. Use a conjugate-gradient method applied to this equation leads to a very rapidly convergent iterative scheme (van den Berg et al., 1988).

H. Blok is program director for a project directed toward the general aspects of inverse scattering of electromagnetic waves by inhomogeneous, transparent objects. Inverse scattering can be used to investigate properties of buried material objects. Such objects are probed by radiation of extremely short wavelengths or investigated at greater distances by long wavelength radiation. Many of the inversion techniques rely on iteration of solutions to the direct problem that can be solved by using integral equation approaches, singularity expansion method, or the Prony method as examples. In this project, a systematic study of determining the most appropriate techniques for ultimate use in the inverse problem solution have been pursued. Many of the results obtained appear in a book that resulted in a Ph.D. thesis for A.G. Tijhuis (Tijhuis, 1987). Tijhuis has done some of his research at the Electromagnetics Laboratory, University of Colorado, Boulder.

In another project directed by Blok, one of his proteges, R.W.C. van der Veen, is investigating an approach called configurational filtering and sampling methods for the computation of frequency domain electromagnetic fields. These are applied alternately to the spectral domain and spatial domain field representations for scattering or direct radiation problems. When applied in the scattering problem, the resulting linear algebraic problem is solved in a global sense by minimizing the root mean square value of the residual. Solving problems in this manner produces a substantial saving in the use of computer time. Also, it brings the problem of scattering by three-dimensional objects within the reach of much smaller computers (van der Veen, 1988).

Professor de Hoop and P.M. van den Berg are directing another project that is looking at the use of acoustical waves as a diagnostic tool in determining the mechanical properties of fluids and solids. Theoretical modeling techniques are used as guidance in the interpretation of experimentally derived data. In particular large offset, both vertical and horizontal, approximations using the Cagniard-de Hoop method are used to compute synthetic seismograms for a horizontally layered earth. These are applied to each of the generalized-ray constituents into which the seismic wave motion has been decomposed (de Hoop, 1988).

### Conclusion

The work and projects discussed here represent a reasonable sample of the activities of this group. The presence of Professors de Hoop and Blok on the faculty assure that the TUD will continue to supply the Nether-

lands and the world with first-class researchers and experts in the fields of electromagnetic and elastodynamic wave propagation. A number of researchers trained here have and continue to contribute to U.S. efforts in the fields of wave propagation and seismic prospecting.

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## Ultrasonics International '89

by Dr. Guillermo C. Gaunaud, Research Physicist, Research and Technology Department, Naval Surface Warfare Center, White Oak Laboratory, Silver Spring, Maryland.

### Introduction

Ultrasonics International '89, took place July 3-7, 1989, at the facilities of the Spanish Council for Scientific Research (CSIC), in Madrid, Spain. This is the oldest and most optimally staffed of the Spanish government research organizations. Ultrasonics International (UI) conferences, held biennially at various European countries, cover most aspects of ultrasonics and acoustics in theory and experiment. There were 150 papers and 90 posters authored by nearly 400 scientists, mostly European. The papers were presented in 4 days, in three daily parallel sessions (the parallel sessions being a first for UI). The posters and some tutorials, mostly for students, were presented in separate sessions. All lectures were presented in English. The organizing committee did a very good job of organizing the plenaries and the 12 sessions that formed the nucleus of the conference. Attendance was close to 400 people, including some spouses and other accompanying persons. Presented by invited scholars, three plenary sessions opened the sessions each day. Professor Manuel Cardona, Max Planck Institute, Stuttgart, Federal Republic of Germany, opened the first plenary session and presented a lecture entitled "Optic and Acoustic Phonons in High  $T_c$  Superconductors." The lecture was a clear and elegant summary of all recent developments in superconductivity and their relation to ultrasonics, and included spectacular demonstrations of magnetic/superconducting levitation. Dr. Cardona is the only Spaniard who teaches in a German university; he is a member of the U.S. Academy of Sciences.

Professor Mack Breazeale, National Center for Physical Acoustics (NCPA), University of Mississippi, opened

the second plenary session with a lecture entitled "Non-linear Acoustic Effects in Solids," a topic to which Professor Breazeale has devoted most of his research. This was an overview of the entire subject and its applications to ultrasonics. Aside from having received many honors in his long career, including the Silver Medal in Physical Acoustics from the Acoustical Society of America, Professor Breazeale is currently editor for nonlinear acoustics for the *Journal of the Acoustical Society of America*.

Finally, the third plenary lecture was given by Professor Larry Crum, NCPA, University of Mississippi. This lecture was entitled "Acoustic Cavitation and Medical Ultrasound," and it included practically all instances in which there is an oscillation of a bubble in some liquid that emits sound. Dr. Crum is one of the rising stars of the NCPA, which is directed by Dr. Ralph Goodman.

The technical sessions covered nearly the entire spectrum of ultrasonics, underwater acoustics, and physical acoustics as classified by the Acoustical Society of America. Following is a summary of a few of the most important papers in the technical sessions that I attended.

**Underwater Acoustics** (Chair: G. Gaunaud, Cochair: L. Bjørnø)

Dr. Victor Akulichev, U.S.S.R. Academy of Sciences Vladivostok, lectured on "Sound Wave Propagation Through Ocean Water Inhomogeneities," and showed experimental studies of low-frequency (200-600 Hz) pulses propagating at long ranges, often exceeding 1,000 kms. Informative pictures of large, high-power transducers used to project these signals were shown, and attempts were made to isolate the effects of eddies, plankton, bubbles, and other ocean microstructure on the received signals.

Dr. Hans Strifors, Swedish Defense Research Establishment, Stockholm (coauthored with G. Gaunard, Naval Surface Warfare Center [NSWC], White Oak, Maryland), lectured on "The Backscattering of Plane Sound Waves by an Elastic Plate Covered with a Viscoelastic Layer." Dr. Strifors showed how modern viscoelasticity principles can be used to model the frequency-dependence of an anechoic or echo-reducing underwater sound absorber attached to an elastic structure. The model predictions agree with earlier data measured in 1977. The coating introduces a selective reflectivity, which can be quite weak or strong at certain frequencies that have been long known to coincide with the resonances or antiresonances of the cavities inside the rubber layer.

Dr. Carolyn Beckett, (coauthored with Professor Victor Humphrey), University of Bath, Avon, U.K., lectured on the "Form-Function Determination for Normally and Obliquely Incident Wavefields on a Solid Cylinder." Dr. Beckett described the use of a parametric array as an acoustical source to measure form-functions of elastic cylinders in water. This experimental technique showed results in the nondimensional frequency range:  $0.5 \leq ka \leq 14$  for aluminum cylinders in water. The agreement between measurements and earlier theories was good at normal incidence, but not so good at oblique incidences. In the question/answer period, someone mentioned that a possible explanation for the latter discrepancy was that an incomplete (earlier) theory had been used for comparison.

**Nondestructive Evaluation** (Chair: L. Bond, Cochair: W. Sachse)

Professor J.D. Achenbach, Northwestern University, presented "Ultrasonic Wave-Reflection from Crack-Permeated Diffusion Bonds." Professor Achenbach, who has devoted much of his research to studying wave reflections from cracks inside materials, presented a new and approximate method to study such reflections from planar distributions of penny-shaped cracks, and compared the predictions to experimental results. The study has uses in fracture mechanics. In "Thin-Film Ultrasonics," K. Kim and W. Sachse, Cornell University, described how line and point sources of ultrasound can be generated from a metal thin film, and how they can be used for testing the adhesion strength of the film to its substrate. This latter information can be extracted from measurements of temperature rise and electrical resistance in the long film.

**Acoustical-Optical Effects** (Chair: R. Metens, Cochair: A. Alipi)

Dr. J. Wolf (coauthored by Professor Walter Mayer), Georgetown University, presented "Optical Examination of Spectral Filtering of Finite-Amplitude Ultrasonic Pul-

ses," Dr. Wolf described an experimental light-diffraction apparatus to measure finite-amplitude ultrasonic pulses reflected and transmitted by brass plates immersed in liquids. Examples showed the selective filtering of the plate through Lamb-mode excitations.

Dr. C. Jen lectured on "Laser Generated Flexural Acoustic Waves." This was a multi-authored paper and most of the authors are with the IMRI, National Research Council of Canada, Quebec. Dr. Jen showed how it is possible to generate the lowest order flexural acoustical waves along fibers and membranes by high-energy lasers. The detection of such waves was achieved by using an optical heterodyne interferometer and piezoelectric transducers. Applications of these optically-induced flexural acoustical waves were discussed.

**Transducers and Transducer Materials** [Two sessions] (1-Chair: L. Bjorno, Cochair: D. Hutchins; 2-Chair: R.E. Green, Cochair: J. Mendiola)

Dr. F.R. Montero de Espinosa, Acoustic Institute of the CSIC, Madrid, lectured on "Metallic Network Composites as Components on Multilayer Ultrasonics Transducers." This is a new concept of loaded polymers, useful to describe both the backing and the matching sections of a transducer. Dr. Montero de Espinosa discussed their application to layered transducers.

In another lecture, coauthored with María S. Sánchez, Dr. Montero de Espinosa presented "Study of the Resonant Frequency Dispersion on Fractured Piezoelectric Composites." This work dealt with an experimental study of the resonant behavior of irregularly shaped piezoceramic elements obtained by a fracturing procedure, and with the calculation of the electrical impedance as a function of frequency and its comparison to practical cases.

J.A. Gallego-Juárez, CSIC, Madrid, presented an overview of the general subject of "New Materials for Ultrasonic Transducers." He emphasized the importance of new magnetostrictive rare-earth compounds, which are currently substituting the conventional ferromagnetic materials for ultrasonic transducers.

**Measurements in Physics** [Two Sessions] (1-Chair: R. Chivers, Cochair: W. Mayer; 2-Chair: W. Lord, Cochair: L. Gacete-Garretón)

L. Gacete-Garretón, University of Santiago de Chile, the Institute of Acoustics, CSIC, Madrid, lectured on "Ultrasound as a Probe of Turbulence." He discussed an experimental technique to measure some parameters of turbulent flows using ultrasonic beams.

R. Chivers (coauthored by L. Anson) University of Surrey, U.K., lectured on "Thermal Effects in Dilute Suspensions in Liquids." Seven solid spheres and 71 types of fluid spheres suspended in 72 liquids were analyzed computationally for their attenuation properties for:

$ka < 1$ . Thermal effects were shown to be significant in all cases for:  $ka \approx 0.5$ .

**Nonlinear Acoustics** (Chair: E. Riera, F. Sarabia, Co-chair: A.P. Sarvazyan)

Since all of linear acoustics could be considered as a subset of nonlinear acoustics, this is the most general subfield of acoustics. Leif Bjørno, (coauthored with T. Neighbors), Technical University of Denmark, presented a general lecture on "Focused Ultrasonic Fields." The lecture dealt with a parametric study of the KZK Model to simulate focused, nonlinear wave propagation in media of variable physical properties. A modification of the method was presented and the results were comprehensively compared to experimental data.

Jerry H. Ginsberg (coauthored by H. Kim), Georgia Tech, lectured on "One-Dimensional Non-Linear Waves in Inhomogeneous Elastic Solids." The authors studied such waves in an elastic half-space with density and elastic properties being periodic functions of the coordinate normal to the boundary. The approach was a combination of perturbation and Laplace Transform methods.

**Wave Propagation** (Chair: J. Roux, Cochair: G. Quentin)

The subject matter of this session, although called "Wave Propagation", really dealt with what is now called structural acoustics in the Journal of the Acoustical Society of America. Leonard Bond (coauthored with J. Taylor), University College, London, discussed "Acoustic Waves in a Plate with a Rib Attached." The work has led to the development of an "Energy Partition Model" to describe propagation in ribbed plates.

A. Jungman, University of Paris VII, (coauthored by X. Jia and G. Quentin) lectured on the "Generation and Characterization of Guided Waves on a Periodic Corrugated Plate." This paper showed the ability of a new method to excite Lamb and Scholte-Stoneley waves along the wet surface of the plate. Theory and experiment showed good agreement. In my view, this was one of the best papers of the conference.

D.K. Lewis, Lawrence Livermore National Laboratory, California (LLNL), (coauthored with R. Ziolkowski, and B.D. Cook, University of Houston), lectured on "Theory of Localized Wave Trains." The authors described exact solutions of the linear wave equation that suggest that wave trains of certain temporal and spatial distributions will propagate to much greater distances than that considered normal. These novel wave trains have huge Rayleigh distances. A video presentation illustrated the pulse distortion during its propagation.

G. Gaunaurd, NSWC, (coauthored with M. Werby, Naval Oceanographic and Atmospheric Research Laboratory, Bay St. Louis, Mississippi), presented a study of "Flexural Resonances in the Oblique Insonification of

Solid Elastic Prolate Spheroids." The study showed that when a submerged prolate spheroid is obliquely insonified, it undergoes flexural vibrations just as a free-free fluid-loaded Timoshenko beam.

**Signal Processing** (Chair: G. Hayward, Cochair: J.L. San Lamerio)

L. Bond (coauthored with J. Rose), University College, London, lectured on the "Application of Born Inversion to Non-Spherical Voids and Inclusions." This erudite work described the interesting resonance effects present during the inversion process, but did not attempt to explain their causes.

E. Riera-Franco de Sarabia presented a paper on "Use of Narrow Temporal Gates in the Measurement of Transient Ultrasonic Patterns," and compared the results of this new experimental technique to classical results for pistons in baffles with promising results.

**Characterization of New Materials** [Two Sessions]  
(1-Chair: R.E. Green, Cochair: C.H. McGogney;  
2-Chair: M. Rosen, Cochair: B. Djordjevic)

M. Rosen, Johns Hopkins University, presented a lecture entitled, "Characterization of Composite Materials by Means of Interface Acoustic Waves." This lecture showed how the local elastic, anelastic, and plastic properties of the interface between the matrix and its reinforcing agents affects the behavior of the bulk mechanical properties of composite materials.

**Medical and Biological Ultrasound** (Chair: L. Crum, Cochair: F.R. Montero de Espinosa)

J.F. Greenleaf, Mayo Clinic Foundation, presented a general overview of "Ultrasonic Tomography." The main advantage of ultrasonic computed tomography is that quantitative measurements of intrinsic material properties can be obtained. The main disadvantage is that energy must be transmitted through the tissue. Several tomographic methods were described.

**Sonochemistry** (Chair: T. Mason, Cochair: J. Luche)

M. Margulis, All Union Institute of Organic Synthesis, Moscow, lectured on "Modern Views on the Nature of Cavitation: Sonoluminescence and Sonochemical Reactions." The author presented the basis of the effect of ultrasonic fields on chemical reactions. The enlightening presentation included sonoluminescence and the electrical phenomena associated with cavitation.

**Acoustic Visualization Techniques** (Chair: T. Sato, Cochair: A. Ramos Fernández)

V.F. Humphrey (coauthored with S. Knapp), University of Bath, U.K., lectured on "Schlieren Visualization of Low-Frequency Ultrasonic Fields." An elegant Schlieren system, designed to visualize pulsed ultrasonic fields in water at frequencies as low as 100 kHz, was described,

and the problems encountered in operating at such low frequencies were identified and discussed in detail.

This concluded the technical sessions. Complete Proceedings are in press. As usual, there were also some poor papers, some repetitions of old work, and some cancellations or withdrawals. Cancellations or "no-shows" announced ahead of time permitted the rescheduling of other papers (from the pool of posters) into the vacated oral time slots. This was not possible with "no-shows" announced at the last minute, resulting in some unpleasant disruptions and interruptions. However, there were several postconference visits that were very informative and popular.

## Comments

If London had *Hatfield House* in 1987, Madrid had *La Casa Grande* in 1989 with magnificent gastronomical displays and a spectacular Flamenco show like the best that can be found in Andalusia. The French organizing committee for UI '91 in Le Touquet, France, should start recruiting talent from the *Lido* or the *Follies Bergere* if they want to top past performances.

The conference was a well-attended technical and social success, and everyone thanks the organizing committee, Butterworth Scientific Ltd, and Ms. Marija Vukovojic and her staff for their remarkable efforts. We are certain the French organizing team will live up to expectations for UI '91.

# BIOTECHNOLOGY

## Organization of Biotechnological Research Funding in the U.K.

*by Dr. Keith E. Cooksey, the Liaison Scientist for Biochemistry, Microbiology and Marine Biotechnology in Europe and the Middle East. Dr. Cooksey is on leave from Department of Microbiology, Montana State University, Bozeman, Montana, where he is Professor of Microbiology.*

### Introduction

As in most countries, biotechnological research in the U.K. is funded by the central government, the private sector, and charitable organizations. This report will concentrate on government funding, especially where the research programs involve mandatory industrial participation.

The Department of Trade and Industry (DTI) is the lead government agency in fostering the application of new technology. This in itself is interesting since this government department is considered the one that promotes enterprise and state-of-the-art technology. The implication is that biotechnology is thought to be an area of great growth potential. Thus, biotechnology has been referred to as an area of science expected to have an impact in the 21st century equivalent to that of information technology in the 20th. Within DTI, biotechnology is the responsibility of the Biotechnology Unit (Unit) of the Laboratory of the Government Chemist. The Unit aims to promote collaborative programs between industry and academia, and between industries. Also, it is the U.K. contact for the European Community (EC) transnational programs. An important responsibility not re-

lated to research and development funding is the Unit's role in risk assessment, regulation of biotechnological products, education, and public awareness.

### Research Programs

Whereas in previous years, research funds were provided to encourage technology that was close to the marketplace, nowadays the emphasis is on strategic research; i.e., research that is essential for the development of the field. The result is that the research that is supported is more basic than in former times; but from the projects I have seen, the research is not usually particularly fundamental. The U.K. government believes that industry should support its own developmental research. Even so, the common denominator of the cooperative programs described here is their large (by U.S. standards), applied content. Fundamental research is supported by the Medical, and Agriculture and Food Research Councils.

### Collaborations Involving Industry

According to the Foreign and Commonwealth Office of the U.K., seven collaborative research clubs exist.

These are in the fields of protein engineering, antibiotics, recombinant DNA, biosensor materials, bioreactor design, biotransformations, and down-stream processing. The clubs are somewhat similar to the U.S. National Science Foundation's (NSF) Industry-University Cooperative Research Centers; but in the U.K., the club will often involve many universities (up to 12), whereas the NSF Centers normally involve only one academic institution. In either case, the research is accomplished in the university. In contrast to the NSF Centers, the research here is largely biological. The fact that these clubs are well-supported by industry in the U.K. is also a further interesting comparison to the U.S. At the time of this writing, there are only one or two NSF Centers whose research is at all biological. In fact, in the U.S. it seems it is much harder to obtain industrial support from the biotechnological sector of industry than from the traditional; e.g., welding, or new (computer) engineering companies. Whether this is caused by the projects involved, the patent laws of the two countries, or the approach of the individual scientists to industry is not clear. However, perhaps government programs in the U.K. foster this type of relationship more than those in the U.S.

The research club idea is being replaced in the next 4 years by the LINK program. In this arrangement, at least one industrial partner is linked with an academic institution, a situation that is more flexible than the former club's scheme. Here, the research budget is funded equally by the government and by the industry. In my opinion, this financial split means that given the high cost of research in general, only larger companies will be able to afford to enter into an exclusive consortium with a university--although one of the program's stated aims is to encourage the participation of small companies. Interestingly for the purpose of the exercise, the government regards its own laboratories as academic institutions. The program's aim is to accelerate commercial exploitation of government-funded research; i.e., the program does not support truly basic research but seeks to build on experience already gained in collaborative ventures. The programs will normally last 3-5 years. Currently, the areas of interest and levels of support are:

- Food processing - \$11.2 million
- Molecular sensors - \$8 million
- Protein engineering - \$7.6 million
- Biotransformations - \$3.2 million
- Selective drug delivery and targeting - \$2.4 million
- Eucaryotic genetic engineering - \$3.7 million
- Molecular electronics - \$16 million

In one area, the Science and Engineering Research Council is supporting a complementary program to provide basic scientific underpinning for the initiative. The Office of Naval Research has programs that deal at least in part with four of these areas.

Where LINK-type consortia involve industrial partners in other EC countries, they fall under the European Research Coordination Agency (EUREKA) program. The requirements of a project for EUREKA status are several, but can be summarized by saying that the project must be carried out in, and the results benefit, the EC. The application document for EUREKA support suggests to me that EC research funds after 1992 will be won only by those who persevere since all project information is to be circulated to all 19 EUREKA member countries. The money for a U.K. project would come from the U.K.; however, granting EUREKA status to a project does not imply it will be funded, only that it has satisfied programmatic standards.

The small company wishing to enter the biotechnological marketplace with a new product is supported by the Small Firms Merit Award for Research and Technology (SMART) program. This program, which is similar to the Small Business Innovative Research (SBIR) programs run by the U.S. Federal agencies, provides start-up capital but does not have the greatly expanded financing for Phase II projects seen in the SBIR program. The U.S. program does not specify the type of business or products it is most interested in; the SMART program does. One-third of the preferred areas involve biotechnology; e.g., diagnostics, monoclonal antibodies.

There are other U.K. government schemes to promote industrial development and the exploitation of new technologies that are applicable to already existing U.K. biotechnology firms. These are aimed at larger companies and do not necessarily involve the academic sector. They are seen as keeping British, and in some cases European, industry competitive with Japan and the U.S. In this vein, there are programs designed specifically to develop European biotechnology. For instance, Biotechnology Research for Innovation, Development, and Growth in Europe (BRIDGE) is open to companies, universities, and research institutes. The projects proposed to BRIDGE must, of course, be transnational and are eligible for up to 50 percent of the costs. Significantly, all of the programs described require considerable input of funds from the recipients of the government largess. Probably ECU 100 million will be available for 1990-93 (one ECU is roughly equivalent to \$1.2). Again, the project areas of major interest are selected by the members, not by the proposers, and reflect the considerable importance that the EC gives to farming. Approximately one-third of the proposed areas of study in biotechnology reflect agricultural emphasis. Importantly, a significant fraction of the total funds available are earmarked for training schemes. An important fact is that European training in biotechnology starts before the age of 16 and is already at quite an advanced level before a student reaches university. At the moment, this is probably the

greatest difference between the U.S. and Europe in their respective commitments to biotechnology.

### Funding of Biotechnology After 1992

There are already several transnational programs that will be running during the change in Europe to a single market in 1992. Necessarily, the administrative paths will be larger and support for biotechnology will be forthcoming from the EC when U.K. national programs are expected to diminish. There are those, however, within the U.K. system who do not necessarily wonder about the amount of funds that will be available but rather, whether governmental regulation of biotechnology will prevent certain types of research to be carried out at all by the members of the EC. For 1992 and beyond, the level of environmental regulation must be agreed by the members of the EC. Certain member states have large political lobbies against genetic engineering, the cornerstone of future advances in biotechnology. Because of the uncer-

tainty of future regulations, it is expected that two major Federal Republic of Germany chemical companies will expand their efforts in biotechnology in the U.S. rather than Europe. Although highly regulated in the U.S., the rules governing biotechnological uses of gene transfer are usually well-known. Because of their concern for the perceived regulatory excesses of the "Bio-Luddites," a senior industry advisory group in biotechnology has been formed. The group, with members from the very highest level of major European companies in biotechnology, will operate from offices within the European Council of Federations of Chemical Industry in Brussels. They will work to form 'a predictable science-based regulatory framework stable over time' within which European industry can make the investments necessary for European biotechnology to succeed.

The next 4 years will be most interesting for science in Europe. The discussions concerning the fate and funding of biotechnology will probably be vigorous.

## COMPOSITES

### Interfacial Phenomena in Composite Materials Conference

*by Michael J. Koczak, the Liaison Scientist for Materials for the Office of Naval Research European Office. Dr. Koczak is on sabbatical leave from Drexel University, Philadelphia, Pennsylvania, where he is a Professor of Materials Engineering.*

#### Introduction

The understanding of stress transfer in composite materials is related to the interface and the complex nature of the chemical and mechanics aspects of the interface. Held at the University of Sheffield, U.K., September 5-7, 1989, the Interfacial Phenomena in Composites Materials Conference brought together various disciplines to include fiber processing and evaluation, polymer chemists, materials processing, mechanics modeling, design and process engineers. The microscopy and surface analytical study of the interface has various surface analysis techniques and viewpoints; e.g., X-ray Photoelectron Spectroscopy (XPS), Secondary Ion Mass Spectroscopy (SIMS), Auger Electron Spectroscopy (AES), Raman Spectroscopy. From a stress transfer assessment, several techniques have been developed in order to assess the interfacial shear stress and the resulting macroscopic properties. Examples include microindentation, fiber pull-out, fiber fragmentation studies, fiber wetting, double compression, and interlaminar shear tests. An important key link is the translation and correlation of

these experimental and analytic approaches with composite performance. The objective of the Sheffield interface conference was to draw the various talented scientists from differing disciplines, thereby creating a forum for an interdisciplinary discussion of interfacial phenomena.

#### Conference Organization And Goals

The conference was divided into plenary and parallel sessions with the following topics considered:

- Assessment of Fiber Matrix Adhesion
- Micromechanics of Adhesion Testing
- Interfaces in Carbon Fiber Composites
- Interfaces in Polymer Matrix Composites: Polymer Fiber
- Interfaces in Polymer Matrix Composites: Environmental Aspects
- Interfaces in Polymer Matrix Composites-Glass Fibers
- Interfaces in Polymer Matrix Composites-Wetting
- Metal Matrix Composites: Fibers and Particulates

- Metal Matrix Composites: Interfacial Reactions
- Metal Matrix Composites: Barrier Coatings
- Ceramic Matrix Composites

The conference emphasis was to provide for a synergistic interaction between materials engineers, fiber chemists, instrumentation specialists, and micromechanics modelers. Currently, interface characterization has a strong research characterization emphasis with several approaches being developed and interfacial stress measurements and values being generated by researchers. The techniques were initially applied to polymeric systems and more recently to metal and ceramic matrix composites. There is value in designing the level of fiber/matrix adhesion and assessing the degree of degradation with processing and environmental exposure. However, it appears that there is a real need for the standardization of techniques with well-characterized composite materials, thereby assessing the validity of the various interface testing techniques. In addition, with knowledge of the interfacial shear stress, emphasis should be placed upon processing and mechanical property design with the associated balance of strength and damage tolerance. Although, several authors developed microscopy and mechanical techniques of interfacial characterization, the complete story, i.e., the translation to interface design, composite processing, and property validation, remains a neglected critical theme. The conference review will highlight particularly noteworthy contributions in the area's interfacial characterization, surface modifications, translation of techniques to composite properties and metal matrix composites.

The conference proceedings (IPCM'89, ISBN 0-408-04875-1) can be obtained from Butterworth Scientific Ltd., P.O. Box 63, Westbury House, Bury Street, Guildford GU2 5BH, Surrey, U.K., Telephone (0483) 300966, FAX (0483) 301563.

### Interfacial Characterization Plenary Sessions

The plenary sessions consisted of review papers highlighted by a review of surface analysis techniques by J.E. Castle, Surface and Interface Analysis Group, University of Surrey. Professor Castle described the resolution limits of a variety of surface techniques, regarding depth, spacial resolution, and atomic number sensitivity (see Figure 1). He indicated that an important development is XPS imaging with resolution limits in the six micron range; i.e., "ESCASCOPE" manufactured by VG. Regarding mechanical methods of interfacial assessment, J.P. Favre, Office National d'Etudes et de Recherches Aeronautiques (French Aerospace Research Institute), Châtillon, France, indicated the key issues to be addressed are... (i) identification of the main features of

interphase operation ... and (ii) reconstruction of composite behavior embodying "interface contribution." A series of interfacial evaluation techniques were discussed; e.g., fiber pull-out, microindentation, fragmentation, as well as description of composite evaluation of the interface via double cantilever, transverse tension, and interlaminar shear approaches. A plea was made for a series of round-robin evaluations of interfacial shear strength on a limited, but well-characterized composite systems. This certainly requires a rather open cooperation of a fiber/matrix supplier with information provided concerning the interfacial processing and fiber treatments; i.e., coupling agents and fiber oxidative treatments. Hopefully, the challenge will be met by a fiber manufacturer.

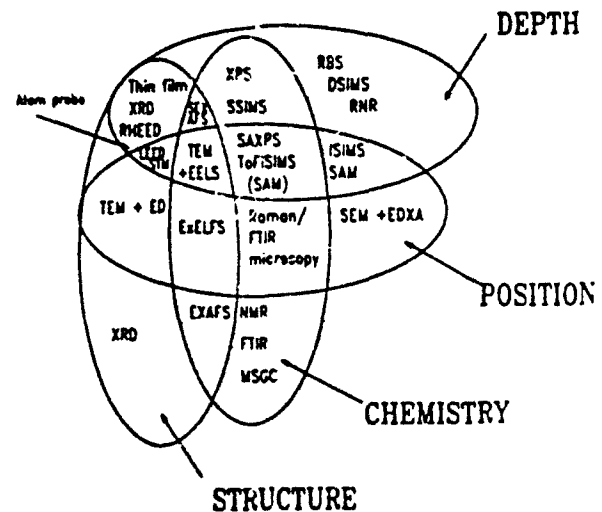


Figure 1. Venn Diagram illustrating the relationship between techniques used for analysis of fibers.

B. Rand and F.R. Jones, University of Sheffield, discussed the evaluation of interfacial effects in ceramic matrix composites and glass fiber reinforced plastic. In ceramic matrix systems, familiar themes of the requirements of improved higher-temperature fibers and oxidative protection for carbon-carbon and silicon carbide systems were echoed. Also, process control must be exercised to prevent nitridation/oxidation as well as grain growth of the reinforcing fibers. Jones discussed the role of coupling agents in glass fiber systems. Although these systems are the most commercial and extensively researched, several models describe the coupling agents to include: a chemical bonding, a deformable layer, a restrained layer, and reversible hydrolytic bonding layer hypotheses. The interfacial layer in silane modified systems must not only consider a simple hydrogen or chemical bond model, but also chemisorbed and physisorbed molecules (see Figures 2a and 2b).

Conference Highlights

**Interfacial Characterization Studies.** The ability to characterize the interface was described by a variety of surface study and instrumental approaches; e.g., Laser Raman Spectroscopy, C. Galiotis et al., Queen Mary College; SIMS' time of flight study, D. Briggs, Imperial Chemical Industries; and Raman optomechanical strain gauge, F. Underwood, British Aerospace. One of the more selective approaches utilized Laser Raman Spectroscopy, C. Galiotis, C. Vlaattas, and H. Jahankhani, Queen Mary College. The Raman spectroscopy approach correlated frequency shifts with fiber strain during loading and unloading cycles in tension and compression. Consequently, the strain distribution along loaded fibers can be assessed *in situ* for optically transparent matrix systems. Therefore, the strain distribution along embedded fibers can be described with shear lag models. The study was applied to aramid and graphite fibers with measurements at resolution limits of approximately thirty microns. The *in situ* laser Raman results depicted an excellent correlation with analytic models of Kelly and Tyson (1) and Cox (2) (see Figures 3a and 3b).

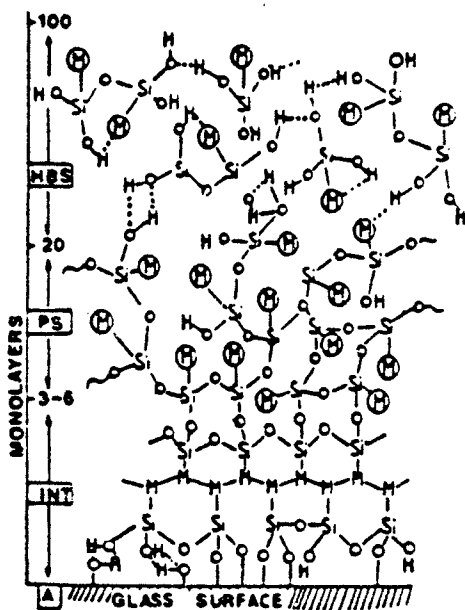


Figure 2a. Schematic diagram of the polysiloxane deposit on glass fibers from  $\gamma$ -MPS) showing the crosslinked methacrylate (M) groups at the interface (INT), polysiloxane (PS) coating with hydrogen bonded oligomeric siloxanes (HBS).

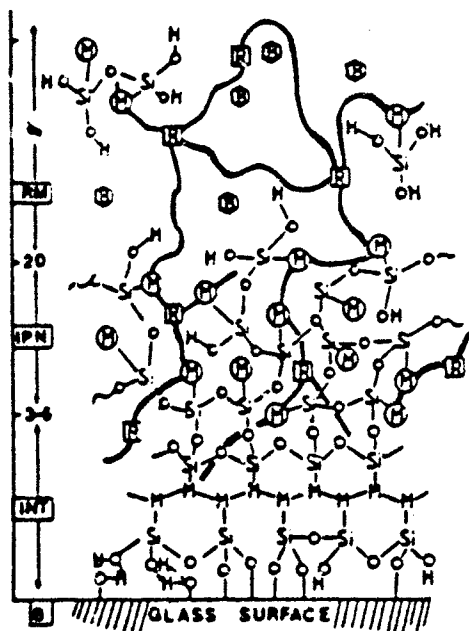


Figure 2b. Schematic diagram of the composite interphase after curing resin (R) showing the interpenetrating network M-R copolymer (IPN) and cured resin (R) which is contaminated with oligomeric silanols and the glass sizing and binder (B).

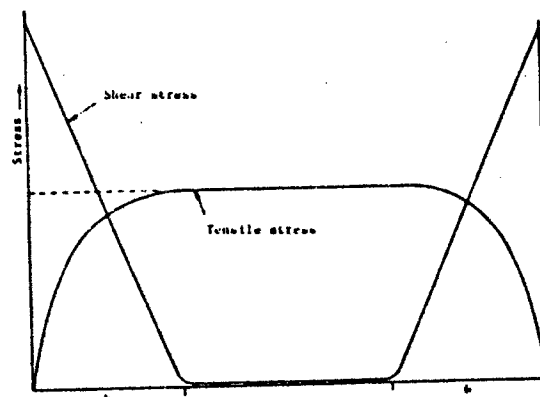


Figure 3a. Stress distributions in a short embedded fiber

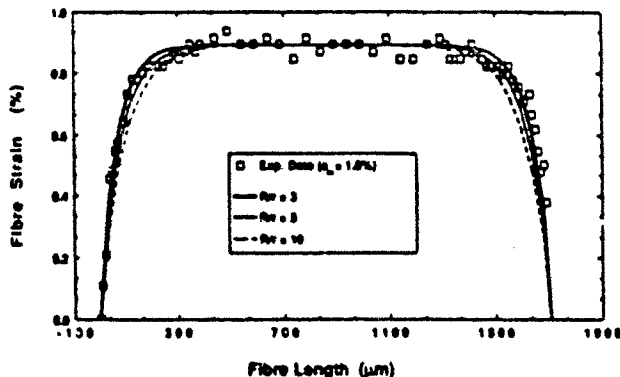


Figure 3b. Fiber Strain as a function of Fiber Length for 1.0% Matrix Strain. The fitted lines have been derived from equal (1) for R/r ratios of 3, 5, and 10.

D.L. Caldwell, Dow Chemical, Freeport, Texas, described the required linkage and correlations between interfacial properties and composite resin transfer molded components. The glass fiber/epoxy composites were evaluated utilizing a microindentation technique with evaluations of the interfacial shear stress. The mechanical properties were correlated with tensile, flexural, and impact property response. Optimum properties were achieved at interfacial shear strength of 70 MPa (see Figures 4a and 4b). In addition, the mechanical properties were assessed under hot/wet conditions. The determination was made that a very strong interface may not be the most desirable particularly with brittle matrix systems where fiber pull-out is required for toughness.

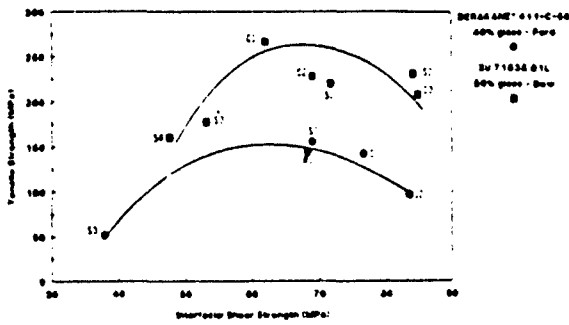


Figure 4a. Vinyl Ester/Glass Mat Composites Resin Comparison (Tensile Strength vs. Interfacial Shear Strength).

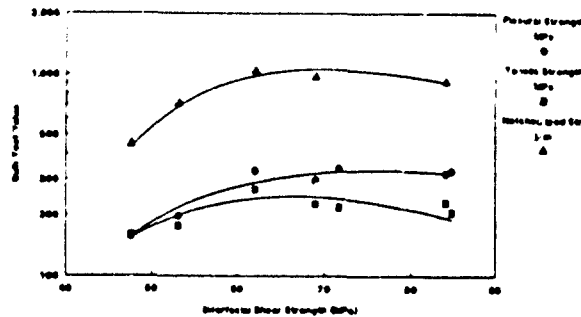


Figure 4b. XU-71835.OIL/Continuous Glass Mat Composites Interfacial Strength Correlations (Flexural, Tensile, and Notched Izod Strengths vs. Interface Shear Strength).

F.M. Underwood and D.N. Batchelder, Queen Mary College, and D.J. Sharpe, British Aerospace, described a Raman spectroscopy strain measurement approach of composite laminates. A polydiacetylene fiber (PDA) is embedded in a composite and laser light from a 6.3-mw HeNe laser is directed by an optical fiber to the strain-sensitive PDA fiber. When the composite is strained, a frequency shift of; i.e., -19.7 cm /percent strain, occurs and appears to be linear and elastic. The experimental strain results when compared with a three-dimensional

finite element approach were lower than the predicted values. The discrepancy is attributable to the nonuniform composite geometry surrounding the optic fiber/PDA junction which perturbs the local stress fields. The technique can be improved with fiber-sized reductions of the optical and PDA sensor which is at least an order of magnitude larger than the 8-micron graphite fibers. The approach can be successfully utilized to monitor processing and servicing of composite laminates at critical sections.

R.R. Kieschke and T.W. Clyne, University of Cambridge, carried out the analysis of spray-deposited SiC/CP-titanium matrix single fiber pull-out tests. Utilizing a W-core Sigma SiC and an Avco (Textron) SiC fiber with vacuum plasma spraying approach, single fiber test coupons were produced. The Avco SiC/titanium interfacial shear stress had a low value of 5 MPa vis-a-vis 50 MPa for the Sigma SiC fiber. The low value of interfacial stress was attributable to the C-rich layer on the Avco/Textron SiC fiber. In addition, Sigma SiC Y/Y<sub>2</sub>O<sub>3</sub>-coated fibers were evaluated in limited tests and the results indicated that the coatings had little effect upon the interfacial shear values. As a result, the bonding between the matrix/coating is stronger than the fiber/coating. An elevated temperature exposure of 950 C for two hours was performed upon an uncoated Avco/Textron fiber with no apparent change in the interfacial shear stress. Although the tests were limited, the tests provide for a convenient interfacial evaluation technique for spray-deposited metal matrix composites. The spray-deposited approach can be an effective processing approach since the fiber exposure time is very short and fiber degradation is minimized. However, the porosity may require secondary forming operation for high performance structures.

The thermomechanical modeling of interfacial reactions in intermetallic and ceramic matrix composites was provided in a paper by M. Singh and H. Wiedemeier, Rensselaer Polytechnic Institute. The reaction and stability of nickel and titanium aluminide composites was evaluated with respect to silicon carbide and alumina. The thermochemical computational technique examined several possible reaction paths and suggested interfacial products. The results indicate that the most stable intermetallic for SiC is NiAl, followed by TiAl<sub>3</sub>, Ni<sub>3</sub>Al, and TiAl. The alumina fiber was calculated to be very stable in the aluminide matrices. In addition, the SiC/Si<sub>3</sub>N<sub>4</sub> was evaluated at several oxygen and nitrogen partial pressures. The thermochemical calculations provide for a guideline for process control and matrix selection, but the competitive interface growth kinetics of these various reactions may override the thermodynamic driving forces for silicide, oxide, and carbide formation and should be assessed. A similar set of calculations for barrier coatings could highlight and suggest compatible systems between the fiber/coating and the matrix/coating interfaces.

## Conclusions And Summary

This conference provided a unique opportunity for the surface chemists, materials engineers, and mechanics theorists to exchange experimental and analytical results. Despite the good quality of the research presentations, a synergistic interaction between the groups did not spontaneously occur. Perhaps a sharper conference focus is required with an open discussion to raise interdisciplinary issues.

The most impressive results were from the composites group at St. Mary's College, London, with their Raman spectroscopy efforts and the excellent correlations with shear lag models. Of note, is the *in situ* monitoring with optical fiber approaches of the stress state during processing and service conditions. Except for the fine paper of Donald Caldwell, Dow Chemical Company, the conference lacked the linkage between the interface shear strength characteristics, processing, and macroscopic mechanical properties. The linkage is essential otherwise the developing interfacial characterization approaches

will languish. The call for a well-characterized round-robin interface testing would aid in the evaluation of the various experimental approaches. The next interface conference should focus upon the vital interface macro-property linkage. The emphasis should catalyze a stronger tie between the chemists, surface scientists, and materials engineers and develop the stronger scientific knowledge base for enhanced composite materials and structures.

## References

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# COMPUTER SCIENCE

## First Institute of Electrical Engineers International Conference on Artificial Neural Networks

by CAPT Walter Bruhns, a visiting scientist/reserve officer to the Office of Naval Research European Office. CAPT Bruhns is attached to the Naval Research Laboratory Unit 105 and is a Research Associate at Eastman Kodak Research Laboratories, Rochester, New York.

### Introduction

The First Institute of Electrical Engineers (IEE) International Conference on Artificial Neural Networks was held at the Institute of Electrical Engineers, London, October 16-18, 1989. There were 363 conferees from 21 countries; of the 363 attendees, 276 were from Great Britain. The next most represented country was the U.S. with 12 attendees, followed by France with 11. All other countries had nine or fewer attendees. Figure 1 provides a complete analysis.

Neural computing continues to be a very high-interest topic. The IEE organizers started planning this conference in 1987. They anticipated a 2-day conference, but because of the large number of paper submissions and high interest in this topic, the conference was extended to 3 days. More than 200 papers were submitted, and approximately 90 were presented. All of the papers were published and distributed at the start of the conference.

Forty-seven papers were presented from the podium, and forty-three were presented in poster sessions.

The conference organizers attempted to maintain a balance between neural network theory and application papers. Conference sessions covered:

- Self Organizing and Feedback Networks
- Implementation Sessions I & II
- Vision
- Speech
- Architectures
- Signal and Data Processing
- Multi-Layer Perceptrons Sessions I & II
- Image Processing
- AI and Neural Networks.

A detailed review of every paper presented at this conference is certainly beyond the scope of this overview. To obtain the 400-page Proceedings, contact the IEE, Savoy Place, London WC2 ROBL. The following information is a brief overview of selected papers chosen for their relevance to potential Naval applications.

Country	Univ.	Ind.	Gov't Military	Other	Total
Australia	1				1
Belgium	8	1			9
Canada	3				3
Cyprus		2			2
Denmark		2			2
Finland	1				1
France	2	9			11
Germany, W.		5			5
Great Britain	159	85	24	8	276
Ireland	2	2			4
Israel		1	1		2
Italy			2		2
Japan	1	1			2
Netherlands	3	4	1		8
New Zealand	1				1
Portugal	1	1			2
Spain		2			2
Sweden	4	4			8
Switzerland	4	3			7
U.S.	9	3			12
Yugoslavia	3				3
Totals	202	125	28	8	363
Percents	56	34	8	2	

Figure 1. Attendees

### Ship-Target Classification by Neural Network Analysis of Radar Signals

W.D. Beastall, Royal Naval Engineering College, U.K., reviewed his investigations of ship classifications by neural network analysis of radar signals. He applied Multi-Layer Perceptron (MLP) and Radial Basis Function (RBF) neural network models to this task. His models were trained and tested on data recorded digitally from a modern high-definition radar set. Echoes were recorded with the targets presenting aspect angles in 10-degree steps to the radar. A total of some 14,000 such range profiles were used representing 9 targets. Each range profile consisted of a vector of 59 8-bit numbers recording the echo signal strength in each of 59 adjacent range cells. All of the vector data were normalized so that signal strength alone could not be used for classification. As a control technique, the same data were analyzed using a K-Nearest Neighbor Classifier. The control technique gave comparable results to the neural network methods but required as much as 20 times the processing, making this approach much slower.

Both the MLP and RBF networks gave good results and were simple to implement. Their performance was independent of the target aspect angle. The results achieved (percent correct) were in the range of 65 to 77 percent depending on the number of hidden neurons, the number of data profiles used for training, and the target type. No preprocessing or feature selection algorithms were used. The techniques used in this study could be applied to any time-varying signals; e.g., sonar returns or medical traces.

### Bearing Estimation

S.K. Jha and T.S. Durrani, University of Strathclyde, U.K., used neural optimization techniques to estimate bearings. The fundamental problem is to determine the precise directions of sources radiating an array of sensors, in the presence of additive noise. An example of such a sensor system might be a passive sonar array. Traditionally, this problem has been attacked with a variety of time series modeling methods. The major limitation is inability to resolve closely located sources. Other high-resolution methods, Pisarenko, MUSIC (Johanson, Degraaf 1982), ROOT-MUSIC, ESPRIT (Paulraj, Kailath 1986), and parallel array methods for eigen-decomposition (Schrieber, 1982) suffer from computational complexity and do not give real-time performance.

When neural network techniques are applied to this problem, gradient descent algorithms are typically implemented. The risk is that the network will find local minima rather than the desired global minimum. Jha and Durrani following (Hopfield, Tank 1985) and (Rastogi, Gupta, Kumeresan 1987) mapped the bearing estimation problem onto the Liapunov energy function of the Hopfield model neural network. To overcome convergence on local minima, three methods were investigated—gain annealing (Hopfield, Tank 1985), iterated descent (Jha, Chapman, Durrani, 1988), and stochastic networks (Levy, Adams, 1987).

The stochastic network offered better convergence than the gain annealing and iterated descent methods. However, the price for this improved performance was two orders of magnitude increase in the number of iterations required for convergence. Additionally, more complex updating procedures were required.

### Multi-Sensor Fusion

G. Whittington and C.T. Spracklen, University of Aberdeen, U.K., presented a paper on the application of artificial neural networks to tactical and sensor data fusion. The objective of this system is to integrate numerous data streams originating from a wide variety of sensors, into a consistent model that represents the pertinent higher level features of the tactical environment and then to present an assessment of their significance. The types of data that need to be fused are surveillance, reconnaissance, intelligence, operational, and environmental. In a hostile situation, the acquisition and assessment processes must be rapid and accurate. The system must also be robust enough to tolerate and correctly circumvent deliberate deceptions.

Whittington described the Aberdeen Neural Tracking System (ANTS), which is a prototype system capable of target classification, identification of the targets mission and target threat assessment. The neural networks used by ANTS are a modified form of the unsupervised, self-

organizing feature map as proposed by Kohonen (Kohonen 1982, 1984, 1987). A conceptual structure for a future ANTS was divided into three blocks. The BLOCK-1 is the threat, target, task block; it receives the sensor data and contains a knowledge data base. The BLOCK-2 is the controller network and the decision unit. The BLOCK-3 is called the post-processor subsystem; it converts the neural network outputs into user understandable text. Initial trials with the prototype ANTS unit were encouraging. This study was supported through a grant from the Admiralty Research Establishment, Portsmouth, U.K.

### A Process Controller that Learns to Control

M. Szarens and A. Soquet, University of Brussels, Belgium, presented a paper describing a process controller that can learn to control in an interactive and autonomous fashion (a neural controller). In order to learn the characteristics of the process, the neural controller must be told what the process outputs should have been. In general, this information is not available: only the error, aim-versus-actual is known.

Two learning schemes avoid this problem. One is the general learning approach. In this case, the process is used to produce a set of input-output pairs. This approach has several drawbacks—first, the controller is not operational during the learning stage; second, the network cannot limit the process variables to relevant levels; and third, the method assumes static targets.

A second learning scheme is specialized learning. In this case, the controller learns from a direct evaluation of the network accuracy with respect to the output of the process. A key objective for this study was to define a specialized learning method based on minimal qualitative knowledge about the process.

They tested their *specialized learning* algorithm with three simulation examples—a pole balancing system, a two-dimensional arm following the random motions of a spot in a box, and a camera trained on a moving target. The learning sequence of each of these examples was shown in a video tape. Error back-propagation was used in each of the simulations and control was achieved in each case.

Further work will be needed to determine the robustness of neural controllers as compared with conventional methods. The presenter emphasized that this was strictly a feasibility demonstration and made no claim that these techniques were better than conventional control methods. Some concerns were raised about the effects that noise in the feedback measurements might have on the system.

### Improved Digital Communications

S. Siu, G.J. Gibson, and C.F.N. Cowan, University of Edinburgh, U.K., investigated a new approach for a de-

cision feedback equalizer (DFE). When digital communications are transmitted via high frequency; i.e., using ionospheric reflections, the radio waves can follow multiple paths from transmitter to receiver. These multiple paths mean that the digital information is not arriving at the receiver at the same time. These multipath errors give rise to intersymbol interference (ISI). The ISI causes the bit error rate to increase. The conventional structure of a DFE uses linear algorithms such as least-mean-square and recursive least square methods aimed at minimizing this problem. A multi-layer perceptron neural network DFE was found to give significantly improved performance, especially under high noise conditions.

### Conclusions

Artificial neural network theory, application, and implementation technologies continue to experience vigorous growth. Numerous papers presented neural network performance that was equal to or orders of magnitude improved over conventional computing methods. In other instances, neural computing was applied to tasks that essentially could not be accomplished with conventional computing architectures. Although I did not review any of the papers aimed at neural device implementations, substantial efforts are being expended in their development. Analog memory devices and optical connectivity were high interest techniques. As more neural computing devices reach commercialization, we will have the opportunity to achieve new advanced computing capabilities.

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# The Edinburgh Concurrent Supercomputer: Second Annual Seminar

by J.F. Blackburn. Dr. Blackburn is the London Representative of the Commerce Department of Industrial Assessment in Computer Science and Telecommunications.

## Introduction

The Edinburgh Concurrent Supercomputer Project (Project) is based on a very large Meiko Multiple Computing Surface (MMCS) funded primarily by the Computer Board for the Universities and Research Councils, the Department of Trade and Industry, the Science and Engineering Research Council (SERC), and industry. The Project provides multiuser access to an electronically configurable computer system of 400 T800 transputers and 1.7 Gbytes of memory, with five display systems, video input, and distributed filestore. This offers a national facility for academic and research applications, and also supports an industrial affiliate scheme with about 18 members. The commissioning and developing of the facility is a collaborative project between Meiko Limited, Bristol, U.K., and the University of Edinburgh. There are active user projects in many different disciplines. The Project staff, in addition to managing the facility, provides courses, documentation and user support, and are engaged in software development and acquisition and in-house research.

About 80 delegates from the U.K. and Western Europe attended the second annual seminar for the Project with one speaker coming from the U.S. The seminar provided an overview of the project, the hardware configurations, and the software environment, and included a selection on research projects in science, engineering, and artificial intelligence from the community of more than 200 users.

## Presentation Summaries

**Introduction to the Edinburgh Concurrent Supercomputer Project**, D.J. Wallace, Project Director, University of Edinburgh

The Project began in 1980 with an ICL DAP system and initiated work in molecular dynamics and lattice field theory. The first ICL DAP was financed by the SERC, and a second ICL DAP was a gift from ICL in 1983.

The first MMCS, a demonstrator system, was installed in April 1986. The system consisted of 40 T414s, an Inmos transputer smaller than the T800 and lacking hardware floating point capability. In 1987, the Phase 1 funding of £2.3 million permitted the installation of a 200-T800 system, and a further award of £569,000 in 1989 permitted

the buildup to the present level of a 400-T800 transputer system.

The services provided include general user support, benchmarking, and system development. Core research is accomplished and staff works with User Research Groups. Also, technology transfer is accomplished through producing software and promoting industrial affiliation through courses and consulting.

**Service and Use**, M.W. Brown, University of Edinburgh

The operating system consists of MMCS, which controls all internal communications and is the base on which the entire system runs; Meikos operating system, a UNIX-based system that runs on the shared internal file servers; Occam programming system that runs on the domain seat processor. Communications is handled through eight direct terminal connections (19200 BAUD), 16 networked connections, external file transfer via VAX, and over Joint Academic Network (JANET).

Soon, the following features will be available: diskless Meikos, UNIX-based, which will run on the domain seat, file-served directly from Meikos file servers over a Surface Filing System (SFS); local area connection via MK050 interface board to the university ether net for file transfer, mail, and terminal traffic; wide-area network connection via MK064 interface board to university campus X25 switch, and hence to JANET and Public Switching System for file transfer, mail, and terminal traffic.

The hardware configuration consists of:

- 400 T800 processors, (most with 400 Mbytes of RAM)
- 23 processor domains, in sizes up to 132 processors
- Multi-user access over a network
- 4 graphical display stations
- 7500 Mbytes of disk storage
- Exabyte video cartridge backup devices
- Frame grabber
- PAL video encoder.

**Project Manager's Report**, D.B. Mercer, University of Edinburgh

The Edinburgh Computing Surface (ECS) system has an underlying spine of transputers connecting clients/servers. A proprietary datagram protocol runs over the Computing Surface Network (CSN). The system includes a 32-seat processor farm each running a UNIX

shell to disk servers. The domains are currently static, but a dynamic compute server is planned.

The MMCS design is similar to a distributed kernel. The operating system is based on message passing and maps onto the CSN. The operating system has four layers: (1) interrupt handling and message passing, (2) input/output, (3) servers, and (4) users. Table 1 provides information about the MMCS funding.

**Table 1. Meikos Operating System Funding**

	£ (thousands)
Department of Trade and Industry	1,144
Computer Board	575
Science and Engineering Research Council	400
Meiko Limited	779
Scottish Development Agency	12
Industrial Affiliation cash and kind	800
Edinburgh University Infrastructure plus	102

The present hardware includes 400 T800s divided into 24 domains, 1.7 Gbytes of memory, 4 graphics stations, 1 frame grabber, 6 Gbytes of disk storage, tape, and cartridge backup.

The present software is Meikos operating system with language support for Occam, Fortran, and C. The system is moving to a UNIX (Meikos) operating system with computing systems tools and the languages above. There are now 321 external users of the system from 36 establishments and 94 departments. The staff consists of a Director, Project Manager, Service Manager, six user-support and club-domain people, and two Meiko personnel.

**Concurrent Supercomputing: International Perspective,** Paul Messina, Director, Caltech Concurrent Supercomputing Facilities

This talk is mainly about the U.S., but with some reference to Japan. Caltech uses commercially available machines, a uniform software environment, and works mainly with real applications. The measure of success is the quality and amount of science output (see Table 2).

**Table 2. Hardware Available at Caltech**

- 32-node Meiko system with a Sun host
- N Cube with 512 processors
- Mark III locally designed and built 128 nodes
- INTEL 16-processor system
- Ametech with 102 processors
- Evans and Sullivan with 32 processors
- Connection machine installed at Argonne
- Sun workstations and personal computers.

A distributed transmission control protocol/internet protocol (TCP/IP) network serves the Science and Technology Center for Parallel Computing serving Caltech; Los Alamos National Laboratory (LANL), New Mexico; Rice University, Texas; and Argonne Laboratory, Illinois. The Defense Advanced Research Projects Agency and the National Science Foundation sponsor a high-speed wide area network that connects LANL, Caltech, the Jet Propulsion Laboratory, and Argonne Laboratory.

The applications work at Caltech deals with astronomical data analysis in looking for pulsars. Use is made of Fast Fourier Transforms and the computing equipment consisting of N cubes, Cray, and IBM 3090s. Work is also underway on optical interferometry to wash out atmospheric turbulence.

There are other U.S. locations with research underway with parallel processing systems (see Table 3).

**Table 3. Parallel Processing Systems Research**

- Cornell University - two 6-processor 3090s
- IBM Kingston, New York - 3090s
- Syracuse University - one CM2
- Sandia National Laboratories (SNL), Albuquerque - one 1024-node N Cube
- Lockheed, Calabasas, California - one CM2
- Shell, U.S. - one N Cube.

For software at Caltech, UNIX is used as an operating system, TCP/IP protocols for communications and X-windows, while main languages used are Fortran, C, and Lisp. For compiling, autoparallelizing is not very efficient, and there are few debuggers available.

Supercomputing reached a sort of turning point in 1989. The field is dominated by vector processing systems, but several key vector clients are buying massively parallel systems for production work (see Table 4).

The winds of change are signaled by LANL purchasing a full-size CM2. A 3-Dimension Lagrangian hydrodynamics code was implemented on the CM2 and performed about equal to that of a Cray YMP. The NASA, Urbana, Illinois, bought a CM2 for production work; SNL and Oak Ridge Laboratories, Tennessee, each bought N Cubes for production work. On the N Cube2, it is possible to have up to 8,192 processors, with 1-16 Mbytes per node. In Japan, 120 vector processing systems have now been distributed to over 100 companies and universities.

**Table 4. Marketed Representative Vector Machines**

- Cray XMP - 8 processors
- Cray YMP - 16 processors
- Cray C-90 - 16 processors
- Nippon Electric Company SX-3 - 4 processors
- Steve Chen SSI-1 - 64 processors.

### Meiko Perspectives, N. Suraett, Meiko Limited

The Meiko Company was founded in 1985 by former employees of Inmos who had been engaged in developing the transputer. Meiko now has a staff of 75 in the U.K. and 85 worldwide. In Europe, Meiko has offices in Bristol (headquarters), The Hague, Paris, Munich, and Milan. In the U.S., there are offices in Boston, San Francisco, Sunnyvale, California, Washington, D.C., and Houston (see Table 5).

**Table 5. Origin of Meiko Systems Revenues**

Academia	27 percent
Research	23 percent
Military	18 percent
Finance	11 percent
Other	21 percent

In 1989, revenues for Meiko were about £10 million, with more than 200 systems sold. Earnings of about £25 million per year are spent on research and development. The six original founders still own the whole company. Table 6 provides a user list.

**Table 6. Meiko Users**

#### Research and Academia

Caltech  
Cambridge University  
Edinburgh University  
Kent University  
National Physics Laboratory  
Southampton University  
Syracuse University  
Rutherford-Appleton Laboratory

#### Industrial

IBM  
Hewlett-Packard  
Intel  
Shell  
Xerox  
General Electric  
British Aerospace  
Thomson  
Plessey  
Philips  
British Broadcasting Company  
Glaxo  
British Petroleum  
British Telecom

#### Defense

Royal Signals and Radar Establishment  
U.S. Department of Defense  
Royal Armament Research and Development Establishment  
Royal Aircraft Establishment  
Atomic Research Establishment

A vector coprocessor node was announced in September 1989. The aim is for a heterogeneous hardware architecture with a transputer, vector add-on, and general purpose processor nodes; also a homogeneous software environment with portable software.

### Parallelizing Tools, D. Pricr, University of Edinburgh

Irregular graphs can provide useful maps for connecting processors together in distributed memory multiple instruction multiple data stream machines such as the ECS. For many applications, the performance of a system in an irregular configuration exceeds by far that of systems in standard configurations; e.g., hypercubes and tori, which are poor over many performance measures. In this work, the ECS is used in a variety of ways to construct optimal or near-optimal graphs with respect to various measures of goodness, including diameter, mean interprocessor distance, and worst through routing load. Where regularity is not important, irregular graphs almost always outperform standard regular ones.

During this work, the ECS was used both to run fully asynchronous parallel programs, such as the generic topology application by Mike Norman, and to permit job-level parallelism by running multiple copies of sequential C programs developed to construct maps through various techniques.

The work is connected with other work in Edinburgh developing topology-independent communications harnesses such as TITCH and Tiny, which greatly simplify the use of parallel machines, especially when configured in these irregular configurations. In real applications, we have seen speedups of more than 10 percent gained by changing the topology without altering the programs concerned.

### Topology-Independent Harnesses, L.G. Clarke, Edinburgh University

Tiny is the latest in a series of message routing harnesses developed for use on the ECS. With interfaces to C, Fortran, and Occam, Tiny allows users to place one or more processes on each of the processors in the network being used, and to transmit messages between them without being concerned about the details of through routing.

The routing software begins by exploring the network to find shortest paths between each pair of processors. This feature allows Tiny to run on arbitrary topologies, which greatly increases its flexibility. Each user process is connected to the Tiny router by one or more read/write channel pairs. The functionality provided includes packet reading and writing and packet broadcast. Tiny is now the basis of several applications, and there is now a Tiny-compatible version of the gfx graphics library.

### Surface Tracking within Three-Dimensional Data Sets, M.G. Norman, Department of Physics, Edinburgh University

Work in the above area follows projects in the Artificial Intelligence Department. The problem is to generate images of objects within three-dimensional (3-D) solid images (tomographs). The approach uses constraints of local continuity, gradient, and intensity to determine the boundaries of continuous objects within the data. The approach then uses local continuity constraints to determine the outermost face of the boundaries it has outlined, and finally uses 3-D, shaded polygon display techniques to render the object that has been detected.

Algorithmic development for object detection and display has largely been completed, but the application forms a complex testbed for several developments on the Edinburgh Concurrent Supercomputer. The locality of the algorithm implies that only a scattered spatial decomposition will allow adequate load balancing, and that asynchronous message-passing techniques are required. In addition, the computation associated with the 3-D polygon display of about 100,000 polygons must be distributed, so the application has formed a testbed for the 3-D distributed polygon display system. The application is now fully functional and can render complex objects within medical tomographs. Use has been extended to datasets from other sources.

### Machine-Independent Image Processing Language, Han Wang, University of Leeds

Low-level, image-to-image processing is an important component of a computer vision system. There is now a wide range of equipment for performing these computations in real and reasonable time and the major problem is porting software between these machines. The APPLY program is a machine-independent, image processing language for expressing local windowing operations; e.g., Canny edge detector. The vision researchers express the image processing computations in APPLY, and these codes are then automatically mapped onto particular image processing equipment. Another advantage of the APPLY approach is that it is easy to extract parallel tasks and implement the computation on a processor array machine such as the MMCS.

### The Investigation of Communications Patterns in Occam Programs, Qiangi Luo, University of Edinburgh

The performance of a concurrent computation running on a multiprocessor system may depend critically on the way in which the program is decomposed and placed on the machine. We hope to provide a programmer with profiling tools, and see to what extent they can implement the program.

A virtual channel mechanism is assumed to be implemented, so that from the programmer's point of view, communication with a remote processor is implemented in the same way as communication within a single processor, apart from different time delays. The programmer is provided with two complementary approaches to studying program behavior: (1) software monitoring on the MMCS to obtain statistics of channel usage and (2) simulation on a Sun workstation of execution of the program to obtain rather greater range of statistical information about program behavior.

### A Distributed Blackboard System for Vision Applications, Malcolm Brown, University of Edinburgh

This project investigates the development of a distributed blackboard expert system for use with vision applications. Blackboard expert systems are based on the metaphor of a group of experts meeting around a table to solve a problem. The blackboard expert system in this project involves experts distributed over a network of processes, with the chairman being a task scheduler process, and the blackboard a distributed database. One of the experts, who knows the specialties (edge detection) of the other experts, is made chairman. They can only communicate with each other through writing on the blackboard, and they can only do so when the chairman permits. The experts write their ideas, proposed or partial solutions, and requests for help.

The blackboard is distributed over the system, with a blackboard process on each processor. The experts direct data requests to their local blackboard process, which then forwards the request to the blackboard process holding the data. The blackboard has three basic data types--arrays, lists, and atomic objects. Arrays can be partitioned over the network, with each blackboard process holding a part of the array.

### Chemical Refinery Simulation, J. Smith et al., University of Edinburgh

A chemical refinery can be modeled as a series of nodes, each of which has an associated pressure value. Some of these pressure values will be known, while others will be unknown. These nodes are linked by pipes with certain unknown flows running through them. The unknown nodes and flows form a system of nonlinear equations that can be solved using standard numerical techniques.

Currently, solving these equations takes so long that plant-running time can be simulated in real time. By using the parallel power of the ECS, it may be possible to simulate a few hours plant-running time in about a quarter of an hour real time. This will allow the user to predict when the simulation will be critical and to say which valves should be turned to alleviate the situation. The display produced by this system will have bar-chart readouts of

flows and unknown pressures that will vary as plant-running time is simulated, while certain unknowns will be plotted against time.

**Oil Reservoir Simulations on Parallel Computers,**  
Mark Baker et al., University of Edinburgh

The detailed modeling by computer simulation of the behavior of petroleum reservoirs under realistic conditions is enormously demanding in terms of computational resources. In such simulations, the reservoir is typically divided into many grid blocks, leading to a set of finite difference equations for the primary physical variables. Much of the computation associated with each grid block involves only properties local to the grid block and to immediately neighboring grid blocks, suggesting a strategy of partitioning the computation among many processors. Recently, there has been a growing realization that this intrinsic parallelism makes the prospect of applying parallel computers to the problem look very attractive from both a cost/performance viewpoint and in terms of absolute computational power.

Ken Bowler and Richard Kenway performed a feasibility study that identified several key areas for further investigation. The solution of the pressure equations requires a sparse linear equation solver, which is both efficient and robust. Several good candidate algorithms exist, but little is known of their performance in realistic problems. Furthermore, standard preconditioning techniques may be inefficient when implemented on a parallel machine. Secondly, the formation of matrix coefficients, including the calculation of the explicit primary variables, can take a very significant fraction of the compute time. The chiefly local nature of these calculations (calculations required for each grid block are largely independent) suggests that very significant speedups may be obtained by a geometrical decomposition of the simulation, where different subregions of the reservoir are allocated to different processors. Thus, the present project was established with the following objectives:

- To develop skill and expertise in parallel computing techniques appropriate for the oil industry
- To recommend a suitable parallel algorithm for the solution of large, sparse systems of linear equations of the type commonly encountered in oil reservoir simulations
- To test several different strategies for implementing simulator code on transputer
- To implement the selected parallel linear equation solver or solvers for full testing under realistic reservoir conditions.

**Variational Monte Carlo Calculations for High Temperature Superconductors,** William Yeung, Queen Mary College, London

This project uses the variational Monte Carlo method to study Fermion systems in condensed-matter physics. The method is a powerful tool for studying the properties of interacting electrons that are responsible for phenomena like the new high-temperature superconductors. Recently, we have developed a parallel algorithm for computing the determinants of large, complex matrices that arise in these systems, and we have implemented it on transputer arrays of different sizes. Thus, using the Hubbard model and the Gutzwiller projected wave functions as concrete examples, we have evaluated the energy as functions of band filling and coupling constant. Within the project, we will consider various extensions of the Hubbard Hamiltonian. In particular, we will consider the so-called  $i$ - $j$  Hamiltonian used in studying the recent high-temperature superconductors. We will investigate various interesting phases described by trial wave functions that are products of a Jastrow-type of correlation factor, and a reference state that is either a single determinant or a pair of determinants. Using the large domains on the ECS, we expect to study 2- and 3-D lattices much larger than previously studied.

# Information Systems and Parallel Computing Program in Italy

by J.F. Blackburn

## Introduction

Under the sponsorship of the Center for National Research (CNR), and chairmanship of Professor C. Ciliberto, Chairman of CNR's Mathematical Science Committee, a proposal for a program on "Information Systems and Parallel Computing" was written and presented for government approval in early 1989. The program was approved and work began in June 1989 and will run for five years at an approximate cost of 9.8 billion lire/year (about \$7.5 million). The goal is to perform research in information systems and parallel computing by consortia of industrial and academic partners. Table 1 indicates research areas and available funds for each. Other related expenses will be about 0.4 billion lire. The industrial partners, the academic community, and CNR will supply 44.71, 37.93, and 17.37 percent of the cost, respectively. A summary of the work plan for the areas of the program is given in the following paragraphs.

**Table 1. Research Areas**

- Parallel Scientific Computing - about 2.3 billion lire
- Special Purpose Processors - about 1.2 billion lire
- Parallel Architectures - about 1.2 billion lire
- Future Generation Languages - about 0.4 billion lire
- Database Systems - about 1.4 billion lire
- Methods and Tools - about 1.4 billion lire
- Systems and Support of Intellectual Activities - about 1.1 billion lire.

## Parallel Scientific Computing

In the parallel scientific computing area, three fields will be considered:

1. Research on the application of large computer systems to general interest scientific problems; e.g., structural analysis and image processing to acquire better knowledge of some natural phenomena and to improve design of high-technology products
2. Research in fundamental parallel algorithms
3. Provide access to mainframes in Italy, Europe, and the U.S., using high-speed connections and special work stations.

## Special Purpose Processors

Coprocessors and modules for image and signal processing, and coprocessors and modules for artificial intel-

ligence will include research and development of traditional chips, boards, and algorithms to implement the most common functions of image and signal processing and artificial intelligence. Coprocessors and systolic modules will involve developing programable systolic systems under certain constraints; e.g., temporization and cost.

## Parallel Architectures

Computing systems seem to be moving towards more intensive use of parallelism, with architectures like single instruction stream, multiple data stream (SIMD), and multiple instruction stream, multiple data stream (MIMD). These architectures can support the logical and functional languages of artificial intelligence. A variety of matters must be considered, including evaluating performance of a parallel computing system, interconnecting the processors, and developing fault-tolerant strategies. The research will include multiprocessors, non-von Neuman architectures, and valuation and complexity.

## Future Generation Languages

Developing new programming languages enhances support for new methods for data processing, including concurrency, distributed computing, and new data types. Also, the increased level of abstraction has made this field interesting from a logical viewpoint. In this area, research will cover: logical, functional, and algebraic languages; concurrent and object-oriented languages; and interpreters, compilers, and run-time utilities.

## Database Systems

The main goal is to develop advanced, user-oriented database management systems. The required functions will include:

- Describe knowledge bases using advanced data models such as frames and rules
- Interact with the database using logical languages
- Interact with multimedia databases, with information, including text, voice, and images
- Interact with heterogeneous databases, with different databases connected via a network.

Fields that will be investigated include: intelligent database systems, logical query languages, multimedia da-

tabase interaction, heterogeneous database interaction, user-oriented methods and tools.

### Methods and Tools for System Design

Although the design phase of a project is less automated since it is based on empirical methods, it is the most delicate and important phase in a project. The aim of this research area is to develop specification systems and automatic tools to support the analysis and the design phase and to translate the specifications into code directly executable by the computer. The fields of investigation are cognitive engineering, specification systems, and prototypes.

### Systems in Support of Intellectual Activities

The diffusion of the personal computer has led to the development of a large class of software packages for individual applications. This area of research will cover decision support systems, expert systems, and advanced individual productivity systems. The decision support systems can be useful in all the situations where the estimation of the consequences of a certain decision are to be determined. The aim of the support systems is to develop tools that allow the user to construct his own decision support system. The research in the expert systems will lead to new languages for the design of expert systems and new methods for the representation of knowledge. In advanced individual productivity systems, new methods for the development of individual productivity tools are being sought.

### Support Initiatives

In support of the research personnel, two initiatives will be taken: (1) support for parallel computing for organizing courses and state-of-the-art conferences in parallel computing, and conducting performance analysis of commercial parallel and vector computers; and (2) support in software engineering to build a library of standardized and unified tools for designing and producing software.

### Activities at the University of Pisa

Although the Parallel Processing and Computer Systems program only began in June 1989, I had discussions at the University of Pisa about the direction of their work and was given authors' abstracts of some previous work that will be relevant to their future work. I talked to Professor Piero Maestrini, Chairman, Faculty of Science; Professor Giorgio Giallo, Chairman, Computer Science

Department; Professor Marco Vanneschi, Computer Science; and Professor Franco Turini, Computer Science.

Professor Vanneschi discussed plans to use both hardware; e.g., modifications of the T800 transputer, and software to achieve an optimal balance between computing and communications in a parallel computer system. The necessary T800 chip modifications have not been determined but may include changes in the logic implemented on the chip to accelerate communications and perhaps add to the present four wires for input/output communication.

Professor Turini said that a major effort will be made on combining logic and functional programming into a single programming system. Logic programming appears to be best suited for the logical portions of an application but it is weak for numerical computing. Functional programming will make its main contribution in numerical computation.

The following authors' abstracts are of recent work that will be relevant to future work in the Parallel Processing and Computing Systems.

**Kernel LEAF: A Logic-Plus Functional Language** - Elio Giovannetti et al. Kernel LEAF is a logic-plus functional language based on the flattening technique, and differs from other similar languages in that it is able to cope with partial (undefined or nonterminating) functions. This is achieved by introducing the distinction between data structures and (functional) term structures, and by using two kinds of equality. The language has clean model-theoretic semantics, where the domains of the interpretation are algebraic complete partial orders (CPO). In these domains, the difference between two equalities corresponds to a different behavior with respect to continuity. The operational semantics (based on linear deduction by selection [SLD]-resolution) is proved correct and complete with the model-theoretic one. Finally, an outermost strategy, more restrictive than SLD-resolution, but still complete, is presented.

**Prolog as a Database Language** - M. Eugenia Occhiuto and Renzo Orsini. A survey is presented of existing approaches to integrate Prolog and databases both at a linguistic and pragmatic level. All the proposals for integration become unsatisfactory because they result in the juxtaposition of two very different languages or because they can not offer adequate mechanisms to deal with persistent data. This paper points out the critical issues of such integration, in order to overcome some of the limitations of the proposed systems and to support the design of future integrated systems.

**The Concurrent Language Shared Prolog** - Antonio Brogi and Paolo Ciancarini. A Shared Prolog (SP) is a concurrent logic language and is composed of a set of modules that are Prolog programs extended by a guard

mechanism coordinating communication and synchronization via a centralized data structure. This communication system is inherited from the blackboard model of problem solving. Intuitively, the granularity of the processes to be elaborated in parallel is large, while the resources shared on the blackboard have a very small granularity (they are Prolog facts). An operational semantics is given in terms of a partial ordering, distributed model. The expressiveness of the language is shown with respect to the specification of two possible classes of applications--software engineering environments and expert systems.

**Cost and Process Mapping in Massively Parallel Systems: A Static Approach** - Silvano Antonelli et al. This program is an integrated approach to the mapping of processes of a concurrent program onto processing nodes of a massively parallel system. Only general purpose systems in the Microcomputer Array class, and hence with a regular communication structure, are considered. No constraints are imposed on the communication structure of the program to be mapped. But since process mapping is solved during compilation, the proposed solution may be applied only to programs whose structure is statically derivable.

The mapping is implemented in two steps. In the first step, an undirected, weighted graph describing process communications is built starting from the concurrent program to be mapped. The weight of an edge expresses the amount of data exchanged between a pair of processes and is determined using only structural characteristics of the program. A detailed heuristic algorithm for an estimation of the weights is described. This step is fundamental for the definition of a programming tool implementing process mapping. During the second step, the nodes of the graph are mapped onto system nodes. The goal of the mapping is to reduce the interprocess communications cost without reducing actual parallelism among processes. Since the problem is nonpolynomial (NP)-hard, an heuristic algorithm has been developed to approximate the optimal mapping. The performance of the whole approach--cost evaluation and mapping--is discussed through a set of examples.

**A Declarative Approach to Abstract Interpretation of Logic Programs** - Roberto Barbuti et al. The theory of abstract interpretation provides a formal framework to develop advanced dataflow analysis tools for logic programming. The idea is to define a nonstandard semantics which is able to compute, in finite time, an approximated model for the program. In the present paper, we define an abstract interpretation framework based on the stand-

ard fixpoint approach to the semantics. This leads to the definition, by a set of operators, of an abstract declarative semantics, which returns an abstract fixpoint characterization of the minimal Herbrand model associated with the program. Thus, we obtain a specializable abstract framework for bottom-up abstract interpretations of logic programs.

**Algebraic Structures and Completion for Higher Order Logic Programs** - Roberto Barbuti et al. In this paper, we extend to a higher-order logic programming language some relevant results of the classical first-order logic programming paradigm. First, we adapt to this ambit the notions of success and failure sets, and we show some interesting computational characterizations of a higher-order logic program. Then we consider a negation-as-failure (n.a.f.) approach to negation and we give a notion of completion for higher-order logic programs and a model-theoretic characterization of n.a.f., analogous to those introduced by Clark. In particular, we show the soundness and completeness of n.a.f. with respect to completion. Finally, we describe an algebra of higher-order logic programs, which is the first step to the construction of a modular structure which maintains a clear semantics and a declarative reading.

**Formal Theories of Inheritance for Typed Functional Languages** - Roberto Amadio. An interesting model-theoretic notion of inheritance arises when working in realizability structures. The purpose of this paper is to define formal theories of inheritance, inspired by the models, and to stress their relevance by completeness theorems and an analysis of the proof-theoretic properties. Towards this aim we consider a relatively simple language, namely a second order lambda-calculus with records and recursive types. This choice allows an explanation at an elementary level of the main mathematical and methodological issues.

## Concluding Remarks

In addition to my visit to Pisa, I also visited the Universities of Rome and Milan. In Rome, Professor Renato Capocelli, Director, CNR program on Parallel Processing and Computing Systems, gave an excellent overview of the program, which I used in the introduction of this article. In Milan, I met with Professor Giovanni Degli Antoni, Director, Department of Computer Science. My discussions with Professor Degli Antoni centered mainly on subjects not directly connected with the program on Parallel Processing and Computing Systems; therefore, I will cover it in another report.

# The First Annual Conference On High-Definition Television

by J.F. Blackburn

## Introduction and Summaries

Although I did not attend this international conference, I am writing this report summarizing the contributed articles in the proceedings of the conference. Speakers came from Europe, the U.S., and Japan, but not all speeches were included in the proceedings.

**History of High-Definition Television**, Thomas Singleton, Editor, "Television," Journal of the Royal Television Society

From its beginning, television has excited imaginations, generated massive profits, and encouraged high-risk-takers to explore technologies that have been expensive failures. Television in the 1990s will offer something new and innovative to a fickle public already assuming the additional costs of introducing satellite-delivered programming into the home.

New technological developments suggest that high-definition television (HDTV) will have an important role to play in the further development of the cinema. The possibility of HDTV videotape replacing film as the basic stock with which artists and directors will work is already a reality. But old traditions die hard, and film technology, spurred by the threat of advanced television systems, is being refined to maintain a competitive edge. Whether it will be able to compete with the advances made in picture manipulation and computer-enhancing processes so closely linked to television technology remains to be seen. Even if film continues to be used in the production stage of program creation, consideration must be given to the method of distribution using film as the common carrier. The cost of film-stock manufacture and, therefore, the raw material of universal distribution is rapidly becoming prohibitive. Alternative technologies being developed promise that within a comparatively short time, films will be transmitted in encrypted form via satellite to cinemas equipped with HDTV record/playback machines that will record cinema features for worldwide, simultaneous release.

A major breakthrough is anticipated with HDTV in general public services. The high fidelity displays, offered by the present HDTV systems (developed in Japan by national broadcasting organization NHK and the European competitor EUREKA 95) promise to bring into the home a new experience in domestic television viewing. The rapid advances being made in compressing the required wide band-widths offer the home viewer a choice of video/disc or video/tape replays, as well as direct trans-

mission by satellite. This presents a challenge to those entrepreneurs of today's new satellite program services, using as they are, a 30-year-old technology. If they are to make advances in the new markets that will be created, then new strategies are an immediate requirement. Deregulation in European broadcasting is not just about "media barons" and "cross-border ownership" and the sale of regional broadcasting franchises. Deregulation is also about billion dollar markets in new technologies, and if history teaches us anything, it teaches that the worldwide general public has an insatiable appetite for the new. The competition for viewers, whether in the cinema or the home, will increase. The creation of discrete and identifiable markets of a specialist nature will fuel further development. One man's fragmentation is another man's marketplace, and there seems to be place for everyone.

**HDTV - The Current State of Affairs**, Bob Whiskin, Senior Partner, BIS Mackintosh Ltd.

The HDTV can be characterized as a technology push rather than a demand pull; it has been driven by engineering developments intended to extend the frontiers of television technology. Now these endeavors have become interwoven with political and commercial issues. This is particularly so in the U.S.

The most successful route to the mass consumer market acceptance of an advanced television system is one that is likely to ensure the maximum availability of programming, which dictates a compatible and evolutionary approach to its introduction. Further, in order to justify the significantly higher prices of advanced television receivers, including HDTV, the widescreen aspect ratio display (16:9) is likely to prove a more successful influencing factor overall than high-definition picture quality for screen sizes realizable with conventional direct view cathode ray tubes (CRT). Full HDTV quality will become justifiable when large flatscreen displays (greater than 1 meter diagonally) are available at competitive prices with the required performance levels, which is unlikely to be achieved before the late 1990s.

The HDTV is attracting immense worldwide interest since it will have repercussions on other strategic sectors of the world electronics industry, not only in displays and semiconductors, but also in personal computers and telecommunications. However, the full impact of HDTV will only be realized if it becomes a mass consumer product and not simply be confined to niche markets; e.g., workstation terminals, medical imaging, and other professional applications.

The HDTV offers doubled horizontal and vertical resolution, widescreen aspect ratio pictures, digital audio, and eliminates artifacts. Artifacts refers to undesirable effects, such as cross color and cross luminance, which are visible defects associated with existing National Television System Committee/Phase Alternation Line/Sequential Couleur à Memoire (NTSC/PAL/SECAM) systems.

The promise of HDTV has been demonstrated using the NHK-1125 line, 60-Hz Japanese system, and the European-1250 line, 50-Hz EUREKA project 95 system. However, some of the benefits of HDTV can be obtained using Improved Definition TV (IDTV) and Extended Definition TV (EDTV). The IDTV can be defined broadly as using existing transmissions, digital processing, and storage in the TV to enhance picture quality. The EDTV provides a typical 50-percent improvement in picture quality, demands a new transmission standard to carry the extra information, implies that the signals are compatible, and offers the potential of wide-screen pictures. The European Multiple Analog Component (MAC) system may be considered a form of EDTV since it is based on a 625-line/50-Hz transmission standard, and decoders can be relatively easily accommodated in the units required to receive the MAC transmissions. Also, MAC permits wide-screen pictures to be transmitted. Japan started EDTV broadcasts on its terrestrial network in 1989, which are NTSC compatible, but the system does not include widescreen. European broadcasters and set-makers intend to introduce wide-screen MAC broadcasts and TV receivers within the next 2 years. In the U.S., the current activities by the FCC Advisory Committee on Advanced Television Service indicate a recommendation no earlier than 1991.

An Advanced TV (ATV) system is a possible interim choice; it would not deny access to the new ATV programming by the vast existing population of set owners. Further, it ensures that programers will provide the services knowing that large audiences will be able to access these new services.

The question arises as to whether it is better to develop a technically excellent incompatible system or one that gives a ready, growing, mass-market business opportunity through compatibility. The technical excellence approach is a "top-down" concept--one that defines studio production standard first, develops transmission standard later, and gives opportunity to achieve single world TV standard. The compatible approach is a "bottom-up" concept--one that follows an evolutionary path to full HDTV and recognizes the consumer's interest in the massive installed base of existing TVs.

The strategy of European manufacturers is to follow the ATV approach, providing interim improvements in picture quality as a first step, while preserving compatibility. As a next step, the system is to be upgraded to full

HDTV quality cost effectively as improvements in technology permit. The BIS Mackintosh forecasts that sales for HDTV do not become really substantial before 2000, although sales of intermediate stage ATV receivers (EDTV, Wide MAC) will have become significant before then, particularly in the U.S.

#### **Current HDTV Activity: Who is Moving Today, and Why, Dale E. Cripps, Publisher, HDTV Newsletter**

The largest HDTV potential is consumer television. Japan's NHK was the early pioneer in developing the HDTV technology, which was adopted in Japan as a standard and a transmission system; MUSE E was a derivative development. In Japan, TV sets have been designed, tubes are being made, projection systems are on the market, and a massive program is underway for developing liquid crystal display, large, HDTV screens. The VCR and videodisc machines are beyond prototype stages. The film industry is accommodated with two tape-to-film transfer systems; Sony uses electron beam, and Nippon Electric Company uses laser scanning.

Europe has agreed that a MAC signal for satellite and cable delivery is a suitable European standard. The MAC signals are required by an EC directive for TV signals from the high-powered, direct broadcast satellites, but not for others; e.g., ASTRA. The market is uncertain about MAC in some regions of Europe because of the promotion of lower-powered satellite services in PAL. However, in the long run, MAC is expected to be the standard. High-definition MAC was conceived to be a compatible signal with MAC.

An initiative by Philips, Bosch, Thomson, and Thorn, EMI resulted in the EUREKA 95 HD-MAC. This is a cost-sharing project with these companies and their respective governments. The HD-MAC system is operational in limited quantities including cameras, recording, special effects, encoding, decoding, sets, and VCRs. Commercialization of European HDTV is expected to begin in 1992 when regular HDTV broadcast begins, though not to be significant until 1995.

In the U.S., the major proponents for broadcast standards are NBC/David Sarnoff with ACTVI and ACTVII systems, NMIK and Narrow MUSE, MUSE 6, and MUSE 9, Philips NA and HD S NA, Faroudja Laboratories with Super NTSC, BTA with ClearVision I and II, and Zenith with their Spectrum Compatible system. Estimates of when an advanced television service will appear in the U.S. vary, but it is generally thought that late 1992 is the earliest and 1995 the latest.

In the U.S., Europe, and Japan experimental programming for television has been and is being undertaken, using different standards in all three cases. Every major consumer electronics manufacturer is engaged in research and development (R&D) of some form of HDTV for a wide variety of markets. Thirty-three companies are in-

volved in the EUREKA 95 HDTV project for Europe. Nearly 40 companies from around the world have joined in the 1125-line/60-Hz Group. In August 1989 in Berlin, Thomson showed a 34" diagonal wide-screen (16:9) ATV receiver capable of delivering 600 TV lines of resolution and accepting a wide variety of signal standards. Japan has shown similar sets able to receive NTSC, EDTV, and HDTV. In spring 1990, their MUSE E HDTV decoder to receive the satellite broadcast from NHK will be in very large scale integration form, and sets will be on the market in Japan the following summer.

In the U.S., Secretary of Commerce, Robert Mosbacher, said recently of HDTV, "I give this (HDTV) the highest priority." The Defense Advanced Research Projects Agency (DARPA) is spending \$30 million on HDTV R&D for signal processing and displays, and more is slated for 1990. Europe has already spent more than \$200 million on HDTV in the EUREKA 95 Project and more money is forecast for a 2-year extension. Japan, coordinated by NHK, has spent some \$800 million on HDTV with every major electronics firm taking on a special aspect of the overall. The U.S. has three major laboratories: (1) David Sarnoff Research Center, Princeton, New Jersey; (2) Philips Laboratories, Briarcliff, New York; and (3) Zenith Laboratories, Glenview, Illinois, working full time on HDTV.

The cost of HDTV is still very high and its introduction and use entails difficulties in traditional television markets. However, other markets will develop far sooner than broadcasting and, in fact, will contribute to the lowering of the introductory costs to the consumer broadcast market. Activities are underway all over the world to prove the usefulness and feasibility of HDTV in a wide variety of applications. Now HDTV appears to be taking an orderly course to become a fully commercialized, widely used technology.

The business world is the only place where high-resolution systems workstations, are in widespread use. Correctly introduced, the corporate market can and will find long-lasting HDTV users. Activities are underway all over the world to prove the usefulness and feasibility of HDTV in a wide variety of applications.

The National Arts Center in Ottawa, Canada, in association with Telesat, Canada, is launching a program to extend the cultural heritage of the nation to rural communities via HDTV satellite broadcasts. Equipment has been ordered and productions are underway.

In the U.S., Ford Motor Company has purchased HDTV equipment with the associated paintbox graphics system, to reduce labor steps in designing a car. With thermal printers, high-quality prints can be made of the designs for distribution for approval or changes.

Shopping malls in the U.S. are interested in HDTV as an attraction and advertising vehicle. People are designing a private network in the U.S. to distribute HDTV

signals to receivers in all the shopping malls that have national stores.

Military applications abound from mapping to safety. Command posts already use high-grade imaging, and the introduction of affordable, commercial HDTV means proliferation of applications. NASA has found uses for HDTV in observing liftoffs to search for any defects that might affect the mission. Many other uses in the space industry are emerging.

The commercialization of HDTV will provide affordable display and recording making the proliferation of high-grade imaging all the more possible; e.g., in the medical field.

Today's theatrical distribution with film is cost effective for the main stream but poorly serves outlying theaters. Although the actual cost of prints on a per-show basis does not immediately suggest HDTV, it is the availability in quantity and quality that suggests it. Experiments with this method are underway in Europe, the U.S., and Japan.

#### **Non-Broadcast Applications of HDTV: An Overview, Kenji Hori, Sony Corporation**

Almost 35 years have passed since the invention of NTSC, PAL, and SECAM systems. Since then, advanced technology has laid the foundation for HDTV through progress in CRT, semiconductor, digital transmission, magnetic recording, laser and precision processing technologies. The HDTV will expand video technology beyond conventional TV applications to software production including motion picture production, computer- and communications-related industrial areas.

#### **Nonbroadcast Applications of HDTV**

With the use of the HDTV system, the quality of reproduction of TV screen images on newspapers and magazines can be greatly improved. Although photographs taken from an HDTV system have yet to match the resolution of conventional film processing, it can be put to practical use. Production of an original program with an HDTV system will allow the copies to retain much of their original quality when transferred to an on-air program or hard copies.

In observation and surveillance systems, the application of the HDTV system provides five times the resolution of present day cameras, resulting in images with much greater detail. The system was used in the filming of the space shuttle "Discovery" launch on March 13, 1989, and the picture was transmitted to a location 110 miles away in Orlando, Florida, allowing simultaneous viewing at many locations. Because of the high-resolution, instantaneous replaying of the image allowed detailed examination of critical scenes.

In medicine, video taping of a complicated operation for later viewing by medical students or for classroom use have proven useful.

Tokyo Institute of Technology has transmitted images taken by an HDTV camera through optical fiber to their branch school and monitored it on an HDTV projection system with good results. This application can be used for TV conferences, seminars, and live recording of mini theaters.

Experiments have been conducted to create an HDTV museum or HDTV gallery by precise reproduction of certain objects with the system. This system will offer access to the major art pieces of the world without visiting a museum.

Some manufacturers are developing computer-aided design (CAD) systems using HDTV technology for designing products with computer graphics. The images are projected directly onto a large HD screen in actual size, so that designers can get a real life impression and evaluate the results. Such images can be transmitted to remote sites. Also, the viewing angle of the product, its color combination, or its background can easily be varied.

The Sony videodisc player, HDL-2000, was first introduced to the market at the beginning of 1989 and is now used in a variety of nonbroadcast applications.

### Software Production and Post-Production Facilities

Sony Plc Inc., a subsidiary of Sony Corporation, has been engaged in high-definition software production since 1985 and recently opened the new HDTV video production workshop in Tokyo. Their services include HDTV editing, conversion to NTSC and digital formats, conversion to 35-mm movie films, and conversion from 35- and 16-mm negative or positive film for HDTV programs. In Japan, HDTV broadcasting will start at the end of 1990. At the beginning, the receiver cost will be very high and will have a limited market. Nonbroadcast applications will be the first HDTV market driver and will lower the cost of displays to the consumer market.

**HDTV Studio Standards, Richard L. Nickelson, Senior Counsellor, International Telecommunications Union, International Radio Consultative Committee**

The standardization work of the International Radio Consultative Committee (CCIR) is carried out in 13 study groups consisting of some 1,100 participants drawn from member telecommunications administrations, broadcasters, operating companies, industry, and international organizations. Formal adoption of CCIR Reports and Recommendations takes place during full study group meetings held every 2 years, followed by a Plenary Assembly to complete a 4-year study cycle. There is a small,

specialized technical secretariat located in Geneva, Switzerland, to assist the elected director and study groups.

Television systems development work is principally carried out in CCIR Study Group 11. The CMTT (joint CCIR/CCITT Study Group dealing with the transmission of television signals) works closely with Study Groups 10 and 11 in these areas.

There is an increasingly strong relationship between broadcast and nonbroadcast activities, and particularly their equipment and specifications, with respect to consumer and telecommunications and computer/data processing applications. The CCITT Study Groups dealing with the Broadband Integrated Services Digital Network (B-ISDN) are concerned with telecommunication network system standards. The International Electrotechnical Commission (IEC) is dealing with equipment standards, and the IEC and International Standards Organization (ISO) together deal with information technology standards.

The current CCIR studies consider HDTV to have about double the horizontal and vertical resolution of conventional 525- and 625-line standards, and a wide-screen aspect ratio. There is general agreement on a 16:9 aspect ratio for HDTV, compared with 4:3 for today's systems. The unprocessed baseband signal for HDTV requires about four times as much bandwidth as conventional television signals. There is also general agreement that HDTV includes one or more stereophonic sound channels that provide quality comparable to that of compact disk units.

The description of HDTV given in CCIR Report 801-3 was agreed during the 1989 Extraordinary Meeting of CCIR Study Group 11 on HDTV. A high-definition system is a system designed to allow viewing at about three times the picture height, such that the system is virtually, or nearly, transparent to the quality of portrayal that would have been perceived in the original scene or performance by a discerning viewer with normal visual acuity. Such factors include improved motion portrayal and improved depth perception.

Standardization is needed; three major color standards in the world (NTSC, PAL, and SECAM) and some 16 variations make it difficult to produce and exchange programs in the global market. Standards conversion is expensive, and degradation resulting from conversion will likely be even more critical in HDTV than in existing systems. The nature of HDTV standardization is especially complicated. Until recently, the work at CCIR was focused on a unique, global studio standard. This would permit the production, exchange, and distribution of HDTV television programs worldwide. Emission standards for broadcasting and transmission standards for distribution were not involved. Recently, the CCIR also assumed emission and transmission standardization. The

immediate goal of Study Group 11 remains to develop a unique studio standard.

The development of HDTV signal formats for terrestrial and satellite broadcasting, for cable distribution, for video cassette machines, and for optical disc distribution is extraordinarily complex, especially if inter-media compatibility and source-signal quality are goals. The advantages of standards to program producers, program distributors, broadcasters, receiver manufacturers, and viewers are apparent. Conversion among multiple standards increases cost and reduces quality.

Keeping in mind the time for consumer acceptance of HDTV, it is reasonable to predict from the present trends in technology that digital processing will be the heart of the 21st century display. The CCIR work is now oriented in this direction. Keep in mind the convergence of television and computer technology in the informatics society of the next century.

Separate, though inter-related, areas for standardization in television are studio, exchange, emission, and display standards. The priorities of these four standards is still unresolved.

More than 10 years ago, the Japanese started developing a HDTV studio system based on analog technology. This system had reached an advanced stage of development and implementation by the time of the 1985 final meeting of CCIR Study Group 11. The system, with certain critical parameters adjusted to meet U.S. requirements, was proposed by the Japanese, with support at that time from the U.S. and some European broadcasters, as the unique world studio standard.

In the meantime, Europe had been preoccupied with the development of an advanced television emission standard intended primarily for satellite broadcasting. Intended to eliminate the annoying artifacts in the PAL and SECAM systems and to provide multiple high-quality audio and data channels, the multiplexed analog component (MAC/packet family) systems provide the same 625 lines of resolution and a conventional 4:3 display, with the potential for upgrading. The MAC signals require a converter or adapter to be viewed on an existing PAL or SECAM receiver.

The first MAC system began experimental operation in 1989 with the launch of the high-power French direct-broadcasting satellite TDF-1. The Federal Republic of Germany initiated similar broadcasting in late 1989 when an identical satellite, designated TVSAT, was commissioned.

Starting in 1985, the European nations began the technology development project, EUREKA-95. This project was to produce a completely new HDTV system, from studio to receiver, including both professional and consumer video tape machines. The system, largely based on analog technology, is now well advanced, with demonstra-

tion units of all major elements shown at the 1989 international television exhibition in Montreux, Switzerland.

Although similar, there is a major difference in strategy between the Japanese and European systems. The Japanese envisage going from conventional systems to HDTV without any intermediate steps. They have already implemented satellite HDTV emissions using a modulation system named MUSE, with baseband video signal parameters compatible with the NHK-designed studio signal standard.

In the EUREKA-95 project, the Europeans are following a strategy in which conventional terrestrial broadcasts will be replaced with satellite-based MAC/packet broadcasts. These will be received directly with small parabolic or flat-plate antennas or via coaxial or fiber optic cable systems. During this first phase, conventional terrestrial transmissions will presumably continue until most existing receivers are replaced with MAC/packet receivers. In the second phase, HD-MAC signals will replace the conventional MAC signals. The HD-MAC is designed to be compatible with conventional MAC so the existing MAC receivers will be able to receive the new HDTV signals with conventional MAC quality, and HD-MAC receivers will be able to receive both kinds of signals. The European strategy was intended to cover a long timespan, in that a completely new intermediate technology system was to be introduced, used, and phased out before HDTV was extensively introduced. There may now be some compression of the timeframe.

The CCIR deferred decision on a world studio standard to the 1986-1990 study period. There are now two proposals for a studio standard before the CCIR: 60.00/1125/2:1 (NHK design) and 50.00/1250/2:1 (EUREKA-95 design). Proposals including progressive scanning are also under consideration.

Recent U.S. interest has centered on emission standards, particularly on compatible emission standards. Previously, U.S. efforts were largely driven by the desire to extend the U.S. advantage in global television program production and distribution into the next generation television systems. A global studio standard for HDTV would favor, and possibly extend, the U.S. production lead. The HDTV is seen by some as creating the basis for a completely new cinema distribution system, with 35- and 70-mm film eventually disappearing, replaced by direct access to encrypted satellite broadcasts of first-run cinema productions by HDTV projection theaters.

The nature of television broadcasting is very different in the U.S. from much of the rest of the world. Until recently, television broadcasting facilities in Europe and Japan have been largely owned and operated by national governments or national government corporations, and the same programs are seen nationwide with little local participation. This naturally leads to the introduction of new television systems such as MAC and HDTV by sat-

elite broadcasting. In the U.S., the situation is completely different with hundreds of locally owned and operated television stations. Canada and Japan also have a significant number of local television broadcasters, in addition to national services. Furthermore, in the U.S., there is insufficient available spectrum for new television services in most of the major population centers.

For many years to come, U.S. broadcasters see the necessity of maintaining present NTSC transmitters while HDTV services are phased in. During the transition from monochrome to color television, the problem was solved by developing a color system that could be received on existing monochrome receivers without causing unacceptable degradation, and that operated without requirement for large amounts of additional bandwidth. The FCC has proposed the same idea for introducing HDTV or other advanced television services. Several innovative proposals have recently come from the U.S., and intensive work is underway in many places. The bandwidth limitation that has been proposed for terrestrial broadcasting of HDTV in the U.S. creates a major engineering challenge, as does the requirement for compatibility with existing NTSC signals. Quality will not be easily obtained that is close to that of the studio signal.

With the shift in interest from program production (software) to the delivery system (hardware), the approach has dramatically shifted. The reason for the high level of economically driven political interest is obvious. Europe alone has about 1.5 times as many television receivers as the U.S., all of which will have to be replaced to obtain the benefits of HDTV.

### Studio Standards

Rapid developments in digital techniques, coupled with lowering costs, will allow complex image analysis and processing in the studio and complementary synthesis in the receiver, together with efficient means of long distance transmitting and broadcasting. The historical interdependence of studio and receiver scanning standards will ultimately disappear.

Related to this, intensive work carried out by CCIR Study Group 11 since the 16th CCIR Plenary Assembly led to the adoption by the Extraordinary Meeting of draft Report XE/11--Future Development of HDTV. The present direction of the CCIR work is established in that report: the long-term future of HDTV lies in the digital domain, and equally, the long-term future of HDTV standards should lie with unique worldwide standards.

Approaches to a unique worldwide studio standard for HDTV in the digital domain were identified at the 1989 CCIR extraordinary meeting of Study Group 11 (see Table 1).

**Table 1. HDTV Worldwide Studio Standards**

- Unique parameter set. A single, digital studio standard could be based on 50 Hz, 60 Hz, or even some other value, depending on such technical factors as motion portrayal and display technology.
- Common image/common data rate. Approaches based on common image formats or common data rate could lead to a universally acceptable alternative means of providing HDTV program source should the attainment of a unique standard prove to be impossible until direct digital distribution of HDTV is established.
- Common image (unified). This approach is based on the definition of a common image that can be used in systems that have different frame rates or even different scanning methods. The common elements include aspect ratio, number of active lines, number of pixels per active line, colorimetry, and transfer characteristics.
- Common data rate (dual standard). The HDTV standards related to current emission standards would be adopted with a maximum of commonality in other parameters such as line and sampling frequency, based on the principles of CCIR Recommendation 601, with the objective of common data rate. Proposals have been made to the CCIR for systems based on 50- and 59.95-Hz field rates as well as for systems based on 50 Hz and 60 Hz.
- Virtual studio standard. A virtual studio standard may be used as a common standard for exchanging programs. A digital data bus with a unique format is used to transport and record HDTV signals. Source and destination could be connected to the unified standard by gateways, which perform necessary standards conversions.
- Two-step approach. This approach assumes previous widespread introduction of switchable 50/60-Hz-based HDTV studio equipment. This would not avoid the need for standards conversion in HDTV program exchange between users who have equipment with different standards, but it would lead to the possibility of the eventual universal use of one or other systems.

### Delivery Methods

There is a real possibility that the next generation television system will be introduced by cable systems or recording media, along with terrestrial broadcasting facilities. Broadcasters have recognized this possibility and are responding by establishing and participating in joint efforts to develop and introduce appropriate HDTV systems for production and, particularly, terrestrial emission.

Satellite emission means are particularly attractive to provide the wide bandwidths required for HDTV. Home-market videocassette recorders are in an advanced state of development and progress is being made toward a read/write optical disk recorder, which could revolutionize television signal recording. Optical fibers

have the capability to deliver multi-channel HDTV (see Table 2).

**Table 2. HDTV Delivery Methods**

- Recording media. Developments in videocassette and optical disk recording techniques could provide the means for initial introduction of HDTV.
- Satellite direct broadcasting. Satellite broadcasting offers the possibility for the wider bandwidths required for HDTV and coverage of large geographic areas. Therefore, satellite broadcasting remains a leading candidate for the initial introduction of HDTV. Japan will start regular satellite broadcasting of HDTV in 1990. These services will be provided by NHK and the Japan Satellite Broadcasting Company.
- Satellite and cable distribution. The distribution, principally to cable systems, of television programming using satellites operating in the fixed satellite service, has been very successful in North America, Europe, the U.S.S.R., and Australia. Conventional channeling bandwidths offer an impediment to the introduction of wide-RF-band HDTV, but techniques are under development to use more than one channel to deliver the signal. The same bandwidth compression techniques used for HDTV in Broadcasting Satellite Service channels can be applied. The bandwidth of existing cable systems is inadequate for wideband HDTV, but several bandwidth compression and multi-channel techniques have been proposed to enable such systems to deliver HDTV signals. Cable systems are candidates for the introduction of HDTV, but with many of the same bandwidth limitation problems in existing systems as terrestrial broadcasting.
- Broadband ISDN. In some countries, sound broadcasting programs have been delivered to homes as a value added service of the public telephone network for many years. A parallel development may come to television with the advent of the B-ISDN. Standardization of the B-ISDN is at an advanced stage in the Comité Consultatif International Téléphonique et Télégraphique and the Postal, Telephone, and Telegraph Administrations, and telephone operating companies in many areas are making plans for its introduction during the next decade.
- Terrestrial broadcasters. Terrestrial broadcasters face the greatest technical difficulties in introducing HDTV. To accommodate the greater bandwidth, they must find additional channels while maintaining conventional emissions. In many areas it may not be possible to have an additional broadcasting spectrum. Techniques such as the alternate use of horizontal and vertical polarization in adjacent service areas offer the possibility for significant improvements in spectrum occupancy for television, but could result in considerable inconvenience to the viewing public.

## Emission Standards

In 1986, CCIR studies on emission standards for satellite began in earnest following adoption by the World Administrative Radio Conference of Recommendation No. 3 on HDTV in the broadcasting satellite service. The

recommendation invited the CCIR to undertake specific studies and to report on the results of its work to the second conference session.

In 1987, a comprehensive report on the subject was approved by the joint interim meeting of CCIR Study Groups 10 and 11. The general conclusion is that the broadcasting of HDTV should provide the potential of a picture quality that comes as close as possible to that of the studio signal for reception in homes.

The extraordinary meeting of CCIR Study Group 11 on HDTV addressed the question of terrestrial broadcasting of HDTV. The following three strategies were considered: (1) introduce HDTV via existing conventional scanning formats, (2) introduce HDTV via a non-compatible scanning format, and (3) introduce HDTV via agile conventional receivers. The HD-MAC has been proposed in Europe for satellite, cable, and terrestrial distribution and is the subject of current studies with different system proposals for AM/VSF and FM emission or transmission.

In 1990, Japan will begin regular satellite broadcasting of HDTV using a member of the MUSE family of HDTV emission formats, which employs an 1125/60 2:1 video signal. Several variants of MUSE, with varying amounts of video signal compressing and processing, have been developed for satellite, terrestrial, and cable emission or transmission.

## The Future

In examining the global implications of the development of the HDTV system of the 21st century, we are talking about a multi-billion dollar market in new equipment; e.g., receivers, studios, recording and transmitting equipment, and program producing. There is the additional multi-billion-dollar existing investment in conventional systems that must be amortized over a reasonable life cycle.

The advent of HDTV in each country will depend on the configuration of broadcasting and its infrastructure as well as the level of economic development; hence, the impact for any particular country will depend upon when and how HDTV is introduced.

In examining the diverse requirements and limitations of source and production media, various delivery media, viewers, and other users, it seems unlikely that a single emission standard, either in terms of quality or technical parameters, could be developed for economical use in all applications. However, a single worldwide family of standards should be achievable if the Study Group 11 approach to a unified worldwide digital HDTV studio standard is followed. Broadcasters and production organizations would especially benefit from a single, worldwide production standard, just as viewers and receiver manufacturers would benefit from a single, worldwide

emission standard, which would ideally use a baseband standard as closely related to the production standard as possible.

Timeframe is the critical element in deciding on a standardization approach. Several factors preclude rapid large-scale introduction of HDTV—size, weight, power consumption of suitable large-screen displays, and cost to the viewer.

Broadcasters have mounted a major campaign in the U.S. to develop a compatible HDTV system, and cable system operators are becoming increasingly concerned about the potential threat of competition from the wide-band ISDN. These efforts and concerns, together with the development of a number of variations of the Japanese MUSE system, the European EUREKA-95 project, and a number of ongoing developments in the U.S. and Canada may well lead to the conclusion of the CCIR standardization effort within the next study cycle.

**The Compatible Delivery of HDTV to the Home,**  
G.T. Tonge, Independent Broadcasting Authority,  
Winchester, U.K.

In the home environment, HDTV must fit in with the existing broadcast environment. A HDTV receiver must be able to display broadcast and recorded services using existing standards. The HDTV receiver should either employ multi-standard scanning standards or contain within it the necessary processing to convert existing standards to the HDTV display standard. The aspect ratio of the HDTV display will be 16:9, while existing service is 4:3. When displaying 4:3 services, some of the top and bottom of the scene content are lost, or there is some geometric distortion of the image. If HDTV delivery to the home is successful, providers of existing services may have to explore ways to change the delivered aspect ratio of their own services.

Since spare spectrum is not available to transmit HDTV and continue delivery of the existing service in the normal way, it will be necessary to introduce HDTV addition to the existing service in a way that ensures existing receivers continue to be served, while allowing an HDTV receiver to take advantage of the modified transmission signal format. This facet of compatibility is the most technically challenging, and the one toward which a great deal of effort is being applied in the U.S. (with NTSC-compatible systems) and in Europe (with MAC-compatible systems).

### Opportunities Offered by MAC Transmission

In the U.S. where terrestrial transmission for HDTV is seen as crucial, the issue is one of direct compatibility with existing NTSC transmission. In Europe, the current emphasis is on the future possibility of HDTV delivery on new services.

Any new service; e.g., Direct Broadcast Satellite (DBS) or Microwave Video Distribution, that uses a different frequency band from current transmissions and/or a different modulation scheme will inevitably mean that the next consumer will need a converter to interface with his existing TV receiver. Such new services are incompatible. Whether the new service uses conventional color coding (PAL or SECAM) or a new system is then a secondary issue. The MAC has emerged as a new standard in this context because it offers sufficient benefit to the service provider and consumer alike that it warrants the marginally increased decoder cost compared with PAL/SECAM (see Table 3).

**Table 3. MAC Requirements and Features**

#### Requirements

- Enables a low-cost service entry option for DBS or other additional services. For example, the U.K. DBS service will commence transmissions using the D-MAC/packet system. The D-MAC offers a relatively inexpensive option for entry into the DBS service by purchasing a receiving dish or flat aerial installation along with a set-top converter to feed an existing receiver. The expected cost of this equipment is about £250. This is less, by a tenfold factor, than the cost of entry into the service would be if a 60-Hz transmission system were used directly in a 50-Hz environment; 60-Hz HDTV would require a completely new HDTV set.
- Allows for the introduction of HDTV in a compatible evolutionary way. The U.K. DBS service could introduce HDTV onto any or all of its program channels at any time by using "HD-MAC" coding techniques.

#### Features

- Uses existing scanning standards, the 625/50/2:1
- Uses component rather than composite video; offers more flexibility for the bandwidth reduction coding needed for HDTV delivery.
- Has a dual aspect ratio specification; picture aspect ratio of either 4:3 or 16:9 can be provided.
- Has a digital data capacity that can be used for control information to assist with HDTV coding.

### Four Stages in Receiver Development

The four stages in receiver development outlined illustrate how the MAC transmission format, for DBS or other additional services, can offer the opportunity for an orderly, evolutionary, and compatible introduction of HDTV for the consumer (see Table 4).

**An Interactive Cable Television Network for Teaching Medicine at a Distance,** Dr. A. Robin Williams, Charing Cross and Westminster Medical School, London, U.K.

Since the formation of the new Charing Cross and Westminster Medical School in 1984, (merger of Charing Cross Hospital and Westminster Medical Schools) the clinical lecture/tutorial program has been delivered via a fully interactive cable television system. The system is

based on state-of-the-art optoelectronic technology and has acted as a demonstration project for the British Department of Trade and Industry. The system links six associated university hospitals with two-way video transmission of all types of educational material. A carefully designed implementation strategy has ensured a successful outcome and the system has been in daily use for 5 years. Both students and teachers appreciate the facilities offered and the system has been well received. Certain groups such as the pathologists, dermatologists, and radiologists have all expressed disappointment in the normal 625-line television signal and possible use of HDTV is being discussed. Closed cable networks of this type may represent a significant market for the HDTV industry.

**Table 4. Receiver Development Stages**

- Low-cost option for a receiver described in the previous section is expected to cost £250 for the U.K. DBS service.
- Integrated MAC receiver; set-top converter is built in; cost £400-500.
- Wide aspect ratio format; market foreseen for 16:9 wide-screen receivers that give high-quality component video and stereo sound performance; second expansion factor so that either 4:3 or 16:9 broadcasts can be shown correctly on 4:3 display; cost about £1,000.
- More of full picture quality available from HDTV sources can be delivered to the home; stage coincides with introduction of HD-MAC encoding into transmission channels; compresses bandwidth of HDTV source to occupy a MAC transmission channel to provide service continuity to existing MAC receivers; work progressing well towards defining optimum HD-MAC approach EUREKA-95, compatible HDTV.

## The 11th Technical Meeting of the Occam User Group, Edinburgh, 25-26 September 1989

by J.F. Blackburn

### Introduction

The Occam User Group is made up of the users of computing systems based on the transputer, for which the original language is Occam. The Occam language enables a system to be described as a collection of concurrent processes that communicate with each other and with peripheral devices through channels. The three primitive processes in Occam are assignment, input, and output. Processes are combined to form sequential, parallel, or alternative constructs. A construct is a process and may therefore be used as a component of another construct (see ESN 40-9:306-308). The meeting was attended by about 140 delegates, mainly from the U.K., but with some from Europe, the U.S., and Singapore.

### Presentation Summaries

**TROS: A Real-Time Kernel for a Fault Tolerant Multiprocessor Computer Based on Argument Flow**, Eric Verhulst et al., Intelligent Systems International, Belgium

The design and realization of a fault-tolerant, load balancing real-time kernel for a multitransputer system was discussed. The system will be able to recover from software as well as from hardware failures by applying the argument flow program organization. Argument flow programs are a mixture of normal control flow at the

lowest level and of data flow at the higher levels. Hence, load balancing can be executed automatically. The architecture of the run-time kernel and the use of argument flow was discussed.

**Dynamicity Through Occam and the Transputer Development System (TDS)**, D. Millot and J. Vautherin, Universite Paris-Sud, France

A parallel program running on a parallel machine involves a logical network of processes and a physical network of processors. When both networks are known at design time, a static mapping of the logical network on the physical one can take place. Dynamicity arises when one of the networks is not determined before execution begins. This can happen when the logical network involves dynamic creation of processes, or when the physical topology cannot be determined at design time. This is the case in a multiuser context, as the configuration a user gets is affected by the other users' computations, or when the programmer wants to develop a generic program that can be executed on any physical topology. When using Occam to design a network of processes that have to be mapped on transputers, the following decisions must be made:

- The network of processes should be composed of an explicitly bounded number of processes because Occam does not allow recursion.
- The topology of the transputer network should be known, for processes are explicitly mapped onto

processors. The physical topology must be investigated in order to write the configuration statements, and a change in topology entails modifications in these statements. An application is therefore dedicated to a configuration.

Nevertheless, it would be very attractive to design software that could run on an unidentified topology, trying to make the best of available processors. Such software has to realize a dynamic placement and therefore includes a phase supposed to investigate the configuration, load the different codes on the appropriate processors, then dynamically start their execution.

The authors' aim is to develop suitable tools to write that kind of application. As a first step, they are investigating the potentiality of Occam and TDS in this field.

**A Computer-Assisted Software Engineering Tool for Designing Deadlock-Free Occam Programs,**  
W.D. Crowe et al., The Open University, U.K.

The authors described a computer-assisted software engineering (CASE) tool aimed at producing correct Occam programs. They used variants of Communicating Sequential Processes (CSP) and Occam2 notation, a strong form of protocols on channels and standard forms for processes in order to lessen the combinatorial problems that arise while investigating deadlock. The CASE tool is graphical and two versions of it are currently being implemented. One version is written in Prolog and runs on Macintosh computers, while the other is written in a mixture of Prolog and C and runs on Sun workstations.

**A Deadlock Detection Tool for Occam,** Wouter Joosen,  
University of Leuven, Belgium

Deadlock is a frequently occurring problem in the development of parallel programs. In the domain of transputer technology, and of parallel computing in general, runtime debugging of software remains a problem. This means that verification tools based on static analysis can be useful even if the functionality is sometimes limited. The author presented an approach to static analysis. The analyzer reduces an Occam program to the relevant actions in the context of the problem (communication, possibly through guards and parallel process constructions), and subsequently examines the program, reporting possible problems that could occur during real execution. The tool goes beyond just detecting deadlocks and also reports other infinite wait situations.

**Solving Partial Differential Equations via Cellular Automata: A Binary and Statistical Approach,**  
F. Desbois et al., ONERA Centre de Calcul, France

The authors discussed the use of cellular automata to solve partial differential equations discretized on an irregular grid. Boolean representation of real numbers were introduced and logical intrinsic computer functions

were used to achieve algebraic operations of the finite difference algorithm. A description was given of the method and its implementation. For diffusion or convection problems, preliminary computations were done on a Cray XMP18 and on a network of T800 transputers.

**Towards a Software Architecture for Solid Modeling Systems on Processor Networks,** D.P. Mallon et al.,  
University of Leeds, U.K.

Programming a parallel computer like the Meiko Computing Surface involves a variety of system level issues that are not normally encountered when programming conventional uniprocessor machines. This additional workload, often machine dependent, provides a significant barrier to parallelizing existing algorithms, designing new parallel algorithms, and porting programs between different parallel machines. Major areas of complexity encountered when programming transputer-based machines are:

- Programming any message-passing computer inevitably brings a focus on communication. Protocols must be followed and often long messages must be broken into shorter packets that can be handled by the routing system. Deadlock must be avoided, not only at the higher level of the processes defining the application program, but also within the underlying routing procedures. The flexibility in topology offered by many transputer systems carries with it the overhead of configuring the chosen topology. Mishandling of communications issues may bring a significant penalty in system performance. There is a need for a higher level model of communication that can release the applications programmer from considering many of these issues.
- A second set of problems arises in relation to scheduling. For a parallel system to be efficiently used, all of the processors must be kept busy doing useful work as much as possible. Hence, load balancing becomes a generic issue in parallel programming. Some applications are naturally load balanced because the partition of the application across the processors produces equal amounts of work. In such cases, a simple static scheduling technique is feasible. However, many applications cannot guarantee such convenient load balancing, and efficiency dictates the use of dynamic scheduling techniques.

There are three important requirements for reducing the complexity of parallel program design:

1. Communication model that abstracts away from the issues of topology, routing, and deadlock avoidance
2. Scheduling mechanisms that permit both large databases and task generation to be efficiently distributed among the processors

3. Programing model that enables the scheduling mechanisms to be transparent to the application programmer.

The authors propose a three-level software architecture for multicomputers to support geometrical computations. The architecture takes into account current and emerging hardware to support communications and scheduling.

**Intelligent Character Reader, Koh Liang Seng and Francis Wong, National University of Singapore**

The authors presented the design of a transputer-based Intelligent Character Reader (ICR) with implementation based on two algorithms. The Filtered Projection Technique (FTP) is a modification of the conventional projection profile techniques; it filters out and projects the structural information of a visual pattern into several components along several directions, such that some salient structural information can be extracted from these components easily. The Structural Complexity Index (SCI) algorithm determines the structural complexity of a visual pattern and produces the corresponding index to indicate its relative complexity. The ICR is capable of recognizing printed characters; e.g., Chinese characters printed on the local newspapers, accurately despite the presence of noise caused by printing, scanning, slight font variations, and misalignment. The ICR prototype is implemented on Occam2 and C, and has been run on an array of transputers.

**An Irregular Distributed Simulation Problem with a Dynamic Logical Process Structure, Ming Q. Xu et al., University of Exeter, U.K.**

This paper described a modeling problem that exhibits many features of more advanced distributed simulation: biological population dynamics--host-parasite interactions. The simulation is a dynamical one in which certain species of hosts and parasites live, move randomly, breed, and infect the hosts in a two-dimensional ocean. Apart from its relevance to realistic biological studies, this simulation program does illustrate many crucial ideas in dynamic time- and event-driven simulations. The approach to the parallel implementation of this simulation requires the simulation objects to be organized as logical processes that can be created and destroyed dynamically at run time to reflect the birth/death of these simulation objects. In addition to their dynamical features, logical processes must preserve the temporal aspects of the real world system. In other words, a global ordering of logical processes must be ensured to preserve the causality principle. Also, the computational load can become imbalanced because the real world system or rather, the distribution of hosts and parasites in the underlying space, is changing with time. The methods for counteracting this dynamical load imbalance were described.

**A Generally Configurable Multigrid Implementation for Transputer Networks, Osama El-Giar and Tim Hopkins, University of Kent, U.K.**

In Occam, the authors discussed the design and implementation of a highly efficient, parallel, multigrid algorithm. The emphasis was on simplicity, and the program does not require the complexities of some other methods to obtain efficiency. The method, implemented on a transputer-based architecture, shows that the combination of fast-floating point hardware, local memory, and fast communication links between processors provides an excellent environment for the parallel implementation of multigrid algorithms. The gain in efficiency by increasing the number of processors is shown to be nearly linear and comparisons are made with published figures for a parallel multigrid Poisson solver on an Intel iPSC 32-node hypercube. There is a far more marked degradation in performance as more nodes are introduced into the solution for the iPSC 32 than for the transputer array.

**Self Adjusting Mapping: A Heuristic Mapping Algorithm for Mapping Parallel Programs onto Transputer Networks, Hong Sken and Ralph-Johan Back, Abo Akademi University, Finland**

The problem of mapping parallel programs on multiprocessor systems is a fundamental problem of great significance in parallel processing, but it is Nonpolynomial-hard in general. In this paper, the authors proposed a fast heuristic algorithm to solve this problem on transputer networks. The mapping algorithm consists of three modules: grouping, placement, and routing. Grouping group processes into tasks that can be placed onto processors in the transputer network in a way of one-to-one, placement places the grouped tasks onto the processors, and routing produces physical communication paths for logical communication requirements. The three modules work cooperatively in a way of progressive self-adjusting, and finally produce a satisfactory solution for the mapping problem.

**Investigation of Communication Patterns in Occam Programs, Rosemary Candlin et al., University of Edinburgh, U.K.**

The performance of a concurrent computation running on a multiprocessor system may depend critically on the way in which the program is decomposed and placed on the machine. In order to exploit the potential of parallel processors, it is necessary to balance the advantage of spreading the computational load as thinly as possible over the processors, with the disadvantage that increased communication delays may slow the computation. In general, there is no satisfactory theoretical model of the complex interaction between the amount of computation carried out by the individual processes, their frequency of communication, and of the topology of the

underlying machine. For many problems, it is not easy to see in advance how computation will interact with communications, and placement strategies that depend only on a static analysis of the program structure may not be sufficient. The work described in this paper is an attempt to provide useful tools for the Occam programmer that can be used to investigate communications patterns and to explore different configurations rapidly.

The authors believe that this approach will be particularly valuable for programs that can be decomposed in a natural way into a fairly large number of top-level Occam processes, so that the preliminary parallelism arises out of the nature of the application. The main problem is to place these processes on a smaller number of physical processors. This is often the case for programs that model real-time systems, and the authors took as an example an application from chemical engineering. In programs like this, there is a natural concurrency in the real world that can be easily represented in terms of Occam processes. At present, they do not attempt to extract parallelism automatically, or handle shared data, though there are several systems that have tackled these problems. The main aim is to provide the programmer with profiling tools and see to what extent they can help to produce an efficient implementation of the program.

The starting point is an existing Occam program, considered purely as a concurrent computation without any placement statements. Assumedly, a virtual channel mechanism can be implemented so that from the programmer's point of view, communication with a remote processor is implemented in the same way as communication within a single processor (apart from different time delays). The programmer is provided with two complementary approaches to studying program behavior:

1. Software monitoring on the Meiko Computing Surface to obtain statistics of channel usage
2. Simulation on a Sun workstation of the execution of the program to obtain a rather greater range of statistical information about program behavior.

These two methods have their advantages and disadvantages. Measurement on the machine itself seems more direct, but running monitoring software inevitably affects the original computation. Monitoring in a simulated system can be independent of the computation and allows more rapid evaluation of alternative placements, but runs the risk that the model does not accurately represent the behavior of the system.

The user can move between the two systems, exploring program behavior at various levels of detail. The aim is to provide statistical information about process execution times and channel data rates, not to provide facilities for program debugging at the instruction level.

#### **System Configuration for Very Large Database Problems, Alan Chalmers and Derek Paddon, University of Bristol, U.K.**

In the past, many applications have ensured success by restricting the size of the application, or by increasing the number of processors and memory size to enable the full databases to be supported. The authors specify that databases of arbitrary sizes should be supported and not be restricted by the memory size of individual processors. The ability to cope with very large databases was easily achieved by many of the early multiple instruction multiple data (MIMD) systems by using a shared-memory model. However, the transputer and Occam model restricts the user from this approach; instead, he may share data.

Unlike shared-memory systems, the user cannot globally address data in a message-passing system. However, if data items carry unique identifiers, one can share single or multiple copies of those data items across many processors. Adopting this system of shared data reference allows the user the same memory flexibility for read-only data as would be obtained in a shared-memory system, without the bus contention problems associated with that class of processor. In its degenerate form, a shared-memory system has only private data that is never available at any other processor. In many applications, such as the ray tracing of very complex computer images, a static allocation of data is inappropriate. Here, a database is managed at each node in a manner similar to that of a cache memory. Shared data systems, for a tree-based system architecture and for very large database problems, are described by S.A. Green, D.J. Paddon, and E. Lewis in: "A Parallel and Tree-Based Computer Architecture for Ray Traced Computer Graphics," in *Parallel Processing for Computer Vision and Display*, Leeds, 1988.

#### **A Comparison of Parallel Implementations of Flux-Corrected Transport Codes, J.M. Long and G.S. Stiles, Utah State University**

The authors presented the results of comparing implementations of the Flux-Corrected Transport (FCT) method on transputers and several other parallel and sequential machines. The FCT is a finite difference scheme used to solve fluid dynamics problems that may involve steep gradients or shocks. The method has proven useful for one- and two-dimensional problems in plasma physics, atmospheric sciences, and detonation studies. The method is also easy to vectorize and runs quickly on supercomputers. Since the calculations at each point involve only a small number of neighbors, the method can also be efficiently implemented on multiprocessor systems. The authors have run one- and two-dimensional problems on transputers and several other systems, including VAX 8650, Sun 4/280, four-processor

Ardent Titan, eight-processor Alliant FX/8, and four-processor Silicon Graphics 240 GTX.

If, in the one-dimensional problem, we consider the speed of a single T800 to be 1.0, Sun ranks at 3.8, VAX 8650 at 4.0, 8 T800s at 7.9, Silicon Graphics 240GTX at 27.0, FX/8 at 56.9, and Titan at 64.4. Results are comparable with the two-dimensional problem. The transputer ranks highest if we calculate the cost effectiveness of the various systems by dividing the relative speed by the approximate cost. If we assume that 8 T800s have a cost effectiveness of 1.0 on the one-dimensional problem, Titan is second at 0.52, followed by 240GTX at 0.17, FX/8 at 0.094, Sun at 0.081, and VAX at 0.021.

#### **Simulating Neural Networks in Distributed Environments, Jukka Vanhala and Kimmo Kaski, Tampere University of Technology, Finland**

Artificial neural networks are modeled on theoretical neurobiology but are practical tools for computing. Neural networks are highly connected systems consisting of simple threshold units. Their inherent parallelism, fault tolerance, and learning ability makes them very useful when the conventional methods fail or perform poorly. On the other hand, their massive parallelism and high connectivity also makes them hard to implement on traditional computer architectures. To make it a bit easier, the authors have tried to analyze some aspects of running neural networks on a distributed multiprocessor.

They compare two implementations of neural network models--the Sparse Distributed Memory model and the Hopfield Neural Network model. In many respects, the Sparse Distributed Memory model is comparable to the Hopfield Neural Network model. The ideas behind these models are quite different, but the resultant behavior is very similar. Both can function as autoassociative memories and both use the Hebbian learning rule. Both network algorithms were implemented on a distributed transputer-based multiprocessor; their behavior was analyzed theoretically and tested in practice. The storage capacity of the networks was compared.

#### **Attribute Evaluation on a Network of Transputers, Matthijs Luiper and Atze Dijkstra, University of Utrecht, the Netherlands**

This paper discusses using parallelism in compilers that are automatically generated from attribute grammars. Their system, Little Red Corvette (LRC), detects parallelism in attribute grammars and automatically generates parallel compilers that run on a network of transputers. A message-passing kernel supports parallel compilers. The authors discussed the structure of these parallel compilers, the message-passing kernel, and the experiences with the construction of the kernel.

The compilers are automatically generated from an attribute grammar definition of the source language. The

work shows that parallelism can also be used in non-numeric computations. As part of implementing parallel compilers, they constructed a general message-passing kernel for transputers. This kernel can also be used in other applications. First results indicate that parallel compiling on transputers is feasible and that 4 to 16 transputers can be used in parallel compilers.

#### **An Object-Oriented Style for the Meiko Computing Surface, Matthew Chalmers, University of East Anglia, U.K.**

During the development of a ray tracer on a Meiko Computing Surface, problems were encountered with poor flexibility of configuration and slow software development. In order to overcome these difficulties and to facilitate experimental programming on the Meiko, a system to support an object-oriented style for Occam programming was developed. The aim was to create a set of library modules that would allow user code to be quickly developed and integrated into existing programs, to support better debugging facilities that were currently available, and to allow program design to be based on a more flexible and dynamic model of concurrency than the current model.

This system has been rewritten to introduce new features and to take advantage of the availability of the language C. The new system was described emphasizing how experience with the system influenced its redesign and detailing newer elements such as the improved facilities for monitoring and debugging.

#### **C-Net: A C++ Based Language for Distributed and Real-Time Programming, Jean-Marc Adame, Ecole Normale Supérieure de Lyon, France**

The C-Net is a high-level C++-based language devoted to multiprocessor architecture programming. The language has been designed to offer concepts of object-oriented programming, communicating processes, and exception handling, all within the same language. This paper describes how merging these concepts into C-Net has been organized. The first part concerns the different roles that the notions of class object and process are intended to play within the language. The argument is that these roles are, in fact, orthogonal since the first two notions are primarily concerned with threads of control and synchronization. The second part describes the exception handling system, which makes it possible to derive process pre-emption mechanisms by combining exceptions with parallelism. Process pre-emption raises some atomicity problems, which were discussed in the second part of the paper. The last part provided information on the state-of-the-project development and on future perspectives.

**Real-Time Transputer Models of Low-Level Primate Vision, Andrew Smith and Peter Welch, University of Kent, U.K.**

From psychological experiments, it is believed that human vision operates in two stages: (1) a parallel pre-attentive stage that extracts simple visual features, and (2) a sequential attentive stage in which local features of the scene are analyzed. A processing model of the early preattentive stage has been developed. This model is computationally intensive, making it unsuitable for implementation on sequential computer architectures. The development of a real-time parallel transputer vision system based on this processing model was discussed.

The current implementation performs edge filtering over four separate resolution/field-of-view levels from 256 by 256 monochrome images. Eight T800 transputers deliver over 40 frames per second. The software/hardware is scalable to support higher resolutions and additional features (auto-focusing, movement direction, and tracking) through adding extra transputers, while maintaining at least camera frame rates.

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ESN 40-9:306-308 (1986).

## ELECTROMAGNETISM

### Union of Radio Science International Symposium on Electromagnetic Theory

*by Dr. Guillermo C. Gaunard, Research Physicist, Research and Technology Department, Naval Surface Warfare Center, White Oak Laboratory, Silver Spring, Maryland.*

#### Introduction

The 1989 Union of Radio Science International (URSI) International Symposium on Electromagnetic Theory took place at the facilities of the Royal Institute of Technology (KTH) in Stockholm, Sweden, on August 14-18, 1989. This week-long conference is the annual world event in electromagnetism. The KTH is one of the best universities in Sweden and is located along the fashionable Valhallavägen Street north of Stockholm. This year, the conference organizer was Professor Stafan Ström from the KTH; the program organizer was Professor T.B.A. Senior, University of Michigan, who was also the Chairman of URSI's "Commission B" in charge of this area.

The symposium was well attended, with over 225 papers coauthored by over 450 scientists and engineers presented in 36 technical sessions. All lectures were presented in English. There were at least four simultaneous parallel sessions in six main areas. All papers in the 36 sessions were contributed, and were assigned time slots of the same duration. Attendance at the conference was 400 people, including spouses and other accompanying persons. The six areas and their corresponding technical sessions is provided in Table 1.

In this report, I summarize a dozen or so papers--a couple from each of the main areas--that were interesting to me, particularly for their naval relevance and general applicability.

**Table 1. Areas and Corresponding Technical Sessions**

Direct and Inverse Scattering (10 sessions) - General Scattering and Diffraction (4), Transient Boundary Value Problems (1), Transient Electromagnetics for Geophysics (1), Rough Surface Scattering (1), Inverse Scattering (3)

Various Types of Media (5 sessions) - Random Media (2), Biological Media (1), Chiral Media (1), Anisotropic Media (1)

Mathematical Methods (6 sessions) - Integral Equations (1), Uniform Asymptotics (1), Finite Elements (1), Method of Moments (1), Numerical Methods (1), Ray Methods (1)

Electromagnetic Theory (2 sessions) - Nonlinear Electromagnetics (1), General Electrodynamics (1)

Antennas (6 sessions) - Dipole Antennas (1), Antenna Theory (1), Reflector Antennas (1), Slot/Aperture Antennas (1), Patch Antennas and Arrays (2)

Waveguides and Periodic Structures (7 sessions) - General Waveguides (1), Dielectric Waveguides (2), Multilayered Waveguides (1), Planar Waveguides (2), Periodic Structures (1)

## General (Direct) Scattering

**Resonant Scattering by Multiple Dielectric Objects.** H. Shao, North China Institute of Electric Power, Beijing, and W. Zheng, Royal Institute of Technology, Stockholm. The authors presented a numerical investigation of electromagnetic scattering by many (multiple) dielectric objects in the resonance region. The emphasis was in extracting object-characterization features. The influence of the coupling between objects on the scattering properties was demonstrated. The average scattering cross-section was proposed as a tool to extract information about an unknown object adjacent to other known objects, from total scattering data measured from multiple scatterers.

**Electromagnetic Scattering from a Body Containing Apertures Terminated by a Microwave Network.** J.A. Gerald and Roger F. Harrington, Syracuse University. The authors presented a procedure based on the method of moments (developed by the second author), in which the scattered electromagnetic field may be obtained when a given impressed field is incident on a conductor containing apertures. They further analyzed the case for which, internal to the body, the apertures were interconnected by a microwave network.

**Natural Frequencies and Eigencurrents of the Elliptic Disk.** J. Björkberg, Royal Institute of Technology, Stockholm. The natural frequencies of a body determine the late-time response of a transient excitation. Here, the author determined the resonances and corresponding eigencurrents of a perfectly conducting elliptic disk by the T-Matrix or Null-field method. The elliptic disk is the zero-thickness limit of a general ellipsoid. The correct edge-behavior was found in this limit, and the theory was illustrated with many calculations.

## Inverse Scattering

**Direct and Inverse Scattering of Transient Electromagnetic Waves.** G. Kristensson, Lund University, Sweden, and R. Krueger, Ames Laboratory, Iowa State University. The authors studied the propagation of transient electromagnetic waves in spatially inhomogeneous slabs of finite length. The permittivity and conductivity profiles varied only with depth. Knowing these profiles, the direct scattering solution determined the scattering kernels. In the inverse scattering problem, these profiles were calculated with knowledge of finite-time traces of the scattering data. The authors presented and compared two approaches to solve both these problems by time-domain techniques.

**Symbol Analysis and the Construction of One-Way Forward and Inverse Wave Propagation Theories.** L. Fishman, Colorado School of Mines, Golden. The

author reviewed the application of phase-space and path-integral methods to forward and inverse wave propagation modeling at the level of the scalar (one-way) Helmholtz equation. The role of operator symbols was stressed and their properties briefly discussed. These path-integral methods extend homogeneous Fourier techniques to inhomogeneous environments.

## Transient Boundary Value Problems and Geophysical Applications

**Scattering of Arbitrary Electromagnetic Pulses by Dielectric Spherical Targets.** H.C. Strifors, Swedish Defense Research Institute, Stockholm, G.C. Gaujaard and W. Wertman, Naval Surface Warfare Center, White Oak, Maryland. The authors developed the complete scattering solution for the echoes returned by dielectric spherical targets illuminated with arbitrary incident electromagnetic pulses. The use of long pulses excites individual target resonances. More important is the use of short pulses, since from these one can recover the entire (steady-state) radar-cross section for c.v. incidences. The methodology presented handled any incident pulse on any material in any frequency band. The methodology was extensively illustrated with pertinent calculations for various types of pulses and materials. The radar applications of the method prompted a one-hour discussion period, taking advantage of a cancellation and a break. The session chairman directed the discussion, which showed that similar theoretical efforts are currently ongoing in Japan, Israel, U.S.S.R., and other countries, but that parallel experimental efforts are sparse and difficult.

**Transient Electromagnetic Waves in Applied Geophysics.** J.R. Wait, University of Arizona. Professor Wait gave an introductory survey of how applied geophysicists have been experimenting for nearly 70 years with time-dependent electromagnetic waves to probe the earth's crustal layers. Since the early days when the current to the current electrodes was interrupted, the voltage at the receiver electrodes decayed more slowly than pure electromagnetic estimates would indicate. This is now recognized as the phenomenon of "induced polarization" which has been extensively exploited in mineral and petroleum exploration. The author reviewed several recent investigations instructively and clearly in two consecutive lectures.

## Various Types of Media

**Average Reflected Power from a One-Dimensional Slab of Discrete Scatterers.** S.S. Saatchi, NASA, Greenbelt, Maryland, and R.H. Land, George Washington University, Washington, D.C. The authors studied reflection from a one-dimensional random medium of dis-

crete scatterers. The medium was modeled as a Poisson impulse process with concentration  $\lambda$ . By employing the Markov property of the Poisson impulse process, an exact integro-differential equation of the Kolmogorov-Feller type was found for the average reflected power. The rest of the paper was devoted to finding approximate solutions of this equation in the limit of small  $\lambda$ , by various methods.

**Reflection and Transmission for General Multilayered Anisotropic Structures.** B. Audone, Aeritalia, Caselle Torinese, Italy, and P.L.E. Uslenghi, University of Illinois. The authors presented a model for a radar-absorbing structure consisting of any number of planar layers of different thicknesses and materials, each represented by permittivity and permeability tensors with complex elements. Additional anisotropic jump-impedance sheets were located at the interfaces between layers. When a plane wave of arbitrary polarization was obliquely incident upon the structure, the reflection/transmission coefficients were determined via a chain-matrix algorithm.

## Mathematical Methods

**Iterative Methods for Solving Integral Equations.** R.E. Kleinman, University of Delaware, and P.M. van den Berg, Delft University, the Netherlands. Many iterative algorithms to solve integral equations arising in field problems were discussed. Some of these were the Neumann Series, the over-relaxation methods, Krylov subspace methods, and the conjugate gradient techniques. Relations between all the methods were described, and the numerical performance was contrasted by using a uniform square error criterion.

**The Physical Theory of Diffraction.** Piotr Ya. Ufimtsev, Institute of Radioengineering and Electronics, Moscow. The author presented the physical theory of diffraction (PTD) or method of edge waves. Elementary edge waves (EEW) are the waves scattered by a neighborhood of an infinitesimal element of edge. Their high-frequency asymptotics were derived. Other definitions of EEWs were discussed. The total edge wave (TEW) scattered by the whole edge is found to be a linear superposition of all the EEWs. The PTD permits the correct determination of the leading term in the high-frequency asymptotic expansions for the primary and the multiple TEWs. This determination is possible in the ray regions and in the diffraction regions such as caustics, shadow boundaries, and focal lines. The author ended his lecture stating that the P in PTD really stands for Piotr.

**Ray Formulation of Waves Guided by Cylindrically Stratified Dielectrics.** L.B. Felsen, I.T. Lu, Polytechnic University, New York, and K. Naishadham, University of Kentucky. This paper presented a very general formula-

tion to deal with curved dielectric waveguides. To parameterize the relevant wave phenomena, the radial ( $r$ ) part of the problem was treated in terms of the radial discrete mode spectrum, while retaining a continuum for the longitudinal ( $z$ ) and the azimuthal ( $\phi$ ) portions, with the  $\phi$ -domain extended to infinity. By asymptotic reduction, the radial mode fields guided inside the layers follow helical ( $\phi, z$ ) trajectories originating at the source; because of dispersion, these waves have anisotropic speeds depending on the departure angle. Thus, in an equivalent two-dimensional rectilinear ( $\phi, z$ ) space, the local modes can be modeled as ray fields that propagate away from the source in a uniform anisotropic medium. Extensions of the theory to layer geometries with weak departures from circularity was said to be under current consideration.

## Electromagnetic Theory - Linear and Nonlinear

**An Approximate Variational Approach to Nonlinear Pulse Propagation in Optical Fibers.** D. Anderson and M. Lisak, Chalmers University, Göteborg, Sweden. The problem of nonlinear pulse propagation in optical fibers, as governed by the nonlinear Schrödinger equation, was reformulated as a variational problem. By suitable selection of trial functions and of a Ritz optimization procedure, approximate solutions are obtained for the evolution during the propagation of pulse-width, pulse amplitude, and nonlinear frequency chirp. Comparisons to results from inverse-scattering theory and/or numerically obtained solutions show very good agreement.

## Antennas

**Antenna Mode and Residual Mode Scattering by a Dipole Antenna.** G.A. Thiele and D.D. Richwine, University of Dayton, Ohio. Scattering by an antenna can be viewed as scattering by two mechanisms or modes--an antenna mode and a structural or residual mode. This paper examined the behavior of both modes for a dipole from well below its first resonance through its third resonance.

**Interactions of Antennas with Radomes.** R. Mittra, K.O. Merwether, and C.H. Chan, University of Illinois. The authors assessed the effects of the interaction between an antenna and a frequency selective surface (FSS) by two methods. The two methods were described and two examples were given--a dichroic subreflector of finite width illuminated by a horn antenna, and an infinite FSS placed in front of a dipole antenna. The numerical results presented in both cases showed that the nonplanar illumination of the FSS by the antenna can cause its pattern to

degrade. A technique for alleviating this problem by tapering the FSS geometry was suggested.

## Waveguides and Periodic Structures

**Anomalous Scattering of Beams by Periodic Structures.** T. Tamir and S. Zhanq, Polytechnic University, Brooklyn, New York. The behavior of Gaussian beams scattered by reflection gratings can differ considerably from that predicted by geometrical considerations. These beams undergo four types of spatial modifications—a lateral displacement, a focal shift, an angular deflection, and a change in beam waist. These beam modifications are largest if the incidence angle is phase-matched to a leaky wave that may be supported by the grating. In this case, there would be a strong Wood anomaly. A canonic sinusoidal reactance plane was used to show that the beam modifications can be very large.

**Electromagnetic Field Solutions Based on Sums of Rectangular Harmonics and Symmetry for Certain Parallelogram and Trapezoidal Waveguides.** P.L. Overfelt, Naval Weapons Center, China Lake, California. The author presented closed-form expressions for the transverse electric and transverse magnetic modes of certain

waveguides with perfectly conducting walls and unusual cross-sections. Some of these cross-sections were the 45-135° parallelogram, the 60-120° parallelogram, the 45-135° trapezoid, and the 60-120° trapezoid. Complete sets of modes were not found for any of those cross-sections. This incompleteness of the mode sets may be a consequence of having nonorthogonal boundaries that can support multiple reflections having periodic extensions that cannot cover all of the space.

## Conclusions

Many other excellent papers were presented. A simultaneous sightseeing program for the spouses was provided by the conference organizers. The social program included a reception at City Hall and an outstanding banquet onboard the tourist ship Rex Polaris that took 300+ happy participants to dinner at sea and through the many islands of the Stockholm archipelago. On the last day, we made technical visits to some government and industrial laboratories. Everyone departed with the nice feeling of having participated in a truly major scientific event in the field of electromagnetic theory.

# MARINE BIOLOGY

## 24th European Marine Biology Symposium

*by Dr. Keith E. Cooksey, the Liaison Scientist for Biochemistry, Microbiology, and Marine Biotechnology in Europe and the Middle East. Dr. Cooksey is on leave from Department of Microbiology, Montana State University, Bozeman, Montana, where he is Professor of Microbiology.*

### Introduction

Held on October 4-10, 1989, the 24th European Marine Biology Symposium was organized by the Scottish Marine Biological Association/Natural Environmental Research Council Laboratory, Oban, and the University of Stirling, Scotland. The focus of the meeting was trophic relationships in the nearshore marine environment. Most of the participants came from Europe; however, there were a few from North America, South Africa, New Zealand, Mexico, and Australia. The largest contingent was from Scandinavia.

The meeting was well organized and there was ample time available for discussion with colleagues. The papers presented were of high quality, but I was impressed that the participants generally did not consider their work's microbiological aspects. Thus, the papers presented

were mostly traditional marine biology with little reference to chemistry, biochemistry, or molecular techniques. Also, it seems that, with one or two exceptions, this large group is not involved in multidisciplinary research. Previously, this meeting has focused on macro- rather than micro-ecology, which could explain the type of papers presented.

### Presentations

Two papers involving lipids were from the University of Stirling, Scotland. In the first, a procedure was described to demonstrate trophic relations based on the possession of unique lipids. Although this is a commonly used technique at the bacterial level, it is used less frequently with higher organisms. A second paper described a unique method to carry out metabolic pathway

investigations with larval fish. These animals are not easily injected with radioisotopes; mortality is high even when injected successfully. The authors have developed a liposome method that allows radioactive lipids to be introduced into larval fish (herring). The study showed that the liposomes were ingested primarily by drinking. For the most part, the fatty acids they contained were incorporated into the polar lipid fraction of the animal. Little radioactivity was incorporated into the triglyceride fraction. This would be expected since larval fish are synthesizing new tissue and thus cell membranes during growth, not lipid stores. The movement of the liposomes in the fish gut and elsewhere was shown cleverly by staining them with a fluorescent dye. The liposome method could be used to label fish with other metabolic precursors or to prepare radioactive fish for studies concerning the transfer of carbon and energy between trophic levels.

Dr. Serge Poulet, Roscoff, France, was the only speaker to consider allelochemically motivated behavior. Potential allelochemicals in seawater were defined by using high-performance liquid chromatography. As a result, dissolved free amino acids and ascorbic acid were selected for testing in an assay that depended on feeding appendage movement in zooplankton. The rate of movement of feeding appendages, which is a measure of feeding effort, was measured using a method that depended on impedance measurements; i.e., the apparatus works on a principle similar to a Coulter Counter. A shift in the vibration rate from 20 to 26Hz indicated that the compound being tested was sensed by copepods. Compounds found effective were leucine, ornithine, and lysine. Although this project is essentially a basic marine biological study, the approach has considerable promise as a test system for detecting behavioral modifications caused by sublethal pollutant concentrations. The research funds are provided under the auspices of a program encouraging collaborative research in the European Economic Community.

Dr. O. Giere, University of Hamburg, presented a paper about work at the Bermuda Biological Station on the gutless oligochaetes that inhabit the thiobiotic horizon of marine sediments. These worms live in an environment that borders the anoxic layer and is characterized by the chemical dynamics of sulfur-containing molecules. The questions posed by Dr. Giere and his collaborator, Dr. C. Schmidt, are two-fold. (1) What are the mechanism(s) by which the oligochaetes positioned themselves at

the oxic/anoxic interface? (2) Are the symbiotic sulfur-oxidizing bacteria that inhabit the subcuticular layer, representing as much as six percent of the dry weight of the worm, involved in the positioning mechanism? By making experimental sand columns containing stable sulfide and oxygen gradients, these workers showed that the animals inoculated into the columns accumulated at the redox-cline--an optimal environment for S-metabolism by the endosymbiotic S-bacteria. Thus, the worms seemed to adjust their position in the sediment according to the metabolic needs of the bacterial symbionts. In my opinion, the key question now becomes, "What is the sensory pathway underlying this mechanism?" Further research must involve putative receptors for particular S-species or changes in redox potential that are coupled to the motor system of the worm. However, the sensor may be a nonspecific one that is related to the energy charge of the endosymbiont.

### Summary

Professor John Sargent, University of Stirling, summarized the meeting. He remarked on the diversity of the papers, and that no one mentioned the influence of disease on the success of a population. Dr. Sargent stressed that currently scientists, especially those dealing with the environment, are expected to provide predictive information. One of the terms in a predictive model should be the impact of disease on the biota. In this general vein, Professor Sargent further suggested that one of the real problems facing us is our lack of understanding of the long-term stability of trophic interactions. This is especially important since we believe that climate is changing (greenhouse effect). In his final remarks, Professor Sargent encouraged workers in this field to consider using molecular techniques. Until now, these techniques have been explored successfully by marine microbial ecologists, but are little-used by those working with macro-organisms.

The next conference in this series will be in Ferrara, Italy, in September, 1990. With eutrophication as a focal topic, it seems likely that microbiology and molecular approaches to ecology will be more evident.

To obtain proceedings of this symposium, contact

Scottish Marine Biological Association  
P.O. Box 3  
Oban, Argyll PA34 4AD, Scotland

# MATERIALS

## Metals Fight Back Conference

by Michael J. Koczak, the Liaison Scientist for Materials for the Office of Naval Research European Office. Dr. Koczak is on sabbatical leave from Drexel University, Philadelphia, Pennsylvania, where he is a Professor of Materials Engineering.

### Introduction

With a growing competition in materials between metals, ceramics, polymers, and composites (see Table 1), the traditional metals industry is facing a more competitive international market. The combination of improved designs, weight savings, higher strength alloys, and materials substitution has reduced metals consumption. With the improved epoxy systems, polymer, and metal matrix composites, traditional isotropic metals face an aerospace market that demands cost-effective, high-performance materials. In an effort to highlight and promote advanced metallic alloys specifically for aerospace application, a conference was organized by Shephard Conferences, 111 High Street, Burnham, Bucks SL1 7JZ, U.K. (Tel: 628-604311). The conference was chaired by Michael Bader, University of Surrey, who ably served as an 'agent provocateur' to stimulate user and materials supplier participation in the session.

Table 1. World Market for New Materials

	1986* MECU	% Average Annual Volume Growth 1986-1995
New steel products	50,000	2.3
Technical thermoplastics	10,000	8.3
Technical thermosets	15,000	5.5
New non-ferrous metals	13,000	3.8
Composites	12,000	8.5
Technical ceramics	7,000	13.9
New glass products	4,000	9.3
Functional materials for electronics	14,000	12.0
<b>TOTAL</b>	<b>125,000</b>	<b>63.6</b>

\*1 ECU = \$1.20

The metals market can be viewed from a cost and performance perspective. Three convenient cost categories can be (1) the automotive sector (\$1-\$5/pound);

i.e., for higher performance systems; (2) the commercial aerospace market (\$50-100/pound material); and (3) the defense aerospace and satellite market where materials costs can exceed \$100/pound.

With increased price, a significant gain in performance is required; e.g., specific strength and specific modulus. In this context, the role of traditional metals in the aerospace market, vis à vis, competitive materials was addressed. The key issues are technical and market oriented, namely: Do the metals industry have the alloys required for these aerospace applications? As important, are they willing to make the commitment to a niche market where the volume of business is limited versus larger volume conventional metal markets?

### Overview

The needs for aerospace materials include structural efficiency, durability, low processing costs, ease of fabrication and cost effectiveness; i.e., total lifetime cost minus scrap value. Dr. Keith Kedward, McDonald Douglas Technologies, keynoted the program and indicated that materials perceived and actual performance decreases with time (or the best news is first and the bad news arrives later). As realization of the materials weaknesses become apparent during development and production, it may become too late to retrace one's steps or recoup the investment. As a result, the material substitution may not be eventually cost effective, even though it is eventually utilized into application. In addition, for a composite material there can be a greater cost for property variability versus a metallic structure. As a result, the typical values for properties must be reduced because of strength variability and further reduced because of degradation caused by moisture and thermal aging. The failure mechanisms of composite materials were generally associated with secondary loading situations, despite having satisfactory property limits for the primary design.

## Review of Metallic Systems for Aerospace Applications

Following the keynote address, a series of speakers addressed a variety of metallic topics:

- Application of High Performance Metals in Gas Turbine Engines, Bob Jeal, Rolls Royce PLC, U.K.
- Advanced Aluminum Alloys by Spray Deposition, Dr. John White, Alcan Aerospace, U.K.
- Synergistic Coatings - Their Special Relevance to Aerospace Markets, Victor C.M. Asselberghs, RKB-MIFA Aluminum bv, the Netherlands
- Processing Aluminum Lithium for the Aerospace Industry, Didier Constant, Cegedur Pechiney Rhenalu, France
- Metallic Materials in Military Airframe Applications, David Common, British Aerospace Military Aircraft Ltd., U.K.
- New Beryllium Materials Developments for Space-Based Applications, Christopher Dorn, Brush Wellman Inc, USA
- Metals and Other Materials in the European Economic Community (EEC) Aeronautics Program, Dr. Frank Green, General Technology Systems Ltd., U.K.
- The Development of Magnesium Materials for Advanced Aerospace Components, John King, Magnesium Elektron Ltd., U.K.
- Developments in Special Steels, Hugh Everson, UES Ltd., U.K.
- Titanium - The Produce's View, Dr. Thomas W. Farthing, IMI Titanium Ltd., U.K.
- Relative Performances of Metals and Composites in Aerospace Structures, Dr. Chris Peel, Royal Aerospace Establishment (RAE), Farnborough, U.K.

The requirements for metallic structures in gas turbine engines was highlighted by B. Jeal, Rolls Royce, for civil and military engines. The requirements and target goals for materials trends are shown in Table 2 with material trends in Figure 1. The increases in thrust to weight ratios and turbine entry temperatures require advances in materials thermal response.

For structural aerospace applications (see Figure 2), the alloys can be examined in the defense as well as the commercial markets. The competition is obvious between conventional aluminum alloys; i.e., 2000 and 7000 series, Al-Li alloys; i.e., 2090, 2091 and 8090, epoxy and thermoplastic composites and hybrid systems; e.g., ARALL<sup>®</sup>, an aluminum layered epoxy aramid fibers. C. Peel, RAE, was very positive concerning the future of conventional aerospace aluminum alloys and the aluminum lithium systems with a significant projected growth for

Table 2. Improvements in Gas Turbine Engine Performance

	Civil		Military	
	1952	1988	1980	2000 +
Year into service	1952	1988	1980	2000 +
Engine	Ghost	RB211-524H	RB199	-
Aircraft	Comet	Boeing 767	Tornado	-
Thrust	5,050 lb	60,000 lb	9,100 lb dry 16,400 lb reheat	7,500 lb approx
Thrust/Weight	2.3:1	6:1	4.2:1 dry 8:1 reheat	20:1
Overall pressure ratio	4.5:1	33:1	23.5:1	32:1
Turbine entry Temp.	1100K	1700K	1600K	2400K target
Specific fuel consumption	1.2lb/hr/lb	0.56lb/hr/lb	0.65lb/hr/lb without reheat	25% less than current technology

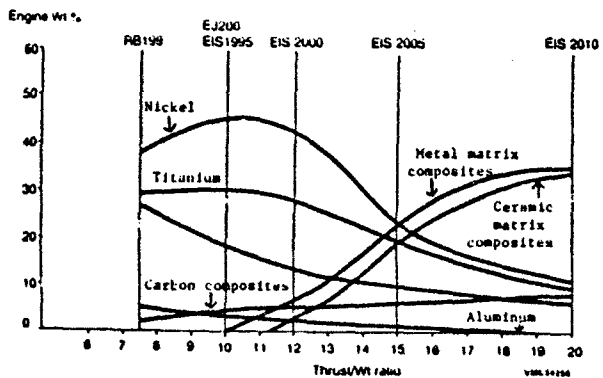


Figure 1. Trends in Gas Turbine Engine Materials Usage

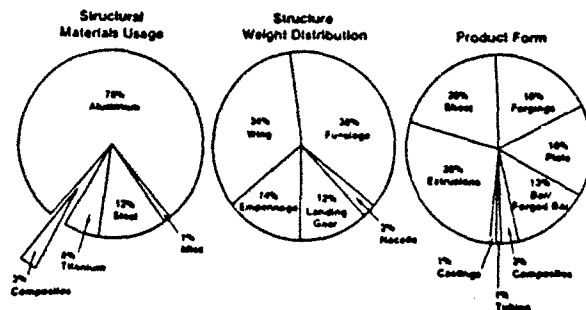


Figure 2. Typical Usage of Product Forms in North American Manufacture of Large Transport Aircraft (Courtesy of C. Peel)

the next 10 years (see Figure 3). For comparison the materials application for military aircraft is seen in Figure 4. As a result, for large structures, aluminum alloys are in a very strong commercial position with the development of superplastic forming, improved cleanliness, casting techniques, and corrosion resistance. For defense applications, carbon fiber composite structure may amount to 40 percent with aluminum and aluminum lithium alloys being reduced to 37 percent (see Figure 4).

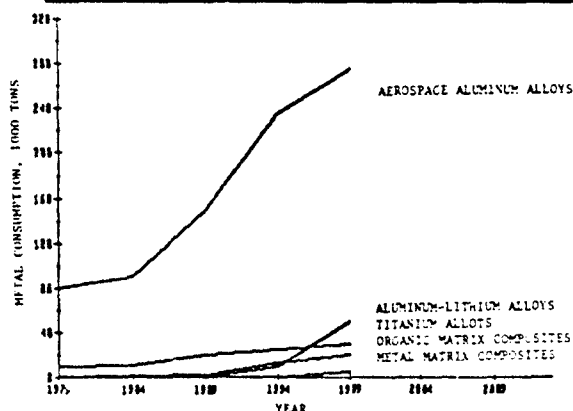


Figure 3. The Growth Potential for Materials in Military and Civil Aircraft (Courtesy of C. Peal)

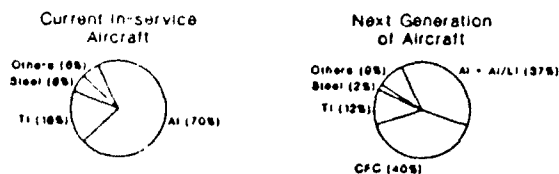


Figure 4. Material Utilization in Military Airframe Construction

Also, aluminum alloys may be very competitive for smaller structural components. The development of aluminum lithium alloys was described by Pechiney where the alloy development has progressed from the "tailor-made" stage to the "ready-to-wear" state. Pechiney have made a strong technology commitment to aluminum lithium alloys in terms of alloy development and manufacturing capability. The size capability of their Isoire plant has progressed to 3000-mm width and thicknesses in the range from 10 to 100 mm for Al-Li sheets for aircraft applications. The Pechiney Al-Li products are in three categories: Damage tolerant (2091), medium strength (2091 and 8090), and high strength Al-Li (CP276). Aerospatiale and MBB are evaluating Al-Li alloys for the Airbus 330/340 for damage tolerant; e.g., 2024-T3 versus 2091 applications. Pechiney is addressing the issues of forming, riveting, chemical milling surface treatments, and welding in order to make the alloys amenable to the manufacturing and assembly processes.

For titanium, the industry has successfully responded to the higher performance demands by improved elevated temperature strength and creep response (see Figure 5) via tailored microstructures for optimum creep and fatigue response. The inherent high-temperature response coupled with superplastic forming and tailored microstructure has provided titanium alloys a strong position in the aerospace market which is difficult to displace. The summary of titanium alloys was provided by

Dr. T.W. Farthing, IMI Titanium Ltd., with an anticipated bright future where performance at long-term exposure temperatures of 700 °C was possible with the addition of barrier coatings. The common concerns of the potential of titanium-based intermetallics were expressed where ambient temperature ductility may exclude application except in reinforced composite systems. The role of intermetallics in competition to nickel and conventional titanium alloys was not addressed by the respective industry speakers possibly because of the implied additional competition of the newer intermetallic systems.

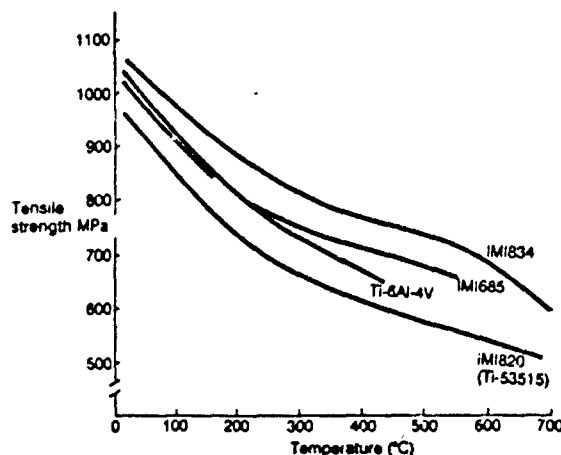


Figure 5. Typical Tensile Strength of Titanium Alloys

The EEC aeronautical materials program was discussed by Dr. F.A. Green. The industry-driven programs have had notable successes with Ariane, Concorde, Airbus, and future programs to include European Fighter Aircraft (EFA), HERMES, and Columbus (see Table 3). The Basic Research in Industrial Technologies in Europe/European Research in Advanced Materials (BRITE/EURAM) programs in the aerospace sector seek to improve the materials science database with emphasis toward aerospace relevance and manufacturing support functions. The topics research include:

Advanced Materials Technologies:

- Metallic Materials and Metal Matrix Composites
- Materials for Magnetic, Optical, Electrical, and Superconducting Applications
- High Temperature Non-Metallic Materials
- Polymers and Organic Matrix Composites
- Specialized Applications; e.g., biomaterials.

Design Methodology and Product/Process Assurance:

- Quality, Reliability, and Maintainability
- Product and Process Assurance.

- Advanced Manufacturing Technologies:
- Advanced Manufacturing Practices with Emphasis on SME's
  - Manufacturing Processes for Flexible Materials.

Technologies for Manufacturing Processes:

- Surface Technologies
- Shaping, Assembly, and Joining
- Chemical Processes
- Particle and Powder Processes.

The EEC emphasis in the aerospace market is based upon an established 'product line'; e.g., Airbus, Airane, which still represents a small product base that can be expected to grow competitively.

The materials research program in advanced aeronautical materials is driven by the commercial aerospace sector through the EEC. The major European aerospace programs are detailed in Table 3. Under the EURAM I, Area I programs, 11 of the 13 programs address Al, Mg, and Ti systems development. In a second area, ceramics were considered. The third area, centered on organic (12 projects) and metal matrix composites (6 projects) with 30 organizations; i.e., aerospace, academic, and governmental laboratories. A second program, BRITE/EURAM, centers about several materials related topics (see Table 4) in an effort to improve materials science with aerospace relevance and to provide for aerospace support. The specific topics in the aerospace sector are related to aerodynamics, acoustics, airborne systems, and equipment and propulsion systems.

**Table 3. Some European Aerospace Programs**

**Space**

Ariane I, II, III, IV (1988)  
Ariane V (1984 with VULCAIN engine)  
Hermes (1996)  
Columbus (1998)

**Civil Aviation**

Fokker F27, F28, F05C, F0100  
Concorde  
Airbus A300, A310, A320, A330, A440  
ATR 42/72

**Military Aviation**

Jaguar  
Tornado  
Alpha-Jet  
Transall  
Atlantic 1-2  
EFA

**Helicopters**

Puma

**Gazelle**

Lynx  
EH 101  
HAP-HAC/PAM2  
NH 90  
A 129 LAH

Source: BIPE

**Table 4. BRITE/EURAM**

Advanced Materials Technologies  
Metallic Materials & Metal Matrix Composites  
Materials for Magnetic, Optical, Electrical, & Superconducting Applications  
High-Temperature Nonmetallic Materials  
Polymers & Organic Matrix Composites  
Specialized Applications  
(Biomaterials, Packaging, Civil Engineering)

Design Methodology & Product/Process Assurance  
Quality, Reliability, & Maintainability in Industry  
Product & Process Assurance

Applications of Manufacturing Technologies  
Advanced Manufacturing Practices with Emphasis on SMEs  
Manufacturing Processes for Flexible Materials

Technologies for Manufacturing Processes  
Surface Techniques  
Shaping, Assembly, & Joining  
Chemical Processes  
Particle & Powder Processes

## Conclusions

The metals industry for aerospace applications appears to be healthy with a sound future certainly in the commercial aerospace market. For traditional aluminum alloys, the future appears healthy. Pechiney is actively developing Al-Li alloys and with the hopeful cooperation of the Airbus/Aerospatiale group, an immediate application is apparent. The niche area, in which titanium resides in the aerospace market, appears secure with little immediate competition in the commercial sector from high-temperature aluminum alloys or intermetallics. The development of metal matrix composite and hybrid laminates will find application in the defense sector; however, design conservatism and cost considerations for the commercial market will limit its progress.

Details of the BRITE/EURAM program can be obtained from:

BRITE/EURAM  
Commission of the EC, DG XII-C, Office 2/44  
rue Montoyer 75  
B-1040 Brussels, BELGIUM  
Telefax: (32 2) 235-8046

Details of the EUREKA program can be obtained from:

Secretariat  
19 H, Avenue des Arts Bie 3  
B 1040 Bruxelles  
Tele: (32 2) 217 00 30  
Telefax: (32 2) 218 79 06  
Telex: 29340

# MATHEMATICS

## Computer Science and Systems Division, Harwell Laboratory, U.K.

*by Richard Franke, formerly the Liaison Scientist for Mathematics and Scientific Computing in Europe and the Middle East for the Office of Naval Research European Office. In September 1989, Dr. Franke returned to the Naval Postgraduate School, Monterey, California, where he is a Professor of Mathematics.*

### Introduction

The Harwell Laboratory is located west of London in Oxfordshire. I visited the Harwell Laboratory through the auspices of Drs. Seamus Considine and Iain Duff. My visit was primarily to the Numerical Analysis Group, although I also spoke with other people. The group consists of about six permanent staff, about two consultants and two students who work part time, and several visitors under an active program encompassing visits consisting of a few hours to give a colloquium. Being a small group, the flow of visitors serves an important purpose in providing fresh ideas and intellectual stimulus.

### Research Areas

Research is largely geared toward the needs of the Harwell scientists and computer users. Harwell is the U.K. Atomic Energy Authority laboratory. The principal computer at the laboratory is a Cray 2, with an IEM 3090 also available. In addition, they support and develop new algorithms for the Harwell Subroutine Library, a commercial package that is sold by the laboratory. They also support TSSD, a typesetting system for scientific documents. Duff is the leader of the numerical analysis group; he is very well known for his work in computations involving sparse matrices and supercomputer applications (see *ESNIB* 89-01:30-31 and *ESNIB* 89-07:42-43). The latter reference was concerned with the European Centre for Research and Advanced Training in Scientific Computation (CERFACS) in Toulouse, France, where Duff spends about one week per month as head of the parallel algorithms group. This is related to much of his work at Harwell regarding performance of the Cray 2 running the Harwell Subroutine Library (see Duff). Harwell also supports work by consultants on using the Cray 2 in multitasking (see Hockney).

Dr. John K. Reid has spent significant amounts of time as a member of the International Federation for Information Processing (IFIP) Working Group 2.5 (Numerical Software). This group is concerned with topics such as software for parallel synchronous execution, exception handling, and standards for the languages Fortran 8X and C. He also was the secretary of the Fortran Standardization Committee X3J3; this sort of effort is very important, but probably thankless. Reid is also involved in sparse matrix work. A recent report gave results of testing an algorithm for ordering the elements in a frontal code (MA40 from the Harwell Subroutine Library). The performance of such codes are very dependent on ordering, so an algorithm for automatic ordering was adapted to the MA27 code (see Sloan). The results are detailed in Duff et al., and for several of the test problems give speed improvements of more than a factor of 10.

Nick Gould works on optimization problems and has recently worked on large-scale nonlinear problems with Andy Conn and Phillippe Toint. In addition to developing and testing of codes, they have proposed a way of inputting data for nonlinear optimization problems (see Conn et al.). The proposed format takes advantage of partial separability in the problem, which they feel is more natural for nonlinear problems than sparsity--the obvious structure for linear problems. Gould has also been working with Reid on linearly constrained optimization problems. They have investigated the use of "crash" algorithms for rapidly finding a good initial basis. This work has resulted in two new algorithms in the Harwell Subroutine Library. The LA06 is provisionally included, and is based on  $P^5$  tearing, which reorders the variables and equations to obtain a coefficient matrix with a staircase structure. The other is based on Reid's algorithm for ordering the columns by looking for columns with increasing numbers of nonzeros. Rows that have nonzeros in previously chosen columns are ignored (see Gould and Reid).

Considine recently completed his Ph.D. degree in numerical solution of ordinary differential equations. One of his tasks at Harwell is implementing a program called TOOLPACK, which is a suite of codes to assist in developing, testing, maintaining, and transporting medium-size software projects written in Fortran 77. The program was used to port the sparse matrix codes in the Harwell Subroutine Library to the Cray 2. There are several large codes for which it would be useful to have TOOLPACK to assist in migration to other machines.

## FLOW3D

As noted above, Harwell produces, sells, and maintains computer software packages. I talked with Dr. Ian P. Jones about the Harwell package FLOW3D, which is available through the Computational Fluid Dynamics Services project. Jones is a member of the Computer Science and Systems Division and is the contact for technical information about FLOW3D. This suite of programs simulates laminar and turbulent flows and heat transfer. The suite is written in Fortran 77 and versions of it have been tested on a wide range of computers, including IBM PC/AT with 32-bit coprocessor board, IBM PS/2 model 70 under OS/2, Sun, Silicon Graphics and Apollo workstations, Vax, Prime, and Masscomp minicomputers, to IBM mainframes and Cray supercomputers. A large code version of TOOLPACK would be useful for assisting in migration to other computers. The code has extensive vectorization for supercomputers while still running efficiently on scalar mainframes. Because Harwell also sells time on the Cray 2, a package can be obtained to use the program on the Harwell computer, including access to the Harwell applications team and the graphics workstations for postprocessing and displaying the results. The Harwell Laboratory periodically conducts workshops, tutorials, and seminars on the use of FLOW3D.

In November 1987, a disastrous fire occurred in one of the Piccadilly Line escalator tunnels at the King's Cross Underground Station. Because of several unfortunate circumstances, the death toll was high. To try to understand the progress of the spread of smoke and combusting volatiles, the Health and Safety Executive contracted with Harwell to conduct FLOW3D simulations of the event and investigate parameters that could have affected the course of events. This is a very large and difficult problem, so many simplifications were made concerning physical modeling and the geometrical representation of the station. Some 48 hours of Cray 2 time were used in conducting the study. The simulations were then relevant for only the first few minutes of the event while the fire was spreading up the escalator tunnel. The simulations

indicated some unexpected heat flow patterns, and subsequently a one-third scale model of the system was built and a simulating experiment was conducted. The results confirmed the flow patterns predicted by the FLOW3D simulation. While the precise way in which the facility was modeled and the computational experiments were conducted and interpreted is interesting (see Simcox et al.; the reports were confidential until after the final hearing), I will concentrate below on the type of modeling capabilities available in the FLOW3D suite of codes.

The FLOW3D codes are used to simulate flow problems and can be used in the development of advanced physical models. The standard turbulence model is the k- $\epsilon$  scheme, with options for algebraic and Reynolds stress models. The code models two- (2-D) and three-dimensional (3-D) problems in steady state or transient regimes, including heat transfer, compressibility, buoyancy, and conduction in solid regions. Additional equations can be specified to represent; e.g., convection and diffusion of a chemical species.

The grid used by FLOW3D is restricted to be topologically rectangular or cubical. However, the grid can be stretched and bent allowing the matching of boundaries of fairly general domains. In addition, blockages can be inserted anywhere into the grid, providing for accurate representation of geometries. Such a grid greatly simplifies problems of vectorizing the scheme for vector supercomputers. In the 2-D model the grid may slide along boundaries, although the grid is fixed on the boundary in 3-D problems. The numerical scheme is based on finite differences using a nonstaggered system with all variables being evaluated at the same points--the centers of the control volumes. Adaptive gridding is used to automatically adjust to finer resolution in regions where the solution changes rapidly. Velocity components are in fixed Cartesian coordinate directions. Advection terms are treated using a hybrid technique, a combination of upwind and central differencing. Because of the possibility of this resulting in a highly diffusive approximation, other techniques are an option to reduce the effects of artificial diffusion.

The solution module of FLOW3D contains no graphics facilities; instead, the output data base is interrogated by postprocessing software that may run on a different computer than FLOW3D itself. A postprocessing package--OUTPROC--is available to display contours, velocity vectors, particle tracks, and profiles along arbitrary lines through the domain. Specialized packages for use on high-performance graphics workstations are available.

The FLOW3D code has been extensively tested and used at Harwell and elsewhere on a variety of problems (see Table 1).

**Table 1. FLCW3D Applications**

Reactor coolant circuits	Engine cooling
Heat exchangers	Mixing vessels
Vehicle aerodynamics	Laser cooling
Furnace and burner flows	Separation systems
Flows around rod bundles	Environmental flows
Buoyant flows in estuaries	Fires
Ventilation systems design	

## Final Comments

The Harwell Laboratory is a first-rate research facility. Because of limited funds from traditional sources, Harwell is actively engaged in sales of computer software and associated supporting services. The FLOW3D code seems to be the premier example, with outstanding success in modeling the King's Cross Underground Station fire, pointing out phenomena that were unexpected and previously poorly understood.

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# PHYSICS

## Advanced Research Workshop on Ion Beam Modification and Processing of High $T_c$ Superconductors: Physics and Devices

by Dr. D.B. Chrisey, Staff Scientist, Condensed Matter and Radiation Sciences Division, Naval Research Laboratory, Washington, D.C.

### Introduction

On April 9-12, 1989, the NATO Advanced Research Workshop on Ion Beam Modification and Processing in High  $T_c$  Superconductors was held at Minster Lovell Mill, Oxfordshire, England, a conference center in the Cotswold Hills about 25 miles west of Oxford. The conference was largely supported by the European Research Office of the U.S. Army, London. Fifteen of the 34 invited participants were from the U.S. and the rest came from: U.K. (6), Federal Republic of Germany (FRG) (5), Belgium (2), France (5), and Austria (1).

The workshop consisted of small discussion-oriented meetings concentrating on the physics of ion and laser beam-produced disorder in high- $T_c$  superconductors. The goal of this workshop was to summarize the current status of our knowledge in this field. The participants gave presentations either on their own work or an overview of a certain area (see selected references below). Because of the group's wide background, there were many interesting and challenging questions for the speakers, which generated stimulating interactions.

Since the discovery of high  $T_c$  copper oxide superconductors, there has been a great deal of interest in under-

standing the structure-property relationship of these complicated materials. Although the mechanism of high  $T_c$  superconductivity is not yet known, there are other important issues; i.e., where these materials will be applied and how to process useful devices, which can be addressed now. Since ion beam and laser beam modification have long been connected with processing in the semiconductor industry, it is natural to expect similar processing techniques will be used with the high  $T_c$  materials.

## Lectures

John Rowell, Bellcore, Red Bank, New Jersey, opened the workshop by drawing parallels between the high technological expectations of the high  $T_c$  superconductors (HTSC) of the present and the old high  $T_c$  superconductors (LHTSC), the A-15s, of the past (Rowell, 1988). Many of the same obstacles currently present with HTSC existed previously with the A-15s; e.g., how to overcome their brittleness in order to make wires. Dr. Rowell also noted that contrary to popular (media) belief, a superconducting technology, based on LHTSC, already exists. The requirements for developing this conventional superconducting technology, at similar stages of its discovery were improved materials, understanding of the problem, market demand, and 20 years of effort.

Regarding market demand for HTSC technology, Dr. Rowell pointed out that for HTSC technology to overcome (or displace) LHTSC technology, it must either offer a similar product at a significantly reduced cost or perform a function that LHTSC technology cannot emulate (Rowell, 1988). The obvious improvement often touted for HTSC over LHTSC technology is operation at 77K, which allows the use of liquid nitrogen rather than liquid helium as the cryogen. The requirements for HTSC conductors and Josephson electronics include producing bulk material with high critical currents and a superconducting surface appropriate for making tunnel junctions, respectively.

Otto Meyer, Institut für Angewandte Kernphysik, Karlsruhe, FRG, summarized the role of ion beams in superconductor research as analysis (rbs, channeling), modification (disorder, doping), and applications (patterning) (Meyer et al., 1988, 1989). The influence of grain boundaries makes HTSC materials very different from the A-15s in determining inter- versus intra-granular effects. Ion beam-induced destruction of the intergranular weak links results in intergrain decoupling and a lowering of the superconducting transition completion temperature.

Bob Dynes, Bell Laboratories, Murray Hill, New Jersey, reviewed some of the more interesting features of transport measurements in HTSC. The extrapolation of

the normal resistance to zero at 0K was described as an anomalous effect; 1-2-3 twins are effective in pinning flux lines. Alan D. Marwick, IBM, Yorktown Heights, New York, continued this discussion adding in the effect of ion bombardment (Marwick et al., 1989). His research has centered on the supralinear increase in the normal state resistivity with dose and was described in terms of a variable-range Mott-hopping model.

H. Adrian, Technische Hochschule, Darmstadt, FRG, described the effect of lattice defects introduced by low-temperature irradiation with 25-MeV oxygen ions in thin films and compared it to the effect of chemical substitution (Ni in the  $\text{CuO}_2$  layers).  $T_c$  was always reduced by irradiation, and the rate (with fluence) depended strongly on the initial sample quality. A more rapid decrease of the critical current at zero applied field,  $J_c(B=0)$ , was also observed after irradiation, whereas irradiation-induced defects could actually enhance  $J_c$  for  $B > 0$ . Features common to both radiation damage and chemical substitution included a strong negative temperature coefficient of the resistivity whenever a significant decrease of  $T_c$  was observed. Alice White, Bell Laboratories, Murray Hill, New Jersey, observed similar changes in for  $T_c$  and  $J_c(B=0)$  following 1-MeV neon ion irradiation (White et al., 1988). A small change in the Hall coefficient as the thin films go through the ion-beam-produced metal-insulator transition, implies that the metal-insulator transition was caused by a reduction in mobility rather than a drop in carrier density.

My presentation centered on a correlation of all existing measurements of the change in the critical temperature (of high-quality films) with fluence,  $dT_c/d\phi$ , for incident ions and electrons, with the nuclear or nonionizing energy loss of the incident particle (Summers et al., 1989). The  $dT_c/d\phi$  had a linear dependence on the energy loss over 7 orders of magnitude for particles that ranged from 2 MeV  $e^-$ , to 800-MeV protons, to 2-MeV argon ions. Physically, it was concluded that the change in  $T_c$  was proportional only to the average number of defects produced and can, therefore, be predicted for any particle, energy, and fluence from a calculation of the nonionizing energy loss.

Professor Weber's, Atominstytut der Österreichischen University, Austria, research focussed on fast neutron irradiation of single crystal  $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$  (Umezawa et al., 1987). Using the Bean model for inferring the critical current densities, his results were the critical current increased with irradiation and the anisotropy of  $J_c$ ; i.e., the ratio of critical current densities for fields parallel and perpendicular to the c-axis, decreased with neutron fluence. Unlike the transport measurements listed above, these increases occurred even for  $B = 0$ .

Lynn Rehn, Argonne National Laboratories, Illinois, described how ion channeling provides a powerful technique for extracting information on thermal vibrational

properties from small, high-quality single crystals (Sharma et al., 1988). While axial scans revealed a normal temperature dependence for thermal vibrations of the rare-earth and Ba atoms perpendicular to the c-axis, a substantially increased temperature dependence was found for similar vibrations of the Cu-O rows, as well as a large anomalous change in Cu-O vibrations at  $T_c$ . This data suggests that the atoms located along the Cu-O rows become strongly coupled in the superconducting state.

Dr. Bruynseraede's, Katholieke University, Leuven, Belgium, presentation centered on the role of oxygen content and ordering in defining the transport and crystallographic properties of HTSC materials. For example, removing oxygen from the Cu-O chains results in a lowering of  $T_c$  from 90 to 60K.

Dr. Linker's, Institut für Angewandte Kernphysik, Karlsruhe, FRG, review talk on the nature of ion beam-induced disorder pointed out that disorder, introduced either by preparation or implantation, results in a general degradation of the transport properties of HTSC films. However, with respect to the critical current, beneficial effects; i.e.,  $J_c$  enhancement, have been observed. The defect structure(s) leading to such increases is of great interest but currently unknown. Furthermore, the large variety of collisionally produced structural distortions makes a unique assignment of defects responsible for the  $T_c$  depressions difficult. But oxygen disordering seems plausible, especially considering annealing effects after low-temperature irradiations.

Describing a new Z-contrast imaging technique using a high-resolution scanning transmission electron microscope, Steve Pennycook, Oak Ridge National Laboratory, Tennessee, presented directly interpretable images of the atomic structure and chemistry of defects and interfaces in bulk polycrystalline and epitaxial and oriented thin films of high- $T_c$  superconductors. Images of the commonly observed planar defects in  $YBa_2Cu_3O_{7-\delta}$  showed clearly that these can exist in both interstitial and substitutional types. An excellent study of the atomic structure and chemistry of low-angle tilt boundaries was described. At low tilt angles, the boundary consisted of an array of partial dislocations but as the tilt angle increased, these collapsed into small amorphous zones. The spacing of these zones was consistent with the predicted tilt boundary effect on the critical current across misaligned grain boundaries (Dimos et al., 1988). Since the amorphous zones were chemically identical to the 123 composition, it was concluded that they are formed by the structural relaxation of the 123 material and not as a result of defect segregation. Z-contrast images of substrate/film interfaces showed that although structurally sharp the interfaces are chemically diffuse.

Dr. Harry Bernas, Centre de Spectrometrie Nucleaire et de Spectrometrie de Mass, Orsay, presented an insightful examination of the nature of ion beam-produced dam-

age and phase transformations in HTSC. At 0.1 dpa (displacements per atom),  $YBa_2Cu_3O_{7-\delta}$  is amorphized and the amorphous state is an insulator. Dr. Bernas emphasized that while irradiation-induced crystalline phase transformations are related to the displacement of specific atoms in the unit cell (oxygen in  $YBa_2Cu_3O_{7-\delta}$ ), amorphization is related to the breakup of the backbone part of the structure (heavy atoms in  $YBa_2Cu_3O_{7-\delta}$ ). The conclusion is that the overall amorphization and the metal-insulator (or even superconductor-nonsuperconductor) transition are independent. These two processes will compete in a given irradiation experiment and the net result will depend on the transferred collisional energy, the deposited energy density, and on the relative stability of the various possible phases.

Dr. Mark Kirk, Argonne National Laboratory, presented some fascinating *in situ* TEM-ion irradiation micrographs of the progression of radiation damage in HTSC (Kirk et al., 1989). Dr. Kirk measured the displacement energy for oxygen in  $YBa_2Cu_3O_{7-\delta}$  to be 23eV/O atom. The defected regions were characterized as a "cellular structure" within grains. Notably, this is different from what is currently accepted; i.e., defects migrating to grain boundaries. The cellular structure appeared at 0.05-0.07dpa; whereas, the crystalline to amorphous transition occurred at 0.1-0.2dpa.

Greg Clark, IBM, Yorktown Heights, New York, described the application of ion implantation, ion etching, and laser ablation to patterning HTSC devices (Koch et al., 1987). Ion implantation patterning results in a planar device with a minimum 0.1- $\mu$ m line width. This technique relies on a lithographically patterned gold mask to shield parts of the film from the ion beam-produced amorphization. Ion etching is basically the same as patterning except that the ion beam mills the film not protected by the resist. The disadvantage is that it produces a nonplanar device. Furthermore, minimum line widths are 0.2-0.3  $\mu$ m with some transport property damage in the remaining film, and 1-2- $\mu$ m line width with no damage. Laser ablation has the problem of edge remelt and the minimum line width is only 2-3  $\mu$ m. The devices produced were Superconducting Quantum Interference Devices (SQUIDs), which relied on the weak-link nature of grain boundaries for junctions. Dr. Clark concluded that improved SQUIDs will require films with improved microstructure.

Dr. T. Venkatesan, Bellcore, Red Bank, New Jersey, gave his view on superconducting electronics. The material requirements for the electronics industry include: low microwave loss (surface resistance), high  $T_c$ , high  $J_c$ , deposition on common substrates, heterostructures, and smooth interfaces.

Dr. Venkatesan opened his discussion of deposition techniques by stating that the best source of (depositing) HTSC material is a bright source, composed of 10-50 eV

atoms. This gives an effectively higher surface temperature. The technique that provides this as well as the ability to operate in high background pressures of oxygen (~100mtorr) is pulsed laser deposition (Venkatesan et al., 1989). Dr. Venkatesan pointed out it is very important to be able to make films in situ. Having to anneal HTSC films results in rough cracked surface. In addition, annealing, which produces a disordered-crystalline transition, will always result in grain boundaries.

### Conference Emphasis and Future Applications

Alan Marwick, IBM, outlined the emphasis and achievements of this conference.

- The power of ion beam analysis - novel techniques of helium oxygen resonance enhanced backscattering, integration with material development
- High-resolution TEM - Z contrast, oxygen-vacancy ordering
- Nuclear energy deposition scaling of  $\Delta T_c$
- Metal-insulator transition done with radiation damage
- $J_c$  increased with radiation damage
- High-resolution *in situ* radiation damage microstructure.

The questions that were raised and need to be answered before moving on are:

- What is the nature of radiation damage at the grain boundaries?
- What defect(s) move at low temperatures?
- Do only oxygen displacements matter for  $\Delta T_c$ ?
- Linearity versus supralinearity of normal resistivity?
- Can we pin flux in a useful way with ions?
- What kind of defects can pin flux?
- What is the nature of the high dose microstructure?

### Proceedings

The Proceedings of the NATO Advanced Research Workshop on Ion Beam Modification and Processing in High  $T_c$  Superconductors: Physics and Devices will appear as a review article in the Journal of Materials Re-

search in early 1990. Written by the organizing committee, this article will present a report of the meeting in the form of a snapshot review of the field.

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# TOXINOLOGY

## 8th European Symposium on Animal, Plant, and Microbial Toxins

by Dr. Findlay E. Russell, Professor, College of Pharmacy, the University of Arizona

### Introduction

The European Section of the International Society on Toxinology held its Eighth Annual Symposium in the beautiful seaport resort of Poreč, Yugoslavia, September 24-27, 1989. The conference was attended by more than 100 society members representing almost every country in Europe, as well as several delegates from Asia, Australia, and the U.S. The principal emphasis of the presentations was on the chemical structures of the various toxins from snakes, scorpions, spiders, some marine animals, tetanus, diphtheria, and *Clostridium*. Other presentations related to the pharmacology and clinical aspects of venom and plant poisoning. More than 50 posters were exhibited over the 4-day period. Several informal discussions were held on the application of various biochemical and pharmacological techniques and processes. The following summaries are representative of the presentations during the conference.

### Reptile Toxins: Chemistry and Pharmacology

"Chemical and Genetic Engineering of Snake Toxins," A. Mènez, F. Ducancel, and J-C. Boulain, Service de Biochimie, Gif-sur-Yvette, France. The Alistair Reid Lecture was delivered by Dr. André Mènez who noted that, based on structure, snake toxins could be divided into two families: (1) those with polypeptide chains folded into three main adjacent loops, and (2) toxins with phospholipase A<sub>2</sub>-like structures. The authors' group cloned and elucidated the DNA sequences of several of the toxins from each group. Postsynaptic-acting neurotoxins belonged to the first group; they bind to the nicotinic ACh receptor with great affinity. The binding site involves residues at 8, 27, 29, 31-34, 38, 46, 47, 49, and 52, located for the most part on loops II and III. Modifications of Lys-27, Trp-29, and Lys-47 resulted in a decrease in toxicity.

"Where is the Toxic Site of Ammodytoxin?" F. Gubenšek, I. Križaj, D. Turk, V. Čurin, J. Pungercar, and D. Kordiš, J. Stefan Institute, Ljubljana, Yugoslavia." Professor Gubenšek described the ammodytoxins A, B, and C from *Vipera ammodytes* venom, noting that they were presynaptic phospholipase A<sub>2</sub>(PLA<sub>2</sub>) isoenzymes that differ in their lethal index because of the exchange of three or two amino acid residues, respectively, in their primary structures near the C-terminus in positions 115, 118, and 119, or 124, and 128. Ammodytoxin belongs to the subgroup IIA of the PLA<sub>2</sub> family of enzymes similar to those known for other Viperidae and Crotalidae venoms. Computer modeling showed that all five mutant amino acids involved in toxicity are located on the surface of the molecule. Using monoclonal and polyclonal antibodies, the authors demonstrated the importance of residues 115, 118, and 119 for toxicity. The stretch between residues 106 and 113 was also shown to be important for toxicity.

"Substitution Therapy for a Hemorrhagic Diathesis After a Snakebite," F. Kornalik, Institute of Pathophysiology, Medical Faculty Charles University, Prague, Czechoslovakia. A severe hemorrhagic diathesis developed 4 hours after a single fang envenomation by a juvenile *Bothrops aspis*. Because of a sensitivity to antivenin, substitution therapy was initiated; an infusion of 2 g fibrinogen and 30 mg of vitamin K following a diagnosis of "disseminated intravascular coagulation (DIC)." Twelve hours after therapy, bleeding ceased, but only for 8 hours. Cryoprecipitates and fibrinogen failed to affect the bleeding, and abnormal laboratory tests remained unchanged. Following plasmapheresis on the 3rd day, 1,800 ml of plasma was exchanged and fibrinogen levels rose to 1 g/l; spontaneous bleeding stopped on the 4th day. All laboratory tests remained unchanged for another 3 days. By the 8th day, fibrinogen rose to 0.8 g/l, and all tests and the bleeding dyscrasias were normal by the 12th day.

Analysis of the venoms of juvenile and adult *B. aspis* showed that the former possessed a strong prothrombin converting action, while the latter had a thrombin-like,

fibrinogen-converting enzyme. Further studies showed that "hemorrhagins" are responsible for the local reaction but do not damage the vessel wall following their intravenous injection. The studies further concluded that the hemorrhagic diathesis caused by *B. aspis* envenomation was caused by activation of coagulant, fibrinolytic, kallikrein, and the complement system mediated by thrombin and its precursors.

"The Proteinases from *Vipera lebetina* and *Vipera berus* Venom," J. Siigur, M. Samuel, A. Mähar and E. Siigur, Institute of Chemical Physics and Biophysics, Estonian Academy of Sciences, Tallinn, Estonia. This presentation was particularly interesting to physicians because of the clinical importance of the proteinases in viper venoms. Professor Siigur and his colleagues found six proteolytic enzymes in *V. lebetina* venom and three in *V. berus* venom. Two of the enzymes from *V. lebetina* were metalloproteinases, one of which activated factor X, while the other possessed fibrinolytic activity. Arginine esterases of *V. berus* failed to hydrolyze casein or BAPNA, while both venoms hydrolyzed BAEE, TAME, and Pro-Phe-Arg-MCA. The metalloproteinase (MW 57,500) of *V. berus* venom is active on casein, splits the oxidized insulin B chain at the peptide bonds Ala<sup>14</sup>Leu<sup>15</sup>, Tyr<sup>16</sup>Leu<sup>17</sup>, and His<sup>10</sup>Leu<sup>11</sup>. This enzyme has hemorrhagic activity.

"Effects of Phospholipase A<sub>2</sub> (PLA<sub>2</sub>) Toxins and Enzymes on Functional Properties of Rat Brain Synaptosomes," P. Rosenberg, E. Condrea, A. Ghassemi, and S.L. Yates, Pharmacology and Toxinology, School of Pharmacy, University of Connecticut, Storrs. Professor Rosenberg's group demonstrated that the many pharmacological activities of PLA<sub>2</sub> enzymes from *Naja nigricollis* and *N. n. atra* venoms do not necessarily correlate with the degree of phospholipid hydrolysis, suggesting that enzyme activity may not be essential for pharmacological actions. Among other things, they found that PLA<sub>2</sub> enzymes cause greater phospholipid hydrolysis than the PLA<sub>2</sub> toxins, that both disrupt plasma membrane integrity of synaptosomes in a concentration and time-dependent manner, and that the PLA<sub>2</sub> enzymes were more potent than the toxins in producing LDH and <sup>3</sup>H d-glucose phosphate from synaptosomes, as well as in reducing their osmotic activity.

"The Chains of Tetanus Toxin: Their Separation and Contribution to Toxicity," E. Habermann, Rudolf-Buchheim Institut für Pharmakologie der JLU, Giessen, Federal Republic of Germany (FRG). Professor Habermann discussed the synthesis of tetanus toxin as a single-chain protoxin (S) that is then converted by limited proteolysis into a series of isotoxins (B). The latter are composed of a light (LC, approximately 50,000 kDa) chain held together by one disulfide bridge. A technique was developed for preparing large amounts of the protoxin that resulted in a two-fold increase in "toxicity"

and a 20-fold increase in action at the neuromuscular junction. Using isoelectric focusing, LC and HC can be separated and recombined giving "toxicity" levels close to the original. The LC can mimic the inhibition of transmitter release caused by toxin B, provided it reaches the cytosolic space. The HC is necessary to render LC active when applied externally to *Aplysia* neurons or brain homogenates. Habermann is currently attempting to determine whether further nicking and reductive separation of the chains alter the *in vivo* action of tetanus toxin.

"Chemistry of Mamba Toxins," E. Karlsson, C. Cerveñansky, and M. Jolkkonen, Department of Biochemistry, Biomedical Centre, Uppsala, Sweden. Karlsson and colleagues described the neurotoxic compounds of *Dendroaspis* venom, which differ pharmacologically from the other neurotoxic fractions of snake venoms. Dendrotoxins enhance the release of AChE by blocking voltage-dependent potassium channels. Fasciculins are noncompetitive inhibitors of AChE and bind to a peripheral anionic site. They are inhibited by neostigmine and physostigmine, which are competitive inhibitors. Muscarinic toxins bind to muscarinic-type acetylcholine receptors.

"Restoration of Neuromuscular Transmission in Rat Regenerating Muscle," J.B. Harris, B.D. Grubb, and C.E. Davis, Muscular Dystrophy Group Research Laboratories, School of Neurosciences, University of Newcastle Upon Tyne, U.K. Skeletal muscle regenerates following the destruction caused by myotoxic venoms and toxins. Professor Harris and colleagues employed intracellular microelectrodes to study the effects of tiger snake venom or notoxin on the rat soleus muscle. Selected muscle was subsequently processed for histological and histochemical or ultrastructural studies. The experiments showed that muscle fiber populations changed from the heterogeneous mixture of fast and slow fibers found in the control soleus muscle to a uniform slow population. Muscles that were temporarily denervated by nerve crush exhibited an identical change. The results indicated that the homogeneity found in regenerated and reinnervated muscles is a result of the transient loss of innervation and not the cycle of degeneration. Further studies showed that neuromuscular transmission is robust when new junctions are first formed, but additional experiments are needed to determine the long-term effects of muscle necrosis and regeneration.

"Molecular Recognition: From Snake Venom Neurotoxin Directly to Complementary Receptor Binding Site," B.A. Low, Department of Biochemistry and Molecular Biophysics, Columbia University. Professor Low demonstrated the three-dimensional molecular structure of one prototype  $\alpha$  toxin of a snake venom "neurotoxin" at high resolution that provided a definitive concept of the toxin's reactive site. Both the stable and highly mobile regions of the structure were well characterized. The probable

binding mode of the toxin's domain led to the identification of the complimentary principal ligand-binding domain on the subunit of the acetylcholine receptor. Residue-residue interactions at the complimentary toxin and peptide binding surfaces were collaborated by NMR. Methods used were designed to provide data on the roles in binding both  $\alpha$  peptide and  $\alpha$  toxia Trp residues.

"Relationship Between Sarafotoxin and Endothelin. A Case of Evolutionary Exaptation," E. Kochva, A. Bololak, D. Graur, and Z. Wollberg, Department of Zoology, Tel Aviv University, Israel. The senior author described the similarities between the sarafotoxins from the venom of the snake *Atractaspis engaddensis* and endothelin from the blood vessels of mammals. The similarities indicate a possible common origin but an adaption for different uses.

"Venomous Snakes and Snake Venom Poisoning in Europe," Z. Maretic and F.E. Russell, Medicinski Centar, Yugoslavia. Nine species and 18 subspecies of *Vipera* are generally recognized in Europe. One Crotalidae, *Agkistrodon halys*, an Asiatic species, is found as far west as the Caspian Sea. Two rear-fanged snakes--*Malpolon monspessulanus* and *Telescopus fallax*--are also said to be "mildly venomous." Although reliable statistics on the number of bites and envenomations by venomous snakes in Europe are not available, statistics from individual countries over the past two decades indicate that the total number would not exceed 8,000. Although there may be as many as 50 deaths per year, the number probably is closer to 20. The present report treats of the general biology of the venomous snakes of Europe, the chemistry and pharmacology of their venoms, and the clinical problem of venom poisoning.

"Applied Immunology in Snake Venom Research," R.D.G. Theakston, Liverpool School of Tropical Medicine, Liverpool, U.K. The enzyme-linked immunosorbent assay (ELISA) is now used extensively in epidemiology studies and various practices of clinical medicine. In the Nigerian savanna, 65 percent of a group of patients previously bitten by *Echis carinatus* possessed specific venom antibodies against the venom of that snake. In Ecuador, 78 percent of a population of Waorani Indians possessed antibodies against a wide range of different snake venoms, as demonstrated by ELISA. Dr. Theakston described an ELISA technique currently being evaluated that would give a differential diagnosis within 5 minutes of blood sampling. He also described his further work on venom/liposome preparations, venom antigens using monoclonal antibodies on affinity columns, and recombinant DNA technology.

"Plant Poisoning in Europe," G.G. Habermehl, Department of Chemistry, University of Veterinary Medicine, Hannover, FRG. Approximately 12,000 cases of plant poisoning occur in Europe each year; most cases are seen during the late summer and fall. Failure to differen-

tiate between poisonous and nonpoisonous plants accounts for the greatest number of treated cases, but the use of "herbal teas" or "spices" of unknown origin is causing an increasing number of poisonings each year. Poisoning in animals occurs more frequently than generally thought. Although not truly plant, *Fungi imperfecti* is becoming an increasing medical problem and is a public health concern in some parts of Europe.

"Structure-Activity Relationship or Polyamine Analogues of Philanthotoxins," T. Piek, Department of Pharmacology, Academic Medical Centre, University of Amsterdam, the Netherlands. Using glutamatergic transmission in insect muscle and nicotinic transmission in the insect CNS, the author studied several polyamine toxins and analogues. These models were considered as being directly related to similar action in the mammalian brain, principally the effects on the cation channel. The author presented a working scheme for the ion channel kinetics.

"Mammal- and Insect-Directed Scorpion Neurotoxins: Cloning and Expression," P.E. Bougis, H. Rochat, L.A. Smith, 1 Université d'Aix-Marseille II, Faculté de Médecine-Nord, Biochimie, France. Dr. Bougis described studies on molecular cloning involved in the structure-activity relationships of the scorpion *Androctonus australis* toxins. Sequencing of 11 cDNAs showed that the precursors of the toxins were signal peptides of approximately 20 amino acid residues. In addition, toxins active on mammalian preparations had diverse peptide extensions at their C-terminus. The processing steps for maturation of precursors into toxins were not the same for all toxins.

## Diphtheria Toxins

"The Active Site of Diphtheria Toxin: Chemical Modification and Site-Directed Mutagenesis," C. Montecucco, E. Papini, G. Schiavo, A. Covacci, and R. Rappuoli, Dipartimento di Scienze Biomediche, Università di Padova, Italy. Professor Montecucco reviewed present concepts of the chemistry and the activity site of diphtheria toxin. Since the mutation of protein toxins at their active sites have potential use as new atoxic vaccines, the group in Padova decided to mutate his-21 in Ser and Val. Mutated oligonucleotide of 21 bases were synthesized, inserted into the LTX-1 plasmid containing a truncated DT gene, and *E. coli* was transformed. Isolation and biochemical characterization of the mutated toxins is now being studied.

## Tetanus Toxins

"Structure-Function Relationships of Tetanus Toxin," B. Bizzini, Pasteur Institute, Paris. Professor Bizzini discussed certain structure-function relationships of tetanus

toxin, noting mechanism of detoxification by formaldehyde and its implication in vaccine preparation, as well as the involvement of specific amino acid residues in toxicity and immunological reactivity. He described the particular significance of these and other relationships in the preparation of the antisera.

### Comments

This symposium was extremely well organized and executed. In addition to the definitive presentations, the informal sessions, excursions, and entertainment provided by the organizing committee, the Hotel Fortuna provided an enjoyable background for the participants. Particular appreciation should be given to the organizing committee composed of Professor Franc Gubensek, Professor Peter Maček, and the late Professor Zvonimir Maretić, as well as to Professor G. Habermehl, President, and Professor F. Kornalik, Secretary, of the European Section of the International Society on Toxinology.

### Posters

The poster selections were chosen for their diversity, not for their importance to the disciplines of toxicology and toxinology.

- "Chemical Modification of Tryptophane Residues in Equinatoxin II," T. Turk, P. Maček, and F. Gubensek.
- "Amino Acid Sequences of Five Neurotoxins from Sea Anemone, *Radianthus macrodectylus*," T.A. Zykova and E.P. Kozlovskaya.
- "Re-Examination of the Dendrotoxins from Mamba Venoms," D.L. Marshall and A.L. Harvey.
- "Application of PCR in Cloning *Echis carinatus* Venom Genes," M.J.I. Paine, R.D.G. Theakston, and J.M. Crampton.
- "Information Management by Hypertext: Animal Venoms and Poisons," I. Claus, T. Langelüddeke, and D. Mebs.
- "Scorpion Toxins Active on the Sodium Channels of the Cockroach *Periplaneta americana*," M.E. de Lima, et al.
- "Experimental General and Local Tetanus and Their Relation to Clinical Tetanus," K. Takano and F. Kirchner.
- "A Neuroactive Kinin from the Venom of the Ant, *Paraponera clavata*," T. Piek, et al.
- "Effects of Myotoxin *a* on Cultured Muscle Cells," A.L. Bieber, et al.
- "Lymphopenia Following Australian Elapid Snake Bite," J. White, et al.

# NEWS, NOTES, AND ABSTRACTS

## European Community Research Funding and Research Databases - An Update

by Dr. Marco Di Capua

### Guidebook - Comprehensive View of EC Research

The Commission of the European Communities (CEC) has published a guidebook--*EC Research Funding, a guide for applicants*--(Krickau-Richter, 1990) that, for the first time, provides the same comprehensive view of the European Community (EC) research programs as portrayed in *ESNIB 90-02*, an issue dedicated to research in Europe. The guide aims "at everyone that is interested in EC research, especially those from the sciences and industry that want to widen their field of work internationally, are looking for partners, and wish to cooperate at the EC level." This is an area that the EC recognizes is full of misunderstandings and information gaps, from terminology (so-called EC jargon) through the formulation of successful project applications. This guide bears striking similarities to the Office of Naval Research *Guide to Programs*.

The guide also provides, in appendixes, the points of contact directories in Brussels as well as the member countries. The appendixes of the guide also list selected databases and information systems for research and development (R&D). I elaborate on the database aspects below.

### European R&D Databases

Databases available through the CEC ECHO-HOST Service are:

**BIOREP** - Biotechnological projects carried out in the EC members (about 7,000 records).

**DIANEGUIDE** - Information on databases, databanks, database producers, and host organizations available on Direct Information Access Network for Europe (DIANE), the only on-line databank that gives the users immediate access to a wide range of information about on-line services in Europe.

**Directory of Materials Data Information Sources (DOMIS)** - On-line directory of information source materials and services in Europe (e.g., databanks and databases, technical centers, scientific and technical laboratories, experts in the areas of metals, alloys and steel, ceramics and glass, composite materials, coatings and joints, plastics and rubber).

**EABS** - On-line version of the monthly journal Euro-Abstracts that references the published results of

scientific and technical programs wholly or partially CEC-sponsored. The database has more than 5.0E + 4 citations dating from 1966 to the present.

**ENREP** - On-line directory of environmental research projects (more than 50,000 entries from over 5,000 organizations).

**European Research Coordination Agency (EUREKA)** - Detailed information on projects carried within the aegis of EUREKA.

**EURISTOTE** - Directory of more than 10,000 theses and studies dealing with EC policies. Information on more than 5,000 professors who are studying the construction of Europe (coverage since 1952).

**Information Exchange System-Data Collections (IES-DC)** - Directory and reference service to the European information technology (IT) community. Database comprises 2,000 projects, 1,000 resources and facilities, and 4,200 addresses. Three domains include data on:

- Publicly funded IT research
- Network resources available to researchers in the IT domain
- Electronic mail addresses of researchers in the IT field.

**SESAME** - Information on EC energy projects.

**Tenders Electronics Daily (TED)** - Electronic form of Series S--the supplement to the EC official journal that carries public calls for tenders from more than 80 countries, including calls for proposals for EC research projects.

**Common Research and Development Information Service (CORDIS)** - Will take under one roof all relevant information in R&D fields from a variety of databases; database is expected to be operational in mid-1990.

Information on access to these databases is available from:

**ECHO Customer Service**  
177, Route d'Esch  
L-1023 Luxembourg  
Phone xx-352-488041 (ECHO Help Desk)  
FAX xx-352-488040  
NUA 270 44 81 12

### References

Krickau-Richter, L., von Schwerin, O., "EC Research Funding - A Guide to Applicants," CEC, Economica Verlag, Bonn, (1990); available from DG XII, 200 Rue de la Loi, B-1049 Brussels, Belgium.  
*ESNIB 90-02.*

## International Congress on Intensity Techniques

by David Feit

The International Congress on Intensity Techniques will be held at Senlis, France (near Paris), August 27-29, 1990. This meeting, the third in a series organized by the Centre Technique des Industries Mécaniques (CETIM), will be devoted to Structural Intensity and Vibrational Energy Flow. The use of intensity as a vector quantity characterizing the directional flow of energy is already developed and well established in the field of airborne acoustics, and this congress will explore the use of similar concepts in structural acoustics. One can imagine that the flow of vibrational energy in structures can be visualized and predicted with the objective of localizing and qualifying sources and transmission paths. The state of the art in the field will be surveyed through presentations and discussions by working experts in the field. Sessions will be organized around the following topics:

- Structural intensity formulations for different types of structures; e.g., beams, plates, shells
- Measurement equipment - transducers and calibration
- Predictive computations of structural intensity
- Characterization of propagation paths and damping treatments, localizations of sources
- Relationship between structural intensity and Statistical Energy Analysis (SEA), application of particular analysis techniques; e.g., finite element methods and modal analysis.

For further information, contact:

Mr. Jean Touret  
 Department Acoustique Industrielle  
 B.P. 67  
 F-60304 SENLIS Cedex, France

## Pop Maths Roadshow

by David Feit

Throughout the world, mathematicians and scientists are concerned about how little the public understands and appreciates mathematics. In our increasingly technological society, this lack of interest in mathematics and science in general can have significant implications for the future. Some people in the U.K. think that the lack of interest in mathematics specifically is particularly serious. As a result, the Joint Mathematical Council (JMC) and the Royal Society's Mathematical Instructional Committee have joined to organize an exciting, interactive exhibition to help create interest in mathematics.

This exhibition has become known as the Pop Maths Roadshow and debuted in Leeds in September 1989. After a week there, the show began its tour of more than 20 other cities throughout the U.K., and will end in late 1990. Leeds was chosen as the initial site to coincide with an international seminar on popularizing mathematics

(organized by the International Commission on Mathematical Instruction). The principal driving forces behind the show are Professor D.G. Crighton, Cambridge University; Ms. Jill Nelson, Royal Society; and Mr. Geoffrey Wain, Leeds University. For more information, contact me at Office of Naval Research European Office.

## New Microfabrication Center for JESSI

by Dean L. Mitchell

As part of its contribution to the Joint European Sub-micron Silicon Initiative (JESSI), the Federal Republic of Germany (FRG) government has approved the formation of a new research institute for silicon technology. The new institute will focus on developing photo-lithographic and processing techniques necessary to fabricate silicon memory chips, with feature sizes smaller than 0.5 micrometers.

The companies currently participating in the JESSI consortium are Philips, the Netherlands; SGS-Thomson, Italy and France; and Siemens, FRG. They will provide one-half the cost of JESSI over an 8-year period ending in 1994; the remainder will be supplied by the European Community (EC) and the governments of France, Italy, the Netherlands, and the FRG. Initial funding, set at the Stockholm conference of ministers, was 550 million European Currency Units (ECU) (\$650 million); the total cost is expected to exceed 3,500 million ECU (\$4,200 million). The objective of JESSI is to generate the fabrication technologies and production facilities that would allow Europe to be a major supplier of memory chips by 1994. The technical targets are 10-100 transistors/chip with 5GBits/sec.

The new institute will be located at Itzhoe in Schleswig-Holstein and will most likely be sponsored by the Fraunhofer Gesellschaft, the public corporation for support of applied research in the FRG. The Fraunhofer Gesellschaft also sponsors the existing Institute for Microstructure Techniques (IMT), which was established in Berlin with similar research objectives. Funds will be provided by the Federal and Schleswig-Holstein state governments with FRG industry, primarily Siemens, providing a share. Construction and major equipment costs will total DM400 million (\$200 million) with completion of the building phase expected in 1991. Industry is expected to contribute 20 percent in the staff and will share in salaries and costs.

The formation of the new institute is a disappointment to the IMT in Berlin that has been the leading laboratory for x-ray photo-lithographic processing techniques for silicon wafers using the BESSY synchrotron source in Berlin and COSY, a compact synchrotron storage ring developed specifically for x-ray photo-lithography. The new institute is also a disappointment to the FRG political leaders who had hoped to use the IMT/BESSY facilities to attract high-technology investment to Berlin.

## Math Employment in Europe

by Dr. Robert D. Ryan

Conversations with several academic mathematicians in Europe reveal mixed prospects for academic jobs in mathematics. For example, in Austria, young mathematicians seeking an academic career are having to leave Europe to pursue their teaching and research careers. The academic system in Austria continues to be quite rigid; there are a fixed number of positions, and the incumbents have lifetime tenure. At the moment, all of these positions are filled.

In France, the cycle is at a different point. Several years ago there was hardly a job to be found, and consequently enrollment in mathematics dropped. Now, jobs are beginning to open up, and more are anticipated for the future, but informal projections indicate that there are not enough French mathematicians in the pipeline to fill them. The prestigious institutions have no trouble finding good people for the few available jobs, but other schools have experienced difficulty. As in the U.S., too few capable young people are going into mathematics and science. French mathematicians tell me that the salary structure (determined by the government since academics are government employees) has not kept up with inflation, and that this presents an added deterrent. Surprisingly, I am told that the French government does not recognize, or does not choose to recognize, this potential lack of mathematics manpower.

One might think that the spirit of the European Economic Community (EEC) would provide job mobility to smooth over the peaks and valleys of employment. In fact, mobility for mathematicians has always existed in Europe and throughout the world. In spite of the hopes of the EC, the patterns of movement and kinds of employment have not changed much in that most of the jobs in other countries have been postdoctoral or similar temporary positions. The coveted permanent positions are rarely awarded to foreign scientists. This has not been the case for mathematicians going to Canada and the U.S., where the pathways created during World War II continue to be used by young mathematicians from all of Europe.

Finally, language plays a small role in this latter movement. English is the language of science, and mathematicians throughout the world read and write English. Most people prefer to teach in their native tongue, but faced with the prospect of having to lecture in a foreign language, many Europeans prefer English. This opinion was expressed by several Austrian mathematicians. Given the fact of few jobs at home or in Germany, they opt for jobs in Canada or the U.S. Their hope is to continue teaching and research until something opens up at home or in Germany.

## Export Company Set Up to Market Products of AT&T and Italtel

by J.F. Blackburn

In mid-1989, an agreement for cooperation between AT&T and Italtel of Italy was completed. As a followup to a specification in the agreement, an AT&T-Italtel marketing company--Joint Export Company (JEC)--is operating. The company is owned equally by AT&T and Italtel, with its main focus on marketing telephone products in European markets. With its head office in Brussels, JEC will be headed by a director general, who will be a European manager recruited from outside AT&T and Italtel.

According to Italtel management, implementation of the joint agreement is going well and collaboration between the partners is excellent. Nine joint projects are being studied for marketing products in the near future. The JEC will handle marketing these products, most of which are intelligent network systems and systems for network access via fiber optics. The digital telephone exchanges, manufactured by Italtel, are not a part of the new arrangement.

In transmission systems, the AT&T-Italtel cooperation has extensive plans. Using American technology, the two partners will be able to be an effective supplier in Europe. The agreement between AT&T and Italtel appears to lessen the likelihood of completing the arrangement between Italtel and Telettra, which was widely discussed several years ago.

A spokesman for Italtel said that Italtel had succeeded in maintaining competitiveness of the digital telephone public switching range, which can be strengthened by the services of intelligent networks. Studies are now being carried out on hardware and software modules, which are common to the AT&T and Italtel systems, in order to create synergy between them. A joint catalogue of products will include the Italtel digital telephone switching system and the AT&T ESS 5 SS, which will be sold in Third World, Middle- and Near-Eastern markets.

In order to manage the agreement, the two companies have established a working group of eight that meets monthly. In the latter part of 1989, some Italian technicians worked in the U.S. and a group of AT&T technicians are currently working in Italy.

Negotiations are now being carried out with the Soviet authorities to establish a technological joint venture, which will be based on the digital telephone systems and which will provide for the construction of a factory.

## European Community Introduces \$85 Billion Value-Added Services Market

by J.F. Blackburn

On December 7, 1989, at a meeting in Brussels, Belgium, the European Community (EC) agreed to introduce the liberalization of the value-added services market in stages over the next 5 years. This market is estimated to be worth \$85 billion and \$5.6 billion/year in services and equipment, respectively. This will be the largest single boost for the providers of services, network management organizations, network equipment providers, and manufacturers of data communications equipment.

Services such as electronic mail and electronic banking, together with automatic transfer services, will be among the first to be liberalized. This will be followed by liberalization of data communications services, including those provided by private companies. The liberalization will be introduced over a period; electronic mail and electronic banking services became competitive in 1989. A transitional period was agreed upon for the introduction of data communications services to be operated by private companies and likely these will start by the end of 1993, but with the full effect of the liberalization not in force until 1995. The delay in data communications liberalization is believed to be because common standards have not yet been agreed upon. There is no move to liberalize basic telecommunications networks nor telex services.

The Federal Republic of Germany (FRG) and the U.K. asserted the greatest pressure for network liberalization; France, Italy, Spain, and Portugal were cautious. However, a compromise was reached with the timed introduction. Bundespost Telekom and British Telecom are said to be ready with plans to enter the European value-added services market and there are several companies with plans already prepared.

British Telecom's Chairman, Ian Vallance, recently told French financial journalists and analysts that British Telecom plans to substantially increase its revenues from international activities; this revenue now is 27 percent of the total. In July 1989, Bundespost Telekom quickly reacted to its new freedom when it announced that it was planning to open several offices in Europe, Japan, and the U.S. The Bundespost Telekom is seeking an additional 20 percent in revenues from foreign involvement within 5 years.

## Telepoint Portable Telephone System for Europe

by J.F. Blackburn

The Federal Republic of Germany, Belgium, Spain, France, Portugal, Finland, and the U.K. signed a draft

agreement to adopt the telepoint portable telephone system throughout Europe. These seven countries will introduce telepoint in experimental or operational form by the end of 1990. The agreement further provides that in 1993 the telepoint system will be extended to all European major towns, airports, and stations.

The telepoint concept consists of a radio base station, having a service range of about 100 meters. An area of customers is served through expanding the number of installed radio base stations or telepoints. Both the domestic and business customer's unit is a lightweight, low-power cordless telephone. In the U.K., Zonephone had about 1,000 zones, served by telepoints, in service at the end of 1989 and expects to have 5,000 zones in use by the end of 1990.

## Planned Reform of the French Postal Organization

by J.F. Blackburn

In an attempt to create autonomous public establishments, France proposes to institute France Telecom to handle telecommunications and the French postal organization to handle postal matters. In January 1989, Spain and the Netherlands made similar moves, and the Federal Republic of Germany (FRG) followed in January 1990. However, a difference from the arrangement in Spain, the Netherlands, and the FRG will be retention of civil service status and social guarantees for the staff.

According to trade union wishes that the Postal, Telegraphie et Telephone (PTT) Ministry should continue to have overall responsibility for employment matters, a Groupe d'Interet Publique [public interest group] (GIP) will be created, supervised by the ministry. The GIP would manage the services common to France Telecom and the postal service as well as employment matters. The boards of the postal service and France Telecom will consist of equal representation elected from government, staff, and politics (including members of Parliament).

At present, France Telecom has debts of F119 billion, which puts it at a disadvantage with respect to its European counterparts. How to handle the debt problem is being discussed.

## Transputer-Based System for Cellular Automata Application

by J.F. Blackburn

A SuperCluster, manufactured by Parsytec in Koln, Federal Republic of Germany, was recently sold to Koninklijke/Shell Laboratorium in Amsterdam (KLSA). One of its main applications will be using the cellular automata technique in the study of fluid flow. The SuperCluster is based on the T800 transputer made by Inmos

of Bristol. In December 1989, the first 100 transputers were installed and 400 more transputers are expected to be installed in 1990. Expansion to more than 1000 transputers is possible in the future. This is expected to be the largest transputer-based system installed by a company, although the Meiko system installed at Edinburgh University has 400 transputers.

The development of the cellular automata technique, combined with the parallel development of parallel computer systems, has led to increased interest in fluid flow simulation. In the cellular automata technique, a flow is simulated by computing the position of many fluid particles of a finite lattice for a period of time, rather than solving a set of continuous partial differential equations. Macroscopic quantities (including local density, velocity, and pressure) can be derived directly from the particle configuration in the lattice.

In the cellular automata technique, a fluid is modeled through satisfying a few fundamental conservation laws. Fluid particles with unit mass are assumed to move with unit speed in a cellular lattice from one cell into neighboring cells in unit time. Particle movements are synchronized; at any time, a cell may contain at most one particle for each possible nearest neighbor direction. In a hexagonal lattice, each cell is surrounded by six nearest neighbors. Thus, a cell may contain up to six particles, representing momentum in one of the six directions along the grid.

Particles may collide in each of the cells, redistribute their momentum to each other, then to particles in neighboring cells.

As the process continues, the calculation is performed for each cell in the grid, and successive snapshots of the grid show how flow patterns have evolved. Each simulation time interval is represented by a state transition for all cells in the model.

The applicability of massively parallel computation together with the cellular automata theory is widely recognized by scientists concerned with the study of fluid flow. For example, this problem is an application of considerable interest at Edinburgh University.

#### Reference

Sopsick, Frances, "Cellular Automata," pages 13-14, *Parallelogram*, Issue 21, December 1989.

### European National Research Centers in Computer Science in Long-Term Cooperation

by J.F. Blackburn

Three national research institutes, the Centrum voor Wiskunde en Informatica (CWI), Amsterdam, the Netherlands; the Gesellschaft für Mathematik und Datenverarbeitung mbH (GMD), Sankt Augustin, Federal Republic of Germany; and the Institut National de Recherche en Informatique et en Automatique

(INRIA), Rocquencourt, France, agreed on a long-term research cooperation during an April 1989 meeting of their delegates in Sankt Augustin.

The agreement provides a joint understanding of the three institutes for cooperation in computer science, applied mathematics, and information technology. Specific strategy is provided for strengthening research and development in these fields. One objective of the cooperation is to prepare to meet the opportunities expected to be provided by the Single European Act of 1992. The agreement will also enhance their contributions to the research community and to Europe, in particular.

The three institutes believe that they will improve their ability to deal with the changing environment after 1993 by combining their efforts and complementing their fields of research. The institutes are open to similar research centers in other European Community countries to join in and support their effort.

Some specific actions being implemented are:

- Offer a fellowship program for outstanding scientists from European countries
- Prepare an advanced training program for industrial/academic target groups as a contribution to technology transfer from research to industry
- Publish a joint, quarterly newsletter describing ongoing joint projects and other activities of the three institutes.

The three institutes held a new workshop series in December 1989 at INRIA in Paris, covering security/cryptography, VLSI design, and software for parallel computers.

### The Wolfson Cytotechnology Laboratory, University of Surrey

by Dr. Keith E. Cooksey

The Wolfson Cytotechnology Laboratory (WCL), University of Surrey, is a pilot-scale animal cell growth facility. The largest of its kind in Europe, WCL is also a research and development facility for industry. Under the direction of Professor R.E. Spier, chairman of the Department of Microbiology, University of Surrey, WCL can design, construct, and test bioreactor control systems, as well as carry out purely biological work.

The WCL building was purpose-built; the pilot plant and medium supply facility occupy two floors, while the third floor is used primarily for utilities. The second-floor cell growth area can be run at positive or negative atmospheric pressure and contains individual reactors able to work at volumes of up to 100 liters. I saw low-shear, stirred reactors as well as hollow-fiber, packed-bed, and airlift reactors from several manufacturers, both from the U.S. and Europe. The WCL is not completed, and I understand that most of the downstream processing

equipment is yet to be installed; however, two containment suites were already operational. The WCL's forte is its ability to grow very large numbers (up to  $10^{12}$ /batch) animal cells without contamination; something that is easier said than done! The reactors I saw were very well instrumented, allowing them to be used to investigate parameters controlling growth as well as merely producing biomass.

The WCL also fulfills a teaching role for the University of Surrey and private industry. For example, a week-long training course was offered last year in conjunction with the Center for Applied Microbiological Research at Porton Down, Wiltshire, U.K. More than half the forty registrants came from abroad. Some of the course faculty were from biotechnology companies, government laboratories, and other U.K. universities. Possibly, the course will be offered as needed. Dr. Anita Handa-Carrigan, WCL Deputy Director and course lecturer, explained that it is the research units' success in growing large, contaminant-free populations of cells that attracts people to their course.

### U.K. Developing Low-Frequency Active Sonar System

by David Feit

Significant advancement achieved by British scientists in detecting increasingly quieter Soviet submarines are occurring at the Admiralty Research Establishment (ARE), Portland, Dorset.

According to Evans (1989), scientists at ARE/Portland are developing a surveillance sonar system capable of transmitting very low-frequency signals that can propagate over hundreds of miles. These signals bounce off submarines and the echoes reveal a target's position. Low-frequency signals can travel over such long distances without being severely affected by the ocean environment because of scattering, refraction, and absorption effects.

The current systems in use by the U.K. Royal Navy are towed arrays that are streamed out by antisubmarine warfare ships and listen passively for the noise signals radiated by target submarines. Because of the advanced silencing techniques employed, recently built Soviet submarines are more difficult to detect by such passive systems. Evans cites the use of quieter propellers, extensive cladding (decoupling) treatments to the outer hull, and improved machinery isolation techniques.

The new systems under development are based on the active transmission of very low-frequency acoustical signals that, in the past, have been hampered by the difficulty of practically generating such signals. Recent breakthroughs have been made in the development of technology to produce such signals. The explanation offered by Evans is that, "... by raising the frequency slightly, they can get good results." I imagine that he is talking about the use of parametric arrays that can produce directive low-

frequency sound waves through the nonlinear interaction of much higher frequency sound beams.

The technology advancement has allowed the scientists to maintain a significant output using smaller transducers. Earlier active low-frequency sonar research had emphasized the need for special platforms to project the searching sound waves. That idea has been abandoned because of the costs. A feasibility study would present a much better cost estimate.

Evans' sources indicate that the most likely platform for the low-frequency active sonar system, weighing up to 50 tons, would be a later version of the "Duke" Class (Type 23) Frigate. He also mentions the possibility of bistatic systems where the transmitter would be on one platform and the receivers on other platforms with data linked by radio telemetry. The scientists expect that by 2000 a system of this type could be developed and deployed to complement current passive systems.

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### Wavelet Analysis in Structural Acoustics

by David Feit

Wavelet analysis, a mathematical technique recently uncovered by Office of Naval Research European Office liaison scientists on their visits throughout Europe, appears to me to be potentially applicable to problems in structural acoustics. This type of analysis has already been applied to seismic signals (Goupillaud, 1984), and a variant of it; i.e., time varying spectra such as speech spectrograms or acoustical signal lofargrams, have been used for several years.

Wavelet analysis yields a two-dimensional representation of a time varying signal that resolves both the scale or frequency content of a signal on a localized basis. If applied to a spatial distribution, we can see the signals wavenumber distribution on a localized basis. A recent article (see ESNIB 90-01:26-29) compares wavelets to Fourier transforms which can locate the positions of discontinuities as well as characterize them.

At a recent workshop on "Complexity in Structures," held at the Catholic University of America (CUA), September 27-28, 1989, L. Felsen suggested the applicability of configuration-phase space transforms to complex structural problems. His description of these transforms suggested to me that he was also talking about a particular adaptation of wavelet analysis.

The wavelet analysis of a function is described in a recent note appearing in NATURE (Argoul et al., 1989) as an expansion in a set of wavelets derived from a single function, say  $g(x)$ , using dilations and translations. The parameters setting the degree of dilation and amount of translation then appear as the two variables over which the wavelet transform is defined. The function  $g(x)$  is a

regular function localized around  $x=0$ , and if it meets certain criteria, the transform can be inverted.

The authors describe the transformation as a "mathematical microscope," with position and magnification corresponding to the translation and inverse of the dilation and the performance related to the wavelet function  $g$ . In the same paper, the transform is applied to the spatial distribution of experimentally measured turbulent velocity fields on a three-dimensional high Reynolds number flow. The intensities of the wavelet transform are shown using different dilations, and the results are used to demonstrate and identify the fractal behavior of fully developed turbulence.

Although it is not necessarily suggested that structural acoustics problems would reveal the same sort of complexity as turbulence-generated velocity fields, I feel that the wavelet analysis potentially offers a new tool that may reveal qualitative features in the measured response of complex structures that may shed further light on our understanding.

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## Aquatic Biochemistry at the University of Stirling, Scotland

by Dr. Keith E. Cooksey

### Introduction

Aquatic Biochemistry at the University of Stirling is organized under the auspices of the Natural Environmental Research Council (NERC) of the U.K. and is housed in the Department of Biological Sciences. Stirling University is only 22 years old and proud of its innovative teaching programs. The NERC unit is housed in modern laboratories and has a scientific complement of about 20 personnel. Six of these, including the Director, Professor John R. Sargent, are at a senior level. The number of senior personnel is in keeping with situations I have noticed in other NERC units. This number seems to be considered an appropriate one for "critical mass" in focused research. Established in 1986, the unit was formed from the Institute of Marine Biochemistry at Aberdeen. I spoke with most of the senior staff and found that they had research collaborations with the Institute of Aquaculture (which has a unique degree program), the Marine Biology group, and several other universities and companies in the U.K. and abroad. Dr. Sargent explained that the research of the unit is directed towards improving our knowledge of the natural aquatic environment, both fresh water and marine, so that predictive information can be

obtained. All the research in the unit is at the molecular or cellular level and is focused in two general areas--lipid structure and function, and molecular toxicology. The toxicology and lipid groups appear to be unique in that they are highly committed to both molecular and field programs.

### Lipid Structure and Function

Much of the work of this section of the NERC unit centers around polyunsaturated fatty acids (PUFAs)--molecules that originate in the phytoplankton but are essential dietary components of higher organisms such as zooplankton, including larval fishes. The research carried out is heavily experimental, but does have field components, notably a collaboration with scientists in Spitsbergen, Norway. A further facet of this concentration on lipids is their use as biomarkers in dissecting marine symbioses and food webs. The latter is particularly important locally since sea lochs in Scotland support a large salmon aquaculture effort and salmonids have an absolute requirement for (N-3)PUFAs. Currently, these essential nutrients are supplied from fish meal, a situation in which, according to Professor Sargent, salmon are merely increasing the value of an existing product! Professor Sargent's group is researching other sources of these valuable molecules for both fish and human nutrition. To this end, they have analyzed the fatty composition of several microalgae species and researched the means by which the physiological status of the cells influences the results. Until now, their findings have shown that as cells become older; i.e., when they divide less frequently, the fatty acids of their lipids become more saturated, shorter in chain length, and are found largely in wax esters or triglycerides. Functional roles for the highly unsaturated species of these molecules are also being followed, especially at the transmembrane-signaling level. The group is a source of information on the lipids of many marine organisms.

### Molecular Toxicology

A second interest of the NERC unit is that followed by Dr. Steven George. He is conducting basic studies of biochemical systems responsible for the detoxification of organic and metal pollutants. The information obtained is expected to aid in the design of molecular probes able to detect levels of pollutant in the environment below those needed to cause lethal effects. Dr. George points out that measurement of primary, sublethal, pollutant response, which precedes the development of overt pathology, can serve as an early warning of potential environmental impact. For instance, levels of toxicants that influence behavior are far lower than those that are needed for mortality. In many cases, pollutant detoxification systems are inducible by sublethal levels of the chemical. Thus, if the products of the induction can be detected, a mechanism to gauge environmental stress can

be developed. This is the research strategy that this group has adopted. In the case of the induction of mixed-function oxidases that add -OH groups to aromatic rings, for instance, the situation is complicated by the fact that several forms of the enzyme system (including the cytochrome P-450 moiety) are constitutive in fish liver cells. However, only some of these isoforms are able to increase their levels in response to various pollutants. This, in turn, provides a means of differentiating between the stress-related and the normal mixed-function oxidases. Dr. George explained that although mixed-function oxidases can be regarded primarily as detoxification systems, in some organisms they are responsible for activating xenobiotics; i.e., they convert relatively innocuous components into extremely toxic ones. This facet of their activity makes them particularly appropriate indicators. Dr. George favors a quantitative immunological (Western Blot) approach rather than using enzymological assays to detect the P-450 system in livers from stressed fish.

Certain heavy metals, as well as organic materials, find their way into our environment and present us with a pollution problem. Dr. George also has worked in this area of physiological response to pollution stress. As in organic pollution, certain specific proteins are induced in organisms by metal exposure. Thus, measurement in tissues of these macromolecules, which are collectively known as metallothioneins, provides a sensitive indicator of stress. For instance, exposure of fish to cadmium or mercury can result in a 20- to 30-fold increase in hepatic metallothionein. Dr. George points out that many proteins will bind metals nonspecifically; thus, an analysis based totally on the metal burden of an animal does not infer recent metal exposure. What is needed is a specific assay for the induced heavy-metal binding protein. In his laboratory, assays based on a polyclonal antibody reaction on radioactive cadmium binding are used. The antibody, which was prepared from trout, cross-reacts with metallothionein from other fish species. This is not surprising since the gene for metallothionein is highly conserved. The assay has been used to show that zinc injections cause a 10- to 20-fold increase in hepatic metallothionein in marine flatfish. Since the Zn-binding protein had a half-life of about 30 days, this assay was capable of detecting exposures in the recent past indicating that care was necessary in interpreting analyses from fish obtained from the field.

Since environmental pollution is rarely of one type, it is important to examine the effects of multiple stresses on an organism. Dr. George's group has examined the activities of both mixed function oxidases (organic pollution indicators) and metallothionein levels (for heavy-metal exposure) in salmon from control rivers and rivers where fish are known to be jaundiced. They found that even in fish that showed no obvious pathology, there were elevated P-450 and metallothionein levels. Work in this lab-

oratory continues to dissect the toxic interactions in situations such as this. A major problem in this area is the influence of enzymes induced by concurrent heavy-metal exposure on mixed function oxidases systems. Because of this, the group is developing new procedures that will be helpful in working with multiple pollutant exposures and the interactions they engender. The first of these is a fish cell culture system (plaice) to replace use of whole fish, and another is an RNA probe for metallothionein.

## Conservatoire National des Arts et Métiers, Paris, France

by Robert D. Ryan

### Introduction

The Conservatoire National des Arts et Métiers (CNAM) was established in 1794 at the height of the Terror. This action by the Convention was based on the ideas and urging of the Abbé Grégoire. The Abbé Grégoire, an active member of the Committee on Public Instruction, believed that the young Republic had to have an improved national industry capable of competing with the English, and that this end would be served by collecting in one place all of the latest tools and machines and by providing instruction in their use. From the beginning, this instruction on the construction and use of new tools and machines was to be provided to people already at work in their professions, and thus, CNAM became one of the first, if not the first, schools for continuing education. The Abbé Grégoire also had the notion that instruction should be given by experts. As an example, Joseph-Michel Montgolfier, who in 1792 invented the hydraulic ram and who, with his younger brother, Jacques-Etienne, developed the hot air balloon, played a key role in organizing CNAM.

At the beginning of the 19th century, CNAM became an institute of higher education for teaching the applications of science to commerce and industry. Today, CNAM is the largest school for continuing and adult education in France. More than 100,000 students take courses in Paris and in towns throughout France and in its territories. Instruction is given at 120 sites that are grouped under 49 regional centers. The CNAM offers a range of diplomas and degrees up to the doctorate in selected fields of science and technology, including computer science. In keeping with the original idea, the students are working adults, and the bulk of the instruction is given after working hours and on Saturday. The CNAM also offers training courses for industry, which are financed by the industry or by the regional government. Courses created in response to specific needs of a profession are given by the various institutes and centers within CNAM. Research at CNAM is organized under 26 laboratories, centers, and institutes dedicated to research in support of French industry.

## Le Centre d'Etudes et de Recherche en Informatique CNAM (CEDRIC)

The center for study and research in computer science at CNAM, CEDRIC, was created in 1988 by bringing together different research groups from the department of Mathématiques et Informatique [mathematics and computer science] at Paris and the Institut d'Informatique d'Entreprise [institute for computer science in business] (IIE) at Evry. The 29 permanent faculty associated with CEDRIC conduct research and supervise about 15 graduate students, who are studying for engineering or doctorate degrees.

Research is carried out in close collaboration with industry to ensure that the work is relevant to industrial applications and that the results are applied as soon as possible. The application of new research results is facilitated by the fact that the students are already members of the work force, typically involved with some aspect of computer science in business or industry.

### Research Areas

The CEDRIC is organized into five research teams. Each team has a leader and a research theme. This subdivision into teams is the typical organizational structure for French research centers and laboratories, and even for academic departments (see Table 1).

### Collaboration

The CEDRIC is embedded in CNAM and IIE for its educational function and the awarding of degrees, but it gains much of its research strength and uniqueness from its collaboration with industry and other research organizations (see Table 2).

### Summary

In the first place, CNAM is a higher education institution for science and technology targeted at students in the work force. In this regard, it has a unique role under the Ministry of National Education for continuing and adult education. In the second place, CNAM does research through 26 centers, laboratories, and institutes. This research is strongly motivated by the needs and interests of business and industry, and much of the research is done cooperatively with business and industry. The students, being in the work force, provide ideal conduits for technology transfer, thus fulfilling the original concepts promoted by the Abbé Grégoire.

Computer science research at CEDRIC reflects the needs of French industry, which intersects heavily with topics current throughout the international research community. Distributed systems, real-time systems, fault tolerance, and parallelism being examples. The work at CEDRIC also reflects the traditional orientation and strengths of French computer science; e.g., research on programming languages, logic programming, and Petri nets.

**Table 1. CEDRIC Research Teams**

1. **Distributed Systems**, including distributed algorithms, distributed operating systems, and system design; emphasis on fault tolerant, real-time systems.
2. **Programming Environments**, including work on languages that manipulate sets, techniques for transforming and optimizing programs written in such languages, logic programming, and the development of the language Modulog. Modulog, a computer engineering tool which is compatible with Prolog, was developed for the design and validation of hardware.
3. **System Modeling**, including system validation using Petri nets, modeling and verification of distributed systems, stochastic Petri nets, and algorithms and methods of optimization; bears on the optimal placement of tasks and files in a distributed systems.
4. **Artificial Intelligence**, including a cognitive approach for the comprehension of natural language and the representation of knowledge, and work on fuzzy logic and the logic of common sense.
5. **Very Large-Scale Integration (VLSI) Architecture Design**, including the development of specific tools for high-level simulation of machine architectures, built to be compatible with existing computer-aided design (CAD) tools used in industry. This research is done under a project called Atelier Logiciel de Micro Architecture [software workshop for micro architecture] in collaboration with Phillips' applied physics laboratory. The project aims to bring to VLSI design the same kinds of tools that software engineering brings to the development of programs. This team is working in collaboration with IBM to use the facilities of Prolog to determine test sequences for the validation of architectures.

**Table 2. CEDRIC Collaborations**

- Sema-Cerci - design of networks and distributed systems for process control (mechanical, transport, energy); design and development of tools for evaluating the performance of industrial systems
- Cimsa-Sintra - methods for evaluating software reliability; design and development of tools to validate distributed algorithms
- Thompson-DSI (industrial simulation division) - software engineering
- Chorus Systèmes - design of distributed operating systems
- Thompson, Enidata SpA (Italian computer science society), University of Patras (Greece), and Hildesheim Hochschule (Germany) under the ESPRIT project entitled SetI Experimentation and Demonstrator (SED), which has the objective to develop a programming environment around the set-based language SetI
- Centre National de la Recherche Scientifique - C<sup>3</sup> (Cooperation, Concurrence, and Communication)
- Institut National de Recherche en Informatique et en Automatique (INRIA) - programming environments
- Laboratoire d'Automatique et d'Analyse des Systèmes, a CNRS laboratory at Toulouse - stochastic Petri nets
- Laboratoire de Recherche en Informatique, a laboratory of CNRS and the University of Paris at Orsay - distributed algorithms, circuit design, and Petri nets
- Laboratoire de Méthodologie et d'Architecture des Systèmes Informatique, a laboratory of CNRS and the University of Paris VI - Petri nets
- University of Paris V - cellular automata
- University of Toronto - circuit design
- University of Turin - stochastic Petri nets
- Duke University - stochastic Petri nets.

## **BRITE-EURAM Offers Feasibility Awards for Small- and Medium-Sized Enterprises**

by J.F. Blackburn

### **Introduction**

The Basic Research in Industrial Technologies for Europe-European Research in Advanced Materials (BRITE-EURAM) program has announced a call for proposals from Small- and Medium-Sized Enterprises (SME). The proposals will be for feasibility studies in the areas of interest to the BRITE-EURAM program, aiming to help SMEs demonstrate their abilities to potential partners in future collaborative proposals. The results of the research are expected to become the basis for an SME to participate in a partnership seeking support for a BRITE-EURAM Industrial Applied Research Proposal.

Sponsored by the Commission of the European Communities (CEC), the scheme will provide financial support for the research and development (R&D) necessary to establish the feasibility of an innovative device, process, or concept within the fields of industrial technologies, and the development and application of advanced materials. The proposed R&D must conform with the technical areas of the BRITE-EURAM program and is aimed at promoting bold and innovative ideas.

Awards to successful applicants will provide support for up to 75 percent of the proposed research cost, with a maximum CEC contribution of 25,000 European Currency Units (ECU). About sixty awards are expected to be made in 1990.

To be eligible, the applicant must:

- Have fewer than 500 employees, a fixed asset value of less than 75 million ECU, and not more than one-third owned by a larger company
- Be located within the EC
- Be a company whose principal activity is not R&D
- Be able to start work by July 1, 1990.

### **Summary of Technical Areas and Objectives of the BRITE-EURAM Program**

The five technical areas of the program are: (1) Advanced Materials Technologies, (2) Design Methodology and Assurance for Products and Processes, (3) Application for Manufacturing Technologies, (4) Technologies for Manufacturing Processes, and (5) Specific Activities Relating to Aeronautics. The latter area is not eligible for feasibility awards.

#### **Advanced Materials Technologies**

In this area, the work will concentrate on developing new or improved materials, and materials processing for a wide range of possible applications, except for those directly related to information technology (IT) covered in European Strategic Programme for Research and Development in Information Technologies (ESPRIT).

In metallic materials and metallic matrix composites, the objective will be extended working life of components, higher operating temperatures for increased thermal efficiency, and better and more efficient material processing techniques. In materials for magnetic, optical, electrical, and superconducting applications, the objective will be improved materials and materials processing for these applications. In high-temperature nonmetallic materials, the objective will be to design methodologies for products based on ceramics, glasses, and amorphous materials; improved monolithic and ceramic composites and metal/ceramic interfaces for industrial applications; and better processing techniques and quality control strategies.

In polymers and organic matrix components, the objectives will be development of polymers for specific applications; more cost-effective process techniques for parts made from polymer and polymer matrix composites; design rules for the specifying and manufacturing engineering polymers and composites; new polymers with improved recycling attributes; and improved product assurance techniques. The objective for materials for specialized applications will be improvement in the materials and their processing.

#### **Design Methodologies and Assurance for Products and Processes**

Part of the work in this area will be developing techniques to improve product quality and the reliability and maintainability of structures and manufacturing systems. This will be done by clarifying the design, aims for both product and process, and by refining the criteria against which the attributes are measured. Also included in this section are the exploitation of materials for application in sensors, and reduction in the whole-life costs of sensors. This work will complement work in EC IT programs where on-line control is treated, including monitoring and diagnostics, predictive maintenance, and quality assurance.

The objectives in quality, reliability, and maintainability will include (1) improved performance measurement for manufacturing operation in a wide variety of industries; (2) improved and more predictable physical and environmental behavior of products; (3) improved quality control strategies; and (4) design rules for reliability and maintainability of components, structures, and systems, including machinery operation under varying conditions.

In process and product assurance, the objectives are (1) reducing whole-life costs of sensor systems for process control; (2) exploiting materials properties for applications in sensors; (3) using advanced measurement techniques for more cost-effective examination of topology; (4) improving energy control for industrial applications;

and (5) improving nondestructive testing methods for product assurance.

#### Application of Manufacturing Technologies

In this sector, the task is to identify and address the needs of the manufacturing industry, and particularly the less-advanced sectors, many of which include primarily SMEs. Modeling of physical processes should be a valuable instrument for progress. Also, work related to industries based on the use of flexible materials will be included. The main focus of the work will be on product and process development, and transferring and adapting technology already used in other sectors. This will complement work in ESPRIT, where IT systems are being developed for advanced manufacturing and computer-integrated manufacturing.

The objectives of the advanced manufacturing practices sector will include identifying the means for improving manufacturing practices in specific sectors, and transferring and adapting technology already used in other sectors. In manufacturing processes for flexible materials, the objectives will include increased process flexibility, reduced waste of material, and improved process and product quality.

#### Technologies for Manufacturing Processes

This area involves improved techniques for shaping, joining and assembling, surface treatment, chemical processes, and particle technology. Advancement in these processes is essential for securing manufacturing competitiveness.

The specific objectives in surface techniques include cost-effective treatment for industrial applications, and techniques for quality assurance and control of the treatment process. Shaping, assembling, and joining have objectives that include (1) improved methodologies for shaping processes and assembly; (2) improved joining techniques to improve reliability and reduce defect levels; (3) methods for testing welded and bonded joints to improve reliability of results and service predictability; (4) design methods for joining; and (5) better understanding of beam/workpiece interactions for industrial powerbeam processes.

Work in chemical processes will cover improved predictability and yield in chemical processes, membrane materials with improved characteristics, improved performance of membrane processes, and new systems for separation in hostile environments.

The objectives in particle and powder processes include (1) improved techniques for particle production to optimize product shape, structure, and stability; (2) cost-effective techniques for particle categorizing and process performance; (3) better approaches to handling and separation; and (4) cost-effective routes for small lots of high-quality powder.

The participants must submit a final report within 6 months of the agreed-upon start date that will include:

- Full account of the work undertaken with reference to the original application
- Results obtained and conclusions drawn
- Outline description of how the work could be further developed within a BRITE-EURAM project
- Details of any industrial or commercial property rights applied for
- Statement of expenditures related to the work undertaken.

#### Symposium on Signal and Image Processing

by Dr. Charles Baker, University of North Carolina, Chapel Hill

Organized by the French Group for Research and Study of Signal and Image Processing (GRETSI) and the Colloque sur le Traitement du Signal et des Images is held biennially. The 1989 conference, held in Juan-les-Pins, France, June 12-16, included attendees from approximately 20 countries, with approximately 250 papers being presented. Although predominantly French, the conference usually attracts many participants from other countries. Languages for the conference are either French or English.

The conference has historically had a strong emphasis on signal detection and estimation, spectral analysis, and spatial and image processing. Other areas of interest include communications, propagation, speech processing, and digital methods. A main area of applications has been sonar, although radar, digital communications, and biomedical systems are also well represented.

The 1989 conference included many interesting papers in the areas mentioned. Especially noteworthy were papers presented by members of two leading French research laboratories--the Laboratory for Signals and Systems (LSS), Gif-sur-Yvette; and the Center for Study of Random Geophysical Phenomena (CEPHAG), Grenoble. The LSS is affiliated with the Superior School of Electricity, Orsay, while the CEPHAG is affiliated with the National Polytechnic Institute of Grenoble. Many of their papers involved several leading French researchers and their colleagues and students--Professor B. Picinbono and Dr. O. Macchi of the LSS, and Professors G. Jourdain and J.-L. Lacoume of the CEPHAG. Their papers were in the main areas of detection, estimation, communications, spectral analysis, and propagation.

The conference is more applied than the Institute of Electrical and Electronics Engineers (IEEE) symposia on Information Theory. Perhaps the most similar IEEE symposia are those held on Acoustics, Speech, and Signal Processing. However, the large representation of French and other European researchers provides a better opportunity to become current on research in those countries (especially France) than is afforded by the IEEE con-

ferences. Attendees from the U.S. are also provided with an unusual opportunity to present their work to a large group of European researchers.

### The Physical Oceanography of Straits

Dr. Thomas H. Kinder, Scientific Officer in the Meso/Large Scale Oceanography Program, and Dr. Alan Brandt, Program Manager for the Coastal Sciences Program of the Office of Naval Research.

Sea straits offer a wide range of interesting fluid mechanical problems, and often they have important influence on the adjacent ocean. On July 10-15, 1989, about 60 scientists, mostly from North America and Europe, gathered at Les Arcs near Bourg-St. Maurice, France. Key scientific issues of flows through straits were discussed and nearly 40 papers were presented on experiment and theory at a NATO Advanced Research Workshop on the Physical Oceanography of Straits. Both reviews and contributed papers will be published by Kluwer in a book edited by Dr. Lawrence Pratt, Woods Hole Oceanographic Institution, who was also conference organizer.

Perhaps the most frequently discussed issue was hydraulic control. Hydraulic control occurs when the speed of the fluid approaches the speed of a gravity wave (the ratio of these speeds is called the Froude number), and thus information about the flow can no longer propagate upstream. For internal gravity waves, the wave speed is less than the flow through the constriction of many straits. Thus, the internal Froude number is one or greater.

Examples of hydraulic phenomena were offered from the recently completed Gibraltar Experiment. Oceanic straits tend to be continuously stratified, to be wide enough to show effects from the earth's rotation, and to have highly variable bottom and lateral boundaries. Additionally, the forcing (often tidal) is highly time-dependent. Because high Froude number flow is inherently nonlinear, these complicating features need careful examination. About a quarter of the papers were theoretical, usually adding one more realistic factor; e.g., time variation, to the theory.

Until recently, the oceanographic literature nearly ignored hydraulic control (nonlinear momentum terms) in straits in favor of friction as a dominant effect. In a discussion session, it became clear that friction may be too neglected in the most recent formulations. Observations show that both friction and hydraulic control play a role in straits such as Gibraltar, so it is timely to re-examine friction within the context of the nonlinear models and realistic boundaries.

The influence of straits on the adjacent oceans was illustrated with data from Lombok Strait in the Indonesian Archipelago. One of the central questions of the general ocean circulation, with relevance to present global climate concerns, is how the mass and heat budget is

balanced for the atmosphere-ocean system. At present, models and observations suggest a net flow of surface water from the Pacific Ocean to the Atlantic Ocean via the Indian Ocean. Data from Lombok suggest that 30 percent of this flow may be through Lombok, and that it is modulated by the large tropical cyclones that occur there.

Because straits may have a large signal of global importance, they are strong candidates for long-term monitoring to detect and study interannual variability and secular changes. For example, if the flow through Lombok were spread over the width of the Pacific Ocean, it would be undetectable. The strait concentrates this so-called throughflow and makes measurement feasible.

### Seventh International Congress of Marine Corrosion and Fouling

by George Loeb, Ship Materials Engineering Department, David Taylor Research Center, Annapolis, Maryland

#### Introduction

The International Permanent Committee on the Preservation of Materials in the Sea (COIPM) sponsors this series of international meetings, which take place at 4-year intervals. The 1989 meeting was held on November 7-11 in Valencia, Spain. The previous meeting was in Athens in 1984, and there was a meeting at the National Institute of Standards and Technology (formerly National Bureau of Standards) in 1972.

The COIPM is an organization originally set up by the European Economic Community to deal with marine materials problems; it is made up of organizations, rather than individuals, that send representatives to annual working group meetings at which cooperative projects are initiated. The members have access to each other's sites for exposures in the Atlantic, Gulf of Mexico, Mediterranean, and Pacific areas, including deep water sites. The U.S. Navy is represented by the David Taylor Research Center and the Naval Ocean Systems Center (NOSC), San Diego, California. The membership is open to, and includes, several universities and other government institutes.

This quadrennial meeting was organized in the tradition of the earlier meetings of the series--plenary lectures, which are attended by all participants and cover broad topics of interest to all, and sets of two simultaneous sessions: Section I on corrosion, and Section II on fouling. This year, the rising interest in biological effects on corrosion among both microbiologists and corrosion scientists resulted in several papers on this topic. They were distributed into both sections, according to the judgement of the individual authors, so it was not possible to be present at all of them. However, the Proceedings are to be published, so that the texts of the papers and the

discussions following them will be available. Unfortunately, several authors who had submitted papers, and who had been included in the program, did not appear. Whether their papers will be included in the Proceedings is unclear. However, their preprints were submitted, and copies were distributed to those who attended.

#### Plenary Lectures

The first, by Professor S. Feliu, Centro Nacional de Investigaciones Metalurgicas, Madrid, dealt with quantitation of the effect of chloride on corrosion of painted metals in marine atmospheric exposure. A correlation was found in which the log of corrosion rate was proportional to log of chloride concentration, log of hydrogen ion concentration, temperature, and rainfall. Effects were seen if NaCl concentrations exceeded a threshold value of 100mg/sq.m.

The second plenary lecture was presented by Professor Dexter, College of Marine Studies, University of Delaware, on microbiologically influenced corrosion. He pointed out that changes of pH in microscopic regions can have severe effects on both corrosion and fouling. Thus, cathodic protection generates pH values high enough to discourage many microbes, while the pH under slime films can be quite acid and so destructive. However, oxygen levels under such films can also be very low. The bacteria found at sites of localized corrosion may have been attracted to these sites by the products of corrosion reactions, rather than being the direct cause of pitting. Dexter suggested that the microbial populations causing ennoblement of large surface areas are the main cause of localized corrosion of alloys. However, by reducing local oxygen concentration bacteria might be capable of destroying passivating films. The differing chemical environments induced by biofilms can change not only the thermodynamic driving force of the electrochemical reactions involved in corrosion, but also the type of reaction that occurs. For example, the oxygen cathodic reaction, which might occur under microbial films, has a higher potential than the cathodic reaction at neutral pH. This was suggested to be at least a partial explanation of the ennoblement found on alloys that fouling films have colonized.

#### Other Fouling Section Papers

**Mussels in the Offshore Fouling of Italian Seas**, G. Relini and M. Montenari, University and Corrosion Institute, Genoa. Mussels are the predominant organisms in the highest 10 meters. In 1 year, shells up to 7 cm are frequent, and weights of 90 kg/sq.m. are found in the Adriatic.

**Interactions Within Fouling Biofilms**, K. Cooksey, Montana State University, and R. Murray, University of Kentucky (Paper not given). Bacterial metabolism could be an order of magnitude greater when diatoms are present in illuminated biofilms. Also, measurements of meta-

bolic activity could be misleading if made after samples of the biofilm are removed from the substratum. The products of algal metabolism are important in the mixed biofilms.

**Towards the Standardization of the Test Exposure Procedure in the Tropic Area**, A. Karande, Naval Chemistry and Metallurgy Laboratory, Bombay (Paper not given). The number, type, placement, and size of panels used in exposure tests is important in interpreting results. Statistical criteria can be used to determine the requirements. There is preference of hydroids for small panels, balanus for big ones, and serpulids do not seem to care. There does not seem to be any common succession pattern of macrofouling organisms: the occurrence of the larvae determines the settlement pattern. Bombay harbor gets fouling of 4 kg/sq.m. per month.

**Summary of U.S. Navy experience with modern anti-fouling (AF) paints**, A. Kaznoif, Naval Sea Systems Command, Washington, D.C. He feels that because the costs of application and removal are very high for tributyl tin (TBT) paints, there is no net/benefit to the Navy in their use. In his mind, the environmental issues are now of greater importance than performance. A test ship at Pearl Harbor, Hawaii, will evaluate nontoxic silicone formulation fouling resistant paints.

**Summary of work on high-build, rapidly dissolving copper AF paints that were effective for 36 months**, J.D. Rascio, G.A. Ciudice, and B. del Amo, CIDEPINT, Argentina. They used zinc oxide as an auxiliary pigment and found it decreased the amount of copper needed. One of the important aspects of their process was the use of CaCO<sub>3</sub>, which prevented adverse reaction of Cu with the high rosin content of these formulations, and which use a highly soluble matrix of rosin and chlorinated rubber/chlorinated paraffin. They found that they could reduce copper to 20-30 percent and feel that this formulation is similar in effect to an ablative type of coating.

**Preliminary data showing a possible route to nontoxic fouling-resistant coatings**, E. Lindner, NOSC. By using very low-surface energy fluorinated components, a material was constructed whose critical surface tension is less than that of barnacle adhesive. This is a criterion for poor adhesion. Results to date show that, at least in the short term, the surface remains resistant to attachment. Lindner also reported formulation of an organotin coating incorporating a derivative of TBT in which one of the butyl groups is unsaturated. This toxin is reported to have a faster degradation than TBT, and so may be helpful in reducing toxin loads in harbors if the ratio of effective dose to degradation rate is proper.

**Characterizations of the microbial algae of the microbial fouling film using microscopy**, D.C. Woods and R. Fletcher, Portsmouth Polytechnic, U.K. They found that there is a species dependence on the particular location on operating ships, and, using the light section micro-

scope, measured the roughness of microbial biofilms at these locations for several ships.

**Measurement of Minimum Effective Antifouling Release Rate by Membrane Perfusion Technique**, E. Gates, W.C. Banta, G. Loeb, and E. Johnson, David Taylor Research Center and American University, Washington, D.C. This membrane perfusion technique allows known amounts of AF agents, and combinations of agents, to be released from surfaces immersed in seawater, thus simulating an AF paint system without the need for formulating paints. The release rates could be varied and accurately controlled, allowing the minimum effective release rate for a particular organism in its local environment to be determined.

**Fouling Preventive Sponge**, B. Wolfrath and D. Barthel, Institute für Meerskunde, Kiel, Federal Republic of Germany. The sponge they worked with did not seem to be fouled. They found that this sponge seems to prevent fouling on its surface by periodic peeling of its outer surface. No chemical or other AF mechanism was noted.

**Corrosion Rate of Copper and Antifouling Activity**, H. Shimada, Nippon Steel Corporation, Japan. Alloys of copper and other metals were prepared and evaluated with respect to corrosion rate of copper and antifouling activity. An alloy containing Mn showed good antifouling activity, while Fe and Si alloys did not. The fouling alloys formed surface films of FeS, Fe<sub>2</sub>O<sub>3</sub>, and Mn<sub>2</sub>O<sub>3</sub>. The nonfouling alloys had surface films of Cu<sub>2</sub>O, Cu<sub>2</sub>(OH)<sub>3</sub>-C1, Mn<sub>2</sub>O<sub>2</sub>, and Cu(OH)<sub>2</sub>CuCl<sub>3</sub>. The Mn<sub>2</sub>O<sub>2</sub> was said to stabilize the Cu<sub>2</sub>(OH)<sub>3</sub>-C1 film.

**Summary of work on dissolved organic matter that enhances adhesion and aggregation of the microalga *Chlorella***, T. Tosteson, University of Puerto Rico. Seasonal differences and immunological specificity of adsorption to different surfaces has been demonstrated for these naturally occurring polymers found in ocean waters, which are related to materials formed in laboratory cultures of aquatic bacteria and microalgae.

**A Method for Sterilization of Seawater**, B. Little, Naval Oceanographic and Atmospheric Research Laboratory, Bay St. Louis, Mississippi. This paper described a method for seawater sterilization developed with the late Professor S. Gerchakov which, unlike autoclaving, one does not perturb the chemistry of seawater; it involves a combination of microfiltration and pasteurization.

#### Corrosion

I did not spend as much time at the corrosion section. However, it is clear that all laboratories dealing seriously with corrosion and its prevention, whether by coatings or inhibitors, are developing their capabilities in modern electrochemical methods--impedance spectroscopy and electrochemical noise measurements.

E.G. Bellinger, Department of Environmental Biology, University of Manchester, U.K., presented a paper

that fell between the two areas. He discussed using microelectrodes to sense parameters such as pH and oxygen concentration within a microbial biofilm fouling layer. They found pH values varying from 4 to 11 depending on the state of the biofilm, and oxygen varying from supersaturated when algae are actively metabolizing to zero under films of nonphotosynthesizing organisms. These values indicate that the nature of the corrosion processes can be very different for chemical reasons in the presence of biocolonization in agreement with Dexter's suggestion.

One of the speakers who was delegated to summarize the meeting remarked that it was evident that the trend in fouling and corrosion research is less towards the descriptive and more towards studies of mechanisms and details of interactions. The overlap of biofouling and corrosion is also becoming more evident, as studies of microbially influenced corrosion demonstrate.

### Advances in Cryogenic Wind Tunnel Technology

by Michael R. Smith, Department of Physics, University of Oregon  
Introduction

The lecture course, "Advances in Wind Tunnel Technology," sponsored by the von Karman Institute of Fluid Dynamics, was held June 5-9, 1989, in Brussels, Belgium. This was the third such course in 9 years; the last was in Brussels in 1985. There were approximately 69 attendees (some were lecturers) representing nearly all major wind-tunnel facilities in Europe, Britain, and the U.S.

All presentations were serial (no parallel sessions), and averaged approximately 1.5 hours each. Though it was called a lecture course, and there was certainly quite a bit of basic and instructional information presented, I suspect that the bulk of the material content was such that it would have been arguably more proper to call it a meeting or conference. Over half of the papers seemed to be geared heavily toward documenting individual facilities' progress in areas of activation, facility modification, or operational streamlining. Additionally, much of the material did not truly stand alone, but had the distinct flavor of a follow-up report. However, there was still plenty of basic instructional or technically exciting material presented that appealed directly to me. In the next section, I will touch on a fairly random sampling of some of the more interesting sessions and material.

#### Course Content

One device that I found very exciting is the so-called *smart* or *adaptive* wall technique. In a two-dimensional (2-D) tunnel, the shape of the tunnel walls is made to conform to the streamlines surrounding the model. This is done by measuring the pressure distribution along each

boundary, then adjusting the shape of the boundary so that the integrated pressure distribution goes to zero. Some iteration is required, along with a bit of on-line computer modeling. Though there is still effort being directed at refining this technique, it is currently being employed at many production and academic facilities; e.g., the NASA 0.3-meter tunnel and a similar tunnel at the University of Southampton U.K., respectively. This may be old news, but in my viewpoint, it seemed very clever.

The problem of locating the transition from laminar to turbulent flow along an airfoil has remained one of the more difficult problems in wind-tunnel testing for many years. Maurice Bazin, ONERA/GME, France, is trying to develop a technique for locating this transition point by infrared (IR) scanning. The basis for this is that the flow transition corresponds to a change in the adiabatic wall temperature, and thus a temperature discontinuity at the point of transition. The IR scanning has a long and successful history in physics. In fact, Dr. Russell Donnelly, University of Oregon, proposed such a technique some time ago. He has had a lot of experience with IR scanning, and in 1975 was involved in a project that used the technique to successfully measure the temperature of Saturn's rings.

At several points, there was some discussion of surface flow visualization techniques, but conspicuously absent was any but the most cursory reference to full 2- and 3-dimensional (3-D) flow-field visualization. Admittedly, this is a problem without a truly satisfying solution. There are many efforts underway to develop such techniques as 2- or 3-D particle tracking, laser speckle velocimetry, pulsed laser velocimetry, and holographic flow visualization. Still, none is anywhere near production use. Other persistent problems faced by the cryogenic wind tunnel community include maintaining a set temperature/density in the test section; inability to model the highest Reynolds Numbers achieved by modern aircraft and ships, separating out the aerodynamic effects of the sting from the model test data; and getting model pressure data past the force balance without creating undesired load paths. This last point is most properly addressed by the research efforts of Dr. Ralph Scurlock, University of Southampton. (I will discuss this in more detail later.) The other problems can be substantially reduced by changing the working medium from low temperature air/nitrogen gas to liquid helium. This brings me to our group's proposal, and the subject of my own presentation at the conference.

#### **A Liquid Helium Wind Tunnel**

An examination of the properties of superfluid He II (the liquid phase present below 2.172°K) quickly highlights many of the advantages of this medium. For example, the kinematic viscosity is approximately 1,600 times less than that of air, and the thermal conductivity is,

for all practical purposes, infinite. Thus, a modest-sized academic prototype facility (no more than 30x15 ft with a 0.3-m test section) could reach a maximum Reynolds Number of  $10^9$  ( $10^7$  per cm) with a power consumption of no more than 124 kW. The large thermal conductivity means extremely uniform, easily controlled temperature and density. We have had years of experience doing this sort of work.

Since the projected temperature is approximately 1.6°K, a superconducting magnetic force balance is a natural choice for lift and drag measurements. This technology is just now coming into production and eliminates the sting and all the problems of separating its associated aerodynamic effects from the data.

Regarding flow visualization, He II (through its associated quantum mechanical phenomenology) offers the possibility of direct, nonintrusive measurement of the vorticity. This measurement employs techniques that have been successfully used in our laboratory for many years. This could be very beneficial in characterizing vortex shedding behind a model. The other flow visualization techniques currently being developed will certainly be as easily applied to liquid helium tunnels as to the more conventional tunnels in use today.

Before about 2 years ago, there was significant doubt about how He II behaves at high Reynolds Numbers. If, after all, it does not behave classically, there is little point in using it in a wind tunnel to study classical flow fields of the sort created by aircraft. However, evidence has recently begun to filter in that indicates that He II does in fact behave classically at high Reynolds Numbers. The ratio of specific heats is still wrong for transonic flight tests, but the Mach Number in the liquid is so low (even at the highest Reynolds Numbers) that compressibility effects are completely negligible.

A fair and complete presentation of the full spectrum of advantages and disadvantages is too great an undertaking for this article, but will be discussed again in detail at a special conference on the subject to be held in October 1989 in Eugene, Oregon.

#### **Course Summary**

Though many of the talks were geared to the facility management and activation end of things, there were still many opportunities to gain first-hand information about the sorts of control and performance problems that wind tunnel users now face, as well as the types of performance curves a user likes to see on a particular tunnel in evaluating its capabilities. Many of these problems; e.g., eliminating undesirable temperature and density fluctuations, would be simplified considerably in a liquid helium tunnel. Currently, revolutionary concepts; e.g., *adaptive* or *smart* walls, miniaturized onboard electronics, and magnetic suspension systems, hold much promise for use in the proposed liquid helium wind tunnel.

### Related Meetings

After the conference, Richard Wiener and I went to the University of Southampton to collaborate further with two conference attendees, Drs. Mike Goodyer and Ralph Scurlock. First, we met with Dr. Goodyer, who showed us a computer-controlled magnetic suspension system suitable for use in a 0.3-m tunnel. Position control was maintained by a laser beam that cast shadows on a series of optical arrays. The apparatus was rather bulky, but going to superconducting technology would help substantially. Afterwards, we toured several operating tunnels, the most notable of which served as a working example employing the concept of adaptive walls.

We then visited Dr. Scurlock where we spoke at some length about the problems of designing a high-volume superfluid pump. Dr. Scurlock also showed us what he felt was a rather cursory study on the subject of liquid helium wind tunnels, which one of his students had produced several years ago before very much was known about the nature of high Reynolds Number flow in He II. Dr. Scurlock then took us through his laboratories. The most fascinating research involved miniaturizing the electronics required to convert pressure data taken off multiple sensors onboard a model, into a digital signal, and either storing it for later retrieval or transmitting it real time via a single wire. This is a great improvement over current techniques whereby the many wires required to carry pressure data off the model must bypass the force balance, creating undesired load paths, which decrease the balance's accuracy. With the advent of gallium arsenide semiconductors, in the next few years such technology may ultimately find application in our proposed tunnel.

### Advanced Research Workshop on Robots and Biological Systems

by Dr. W.S. Vaughan, Jr., Office of Naval Research, Arlington, Virginia

#### Introduction

The NATO-Sponsored Advanced Research Workshop on Robots and Biological Systems Workshop, held at Il Ciocco, Tuscany, Italy, on June 26-30, 1989, was organized to explore the potential of biological models to robotic systems and promote the interaction between roboticists and neuroscientists. The idea that biological models will provide the basis for a new generation of robotic devices is central to the program of research in the Cognitive and Neural Sciences Division (Division). I was one of 60 invited participants, and I cochaired one of the seven technical sessions with Neville Hogan.

The 60 participants included 30 American and Canadian scientists, and 30 European, Japanese, and Israeli researchers. Foreign country scientists whose research is

most closely related to the Division's interests and who will be key points of contact for future coordination are the following:

- Dr. Masuo Aizawa, Department of Bioengineering, Tokyo Institute of Technology, Tokyo, Japan
- Dr. Paolo Dario, Scuola Superior S. Anna, Pisa, Italy
- Dr. Tamar Flash, The Weizmann Institute of Science, Rehovot, Israel
- Dr. Danilo De Rossi, University of Pisa, Pisa, Italy
- Dr. Giulio Sandini, University of Genoa, Genoa, Italy
- Dr. Atsuo Takanishi, School of Science and Engineering, Waseda University, Tokyo, Japan
- Dr. Gabriele Vassura, University of Bologna, Bologna, Italy

The scientific program was organized into four topical areas: Visual and Tactile Perception, Motor Control in Manipulation, Locomotion in Legged Robots, and New Design Technologies.

#### Visual and Tactile Perception

Ruzena Bajcsy, University of Pennsylvania, called attention to the recent shift in interest from passive to active perception in both visual and tactile domains. She illustrated the shift in her laboratory studies of exploration-based perception in the context of a disassembly task; the robot sensory systems systematically explore arbitrary objects for cues about how it might be taken apart.

Dana Ballard, University of Rochester, followed this theme with an experimental study in visual scene analysis. Eye tracking revealed different patterns of eye movements when a given scene was viewed by subjects with different instructions; e.g., guess the ages of the people in the scene, remember the spatial locations of the men in the scene.

#### Motor Control in Manipulation

Current robotic end-effectors are vise grips or special purpose tools; multi-fingered robotic hands of various design exist in a few university laboratories, and their functionality is seriously limited by lack of tactile sensors, appropriate actuators, and control strategies. Dr. Vassura emphasized the need for micro-motion analyses and micro-kinematic descriptions in dexterous, whole-hand manipulation. He showed interesting videos of human and robotic hands performing a variety of manipulative tasks, and described the design of the mechanical fingers relative to human fingers.

William Townsend, MIT, described the mechanical design of a device for whole-arm manipulation based on his work with Ken Salisbury and the three-fingered Salisbury hand. Neville Hogan, MIT, asserted that contact stability is a major unresolved problem in robotics and a prerequisite for dexterous manipulation (see *ESNIB 90-01:39-48*).

Kazuo Tanie, MITI, Japan, described his studies of compliance control that achieves contact stability in a two-fingered robotic hand. Hand design includes tension differential torque sensors at the finger joints and compliance-adjustable joints that satisfy stiffness requirements at the fingertips when grasping an object.

One problem in robotics, trajectory planning, and execution in reaching, appears solvable by neural network processors. Michael Jordan, MIT, described a network for a robotic arm that learns its own dynamics over several hundred trials at reaching for targets in its workspace. The network develops a kinematic model of the arm, then uses the model to solve inverse problems in reaching for new targets.

#### Locomotion in Legged Robots

Jack Todd, University of Edinburgh, U.K., reviewed locomotion in biological systems, noting the enormous variation in number of legs, their length and configuration, gaits and footpad design. He called attention to the use of a flexible trunk or tail for balance in several biological models.

Dr. Takanishi then described the implementation of a two-legged, anthropomorphic robot that used an elongated body trunk for balance in unsupported walking. Using trunk angle stabilization, the robot walks in 0.3-meter step lengths at a rate of 0.8 seconds per step. The control method includes an algorithm that computes the balancing motion of the trunk automatically from the motion of the lower limbs and a time trajectory of a zero-moment point planned before the robot begins walking. Recent work in the Waseda University laboratory is developing control algorithms that enable the robot to adjust gait in response to external forces.

#### New Design Technologies

This session included papers describing current progress of research into biologically inspired technologies applicable to robotics: flexible manipulator arms and grippers, muscle-like actuators, and retina-like visual sensors. James Wilson, Duke University, described the technical characteristics of elephant trunks and squid tentacles that make them appealing design candidates for flexible manipulators and grippers when emulated as convoluted polyurethane tubes with pressure-controlled bending. Wilson described experiments that show how these fast-acting and lightweight flexible devices can be used to grasp, lift, and manipulate a variety of objects.

Dr. De Rossi reported progress on the development of gel-like polymers that can be electronically activated to stretch and contract. Pairs of these actuators can be configured as agonist/antagonist muscles and made to control a joint or end effector.

Dr. Ario described recent research using shape memory alloys as actuators. These alloys can be trained to assume two distinct shapes according to its temperature. Shape changes can drive joint angles, and this was illustrated in the Hitachi Hand for finger control.

Dr. Sandini described a chip based on charge-coupled device technology that mimics the sampling structure of the human retina. The chip design consists of 30 concentric circles of photoreceptors whose spatial density decreases linearly with distance from the center (fovea). The chip is a space-variant visual sensor which, like the human retina, has the property of high resolution at the center of gaze, and yet wide field of view for detecting the presence of "interesting" events in the periphery.

#### Unusual Observations and Happenings

The extraordinary statement was made by one scientist and confirmed by a second, that the Japanese anticipate a society evolving in Japan during the 21st century that will be 50 percent robots. Their emphasis on anthropomorphic robot design is to ensure compatibility with work places, homes, and transportation systems that the robots will share with humans.

#### References

ESNIB 90-01:39-48.

#### Proceedings Are Available

by M.M. Rao, Department of Mathematics and Computer Science, University of California, Riverside

Proceedings of the 1989 International Conference on Recent Developments in Statistical Data Analysis and Inference (held in Switzerland) were published by North-Holland, Amsterdam, and are available in the U.S. from:

Elsevier Science Publishing Company, Inc.  
655 Avenue of the Americas  
New York City, NY 10010

## ONREUR REPORTS AND MAS BULLETINS

### MAS Bulletins

The following Military Applications Summary (MAS) Bulletins were published between 26 February and 9 March 1990. The MAS Bulletin is an account of accomplishments in European naval research, development, and evaluation. Request copies by number from ONREUR.

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| <p>1-90 Pyrocool: The Generation of High Purity Gas from Solids</p> <p>2-90 Royal Ordnance Develops New Signal Flare Kit</p> <p>3-90 Explosive Cutting Tape - ROECT</p> | <p>4-90 Submarine Communications Multi-Function Antenna</p> <p>5-90 Submarine Communications and Navstar Antenna</p> <p>6-90 Submarine Communications Low Profile Antenna</p> <p>7-90 Expendable Communications Buoy</p> <p>8-90 Submarine Integrated Communications Mast</p> <p>9-90 14th International Pyrotechnics Seminar Proceedings</p> <p>10-90 SIMRAD Subsea Split Beam Transducer for Phase-Angle Measurements in Narrow Beam Sonars</p> |
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## REPORTS ON EUROPEAN SCIENCE AND TECHNOLOGY FROM OTHER COMMANDS

### Reports

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

**EOARD** - European Office of Aerospace Research and Development, Box 14, FPO New York 9510

*Materials Chemistry*, by LTC Chet Dymek, EOARD. (15 pp) [EOARD-LR-89-071]

High-temperature thermodynamics of transition metal alloys is the main area at the Laboratoire de Thermodynamique Chimique et Metallurgique, Nancy, France. They are working in measurement of standard free enthalpies of oxidation of pure or alloyed metals using the point electrode technique, solid ceramic/solid metal interface chemistry, and relaxation processes in ceramics. At the Laboratoire de Chimie du Solide Minérale, the work includes high-temperature oxidative protection, chemistry at metal and ceramic grain surfaces, and thermodynamics of the protective coatings applied to Ni superalloy turbine blades. At the Laboratoire de Chimie-Physique Macromoléculaire, work in membrane fractionation techniques and oligopeptide conformations was briefly described.

*II-VI Compound Conference 89*, Dr. Eirug Davies, EOARD. (6 pp) [EOARD-LR-89-072]

The II-VI Compound Conference 89 was held in West Berlin and attracted around 350 participants from 25 countries. Primary coverage was given to the very wide-band gap materials suitable for blue emission and the narrowband gap alloys used in infrared detectors. A resurgence of interest is occurring with the wideband gap materials as a result of conduction type conversion being supposedly achieved in ZnSe. This is particularly significant because it is this failure to produce p-n junctions that has traditionally inhibited progress in developing blue emitters. Several papers are summarized concerning the issue of type conversion in ZnSe.

*"Metals Fight Back" Conference*, by LTC James G.R. Hansen, EOARD. (16 pp) [EOARD-LR-90-002]

Held in London in October 1989, this conference was highlighted by presentations from three British companies. Rolls Royce discussed using the emerging alloys--IM1834 titanium and U720 nickel superalloy--for turbine engines. Alcan presented their spray deposited aluminums, and Magnesium Elektron stressed their new WE43 cast magnesium alloy and their new EA55 rapidly solidified magnesium alloy.

*Narrowband Gap Semiconductor Activities*, by Dr. Vince Donlan, EOARD. (3 pp) [EOARD-LR-90-003]

The National Institute of Applied Science (Institute) in Rennes is one of four so-called French institutes. The Institute is relatively small (staff of around 100) and conducts research in Computer Sciences, Electronic Engineering (robotics), Civil Engineering, and Physical Engineering. Included in the latter area is a strong effort devoted to characterizing narrowband gap semiconductors. Current work is directed at establishing HgZnTe as a more stable alternative to HgCdTe in infrared detectors.

*University of Birmingham, School of Metallurgy and Materials*, by LTC James G.R. Hansen, EOARD. (18 pp) [EOARD-LR-90-004]

Professor Loretto heads what is probably the largest U.K. university research program in titanium composites and titanium aluminides. A British government-funded, \$17-million Interdisciplinary Research Centre at the University of Birmingham will stress titanium and titanium aluminide research. As a result, research will become even stronger in the future. Current research shows great promise for a metal matrix composite using TiC powders in a titanium alloy matrix, while the same powders in a titanium aluminide matrix are probably too reactive. Other research is aimed at understanding and improving the ductility of titanium aluminides. There may be great potential for increased ductility via high-purity titanium aluminides.

*SAFT Advanced Battery Division*, by Dr. Vince Donlan, EOARD. (7 pp) [EOARD-LR-90-007]

The SAFT company of France, a member of the Compagnie Generale d'Electric group, develops and produces special purpose (non lead-acid) batteries for aircraft, missiles, spacecraft, computers, and telecommunications. In this report, the product lines of the four SAFT divisions--portable battery, advanced battery, energy, and industrial battery--are described briefly, as are current research projects on rechargeable lithium, high-discharge rate liquid cathode Li/SOCl<sub>2</sub>, and portable Ni/H<sub>2</sub> batteries.

*Matra Espace in Velizy-Villacoublay, France*, by Dr. Vince Donlan, EOARD. (12 pp) [EOARD-LR-90-008]

Matra Espace, the space and defense sector of the Matra company, has its head offices and research and development center in Velizy-Villacoublay, France. The main integration facilities are located in Toulouse. Since the 1970s, Matra has been involved in 30 space programs--from Meteosat to SPOT 4. Data sheets on some past programs and brief descriptions of some current programs are included in this report, including an optical space communications transceiver and a LADAR sensor for spacecraft rendezvous.

*Laser Research in Milan*, by Dr. Stacey Lazdinis, EOARD. (7 pp) [EOARD-LR-90-016]

A summary is provided about the work performed by the Laser Systems and Processing Section, Electro-Optics Department, Italian Electricity Generating Board, Segrate, Italy. Dr. Alberto Sona heads the department. Detailed description is provided about the efforts in basic optics, solid-state lasers, high-power industrial CO<sub>2</sub> lasers, laser materials processing, and the development of sophisticated optical instrumentation.

*Chemistry Research at the University of Sussex*, by LTC Chet Dymek, EOARD. (17 pp) [EOARD-LR-90-013]

The University of Sussex is in the top tier of U.K. universities. The Chemistry and Molecular Sciences Department is well equipped and has outstanding scientists on its staff. Research includes pioneering work in the structure and chemistry of room temperature ionic liquids and new nonlinear optical materials with high second harmonic generation activity. There are also excellent programs with plans for research into the formation of novel polyacetylenes and precursors and intermediates to silicon nitride ceramics with multifunctional properties. Sussex University probably has the largest and best-equipped laboratory in the U.K. to study the properties and chemistry of what is essentially a new phase of matter; i.e., clusters.

## THE EMBASSIES: TECHNOLOGY ROUNDUP

### Federal Republic of Germany

For further information on FRG items, contact Mr. Edward M. Malloy, Science Counselor, American Embassy, Bonn, APO New York 09080-7400.

#### Federal Republic of Germany High-Temperature Superconductivity Research Update

**Background.** In compiling this information on German High-Temperature Superconductivity (HTS) research, Drs. Von Stackelberg and Dietrich at the BMFT were contacted. Dr. Von Stackelberg likened the approach to HTS research to a staircase having continuous, deliberate, upward steps. Other information seems to substantiate that analogy. The research appears to be conservative, methodical, and thorough while funding increases over the past 5 years have been substantial and consistent.

According to the Bundesministerium für Forschung und Technologie [Federal Ministry for Research and Technology] (BMFT), there are currently about 80 different groups (about 500 scientists) working on HTS projects in the Federal Republic of Germany (FRG). In 1987, there were about 70 groups working on this subject.

**Funding.** The BMFT has launched a 5 year, DM 390-million (\$210 million) funding program for HTS. Between 1989 and 1995, following amounts will be allocated yearly: 1989 - DM 35 million, 1990 - DM 45 million, 1991 - DM 50 million, 1992 and 1993 - DM 55 million, and 1994 and 1995 - DM 75 million each. This steady, continual increase in funding shows BMFT's continuing interest in HTS.

The BMFT provides 100 percent of the funding for authorized university projects, and underwrites up to 50 percent of the costs on corporate research projects. The BMFT's goal is to bring superconductor technology up to a level where it can be economically and effectively applied as soon as possible.

**The BMFT's Role.** According to Von Stackelberg, the BMFT-sponsored HTS research program is the only national program. He noted that only research projects that fit into the "integrated research program" (Verbundforschung) are funded.

The BMFT coordinates the work of all the different participants so that there is no duplication of effort, and refers to this as their "interdisciplinary" approach. The BMFT is also very active in distributing and exchanging information among the various research groups. According to Van Stackelberg, cooperation between university and cooperate research projects "has been very good from the beginning." He continued by saying that since

the BMFT coordinates the various research projects, there should be (and is) no problem of university research not eventually being useful to corporations.

**Research Goals.** Research activities in the FRG center on:

- Preparing technology regarding the reproducibility and homogeneity of HTS compounds
- Optimizing critical characteristics of compounds with respect to high-current intensities (larger than one million amp/sq cm) and intensive magnetic fields
- Stabilizing the relevant material characteristics against chemical and physical influences
- Developing suitable and cost-efficient process technologies for the microstructuring and manufacturing of thin films as well as conductors.

More specifically, priority research activities will include:

- Synthesizing new compounds with high-temperature superconductivity behavior
- Theoretical investigating and experimenting leading to a better understanding of the mechanisms of high-temperature superconductivity
- Preparing chemically stable solid materials and thin films
- Improving the specific criteria of superconductivity compounds with respect to their technical application and commercialization
- Developing measurement technologies based on superconductivity
- Investigating new uses for superconductors.

**Detailed Research Goals.** Theoretical and experimental basic research focuses on the theory of electronic and crystalline structures, the isotope effect, the determination of the specific thermal capacity, and the temperature dependency of the superconducting energy gap. Also being investigated is the determination of the intrinsic material parameters of single crystals or single-crystalline films, pointing to the development of new theoretical concepts and their experimental approval.

In the field of preparation and characterization of solid materials, research concentrates on the systematic search for new superconducting materials. Other research objectives are the investigation of single crystals, the preparation and chemical characterization of superconducting ceramic materials, and to the preparation, physical characterization and spectroscopy of HTS materials. Research on preparation and characterization of thin films covers the development of basic technologies, such as their creation of superconducting yttrium-barium-cop-

per-oxygen (y-ba-cu-o) films on zirconium-yttrium oxygen (zr-(y)-o) and strontium-titanium-oxygen (sr-ti-o) substrates by cavity cathode magnetron sputtering, as well as the creation of superconducting films by diffusion and laser vaporization. Other priority research goals are: the development of advanced thin film technologies for oxidic HTS materials, such as creation of plasma-sprayed HTS films; the creation of thin yk-ba-cu-o films on several carrier materials; the investigation of the physical and mechanical characteristics of single crystals and thin films of oxidic superconducting materials; and the development and construction of a plasma deposition facility.

Research is being carried out to better understand the mechanisms of HTS materials, concentrating on macroscopic and atomic material structures of various HTS substances, as well as their structure-related characteristics.

Research work is also being done on the microstructuring and forming of current-conducting components. This involves developing HTS filaments, microstructuring and measuring the critical current density of thin y-ba-cu-o layers, and developing Josephson elements based on oxidic superconductors. The first steps of application-related research focus on investigating high-frequency characteristics of the y1-ba2-cu3-07 superconducting material, the y-ba-cu-o films, and developing field effect inductor-based technologies of high-temperature superconductors for application in the energy sector.

**Promising Participants.** Drs. Dietrich and Von Stackelberg seemed to feel that VAC, a wholly owned subsidiary of Siemens, is particularly active and productive. They also mentioned AEG, Dornier, and ABB. Hoechst is working with several smaller firms on ceramic technology, which also appears to be promising. The Max Plank Institute continues to be the most important institute involved in the HTS project.

The overall level of research and equipment used in German HTS research appears to be as high as possible. Von Stackelberg pointed out that the steady and substantially increasing budget allows the research to be "at the very highest levels." He also said that "the Japanese and Americans don't know anything we don't know." Admitting that the Japanese and Americans had indeed been very successful, Von Stackelberg felt that they were no more successful than the Germans.

#### **Major Government-Supported R&D Organizations in the Federal Republic of Germany**

In the Federal Republic of Germany (FRG), the federal and state (Laender) governments provide roughly one-third of the R&D funds. The remaining two-thirds are provided by private industry. Governmental support for basic and applied research is channeled mainly through four organizations: the German Research So-

ciety (Deutsche Forschungsgemeinschaft [DFG]), the Max Planck Society (Max-Planck Gesellschaft Zur Foerderung Der Wissenschaften [MGP]), the Fraunhofer Society (Fraunhofer Gesellschaft [FHG]) and the Association of Science Establishments (Arbeitsgemeinschaft der Grossforschungseinrichtungen [AGF]).

The OFG and MPG are both independent organizations that support basic research and receive federal/state government funding. The resemblance, however, ends there. The MPG is the coordinating body for the 60 Max Planck institutes. Twenty-nine of these institutes specialize in biology and medicine; 21 in chemistry, physics, and technology; and 10 in humanities. In 1988, the Federal Ministry for Research and Technology (BMFT) contributed roughly \$300 million to the MPG, and the state governments about another \$250 million. Another \$50 million comes from membership fees, donations, and patents. In contrast to the MPG, the DFG provides research grants to individual scientists for specific projects, ninety percent at German universities. The Federal Ministry for Education and Science provides over 60 percent of a total budget of about \$500 million, with the rest coming from the various state governments.

Applied research is the basic goal of the FHG, the coordinating body for the 35 Fraunhofer Institutes. These institutes work closely with industry to facilitate the transfer of research results into production processes. Industry, through contracts, provides over half the annual income of the Fraunhofer Institutes (nearly \$350 million). The BMFT and the state governments provide about 90 and 10 percent of the total budget, respectively.

The AGF coordinates the work of the 13 large science establishments. The main function of these institutes is to carry out R&D in the natural sciences and engineering that requires substantial financial resources and manpower. Among these establishments are some of the country's most famous scientific institutes: Nuclear Research Centers in Juelich (KFA) and Karlsruhe (KFK), German Aerospace Research Center (DLR), German Electron Synchrotron (DESY), and Society for Mathematics and Data Processing (GMD). The BMFT and the states (with research centers) provide 90 and 10 percent of the budget, respectively, amounting to nearly \$1.5 million per year.

In addition to the above organizations, the Federal Economics Ministry promotes industrial R&D through financial support to the confederation of industrial research associations (Arbeitsgemeinschaft Industrieller Forschungsvereinigungen [AIF]). The AIF has 90 member associations, which represent nearly all branches of German industry. Finally, world famous for its support of scientific exchanges, is the Alexander Von Humboldt Foundation. The Foreign Office provided about two-thirds (\$33 million) of this foundation's 1989 budget of DM 57.4 million.

## Science and Technology in the Federal Republic of Germany

**Cooperation with the German Democratic Republic.** In early 1990, FRG and German Democratic Republic (GDR) officials will meet to discuss further projects included in the FRG-GDR agreement on scientific cooperation. There are already 27 projects underway in energy research and technology, reactor safety, basic research, environmental research, water pollution, flue gas treatment, forest damage, and medical research. New programs are expected in environmental protection (11 projects identified), biological procedures, biotechnology research, and the development of data processing for materials flow and logic systems. The total new project expenditures is expected to be 660 million DM (FRG) and 1.13 billion EM (GDR).

**Cooperation with Bulgaria.** Under the February 1988 Science and Technology (S&T) agreement with Bulgaria, 21 projects have been completed thus far, primarily in nuclear basic research, nuclear safety, ship building, materials research, chemistry, regulation and production technologies, biotechnology, and philosophy. In the FRG, active participants have been universities, Max Planck Societies, large science establishments and federal institutions, such as the Federal Health Office, Federal Institute for Material Testing, and Physics and Technology Federal Institute. For the most part, cooperation has consisted of exchange of scientists and joint seminars for the preparation of research programs.

**Cooperation with Yugoslavia.** The FRG has had cooperative agreements with Yugoslavia, which included S&T, for 20 years; 80 projects have been completed thus far. These projects were primarily in environmental research, biotechnology, energy and reactor safety research, marine research, production and materials technology, as well as medicine, urban transportation, and raw materials.

**Cooperation with Brazil.** In the 1970s, cooperation with Brazil focused mainly on nuclear energy programs, but it has since expanded into joint R&D programs for industrial development through effective technology transfer.

Cooperation covers programs in physics, mathematics, data processing, electronics, materials research, geology, marine and polar research, and life sciences. The FRG Ministry for Research and Technology has also initiated program planning in ecology, mainly for the protection of tropical rain forests, as well as projects in marine research, biotechnology, and solar energy.

**Change in Presidency of the Humboldt Foundation.** On November 3, 1989, Professor Reimar Luest, Director General of the European Space Agency (ESA) became President of the Alexander Von Humboldt Founda-

tion, succeeding Professor Wolfgang Paul (a recent Nobel Prize winner), who had been President since 1979 and is now Honorary President of the Humboldt Foundation. Professor Luest studied physics at Goettingen and was a Fulbright Scholar in the U.S. in 1955. He was named Scientific Director of ESA in 1962 and later became Vice President. While Director of the Institute for Extraterrestrial Physics and Astrophysics at the Max Planck Society in Munich-Garching, Luest lectured at the University of Munich and Technical University. He was Chairman of the Scientific Advisory Council and President of the Max Planck Society for 12 years.

**New Name for KFA Juelich.** As of January 1, 1990, the Kernforschungsanlage (Nuclear Research Institution), Juelich assumed the name Forschungszentrum (Research Center), Juelich. This change reflects the Juelich facility's diversification in the past years into research in materials, environment, and information technologies.

**Berlin Hahn-Meitner Institute.** The Federal Ministry for Research and Technology (R&T) has made 18.5 million DM available to the Hahn-Meitner Institute in Berlin for materials and solar energy research. The intent is to develop the institute into a focal point for German research in active solar technologies.

**Clean Air Laboratory.** The largest clean air laboratory for applied research at the European University has recently been inaugurated at the Berlin Technical University. The laboratory, constructed at a total cost of 52.6 million DM, will be equipped with the latest technology and allocated six new professorships and 100 positions.

**Ozone Measurement by Laser.** The Minister for R&T has approved a 1.3 million DM research project to measure the ozone layer at the North Pole with a special laser instrument. The new procedure was developed by Dr. Karl-Heinz Fricke and Professor Ulf Von Zahn from Bonn University's Physics Institute. They will lead a delegation of Bonn students to work at the Geophysical Observatory on the Island of Andoya, northern Norway. The project will consist of studying temperature and aerosol content in cloud particles at 10 to 50 kilometers altitude in order to investigate the destruction process of the ozone layer.

In 1991, the scientists intend to establish a routine measurement program at the Andoya station, which lies approximately the same distance from the North Pole as the Georg-Neumayer Station from the South Pole. Professor Von Zahn believes that establishment of a permanent manned research center in the Arctic, similar to that in Antarctica, would be highly beneficial. At present, he believes that destruction of the ozone layer is proceeding more slowly at the North Pole than at the South Pole, but

he does not believe that this trend will necessarily continue into the future.

**Test Installation for Lignite Gasification.** The Rheinische Braunkohlenwerke AG in Wesseling recently began operating a fluidized bed test installation for the gasification of lignite. The firm considers the installation to be a "most important step on the path towards a new generation of lignite power stations." The station combines gas and steam turbines to increase efficiency and reduce hazardous waste exhaust. Instead of incinerating, the power station transforms lignite under pressure into combustion gas. This process cost effectively separates waste exhausts and is 25 percent more efficient than conventional turbine power stations. The Ministry for R&T contributed more than 300 million DM to develop fluidized bed and lignite gasification technologies.

**Test Installation for Plastic Recycling.** The Volkswagenwerk AG at Wolfsburg is building a test installation in Leer to recycle plastic from scrap automobiles. According to Professor Christian Voy, Head of the VW Research Center, the objective is to develop methods to recycle as much plastic waste from automobiles as possible. During the past few years, the amount of plastic in automobiles has increased from 10-20 kg/car to 80-100 kg/car. In the FRG, about 1.8 million cars are scrapped annually.

**Recycling of Waste Oils.** A sodium process for recycling of chloride-contaminated industrial oils was successfully tested at an installation established in 1988 in Lille, France. A second installation to recycle PCB-containing transformer products using the same process recently went into operation in Lille. Installations using this process are in various stages of planning and licensing in the FRG. The sodium process is considered a problem-free method for turning chlorine contaminants, such as hazardous dioxins and polychlorinated biphenyls, into common salt and nontoxic polymers. This could relieve the problem in the FRG caused by insufficient incinerator capacity, as well as conserve raw materials.

**Waste Repository Sanitation.** There are an estimated 50,000 contaminated waste repositories and industrial production areas in the FRG. The cost for cleanup of the approximately 6,000 most contaminated sites is expected to run into the double digit billion range.

The Ministry for R&T funds 100 research projects at a cost of DM 84 million to promote developing new technologies and methods for registration, evaluation, and sanitation of abandoned waste repositories. The priorities of the research efforts are:

- Testing sanitation techniques to determine practical application and dependability
- Soil recycling and returning sites to their natural state

- Controlling sites to evaluate the results of sanitation methods.

**Modernizing Wastewater Treatment Plants.** The Federal Cabinet has adopted Federal Minister for the Environment Dr. Toepfer's recommendations to strengthen industrial water purification legislation. These regulations cover 17 industries, including lignite and briquet fabrication, dairies, breweries, glass, and soda producers. These industries will be required to use water purification measures to eliminate nitrogen, phosphorus, hazardous heavy metals, and halogen compounds in effluent. The cabinet had previously adopted stricter regulations for community sewage plants, as well as for cellulose industries, metal processing plants, power stations, and waste incineration plants. The modernization of water treatment plants by industry will cost approximately 15 billion DM.

**Improvement of Radioactive Waste Management.** The Karlsruhe Nuclear Research Center placed into operation a new installation for incineration of radioactive research, medical, and industrial wastes. The 33-million DM installation is equipped with the latest incineration and flue gas purification technologies. A blast furnace, equipped with a secondary combustion chamber producing heat at 1,000°C, is used to reduce as much waste volume as possible. Dust is cleaned from the furnace flue gasses and then hazardous chemical substances, such as chlorine, fluor, and sulfur dioxide are separated using S class mechanical filters.

**Deposit for Plastic Bottles.** Effective December 1, 1989, a 50-pfenning deposit was required on plastic beverage bottles to reduce household waste. The measure was contested by French mineral water suppliers, whose sales dropped substantially after the new regulation was implemented.

**Environmental Expenditures.** According to information published by the Federal Statistics Office, expenditures for environmental measures (waste management, noise abatement, air and water protection) totaled 32.3 billion DM in 1987 (17 billion DM and 15.3 billion DM by industry and government, respectively).

**Reducing Halogen Hydrocarbons.** In the FRG, 300,000 tons of halogen hydrocarbons, including 90,000 tons of chlorofluorocarbons (CFC), are emitted into the atmosphere. The Parliamentary Enquete Commission for the Protection of the Atmosphere called for a reduction of CFC output to 5 by 1995. A reduction of total halogen hydrocarbons to 30 of the present output is considered possible using existing technologies.

The annual chlorohydrocarbon output in the FRG is 200,000 tons, of which two-thirds are emitted into the atmosphere and one-third is waste. Seventy-five of these

materials are used in the metal industries. With presently available technologies, some reduction is possible; further reductions would require new technologies and methods. New methods for reducing the use of CFCs have been invented by German firms. The Rupp and Hubrach Company in Bamber has installed a filter installation to clean optical glass using purified water and drying processes, replacing CFCs as a washing agent. KLN-Ultraschall GMBH in Heppenheim uses alcohol for cleaning electronic parts, eliminating drying and waste water problems. Alpha Grillo Loetsysteme GMBH in Duisburg markets lemon and orange peel extract solvents for electronic building elements. Nevertheless, extensive further research work is necessary to find effective substitutes for other CFC uses.

**Heat Recovery in Glass Industries.** Of the consumer product industries in the FRG, the glass industry has the highest rate of energy consumption, using approximately 2 million tons in hard coal units. The Ministry for R&T is promoting better utilization of exhaust heat in glass-melting furnaces with a 785,000 DM research program. A heat exchanger is used to direct exhaust gas into separate shafts where recycled glass is pre-heated to 320 degree celsius. A 3-year payback period is expected. A prototype has been in operation since early 1987 at a Basalt melting furnace.

**Gene Technology.** In early November, the Hessian Administrative Court ruled to halt construction of a Hoechst AG human insulin installation at Frankfurt. The ruling foreclosed industrial utilization of gene technology in the FRG, and can only be overturned by the Federal Constitutional Court. The court states: "As long as the Legislature does not expressly permit utilization of gene technology, installations for genetic engineering-regardless of how their eventual individual risk and safety is classified-may not be established and operated." The Federal Ministry for R&T has made no comments on the court decision, but has highlighted the necessity of passage of a gene technology law as soon as possible.

**AIDS.** In the FRG at the end of November 1989, there were 4,220 AIDS cases registered at the Federal Health Office. Of the registered cases, 1,797 have been fatalities. The largest number of cases were homo- or bi-sexual men, 12.4 were drug users, and 7.2 were blood transfusion recipients.

According to an article published by the East Berlin "Wochenpost," as of November 1, 1989, the GDR had 16 registered cases of AIDS according to the Chairman of an AIDS Advisory Group of the GDR Health Ministry. The reason given for the low number of infections was the lack of drug abuse in the GDR.

### Minister for Science and Technology of the German Democratic Republic Visits the Federal Republic of Germany

At the invitation of Federal Minister of Research and Technology, Heinz Riesenhuber, the Minister for Science and Technology of the GDR, Dr. Klaus-Peter Budig, visited the FRG from January 21-25, 1990. Budig and Riesenhuber discussed intensified cooperation in the scientific and technological fields following political changes in the GDR. Besides a general exchange of information regarding basic problems of research and technology policy, the discussions focused on the possibilities of intensified cooperation based on the mutual governmental agreement of 1987.

Preference in cooperation will be seen in environmental, biotechnological, and basic physical research. Increased cooperation already exists in material, coal, and reactor safety research; production engineering; and the conservation of historical buildings. In this context, the Federal Ministry of Research and Technology emphasized that on the occasion of Budig's visit to the FRG, another 11 agreements on specific research projects will be signed covering projects of conservation of historical glass objects, enzyme-technological peptide analysis, plant virology, safety aspects of biotechnology, forest research, and research on technologies for community transportation. To date, the inner-German agreement of 1987 on scientific and technological cooperation incorporates 55 single projects.

During his stay in the FRG, Budig also visited some scientific and technological establishments and installations, such as a lignite-fired power plant near Cologne, Siemens Research Center at Munich/Pallach, Max Planck Institute for Plasma Physics at Garching near Munich, Fraunhofer Society headquarters, Technology Center at Stuttgart, and KFK at Karlsruhe.

Before his nomination as Minister for Science and Technology of the new GDR government, Budig was Dean of the Faculty of Electrical Engineering at the Technical University of Karl-Marx-Stadt. He is an expert in automation and electric motor technology.

Commenting on the Budig visit, a senior science policy official contrasted the enormous scientific potential and good will for inner German cooperation with the meager tangible results thus far achieved--a shortfall he ascribed to lack of funds and bureaucratic follow-up on the GDR side.

## France

*For further information on France items, contact Dr. Michael Michaud, Science Counselor, American Embassy, Paris, APO New York 09777.*

### Industry Research and Development Expenditures

According to the report attached to the 1990 budget law prepared by the French Ministry of Research and subjected to French Parliament, French companies (private and state owned) are making a growing contribution to the overall French research and development (R&D) effort. The R&D expenditures of French companies doubled between 1970 and 1987, increasing by 4.2 percent per year on average (7 percent in 1987) against an average 2.9 percent for public R&D expenditures. Industry R&D spending in 1987 amounted to FF 53.4 billion (\$9.2 billion), 44 percent of total domestic R&D expenditures, and is estimated to have reached FF63.5 billion (\$10.9 billion) in 1989. Both governmental policy to support industrial R&D and the upcoming European Single Market are prompting French companies to invest more in R&D. However, French industry has not yet caught up with its main Organization for Economic Cooperation and Development competitors.

### National Institute for Research in Computer Science and Automation

The Institut National de Recherche en Informatique et en Automatique (INRIA) is a French public sector scientific and technological institute under the purview of the Ministry of Research and Technology and the Ministry of Industry. The headquarters are at Rocquencourt, near Versailles, but there also are INRIA Research Centers at Rennes, Nancy, Sophia Antipolis, Toulouse, and Grenoble. With an 1989 budget of FF 360 million (over \$60 million), INRIA employs over 900 people, including 630 researchers. Of these, 230 are fulltime government employees, 230 are scholars and trainees, 90 are researchers from public laboratories, 40 are engineers from industry, and 40 are visiting researchers from other countries, which usually includes about 10 U.S. researchers.

The purposes of INRIA are basic and applied research, design of experimental systems, technology transfer, knowledge transfer, international scientific exchanges, contribution to international cooperation programs, scientific expertise, and contribution to standardization. Over 50 projects are underway in 8 fields: programming, symbolic computation, and artificial intelligence; new computer architectures; networks and dis-

tributed systems; data bases; control data and signal processing; manufacturing automation, robotics, image, and vision; scientific computing, numerical software, and computer-aided engineering; and man/machine communication.

With more than 350 UNIX workstations, INRIA is well equipped. There are more than 200 microcomputers, 12 servers, one Convex C2 minisupercomputer, and access to a Cray-11 supercomputer. The INRIA recently received a connection machine from the U.S., and its computers are interconnected by several networks, including ethernet, X.25, Hyperchannel, and FODI.

The INRIA has extensive relations with French industry, with about 90 industry contracts each year, bringing in 15-20 percent of the budget. The INRIA collaborates directly with both computer manufacturers and computer users, and had a contract from Cray in 1989. The INRIA is increasingly involved with European programs, notably the EC's ESPRIT program and projects under EUREKA. The INRIA licensed 20 products to industry in 1988, and received royalties in return. During the past 3 years, INRIA has provided more than 300 sets of experimental software to other institutions. Human transfer is emphasized through industry engineers working at INRIA, and through the 15 or so researchers who leave INRIA each year for employment elsewhere; INRIA researchers have created nine private sector companies; subsidiaries including GIPSI SA, GIP ALTAIR, SIMULOG, and ILOG have spun off. Seven other spinoff companies are also helped, but without participation in their capitalization.

In international relations, INRIA has particularly close links with the German Gesellschaft fur Mathematik und Datenverarbeitung MBH (GMD) and the Dutch Centrum Voor Wiskunde en Informatica (CWI). Other important INRIA relationships are with ICOT in Japan and the National Science Foundation in the U.S. About 900 professional missions are sent abroad each year, of which 70 percent are to Western Europe, 20 percent to North America, and 10 percent to the rest of the world. The INRIA also participates in training programs for less-developed countries in North Africa, Southeastern Asia, and Latin America.

Alain Bensoussan and Georges Nissen are President and Director General, and Director of International Scientific Relations and Industrial Relations, respectively. The INRIA Headquarters address is Domaine de Voluceau, Rocquencourt, BP 105, 78153 le Chesnay, CEDEX France, telephone (33) (1) 39-63-55-11.

## Italy

*For further information on Italian items, contact Reno Hamish, Office of Science Counselor, American Embassy, Rome, APO New York 09794-9500.*

**Tecnospazio Obtains Contracts from ESA.** Tecnospazio, an Italian company, is working on many activities in the sector of space robotics. Working as a subcontractor, it recently concluded design work for the European Space Agency (ESA) equipment manipulator and transportation system (EMATS), an integral part of the robotic system for the Columbus Laboratory. Presently, Tecnospazio is ESA's prime contractor for the realization of a minirobot to pick up samples from Comet Nuclei. Tecnospazio is expecting to receive 400,000 ECUs for the development, jointly with the French firm Sagem of the "stereovision" project for the realization of an expert system for automatic interpretation of images. Tecnospazio also will participate with the Dutch firm, Fokker Space & Systems, in developing the robotic arm for the European shuttle HERMES.

**Genoa's ICFAM Institute Involved in Many Microgravity Research Projects.** The Institute of Chemical Physics Applied to Materials (ICFAM) of the Genoa-based branch of the National Research Council is studying and planning several microgravity research projects to be flown in the next years on SPACELAB and as part of the European EURECA program. One of these projects is called Measurement of Interfacial Tension Experiment (MITE) to measure interfacial tension between nonmixable liquids to be flown on the MASER-4 ESA mission in early 1990. Two other projects involving the multifurnace assembly will be aboard the May 1991 EURECA-1 flight. These experiments will be proposed by ICFAM and financed by the Italian Space Agency to study the interaction between liquid metals and ceramic materials in spatial microgravity conditions. With the support of the Milan Polytechnic Institute, ICFAM will also carry out some experiments of heterogenous nucleation in nonmixable liquid metals through the isothermal heating facility to be flown on SPACELAB-D2 in February 1992.

**Reorganization of ENEA.** The Italian National Agency for Nuclear and Renewable Energies (ENEA) has announced its reorganization into four sections--nuclear energy, energy, innovation, and environment. In nuclear energy, after the Italian withdrawal from construction of nuclear energy plants, ENEA will stop its research of fast reactors and the nuclear fuel cycle and will focus instead on new intrinsically safe reactors and fusion research. In energy, ENEA will focus on developing new technologies for renewable energies and for energy conservation. In innovation, ENEA will conduct research in lasers, robotics, new materials, and informa-

tics. In environment, ENEA will support the Ministry of Environment in improving the environment through research projects. In this research, it is currently conducting construction of a national network to monitor the quality of air, water, and earth.

**SESA to Produce Control Systems for Ariane 5 Engines.** The Italian company, SESA, active in telecommunications and space systems, obtained from the French company Societe Europeenne De Propulsion (SEP) the subcontract to build an advanced system for data acquisition and elaboration. The system, ETNA 5, will analyze the tests of the components of the vulcan engine of Ariane 5 to indicate possible faults in the components that could cause failure during space flights. The ETNA 5 will decrease the length of the time needed for the production of the engine and is expected to improve quality control.

**Italian National Program for Advanced Materials.** The National Program for Advanced Materials will be articulated into five key sectors:

- Structural materials for the construction industry (polymers, glass, special metallic alloys)
- Materials resistant to high temperature (ceramics, advanced technology coatings)
- Electromagnetic materials (optical fibers, insulating and electroluminescent materials)
- Superconducting materials
- Biocompatible materials to be employed in the human organism for the partial or total organ replacement.

The total financing of the 5-year program is 500 billion lire (about \$370 million). An additional 85 billion lire (about \$65 million) has been approved for the National Research Council's (CNR) targeted research project on special materials for advanced technologies, and 13 billion lire more (about \$10 million) has been requested for a subproject on biocompatible materials to be added to the CNR targeted project. This financial and organizational effort is aimed at improving Italian research on new materials, improving Italy's position from last in Western Europe for research expenditure in this area with an average expense of only 75 billion lire per year.

**Photovoltaic Research in Naples.** A Center for Photovoltaic Research (CRIF) near Naples was established under the aegis of National Agency for Nuclear and Renewable Energies (ENEA) about 4 years ago with an initial investment of 22 billion lire (about \$16 million). The CRIF now has an annual budget of 10 billion lire and employs about 130 researchers working on the complete cycle of amorphous silicon cells from the process of manufacturing to final applications. The CRIF is also managing and testing the demonstration electric photovoltaic system (DELPHOS) which is Europe's largest photovoltaic power plant. The plant is formed by 311,000

photovoltaic cells in a 162- x 27-m area producing 300 kW of electricity, and is presently being upgraded to produce 600 kW with a final production goal of 1200 kW.

**National Institute of Nuclear Physics Plans a Supercomputer.** The Italian National Institute of Nuclear Physics, in cooperation with the universities of Rome, Bologna, and Pisa, is developing a new parallel processing supercomputer for completion by 1992. The supercomputer, called APE 100, derives from the computer array processor expansible (APE) operating since 1988 in the Physics Department of the University of Rome (La Sapienza). The supercomputer cost 1.2 billion lire (about \$880,000) and is capable of handling one billion operations per second with a memory of 256 megabits and 16 processors. The APE 100 will be able to handle from 100 to 200 billion operations per second with a memory of 8 billion bits and with 4096 processors working in parallel. The APE 100 is being designed and projected by the physicists of the National Institute of Nuclear Physics.

**Castor Markets Sterile Refrigerator.** Castor is marketing a new type of refrigerator equipped with a device called SOLARIS which does not allow formation of molds and kills bacteria in the food stored within. The device acts through a low-tension ultraviolet source of light which, by forced air circulation, continuously regenerates and purifies the air inside the refrigerator and impedes mold formation and bacterial development in food. The SOLARIS was obtained with an initial research investment of 1 billion lire (about \$770,000) and its presence in refrigerators will add 100,000 lire to the sale price.

**SCOUT, Old NASA Rocket, Being Upgraded in Italy.** The Italian Center for Space Research of the University of Rome recently presented an upgraded version of the NASA SCOUT Rocket called "San Marco Scout." At the same time, the Italian company, BPD Difesa/Spazio, presented a similar version called SCOUT II. Italian National Space Agency (ASI) will merge the two initiatives to allow joint production by the University of Rome and by BPD Difesa/Spazio of a Scout Rocket capable of launching satellites weighing from 200 to 500 kilograms into an orbit 555 kilometers high.

**Finmeccanica Seeking Concentration of Italian Space Industry Activities.** In the continuing saga of Italian sectorial concentration, there are signs that Finmeccanica, the mechanical holding of the state-owned IRI group, is seeking to gain control over all state-owned Italian space industry activities. A merger is being proposed of the Space System Group of Aeritalia, Selenia Spazio, Laben, Fiat, and other minor space activities partially owned by Aeritalia. Companies to be included are: Space Software Italia, Carlo Gavazzi Space, Italian Center for Aerospace Research/CIRA, Microgravity Ad-

vanced Research and User Support Center/MARS, ITALASPAZIO, and ELMER. As a result of this merger, the Space Group would have expertise in projects such as space platforms (SPACELAB, COLUMBUS), scientific satellites (HIPPARCOS, TETHERED), telecommunications satellites (ITALSAT, INTELSAT, OLYMPUS), remote-sensing and meteorological satellites (METEOSAT, ERS-1, X-SAR) and ground-tracking stations (INTELSAT, EUTELSAT, ARGO). The concentration sought by Finmeccanica and supported by some of the presidents of the companies involved would create in Italy an industrial space group comparable in size and competence with those of other major Western European countries, but would not include the space activities of private sector companies, such as Fiat.

**Snapshot: Italian National Plan for Oceanographic Research.** The Ministry of Scientific Research and Universities approved the creation of the National Plan for Oceanographic Research (Piano Nazionale Di Ricerca Sul Mare/PNRM). The plan aims to reorganize and supervise oceanographic research that was hitherto carried out by several public and private organizations with limited coordination and insufficient financing. In 1988, the total national expenditure for oceanographic research amounted to an overall total of 73,755 billion lire (about \$55 million). The 5-year national plan for oceanographic research provides 571 billion lire (about \$420 million). About 191 billion lire will be employed for updating and reorganizing infrastructure, and the remaining 380 billion lire will go to research, management of marine resources, marine environment, and personnel training. An operational secretariat will be set up within the Ministry of Scientific Research and Universities to coordinate and manage the plan. Some of the most urgent initiatives in the plan are: high-sea oceanographic ship also fitted for Antarctic expeditions (about 40 billion lire), a data bank and experimental structures for submarine testing and calibrations, two 5-year CNR-targeted research projects on oceanography (131 billion lire) and marine technologies (97 billion lire), graduate courses in marine environmental sciences, and fellowships for training of personnel at the foreign oceanographic institutions. These urgent initiatives are estimated to require 288 billion lire of the total financing. At present, the National Research Council has two oceanographic ships plus seven high-seas motorboats and an iron structure platform 12 meters above sea level installed 8 miles from the Venice Lido Beach. The Platform Laboratory is equipped with sensors and basic instrumentation such as tide gauges, wavemeters, barographs, and anemometers for continuous measurements of phenomena that effect the Venetian Lagoon and for other tests at sea.

**Nuclear Powerplant Retrieves and Manages Data and Information.** The Italian agency for Nuclear and Renew-

able Energies (ENEA) and the BREDA Research Institute (IRB) have developed the Automatic Retrieval and Management Inservice Inspection System (ARAMIS). The program retrieves and manages data and information for nuclear powerplants preservice and periodic inservice inspections can file, edit, plan, retrieve, and sort the 40 years of plans and data from the expected life of a nuclear powerplant. The ARAMIS is also equipped with a graphic module that prepares, edits, and video displays all the inspection relevant drawings in the plant archives.

**Subsidy for Energy Conservation and Cogeneration.** The Ministry of Industry has approved several projects for the rational utilization of energy with a total financing of 193 billion lire (about \$150 million). The government contribution will cover up to 30 percent of the investment for energy conservation and heat and energy cogeneration projects. Several public and private companies already have applied to obtain the financing for 9 heat and energy cogeneration plants, 15 waste heat and recycling plants and 3 district heating plants. The new initiatives are expected to save 120,000 tons of oil equivalent per year.

**EUREKA Biotech Project for Mass Production of Mammal Tissue Cells.** SORIN, Fiat group, (Italy) has been active in the field of biotechnology since 1980 and is presently participating with Bertin & Cie (France) and IMMUNO AG (Austria) in the EUREKA project for mass production of mammal cell cultures. The total cost of the project is 25.5 million European Current Units (ECU). SORIN has obtained from the Italian government a financing of 2.6 billion lire (about \$21 million). Presently, SORIN is working on cell cultures of rats and mice using mainly bovine foetal serum as a media. Soon, SORIN will culture human cells and do research on synthetic culture media.

**Submarine Optical Fiber Cable to Surround the Italian Boot.** A submarine optical fiber cable, supplied and positioned by Maristel and Cavi Pirelli, will link Genoa to Trieste surrounding the Italian boot. The 4,000-kilometer cable can handle 48,000 telephone channels for long distance calls and is expected to cost 2,500 billion lire (about \$2 billion) entirely supplied by the government agency for telephone services. The Rome-Naples and Rome-Messina sections are already operating. The Rome-Genoa will be operating by the end of 1990, and in 1991 the whole circuit from Genoa to Trieste will be complete. The cable will also be able to transmit high-definition TV programs.

**Italian Industry Research Expenditures Rising.** The Italian Association of Industrialists (CONFINDUSTRIA) presented recently some data on the research expenditure of Italian industry. In 1987, Italian private

companies were estimated to spend for research 3,200 billion lire (about \$2.5 billion). In 1988, the expenditure reached 3,700 billion lire while in 1989 it is assumed to have reached 4,300 billion lire (about \$3.4 billion). Publicly held companies spent an additional 1,100 billion lire in 1987, 1,200 in 1988, and 1,400 in 1989 (about \$1.1 billion). Although private companies are much more active in research, their average expenditure is estimated to be only 3.7 percent of sales. Italian private sector expenditures for research are still low compared with other West European countries and this is reflected negatively in advanced sectors like lasers, microelectronics, and biotechnologies where Italian industrial presence is negligible. In addition, the government has decreased financial aid to applied research in industry from 586 billion lire in 1986 to 350 billion lire in 1990. Italian industry believes that the fiscal policy of the government must be revised to support research.

**ENEL Program for Wind Energy.** The Italian National Agency for Electricity (ENEL) is planning to establish a testing group of eight wind energy generators capable of producing 2.4 MW. The testing ground will be located in the Appennine mountains of Central Italy at an altitude of 1,300 meters, which makes it the highest place for wind energy generators in Europe. In this location, the wind is more or less constant and blows at an average speed of 5-6 m/sec. The first eight generators equipped with blades 30 meters in diameter will be increased to 40 by 1993 costing 115 billion lire (about \$90 million). The project will produce enough energy for the use of 20,000 domestic consumers. The cost to install one wind-produced kW is 4.5 million lire, about twice as much as that to install one kW obtained through traditional sources of energy. Wind energy generators are very cheap to operate.

**Montedison Presents New Plastics.** The Italian chemical company Montedison will produce three new "ecological" polymers for the production of plastics. The Montedison Centro Sviluppo Impieghi (CSI) carries on polymer research in six commercial sectors: transportation, building, furnishing, packing, agriculture, and electronics with a business turn over of 20 billion lire/year. The company presented three new environmentally compatible polymers. The first is a multiuse plastic especially suited for automobile, making the recycling of automobile scraps easier to handle because one must deal with only one type of product. The second is a polymer obtained from corn starch and will be used to make transparent canvas for use in agriculture to provide a greenhouse effect protecting crops from frostbite. The canvases can be left on the ground where they will undergo a total biodegradation. The third polymer is for food wrapping and will protect foodstuff from bacteria and molds. All three polymers will be commercially available in 1990.

**Rice Straw and Husk for Energy Production.** The EC has granted financing for a project in which rice straw and husk are burned to produce electricity and heat for agricultural purposes. The project will be carried out in a farm near the town of Novara in the center of Italian rice cultivation under the supervision of ENEL and ENEA. The experimental plant will cost 4.5 billion lire (about \$3.6 million) and will develop a maximum power of 680 kW. The plant will be fueled with 13,000 tons of rice straw and husk per year. Italy produces about 760,000 tons of rice straw and husk per year that has always posed an environmental problem for its disposal. Use as fuel could result in a saving of 220,000 tons of oil equivalent.

**Italy Supplies Soviet Union with Synthetic Insect Hormones.** The research center "Donegani" of the Enimont Company has signed an agreement with the Soviet Academy of Sciences to supply chemically synthesized insect hormones. Known in Italy as "Feromoni," the hormones will help to prevent attacks on fruit crops by several types of insects in Siberia. Enimont's "Feromoni" are especially suited for the 90-day Siberian cultivation season and endure very well the great thermal excursions occurring at those latitudes. The "Feromoni" trigger a sexual attraction in the male insect which is trapped and killed without the use of environmentally hazardous pesticides.

**Italian-Made Gallium Arsenide Solar Cells for British Satellite.** The Italian company FIAR, in cooperation with the Centro Informazioni Studi e Esperienze (CISE), has supplied the British UOSAT-E satellite with gallium arsenide (GaAs) solar cells located in the four 53 x 33-cm panels on the sides of the satellite. Each panel contains 336 cells of 4 sq cm each supply 29 watts of power. The output of these cells is 18.5 percent versus the 14 percent obtained with silicon cells. In CISE laboratories, the output of experimental GaAs cells is reaching 21.5 percent. The Italian Space Agency has a 3-year, 3-billion lire contract with FIAR to develop the aspects of connection between cells and the solar, while ESA has a 2-billion lire contract with FIAR for the development of large cells.

**Oil Price Increase Leads to Reintroduction of TOTEM.** In the 1970s, the Fiat Research Center developed the TOTEM total energy module, for the combined production of power and heat utilizing methane from the normal distribution network, or biogas, methanol, and alcohol. The TOTEM has an energy output of over 90 percent and decreases substantially the dumping of sulphur and nitrogen dioxide and carbon monoxide in the atmosphere. Probably 5,000 operational TOTEMS would save 80,000 tons of oil equivalent annually. This cogenerating engine is manufactured in Italy by Biklim under Fiat license and is already in operation in the Federal Republic of Germany, Denmark, the Nether-

lands, and Spain. In Italy, the city of Vicenza employs TOTEM on a large scale. The one-cu m volume makes it suitable for smaller public buildings.

**Trento Institute Seeks to Produce Artificial Intelligence System.** Trento Institute for Scientific and Technological Research (IRST) is trying to assemble the best of Italian research in artificial intelligence (IA) and to integrate the various study sectors such as artificial vision, identification of voice and language, expert systems, automated reasoning, and advanced microelectronics into a single project capable of producing the first intelligent systems. So far, a little robot is circulating in a corridor of IRST and is capable of rudimentary actions like recognizing and avoiding obstacles, performing turns, and obeying some elementary voice commands. To accelerate the pace of the project, IRST is recruiting the best researchers available and hopes to increase the number of scientists from the present 170 to 200 which is considered optimum for the operation. The IRST spent 21 billion lire (about \$16 million) in 1989. Seventy and 30 percent was spent for research inside and outside, respectively. In 1989, IRST had 120 scientific publications in international science magazines and had cooperation projects with Xerox, Hewlett-Packard, SGS-Thomson, and Italian companies like Ansaldo, Selenia, and Aeritalia. The sale of IRST's technology brought in 1 billion lire in 1990. In 1991, IRST will open a silicon foundry complete with the most advanced equipment to develop high-integration experimental chips, a circuit integrating a telecamera and a microprocessor, neuronal networks, and voice identifiers. The object is to have a robot capable of operating in a casual environment, a reasonable behavior, sufficiently developed to accomplish some practical tasks.

**Rome Organizes a Science Park.** The Consorzio Roma Ricerche, an organization that joins university with industry to facilitate technology and research exchange, has presented a project for a science park. The park would be located in a suburban area southeast of Rome around the Via Tiburtina. Eight hundred fifty companies employing 36,000 individuals are already operating in this zone. The science park will focus on electronics, informatics, telecommunications, biotechnologies, new materials, robotics, environment, and transportation. The new initiative is sponsored by both Rome universities, by the Italian National Research Council, the National Agency for Nuclear and Renewable Energies, the National Institute of Nuclear Physics, by private companies like Selenia, Hewlett Packard, the new Chamber of Commerce of the Latium region, and a few local banks.

## Italian AIDS Update

**Research Developments.** Professor Alberto Mantovani, Institute of Pharmacological Research "Mario Negri," Milan, said that studies carried out at the institute have singled out new cells called macrophages that store within themselves the HIV for the introduction of the virus into the central nervous system where the HIV would not have access by itself.

Professor Pier Mannucci, Director of the School of Hematology, University of Milan, said that blood products for the treatment of hemophiliacs are now treated with adequate heat procedures that make the products sterile. Through 1986, 700 out of 3,000 Italian hemophiliacs become serum positive by use of untreated products--the great majority imported from the U.S.

University Professors Valeria Basso and Giorgio Moretti, Hygiene Institute, University of Padua, conducted a course on AIDS in the high schools of Padua. They have now written a textbook for high school use--*Sexually Transmitted Diseases, a Guide to Know and to Prevent Them*.

At a recent AIDS international conference held in Rio de Janeiro, Professors Adolfo Turano and Dante Bassetti, University of Brescia, and University of Verona, respectively, reported on using papaverine (an extract from puppy flowers) which is responsible for delaying the onset of AIDS and to keep diseased individuals living longer without harmful and toxic side effects. Papaverine was also noted to inhibit in vitro the reproduction of HIV viruses.

**Government Actions.** The National Commission for the Fight Against AIDS has published a detailed and updated manual of operations and behavior for physicians and medical personnel who assist AIDS-diseased people. The rules indicated in the manual are those formulated by international organizations that are used in other advanced countries.

The government has decided to spend 10 billion lire (roughly \$8 million) to produce and promote special syringes that block themselves after the first intake of liquid is completed. These syringes would prevent multiple use, which is mainly responsible for AIDS diffusion among drug addicts. This type of syringe is ready for commercialization; however, it costs five times as much as the traditional syringe; hence, its use by drug addicts depends on free distribution which the government has not yet approved.

The Ministry of Health has printed a four-page booklet of instructions for tourists and travellers on how to avoid AIDS, especially in high-risk countries. Two million copies will be distributed freely in Italian international airports and ports of entry.

One hundred ninety-one billion lire (about \$147 million) out of the health fund provided by the financing law

will be employed for AIDS. The money will be used to increase capability of research laboratories, blood controls of research laboratories, and blood controls for transfusion; increase and train personnel; establish consulting centers for sexually transmitted diseases; assist drug addicts; and establish a home care organization.

**Other.** The association of blood donors is protesting the government policy and is requesting a new measure to enable Italy to be self-sufficient in providing blood for transfusions. The association says that Italy imports blood valued at 200 billion lire/year and that even today not all transfusion centers are equipped to guarantee safety from AIDS. Especially in southern Italy, the risk of acquiring AIDS through a blood transfusion is still 25 percent while in the north it is under 2 percent.

The union of nurses has encouraged its members to send letters requesting transfer from jobs where they are at risk from AIDS to other clinical sectors. So far, hospital administrators have received over 500 of these requests, but the number is expected to increase unless the government makes special provisions to insure better protection and more rational assignment of duties to AIDS nurses.

Hospitals in Naples, Rome, and Milan are reaching a critical situation from the increase of AIDS-diseased individuals. The Minister of Health, in visiting the Naples hospital "Cotugno," stated to the press that he was ashamed of the way AIDS people are treated. Rome's hospital for infectious disease "Spallanzani" houses 94 cases of AIDS, but there is no space for over 30 people who have requested admission and a new ward with 350 beds will not be ready for 2 years. In Milan, the infectious disease hospital "Sacco," stopped the admitting AIDS-diseased people; they are sent to hospitals not specially equipped for infectious diseases.

## Belgium

*For further information on Belgium items, contact Ms. Patricia Haigh, U.S. Mission to the European Communities, 40 Blvd. du Regent, B-100 Brussels, APO NY 09667-1030.*

### European Community Health Ministers Adopt Position in "Europe Against Cancer" Program

In November 1989, the European Community (EC) Council of [Health] Ministers (Council) adopted its common position on a directive that provides for maximum ceilings for the tar yield in cigarettes and for the labeling of health warnings on tobacco products under the "Europe Against Cancer" Program.

If every cigarette is noxious for the health, whatever its tar yield, it is however indisputable that the risks of lung cancer are higher if the cigarettes smoked have a high tar yield. Two countries of the EC already forbade cigarettes

with a high tar content--Spain and Portugal. Because the World Health Organization (WHO) further recommend the reduction of these limit values to 15 mg, the Commission's proposal requests the harmonization of national measures in this respect in the EC, establishing a uniform limit value of 15 mg of tar per cigarette before the end of 1992.

This directive is not likely to create any adaptation problems for the tobacco industry. Recent experience shows that manufacturers are able to reduce the tar yield of cigarettes by using better tobaccos, papers, filters, and preparation. As an example, the tar yield of gauloises varies from 22.8 mg to 5.9 mg.

On the other hand, the EC knows that the limitation of tar yield of cigarettes will pose serious adaptation problems to producers to tobacco varieties with a high tar yield. Therefore, the Council accepted the necessity of granting a specific temporary derogation for Greece to permit this country to adapt softly to the new situation. In addition, within the framework of common agricultural policy or Mediterranean integrated programs, the EC will reinforce its actions seeking to promote the reorientation towards the production of tobaccos that are less dangerous to health or the reconversion to other productions such as cotton, corn, fruits, or vegetables.

This directive is considered by the committee of cancer experts of the "Europe Against Cancer" program as one of the most vital measures in order to achieve the target of 14 percent of reduction of mortality by cancer by 2000.

From January 1, 1992, all tobacco products must carry a general warning: "Tobacco seriously damages your health." In addition, all cigarette packets in EEC will carry specific health warnings to be chosen from a list containing at least the two following warnings: smoking causes cancer; smoking causes cardiovascular diseases. Moreover, all cigarette packs in Europe will have to carry the indication of tar and nicotine yield. Tar and nicotine are both prejudicial to health and nicotine is the substance that makes smokers dependent on tobacco. The need for protection is supported by scientific evidence. Over 50,000 studies worldwide document the damage caused by tobacco. The WHO estimates that every year 440,000 EEC citizens die prematurely from diseases caused by smoking; that is more than 1,000 every day. With over 500 billion pieces sold every year in the EEC, cigarette are the most important tobacco product. But other products are dangerous as well, so they were therefore included.

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