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A Summary of Research Projects Sponsored by the Office of Naval Research. Report for the Period 1 October 1979 to 30 September 1980

Monterey, California. Naval Postgraduate School

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

A SUMMARY OF RESEARCH PROJECTS SPONSORED BY
THE OFFICE OF NAVAL RESEARCH

Report for the Period

1 October 1979 to 30 September 1980

Title: Operating System Structures for Distributed
Multi-Microcomputer Systems

Investigators: Uno R. Kodres, Associate Professor of
Mathematics and Computer Science and
Roger R. Schell, Assistant Professor of
Computer Science

Sponsor: Office of Naval Research

Objective: Identify hardware and operating system
software characteristics for effective
use of multi-microcomputers in combat
systems.

Summary: The recent development of Large Scale
Integrated (LSI) general purpose computers
(microcomputers) and the immediate future
development of Very Large Scale Integrated
(VLSI) systems (minicomputers) will radi-
cally change the economics and design
concepts of dedicated computational
systems. High performance computational
systems can be built from concurrently
operating multicomputer systems composed
of commercially successful single board
(in the future-single chip) computers.
The purpose of this study: (1) identify
operating system structures that will more
effectively support combat systems applica-
tions, (2) provide architectural guidelines
for hardware design to support the required
operating system capabilities and effi-
ciences and (3) to identify the hardware
and operating system features which
enhance the implementation of secure
systems composed of multi-microcomputers.

Conference
Presentation: R. R. Schell, U. R. Kodres, H. Amir,
J. Wasson, and T. F. Tao, "Processing of
Infrared Images by Multiple Microcomputer
System," Proceedings SPIE Annual Interna-
tional Technical Symposium, Vol 241,
(28 Jul - 1 Aug 1980).

Theses
Directed:

P. A. Myers, "Subversion: The Neglected Aspect of Computer Security," Master's Thesis, June 1980.

W. J. Wasson, "Detailed Design of the Kernel of a Real Time Multiprocessor Operating System," Master's Thesis, June 1980.

J. L. Ross, "Design of a System Initialization Mechanism for a Multiple Micro-Computer," Master's Thesis, June 1980.

G. B. Blanton, "Dynamic Linking in a Microcomputer Environment," Master's Thesis, September 1980.

Title: Interpolation of Scattered Data

Investigators: R. Franke, Associate Professor of Mathematics, G. Nielson, Associate Professor of Mathematics, Arizona State University (supported by contract with Arizona State University)

Sponsor: Office of Naval Research

Objective: The objective was to investigate the mathematical basis for the "multiquadric method" due to R. L. Hardy.

Summary: The multiquadric method is a special case of a class of interpolation methods which minimize certain functionals involving the Fourier transforms of elements in a space of generalized functions (distributions). Investigation of this class of methods is presently continuing.

Publications: Will be forthcoming.

Title: HP-67 Program Development and Support

Investigators: Alvin F. Andrus and Rex H. Shudde, Asso-
                 ciate Professors of Operations Research

Sponsor: Office of Naval Research

Objective: Provide HP-67 program development and sup-
                 port to COMPATWINGSPAC for tactical develop-
                 ment and evaluation.

Summary: Empirical and mathematical approaches were
                 considered for providing accurate LORAN
                 positioning within the tactical constraints
                 of P-3 air crew capabilities and the memory
                 constraints of the HP-67. Empirical curve
                 fitting approaches were non-beneficial.
                 This approach was considered by Professor
                 Andrus. The mathematical approach was
                 successful. This approach was considered
                 by Professor Shudde.

Publications: Rex H. Shudde, "An Algorithm for Position
                 Determiniation Using LORAN-C Triplets with
                 a BASIC Program for the Commodore 2001
                 Micro-computer," NPS Technical Report,
                 NPS55-80-009, March 1980.

                 Rex H. Shudde, "Position Determination with
                 LORAN-C Triplets and the Hewlett-Packard
                 HP-67/97 Programmable Calculators," NPS
                 Technical Report, NPS55-80-010, March 1980.

                 The HP-67 program has been submitted to
                 the Fleet Mission Program Library by
                 COMPATWINGSPAC.

Title:	Large-Scale Optimization
Investigators:	Gerald G. Brown, Associate Professor of Operations Research and Computer Science and Gordon H. Bradley, Chairman and Professor of Computer Science
Sponsor:	Office of Naval Research
Objective:	Continued development of theory and algorithms for solution of large-scale optimization models.

Summary: Large-scale models with Generalized Upper Bound and Network structure have been intensively studied: identification of such structure has been automated. Large linear, mixed integer, and nonlinear models can now be solved with the experimental optimization system developed over the period of this research. Decomposition and basis factorization have been incorporated with complete degeneracy resolution in a unique new algorithm for elastic programming. Applications at large scale have proven the efficiency of this approach for a broad range of problems. Computer-assisted analysis of problems prior to solution has materially contributed to several large-scale applications.

Publications: G. H. Bradley, G. G. Brown and G. W. Graves, "Structural Redundancy in Large-Scale Optimization Models," Redundancy in Mathematical Programming (Zoints and Telgen, eds.), Academic Press, to appear.

G. G. Brown and D. S. Thomen, "Automatic Identification of Generalized Upper Bounds in Large-Scale Optimization Models," Management Science, to appear.

G. H. Bradley, G. G. Brown and P. I. Galatas, "ATHENA: A System to Interactively Analyze Large-Scale Optimization Models," NPS Technical Report, NPS52-80-005, April 1980.

G. H. Bradley, G. G. Brown and P. I. Galatas, "ATHENA: Users Manual for Interactive Analysis of Large-Scale Optimization Models," NPS Technical Report, NPS52-80-006, April 1980.

G. G. Brown, A. M. Geoffrion and G. H. Bradley, "Production and Sales Planning with Limited Shared Tooling at the Key Operation," Management Science, to appear.

G. G. Brown and G. W. Graves, "Real-Time Dispatch of Petroleum Tank Trucks," Management Science, to appear.

G. G. Brown and A. R. Washburn, "Khachian's Algorithm: A Tutorial," NPS Technical Report, NPS55-80-008, February 1980.

G. G. Brown and W. R. Wright, "Identification of Embedded Network Rows in Large-Scale Optimization Models," Computer-Assisted Analysis and Model Simplification, Academic Press, to appear.

G. H. Bradley and G. G. Brown, "Computational Analysis of the BNL Regional Demand Pulp and Paper industrial Process Model," Brookhaven National Laboratories, June 23, 1980.

G. G. Brown and W. G. Wright, "Identification of Embedded Special Structure in Large-Scale Optimization Models," IIASA Large-Scale Optimization, Academic Press, to appear.

Thesis
Directed: "Automatic Identification of Network Rows in Large-Scale Optimization Models," W. G. Wright, Master's Thesis, September 1980.

Title: Stochastic Analysis

Investigators: Peter A. W. Lewis, Professor of Operations
                  Research and Statistics, Donald P. Gaver,
                  Professor of Operations Research and
                  Statistics

Sponsor: Office of Naval Research

Objective: To develop models for the analysis of
                  stochastic point processes and time series,
                  develop new statistical methodology for use
                  in simulations, and to pursue probability
                  modelling, numerical methodology and data
                  analysis techniques for communications net-
                  works and other stochastic systems.

Summary: A very general 2-parameter first-order
                  auto-regressive exponential process
                  (GNEAR (1)) has been derived. This pro-
                  cess will give the full range of correla-
                  tions obtainable with bivariate exponential
                  variates and a wide range of sample path
                  behavior. It is extendable to a complete
                  mixed autoregressive moving average correla-
                  tion structure to give a GNEAR (p,q) process.
                  Multivariate structures open estimation
                  problems and applications in stochastic
                  systems are being investigated.

                  Processes with mixed exponential and Gamma
                  marginals have been derived but this work
                  is not as complete as that for the exponen-
                  tial case.

                  The thinning method for simulating non-homoge-
                  nous Poisson processes has been extended
                  to renewal process. It gives an entirely
                  new way of generating random variables
                  based on the hazard function instead of
                  the probability density function.

                  A statistical and graphical method (regres-
                  sion adjusted graphics and estimation) has
                  been developed and applied to the analysis
                  of regenerative simulations. The method
                  allows a sequential analysis of the size
                  of the simulation required to obtain a
                  given precision in the estimate. The
                  methodology is being applied to other

simulation output analysis problems.
A solution has been obtained to the problem
of obtaining quantile estimates from
(simulated) sequences of dependent data.
The method is robust with respect to initial
transients in the sequence. It uses max-
min and next-to-max-next-to-min transforms
in a folded two-way table of the data. The
output is both point and confidence interval
estimates. The data compaction achieved
in the procedure is very large.

Point process methodology is being applied
to that analysis of sleep-wake behavior
in mice (mus musculus). Initial data
analysis has indicated that there is no
evidence for ultradian rhythms in mice
(mus musculus). Further analysis of cir-
cadian rhythms using complete intensity
functions is underway.

Work continued on the probabilistic study
of delays at communications channels that
cooperatively service data and voice mes-
sages , voice having preemptive priority.

A report was completed on the influence of
information on combat outcome. This work
will be of use in evaluating the contribu-
tion of Command and Control. A second re-
port is in progress.

Models were derived for the performance of
service systems under stress, such as might
be encountered in a Command-Control environ-
ment. A presentation was made at the Annual
ORSA meeting, and another at Bell Telephone
Labs. A paper will be prepared.

Lectures on applied statistics and data
analysis were prepared for, and presented
at, a Summer School in Remote Sensing held
at the University of Dundee, Scotland.
These lectures will appear in a book to be
published by Ellis Horwood, England.

Work continues on convenient methods for
sampling from variations of standard dis-
tributions ("distributional sculpturing")
and for approximating distributions and

their inverses. Some of this is on-going with K. Kafeder of the U.S. Bureau of Standards.

Publications:

P. A. W. Lewis and A. J. Lawrance, "A Mixed Exponential Time Series Model, NMEAR (p,q)," submitted to Management Science.

P. A. W. Lewis and A. J. Lawrance, "A New Autoregressive Time Series Model in Exponential Variables, NEAR (1)," accepted for publication in J. Applied Probability.

P. A. W. Lewis and A. J. Lawrance, "The Exponential Autoregressive-Moving Average Sequence EARMA (p,q)," appeared in J. Roy. Stat. Soc. B, Vol. 42, No. 2, 1980.

D. P. Gaver and P. A. W. Lewis, "First Order Autoregressive Gamma Sequences," appeared in Ad. Appl. Prob., Vol. 12, No. 2, 1980.

P. A. W. Lewis and P. Heidelberger, "Regression-adjusted Estimates for Regenerative Simulations, with Graphics," will appear in Comm. of the ACM in March.

P. A. W. Lewis and A. J. Lawrance, "Generation of Some First-Order Autoregressive Markovian Sequences of Positive Random Variables with Given Marginal Distributions," NPS Technical Report, NPS55Lw-81-003, and will appear in the Proceedings of the AP/CMS conference.

P. A. W. Lewis, "Chapter G of the IMSL Library-Generation and Testing of Random Diviate: Simulation," appeared in the Proceedings of the 1980 Winter Simulation Conference.

P. A. W. Lewis, G. Richardson and W. Dement, "Serial Correlation in Sleep and Wakefulness States in the Mouse: Dependence on Circadian Phase," appeared as a Stanford Technical Report and has been submitted to Science.

D. P. Gaver and P. A. Jacobs, "On Combinations of Random Loads," to appear in <u>SIAM J. for Applied Mathematics</u>.

D. P. Gaver and P. A. Jacobs, "Storage Problems When Demand is 'All or Nothing,'" to appear in <u>Naval Research Logistics Quarterly</u>.

D. P. Gaver and J. P. Lehoczky, "Channels that Cooperatively Service a Data Stream and Voice Messages," submitted to <u>IEEE Trans. on Communications</u>.

J. P. Lehoczky and D. P. Gaver, "Diffusion Approximations for the Cooperative Service of Voice and Data Messages," to appear in the <u>Journal of Applied Probability</u>.

Title:

Stimulated Electromagnetic Shock Radiation Demonstrated Experiment

Investigators:

F. R. Buskirk, J. N. Neighbours, J. N. Dyer, Professor's of Physics and Chemistry; W. Zeleny, Associate Professor of Physics and Chemistry, and R. Spitzer (Stanford)

Sponsor:

Office of Naval Research

Objective:

To measure the radiation produced when electrons passing through a gas under Cerenkov conditions, have an oscillating motion superposed perpendicular to their linear, relativistic motion.

Summary:

This series of experiments has been initiated to verify predictions made by S. Schneider and R. Spitzer for the radiation produced by electrons which are moving in a medium under Cerenkov conditions, with the addition of transverse oscillation of the beam caused by a static or travelling wave wiggler field. Magnetic wigglers are being investigated, because a very high power microwave beam, 20 megawatts in the S Band, will produce the same affect as a 50 gauss static, spatially periodic wiggler field. Two wigglers are being pursued.

1. Iron Core Wiggler. This produces a field amplitude of up to 1.5 k gauss, D.C., period = 8 cm and a gap width of 2 cm.

2. Pulsed Spiral Wiggler. A pulsed spiral arrangement with geometry similar to the superconducting spiral used in the Stanford F.E.L. experiments is being developed.

The iron core wiggler has been installed and is under test. Quantitative measurements of the radiation produced must overcome an unexpected problem: net deflection is given to the electron beam when the magnets are turned on, so that comparison of shock radiation [magnet on and Cerenkov (magnet off)] are not yet quantitative.

Thesis Directed:

W. M. Decker, and J. P. Mackin, "Measurements of Pumped Superluminal Electromagnetic Radiation, Master's Thesis, June 1980.

Title: Ocean Parameters Affecting Sound Propagation

Investigator: Herman Medwin, Professor of Physics and
                    Chemistry

Sponsor: Office of Naval Research

Objective: To determine those oceanographic factors
                    which affect the propagation and detection
                    of sound at sea.

Summary: During FY 1980: 1) We completed our physi-
                    cal model study of diffraction by a seamount
                    and provided the first successful predic-
                    tion of the attenuation due to seamount
                    shadowing, and its frequency dependence, at
                    sea; 2) We demonstrated how the impulse
                    diffraction technique can be used for
                    accurate computer predictions of attenua-
                    tion by a finite noise barrier and
                    3) Our computer model of scattering from
                    the ocean surface clarified the conditions
                    under which the range dependence of the
                    backscattered intensity can vary from
                    R^{-2} to R^{-4}.

Conference
Presentations: H. Medwin and R. Spaulding, "Shadowing by
                    Seamounts," Journal of the Acoustical
                    Society of America, 66, S76, 1979.

                    H. Medwin and R. Spaulding, "The Seamount
                    as a Diffracting Body," Proceedings,
                    Bottom-Interacting Ocean Acoustics
                    Conference, SACLANTCEN, 1980. To be
                    published by Plenum Press 1981.

                    H. Medwin, "Shadowing by Finite Barriers,"
                    Journal of the Acoustical Society of
                    America, 67, p. 87, 1980.

                    H. Medwin and J. C. Novarini, "Rough
                    Surface Backscatter with Secondary
                    Diffraction and Without Kirchhoff
                    Approximation," Journal of the Acoustical
                    Society of America, 67, S67, 1980.

Publications: H. Medwin, "Shadowing by Finite Noise
Barriers," accepted for publication,
Journal of the Acoustical Society of
America, 1981.

H. Medwin, and J. C. Novarini, "Back-
scattering Strength and the Range
Dependence of Sound Scattered from the
Ocean Surface," accepted for publication
in Journal of the Acoustical Society of
America, 1981.

Patents: "Surface Acoustic Signal Defader,"
Inventor, H. Medwin; Assignee, U. S. Navy
Patent Number 4,219,888 granted 26 August
1980.

"Acoustical Deverberator," Inventor,
H. Medwin; Assignee, U. S. Navy, Patent
Number 4,225,954 granted 30 September.

Title: Investigation of Geomagnetic Field Fluctu-
                  ations on the Ocean Floor

Investigators: P. H. Moose, Associate Professor of Electri-
                  cal Engineering, and O. Heinz, Professor of
                  Physics and Chemistry.

Sponsor: Office of Naval Research, and Arms Control
                  and Disarmament Agency

Objective: To determine the nature, level, spectra,
                  spatial coherence, and origins of ULF
                  electromagnetic fields at and near the sea
                  floor.

Summary: This is a continuation of a project begun
                  in 1978. In addition to the Cs-vapor
                  magnetometer previously packaged for under-
                  sea use, a 6000 turn ULF coil antenna and
                  low-noise amplifier system was designed,
                  procured and packaged for underwater oper-
                  ations. Field tests in Monterey Bay show
                  this to be an ideal sensor for the .5 to 25
                  Hz frequency range, thus augmenting the Cs-
                  vapor magnetometer which operates well only
                  at frequencies less than 3 Hz. Also, the
                  coils measure field components in contrast
                  to the Cs-vapor magnetometer, which mea-
                  sures total field strength. Thus we were
                  able to verify experimentally the theore-
                  tical prediction that horizontal field com-
                  ponents are much greater in magnitude than
                  vertical components at the sea floor. Work
                  has also begun on the problem of measuring
                  sea-floor conductivity. The problem of
                  finding a suitable magnetic component gra-
                  diometer for use in the sea will be ad-
                  dressed in the coming year. An undersea
                  digital multichannel data logger is being
                  developed with the assistance of APL/UW.
                  It will record cassettes of 10^6 - 12 bit
                  data samples over experimental periods up
                  to 16 months. This equipment, including
                  playback and decoding for readout, will be
                  available for initial field testing in
                  early 1981.

Thesis
Directed:

E. J. Chaffee, "Low Frequency Geomagnetic
Fluctuations (.01 to 3 Hz) on the Floor
of Monterey Bay," Master's Thesis, December
1979.

G. R. McDevitt and B. B. Homan, "Low Fre-
quency Geomagnetic Fluctuations (.04 to
25 Hz) on Land and on the Floor of Monterey
Bay," Master's Thesis, June 1980.

Title: Transmission of Acoustic Energy from a
                  Fluid Wedge into a Fast Bottom

Investigators: James V. Sanders and Alan B. Coppens,
                  Associate Professors of Physics and Chemistry

Objective: To develop the ability to predict the pro-
                  perties of a sonic beam transmitted into a
                  fast bottom underlying a wedgeshaped fluid-
                  like layer.

Summary: This is a continuation of an ongoing project.
                  Since the summary presented in last year's
                  activity report, the computer analysis has
                  provided beam predictions over a selection
                  of values of densities, speeds of sound,
                  and wedge angles for both finite-distance
                  and infinite-distance sources. The results
                  have revealed the importance of phase coherent
                  interference between adjacent beams in the
                  bottom. The programs have been adapted to
                  allow for losses in the bottom. Empirical
                  expressions for the angle of depression and
                  the beam width of the first beam (resulting
                  from the cutoff of the lowest normal mode)
                  have been obtained; the expressions are
                  simple functions of the ratio of densities,
                  ratio of speeds of sound, wedge angle, and
                  critical angle. The problem has also been
                  reapproached from the theoretical side using
                  the method of stationary phase to isolate the
                  principle contribution of each image to the
                  field at some point in the bottom. This has
                  revealed the importance of diffraction
                  effects, which will be studied this coming
                  year, but also, and most importantly, allowed
                  the problem to be programmed for a moderate
                  sized table top calculator (Wang 2200) with a
                  running time on the order of 5 minutes. The
                  new approach has also provided considerable
                  physical understanding of the nature of the
                  propagation which was not available from the
                  older "brute force" approach.

Publication: A. B. Coppens, J. V. Sanders, N. Bradshaw,
M. Kawamura, and I. Ioannou, "Propagation
of Sound from Water into a Sloping Fast
Bottom," Journal of the Acoustical Society
of America, Suppl. 1, Vol. 66, Fall 1979.

Conference
Presentation: "Propagation of Sound from Water into a
Sloping Fast Bottom," 98th Meeting:
Acoustical Society of America, Salt
Lake City, Utah, 26-30 November 1979.

Thesis
Directed: N. Bradshaw, "Propagation of Sound in a
Fast Bottom Underlying a Wedge-Shaped
Medium," Master's Thesis, September 1980.

Title: Reduced Order Characterization of Circuits
          and Systems

Investigator: S. R. Parker, Professor of Electrical
                 Engineering.

Sponsor: Office of Naval Research

Objective: The investigation of techniques for the
              reduced order modelling of linear and non-
              linear circuits and systems for purposes of
              fault detection and performance analysis.
              The macroscopic model parameters are to be
              developed dynamically from a finite set of
              input/output measurements on the circuit/
              system. The techniques being developed are
              particularly significant in light of the
              rapidly developing technology in very
              large scale integrated circuit technology
              (VSLI) which can be expected to expand on
              line computational capabilities well
              beyond what is available today.

Summary: As a result of research funded this fiscal
            year, several significant results have
            been obtained:

            1. As a result of linear model studies
            using an equation error formulation, the
            coefficients of the denominator of a
            general zero/pole (ARMA) model have been
            related to the coefficients of the all
            pole (AR-autoregressive) model; and the
            coefficients of the numerator of a general
            zero/pole model have been related to the
            all zero (MA-moving average) model coeffi-
            cients. This transitional type of formu-
            lation enables a full set of model para-
            meters, ranging from the all pole model
            through the mixed zero/pole model to the
            all zero model, to be obtained readily
            from measured data.

            2. As an extension of the foregoing
            linear studies, a generalized discrete
            nonlinear ARMA model has been postulated
            and tested. This model is based upon the
            equation error formulation and includes
            discrete Voltefra series expansions for
            the input and output signals, respectively,

and discrete bivariate expansions between the input and output signals. Minimizing a quadratic equation error between the model and system outputs leads to a model parameter estimation procedure which involves the solution of a set of linear equations. The coefficients of these equations involve high order auto and cross correlation function of the input and output data.

3. The foregoing nonlinear ARMA model is linear in the model parameters and has been shown to be applicable to a broad class of interconnected linear and memoryless nonlinear systems. Conditions for the identifyability of such systems in terms of the model parameters (including a test for the existance of zero delay free loops in the system to be modelled) and memory requirements for the model have been derived.

4. It has been demonstrated that multichannel autoregressive and moding average methods can be applied to the modelling of large scale linear and nonlinear systems from discrete measurements of input and output data. Thus, a multiple-input multiple-output linear system can be modelled efficiently by means of a multichannel autoregressive lattice. A nonlinear Volterra system can be modelled by means of a multichannel moving average lattice; and a nonlinear ARMA system can be modelled by means of a multichannel autoregressive lattice. Solutions to these multichannel lattice model parameters can be calculated by either a batch processing of the measurements, or adaptively on-line. The resulting lattice parameters appear to be a powerful set of descriptors for reduced order identification of linear and nonlinear systems

5. Using an extension of a recently published concept of the regular form of nonlinear kernels for Volterra Series, and the definition of hybrid input signals which can be calculated, the general nonlinear ARMA model has been cast in the form of a

linear multichannel lattice filtering problem. This provides a signal unified approach to both linear and nonlinear parametric modelling which is suitable for either batch or adaptive solution. It includes as special cases the linear autoregressive (AR) the linear moving average (MA), the linear autoregressive moving average (ARMA) and the nonlinear Volterra models. Funding for the continuation of this work has been received.

Publications:

"The Use of Lattice Modelling for Large Scale Linear and Nonlinear Systems," with F. A. Perry and M. Romeo, 1980 IEEE International Conference on Circuits and Computers, Rye, New York, 1-3 October 1980.

"Adaptive Solutions of Multichannel Lattice Models for Linear and Nonlinear Systems," with F. A. Perry, 1980 IEEE International Symposium on Circuits and Systems Proceedings, pp. 744-747, Vol. 3, 80CH1564-4.

"An Autoregressive Moving Average (ARMA) Discrete Nonlinear Model," 1980 IEEE International Symposium on Circuits and Systems Proceedings, pp. 918-920, Vol. 3, 80CH1564-41.

"Recursive Solutions for Zero-Pole Modelling," with F. A. Perry, 13th Asilomar Conference on Circuits, Systems, and Computers, Nov. 1979, pp. 509-512, IEEE Catalog #79Ch1468-8C.

"Reduced Qrder Modelling of Analog Circuits," presentation at the 1979 IEEE International Symposium on Circuits and Systems, Tokyo, Japan. Seminar presentations at Kobe University and Tokyo University, Japan.

Thesis Directed:

F. A. Perry, "Parametric Modelling of Linear and Nonlinear Systems," Ph.D Thesis, June 1980.

Title: Oceanic Thermal Response to Atmospheric
                  Forcing

Investigators: Russell L. Elsberry, Professor of Meteoro-
                  logy, and Roland W. Garwood, Jr., Assis-
                  tant Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To understand through numerical model simu-
                  lations and data analysis the role of
                  atmospheric forcing in the dynamics of the
                  upper layers of the ocean.

Summary: During the past few years we have demon-
                  strated that a major fraction of the near-
                  surface ocean thermal structure changes can
                  be related to the diurnal and synoptic
                  time-scale atmospheric forcing. An ocean
                  circulation model with an embedded mixed
                  layer has been developed (Adamec, Elsberry,
                  Garwood and Haney, 1980) as a tool to better
                  understand the three-dimensional oceanic
                  response to strong forcing. The first
                  application of this new tool has been to
                  study the oceanic response to hurricane
                  forcing. We have been able to simulate the
                  basic differences in oceanic response to
                  fast-moving versus slow-moving hurricanes.

Publications: R. L. Elsberry, D. Adamec, R. W. Garwood,
                  Jr., and R. L. Haney, "An Embedded Mixed
                  Layer-Ocean Circulation Model," Dynamics
                  of Atmospheres and Oceans, Submitted for
                  publication.

                  R. L. Elsberry, R. W. Garwood, Jr., "Numer-
                  ical Ocean Prediction Models -- Goal for the
                  1980's," Bulletin of American Meteorological
                  Society, 61, #12, December 1980.

                  R. L. Elsberry, R. W. Garwood, Jr., "First
                  Generation Numerical Ocean Prediction Models
                  -- Goal for the 1980's," NPS Technical Re-
                  port, NPS63-79-007, 1979, 41 pp.

                  R. W. Garwood, Jr., "Air-Sea Interaction and
                  Dynamics of the Surface Mixed Layer," Rev.
                  Geophys. Space Phys., 17, 1507-1524.

Conference
Presentations: D. Adamec, R. L. Elsberry, R. L. Haney,
                   and R. W. Garwood, Jr., "Coupling a
                   Mixed Layer Model with a General Circula-
                   tion Model," presented at 1979 AGU Fall
                   Meeting, abstract in EOS, 60, 862.

                   R. L. Elsberry, G. W. Garwood, Jr., and
                   D. Adamec, "Numerical Simulation of the
                   Effect of Surface Heating and Stratifica-
                   tion upon an Ocean Surface Density Front,"
                   presented at Third Conference on Ocean-
                   Atmosphere Interaction, Los Angeles, CA.
                   January 1980, abstract in Bull. American
                   Meteorological Society, 60, 1244.

                   R. L. Elsberry, B. W. Budd, P. C. Gallacher
                   and R. W. Garwood, Jr., 1980, "Prediction
                   of Sea-Surface Temperature Anomalies Gener-
                   ated During Spring Transition," presented
                   at Third Conference on Ocean-Atmosphere
                   Interaction, Los Angeles, CA, January
                   1980, abstract in Bull. American Meteorolog-
                   ical Society, 60, 1244.

Thesis
Directed: R. Shook, "The One-Dimensionality of the
                   Upper Ocean and the Role of Mixing and
                   Advection During the POLE Experiment,
                   Master's Thesis, 1980.

Title: Numerical Modeling of Large-Scale Ocean
Variability

Investigator: Robert L. Haney, Associate Professor Meteor-
ology

Sponsor: Office of Naval Research

Objective: To continually develop and improve a numeri-
cal model of the North Pacific Ocean and
to use the model to identify processes re-
sponsible for the formation and evolution of
large-scale thermal anomalies in the ocean.

Summary: During the period of this research, consider-
able attention was given to a study of the
climatological distribution of synoptic storm
activity over the North Pacific Ocean using
6-hourly surface wind analyses obtained from
FNOC. This wind data will be used to drive
a new embedded mixed layer ocean circulation
model in a 10 year hindcast (1969-78) of
the currents and temperature structure in the
Central mid-latitude North Pacific Ocean.

Publications: R. L. Haney, "A Numerical Case Study of the
Development of Large Scale Thermal Anomalies
in the Central North Pacific Ocean," J. Phys.
Oceanogr., 10 (1980), p. 541-556.

R. L. Haney, M. S. Risch and G. C. Heise,
"Wind Forcing due to Synoptic Storm Activity
Over the North Pacific Ocean," submitted to
Atmosphere-Ocean.

D. Adamec, and R. L. Elsberry, R. W. Garwood
Jr., and R. L. Haney, "An Embedded Mixed Lay-
er-Ocean Circulation Model," submitted to
Dyn. Atmos. Oceans.

Conference
Presentations: R. L. Haney, "A Numerical Study of the
Development of Large-Scale Thermal Anomalies
in the Central North Pacific Ocean," XVII
General Assembly of the IUGG, Canberra,
Australia, 2-15 December 1979.

D. Adamec, R. L. Elsberry, R. L. Haney and
R. W. Garwood, Jr., "Coupling a Mixed-Layer
Model with a General Circulation Model,"
Fall Annual Meeting of the AGU, San Francisco,
3-7 December 1979.

R. L. Haney, and M. S. Risch, "On the Pumping
and Mixing of the Ocean by Synoptic Storm
Activity," AMS Third Conference on Air Sea
Interaction, Los Angeles, 30 January - 1
February 1980.

Title: Beam Quality in Eximer Lasers

Investigators: Allen E. Fuhs, Distinguished Professor of Aeronautics, and Physics and Chemistry, Mr. Gregory A. Blaisdell, California Institute of Technology

Sponsor: Office of Naval Research

Objective: Investigate Transient index of refraction in an e-beam pumped XeF excimer laser.

Summary: Transient refractive index was calculated for an e-beam pumped XeF laser having initial concentrations $Ne:Xe:NF_3::95.5:4.3:0.2$. The calculation used Ne in excited states including the transition array $3s \to 4p$ and all other constituents in ground state. Lines in $3s \to 4p$ array may be resonant with XeF radiation. To obtain the transient populations for Ne, a modification was made to a Naval Research Laboratory computer code which typically accounts for 180-200 reactions involving 50-60 different species. The modified program included populations in 12 electronic configurations of Ne. Electron beam current was changed 10 per cent at constant voltage to simulate the influence of a hibachi shadow. For a nonresonant laser wavelength, an optical pathlength in the laser, L, less than 35 meters will have distortion δ/λ less than 0.1; however, for a laser wavelength in resonance with Neon, L of only 0.11 meter will cause $\delta/\lambda = 0.1$. The difference in optical pathlength is δ.

Publication: Allen E. Fuhs, James Etchechruy, Lonnie Cole, and Gregory A. Blaisdell, "Transient Refractive Index in a XeF Laser," NPS Technical Report NPS67-80-012, September 1980, pp. 45.

Conference
Presentation: The paper was presented by Dr. Allen E. Fuhs at the 1980 Annual Meeting of the Optical Society of America at Chicago, Illinois, 14-17 October 1980.

Theses
Directed: James Etchechury, "A Simple Model for
Calculating the Index of Refraction of
Neon I and Neon*(3_s) in the Cavity of a
Xenon Fluoride Laser," <u>Master's Thesis</u>,
June 1979.

Lonnie William Cole, "Computer Program
for Kinetics and Populations in a XeF
Laser," <u>Master's Thesis</u>, December 1979.

Title: Axial Compressor Flow Fields

Investigator: Raymond P. Shreeve, Associate Professor of
                    Aeronautics

Sponsor: Office of Naval Research

Objective: To improve our understanding of flow fields
                    in axial compressors and to obtain detailed
                    measurements against which new computer codes
                    can be verified.

Summary: The complete definition of the flow field
                    leaving a high speed single stage axial rotor
                    in a rotor-first arrangement is being attempted
                    using a new measurement technique. Two
                    simi-conductor probes of simple geometry are
                    used together with "synchronized sampling"
                    to measure the periodic component of the
                    velocity (vector) field. Comparison with
                    two component LDV measurements of the same
                    flow field is planned. To date, the distri-
                    bution of flow yaw angle on the annulus center-
                    line has been measured in the compressor using
                    a single probe, and the first data were ob-
                    tained from the compressor with a system of
                    two probes. Multiple techniques for deriving
                    the velocity vector from the two probe system
                    have been devised and the required software
                    has been written. Tests to obtain rotor exit
                    velocity map data at high rotational speeds
                    will resume shortly.

Publications: R. P. Shreeve, A. G. McGuire, and J. A. Hammer,
                    "Calibration of a Two Probe Synchronized
                    Sampling Technique for Measuring Flows Behind
                    Rotors," paper presented at IEEE International
                    Congress on Instrumentation in Aero-Space
                    Simulation Facilities, Monterey, CA. Septem-
                    ber 24-26, 1979. Proceedings, ICIASF'79
                    Record, IEEE Catalogue No. 79CH1500-8AEs.

                    D. Adler, and R. P. Shreeve, "A General
                    Procedure for Obtaining Velocity Vector from
                    a System of High Response Impact Pressure
                    Probes," Naval Postgraduate School Techni-
                    cal Report, NPS67-79-007, July 1979.

                    D. Adler, and P. M. Taylor, "A Procedure
                    for Obtaining Velocity Vector from Two High
                    Response Impact Pressure Probes," Naval
                    Postgraduate School Technical Report, NPS67-
                    80-007, August 1980.

Title: Studies of the Oceanic Planetary Boundary
                   Layer

Investigator: Roland W. Garwood, Jr., Assistant Professor
                   of Oceanography

Sponsor: Office of Naval Research

Objective: To understand by means of model simulations
                   and data analysis the role of the oceanic
                   planetary boundary layer in the distribu-
                   tion of energy, momentum and mass in the
                   upper ocean.

Summary: This project is in part a continuation of
                   studies begun in an ONR-sponsored project
                   with R. L. Elsberry from 1976 to 1980.
                   There are two primary new elements to be
                   undertaken this year: (i) a model study of
                   the response of a two-dimensional upper ocean
                   density front to local non-stationary atmos-
                   pheric forcing, and (ii) a critical examina-
                   tion of turbulence dynamics and process para-
                   meterization in mixed layer model closure.
                   The first of these elements is now possible
                   only because of the successful embedding
                   of the Garwood (1977) turbulence closure
                   mixed layer model into the Haney (1975)
                   ocean circulation model. This task was com-
                   pleted by Adamec, Elsberry, Garwood and
                   Haney under the sponsorship of the Naval
                   Postgraduate School Foundation and the Office
                   of Naval Research from 1977 to 1980.

Publications: R. W. Garwood, Jr., "Air-Sea Interaction and
                   Dynamics of the Surface Mixed Layer," a U.S.
                   Report to the International Union of Geodesy
                   and Geophysics, in Reviews of Geophysics and
                   Space Physics, 17 (7), 1507-1524.

                   R. L. Elsberry and R. W. Garwood, Jr., "Nu-
                   merical Ocean Prediction Models--Goal for
                   the 1980's," accepted for publication in
                   the Bulletin of the American Meteorological
                   Society.

Conference
Presentations: R. W. Garwood, Jr., D. Adamec and R. L.
                    Elsberry, "Numerical Simulation of the
                    Effect of Surface Heating and Stratifica-
                    tion upon an Ocean Surface Density Front,"
                    presented at Third Air-Sea Interactions
                    Conference of the American Meteorological
                    Society, January 1980, Los Angeles.

                    D. Ademec, R. L. Elsberry, R. W. Garwood
                    and R. L. Haney, "Coupling a Mixed Layer
                    Model with a General Circulation Model,"
                    presented at the Fall Annual Meeting of
                    the American Geophysical Union, December
                    1979, San Francisco.

Title: Biology of Stone and Wood Boring Animals in the Monterey Submarine Canyon and the Deeper Waters Off the Central California Coast

Investigator: E. C. Haderlie, Distinguished Professor of Oceanography

Sponsor: Office of Naval Research

Objective: To determine the distribution of stone and wood borers in the deeper waters of Monterey Bay and offshore of wood and various kinds of stone in the sea.

Summary: During the Fall of 1979 and the first half of 1980 new arrays in deeper water have been deployed and recovered for analysis of borer activities. Samples of stone known to carry infestations of borers have been brought to the laboratory on a regular basis and x-rayed to determine rates of growth.

Publications: E. C. Haderlie, 1980a, "Seastar Predation on Rock Boring Bivalves," The Veliger 22 (4): 392.

E. C. Haderlie, 1980b, "Stone Boring Marine Bivalves from Monterey Bay, California," The Veliger, 22 (4): 345-354.

E. C. Haderlie, 1980c, "Stone Boring Marine Bivalves as Related to the Geology of Monterey Bay, California," pp. 231-248; Proceedings of the 5th International Congress on Marine Corrosion and Fouling, Editorial Garci, Madrid, Spain.

Title: Synoptic Studies of Oceanic Fronts

Investigator: Christopher N. K. Mooers, Professor and
Chairman of Oceanography

Sponsor: Office of Naval Research

Objective: This was the first year of a two-year study
of oceanic fronts being conducted as part
of the ONR-sponsored, multi-institutional
informal program called FRONTS, which in-
volves a field study, and subsequent analysis,
of the North Pacific Subtropical Front. The
field study was mainly conducted between
early December 1979 and late February 1980.
It involved two research vessels, Navy P3
aircraft, satellite-tracked drifters, and
about twenty individual projects. The NPS
project had as its motivating objective the
development of a diagnostic model to im-
prove our ability to analyze oceanic fronts.
The project has several preliminary compo-
nents directed to achieve the above objec-
tive, and to support the overall field
study:

     1.   The analysis of synoptic scale
atmospheric forcing information available
from FNOC in the FRONTS domain, which is
ca. 10° x 10° x 100 days.

     2.   The analysis of ocean thermal
fields available from FNOC.

     3.   The analysis of GOES WEST IR
imagery using the SPADS image processing
facility at NEPRF.

A subsidiary objective is to evaluate the
FNOC and NEPRF products vis-a-vis the "Sea
Truth" available from the FRONTS field
study. This evaluation is a necessary pre-
cursor to producing an enhanced analysis.

Summary: At the end of the first year, the data base
referred to in 1 and 2, above had been ac-
quired from FNCO by subcontractors and set-
up and screened at NPS. They were examined
and partially reported to interested inves-
tigator to one of whom a complete copy was

sent on computer tape. Due to difficulties associated with equipment upgrades, SPADS was unable to capture GOES WEST data during FRONTS as referred to in 3 above. However, a copy of the data was purchased from the University of Wisconsin for processing on SPADS by subcontractors. Due to extensive cloud cover, not much of the sea surface was detectable during FRONTS. There is some hope that at least one usable image will be produced.

As noted below, an abstract was submitted for presentation of very preliminary results at the December 1980 meeting of the American Geophysical Union.

In the next year, it is planned to further analyze the atmosphere forcing and ocean thermal structure fields, to participate in the program-wide integration of results, and to develop and evaluate the diagnostic model. A search to fill a postdoctoral level position to work on this project is still in progress. Planning of future studies is also intended.

Publication: C. N. K. Mooers, "Atmospheric Forcing and GOES IR Imagery During FRONTS," EOS, 61, (46): 1001 (abstract only), 1980.

Title: Kinematics of Breaking Waves in the Surf
Zone

Investigator: Edward B. Thornton, Associate Professor of
Oceanography

Sponsor: Office of Naval Research

Objective: Basic studies are being made on the kine-
matics of breaking waves within the surf
zone in the field. The specific objectives
of the proposed research are: (1) determine
breaking criterion as a function of depth,
beach slope and wave frequency and (2)
determine the transformation of waves across
the surf zone due to energy conversion and
dissipation in the breaking process.

Summary: This research is being accomplished at
various field sites for the conditions of
spilling, plunging and collapsing breaking
waves. Waves and orthogonal water particle
velocities are measured at a large number
of locations within the surf zone. The spec-
tral characteristics and probability density
functions for breaking waves and water par-
ticle velocities are calculated.

Measurements have been made on both sandy
beaches and coral reefs. The dynamics of
wave transformation are similar and are
shown to be highly nonlinear. Energy is
transferred from the primary spectral wave
frequency to higher and lower frequencies
in the shoaling and subsequent breaking
process. The energy transferred to higher
frequencies results in secondary waves at
harmonic frequencies and a cascade of energy
in a saturation range above the harmonic
region. Stochastic wave transformation
models of breaking waves are being deve-
loped and give reasonable comparisons with
measurements.

Publications: R. T. Guza, and E. B. Thornton, "Local and
Shoaled Comparisons of Sea Surface Elevations,
Pressures and Velocities," Journal Geophys.
Res., Vol. 85, 1524-1530, 1980.

R. T. Guza, and E. B. Thornton, "Wave Set-Up on a Natural Beach," accepted by Journal Geophys. Res., 1980.

D. A. Huntley, R. T. Guza, and E. B. Thornton, "Field Observations of Surf Beat: Part 1, Progressive Edge Waves," submitted to Journal of Geophys. Res., 1980.

E. B. Thornton and R. T. Guza, "Longshore Currents and Bed Shear Stress," Proc. of Euromech '80, abstract, 1980.

Title: Satellite and Synoptic Studies of Bio-Chemi-
          cal Fronts in the Ocean

Investigator: Eugene D. Traganza, Associate Professor of
                 Oceanography

Sponsor: Office of Naval Research

Objective: Development of a satellite referenced, synop-
              tic model of the evolution and ecological
              significance of chemical fronts associated
              with upwelling and upper ocean mixing pro-
              cessess.

Summary: Satellite remote sensing of thermal patterns
            of the sea surface and underway sampling has
            led to the discovery of distinctively struc-
            tured upwelling systems off Pt. Sur, CA.
            Thermal patterns with the appearance of cy-
            clonic motion and sharp thermal fronts fre-
            quently form over Sur Canyon. At times
            upwelling waters also form giant plumes
            extending more than 250 km across the Califor-
            nia current. In ten seasonal cruises since
            December 1978, nutrient fronts were strongly
            correlated with thermal fronts. However,
            upwelling fronts which are well defined by
            IR satellite imagery may not be nutrient
            rich. When they are, the strong chemical
            gradient is an excellent potential source
            of nutrients and may represent a nutrient
            flux to which production is quantitatively
            related. Microplankton in the surface lay-
            er (2.5m) show a preference to grow in the
            gradients and particularly on the equator-
            ward edge of cyclonic upwelling systems.
            High adenosine triphosphate or "ATP-biomass"
            and high guanosine triphosphate or "GTP-pro-
            ductivity" were found in the strong thermo-
            chemical gradient associated with a newly
            upwelled system in June 1980. Although the
            surface circulation is not sufficiently
            known for computation of surface fluxes, a
            good correlation between productivity and
            nutrient flux is suggested qualitatively in
            the data. Images from satellite "color
            slicing" data have been calibrated to pro-
            duce nutrient maps from which quantitative
            inference on mean nutrient fluxes and biomass
            distributions can be made.

Publications: E. D. Traganza, J. C. Conrad and L. C. Breaker, "Satellite Observations of a Cyclonic Upwelling System and Giant Plume in the California Current," in Coastal Upwelling Research, 1980. (1981) American Geophysical Union (In Press).

E. D. Traganza, D. A. Nestor and A. K. McDonald, "Satellite Observations of a Nutrient Upwelling Off the Coast of California," Journal of Geophysical Research, 85, 4101-4106 (1980).

E. D. Traganza, J. W. Swinnerton and C. H. Cheek, "Methane Supersaturation and ATP-Zooplankton Blooms in Near-Surface Waters of the Western Mediterranean and the Subtropical North Atlantic Ocean," Deep Sea Research, 26, 1237-1245 (1979).

Presentations: E. D. Traganza, "Chemical Fronts in the California Current," Gordon Research Conference on Chemical Oceanography, January 28 to February 1, 1980. Miramar Hotel, Santa Barbara, CA. (1980) (Poster Paper).

E. D. Traganza and J. C. Conrad, "Satellite and in situ Observations of Nutrient Upwelling and Microplanktonic Biomass in the California Current System," IDOE International Symposium on Coastal Upwelling, February 4-8. 1980. USC Conference Center, Los Angeles, California. (1980) AGU, AMS, ASLO, NSF. (Plenary Paper).

E. D. Traganza, "Satellite and in situ Studies of Upwelling Frontal Systems in the California Current," National Research Council Seminar-Workshop on Underway-Water Sampling Technology, February 11-12, 1980. National Academy of Sciences, Washington, D. C. (1980) (Panel Presentation).

Thesis Directed: W. E. Hanson, "Nutrient Study of Mesoscale Thermal Features Off Point Sur, California," Master's Thesis, September 1980.

S. H. Bronsink, "Microplankton ATP-Biomass and GTP-Productivity Associated with Up-welling Off Point Sur, California," Master's Thesis, September 1980.

J. E. Johnson, "Subsurface Dynamical Proper-ties of Variable Features Seen in Satellite IR Imagery Off Point Sur and Their Acoustic Significance," Master's Thesis, June 1980.

R. W. Phoebus, "Distribution of Chlorophyll Biomass in Chemical Mesoscale Features Detected by IR Satellite Imagery," Master's Thesis, 1980.

J. W. Conrad, "Relationships Between Sea Surface Temperature and Nutrients in Satellite Detected Oceanic Fronts," Master's Thesis, March 1980.