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NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS.(U)
SEP 80 L R SCOTT   F49620-79-C-0149

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

Several problems relevant in the application of mechanics to real-world problems were treated. The work included theoretical analysis of solutions of partial differential equations, detailed studies of numerical techniques for approximately solving differential equations arising in mechanics, as well as actual numerical computations using such numerical schemes to model experimental → next page

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20. ABSTRACT (Cont'd.)

phenomena. Application areas impacted by this research include heat conduction and fluid mechanics. Also closely related are problems arising in the study of controlled fusion. In addition, the work has added significantly to theoretical understanding of numerical methods for solving various partial differential equations.

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NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

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September 1980

Interim Report No. 1 for the Period: 1 July 1979 to 30 June 1980

Prepared for

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Building 410, Bolling Air Force Base
Washington, D.C. 20332

Progress Report on Work Originally Proposed: Ridgway Scott

1. <u>Maximum-norm estimates for finite element methods</u>.

A general approach was found that unifies the analysis of several different techniques for treating Dirichlet boundary conditions, giving a significant simplification over the analysis in [8]. A manuscript reflecting this entitled "Optimal maximum-norm error estimates for some finite element methods for treating the Dirichlet problem" has been written jointly with C. I. Goldstein and will be submitted for publication.

During a visit in Bonn last summer, the proposer learned that Dobrowolski had recently considered the second research problem described in this area (see original proposal) in a special case, the implicit Crank-Nicolson scheme. Discussions were had concerning generalization of his results to more practical schemes, e.g., linearized Crank-Nicolson. Further work in this area will be pursued.

2. <u>Numerical simulation of nonlinear dispersive waves</u>.

A numerical scheme for an initial - and boundary - value problem that is fourth-order accurate in both space and time was developed. This was used to compare solutions of the model equation (2.1) appearing in the original proposal with experimental data. The flexibility of the computer code allowed modification of the dispersion (D_o) and dissipation (D_1) operators defined there to fit more closely model assumptions. In this way, it was possible to explain some observed experimental effects that, at first, appeared to contradict the model. Also, this made it possible to study the effects of different forms of dissipation. A manuscript describing these results entitled "A comparison of laboratory experiments with a model equation for water waves" had been written jointly with J. L. Bona and W. G. Pritchard. This will be submitted for publication.

Progress Report on Work Originally Proposed: Mitchell Luskin

1. Approximation of the spectral properties of closed operators.

The proposer has written a paper "Approximation of the spectral properties of closed operators: the determination of normal modes of a rotating basin" with Jean Descloux and Jacques Rappaz which contains a complete analysis of the problems discussed in the original proposal. This paper will appear in Mathematics of Computation, Jan., 1981.

2. A collocation-Galerkin method for nonlinear first-order hyperbolic systems.

The proposer has established existence and regularity of solutions to the nonlinear hyperbolic system of equations used to model the flow of gas in a pipe. These results give a rigorous justification of assumptions made by previous researchers on the qualitative nature of the solutions of these equations. A paper entitled "On the existence of global smooth solutions for a model equation for fluid flow in a pipe" on this research has been written and will be submitted for publication.

Further analysis of numerical procedures for gas transmission equations is planned which will utilize this theoretical work.

3. Finite element methods for hyperbolic systems.

The proposer has written a preliminary report giving optimal order error estimates for a numerical procedure for a linearization of the shallow water equations. The current research effort is now being directed to developing a generalization of this procedure and its analysis to the nonlinear shallow water equations and to a wider class of boundary conditions.

LIST OF PROFESSIONAL PERSONNEL ASSOCIATED WITH THE RESEARCH EFFORT:

1. Faculty Investigators at University of Michigan

   L. Ridgway Scott
   M. Luskin

2. Professor Rolf Rannacher, University of Bonn, West Germany (partially supported by the University of Michigan as a Visiting Associate Professor during the 1979-80 academic year).