Review of Progress in QUANTITATIVE NONDESTRUCTIVE EVALUATION

Edited by Donald O. Thompson
and Dale E. Chimenti

Volume 4A

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QUANTITATIVE NONDESTRUCTIVE EVALUATION

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PREFACE

This volume (parts A and B) contains the edited papers presented at the annual Review of Progress in Quantitative NDE held at the University of California, San Diego, July 8-13, 1984. We have chosen to organize the papers by subject, an arrangement that we feel to be more useful for a reference volume than the order of paper presentation at the Review. To do this, topical subject headings have been selected under which the large majority of papers reasonably fall. These categories cover a broad spectrum of research in NDE and encompass activities from fundamental work to early engineering applications. The scope and depth of the Review may be easily assessed by examination of the Table of Content The Review was sponsored by the Center for Advanced NDE at the Ames Laboratory of the U.S. Dept. of Energy in cooperation with the Office of Basic Energy Sciences, USDOE, the Materials Laboratory at Wright-Patters AFB, and the Naval Sea Systems Command. Approximately 300 attendees representing various government agencies, industry, and universities parti cipated in the technical presentations, poster sessions, and discussions This Review, possibly the most comprehensive annual symposium in NDE, provides a valuable forum for the timely exchange of technical information. A few highlights of the Review are summarized in the following paragraphs.

Dr. Gary H. Glover of General Electric, Medical Systems Business Group, presented the keynote address on magnetic resonance imaging and its use in characterizing the internal structure of living tissue. In his paper, Dr. Glover describes several facets of this powerful imaging technique including volume imaging with relaxation time and chemical shift methods and system performance considerations. He concludes his paper with a brief discussion of potential NDE applications of this technique.

Major consideration was given in this conference to ultrasonic NDE, and several interesting developments in this topic are reported in Chapter 1. A decision-theoretic approach to flaw detection is shown to result in significant experimental improvements in signal-to-noise ratio in real-time signal processing. The interaction of a spatially varying elastic field from a transducer with a flaw of comparable dimensions has been modeled, and several other papers deal with the practical treatment of signals from commercial ultrasonic transducers and systems. In another development, tomographic reconstruction from ultrasonic attenuatio and velocity has been made to yield defect and material property informa tion.

A number of advances were reported that deal with techniques for th detection and characterization of surface-connected flaws. In Chapter 2

on eddy current technology, an unusual application of a highly sensitive SQUID device to map the magnetic field of an eddy-current coil is reported. A series of papers that relate to the display of low frequency eddy-current data using methods derived from holographic image reconstruction and which produced a lively exchange at the Review is also given. Impressive results are reported in Chapter 3 that deal with the inversion of eddy-current data. In measurements on narrow slots in flat plate specimens, it is shown that slot length, depth, and opening could be deduced by analyzing two-dimensional scan data according to a recent theory for non-uniform coil fields. Papers that report the use of less traditional techniques for surface flaw detection and characterization are consolidated in Chapter 4. In a departure from typical detection methods used in thermal imaging, it is shown that the phase perturbation of an acoustic wave propagating in air just above a heated zone can be used to infer the thermal properties of the solid. Another paper reports the application of sensitive magneto-optic film materials to flaw visualization in ferrous materials.

A number of advances in inverse theoretical techniques and additional applications of inverse procedures to ultrasonics and eddy current technology were reported. It is shown in Section A of Chapter 3 that the use of a sensitivity matrix to assess the effects of noise and band limiting upon the quality of flaw reconstruction may provide a useful "bridge" between inverse theory and practical application. Section B includes a description of a technique to detect and characterize small surface flaws in ceramics using leaky Rayleigh waves. It is shown that the size of the cracks can be obtained from the acoustic spectra and that the spectra are not strongly dependent on the crack orientation. An interesting application of a probabilistic technique to size and classify flaws is also given in this section. In this case, the power spectrum of the reflected ultrasonic wave is utilized to obtain the information.

With the arrival of in-process inspection and control has come an awareness of the need for accurate measurement of material properties. The large number of papers in Chapter 5 reflect the justified interest in this growing area. Headed by a review article on material processing, this group includes work on thermal imaging to characterize thin coatings, acoustic resonance, and ultrasonic scattering to determine the porosity content of materials. Lamb-wave coupling between two plates through the nugget of a spot weld is proposed as a measurement of weld strength. Several papers treat the problem of wave propagation in the presence of crystal grains, and acoustic microscopy is demonstrated in application to surface characterization. Related research is contained in Chapter 6 on acoustoelasticity and stress. Since the stress state of a manufactured component can be a critical design parameter, reliable determination of residual stress in the presence of crystalline texture would be a highly useful capability. Work relating to stresses in plates, interfacial stresses, and temperature effects is reported here.

This Review included several new features. Papers from a session on product liability issues that arise from an increased reliance on NDE to assure conformance to product quality standards are included as Section A of Chapter 8, while nondestructive evaluation system reliability forms the subject of a group of papers collected in Section B. Topics covered range from statistical aspects of inspection to system performance modeling. A regular element of the Review over the past half-dozen years

has been an informal evening discussion session which focusses attention on current NDE problems. Because of the substantial interest generated among participants by this year's topic, Education for NDE Engineers, the editors have included papers and the edited transcript drawn from discussions at that session as Chapter 9.

The organizers of the Review wish to acknowledge the encouragement provided by the management of the Ames Laboratory and the cooperation of the various agencies recognized in the first paragraph of this Preface. They especially wish to thank Dr. Gary Glover of General Electric's Medical Systems Business Group for his excellent discussion of magnetic resonance imaging techniques. They are also grateful to Drs. H. Wadley, National Bureau of Standards, W. R. Scott, Naval Air Development Center, P. Gammel, Naval Surface Weapons Center, C. Annis, Pratt & Whitney, A. Berens, University of Dayton Research Institute, S. Marinov, Dresser Atlas, H. Sabbagh, Analytics, Inc., and O. Smith, Rockwell International Science Center, for their assistance in arranging selected sessions, and to the chairpersons and participants at the Review who initiated and contributed to the lively discussions. The organizers are particularly indebted to Mrs. Diane Harris who managed the logistics of the Review, to Ms. Linda Martin for her preparation of Review materials and assistance at the meeting, and to Ms. Margaret Pickett for her preparation of this manuscript and many details of the Review preparations.

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