Review of Progress in
QUANTITATIVE
NONDESTRUCTIVE
EVALUATION

Volume 17A

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Review of Progress in

QUANTITATIVE NONDESTRUCTIVE EVALUATION

Volume 17A

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PLENUM PRESS • NEW YORK AND LONDON

The Library of Congress has cataloged earlier volumes of this title as follows:

Library of Congress Cataloging in Publication Data

Main entry under title:

Review of progress in quantitative nondestructive evaluation.

"Proceedings of the Eighth Air Force/Defense Advanced Research Projects Agency Symposium on Quantitative Nondestructive Evaluation, held August 2-7, 1981, at the University of Colorado, Boulder" — Vol. 1, verso t.p.

"First half of the proceedings of the ninth review of progress in quantitative nondestructive evaluation, held August 1-6, 1982, at the University of California, San Diego, California"—Vol. 2A, t.p. verso.

"Proceedings of the Tenth Annual Review of Progress in Quantitative Nondestructive Evaluation, held August 7-12, 1983, at the University of California, Santa Cruz, California"—Vol. 3, verso CIP t.p.

Includes bibliographical references and index.

1. Nondestructive testing—Congresses. I. Thompson, Donald O. II Chimenti, Dale E. III. United States. Air Force. IV. Air Force/Defense Advanced Research Projects Agency Symposium on Quantitative Nondestructive Evaluation (8th: 1981: University of Colorado, Boulder) V. United States. Defense Advanced Research Projects Agency.

TA417.2.R48 1982

620.1'127

82-9140

ISBN 978-1-4613-7436-7 ISBN 978-1-4615-5339-7 (eBook)
DOI 10.1007/978-1-4615-8291-5

First half of the proceedings of the Twenty-Fourth Annual Symposium on Quantitative Nondestructive Evaluation, held July 27–August 1, 1997, in San Diego, California

© 1998 Plenum Press, New York

Softcover reprint of the hardcover 1st edition 1998

A Division of Plenum Publishing Corporation
233 Spring Street, New York, N.Y. 10013
<http://www.plenum.com>

10 9 8 7 6 5 4 3 2 1

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PREFACE

These Proceedings, consisting of Parts A and B, contain the edited versions of most of the papers presented at the annual Review of Progress in Quantitative Nondestructive Evaluation held at University of San Diego, San Diego, CA, on July 27 to August 1, 1997. The Review was organized by the Center for NDE at Iowa State University, in cooperation with the Ames Laboratory of the USDOE, the American Society of Nondestructive Testing, the National Institute of Standards and Technology, the Federal Aviation Administration, and the National Science Foundation Industry/University Cooperative Research Centers.

This year's Review of Progress in QNDE was attended by approximately 370 participants from the US and many foreign countries who presented a total of approximately 350 papers. As usual, the meeting was divided into 36 sessions with four sessions running concurrently. The Review covered all phases of NDE research and development from fundamental investigations to engineering applications and inspection systems, and methods of inspection science from acoustics to x-rays. The Review continues to experience some fluctuations in size, mostly under pressure from a decrease in funding for NDE research at the US Federal level, but increased participation from foreign laboratories has more than made up the difference. The Review is ideally sized to permit a full-scale overview of the latest developments in a collegial atmosphere that most participants favor.

The opening plenary session this year concentrated on advances in imaging technologies and methodologies that have been made in recent years. Dr. K. Wickramasinghe of the IBM T. J. Watson Research Center discussed advances in scanning probe microscopy that have been made in recent years. Special attention was given to a discussion of the scanning tunneling microscope (STM) and the atomic force microscope (AFM). Dr. Wickramasinghe has made many important contributions to QNDE in the past. It was indeed a pleasure to welcome him back as the keynote speaker. Professor James Oliver of Iowa State University and Dr. William Green of the Jet Propulsion Laboratory at the California Institute of Technology completed the Plenary Sessions with overview papers on interactive visual supercomputing and digital processing of remotely sensed imagery. Prof. Oliver's talk highlighted recent advances in the use of virtual reality as an interface tool to explore results of simulations. Dr. Green provided an excellent discussion of digital processing technologies and provided an extremely timely highlight in the form of images from the Mars Pathfinder mission.

One of the traditions of the QNDE review is the Wednesday evening special session, a session that is designed to focus attention on current events that may influence research and development activity in NDE. This year's invited speaker was Mr. Tobey M. Cordell, NDE Branch Chief, Metals, Ceramics, and NDE Divisions at the Wright Laboratory. In his talk, "NDE: A Full Spectrum Technology," Mr. Cordell discussed Air Force NDE activities that

extend through and include all elements of the use cycle of military aircraft. It was followed by a period of active discussion.

Following a pattern set about ten years ago, the Proceedings are structured to reflect the organization of the Review itself, making chapters and papers easier to find. Arrangement of papers into topical subject headings follows a plan now familiar to regular attendees of the Review. As always, some minor changes in the headings and their subcategories need to be introduced to accommodate the evolution of the field and the specific contributed items in any particular year. The Contents contain subject areas which reflect the current activity in NDE. In the following paragraphs we offer a brief summary of the research presented in the two parts.

The leading paper in the initial, highlighted Special Topics section, "Fatigue Damage and its Nondestructive Evaluation: An Overview," is a tribute to our dear friend and colleague, Professor Otto Buck of Iowa State University. Otto participated in the 1997 Review in its entirety and delivered the above paper himself, a review of research he and others have conducted in this area over the past 25 years. Last November, Otto lost his battle with pancreatic cancer, a deadly disease he faced with grace, wit, and courage. Otto will be sorely missed as a friend and fellow scientist. His work in metal fatigue, ultrasonic harmonic generation, and other areas in which he was active over the past 37 years, is held in high regard by the materials and NDE communities. Dr. Green's paper on imagery (including some very recent Mass imaging) is also included in the Special Topics. This was indeed a timely talk, and coincided with the early portion of the Mars Mission. Also part of this special section is a talk given on Tuesday from Dr. E. G. Jablonski, a physician with Molecular Biosystems, Inc. of San Diego on "Ultrasound Contrast Agents: The Advantage of Albumin Microsphere Technology." His talk was part of a biomedical session the Review has sponsored in recent years to foster the connection between biomedical and inspection sciences featuring noninvasive measurements.

Parts A and B follow the Special Topics section. As we have done in earlier volumes, Part A of the Review treats subjects related to technique development, whereas Part B is dedicated to the theme of materials. Topics such as elastic waves, guided waves, and eddy current detection, inversion, and modeling can be found in Part A. Radiography and computed tomography, thermal techniques, and acoustic emission are also included. Emerging technologies such as laser ultrasonics, optical methods, and microwaves form Chapter 2. Signal processing and image analysis and reconstruction, with an emphasis on interpretation for defect detection, come next. Chapter 4 on NDE Sensors and Fields, both ultrasonic and electromagnetic, closes Part A of the Review. In Part B are collected papers on engineered materials, materials characterization, and NDE systems. In the contributed papers of Chapter 5, composites coatings and films, and bonded joints are covered. The next chapter, on material characterization, includes sections on properties, construction materials, cracks, and residual stress and texture. This is one of the longest chapters in the Review and amply demonstrates the strong synergistic relationship between NDE and materials science. Two further chapters deal with important emerging application areas of new inspection procedures and process control. The last chapter also includes papers on new systems and techniques, and questions associated with NDE education.

The organizers of the Review wish to acknowledge the assistance of the many individuals whose efforts and participation helped to make this year's Review a success. They are indebted to the guest speakers for the opening Plenary and the Wednesday evening discussion sessions. A number of people from various institutions helped in the organization of special sessions. They include M. Gorman (Digital Wave Corporation), M.

Holland (Washington University, St. Louis), J. Moulder (Iowa State University), P. Nagy (University of Cincinnati), H. Ringmacher (General Electric Corp.), S. Rohklin (Ohio State University), R. Thomas (Wayne State University), S. Udpa (Iowa State University), and R. Zoughi (Colorado State University). The organizers are indebted to the many chairpersons for managing and keeping sessions on time yet finding room for key points of technical discussion. They are indebted to Ms. Linda Poore, Ms. Judy Johnson, Ms. Libby Bilyeu, and Ms. Heidi Clinton for their assistance both prior to and at the meeting, and to Ms. Karen Cheney and Ms. Joann Wallace of Summit Associates, Inc., for their management of conference logistics. The organizers are deeply indebted to Ms. Connie Nessa and Ms. Sarah Kallsen for their devoted dedication and highly professional attention to the preparation of meeting materials especially the careful handling of all abstracts and manuscripts for the Proceedings. Finally, and by no means last, the organizers appreciate the support and contributions of the Review attendees both in their presentations and prepared manuscripts without which these volumes would be impossible.

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Note added in proof:

It is with heartfelt sadness that we note the untimely passing of Mr. John Charles Moulder, Center for NDE and Iowa State University, on January 19, 1998. John, a leading contributor in eddy current research, will be sorely missed by friends and colleagues alike. We wish to pay tribute to John for his many lasting contributions to science and technology.

CONTENTS

VOLUME 17A

SPECIAL TOPICS

Fatigue Damage and Its Nondestructive Evaluation: An Overview	1
O. Buck	
Ultrasound Contrast Agents: The Advantage of Albumin Microsphere Technology . .	15
E. G. Jablonski, H. C. Dittrich, J. M. Bartlett, and S. B. Podell	
Digital Processing of Remotely Sensed Imagery	23
W. B. Green, D. Jensen, and A. Culver	

CHAPTER 1. STANDARD TECHNIQUES

Section A. Elastic Wave Scattering/Backscattering

Multiple Scattering Calculations by Born Series Integral Equations	33
M. Kitahara and K. Nakagawa	
Acoustic Response of a Layer of Spherical Inclusions with a Random or Periodic Arrangement	41
V. K. Kinra, K. Maslov, B. K. Henderson, and G. Diderich	
Coherent Reflection and Transmission by a Randomly Cracked Elastic Slab	49
Y. C. Angel and A. Bolshakov	
Theoretical Evaluation of Ultrasonic Scattering by Flaws in Anisotropic Media	57
M. Spies and M. Kröning	
Elastic Wave Scattering from a Rough Strip-Like Crack	65
P. Å. Jansson	
SH Wave Scattering by a Defect in a Plate	73
S. Hirose	
A 2D Hybrid Model for Ultrasonic Pulse-Echo Scattering from a Rough Interface Buried in a Layered Medium	81
S. Zeroug and Y.-H. Chen	

Use of Electron Backscatter Diffraction in Understanding Texture and the Mechanisms of Backscattered Noise Generation in Titanium Alloys	89
P. D. Panetta, R. B. Thompson, and F. J. Margetan	
The Application of Angular Profile of Ultrasonic Backscattering on the Layered Substrate	97
S. D. Kwon, D. J. Yoon, and B. Y. Ahn	
Use of Rician Distributions to Predict the Distributions of Ultrasonic Flaw Signals in the Presence of Backscattered Noise	105
I. Yalda, F. J. Margetan, and R. B. Thompson	
Section B. Guided Waves and Applications	
Characteristics of the Reflection of Lamb Waves from Defects in Plates and Pipes . .	113
M. Lowe	
Wave Propagation in a Plate with Defects	121
Z. Chang and A. Mal	
Effect of Rough Surfaces on Guided Waves in Plates	129
D. E. Chimenti and O. I. Lobkis	
Geometrical Acoustics in a Heterogeneous Anisotropic Elastic Solid: Application to a Wavy Composite	137
K. Y. Kim, W. Zou, and W. Sachse	
Effects of a Flaw on Acoustic Wave Propagation by an EMAT System	145
T. Sugiura and S. Maruyama	
Guided Transient Waves in a Circular Annulus	153
G. Liu and J. Qu	
Application of Finite Element Methods to Study Transient Wave Propagation in Elastic Wave Guides	161
F. Moser, L. J. Jacobs, and J. Qu	
Experimental Observation of the Slow Squirting Mode in Solid/Fluid/Solid Trilayers	169
W. Hassan and P. B. Nagy	
Characterization of Piezoelectrics Using Line-Focus Transducer	177
C.-H. Yang	
Calculation of Dispersion Curves in Bonded Joints Using Either Complex Frequency or Complex Slowness and Comparison of the Results with the Minima of the Plane Wave Reflection Coefficients	185
A. Bernard, M. Lowe, and M. Deschamps	
An Experimental Study of Crack Detection in Annular Components by Ultrasonic Guided Waves	193
Z. Li and Y. H. Berthelot	

EMAT Generation and Laser Detection of Single Lamb Wave Modes	201
Z. Guo, J. D. Achenbach, and S. Krishnaswamy	
Section C. Eddy Currents	
Modeling Eddy Current Crack Signals of Differential and Reflection Probes	209
N. Nakagawa, K. Dasoju, T. A. Khan, and J. C. Moulder	
Eddy Current Scan Simulation with Coupled FEM/BEM	215
E. A. Creek and R. E. Beissner	
Recent Development of MESSINE, a 3D Eddy Current Model	221
R. La, B. de Barmon, B. Benoist, M. Talvard, R. Lengellé, and P. Gaillard	
Mathematical Modeling of the Interaction of Non-Uniform Field ACFM with Finite Size Cracks	229
R. Mostafavi and D. Mirshekar-Syahkal	
Review of High Sensitivity AC Field Measurement—Recent Advances and Future Work	235
D. Mirshekar-Syahkal	
Scaling Relation for the Inductance of a Coil on a Ferromagnetic Half-Space	243
J. H. Rose, C.-C. Tai, and J. C. Moulder	
Pulsed Eddy-Current Measurements for the Characterization of Thin Layers and Surface Treatments	251
M. J. Johnson and J. R. Bowler	
Finite Element Simulation of Pulsed Remote Field Eddy Current Phenomenon	259
Y. Sun, W.-C. Loo, D. C. Kuerth, and T. K. O'Brien	
Theoretical Aspects of Transient Electromagnetic Field in Finite Sized Conducting Media	267
M. Namkung, B. Wincheski, J. P. Fulton, and S. Nath	
Optimization of a Wide-Field Eddy Current Probe Using a Boundary Element Method Based Model	275
J. M. Amos and J. C. Chao	
Computer Modeling of Eddy Current Transmit-Receive Probes for Tube Inspection . .	283
S. P. Sullivan, V. S. Cecco, L. S. Obrutsky, D. Humphrey, S. P. Smith, and K. A. Emde	
Low Frequency, Pulsed Eddy Currents for Deep Penetration	291
W. W. Ward III and J. C. Moulder	
Rotating Excitation Probes for Inspecting PWR SG Tubes	299
H. Schepens, M. Pigeon, B. Benoist, J. Reuchet, and D. Boulanger	
Transient Eddy-Current NDE for Hidden Corrosion in Multilayer Structures	307
S. K. Burke, G. R. Hugo, and D. J. Harrison	

Quantitative Assessment of Corrosion in Aircraft Structures Using Scanning Pulsed Eddy Current	315
J. A. Bieber, C.-C. Tai, and J. C. Moulder	
Integrating a Stress Corrosion Crack Model into Finite Element Electromagnetic NDT Code	323
G. Kobidze, W. Lord, and S. Udpa	
Detection of Sublayer Fatigue Cracks under Airframe Rivets	331
B. Wincheski and M. Namkung	
Characterization of Mechanical Damage in Gas Transmission Pipelines	339
V. Kamat, C. Yeoh, P. Ivanov, D. Kim, Y. Sun, S. Mandayam, L. Udpa, S. Udpa, and W. Lord	
Eddy Current Evaluation of Flaws in Coated Conductors	347
A. Ptchelintsev, B. de Halleux, and D. Degreve	
Eddy Current Imaging Using Multi-Frequency Mixing Methods for Aircraft Structural Integrity Verification	355
B. A. Lepine	
Section D. X-Rays and Computed Tomography	
Quantitative X-Ray Inspection	363
F. Retraint, J. M. Dinten, R. Campagnolo, and F. Peyrin	
Radiographic Least Squares Fitting Technique Accurately Measures Dimensions and X-Ray Attenuation	371
T. A. Kelley and D. M. Stupin	
Status and Future Aspects of X-Ray Backscatter Imaging	379
W. Niemann and S. Zahorodny	
SINDBAD: From Cad Model to Synthetic Radiographs	387
A. Glière	
COBRA: Cone Beam Computed Tomography (CT) Reconstruction Code in Interactive Data Language (IDL)	395
M. J. Sheats and D. M. Stupin	
Limited Projection 3D X-Ray Tomography Using the Maximum Entropy Method ...	403
V. L. Vengrinovich, Y. B. Denkevich, and G.-R. Tillack	
Dimensional Accuracy in X-Ray Computed Tomography Imaging	411
S. T. Neel, R. Gibson, C. R. Daniels, and E. L. Klosterman	
Multi-Modality 3D Visualization of Hard-Alpha in Titanium Billets Utilizing CT X-Ray and Ultrasonic Imaging	419
M. Bashyam and U. Suh	
Section E. Thermal Wave Imaging	
Towards a Flat-Bottom Hole Standard for Thermal Imaging	425
H. I. Ringermacher, D. J. Mayton, D. R. Howard, and B. N. Cassenti	

Thermographic Characterization of Corrosion Using a Scanned Thermal Line Source	431
K. E. Cramer and W. P. Winfree	
Enhanced Thermographic Detection of Delaminations with Computational Pulse Shaping	441
W. P. Winfree	
NDE of Corrosion and Disbonding on Aircraft Using Thermal Wave Imaging	449
X. Han, L. D. Favro, T. Ahmed, Z. Ouyang, L. Wang, X. Wang, P. K. Kuo, and R. L. Thomas	
Novel Measurement of Anisotropic Thermal Diffusivity	453
Z. Ouyang, F. Zhang, L. Wang, L. D. Favro, and R. L. Thomas	
Thermographic Imaging of Defects in Anisotropic Composites	457
Y. A. Plotnikov and W. P. Winfree	
Infrared Imaging of a Stress-Crazed Polymer	465
Y. Wang, S. A. Telenkov, Y. Lu, L. D. Favro, P. K. Kuo, and R. L. Thomas	
Application of a Generalized Methodology for Quantitative Thermal Diffusivity Depth Profile Reconstruction in Manufactured Inhomogeneous Steel-Based Materials	469
M. Munidasa, F. Funak, and A. Mandelis	
Theoretical Study for Detection of Defects in Weakly Absorbing Samples by Crossed-Beam Photothermal Technique	477
B.-C. Li and S.-Y. Zhang	
Section F. Acoustic Emission and Applications	
Rapid Calculation of Lamb Waves in Plates Due to Localized Sources	485
D. Guo and A. Mal	
Application of Mindlin Plate Theory to Analysis of Acoustic Emission Waveforms in Finite Plates	493
W. Huang	
The Role of Propagation Characteristics in Acoustic Emission Pipeline Leak Location	501
L. E. Rewerts, R. A. Roberts, and M. A. Clark	
A Comparison of AE Measurements from Aluminum Alloys and Glass/Epoxy Composites with Different AE Techniques	509
S. H. Carpenter and M. R. Gorman	
Waveform-Based Analysis of Acoustic Emission from Fiber Fracture in Model Composite Plates	517
T. Bidlingmaier, A. Wanner, and S. Ritter	
Two Dimensional Dislocation Sources in Fiber Composite Laminates	525
E. R. Green	

The Effect of Rise Times on the Response of Fiber Composite Laminates to Dislocation Sources	533
E. R. Green	
Hydroproof Acoustic Emission for Prediction of Failure Behavior in Composite Pressure Vessels	541
S.-J. Song, C.-H. Oh, H.-J. Kim, and J.-U. Choe	
Acoustic Emission Characterization of Single and Dual Fiber Reinforced Metal Matrix Composites	549
J.-H. Lee and W.-J. Sung	
Progress in Detecting Transverse Matrix Cracking Using Modal Acoustic Emission ..	557
M. R. Gorman	
Characterization of Acoustic Emission Waveforms from Fracture Events	565
Z. Shi, M. Koutsak, S. Bair, J. Jarzynski, and L. J. Jacobs	
An Acoustic Emission Evaluation of Environmentally Assisted Cracking of 7039-T6 Aluminum	571
P. F. Buckley, K. Baldwin, M. J. Ehrlich, and J. W. Wagner	
Analysis of Acoustic Emission Output from Propagating Fatigue Crack	579
I. M. Daniel, C. G. Sifniotopoulos, and J.-J. Luo	

CHAPTER 2. EMERGING TECHNOLOGIES

Section A. Laser/Optical Ultrasonics

Affordable NDE of Aerospace Composites with Laser Ultrasonics	587
T. E. Drake, Jr., K. R. Yawn, S. Y. Chuang, and M. A. Osterkamp	
Laser-Based Ultrasonic Inspection of Complexly Contoured Rocket Engine Components	595
A. D. W. McKie and R. C. Addison, Jr.	
Laser Ultrasound Imaging of Lamb Waves in Thin Plates	603
P. W. Lorraine	
SAFT Data Processing Applied to Laser-Ultrasonic Inspection	611
A. Blouin, D. Lévesque, C. Néron, F. Enguehard, D. Drolet, and J.-P. Monchalín	
Thermoelastic and Ablative Generation of Ultrasound: Source Effects	619
T. W. Murray and J. W. Wagner	
Characterization of the Photo-emf Response for Laser-Based Ultrasonic Sensing Under Simulated Industrial Conditions	627
D. M. Pepper, G. J. Dunning, M. P. Chiao, T. R. O'Meara, P. V. Mitchell, I. Lahiri, and D. D. Nolte	

Ultrasonic NDE of Composite Panels with Gas-Coupled Laser Acoustic Detection . .	635
J. N. Caron, J. B. Mehl, and K. V. Steiner	
A New Concept for a Laser-Based Ultrasonic Phased Array Receiver Using Photo-emf Detection	643
D. M. Pepper, T. R. O'Meara, and G. J. Dunning	
Laser Ultrasonics NDE of Two-Layered Samples	651
R. Coulette, E. Lafond, F. Lepoutre, D. Balageas, M.-H. Nadal, and C. Gondard	
Numerical Methods for Computing Laser Generated Ultrasound Waves	659
T. Sanderson, C. Ume, J. Jarzynski, and M. Stallybrass	
Finite Element Modeling of Ultrasonic Waves Produced by a Pulsed Laser	667
J. J. Dike	
Characterization of Laser Ultrasonic Sources Using a Sagnac Interferometer	675
P. A. Fomitchov, A. Kromine, S. Krishnaswamy, and J. D. Achenbach	
Analysis of Intensity Modulated Pulse Train Length for Laser Ultrasonic NDT	683
T. Sanderson, C. Ume, and J. Jarzynski	
Ultrasound Generation in Composites via Embedded Optical Fibers	691
D. L. Balageas, N. Jaroslavsky, M. Dupont, F. Lepoutre, J.-C. Gonthier, and L. Bertrand	

Section B. Microwaves

Microwave Scattering for the Characterization of a Disc-Shape Void in Dielectric Materials and Composites	699
J. M. Liu	
A Multi-Mode Solution for Analysis of the Reflection Coefficient of Open-Ended Rectangular Waveguides Radiating into a Dielectric Infinite Half-Space	705
K. Bois, A. Benally, and R. Zoughi	
Development and Testing of the Time-Domain Microwave Nondestructive Evaluation System	713
F.-C. Chen and W. C. Chew	

CHAPTER 3. SIGNAL PROCESSING AND IMAGE ANALYSIS

Section A. Signal Processing

Ultrasonic Analysis of Damage Development in Polymer Composites by Signal Processing Techniques	719
J. Stanullo, G. Busse, S. Bojinski, N. Gold, and S. Shapiro	
Ultrasonic Signal Processing Applied to Flaw Characterization in Composite Materials	727
S. Alatissière, A. Liot, F. Thevenot, M. Dessendre, H. Trétout	

Use of a Priori Information for the Deconvolution of Ultrasonic Signals	735
J. Sallard and L. Paradis	
Time Scaling and Frequency Invariant Multiresolution Analysis of Ultrasonic NDE Signals	743
R. Polikar, L. Udpa, S. S. Udpa, and J. Spanner	
Artmap Networks for Classification of Ultrasonic Weld Inspection Signals	751
P. Ramuhalli, L. Udpa, S. S. Udpa, and J. Spanner	
A New Adaptive Grain Noise Cancellation Filtering Technique	759
S. Bae, J. Kim, L. Udpa, and S. S. Udpa	
Case-Based Reasoning for Automatic Interpretation of Data from Eddy-Current Inspection	767
J. Jarmulak	
The Application of Wavelets and Fuzzy Logic to Eddy Current Flaw Detection in Steam Generator Tubes	775
S.-F. Chuang, J. P. Basart, and J. C. Moulder	
Shape Estimation of Defects on Steam Generator Tubes	783
K. Shiraishi, M. Izumida, and K. Murakami	
Section B. Imaging and Reconstruction	
Linear and Nonlinear Image Restoration Methods for Eddy Current Nondestructive Evaluation	791
B. Wang, J. P. Basart, and J. C. Moulder	
Clear Eddy Current Flaw Image Using Computerized Tomography Inversion Technique	799
H. Hoshikawa and K. Koyama	
A Homomorphic Deconvolution Technique for Improved Ultrasonic Imaging of Thin Composite Laminates	807
S.-C. Wooh and C. Wei	
A Two-Step Inverse Procedure for Outer Surface Defects Characterization from Ultrasonic BScan Images	815
M. Faur, L. Paradis, and P. Morisseau	
Development of Geometrical Models of Hard-Alpha Inclusions for Ultrasonic Analysis in Titanium Alloys	823
B. Boyd, C.-P. Chiou, B. Thompson, and J. Oliver	
Direct Numerical Approach for Analyzing Thermal Wave Interferometry Data	831
M. Oksanen	
Using Complementary Types of Data for 3D Flaw Imaging	837
S. Gautier, B. Lavayssière, E. Fleuet, and J. Idier	

CHAPTER 4. NDE SENSORS AND FIELDS

Section A. UT Sensors, Transducers, and Fields

An Embedded Ultrasonic Wire Waveguide Sensor for In-Process Cure and In-Service Dynamic Response Monitoring of Liquid Molded Composite Parts . .	845
Y. Li, S. M. Menon, and G. J. Posakony	
Sensor Development for High Temperature Viscosity Measurement	853
V. Shah, K. Balasubramaniam, R. D. Costley, and J. P. Singh	
Torsional Waveguide Sensor for Molten Materials	859
R. D. Costley, K. Balasubramaniam, W. M. Ingham, J. A. Simpson, and V. Shah	
Three Ultrasonic Devices for the Elastic Moduli Determination at High Temperatures	867
C. Gondard, M.-H. Nadal, and C. Hermerel	
Periodic Composite Backing Filter for the Design of Ultrasonic Transducers	875
S. Chakraborty and B. DeFacio	
Optimization of Ultrasonic Phased Arrays	883
S.-C. Wooh and Y. Shi	
Electromechanical Modeling of Ultrasonic Transducers	891
L. W. Schmerr, Jr., C. Dang, and A. Sedov	
Calculation of Wideband Ultrasonic Fields Radiated by Water-Coupled Transducers into Anisotropic Media	899
N. Gengembre, A. Lhémy, and P. Calmon	
Reconstruction of a Piston Transducer Beam Using Multi-Gaussian Beams (MGB) and Its Applications	907
A. Minachi, F. J. Margetan, and R. B. Thompson	
The Use of Huygens' Principle to Model the Acoustic Field from Interdigital Lamb Wave Transducers	915
P. Wilcox, R. Monkhouse, M. Lowe, and P. Cawley	
Ultrasonic Transducer Radiation through a Curved Fluid-Solid Interface	923
T. P. Lerch, L. W. Schmerr, Jr., and A. Sedov	
Using CAD Models in Transient Field Calculations through Arbitrarily Curved Surfaces	931
A. Schumm	
Uniform Evaluation of the Four Dimensional Transducer Transmission Phase Integral	939
R. A. Roberts	
Forward Modeling of Transducer Misalignment Effects in Ultrasonic Leaky Wave Measurements	947
S. Zeroug, H. Zhang, and D. E. Chimenti	

New Developments in Ultrasonic NDT Modeling in <i>CIVA</i>	955
A. Lhémy, P. Calmon, R. Raillon, and L. Paradis	
Spurious Modes in Finite Element Models for Ultrasonic Waves in Fluid-Solid Systems	963
P. Stucky and W. Lord	
Simulation of Ultrasound Propagation across Interfaces with Imperfect Contact	971
N. K. Batra, R. B. Mignogna, R. S. Schechter, P. P. Delsanto, E. Ruffino, and M. Scalerandi	
Material Parameter Determination from Time-Domain Signals Transmitted and Reflected by a Layered Structure	979
A. Cheng	
Evaluation of Dispersion Modes for Layered Structures Using Focused Acoustic Waves	987
W.-J. Xu and M. Ourak	
Finite Element Simulation of Leaky Surface Wave Propagation Excited by a Line-Focused Transducer	995
K. Kawashima, T. Ito, and K. Mori	
Simulation of Lamb Wave Propagation Using Pure Mode Excitation	1003
B. Pavlakovic, D. Alleyne, M. Lowe, and P. Cawley	
Section B. Electromagnetic Sensors	
Boundary Integral Equations for Modeling Arbitrary Flaw Geometries in Electric Current Injection NDE	1011
A. P. Ewing, C. H. Barbosa, T. A. Cruse, A. C. Bruno, and J. P. Wikswo, Jr.	
Electromagnetic Microscope for Low Frequency, Pulsed, Eddy Current Evaluation of Airframes	1017
W. Podney	
Response Function of an Electromagnetic Microscope	1025
W. Podney	
New Electromagnetic Sensors for Detection of Subsurface Cracking and Corrosion . .	1033
E. S. Boltz and T. C. Tiernan	
Detection of Deep Flaws in Aluminum Structure with Magneto-Resistive Sensors . .	1039
W. F. Avrin and R. D. Rempt	
New Capacitive-Array Sensors for Post-Process Cure Verification and NDE of Polymers and Composites	1143
E. S. Boltz, T. C. Tiernan, and W. F. Hartman	
A Modified Differential Pickup Reflection Probe	1051
S. Sharma, L. Udpa, Y. Sun, and S. S. Udpa	
Uniform Eddy Current Probe with Little Disrupting Noise	1059
H. Hoshikawa and K. Koyama	

SQUID Magnetometers for Depth-Selective, Oriented Eddy Current Imaging	1067
Y. P. Ma and J. P. Wikswo, Jr.	
HTS SQUID System for Eddy Current Testing of Airplane Wheels and Rivets	1075
H. Grünekle, H.-J. Krause, R. Hohmann, M. Maus, D. Lomparski, M. Banzet, J. Schubert, W. Zander, Y. Zhang, W. Wolf, H. Bousack, A. I. Braginski, and M. I. Faley	
A SQUID NDE Measurement Model Using Bem	1083
A. P. Ewing, T. A. Cruse, and J. P. Wikswo, Jr.	
Measurements of Surface-Breaking Flaws in Steel Pipes Using a SQUID Susceptometer in an Unshielded Environment	1091
C. H. Barbosa, A. C. Bruno, G. S. Kühner, J. P. Wikso, Jr., A. P. Ewing, Y. P. Ma, and C. S. Carmerini	

VOLUME 17B

SPECIAL TOPIC

NDE: A Full Spectrum Technology	1099
T. Cordell	

CHAPTER 5. ENGINEERED MATERIALS

Section A. Composites

Acoustic Tomographic Reconstruction of Fiber Angle in Orthotropic Composite Materials	1109
C. Sullivan, R. A. Kline, and R. B. Mignogna	
Identification of Viscoelastic Moduli of Composite Materials from the Plate Transmission Coefficients	1117
B. Hosten, M. Castaings, and T. Kundu	
Measurement of Anisotropic Elastic Constants of an Aluminum Composite Plate Using a Double Reflection Method	1125
K. Kawashima, Y. Shimizu, and M. Imuta	
Load-Induced Change in the Elastic Symmetry of a Ceramic Matrix Composite under Off-Axis Tensile Loading	1131
C. Aristégui and S. Baste	
In-Plane Elastic Property Characterization in Composite Plates	1139
O. I. Lobkis, D. E. Chimenti, H. Zhang, and M. Rudolph	
Characterization of the Ply Boundaries in Carbone-Epoxy Composite Materials Using Longitudinal Ultrasonic Waves	1147
M. Ourak, M. Ouafthouh, M. Duquennoy, and W. Xu	

Efficient Reconstruction of Elastic Stiffnesses in Isotropic and Anisotropic Plates . . .	1155
M. Rudolph, O. I. Lobkis, and D. E. Chimenti	
Elastic Wavefield Modeling for Arbitrarily Oriented Orthotropic Media	1163
M. Spies and M. Kröning	
Rapid Characterization of the Degradation of Composites Using Plate Waves	
Dispersion Data	1171
Y. Bar-Cohen, S-S. Lih, A. Mal, and Z. Chang	
Parallel Computation of Ultrasonic Wave Propagation in Orthotropic Composite	
Materials	1177
R. S. Schechter, N. K. Batra, R. B. Mignogna, K. E. Simmonds, and P. P. Delsanto	
Nondestructive Holographic Interferometry Methods for the Dynamic Structural	
Analysis of a Graphite-Epoxy Polymer Composite Structure	1185
H. Fein	
Evaluation of the Interfacial Sliding Stress of Ceramic Matrix Composites under	
Tensile Loading	1193
J.-M. Morvan and S. Baste	
In-Situ Observation of the Stress Field of the Failure Process in Single Fibre	
Reinforced Polymers	1201
S. Ritter and G. Busse	
Investigation of Thermal Diffusivity for Nano-Phase Composite Ceramics	1209
F. Xiao, X. R. Zhang, D. Fei, C. M. Gan, G. H. Lei, D. Zhang, Y. P. Jin, and G. D. Zhang	
Simple Thermal Wave Method for the Determination of Longitudinal Thermal	
Diffusivity of SiC-Based Fiber	1217
M. Oksanen, R. Scholz, and L. Fabbri	
Detection of Vertical Cracks in Carbon Fiber Composites Using an Infrared Line	
Scanner	1223
J. Varis	
Ultrasonic Backscatter Rotation Scanner for Detection of Ply Bends and Fiber	
Wrinkles	1229
L. H. Pearson, L. G. Porter, and G. A. Yurich	
Ultrasonic Studies of Composites Undergoing Thermal and Fatigue Loading	1237
E. I. Madaras, W. P. Winfree, and P. H. Johnston	
Quantification of Damage Evolution in Multilayered High Temperature Composites	
from Ultrasonic Measurements	1245
A. D. Degtyar and S. I. Rokhlin	
Advanced Inspection of Thermal Protection Systems	1253
J. O. Taylor	

Section B. Coatings, Films, and Bond

Characterization of Epoxy-Coated Oxide Films Using Acoustic Microscopy	1261
B. D. Zeller, A. J. Kinloch, P. Cawley, P. Zinin, O. Lefeuvre, G.A.D. Briggs, G. E. Thompson, and X. Zhou	
Investigation of Thin Layers Ceramic Structures Based on Doppler Scanning Acoustic Microscopy	1269
S. A. Titov, R. G. Maev, and A. N. Bogachenkov	
An Ultrasonic Method for Simultaneous Determination of Elastic Moduli, Density, Attenuation and Thickness of a Polymer Coating on a Foil	1277
A. I. Lavrentyev and S. I. Rokhlin	
Ultrasonic Characterization of Nickel-Chromium-Base Anticorrosive Coatings	1285
V. F. Godínez-Azcuaga, M. A. Marcial-Amaro, J. Porcayo-Calderón, and O. Mayorga-Martín	
Lamb Wave Imaging and V(Z) Using a Broadband System	1291
N. Saffari and C.-S. Ong	
Buried Thermoplastic Layer Diagnostics by the Use of Photo-Thermo-Acoustic Radiometry	1299
M. Munidasa, A. Mandelis, and M. Ball	
Efficient Eddy Current Models for Evaluation of Thin Conductive Coatings on Ferromagnetic Substrates	1307
B. de Halleux and A. Ptchelintsev	
Brillouin Scattering as a Tool for Characterizing Surfaces, Interfaces and Thin Films	1315
W. Pang, A. G. Every, J. D. Comins, P. R. Stoddart, X. Zhang, J. C. Crowhurst, and D. Pietersen	
Observation of Shear Wave Generation at Bonded Silicon-Carbide Interface	1323
D. K. Rehbein, M. Akinc, J. Zheng, and O. Buck	
Acousto-Ultrasonic Techniques for Evaluation of Bond Integrity of Composite Repair Patches	1331
I. M. Daniel, J.-J. Luo, and H.-M. Hsiao	
The Ultrasonic Detection of Environmental Degradation in Adhesive Joints	1339
K. Vine, P. Cawley, and A. J. Kinloch	
An Ultrasonic Technique to Detect Nonlinear Behavior Related to Degradation of Adhesive Bonds	1347
Z. Tang, A. Cheng, and J. D. Achenbach	
Ultrasonic Characterization of Thin Plate Bonding	1355
Q. Xie, A. I. Larentyev, and S. I. Rokhlin	
Ultrasonic Evaluation of Transient Liquid Phase Bonding in Single Crystal Superalloy Castings	1363
D. K. Hsu, J. J. Peters, R. Singh, P. D. Freyer, R. E. Shannon, and P. Zombo	

Microtopographic Inspection of Thermoplastic Rubber Shoe's Sole: The Influence of Surface Roughness on Sole to Leather Gluing	1371
M. F. M. Costa, and V. Pinho	
Ultrasonic Spectroscopy of Two Parallel Imperfect Interfaces	1379
A. I. Lavrentyev, A. Baltazar, and S. I. Rokhlin	
Imaging Flaws in Adhesive Joints Using Acoustic Techniques and Infrared Thermography	1387
D. Hopkins, S. Nakagawa, K. Nihei, and D. Turler	
Nondestructive Testing System to Assess Lack-of-Bond in Brazed Generator Coils by Ultrasonic Retro-Reflection	1395
W. Hassan, P. B. Nagy, and J. F. Hopeck	
Evaluation of Bonded Boron/Epoxy Repairs on Aircraft Skin with Simulated Damage	1403
H. Aglan, Z. Zhang, T. Rowell, T. Ahmed, and R. Thomas	

CHAPTER 6. MATERIALS CHARACTERIZATION

Section A. Materials Properties

Effects of Molecular Weight on Mechanical Properties of the Polyimide LaRC-Si™ ..	1411
W. T. Yost, J. H. Cantrell, T. S. Gates, and K. S. Whitley	
Laser-Ultrasonic Optical Characterization of Nonmetals	1419
A. Hammoutene, F. Enguehard, and L. Bertrand	
Numerical Solution of a Direct 3D Electrostatic Resistivity Test of Green-State Metal Powder Compacts	1427
S. Makarov, R. Ludwig, and D. Apelian	
Characterization and Depth Profile of Lithium Depletion in Aluminum-Lithium Alloys by Ultrasound	1435
E. A. Lindgren, L. P. Martin, and M. Rosen	
Structure and Deformation of Aluminum Foams through Computed Tomography ...	1443
D. J. Sypeck, H. N. G. Wadley, H. Bart-Smith, S. Koehler, and A. G. Evans	
The Detection of Magnetic Phase Transitions in ER-TM by Electromagnetic Acoustic Transducers	1451
C. M. Lim, S. Dixon, C. Edwards, and S. B. Palmer	
Investigation of Sound Property of Laser-Shocked Aluminum Alloy	1457
X. R. Zhang, Y. K. Zhang, and S. Y. Zhang	
Detection of Hardness Variations of Steel through Stainless Steel	1465
J. T. Lovett, O. H. Zinke, and W. F. Schmidt	
Ultrasonic Signal Attenuation in Engine Titanium Alloys	1469
F. J. Margetan, P. D. Panetta, and R. B. Thompson	

Nonlinear Ultrasonic Properties of As-Quenched Steels	1477
D. C. Hurley, P. T. Purtscher, D. Balzar, K. W. Hollman, and C. M. Fortunko	
Magnetostrictive EMAT Efficiency as a Materials Characterization Tool	1485
B. Igarashi, G. A. Alers, and P. T. Purtscher	
Finite Element Modeling of the Effect of Creep Damage on a Magnetic Detector Signal for Seam-Welded Steel Pipes	1493
M. J. Sablik, D. C. Jiles, and M. R. Govindaraju	
Thickness Evaluation for Steel Sheets Using Saturation Magnetization	1501
G. H. Shirkoohi and J. Z. Cao	
Detection of Fatigue Crack Propagation in Steel Using Magnetic Measurements	1509
Y. Bi and D. C. Jiles	
Ultrasonic Imaging of Spall Damage under Repeated Plate Impact Tests with C-scan Acoustic Microscope	1517
K. Kawashima, N. Nishiura, M. Takano, and O. Nakayama	
Acoustic Microscopy Inspection of Glass Repair Techniques	1523
J. Johnson	
Section B. Construction Materials	
A Formalism for Acoustical Traveltime Tomography in Heterogeneous Anisotropic Media	1529
L. Song, S. Zhang, H. Liu, S. Chun, and Z. Song	
Ultrasonic Wave Dispersion and Attenuation in Fluid Filled Porous Media	1537
H. Tavossi, B. R. Tittmann, and F. Cohen-Tenoudji	
Characterization of Rayleigh Wave Propagation in Concrete Using Laser Ultrasonics	1545
J. O. Owino and L. J. Jacobs	
Acoustic Inspection of Bond Strength between Mortar and Reinforcement	1551
C.-H. Chiang, Y.-C. Kan, C.-K. Tang, and C.-S. Su	
Guided Ultrasonic Waves for the Inspection of Post-Tensioned Bridges	1557
B. Pavlakovic, M. Lowe, and P. Cawley	
Defect Visualization and Location of Reinforcing Bars and Cables in Concrete Using Active Electromagnetic Induction Imaging	1565
J. L. Simmonds and P. A. Gaydecki	
Section C. Fracture and Cracks	
Thermo-Electric Detection of Early Fatigue Damage in Metals	1573
P. B. Nagy and J. Hu	
Acoustic, Electron and Optical Microscopy Visualization of Surface and Sub-Surface Cracks	1581
Z. M. Connor, M. E. Fine, and J. D. Achenbach	

Ultrasonic Imaging of Cracks under Installed Fasteners	1589
K. I. McRae and R. W. Nolan	
Characterization of the Fatigue Behavior of Austenitic Steel Using HTSL-SQUID . .	1597
H.-J. Bassler, D. Eifler, M. Lang, and G. Dobmann	
Ultrasonic Characterization of Fatigue Damage in Metal Matrix Composites	1605
S. I. Rokhlin, M. Ganor, and A. D. Degtyar	
Assessment of the Crack System Orientations of a Ceramic Matrix Composite under Off-Axis Tensile Loading	1613
S. Baste and C. Artistégui	
Section D. Stress/Texture	
Stress State Evaluation of Laminated Aluminum Alloy Sheets by Surface Acoustic Waves	1621
M. Duquennoy, M. Ouaftouh, M. Ourak, and L. Camus	
Dynamic Stress Distribution in Unidirectionally Undulated Fibrous Composites . . .	1627
W. G. Abdelrahman and A. H. Nayfeh	
Effects of Residual Stress on Guided Waves in Layered Media	1635
J. Qu and G. Liu	
Measurement of Acoustoelastic Effect of Rayleigh Surface Waves Using Laser Ultrasonics	1643
W.-Y. Lu, L. W. Peng, and S. Holland	
Attenuation and Dispersion of Ultrasonic Waves in Rolled Aluminum	1649
S. Ahmed and R. B. Thompson	
Extension of Ahmed & Thompson Theory to General Elastic Plane Quasi-Wave Propagation in Textured Polycrystalline Material	1657
V. K. Munikoti and A. W. Eberhard Neumann	

CHAPTER 7. NEW INSPECTION/CONTROL PROCEDURES

Section A. New Techniques

Thickness Measurements of Curved Multi-Layered Polymer System Using Ultrasonic Pulse-Echo Method	1665
R. G. Maev, H. Shao, E. Y. Maeva	
Simultaneous Determination of Orientation and Thickness in Anisotropic Media . . .	1673
R. A. Kline, J. B. Deaton, and D. R. Howard	
High-Speed Monitoring of Surface Defects in Rail Tracks Using Ultrasonic Doppler Effect	1681
S.-C. Wooh and A. Clay	

NDT of Specimen of Complex Geometry Using Ultrasonic Adaptive Techniques—The F.A.U.S.T. System	1689
O. Roy, S. Mahaut, and M. Serre	
Self-Focusing of Rayleigh Waves: Simulation and Experiment	1697
W.A.K. Deutsch, A. Cheng, and J. D. Achenbach	
Numerical Simulation of Self-Focusing of an Array on an Interior Crack	1705
M. Zhang and J. D. Achenbach	
A Novel High Speed, High Resolution, Ultrasound Imaging System	1713
M. Lasser	
Ultrasonic Wave Propagation in a Tooth Phantom	1721
S. R. Ghorayeb, T. Xue, and W. Lord	
Wide-Area Imaging of Ultrasonic Fields by Digital Phase-Stepping Shearography . .	1729
G. A. Gordon, B. A. Bard, and S. Wu	
Spatial Resolution with Time-and-Polarization-Resolved Acoustic Microscopy	1737
D. Xiang, N. N. Hsu, S. E. Fick, and G. V. Blessing	
Time-Resolved Line Focus Acoustic Microscopy Using Lamb Waves for Material Characterization of Thin Plates	1745
J. Vollmann, A. Cheng, and J. D. Achenbach	
Photoinductive Imaging for Bolt Hole Corner Crack Inspection	1753
C.-C. Tai and J. C. Moulder	
D2D: A Robust Technique for Detection of Structural Heterogeneities in Solids, Based on Transient Thermography	1761
A. Braggiotti, S. Marinetti, and A. Mazzoldi	
Fresco Thermographic Inspection by Convective Heating Technique	1769
P. G. Bison, E. Grinzato, S. Marinetti, and A. Braggiotti	
Response of Laser-Induced Thermal Lens Effect at Solid Surface	1777
J. Fang and S. Zhang	
High-Speed High-Resolution Subsurface Defect Detection in Ceramics Using Optical Gating Techniques	1785
M. Bashkansky, M. D. Duncan, and J. Reintjes	
Non-invasive Measurement of Prepreg Resin Content Using Nuclear Magnetic Resonance	1793
G. A. Barrall, P. V. Czipott, E. E. Magnuson, C. R. Moeller, and S. M. Menon	
A Study on the Measurement of In-Plane Displacement at High Temperature by Electronic Speckle Pattern Interferometry Method	1801
K.-S. Kim, H.-T. Kim, Y.-H. Cha, H.-C. Jung, S.-S. Jarng, J.-Y. Kim, and S.-P. Yang	
Recent Advances and Implementations of Flexible Eddy Current Probe Technology . .	1809
R. J. Filkins, J. P. Fulton, T. C. Patton, and J. D. Young	

Characterization of Non-Symmetrical Damage in Smart Plate-like Structures	1817
H. T. Banks and P. Emeric	
Refining Automated Ultrasonic Inspections with Simulation Models	1825
M. Garton	
Saw-Cut Scanning Patterns	1831
W. F. Schmidt and O. H. Zinke	
Section B. Process Modeling/Control	
Modeling of Microporosity Evolution during Solidification Processes	1839
J. Huang and J. G. Conley	
Coupling Microstructure Outputs of Process Models to Ultrasonic Inspectability Predictions	1847
R. B. Thompson, F. J. Margetan, I. Yalda, C. P. Chiou, and P. Panetta	
A Formalism for Predicting Ultrasonic Properties of Alloys in a Semi-Solid State . . .	1855
A. F. Niessner III and G. A. Gordon	
Model Based Predictive Control for the Tow-Placement Technique	1863
D. Heider and J. W. Gillespie, Jr.	
A Study on Characteristics of Echoes from Planar Defects by the Ultrasonic Testing of Angle Beam Technique	1869
H. Shirahata and C. Miki	
Defect Detection in Copper Products with an Infrared Line Scanner	1877
J. Varis	
Development of On-Line NDE for the Continuous Resin Transfer Molding (CRTM) TM Process	1883
R. W. Engelbart and D. D. Palmer	
Ultrasonic Measurement of Clearances of a Rolling-Piston Type Rotary Compressor	1891
N. Kim and J. Kim	
Ultrasonic Monitoring of Recrystallization Textures in Aluminum	1899
G. Liu, F. Laabs, D. Rehbein, O. Buck, and R. B. Thompson	

CHAPTER 8. SYSTEMS, RELIABILITY, TRAINING

Section A. New Systems

A Non-Contact Laser-Emat System for Crack and Hole Detection in Metal Plates . . .	1907
S. Dixon, C. Edwards, and S. B. Palmer	
A New Automated System for Boreside Ultrasonic Inspection of Power Plant Turbine Rotors	1915
M. Ley-Koo, V. F. Godinez-Azcuaga, M. A. Marcial-Amaro, A. Aguilar-Soto, and S. Salazar-Cruz	
Field and Beta-Site Testing of the Dripless Bubbler Ultrasonic Scanner	1921
D. J. Barnard and D. K. Hsu	

A Novel Non-Contact Ultrasonic System for Liquid Level Measurement in Moving Metallic Containers	1929
S. Dixon, C. Edwards, and S. B. Palmer	
Adaptive Heterodyne Interferometer for Ultrasonic NDE	1937
B. F. Pouet, R. K. Ing, S. Krishnaswamy, and D. Royer	
Inspection of Flip-Chip Epoxy Underfill in Microelectronic Assemblies Using Compensated Laser-Based Ultrasonic Receivers	1943
D. M. Pepper, G. J. Dunning, M. P. Chiao, T. R. O'Meara, and P. V. Mitchell	
Digital Measuring Borescope System	1951
G. McGarry	
Detection of Open Cracks by a Photothermal Camera	1959
L. Legrandjacques, J. C. Krapez, F. Lepoutre, and D. L. Balageas	
An Adaptive Morphological Filter for Defect Detection in Eddy Current Aircraft Wheel Inspection	1965
S. Gao and L. Udupa	
Integrated Quality Assurance Program for the Hydra-70 Solid Rocket Motor	1973
E. Morris, L. M. Glowacki, and L. J. Bond	
CEA Program for Multiple-Technique Non-Destructive Testing: The <i>CIVA</i> System ..	1981
L. Paradis, M. Talvard, P. Benoist, P. Rizo, G. Pascal, and G. Bayon	
Versatile Robotic Instruments for NDT/NDE Data Acquisition	1989
B. Bridge, T. Sattar, A. Khalid, S. Chen, M. Rakocevic, and X. Wang	
Complex Contour Ultrasonic Scanning System Application and Training	1997
S. J. Wormley and H. Zhang	
Section B. System Reliability	
POD Assessment Using Real Aircraft Engine Components	2005
A. Fahr and D. S. Forsyth	
The Application of a Dynamic Threshold to C-Scan Images with Variable Noise	2013
P. J. Howard, D. C. Copley, and R. S. Gilmore	
A Comparison of the Ability of Phase-Insensitive and Phase-Sensitive Ultrasonic Receivers to Detect Material Abnormalities beneath Rough Surfaces	2021
K. W. Hollman, R. L. Trousil, M. R. Holland, and J. G. Miller	
An Experimental Evaluation of the Resonant Ultrasonic Spectroscopy Method	2029
M. C. Renken, C. M. Fortunko, K. W. Hollman, and S. Kim	
Ultrasonic C-Scan Standardization for Polymer-Matrix Composites—Acoustic Considerations	2037
R. A. Smith, D. A. Bruce, L. D. Jones, A. B. Marriott, L. P. Scudder, and S. J. Willsher	
Probability of Detection Modeling for Ultrasonic Testing	2045
P. Sarkar, W. Q. Meeker, R. B. Thompson, T. A. Gray, and W. Junker	

Ultrasonic Inspectability Models for Jet Engine Forgings	2053
T. A. Gray	
Improved Methodology for Inspection Reliability Assessment for Detecting Synthetic Hard Alpha Inclusions in Titanium	2061
W. Q. Meeker, S.-L. Jeng, C.-P. Chiou, R. B. Thompson	
The Use of Ultrasonic Flaw and Noise Models in Designing Titanium Test Blocks ..	2069
C.-P. Chiou, I. Yalda, F. J. Margetan, R. B. Thompson, and D. J. Sturges	
Section C. Training	
North Central Collaboration for Education in NDE/NDT	2077
B. Larson and D. Holger	
Technology Transfer Using XRSIM as a Training Tool	2085
B. Crouse, J. Gray, and B. Larson	
Internet Offering to Foster NDE/NDT Technological Education in Community and Technical Colleges	2093
S. J. Wormley	
Attendees	2099
Contributors Index	2115
Subject Index	2123