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Robert C. Wetherhold

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University at Buffalo, SUNY
Mechanical and Aerospace Engineering
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Research Area All aspects of heterogeneous materials, from their fabrication through their end-use; specialties in fracture behavior, in laminate design, in smart/multifunctional materials and composites, and in surface modification.

Education

Fall 1981 to Summer 1983 — Graduate School, Department of Mechanical and Aerospace Engineering, University of Delaware

Degree: Ph.D. in Applied Sciences
Thesis: Statistics of Fracture of Composite Materials under Multiaxial Loading (Advisor: Dr. R. Byron Pipes)

Fall 1974 to Spring 1976

Degree: Master of Mechanical and Aerospace Engineering
Thesis: An Analytical Model for Bonded Joint Analysis in Composite Structures Including Hygrothermal Effects

Fall 1969 to Spring 1974 — Department of Mechanical and Aerospace Engineering, University of Delaware

Degree: BME and BA (5-year arts-engineering program)
Scholastic Average: 3.76/4.00; 1/36 of M.E. Class (1974)

Employment

9/83 to present — STATE UNIVERSITY OF NEW YORK
Department of Mechanical and Aerospace Engineering, Furnas Hall, Buffalo, NY 14260

Title: Professor (2002-), Associate Professor (1989-2002); Assistant Professor (1983-1989)

Activities: Taught undergraduate and graduate courses in Mechanics and Materials; conducted research of composite and multifunctional ("smart") materials using modeling and experimental approaches; developed experimental mechanics laboratory facilities.

Title: Graduate Director (2001-7)

Activities: Supervised and coordinated the recruitment and advisement of M.S. and Ph.D. Students in MAE, member of Graduate APC.

Title: Undergraduate Director, Mechanical Engineering (2007-)

Activities: Advised undergraduate students; wrote ME self-study and participated in ABET accreditation visit for Fall 2008 visit and its follow-through; Supervised exchange with Thai Nguyen University of Technology, Vietnam, so that they can model their "Advanced Program" after UB's MAE program (2009-); member of UG APC.

10/80 to 9/81 E.I.DUPONT DE NEMOURS & CO., Wilmington, DE and Old Hickory, TN
Engineering Department, Design Division
Title: Specialist Engineer
Activities: Maintained and supervised the use of vendor-supplied computer software for various engineering disciplines. Applied structured programming techniques to my own computer programs.

7/77 to 10/78 Engineering Department, Design Division
Title: Engineer
Activities: Performed chemical engineering design and equipment procurement for various design projects.

6/76 to 7/77 Textile Fibers Research and Development Laboratory
Title: Engineer
Activities: Worked on projects dealing with Polymer processing and product research, including semi-works operations.

10/78 to 10/80 UNIVERSITY OF DELAWARE, Newark, DE
Center for Composite Materials
Title: Research Associate
Activities: Conducted research into fracture behavior and statistics of reinforced plastics. Served as Assistant to the Director of the Center (Dr. R. Byron Pipes); edited portions of "Design Guide for Composite Materials"; assembled Center's reference library on composite materials.

Professional and Academic Honors

Elected Fellow of American Society of Mechanical Engineers, (2011).

J. William Fulbright Fellow, University of Kaiserslautern (Institut für Verbundwerkstoffe), Fall 1997-Spring 1998.

Associate Fellow of AIAA (1996).

Listed in: Who's Who in America, 69th ed. (2015), Who's Who in the East, 41st ed. (2014); American Men and Women of Science, 28th ed. (2012), Who's Who in Science and Engineering, 10th ed, (2008-09), Who's Who in American Education, 7th ed. (2005).

Ralph R. Teetor Engineering Educator Award (1992) and Faculty Advisor Award (1995), Society of Automotive Engineers.

Visiting Scientist (Winter-Spring 1990) in Engineering Ceramics at Rockwell International Science Center, Thousand Oaks, CA.

AFOSR Summer Faculty Fellow (1987, 1988) and Visiting Scientist (Fall-Winter 1989) at Air Force Materials Laboratory.

American Society for Engineering Education NASA Summer Faculty Fellow (Summer

1985, Summer 1986).

George W. Laird Merit Fellow (as outstanding graduate student, College of Engineering), University of Delaware (1981).
Member of Tau Beta Pi (Engineering Honorary), Phi Kappa Phi (Scholastic Honorary), and Sigma Xi (Research Society), Mensa and Intertel.

Professional Societies-Memberships and Activities

Member, American Institute of Aeronautics and Astronautics
Advisory Council Member of Niagara Frontier Section of AIAA (1983-89)
Faculty Advisor and Member, Society of Automotive Engineers (1986-96)
Member, American Society for Materials
Member, American Society of Mechanical Engineers (1992-);
Member (1992-), Vice-Chair (1996-98), Chair (1998-2000) of Composites Committee of Materials Division, ASME;
Member, Composites Committee of Applied Mechanics Division (1995-).
Member, Executive Committee of Materials Division (2001-06), including Chair (2005-06)
Materials Division representative to Congress Steering Committee of International Engineering research and Innovation Congress (IERIC), (2006-2008)
MD representative to Strategic Planning Committee of Basic Eng'g Group Operating Board (2008-)
Inaugural-Founding Member of MD EC Advisory Board (2009-2013)
Member, Aerospace Engineering Advisory Committee, Ryerson University, Toronto (2006-10)
Reviewer, NASA post-doctoral Fellowship Program (2006)

University Service

Graduate Studies Committee: Member, 1986-2007; devised new Ph.D. Qualifier formats, 1996, 2007; member Ph.D. Qualifier Committees, (1992-).

Director, Graduate Studies, MAE (2001-2007).

Director, Undergraduate Studies, Mechanical Engineering (2007-)

Member, Graduate Academic Programs Committee, SEAS, (2001-2007).

Member, Graduate School Executive Committee (Sp2006, 2006-07)

ABET (Accreditation Board for Engineering and Technology) Coordinator (1998-2003); Supervised and coordinated the survey information which was used to revise the ME and AE undergraduate course curriculum; formulated the plan and justification methodology which will be used for future program revisions. Led the effort for the Mechanical Engineering program for the ABET accreditation in 2008, which resulted in a successful review (no deficiencies or weaknesses).

Member, Faculty Senate (1992-94, 95-97, 200-02, 2003-05, 2006-08, 2012-2014)

Educational Policies and Planning Committee (1992-2002),

FS Executive Committee (1995-97; F2005, F2006)

Chair, Facilities Planning Committee (Sp 2008-2013)

Member, Academic Standards Committee (1998-2001); member, Vice-Provost's Committee on Academic Dishonesty (2001-2003)

Freshman Faculty Mentor, SEAS, 1998-2003, 2010-.

Service to the Profession--Journal and Review Activities

Member, International Advisory Board for Polymers and Polymer Composites (1996-)
Guest Editor, October 1999 J Eng Materials and Technology
Reviewer for:
Composites Science and Technology
Journal of Materials Science
Journal of Composite Materials
Materials Science and Engineering
International Journal of Solids and Structures
Journal of Mechanical Design (ASME)
Metallurgical Transactions
AIAA Journal
Experimental Mechanics
AIChE Journal
Journal of Vibration and Acoustics
National Science Foundation
South Carolina Experimental Program to Stimulate Competitive Research
See also "Books /Conference Proceedings Edited"

Community Service

"Key Person" in Western New York for SERVAS, international organization for peace and understanding through travel (2001-)

President, Erie County Wind Ensemble, (semi-professional local wind ensemble) (2012-)

Courses Taught

MAE 381	Introduction to Materials Science
MAE 311	Machines and Mechanisms (I)
MAE 415	Analysis of Structures
MAE 416	Aerospace Structures
MAE 483/584	Mechanics and Design Using Composite Materials, A new course
MAE 492/592	Experimental Methods for Composites, A new course
MAE 457	Stress Analysis
MAE 459	Design Project (coordinated lectures)
MAE 485	Mechanical Properties of Materials, A new course
MAE 482/582	(Introduction to) Composite Materials
MAE 524	Elasticity

Students Graduated-M.S.

1. S.K. Park, "Computational Fracture Mechanics for Anisotropic Materials," MS, 1985.
2. Y. Retter, "Optimization of Composite Material Laminate under Inplane and Bending Loads," MS, 1985.
3. M. Moschos, "Heat Transfer in a Direct Resistance Heated Metal Matrix Composite," MS, 1987.
4. T. Klementowski, "Probabilistic Aspects of Fracture Energy in Short Fiber Composites", MS, 1987.
5. J. Fritz, "Image Processing Techniques for Determination of Short Fiber Composite Orientation Distribution", MS, 1988.
6. G. Popp, "On the Dynamics of Damped Distributed Composite Laminate Systems", MS, 1988.
7. L.K. Jain, "Inelastic Modelling of Composites Subjected to Thermal Fatigue and Thermo-Mechanical Fatigue", MS, 1989.
8. D.J. Thomas, "Reliability Analysis of Continuous Fiber Composite Laminates under Multi-axial Loading Conditions", MS, 1989
9. S. Schlonski, "Computer Control of a Thermomechanical Fatigue Test Apparatus," MS, 1989.
10. J. Forand, "Methods for Studying Crack Propagation in Brittle Composites," MS, 1991.
11. P. Juneja, "Damage Evolution in SiC/Glass Matrix Composites under Tensile Loading", M.S., 1991.
12. G. Giammalvo, "Approximate Fracture Mechanics Solutions for Bridged Cracks in Brittle Matrix Composites", MS, 1992.
13. A. Ucci, "Probability Techniques for Reliability Analysis of Composite Materials,", MS, 1992.
14. N. Panthalingal, "Piezoceramic Composites of PZT/Epoxy for Sensing and Actuating Torsional Motion", MS, 1992.
15. J. Wang, "Experimental Characterization of the Bending Fracture of Ceramic Matrix Composites," M.S., 1992.
16. V. Vedula, "Stress Intensity Solutions for Ductile Fiber/Brittle Matrix Composites", MS, 1993.
17. M. Clifford, "Prediction of the Thermoelastic Properties of Woven Composites," M.S., 1994.
18. J. Noiseux, "Finite Element Modeling of an Elastomer Wheelchair Cushion", M.S., 1995.
19. S. Seelman, "Using Laminated or Functionally Graded Materials to Control or Reduce Thermal Deformation in Thin Plates and Beams", M.S., 1996.
20. J. Bös, "Fracture Toughness of Composite Materials Reinforced with Short, Ductile Fibers," M.S., 1997.
21. K. Baldus, "Berechnung, Fertigung und Prüfung von thermisch belasteten Hochleistungs-Verbundwerkstoff-Bauteilen"="Design, Manufacture and Testing of Thermally Loaded High-Performance Composite Structures," Studienarbeit (IVW, Uni Kaiserslautern) June, 1998.
22. F.K. Lee, "Use of Shaped, Ductile Fibers to Improve Toughness of Composite Materials," M.S. 2000,
23. M. Messer, "Optimization of Piezoelectric Actuators and Sensors," M.S. 2000.
24. G. Giraud, "Shape Variation to Improve the Performance of a Piezoelectric Actuator," M.S. 2001, co-advised with A. Patra.
25. R. M. Bagwell, "Improved Fracture Toughness of Brittle Composites through the use of Shaped Ductile Fibers," M.S., 12/02.

26. B Farrokh, “Phenomenological Curve Fitting of Magnetostrictive and Piezoelectric Strains,” M.S. (project) 2/03.
27. B. Daruwalla, “Vibration Analysis of Symmetric, Rectangular Laminated Plates using Approximation Methods”, M.S. 2/04.
28. H. Vadel, “Development and Analysis of Magnetostrictive Cure Monitoring Sensor with Variable Boundary Condition for Composite Cure Monitoring ,” M.S. 2/04.
29. J. McManaman, “EMI Shielding Improvements using Short Shaped Copper Fibers in a Thermoset Matrix,” M.S. 9/04.
30. J. Parks, “Copper Fiber – Thermoset Matrix Interface Improvement Using γ–Aminopropyltriethoxysilane (γ-APS) Coupling Agent,” M.S. 1/05.
31. M. Corjon, “Copper Fiber-Thermoset Matrix Interface Design using a Mesoscale Spraying Technique of a γ-aminopropyltriethoxysilane (γ-APS) Coupling Agent,” M.S. 9/05.
32. G. Dietz, MS all-course, 5/06.
33. P. Das, “Oxidation Treatment of Copper Surface for Improved Adhesion to Epoxy Matrix and Improved Fracture Toughness,” M.S. 6/06.
34. T. Vincent, “Osmosis Damage in Polyesters”, M.S. 12/06.
35. Z. Harry, “Application of Spray Technology using Silanes to Improve the Peel Strength of Cu/Epoxy Interfaces”, M.S. 8/07.
36. Hani Alarifi, “Effect of surface modifiers on peel strength of Cu-epoxy interfaces,” M.S. 9/08.
37. Jennifer Labuda, “Observations of the Coffee Ring Effect for Drying Droplets in the Presence of Surface Modifiers,” MS, 6/08.
38. B. Eshmatov, “Aeroelastic Effects in Anisotropic Wing-like Structures,” M.S. 1/10.
39. P.S. Padliya, “Non-linear Vibration Analysis of Orthotropic Membranes”, 2/12.
40. C Chungbin, “Simulation of the Effects of Uncertainty on Vibration-Based Structural Health Monitoring,” M.S. 1/17.
41. T.S. Mhatre, “Adhesive Strength Improvement at Bi-material Interface by Adjusting Interface Angle under Torsional Loading,” M.S. 1/17.

Students In-Progress-M.S.

Students Graduated-Ph.D.

1. L. Jain, "Fracture Toughness of Short Fiber/Brittle Matrix Composites", PhD, 1992. Current position: Senior Business Application Leader, Kao USA, Cincinnati.

2. D.J. Thomas, "Analysis of the Progressive Failure of Brittle Matrix Composites", Ph.D., 1993. Current Position: Structural Analyst, Gas Turbine Div, Rolls Royce/North American Techn Center, Indianapolis.

3. J. Wang, "Controlling Thermal Deformation and Stresses in Laminated Structures," Ph.D., 1994.Current Position: Project Manager, Landrum & Brown Worldwide Services, San Francisco, CA.

4. O. Aldraihem, "Mechanics and Control of Bending and Twisting Vibration of Smart Piezoelectric Laminates", Ph.D., 1997. Current Position: Professor, Mechanical Engineering, King Saud University, Saudi Arabia.

5. R. Rodriguez (Rodriguez-Castro), "Processing, Microstructure and Mechanics of Functionally Graded Al/Si_p Composite," Ph.D., 2000. Current Position: Research Professor, Departamento de Ingeniería Mecánica, Instituto Tecnologico Celaya, Mexico.

6. R. Bagwell, "Multifunctional Short Shaped Copper Fiber/Thermoset Matrix Composites with Improved Toughness and EMI Shielding Capabilities", Ph.D. 9/05. Current Position: Process Engineer, Harper International, Lancaster, NY.

7. V. Guerrero, "Modeling of the Magnetoelastic Interactions in Giant Magnetostrictive Film-Substrate Systems," Ph.D. 9/05. Current Position: Profesor Principal Dpto. de Materiales y Manufactura, Escuela Politecnica Nacional, Quito, Ecuador.

Proposals or Contracts Funded; Wetherhold as sole PI unless otherwise noted

"Material Characterization of Crankshaft," Luvata Buffalo, 3/08, $1,325, 1 mo.

"Amber Glass Container Testing", Minrad Int'l, $8,172, 6/07, 1 mo + phase 2, 8/07, 1 mo.

"Testing of Graphite Insulation Plates," Harper Int'l, $1,535, 5/07, 1 mo, $632, 8/07, 1 mo.

"Wall fastening system testing," Boston Valley Terra Cotta, $2,616., 3/06, 1 mo.

"Pressure capsule testing and evaluation," Viatran Corp/SPIR, $10,852+$4,276=$15,128, 12/04-1/05.

"Tent Closure Prototype," CUBRC/Natick Soldier Center, $35,850, 8/1-12/31/04.

"Magneto-mechanical Interactions in Giant Magnetostrictive Multilayers," Co-PI H. Chopra, NSF, 3 yrs, $200,000, 9/01-8/04, NSF: 9/01-8/02, $69,811; 9/02-8/03, $65,378; 9/03-8/04, $64,543.

Various Projects with GM Engine facility, Tonawanda, NY: "Spring Testing," 1 mo, $7,339, 7/01; "Block Testing," 1 mo, $6,342, 9/01.

"Fracture Toughness Improvement of Composites Reinforced with Optimally Shaped Short Ductile Fibers," PI R. Wetherhold, Co-PI A. Patra, Army Research Office, 3 years, $300,000, 6/01-5/04; history: 5/01-3/02, $83,000; 4/02-1/03, $83,500; 1/03-1/04, $100,000; 2/04-6/04, $33,500.

"A Novel Approach to Low Switching Field Giant Magnetostrictive Films,"CAPEM Seed Grant, PI R. Wetherhold, $7,000, 7/99, 10 mo.

"A Non-destructive Magnetic Testing Method for the Assessment of Mechanical Properties and Materials Damage in Ferritic Steels," Co-PIs R. Wetherhold and H. Chopra, 1 year, $15,000 (direct cost), 6/99-5/00, American Society for Non-destructive Testing.

"Effect of Surface Finish on Fatigue Life-Phase I," Moog, Inc. Technology Center [TCIE], $14,574, 6/97, 6 mo.

"Impact Testing of Materials," with A. Soom, L. Gore & Assoc., Total: $26,041; funding history,

4/97, 3 mo., $5,659; 6/97, 3 mo., $4,797; 9/97, $90; 12/97, 3 mo., $7,195; 1/98, 3 mo., $5,593; 3/98, 3 mo., $2,797.

"Improving Stiffness Uniformity of Joy Manufacturing Belt," SPIR/Buffalo Weaving & Belting Co., 6/95, 3 mo., $9,775.

"Kineflex Seat Cushion", subcontract to Occupational Therapy, U/B, 2/95, 6 mo., $9,950.

"Thermal Fatigue in Ceramic Matrix Composites, Univ. Techn. Corp/AF Materials Lab, 6/90, 5 mo., $5,600.

"Testing of a Child's Toy", Fisher-Price, 6/89, 1 mo., $3,410.

"Failure Analysis of Pressure Vessels," Atlantic Research Corp., total $259,580; funding history: 1/89-6/89, $9,850; 5/89-11/89, $20,730; 1/90-7/90, $28,800; 8/90-2/91, $29,100; 12/90-5/91, $38,200; 8/91-3/92, $37,800; 8/92-2/93, $40,700; 11/92-5/93, $23,100; 11/93-5/94, $31,300.

"Thermal Fatigue of Ceramic Matrix Composites", Universal Technology Corp/Air Force Materials Laboratory, 11/30/88, 6 mo, $9,400.

"Thermal Fatigue and Thermo-mechanical Fatigue of Ceramic Matrix Composites", Universal Technology Corp/Air Force Materials Laboratory, 5/1/88, 6 mo, $9,976.

"Statistical Fracture Analysis of Composite Materials", NASA-Lewis, total $341,149; funding history: 1/88-12/88, $61,763; 1/89-12/89, $69,428; 1/90-12/90, $69,958; 1/91-12/91, $60,000; 1/92-12/92, $40,000; 1/93-10/93 (ext. to 10/94), $40,000.

Publications (Refereed Journals - full papers unless noted)

World of Science Statistics: Results found: 85

Sum of the Times Cited: 984

Sum of Times Cited without self-citations:885

Average Citations per Item: 11.58

h-index: 18

1. R.B. Pipes, R.C. Wetherhold, J.W. Gillespie, Jr., "Notched Strength of Composite Materials," J. Compos. Mat., 13 (1979) pp. 148-160.
2. R.B. Pipes, R.C. Wetherhold, J.W. Gillespie, Jr., "Superposition of the Notched Strength of Composite Materials," Polym. Eng. and Sci., 19 (1979) pp. 1151-1155.
3. R.B. Pipes, R.C. Wetherhold, J.W. Gillespie, Jr., "Macroscopic Fracture of Fibrous Composites," Mat. Sci. and Eng., 45 (1980) pp. 247-253.
4. R.C. Wetherhold, J.M. Whitney, "Tensile Failure of Notched Fiber-Reinforced Composite Materials," Polymer. Compos., 2 (1981) pp. 112-115.
5. R.C. Wetherhold, "A Weibull Brittle Failure Model for Biaxial Loading of a Notched Composite Material," Mat. Sci. Eng., 47 (1981) pp. 271-275; erratum 49 (1981) p. 194.
6. R.C. Wetherhold, "Reliability Calculations for Strength of a Fibrous Composite Under

Multiaxial Loading," J. Compos. Mat., 15 (1981) pp. 240-248.
7. R.C. Wetherhold, R.B. Pipes, "Statistics of Fracture of Composite Materials under Multiaxial Loading," Mat. Sci. Eng., 68 (1984) pp. 113-118.
8. R.C. Wetherhold, W. Hwang, "An Inconsistency in the Maximum Strain Theory for Failure of Biaxially Stressed Composite Materials," Mat. Sci. Eng., 66 (1984) L7-L8 (Technical Note).
9. R.C. Wetherhold, "The Effect of Stress Concentration on the Reliability of Composite Materials," J. Compos. Mat., 19 (1985) pp. 19-28.
10. R.C. Wetherhold, "Statistical Distribution of Strength of Fiber-Reinforced Composite Materials," Polymer. Compos., 7 (1986) pp. 116-123.
11. R.C. Wetherhold, S.K. Park, "Energy Release Rate Calculations for the Compact Tension Specimen using Brittle Orthotropic Materials," Compos. Sci. Tech., 25 (1986) pp. 219-230.
12. R.C. Wetherhold, M. Mahmoud, "Tensile Strength of Notched Composite Materials," Mat. Sci. Eng., 79 (1986) pp. 55-65.
13. R.C. Wetherhold, "Probabilistic Aspects of Strength of Short-Fiber Reinforced Composites with Planar Fibre Orientation," J. Mat. Sci., 22(1987) pp. 663-669.
14. R.C. Wetherhold, L.J. Westfall, "Deformation of Surface Cladding and Matrix of Tungsten-Reinforced Superalloy Under Thermo-Mechanical Loading," Mat. Sci. Eng., 85 (1987) pp. L13-L17. (Technical Note).
15. R.C. Wetherhold, "Probabilistic Aspects of Strength of Fiber Dominated Short Fiber Composites - Part I Aligned Fibers," Mat. Sci. Eng., 91 (1987) pp. 7-12.
16. R.C. Wetherhold, "Probabilistic Aspects of Strength of Fiber Dominated Short Fiber Composites - Part II Biased Fiber Distribution," Mat. Sci. Eng., 91 (1987) pp. 13-18.
17. R.C. Wetherhold, M. Moschos, "Thermal Gradient Effects in Direct Resistance Heated Metal Matrix Composites," Mat. Sci. Eng., 96 (1987) pp. L17-L20 (Technical Note).
18. R.C. Wetherhold, L.J. Westfall, "Thermal Cycling of Tungsten-Fiber Reinforced Superalloy Composites," J. Mat. Sci., 23 (1988) pp. 713-717.
19. R.C. Wetherhold, C.S. Boss, "Transverse Thermal Expansion Coefficients for Composite Laminates," J. Compos. Mat., 22 (1988) pp. 812-817.
20. R.C. Wetherhold, "Energy of Fracture of Short Brittle Fiber/Brittle Matrix Composites with Planar Fiber Orientation," Mat. Sci. Eng., A112 (1989) pp. 31-37.
21. R.C. Wetherhold, "A Probabilistic Formulation for Fracture Energy of Continuous Fiber/Brittle Matrix Composites," J. Mat. Sci. Lett. 8(1989) pp. 576-577 (Technical Note).
22. L.K. Jain, R.C. Wetherhold, "Viscoelastic Analysis of Concentric Cylinders for Composite Materials and Seals," J. Amer. Cer. Soc., 72(1989) pp. 1844-1849.
23. R.C. Wetherhold, "Fracture Energy of Short Brittle Fiber/Brittle Matrix Composites with Three-Dimensional Fiber Orientation," J. Eng. Gas Turb. Power, 112(1990) pp. 502-506.
24. R.C. Wetherhold, P.D. Scott, "Prediction of Thermoelastic Properties in Short Fiber Composites using Image Analysis Techniques," Compos Sci. Techn., 37 (1990) p. 393-410.
25. G. Popp, R.C. Wetherhold, "Mechanical Characterization of a Woven Ceramic Fiber/Ceramic Matrix Composite," J. Mat. Sci. Lett. 9 (1990) p. 1187-1189.
26. L.P. Zawada, R.C. Wetherhold, "The Effects of Thermal Fatigue on a SiC Fiber/Aluminosilicate Glass Composite," J. Mat. Sci., 26(1991) p. 648-654.
27. R.C. Wetherhold, "The Sensitivity of Fracture Location Distribution in Brittle Materials," Int. J. Fract., 49 (1991) p. 305-315.
28. D.J. Thomas, R.C. Wetherhold, "Reliability Analysis of Continuous Fiber Composite Laminates," Compos Struct, 17 (1991) p. 277-293.
29. R.C. Wetherhold, L.P. Zawada, "Thermal Exposure Effects on Ceramic Matrix Composites," Am. Cer. Soc. Ceram. Trans. 17 (1991) p.391-405.
30. R.C. Wetherhold, and J.A. Forand, "Improving Stability in the Double Cantilever Beam

Fracture Test", Mat. Sci. Eng. A 147(1991) p. L17-L20 (Technical Note).
31. R.C. Wetherhold and L.P. Zawada, "Heat Treatments as a Method of Protection for a Ceramic Fiber/Glass Matrix Composite," J. Am. Cer. Soc. 74 (1991) p.1997-2000.
32. D.J. Thomas, R.C. Wetherhold, "Reliability Analysis of Composite Laminates with Load Sharing", J. Compos. Mat., 25 (1991) p. 1459-1475.
33. L.K. Jain, R.C. Wetherhold, "Effect of Fiber Orientation on the Fracture Toughness of Brittle Matrix Composites," Acta. Metall. Mater., 40 (1992) p. 1135-1143.
34. R.C. Wetherhold, L.K. Jain, "The Toughness of Brittle Matrix Composites Reinforced with Discontinuous Fibers," Mat. Sci. Eng. A, 151 (1992) p. 169-177.
35. L.K. Jain, R.C. Wetherhold, "The Effect of Fiber Extensibility on the Fracture Toughness of Short Fiber/Brittle Matrix Composites," Appl. Mech. Rev., 45 (1992), p. 377-389.
36. S.F. Duffy, R.C. Wetherhold, L.K. Jain, "Extension of a Non-Interactive Reliability Model for Ceramic Matrix Composites," J. Eng. Gas Turb. Power, 115 (1993), p. 205-207.
37. D.J. Thomas, R.C. Wetherhold, "Reliability Analysis of Ceramic Matrix Composite Laminates," J. Eng. Gas Turb. Power, 115 (1993), p. 117-121.
38. R.C. Wetherhold, L.K. Jain, "The Effect of Crack Orientation on the Fracture Properties of Composite Materials," Mat. Sci. Eng. A, 165 (1993) p. 91-97.
39. R.C. Wetherhold, A.M. Ucci, "Probability Methods for the Fracture of Composite Materials," Compos. Struct., 28 (1994) p. 113-119.
40. D.J. Thomas, R.C. Wetherhold, "Progressive Matrix Crack Modeling in Off-Axis Plies," J. Thermoplast. Compos. Mat., 7 (1994) p. 139-154.
41. R.C. Wetherhold, N. Panthalingal, "Piezoelectric PZT/Epoxy Composites for Controlling Torsional Motion," J Intell. Mater. Sys. Struct., 5(1994) p. 576-580.
42. R.C. Wetherhold, J. Wang, "Difficulties in the Theories for Predicting Transverse Thermal Conductivity of Continuous Fiber Composites," J. Compos. Mat., 28(1994) p. 1491-1498.
43. R.C. Wetherhold, J. Wang, "A Self-Correcting, Thermal-Curvature-Stable Bending Element," J. Compos. Mat., 28(1994) p. 1588-1597.
44. R.C. Wetherhold, J. Wang, "Tailoring Thermal Deformation by Using Layered Beams," Compos. Sci. Techn., 53(1995) p. 1-6.
45. R.C. Wetherhold, J. Wang, "Controlling Thermal Deformation by Using Laminated Plates," Composites, 27B (1996) p. 51-57.
46. R.C. Wetherhold, S. Seelman, J. Wang, "Using Functionally Gradient Materials to Eliminate or Control Thermal Deformation," Compos. Sci. Techn., 56(1996) p. 1099-1104.
47. R.C. Wetherhold, D.J. Thomas, "Regularity of the Transverse Crack Spacing in a Damaged Laminate," Reliability Eng. Sys. Safety, 56 (1997) p. 221-224.
48. D.J. Thomas, R.C. Wetherhold, "Modeling the Effective Elastic Behavior of a Transversely Cracked Laminated Composite," J. Eng. Gas Turb. Power, 120 (1998) p. 191-198.
49. O.J. Aldraihem, R.C. Wetherhold, "Mechanics and Control of Coupled Bending and Twisting Vibration of Laminated Beams," Smart Mater. Struct., 6(1997) p. 123-133.
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51. M. Zhu, R.C. Wetherhold, D.D.L. Chung, "Evaluation of the Interfacial Shear in a Discontinuous Carbon Fiber/Mortar Matrix Composite," Cement Concr. Res. 27(1997) p. 437-451.
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STATEMENT OF RESEARCH ACTIVITY: My research activities can be loosely grouped into three areas. A summary is provided below of my contributions in these areas and my plans for continuing work in these areas.

Control of Deposition of Surface-active Agents: In examining the chemical treatment of surfaces to improve toughness and reliability, the distribution of deposited material turns out to be critical. This result has led me to related fields in which the "coffee ring effect" (CRE) plays an important role. In particular, various dissolved or suspended solids, including proteins and other biological molecules, can display the CRE effect. This can lead to an undesirable uneven distribution of the solids after the fluid evaporates. I am interested in the role that surface-active agents can play in order to control the deposition of solids onto surfaces. Applications include deposition of biological materials onto active surfaces, which materials experience reactions and can thus be clinically analyzed.

Durability and Fracture Toughness of Composite Materials: I am interested in general durability problems including the progressive failure of composite laminates, thermal cycling and thermal exposure and, perhaps most importantly, determining the influence of the constituents (fiber, matrix, interphase) on fracture toughness and fracture behavior. One result of this latter research included a method for predicting the effective crack bridging law and thus the toughening improvement for short fiber reinforcement, based on the fiber orientation distribution and individual fiber behavior. Structural composite materials for use in aerospace as well as commercial applications have benefited from this type of fundamental analysis. Portions of this durability research have in the past been sponsored by NASA-Lewis and the Air Force Materials Lab as well as the Army Research Office.

Current research in this area is aimed improving toughness while still maintaining stiffness by exploring a multiscale design space involving fiber shape and surface treatments. The goal is to produce ductile reinforcements with a shape and surface that has been tailored to permit the maximum ductile work by fibers which bridge cracks. The inspiration for this work is biomimetics, where fiber shape and surfaces are modeled after forms found in nature. This work has attracted wide attention and led to a joint program with Los Alamos National Lab Materials Science and Technology Div for the exchange of students and information.

Smart and Multifunctional Materials: This research studies the ways in which materials and structures can be tailored to respond in useful ways to achieve design goals and can fulfill more than one function (e.g. combining high strength with thermal conductivity). I have worked on solving design problems by exploiting the unique symmetry properties of composites and their

useful behavior in laminates. This has included the discovery of a class of laminates and functionally graded materials that have strength, stiffness, and unique thermal dimensional stability properties. I also became involved in the design and fabrication of unique orthotropic composite actuators that can control bending and twisting vibration of plates or beams in a flexible structure. Such flexible structures can be found in a variety of applications, especially in space and aircraft structures.

I am pursuing further work on the control and sensing of deformation by using composites. The area of sensing is especially interesting, as there is a need for temperature-insensitive sensors that possess orthotropy. I have also worked in the area of MEMS and specifically on the fundamental relationship of stress and magnetic behavior in giant magnetostrictive multilayers. Such multilayers have a number of transducer applications involving actuation in adaptive micro-systems. Applications include resonant or actuator devices involving switches, laser beam deflectors, fluid jet deflectors, valves, ultrasonic motors, micro-grippers, and pumps. This effort was funded by NSF's Civil and Mechanical Systems.

STATEMENT OF TEACHING ACTIVITY: I have always viewed the teaching of undergraduate and graduate students to be the most essential task that we, as faculty, fulfill. Undergraduates must be prepared both for the demands of the current workplace and for lifelong learning, which may include graduate school. Graduate students need a more rigorous fundamental training that will equip them to be independent and will enable them to understand and contribute to current research. My general area of teaching is in solid mechanics and materials. Although I was trained as a mechanical engineer, I view a complementary knowledge of materials to be essential for our students. The days when engineers could learn about a few "classical" materials and have this training be sufficient for their entire careers are over. New materials such as composites, electronic packaging, multifunctional materials and MEMS have all added possibilities and challenges for the engineer and must be integrated into the educational curriculum. Students need to be given a proper background in both materials and mechanics to enable them to use these materials of the future.

The majority of my courses has, to be sure, had a solid mechanics emphasis. This includes such courses as MAE 524 Elasticity, MAE 415 Analysis of Structures, MAE 416 Aerospace Structures, and MAE 311 Machine Design. There is a limited possibility to include alternative, modern materials in such courses, and I have used the opportunity where possible. I have also taught courses in materials, including MAE 381 Materials I and MAE 485 Properties of Materials. It is in courses that deal with composite materials such as MAE 482/582, MAE 492/592, and MAE 483/584, Mechanics and Design Using Composite Materials where I have been able to introduce the students to concepts of materials and how their properties influence the behavior of the structure. In the future, I will continue to introduce students to the important interaction between solid mechanics and materials.