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## **Ghassan Chehab**

### **EDUCATION**

<b>Ph.D. (2002)</b>	Civil Engineering; North Carolina State University; Raleigh, NC Topic: Advanced Modeling of Pavement Engineering Advisor: Dr. Richard Kim
<b>M.E.M. (1998)</b>	Construction Management; American University of Beirut; Beirut, Lebanon
<b>B.E. (1996), with Distinction</b>	Civil Engineering; American University of Beirut; Beirut, Lebanon

### **RESEARCH**

<b>Experience</b>	
2004-Present	Assistant Professor, Department of Civil and Environmental Engineering, Penn State University <ul style="list-style-type: none"><li>• Evaluation of Construction Materials</li><li>• Accelerated &amp; Full-scale Pavement Testing</li><li>• Advanced Modeling of Asphalt Concrete Behavior</li></ul>
2004	Pavement and Materials Research Engineer, Division of Research, Indiana Dept. of Transportation <ul style="list-style-type: none"><li>• Evaluation and sensitivity analysis of the M-E Design Guide.</li><li>• Strategic planning for implementing the M-E Design Guide in Indiana.</li><li>• Management of data from Indiana LTPP sites.</li><li>• Management of state-wide FWD testing and backcalculation analysis.</li></ul>
2002-2003	Postdoctoral Research Associate; Department of Civil Engineering, NCSU; Advisor: Dr. Richard Kim Supervision of the Asphalt Materials Analysis Group and Superpave fabrication and testing labs. Research projects supervised: <ul style="list-style-type: none"><li>• Characterization of ALF mixes using the viscoelastoplastic continuum damage (VEPCD) model</li><li>• Determination of E* from IDT, uniaxial, and impact resonance testing for typical AC mixtures</li><li>• Performance related specifications for AC mixes in NC.</li></ul>

### **PUBLICATIONS**

#### **Peer Reviewed Journals**

1. G.R. Chehab, J.S. Daniel, (2006), "Evaluating RAP Mixtures using the Mechanistic Empirical Pavement Design Guide", paper accepted for presentation and publication at the 2006 Transportation Research Board Annual Meeting, Washington D.C.
2. Yin H., G.R. Chehab, S. Stoffels, (2005), "A Case Study: Assessing the Sensitivity of the Coefficient of Thermal Contraction of AC Mixtures on Thermal Crack Prediction", *ASCE Geotechnical Special Publication*, In print.
3. G.R. Chehab and K. Galal, (2005) "The M-E Design Guide: A Case Study on HMA Overlays over Fractured PCC Slabs", *Journal of Asphalt Pavement Technology*, AAPT, Vol. 74E.

4. T. Nantung, G.R. Chehab, K. Galal, S. Li, and D.H. Kim, (2005) "Implementation Initiatives of the Mechanistic-Empirical Pavement Design Guides in Indiana", *Transportation Research Record*, Transportation Research Board, Washington, D.C., In Print.
5. K. Galal and G.R. Chehab, (2005) "Considerations for Implementing the 2002 M-E Design Procedure Using a HMA Rehabilitated Pavement Section in Indiana", *Transportation Research Record*, Transportation Research Board, Washington, D.C., In Print.
6. Y. Seo, G.R. Chehab, Y.R. Kim (2005) "Viscoelastoplastic Characterization of Post-Peak Behavior of Asphalt-Aggregate Mixtures using Digital Image Correlation", accepted to the *International Journal of Geomechanics*, ASCE.
7. G.R. Chehab, Y.R. Kim, (2005) "Viscoelastoplastic Continuum Damage Model Application to Thermal Cracking of Asphalt Concrete", *Journal of Materials in Civil Engineering*, ASCE, Vol. 17, Issue 4, 384-392.
8. J. Daniel, G.R. Chehab, Y.R. Kim, (2004) "Issues Affecting Measurement of Fundamental Asphalt Mixture Properties", *Journal of Materials in Civil Engineering*, ASCE, Vol. 16, Issue 5, 469-476 .
9. B.R. Nilsson, G.R. Chehab, Y.R. Kim, (2004) "Application of a Viscoelastoplastic Model to Asphalt Mixes in Sweden", *Road Materials and Pavement Design*, Lavoisier, Vol. 5, SI, 2004.
10. G.R. Chehab, Y.R. Kim, R.A. Schapery, M. Witzack, R. Bonaquist, (2003) "Characterization of Asphalt Concrete in Uniaxial Tension Using a Viscoelastoplastic Model" *Journal of Asphalt Paving Technology*, AAPT, Vol. 72.
11. G.R. Chehab, Y.R. Kim, R.A. Schapery, M. Witzack, R. Bonaquist, (2002)"Time-Temperature Superposition Principle for Asphalt Concrete Mixtures with Growing Damage in Tension State" *Journal of Asphalt Paving Technology*, AAPT, Vol. 71, pp. 559-593.

### **Refereed Proceedings**

12. T. Kumar, G.R. Chehab, S. Stoffels, D. Morian (2006), "Effect of Binder Course on Overlay Performance: Case Study on I-79", Proceedings for the 2006 ICAP Conference, International Society of Asphalt Pavements, Quebec, Canada.
13. Yin H., G.R. Chehab, S. Stoffels, (2006), "Sensitivity of Thermal Cracking Prediction to AC Mixture Properties using the M-E Pavement Design Guide", Proceedings for the 2006 ICAP Conference, International Society of Asphalt Pavements, Quebec, Canada.
14. K. Galal and G.R. Chehab, (2006) "Evaluating High Performing Structural HMA Pavement Systems using the ME Design Guide", paper accepted to CEIS 2006: Civil Engineering Infrastructure Systems Conference Proceedings, Beirut, Lebanon.

Francesco Costanzo

Francesco Costanzo is an Associate Professor of Engineering Science and Mechanics and Mathematics at Penn State. Following a B.S. degree (*magna cum laude*) in Aeronautical Engineering from the Politecnico di Milano in 1989, he came to the USA on a Fulbright Scholarship and obtained his Ph.D. degree in Aerospace Engineering from Texas A&M University (College Station, TX) in 1993. After a postdoctoral experience in the Mathematics Department at Texas A&M University, he joined the Penn State faculty in 1995. Since then, his main research objective has been the theoretical characterization of the mechanical behavior of materials, with a focus on modeling and computation for dynamic fracture and damage evolution. He has worked in the analytical characterization of heterogeneous media with evolving microstructure due to damage and has received an NSF CAREER Award in 1998 for the study of mechanical properties of amorphous thin film. Prof. Costanzo has co-created and is currently co-directing a parallel computational lab for the study of complex and nonlinear problems in mechanics of materials including the development of novel finite element methods for the study of fully coupled thermo-dynamic fracture. He is a member of ASME, SES, and ASEE. Also, he has served as co-organizer several symposia in rate dependent fracture (e.g., as part of the 1996 SES meeting at Arizona State University and at the 2002 SES meeting at Penn State). He has served Co-chair and co-technical chair for the *43rd Annual Technical Meeting Society of Engineering Science*, held at The Pennsylvania State University on August 13–16, 2006. In 2006, Prof. Costanzo was given a courtesy appointment with the Department of Mathematics at Penn State.

## RELEVANT PUBLICATIONS

### DAMAGE/HOMOGENIZATION RELATED PUBLICATIONS

Andia P. C., F. Costanzo, and G. L. Gray, “A classical Mechanics Approach to the Determination of the Stress-Strain Response of Particle Systems,” *Modelling and Simulation in Materials Science and Engineering*, **14**, 2006, pp. 741–757.

Andia P. C., F. Costanzo, and G. L. Gray, “A Lagrangian-Based Continuum Homogenization Approach Applicable to Molecular Dynamics Simulations,” *International Journal of Solids and Structures*, **42**(24–25), 2005, pp. 6409–6432.

Costanzo F., G. L. Gray, and P. C. Andia, “On the Definitions of Effective Stress and Deformation Gradient for Use in MD: Hill's Macro-homogeneity and the Virial Theorem,” *International Journal of Engineering Science*, **43**(7), 2005, pp. 533–555.

Costanzo F., G. L. Gray, and P. C. Andia, “On the Notion of Average Mechanical Properties in MD Simulation via Homogenization,” *Modelling and Simulation in Materials Science and Engineering*, **12**, 2004, pp. S333–S345.

Caiazzo A. A. and F. Costanzo, “Modeling the Constitutive Behavior of Layered Composites with Evolving Cracks,” *International Journal of Solids and Structures*, **38** (20), 2001, pp. 3469–3485.

Caiazzo A. A. and F. Costanzo, “Effective 3D Constitutive Relations of Composites with Evolving Damage,” *Journal of Engineering Mechanics*, **127**(7), 2001, pp. 661–666.

Costanzo F., J. G. Boyd, and D. H. Allen, “Micromechanics and Homogenization of Inelastic Composites Materials with Growing Cracks,” *Journal of the Mechanics and Physics of Solids*, **44**, 1996, pp. 333–370.

## WAVE PROPAGATION RELATED PUBLICATIONS

Miller S. T. and F. Costanzo, “A Numerical Verification for an Unconditionally Stable FEM for Elastodynamics,” *International Journal of Numerical Methods in Engineering*, 2007. Submitted for publication July 2007.

Khalmanova D. K. and F. Costanzo, “A Space-Time Discontinuous Galerkin Finite Element Method for Fully Coupled Linear Thermo-elasto-dynamic Problems with Strain and Heat Flux Discontinuities,” *Computer Methods in Applied Mechanics and Engineering*, 2007. Under revision.

Costanzo F. and H. Huang, “Proof of Unconditional Stability for a Single-field Discontinuous Galerkin Finite Element Formulation for Linear Elasto-dynamics,” *Computer Methods in Applied Mechanics and Engineering*, **194**(1820), 2005, pp. 2059–2076.

Huang H. and F. Costanzo F., “On the Use of Space-time Finite Elements in the Solution of Elasto-dynamic Fracture Problems,” *International Journal of Fracture*, **127**(2), 2004, pp. 119–146.

Huang H. and F. Costanzo F., “On the Use of Space-time Finite Elements in the Solution of Elasto-dynamic Problems with Strain Discontinuities,” *Computer Methods in Applied Mechanics and Engineering*, **191**(46), 2002, pp. 5315–5343.

Costanzo F. and J. R. Walton, “Steady Growth of a Crack with a Temperature Sensitive Cohesive Zone,” *Journal of the Mechanics and Physics of Solids*, **50**, 2002, pp. 1649–1679.

## SYNERGISTIC ACTIVITIES

- A. Prof. Costanzo is a Co-PI on a ONR-sponsored MURI program for the study of the failure behavior of rocket nozzles. This project focuses on the damage nucleation and evolution in the presence of high temperature and pressures in rocket nozzles. Prof. Costanzo's contribution to this project is the modeling of the detail of crack nucleation and propagation using FEM. The modeling and code development due to this MURI program can be used to support research on damage evolution.
- B. Prof. Costanzo is the PI on a AFOSR-sponsored grant (from the Applied Analysis program) program for the formulation of accurate space-time FEM for use in thermo-elasto-dynamic crack propagation with temperature and rate dependent cohesive zone models. Again, the modeling and code development due to this MURI program can be used to support research on damage evolution.

## EDUCATION/TRAINING

Institution	Degree	Year	Field of Study
Politecnico di Milano	B.S. (magna cum laude)	1989	Aerospace Engineering
Texas A&M University	Ph.D.	1993	Aerospace Engineering
Texas A&M University	Postdoctoral training	1994	Mathematics

## **JEFFREY A. LAMAN**

Associate Professor of Civil Engineering, Penn State  
Research Associate, Pennsylvania Transportation Institute

### **Education**

Ph.D., Civil Engineering, University of Michigan, 1995  
M.S.E., Civil Engineering, University of Michigan, 1984  
B.S., Civil Engineering, Michigan Technological University, 1980

### **Areas of Expertise**

Design and Behavior of Bridge Structures  
Long-Term and Health Monitoring of Structures  
Bridge Load Models, Fatigue  
Design and Behavior of Steel Structures

### **Selected Certifications, Memberships, Honors**

Registered Professional Engineer, State of Michigan  
American Society of Civil Engineers  
American Institute of Steel Construction  
Transportation Research Board

### **Selected Publications**

Kim, W-S, J.A. Laman, and D.G. Linzell, "Live Load Radial Moment Distribution for Horizontally Curved Bridges," *ASCE Journal of Bridge Engineering*, to appear Nov. 2007.

Nevling, D., D.G. Linzell, and J.A. Laman, "Examination of Level of Analysis Accuracy for Curved I-Girder Bridges Through Comparison to Field Data," *ASCE Journal of Bridge Engineering*, Vol. 11, No. 2, March/April 2006, pp. 160-168.

Paul, M., Laman, J.A., Linzell, D.G., "Thermally Induced Superstructure Stresses in Prestressed Girder Integral Abutment Bridges," *Transportation Research Record: Journal of the Transportation Research Board*, CD 11-S, Transportation Research Board of the National Academies, Washington, DC, 2005, pp. 287-297. July 2005

Fennema, Laman, Linzell, "Predicted and Measured Response of Integral Abutment Bridges," *ASCE Journal of Bridge Engineering*, Vol. 10, No. 6, Nov/Dec 2005, pp 666-677.

Leighty, Laman, Gittings, "Heavy Axle Study: Impact of Higher Rail Car Weight Limits on Short-Line Railroad Bridge Structures," *Civil Engineering and Environmental Systems*, Vol. 21, No. 2, June 2004, pp. 91-104

Laman, J.A., M-S Lee, and T.E. Boothby. "Experimental and Numerical Evaluation of a Braced-Chain Eyebar Bridge," *Journal of the Transportation Research Board No. 1770*, TRB, National Research Council, Washington, D.C., December 2001, pp. 37-44.

**Daniel G. Linzell, Ph.D., P.E.**  
**Department of Civil and Environmental Engineering**  
**The Pennsylvania State University**  
**231L Sackett Building**  
**University Park, PA 16802**  
**(814) 863-8609**  
**Fax: (814) 863-7304**  
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**Research Focus Areas:**

**Curved and Skewed Concrete and Steel Bridges:** response to service and construction loads  
**Advanced Materials for Structural Engineering:** application of high-performance steel and fiber-reinforced polymer materials to structures  
**Force Protection:** detailing of steel frames and connections to resist blast loads  
**Laboratory and Field-Testing of Structures, Structural Health Monitoring**  
**Advanced Finite Element Modeling**

**Education:**

**Georgia Institute of Technology, Atlanta, Georgia**

Ph.D., Civil Engineering, August 1999.

Thesis Title: "*Studies of a Full-Scale Horizontally Curved Steel I-Girder Bridge System Under Self-Weight*"

Advisors: Dr. Roberto T. Leon, Dr. Abdul-Hamid Zureick.

M.S., Civil Engineering, December 1995.

**The Ohio State University, Columbus, Ohio.**

B.S., Civil Engineering, December 1990.

**Employment History:**

7/05 – present     **Associate Professor**, School of Civil and Environmental Engineering, The Pennsylvania State University, University Park, Pennsylvania.  
8/99 – 6/05        **Assistant Professor**, School of Civil and Environmental Engineering, The Pennsylvania State University, University Park, Pennsylvania.  
2/98 – 9/98        **Associate Engineer**, Construction Technology Laboratories, Skokie, Illinois.  
9/94 – 8/99        **Graduate Research Assistant**, School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, Georgia.  
12/90 - 9/94       **Structural Inspection Engineer**, Burgess and Niple, Ltd., Columbus, Ohio.

**Honors and Affiliations:**

Commonwealth of Pennsylvania Professional Engineer Certification, 2000.  
State of Georgia Professional Engineer Certification, 1997.  
Member: American Society of Civil Engineers, American Institute of Steel Construction, Structural Engineering Institute, Structural Stability Research Council.  
Member: Tau Beta Pi, Chi Epsilon, Gamma Beta Phi Honor Societies.

**Relevant Publications:**

Bell, B. and Linzell, D., "Erection Procedure Effects on Deformations and Stresses in a Large Radius, Horizontally Curved, I-Girder Bridge," ASCE Journal of Bridge Engineering, v12, n1, July 2007, pp. 467-476.  
Nevling, D., Linzell, D. and Laman, J., "Examination of Level of Analysis Accuracy for Curved I-Girder Bridges through Comparisons to Field Data," ASCE Journal of Bridge Engineering, v11, n2, March/April 2006, pp.160-168.  
Domalik, D.E., Shura, J.F. and Linzell, D.G., "Design and Field Monitoring of Horizontally Curved Steel Plate Girder Bridge," Transportation Research Record, Journal of the Transportation Research Board No. 1928, pp. 83-91, 2005.  
Fennema, J.L., Laman, J.A. and Linzell, D.G., "Predicted and Measured Response of an Integral Abutment Bridge," ASCE Journal of Bridge Engineering, v10, n6, November/December 2005, pp. 666-677.  
Choo, T., Linzell, D., Lee, J. and Swanson, J., "Response of a Continuous, Skewed, Steel Bridge during Deck Placement," Journal of Constructional Steel Research, v61,n5, May 2005, pp. 567-586.

**Cliff J. Lissenden**

Director, Ben Franklin Center of Excellence in Structural Health Monitoring

Associate Professor of Engineering Science and Mechanics

Penn State University

212 Earth-Engineering Science Building

University Park, PA 16802

[Lissenden@psu.edu](mailto:Lissenden@psu.edu)

**Professional Preparation:**

Virginia Polytechnic Institute and State University, B.S. in Civil Engineering, 1985.

University of Virginia, M.S. in Civil Engineering, 1988.

University of Virginia, Ph.D. in Civil Engineering/Applied Mechanics, 1993.

**Appointments:**

Undergraduate Officer, Engineering Science and Mechanics, July 2004-present

Associate Professor of Engineering Science and Mechanics, Pennsylvania State University, 2001-present.

Assistant Professor of Engineering Science and Mechanics, Pennsylvania State University, 1995-2001.

Summer Faculty Fellow, NASA Lewis Research Center, 1994-1995.

Visiting Assistant Professor of Engineering Mechanics, University of Kentucky, 1993-1995.

Research Assistant/Associate/Instructor, University of Virginia, 1990-1993.

Structural Engineer/Associate, Gee & Jenson, West Palm Beach, FL, 1988-1990.

Structural Engineer, Kimley-Horn & Associates, West Palm Beach, FL, 1985-1987.

**Recent Related Projects:**

Penetration power of ultrasonic guided waves for piping and well casing integrity analysis, 8/1/07-7/31/08, \$158,281 (\$85,000 from Gas Storage Technology Consortium, \$28,000 from FBS, \$45,281 from Penn State)

Nondestructive evaluation of polymer-matrix composites and joints using ultrasonic guided waves, NASA Aeronautics Research Mission Directorate, 1/1/07-12/31/09, \$359,328

Applied Research Laboratory, Technology Development for Shaft Crack Detection in Nuclear Power Plants, EPRI, Ken Maynard PI, 7/1/02-12/30/06

Continuation of deformation response and life of metallic composites, NASA GRC, 12/18/02-12/17/03, \$50,000

**Recent Publications:**

1. C.J. Lissenden, S.P. Tissot, M.W. Trethewey, and K.P. Maynard, 2007, "Torsion response of a cracked stainless steel shaft," *Fat. Fract. Engng. Mat.* Vol. 30, pp. 734-747.

2. C. Lissenden, F. Yan, E. Hauck, D. Noga, J. Rose, 2006, "Internal damage detection in a laminated composite plate using ultrasonic guided waves," in *Review of Quantitative Nondestructive Evaluation Vol. 26*, In: *Review in Quantitative Nondestructive Evaluation*, Vol. 26B, D.O. Thompson and D.E. Chimenti, Eds., American Institute of Physics, pp. 1029-1035.

3. J.L. Rose, J. Mu, L. Zhang, and C.J. Lissenden, 2006, "Long range focused ultrasonic guided waves for corrosion detection in tubular structures," NACE Conference proceedings.

4. C.J. Lissenden, D. Doraiswamy, and S.M. Arnold, 2006, "Experimental investigation of cyclic and time-dependent deformation of titanium alloy at elevated temperature," *Int. J. Plasticity* Vol. 23, pp. 1-24.

5. S.M. Arnold, A.F. Saleeb, L. Powers, C.J. Lissenden, 2005, "High temperature characterization and prediction of Timetal 21S cyclic and cyclic-relaxation deformation behavior using a multimechanism



viscoelastoplastic model,” In: Dislocations, Plasticity, Damage and Metal Forming: Material Response and Multiscale Modeling, A.S. Khan and A.R. Khoei, Eds., Neat Press, pp. 175-177.

6. P.A. Solimine and C.J. Lissenden, 2004, “Fatigue of beta titanium alloy at 20, 482, and 648 °C,” *Fatigue Fract. Engng. Mater. Struct.* Vol. 27, pp. 943-955.

7. M.S. Lebold, K. Maynard, K. Reichard, M. Trethewey, D. Bieryla, C. Lissenden, D. Dobbins, 2004, “Using torsional vibration analysis as a synergistic method for crack detection in rotating equipment,” 2004 IEEE Aerospace Conference Proceedings, Vol. 6, pp. 3517-3526. (refereed proceedings).

8. C.J. Lissenden, J.F. Colaiuta, and B.A. Lerch, 2004, “Hardening behavior of three metallic alloys under combined stresses at elevated temperature,” *Acta Mech.* Vol. 169, pp. 53-77.

9. C.J. Lissenden and X. Lei, 2004, “A more comprehensive method for yield locus construction for metallic alloys and composites,” *Exp. Mechanics*, Vol. 44, pp.10-20.

10. S.K. Iyer and C.J. Lissenden, 2003, “Multiaxial constitutive model accounting for the strength differential in Inconel 718,” *Int. J. Plasticity*, Vol. 19, pp. 2055-2081.

### **Recent Presentations:**

1. P.K. **Puthillath**, F. Yan, C.J. Lissenden, and J.L. Rose, “Ultrasonic guided waves for the inspection of adhesively bonded joints,” Review of Progress in Quantitative NDE, Golden, Colorado, 23-27 July 2007.

2. C.J. **Lissenden**, “The imminent guided wave revolution in NDE,” NDE Center Application Challenges of NDE in Jordan Industries, 17 May 2007, Hashemite University, Zarqa, Jordan.

3. C.J. **Lissenden**, “Guided waves for nondestructive evaluation (NDE) and structural health monitoring (SHM),” 43<sup>rd</sup> Annual Technical Meeting of the Society of Engineering Science, State College, Pennsylvania, 13-16 August 2006.

4. C.J. **Lissenden**, F. Yan, E.T. Hauck, D.M. Noga, J.L. Rose, “Internal damage detection in a laminated composite plate using ultrasonic guided waves,” Review of Progress in Quantitative NDE, Portland, Oregon, 30 July-4 August 2006.

5. J.L. Rose, J. Mu, L. Zhang, C.J. **Lissenden**, “Long range focused ultrasonic guided waves for corrosion detection in tubular structures,” NACExpo 2006, San Diego, California, 12-16 March 2006.

### **Synergistic Activities:**

1. Have organized symposia on continuum plasticity and damage mechanics (SES annual meeting), mechanics of fibrous composites (US NCTAM), and understanding and predicting material degradation (ASME PVP conference).

2. Served on Mil Handbook 17 Metal Matrix Composites committee and wrote design and analysis section on micromechanics.

3. Developed an integrated design project focused on a bicycle crank arm for an advanced mechanics of materials course.

4. Organized a lighter-than-air design-build competition for undergraduates and high school students in conjunction with the Society of Engineering Science Annual Meeting.

### **Collaborators:**

James Blackshire, AFRL; Joseph Rose, Penn State Engineering Science and Mechanics; Steven Arnold, NASA Glenn Research Center; Mitchell Lebold, Penn State Applied Research Lab; Bradley Lerch, NASA Glenn Research Center; Kenneth Maynard, Penn State Applied Research Lab; Nicholas Salamon, Penn State ESM; Martin Trethewey, Penn State Mechanical Engineering; Mark Horn, Penn State ESM; Atef Saleeb, Akron University Civil Engineering.

**Maria Lopez de Murphy, Ph.D.**

Assistant Professor and Will Development Professor of Civil Engineering  
Department of Civil and Environmental Engineering  
The Pennsylvania State University  
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**Awards**

**2005- 2003 James F. Will Developmental Professorship**, Penn State University

**2002 Faculty Early Career Development (CAREER) Award** from the National Science Foundation. The CAREER Award is NSF's most prestigious honor for junior faculty members.

**2001 Boeing Outstanding Educator Award**, Clarkson University

**Related Publications**

Coronado, Carlos A. and Lopez, Maria M., A damage approach for the prediction of debonding failure on concrete elements strengthened with FRP, *ASCE Journal of Composites for Construction*, **11:4** July-August 2007

Cole, T., Lopez, M. , Ziehl, P. Fatigue Behavior and Nondestructive Evaluation of Full-Scale FRP Honeycomb Bridge Specimen. *ASCE Journal of Bridge Engineering* **11:4**. pp. 420-429. July 2006

Coronado, C. A., Lopez, M. M., Sensitivity Analysis of Reinforced Concrete Beams Strengthened with FRP Laminates, *Journal of Cement and Concrete Composites* **28:1** pp. 102-114. 2006

Lee, J. H., Lopez, M., and Bakis, C. "Flexural Behavior of Reinforced Concrete Beams Strengthened with Mechanically Fastened FRP Strip," *Proc. 8<sup>th</sup> Intl. Symp. on Fiber Reinforced Polymer Reinforcement for Concrete Structures, FRPRCS-8*, Patras, Greece 2007.

Lopez, M. and Coronado, C. "Characterizing the Concrete-Epoxy Layer on Externally Bonded FRP Bonded Systems," *Proc. 8<sup>th</sup> Intl. Symp. on Fiber Reinforced Polymer Reinforcement for Concrete Structures, FRPRCS-8*, Patras, Greece 2007.

**Biographical sketch**

Maria Lopez received her MS and PhD from the University of Michigan. She holds a Civil Engineering degree from the Universidad del Valle in Colombia and is a registered professional engineer in that country. She has been a faculty member at Penn State University in the Department of Civil and Environmental Engineering since 2003, where she was awarded the Will Development Professorship. Dr. Lopez is a recipient of the *National Science Foundation Faculty Early Career Development (CAREER) Award*.

Dr. Lopez is active on a large number of professional committees both in the US and abroad. She is a current voting member of several ACI technical committees: 440 Fiber Reinforced Polymer Reinforcement, 544 Fiber Reinforced Concrete, and 446 Fracture Mechanics. Dr. Lopez has also served on NCHRP project review panels and is a member of the TRB AFF80 committee on FRP. She has served as member of the Editorial Board of the *Journal of Cement and Concrete*. She has more than ten years of experience on laboratory instrumentation and testing of medium to large scale structural components.

**Thesis Advisor:** Advised 2 PhD, 6 MS, 2 MEng, and 3 BS honors students to date.

**JOSEPH L. ROSE**  
**Paul Morrow Professor**  
**Engineering Design and Manufacturing**  
411E Earth & Engineering Sciences Building  
Department of Engineering Science and Mechanics  
College of Engineering  
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University Park, PA. 16802  
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<http://www.psu.edu/ultrasonics>

### **Research Profile:**

Dr. Rose is the Paul Morrow chaired professor in the Engineering Science & Mechanics Department of Pennsylvania State University. Dr. Rose received his Ph.D. from Drexel University in 1970. He received a variety of awards and was a finalist in the 1995 Discover Awards for technological innovation in Aviation and Aerospace for the development of a hand-held probe for aging aircraft inspection. He was also the American Society for Nondestructive Testing (ASNT) Mehl Honor Lecture recipient in 2001. Dr. Rose was the recipient of a University Faculty Scholar Medal for achievement in Engineering in 1996, and a premier research award in 2002. Dr. Rose received the ASME Nondestructive Evaluation Engineering Division Founders Award in 2003. Dr. Rose is currently a fellow of ASNT, ASME, IEEE and the British Society for Nondestructive Testing.

Dr. Rose is author of seven patents, four text books, and over 500 articles on ultrasonic NDE, wave mechanics, medical ultrasound, adhesive bonding, concrete inspection, pipe and tubing inspection, composite material inspection, ice detection, signal processing, and pattern recognition. Textbooks include Basic Physics in Diagnostic Ultrasound, John Wiley & Sons Inc, New York, 1979, and Ultrasonic Waves in Solid Media, Cambridge University Press, 1999. He has served as principal advisor to over 40 Ph.D. and 150 M.S. students.

### **Recent Publications:**

1. Zhao, X., Gao, H., Zhang, G., Ayhan, B., Yan, F., Kwan, C., Rose, J.L., 2007, "Active Health Monitoring of an Aircraft Wing with Embedded Piezoelectric Sensor/Actuator Network: I. Defect Detection, Localization and Growth Monitoring," *Smart Materials and Structures*, **16**, pp. 1208-1217.
2. Luo, W., Rose, J.L., 2007, "Phased Array Focusing with Guided Waves in a Viscoelastic Coated Hollow Cylinder," *Journal of the Acoustical Society of America*, **121**(4), pp. 1945-1955.
3. Rose, J.L., Mu, J., Van Velsor, J.K., 2007, "New Directions in Guided Wave Pipe Testing," *Materials Evaluation*, pp. 375-378.
4. Lynnworth, L.C., Cohen, R., Rose, J.L., Kim, J.O., Furlong, E.R., 2006, "Vortex Shedder Fluid Flow Sensor," *IEEE Sensor Journal*, **6**(6), pp. 1488-1496.
5. Hay, T.R., Royer, R.L., Gao, H., Zhao, X., Rose, J.L., 2006, "A comparison of embedded sensor Lamb wave ultrasonic tomography approaches for material loss detection," *Smart Materials and Structures*, **15**, pp. 946-951.
6. Hay, T.R., Rose, J.L., 2006, "Flexible Piezopolymer Ultrasonic Guided Wave Arrays," *Correspondence in IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, **53**(6), pp. 1212-1217.
7. Zhao, Z., Rose, J.L., Gao, H., 2006, "Determination of Density Distribution in Ferrous Powder Compacts Using Ultrasonic Tomography," *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, **53**(2), pp. 360-369.
8. Sun, Z., Zhang, L., Rose, J.L., 2005, "Flexural Torsional Guided Wave Mechanics and Focusing in Pipe," *ASME Transactions Journal of Pressure Vessel Technology*, **127**(4), pp. 471-478.

9. Bian, H., Rose, J.L., 2005, "Sparse Array Ultrasonic Guided Wave Tomography," *Materials Evaluation*, **63(10)**, pp. 1035-1038.
10. Li, J., Rose, J.L., 2005, "Natural beam focusing of non-axisymmetric guided waves in large-diameter pipes," *Ultrasonics*, **44**, pp. 35-45.
11. Rose, J.L., Zhang, L., Avioli, M.J., Mudge, P.J., 2005, "A Natural Focusing Low Frequency Guided Wave Experiment for the Detection of Defects Beyond Elbows," *ASME Transactions Journal of Pressure Vessel Technology*, **127(3)**, pp. 310-316.
12. Hayashi, T., Kawashima, K., Sun, Z., Rose, J.L., 2005, "Guided Wave Propagation Mechanics Across a Pipe Elbow," *ASME Transactions Journal of Pressure Vessel Technology*, **127(3)**, pp. 322-327.
13. Hayashi, T., Kawashima, K., Sun, Z., Rose, J.L., 2005, "Guided Wave Focusing Mechanics in Pipe," in *ASME Transactions Journal of Pressure Vessel Technology*, **127(3)**, pp. 317-321.
14. Luo, W., Zhao, X., Rose, J.L., 2004, "A Guided Wave Plate Experiment for a Pipe," *ASME Transactions Journal of Pressure Vessel Technology*, **127(3)**, pp. 345-350.
15. Owens, S.E., Hauck, E.T., Rose, J.L., 2005, "A Novel Couplant Free Mediator Ultrasonic Rayleigh Wave Technique for Detecting Surface Cracks in Green Parts," *SAE 2004 Transactions Journal of Materials and Manufacturing*, **5**, pp. 205-213.
16. Kim, J.O., Rose, J.L., 2005, "Thin-Shell Approach for Elastic Wave Propagation in a Pipe with Liquid," *Journal of Mechanical Science and Technology*, **19(5)**, pp. 1087-1094.
17. Luo, W., Rose, J.L., and H. Kwun, 2004, "Circumferential Shear Horizontal Wave Axial-Crack Sizing in Pipes," *Research in Nondestructive Evaluation*, **15(4)**, pp. 149-171.
18. Hayashi, T., Kawashima, K., Rose, J.L., 2004, "Calculation for Guided Waves in Pipes and Rails," *Key Engineering Materials*, **270-273(1)**, *Advances in Nondestructive Evaluation*, pp. 410-415.
19. Zhao, X., Rose, J.L., 2004, "Three Dimensional Defect in a Plate Boundary Element Modeling for Guided Wave Scattering," *Key Engineering Materials*, **270-273(1)**, *Advances in Nondestructive Evaluation*, pp. 453-460.
20. Rose, J.L., 2004, "Ultrasonic Guided Waves in Structural Health Monitoring," *Key Engineering Materials*, **270-273(1)**, *Advances in Nondestructive Evaluation*, pp. 14-21.
21. Barshinger, J., Rose, J.L., 2004, "Guided Wave Propagation in an Elastic Hollow Cylinder Coated with a Viscoelastic Material," *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, **51**, pp. 1547-1556.
22. Song, W.-J., Rose, J.L., Galan, J.M., Abascal, R., 2005, "Ultrasonic Guided Wave Scattering in a Plate Overlap," *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, **52(5)**, pp. 892-903
23. Bian, H., Rose, J.L., 2004, "A Physical Interpretation of Elastic Guided-Wave Reflection from Normal Ends of a Wave Guide," *IEEE, Transactions on Ultrasonics, Ferroelectrics and Frequency Control*, **51(7)**, pp. 839-848.
24. Luo, W., Rose, J.L., 2004, "Lamb Wave Thickness Measurement Potential with Angle Beam and Normal Beam Excitation," *Materials Evaluation*, **62(8)**, pp. 860-866.
25. Luo, W., Rose, J.L., 2003, "Guided Wave Thickness Measurement with EMATS," *Insight*, **45**, pp. 735-739.

## BIOGRAPHICAL SKETCH

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### ANDREA J. SCHOKKER

#### *Professional Preparation*

Washington University, St. Louis, Missouri	Civil Engineering	BS	1993
Washington University, St. Louis Missouri	Civil Engineering	MS	1994
The University of Texas at Austin	Structural Engineering	Ph.D.	1999

#### *Appointments*

Director, Protective Technology Center, 2006-present  
Associate Professor of Civil Engineering, The Pennsylvania State University, 2004-present  
Assistant Professor of Civil Engineering, The Pennsylvania State University, 1999-2004  
Henderson Professor, Developmental Chair, The Pennsylvania State University, 1999-2002

#### *Research Interests:*

- Segmental concrete bridge design and construction related research
- Design and materials related improvements in prestressed concrete
- Durability of concrete structures / corrosion of metals in concrete
- Blast resistant concrete structures

#### *Related Publications/Presentations*

**Pacheco, A., Schokker, A.J., and Hamilton, H.R.**, "Revisions to the Accelerated Corrosion Test Method for Post-Tensioning Grouts," *ACI Materials Journal*, Vol. 4, No. 2, American Concrete Institute, Farmington Hills, MI, March 2007, pp. 123-128.

**Schokker, A.J. and Brennan, J.D.**, "Monitoring during the Retrofit of Frank Lloyd Wright's Fallingwater House," *Proceedings of the International Conference on Applications of Codes, Design, and Regulations*, Dundee, Scotland, September 2005, pp. 735-740.

**Schokker, A.J. and Moser, E.J.**, "Impact Resistance of Long Fiber Concrete," *Proceedings of the Canadian Society of Civil Engineers Annual Conference*, Toronto, Ontario, June 2005.

**Smith, K.M., Schokker, A.J., and Tikalsky, P.J.**, "The Performance of Supplementary Cementitious Materials in Concrete Resistivity and Corrosion Monitoring Evaluations," *ACI Materials Journal*, Vol. 101, No. 5, Sept.-Oct. 2004, pp. 385-390.

**Iyer, S., Schokker, A.J., and Sinha, S.**, "Ultrasonic C-Scan Imaging- Preliminary Evaluation for Detecting Corrosion and Voids in Post-tensioning Tendons," *Transportation Research Record, Journal of the Transportation Research Board*, No. 1827, National Research Council, Washington, D.C., 2003, pp. 44-52.

#### *National Committee Memberships*

*ACI (American Concrete Institute):*

*Chair:* ACI/ASCE Joint Committee 423, Board Advisory Committee on Students and Young Professionals

*Member:* Corrosion of Metals in Concrete; Cracking; Membership Committee; Faculty Network Coordinating Committee; Chapter Activities Committee

*PTI (Post-Tensioning Institute):* Committee on Post-Tensioning Grouting Specifications; PTI Educational Committee, Chair

*fib (fédération internationale du béton):* Task Group 5.4, Construction for Service Life Including Specifics for Prestressed Concrete Structures

*ASBI (American Segmental Bridge Institute):* Grouting Training and Specification Committee

*Transportation Research Board:* Concrete Bridge Committee

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*The Pennsylvania State University*  
*Department of Aerospace Engineering*  
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### **Overview**

Professor of Aerospace Engineering, Penn State  
VLRCOE Director

Ph.D. University of Maryland Center for Rotorcraft Education and Research, 1992

*Expertise:* Rotorcraft dynamics and aeromechanics, advanced composite materials and structures, elastomeric materials, active vibration control, health and usage monitoring systems. **Key Awards & Honors:** CRI TAC University Rep. 2005-present, 2002 AIAA Lawrence Sperry Award, 2002 PSES Outstanding Research Award, AHS Director's Award (1994), Chair, AHS Dynamics Tech. Comm. (2000-2002), Chair, AHS Education Comm. (1999-present), 1994 ARO Young Investigator Award

### **Professional Experience**

Professor of Aerospace Engineering, 2004-present  
Director, Penn State Rotorcraft Center of Excellence

Associate Professor of Aerospace Engineering, 1998-2004  
Director, Penn State Rotorcraft Center of Excellence

Assistant Professor of Aerospace Engineering, 1992-1998  
Co-Director, Director, Penn State Rotorcraft Center of Excellence (1996-2000)

Areas of research include rotorcraft dynamics and aeromechanics, composite structures, elastomeric materials, adaptive structures, and active vibration control.

Graduate Research Fellow, University of Maryland, 1988-1992.

Undergraduate Research Assistant, Penn State Applied Research Laboratory, Fabrication and damping characterization testing of metal matrix composite materials, 1986-1988.

### **Education**

Ph.D., Aerospace Engineering  
University of Maryland, Center for Rotorcraft Education and Research, August 1992  
Dissertation: *Aeroelastic Response and Aeromechanical Stability of Helicopters with Elastically Coupled Composite Rotor Blades*

M.S., Aerospace Engineering,  
University of Maryland, Center for Rotorcraft Education and Research, May 1990.

B.S. with High Distinction, Aerospace Engineering, Minor in Mathematics,  
The Pennsylvania State University, May 1988.

## Journal Publications

Kang, H., Smith, E.C., and Lesieutre, G.A., "Experimental and Analytical Study of Blade Lag Damping Augmentation Using Chordwise Absorbers," *Journal of Aircraft*, Vol. 43, No. 1, January-February 2006.

DeSmidt, H.A., Wang, K.W., Smith, E.C., and Provenza, A., "On the Robust Stability of Segmented Driveshafts with Active Magnetic Bearing Control," *Journal of Vibration and Control*, Vol. 11, No. 3, March 2005, pp. 317-239.

Kim, J.S., Wang, K.W., and Smith, E.C., "High-authority Piezoelectric Actuation System Synthesis through Mechanical Resonance and Electrical Tailoring" *Journal of Intelligent Material Systems and Structures*, Vol. 16, January 2005, pp. 21-31.

Heverly II, D.E., Wang, K.W., and Smith, E.C., "Dual Stack Piezoelectric Device with Bidirectional Actuation and Improved Performance," *Journal of Intelligent Material Systems and Structures*, Vol. 15, July 2004, pp. 565-574.

Ramrakhiani, D.S., Lesieutre, G.A., and Smith, E.C., "Modeling of Elasticmeric Materials Using Nonlinear Fractional Derivative and Continuously Yielding Fraction Elements," *Accepted International Journal of Solids and Structures*, Vol. 41, No. 14, July, 2004, pp. 3929-3948.

Zhang, J., Smith, E.C., and Wang, K.W., "Active-Passive Hybrid Optimization of Rotor Blades with Trailing Edge Flaps," *Journal of the American Helicopter Society*, Vol. 49, No. 1, January 2004, pp. 54-65.

DeSmidt, H.A., Wang, K.W., and Smith, E.C., "Stability of Segmented Supercritical Driveline with Non-Constant Velocity Couplings Subjected to Misalignment and Torque," *Journal of Sound and Vibration*, Vol. 227, 2004, pp. 895-918.

Keller, J.A. and Smith, E.C., "Active Control of Gimballed Rotors Using Swashplate Actuation During Shipboard Engagement Operations," *AIAA Journal of Aircraft*, Vol. 40, No. 4, July-August 2003, pp. 726-733.

Szefi, J.T., Smith, E.C., and Lesieutre, G.A., "Formulation and Validation of A Ritz-Based Analytical Model Of High Frequency Periodically-Layered Isolators in Compression," *Journal of Sound and Vibration*, Vol. 268, No.1, July 2003, pp. 85-1001.

Howard, A., and Smith, E.C., "Prediction of Air and Ground Resonance Stability Of Soft-Inplane Tiltrotors Using A Semi-Span Analytical Model," *Accepted For Publication in the American Helicopter Society*, January 2003.

Brackbill, C.R., Smith E.C., and Lesieutre, G.A., "Application Of A Refined Time Domain Elastomeric Damper Model to Helicopter Rotor Aeroelastic Response and Stability," *Journal of the American Helicopter Society*, Vol. 47, No.3, July 2002, pp. 186-197.

DeSmidt, H.A., Wang, K.W., and Smith E.C., "Coupled Torsion-Lateral Stability of a Shaft-Disk System Drive Through a Universal Joint," *Journal of Applied Mechanics*, Vol. 69, No. 3, May 2002, pp. 261-273.

Centolanza, L.R., Smith, E.C., and Morris A., "Induced-Shear Piezoelectric Actuators For Rotor Blade Trailing Edge Flaps and Active Tips," *Journal of Smart Materials and Structures*, Vol. 11, No. 1, February 2002, pp. 24-35.

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**ACADEMIC TRAINING:**

B.S. (Physics and Mathematics), George Washington University, Washington, DC, 1957

Ph.D. (Solid State Physics), University of California at Los Angeles, CA, 1965

**TEACHING EXPERIENCE:**

Professor, The Pennsylvania State University, University Park, PA 16802, 1989-present; Courses in Scanned Probe Microscopy, Ultrasonic Nondestructive Evaluation, Survey of Techniques in Nondestructive Evaluation, Statics, Dynamics, and Strength of Materials.

Visiting Professor, Summer 1997. Johannes Kepler University, Linz, Austria.

Visiting Lecturer, University of Linz, Austria, 1995. Graduate seminar lecture series (two lectures/week for three months).

Invited Summer Professor, 1993. University of Paris VII, Paris, France.

Visiting Professor, University of Paris III, Physics Department, 1982. Graduate course in Ultrasonic Methods in Solid State Physics.

Visiting Professor (appointed by French Ministry of Education), 1977-78. Research at Ecole Normale Supérieure, teaching at University of Paris VII, Physics Department, foreign assignment for Science Center.

Assistant Professor (in residence), 1965-1966. Physics Department, University of California at Los Angeles, CA.

**INDUSTRIAL EXPERIENCE:**

Manager, Materials Characterization. Science Center, Rockwell International, 1979 - 1989.

Member of Technical Staff, Materials Mechanics Group. Science Center, Rockwell, 1971-1977.

Member of Technical Staff, Physical Electronics Group. Science Center, Rockwell (formerly North American Aviation), 1966-1971.

Member of Technical Staff - Research. Hughes Aircraft Co., Culver City, CA, 1957-1961.

**PROFESSIONAL SOCIETIES:**

- American Ceramic Society (ACS), Member 1995 – present
- American Physical Society (APS), Member 1964 – present
- American Society for Metals (ASM) International, Member 1993, Fellow 2006 – present
- American Society of Nondestructive Testing (ASNT), Member 1980 – present
- Materials Research Society (MRS), Member, 1995 – present
- American Society of Mechanical Engineers International (ASME), Member, 2001 – present
- Acoustical Society of America (ASA), Fellow, 2001 – present
- Institute of Electrical and Electronics Engineering (IEEE), Fellow, 1990; Life Fellow, 2005 – present
- International Society for Optical Engineering (SPIE), Member
- Society for the Advancement of Science, Member
- Sigma Xi (National Society for the Advancement of Science), Member
- Sigma Pi Sigma (Physics Honor Society), Member

**PATENTS AWARDS:**

1. "Method for Measuring the Depth of Surface Flaws." Patent No. 4,274,288, June 23, 1981.
2. "Method and Apparatus for Characterizing Surface Flaws Utilizing Ultrasonic Surface Waves." Patent No. 4,307,614, December 29, 1981.
3. "Acoustic Measurement of Near-Surface Property Gradients." Patent No. 4,372,163, February 8, 1983.
4. "High Temperature Ultrasonic Viscometer." Patent No. 4,779,452, October 25, 1988.
5. "Method of Measuring the Dynamic Viscosity of a Viscous Fluid Utilizing Acoustic Transducer." Patent No. 4,862,384, August 29, 1989.
6. "Sonic Gas Pressure Gauge." Patent No. 4,869,097, September 26, 1989.
7. "Ultrasonic Self-Cleaning Catheter System for Indwelling Drains and Medication Supply" Patent No. 4,698,058, October 6, 1987.

**PUBLICATIONS:** Over 350 technical articles on nondestructive evaluation. Detail will be forwarded upon request.



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## **EDUCATION**

1974, BSME, Michigan Technological University  
1976, MSME, Michigan Technological University  
1981 Ph.D. Mechanical Engineering-Engineering Mechanics, Michigan Technological University

## **PROFESSIONAL HISTORY**

1974 (Summer)	Engineer Intern, Eastman Kodak Company, Kodak Apparatus Division, Rochester, NY
1976-77	Project Engineer, Union Carbide Corporation, Linde Division, Buffalo, NY
1977-78	Engineer, General Motors Corporation, Noise and Vibration Laboratory, GM Proving Ground, Milford, MI
1981-82	Visiting Assistant Professor, Michigan Technological University
1990-91	Visiting Research Fellow, Institute of Sound and Vibration Research, University of Southampton, Southampton, England
1999	Honorary Research Associate, Department of Mechanical Engineering, Monash University, Melbourne, Australia
1982-Date	Professor, Department of Mechanical and Nuclear Engineering, The Pennsylvania State University, University Park, PA

## **RESEARCH INTERESTS**

M.W. Trethewey's research has focused on the development and analysis of machine dynamic systems from experimentally acquired data. The effort involves research in experimental technique development, signal processing, experimental modal analysis and structural modeling.

He has supervised 48 graduate theses. He has over 45 funded research projects with primary funding coming from industrial sources supplemented by some federal resources. He has published over 125 technical papers including over 45 in archival journals. Core research expertise is in the areas of 1. Machine dynamics; 2. Vibrations; 3. Dynamic instrumentation; 4. Experimental modal analysis; 5. Data Acquisition and Signal processing; 6. Noise control.

*For the past ten years a main focus of his activities has been in the condition based machine health monitoring. Related projects include Disk Crack Detection using Torsional Vibration (GEAE/NASA Glenn); Torsional Vibration Measurement for Shaft and Blade Cracking (Southern Company); Development of a Torsional Vibration Monitoring System for Shaft Crack Monitoring; Wind Tunnel Fan Blade Diagnostics (NASA Ames)*

## Qiming Zhang

Distinguished Professor of Electrical Engineering and Materials Science and Engineering  
Department of Electrical Engineering, Penn State University, University Park, PA 16802

### EDUCATION BACKGROUND:

Ph. D., Solid State Physics, The Pennsylvania State University, 1986  
B. S., Physics, Nanjing University (Nanjing, China), 1981.

### APPOINTMENTS:

2007 - Distinguished Professor of electrical Engineering and Materials Science and Engineering, the Pennsylvania State University  
2001 - 2006 Professor of electrical Engineering and Materials Science and Engineering, the Pennsylvania State University  
Fall 2003 Sabbatical leave at California Institute of Technology  
1994-2001 Associate Professor of Electrical Engineering, Materials Research Laboratory and Electrical Engineering Department, the Pennsylvania State University.  
1991-1994 Assistant Professor of Materials, the Pennsylvania State University.  
1988-1991 Assistant Scientist, Brookhaven National Laboratory

### AWARDS:

David Rank Award, 1982, Penn State University; Davey Fellowship, 1983, Penn State University; Outstanding research award, 1999, College of Engineering, Penn State University.

### PROFESSIONAL SOCIETY:

Fellow, IEEE; Member, American Physical Society, SPIE, and Materials Research Society.

### SELECTED PUBLICATIONS (OUT OF 270 PUBLICATIONS AND 9 PATENTS):

1. Feng Xia, Srinivas Tadigadapa and Q. M. Zhang. Electroactive Polymer Based Microfluidic Pump. *Sensors & Actuators A125* 346 (2006).
2. Baojin Chu, Xin Zhou, Kailiang Ren, Bret Neese, Minren Lin, Qing Wang, F. Bauer, and Q. M. Zhang. A Dielectric Polymer with High Electric Energy Density and Fast Discharge Speed. *Science* **313**, 334 (2006)
3. J. Su, T. Xu, S. Zhang, T. Shrout, and Q. M. Zhang, An Electroactive Polymer-Ceramic Hybrid Actuation System for Enhanced Electromechanical Performance. *Appl. Phys. Lett.* **85**, 1045 (2004)
4. Feng Xia, Z.-Y. Cheng, and Q. M. Zhang. In-air and Underwater Performance and Finite Element Analysis of a Flexensional Device Having Electrostrictive P(VDF-TrFE) Polymer as the Active Element. *IEEE Trans. UFFC* **50**, 932 (2003).
5. Q. M. Zhang, Hengfeng Li, Martin Poh, Haisheng Xu, Z.-Y. Cheng, Feng Xia, Cheng Huang. An all-organic Composite Actuator Material with High Dielectric Constant. *Nature*, **419**, 284 (2002).
6. Z.-Y. Cheng, T.-B. Xu, Q. M. Zhang, R. Mayer, Jr. D. Van Tol, and J. Hughes. Design, Fabrication, and Performance of A Flexensional Transducer Based on Electrostrictive P(VDF-TrFE) Copolymer. *IEEE Trans. UFFC*. **49**, 1312 (2002).
7. Q. M. Zhang, Vivek Bharti, and X. Zhao. Giant Electrostrictive Response and Ferroelectric Relaxor Behavior in Electron Irradiated P(VDF-TrFE) Polymer. *Science*, **280**, 2101 (1998).
8. T. B. Xu, Z. Y. Cheng, and Q. M. Zhang. High Performance Micromachined Actuators Based on Electrostrictive Poly(vinylidene fluoride-trifluoroethylene) Copolymer. *Appl. Phys. Lett.* **80**, 1082 (2002).

9. Z.-Y. Cheng, T.-B. Xu, Q. M. Zhang, R. Mayer, Jr. D. Van Tol, and J. Hughes. Design, Fabrication, and Performance of A Flexensional Transducer Based on Electrostrictive P(VDF-TrFE) Copolymer. *IEEE Trans. UFFC*. 49, 1312 (2002).
10. A. E. Glazounov, S. Wang, Q. M. Zhang, and C. Kim. Piezoelectric Stepper Motor with Direct Coupling Mechanism to Achieve High Efficiency and Precise Control of Motor. *IEEE Trans. UFFC*, 47(4), 1059-1068 (2000).
11. Xuecang Geng and Q. M. Zhang, Resonance Modes and Losses in 1-3 Composites for Ultrasonic Transducer Applications. *J. Appl. Phys.* 85, 1342-1350 (1999).
12. Xuecang Geng, Q. M. Zhang, Evaluation of Piezocomposites for Ultrasonic Transducer Applications -- Influence of the Unit Cell Dimensions and the Properties of Constituents on the Performance of 2-2 Piezocomposites. *IEEE Trans. UFFC*. 44, 857-872 (1997).

SYNERGISTIC ACTIVITIES: Chair of the organizing committee of symposium on electroactive polymer and offered short course on ferroelectric polymer in 1999 and 2001 MRS Fall meeting. Co-Chair of symposia in electropolymers at MRS 2003, 2005, 2006 Fall Meetings; Organization committee on electroactive polymer actuators and devices at 1999-2006 SPIE International Symposium. Organizing committee of First and 2<sup>nd</sup> World Congress on Biomimetics and Artificial Muscles (2002 and 2004). Organized focused session on ferroelectrics at APS 1998 and 1999 March meeting. Technical program committee of IEEE International Ultrasonic Symposium (1994 to 2006). IEEE Committee on Ferroelectrics (1995-present). IEEE Subcommittee on Standard of Ferroelectricity (1996-present). Associate Editor, IEEE Trans. UFFC.

SELECTED RECENT INVITED And KEYNOTE PRESENTATIONS FOR PAST FIVE YEARS:

MRS Fall Meeting (Boston, 2005); International Meeting of Ferroelectrics (September 2005); IEEE International Symposium of Applied Ferroelectrics. Montreal, Canada (August, 2004); SPIE 10<sup>th</sup> Annual International Symposium on Smart Structures and Materials, March 2-6, 2003, San Diego; First World Congress on Biomimetics and Artificial Muscles (Albuquerque, Dec. 9-11, 2002); 11<sup>th</sup> International Symp. on Electrets (Melbourne, Australia, 1-3 Oct., 2002); 10<sup>th</sup> International Meeting on Ferroelectrics. (Madrid, Spain, September 3-7, 2001).

Related funding:

- 04/01/04 – 02/28/08, “Novel high dielectric constant polymers for energy storage capacitors,” ONR, \$965,000, PI
- 05/01/05 – 04/30/2010, “Unconventional dielectric materials and structures for ultra-high performance pulsed power capacitors,” ONR MURI, \$5,000,000, Co-PI
- 08/01/05 – 07/30/08, “Polymer microactuators,” NIH, \$400,000, PI
- 0815/07 – 08/14/11, “Possible giant electrocaloric effect in polar-polymers,” DOE, \$600,000, PI
- 07/01/07 – 06/30/12, “Ionic liquids in electroactive devices,” ARO MURI, \$6,250,000, Co-PI