

MICHAEL D. HAYES, Ph.D., P.E.

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HIGHLIGHTS

- Ph.D. in Engineering Mechanics, focus on durability of polymeric composite structures
- Licensed Professional Engineer (M.E.)
- 20+ years' experience
- Court-recognized expert witness in product liability cases
- Areas of expertise: polymers, composites, product development, stress analysis, root cause failure analysis, forensic investigation, R&D

PROFESSIONAL EXPERIENCE

HAYES ENGINEERING, LLC, Atlanta, GA

2024-present

Independent Consultant

Provide consulting services to clients with focus on product development support and failure analysis, particularly in polymer and fiber reinforced polymeric products

ESE CARBON COMPANY, Miami, FL (production located in Jasper, GA)

Vice President, Head of Engineering & Product Development

2019-2024

- Member of Board of Directors
- Work with CEO/President and Business Development to explore new business opportunities and set direction of new product development.
- Played key role in winning and managing development projects for eVTOL, commercial trucking, and military customers.
- Co-developed the "E3" carbon fiber composite wheels.
- Managed DOE-funded "LightMAT" grant that partnered company with Oak Ridge National Laboratory (ORNL) to develop a material property database for our laminates.
- Served on task force for SAE J3204 Aftermarket Composite Wheel Recommended Practice, SAE J175 "Lateral Impact" working group, and SAE Wheel Committee

Vice President, Product Development

2018-2019

- Managed the Product Development team consisting of Mechanical Engineers and Stress Analysts.
- Co-developed the "E2" carbon fiber composite wheels (patent pending).
- Built out the company's Product Development processes, including FE simulation of laboratory wheel tests.

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- Provided root cause analysis support to Manufacturing to address process-related problems in lay-up, tool closure, infusion, cure, post-curing, coatings, and ancillary metallic mounting hardware.
- Interfaced with resin and chemical suppliers to solve processing and performance related issues.
- Managed laboratory and proving grounds testing and postmortem analysis of prototype wheels.

Senior Composites Engineer

2017-2018

- Served as in-house authority for mechanics and materials related issues, including the application of micromechanics models, laminate theory, stress analysis, finite element analysis, composite failure models, and damage theories to guide wheel design.
- Guided and interpreted performance testing of wheels.
- Introduced and managed the use of non-destructive test (NDT) methods to assess manufacturing quality and diagnose failure modes.
- Coordinated material testing with laboratory.
- Applied forensic tools to perform failure analysis of prototype wheels.

ENGINEERING SYSTEMS, INC., Norcross, GA

2007-2017

Senior Consultant

- Deliver engineering consulting services in root cause failure analysis and forensic investigation to manufacturers, insurance companies, and attorneys
- Advise clients with specialized expertise in Polymers, including Plastics, Thermosets, Elastomers, & Fiber-Reinforced Composites
- Serve as in-house authority on creep, fatigue, durability, strength, stress analysis, finite element analysis (FEA), and life prediction
- Utilize advanced constitutive models for material behavior in FEA
- Develop custom, bench top experiments to evaluate products and test hypotheses
- Provide expert witness testimony in state and federal courts
- Lead large-scale (>\$750k billings), multi-office, multi-disciplinary engagements including large loss insurance claims and class action lawsuits
- Develop business through client relationships, conference participation, publishing, continuing education presentations
- Manage partner relationships with external test labs, service providers, and other vendors to supplement client services
- Mentor junior staff

METALS & MATERIALS ENGINEERS, LLC, Suwanee, GA

2006-2007

Senior Engineer

- Conducted failure analyses of a wide range of products, structures, and mechanical systems for insurance, legal, and industrial clients
- Provided general product support to industrial clients
- Served as in-house engineering mechanics expert for stress analysis, FEA, and custom test development

STRESS ENGINEERING SERVICES, INC., Norcross, GA

2004-2006

Associate

- Provided design, analysis, and testing services for a variety of clients in packaging, consumer products, medical devices, commercial equipment, and military applications
- Supported product development efforts to eliminate failures, improve performance, predict service life, and reduce weight and cost
- Performed hand calculations and FEA in ABAQUS and ANSYS to solve problems involving static and fatigue failures, creep, buckling, vibration, and contact
- Assisted clients with issues in design and material selection for metallic, plastic, and composite structures
- Conducted physical testing and materials characterization to assess product performance
- Developed client network and manage projects from proposal stage to completion
- Managed client engagements from proposal stage to completion in both fixed price and time & material agreements

INTEGRATED POLYMER COMPOSITE TECHNOLOGIES, INC., Blacksburg, VA 2003**Consultant**

- Developed a preliminary design for an all-composite marine cargo shipping container
- Performed sag-tension simulations for a composite core power transmission cable

MICHELIN AMERICAS R&D CORPORATION, Greenville, S.C.

1998-2000

Materials Engineer

- Provided technical support in reinforcements to tire design teams
- Performed rubber compounding studies to improve the durability of runflat tires
- Interfaced with reinforcement suppliers to evaluate new product offerings
- Managed laboratory qualification of new textile and metallic reinforcements
- Developed a training manual for use in "Metallic and Textile Reinforcements" class
- Served on a committee to fund and coordinate undergraduate research at universities
- Completed Basic French course (Levels 1,2)

MATERIALS RESPONSE GROUP, Virginia Tech, Blacksburg, VA 1996-1998, 2000-2003**Research Assistant**

- Developed a strength and fatigue life prediction for a fiber-reinforced polymer (FRP) composite bridge girder using FEA coupled with a remaining strength damage model
- Studied stress-based and energy-based methods for predicting delamination failures
- Conducted static and fatigue tests on the composite beams to assess stiffness parameters, failure mechanisms and strength, and fatigue performance
- Implemented an analytical bridge model and provided other assistance in the design and planning of two short span composite bridges
- Studied the static and fatigue performance of an experimental polymer composite bridge deck
- Characterized the effects of moisture on the fatigue behavior of a glass fiber composite

DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING, Virginia Tech, Blacksburg, VA, 1995-1996

Undergraduate Researcher

- Experimented with polymer processing techniques to produce biodegradable polymer (PLLA, PLGA) components for implantable orthopedic devices

CENTER FOR ADHESIVE AND SEALANT SCIENCE, Virginia Tech, Blacksburg, VA, 1994-1995

Undergraduate Researcher

- Evaluated the use of an antioxidant to counteract the damaging effects of gamma radiation on ultra-high molecular weight polyethylene (UHMWPE) for orthopedic applications
- Manufactured specimens using compression molding; performed tensile tests and pin-on-disk wear tests

EDUCATION

Ph.D., Engineering Mechanics, Virginia Tech, December 2003

M.S., Engineering Mechanics, Virginia Tech, December 1997

B.S., Engineering Science and Mechanics, Virginia Tech, May 1995

CONTINUED TECHNICAL EDUCATION

- Failure Analysis of Polymers using FEA, Veryst Engineering, Needham, MA, 2013.
- ASME Boiler and Pressure Vessel Code: Section VIII, Division I, Design and Fabrication of Pressure Vessels with Repairs and Alteration Consideration, ASME, Houston, TX, 2010.
- Practical Fracture Mechanics, ASM International, Ithaca, NY, 2009
- Practical Fractography, ASM International, Ithaca, NY, 2009
- NEiNastran Nonlinear Analysis: Introductory Training, Noran Engineering, Westminster, California, 2006.
- Introduction to Composites, ANSYS Customized Training, Blacksburg, VA, 2002.
- Metallurgy for the Non-Metallurgist, ASM International, Cleveland, Ohio, 1998.

PROFESSIONAL ENGINEERING LICENSES

- Georgia (032210)
- NCEES (52849)

PROFESSIONAL AFFILIATIONS

- American Society of Mechanical Engineering (ASME), Member
- SAE International, Member of Wheel Committee
- Society of Plastics Engineers (SPE)
 - Former Board Member of Failure Analysis & Prevention Special Interest Group (FAPSIG)
 - Moderator of FAPSIG Technical Session #T30 at SPE's ANTEC Conference, April 29, 2014
 - Recipient of the Dr. Myer Ezrin Best Paper Award at ANTEC 2015, March 25, 2015

ADDITIONAL PROFESSIONAL ACTIVITIES

- Reviewer, Journal of Failure Analysis and Prevention
- Former Instructor, "Failure Analysis of Plastic Products through Stress Analysis", Day 5 of ESI's "Plastics Failure Analysis Workshop & Prevention Seminars"
- Former Reviewer, Journal of Composites for Construction
- Former Reviewer, ANTEC Failure Analysis and Prevention Special Interest Group Proceedings
- Former Member, Advisory Board for the Department of Engineering Science & Mechanics at Virginia Tech, 2009-2015 (served as Chair in 2011)
- American Society of Composites (ASC), Past Member
- American Society of Standards and Technology (ASTM), Past Member
- ASM International, Past Member
- Failure Analysis Society (FAS), Past Member

PUBLICATIONS

- **M.D. Hayes**, A.R. Shah, and D.B. Edwards, *Fractography in the Failure Analysis of Plastics*, Plastics Design Library Series, 1st Edition, Elsevier Inc., printed by Edwards Brothers Malloy, Ann Arbor, MI, 2015.
- **M.D. Hayes** and D.L. Ahearn, "Thermomechanical Analysis of a Ceramic Cooker", *Journal of Failure Analysis and Prevention*, v13 n4 (2013), 383-388.
- **M.D. Hayes** and J.J. Lesko, "Failure Analysis and Fatigue Life Prediction of a Composite Structural Beam", American Society for Composites Series on Advances in Composite Materials: Vol 3, Fatigue of Composite Materials, ed. Ronald F. Gibson, August 2012.
- M.E. Stevenson, **M.D. Hayes**, J.L. McDougall, S.A. Sanders, "Failure Analysis of Hydraulic Fitting Brazed Connections," *ASM Journal of Failure Analysis and Prevention*, Vol. 12, Issue 2, April 2012
- **M.D. Hayes**, M.L. Hanks, F.E. Hagan, D.B. Edwards, and D.E. Duvall, "Challenges in Investigating Chlorinated Polyvinyl Chloride Pipe Failures," *Journal of ASTM International*, v8 n1 (2011).
- M.E. Stevenson, J.L. McDougall, and **M.D. Hayes**, "Metallurgical and Metallographic Aspects of Engineering Failure Analysis," *Proceedings of Microscopy and Microanalysis*, 14 (Suppl 2) (2008)
- M.E. Stevenson, **M.D. Hayes**, J.L. McDougall, E.R. Weishaupt, and D.A. Turnquist, "Failure Analysis of a Tree Pruner Saw Blade Anchor Screw," *Proceedings of Microscopy and Microanalysis*, 14 (Suppl 2) (2008)
- **M.D. Hayes** and J.J. Lesko, "Failure Analysis of a Hybrid Composite Structural Beam," *Composites: Part A*, v38 (2007), 691-698.
- **M.D. Hayes** and J.J. Lesko, "The Effect of Non-Classical Behaviors on the Measurement of the Timoshenko Shear Stiffness," *Journal of Composites for Construction*, v11 n3 (2007), 336-342.
- **M.D. Hayes** and J.J. Lesko, "The Effect of Transverse Compressibility on the Measurement of the Timoshenko Shear Stiffness," *Journal of Composites for Construction*, v11 n3 (2007), 343-349.
- **M.D. Hayes**, J.J. Lesko, J. Haramis, R.E. Weyers, T.E. Cousins, J.C. Duke, J. Gomez, and P. Masarelli, "Laboratory and Field Testing of a Composite Bridge Superstructure," *Journal of Composites for Construction*, v4 n3 (August 2000), 120-128.
- F. McBagonluri, K. Garcia, **M. Hayes**, K.N.E. Verghese, and J.J. Lesko, "Characterization of fatigue and combined environment on durability performance of glass/vinyl ester composite for infrastructure Applications," *International Journal of Fatigue*, v22 n1 (2000), 53-64.

- **M.D. Hayes**, D. Ohanehi, J.J. Lesko, T.E. Cousins, and D. Witcher, "Performance of Tube and Plate Fiberglass Composite Bridge Deck," *Journal of Composites for Construction*, v4 n2 (May 2000), 48-55.
- N. Verghese, **M.D. Hayes**, K. Garcia, C. Carrier, J. Wood, J.R. Riffle, and J.J. Lesko, "Influence of Matrix Chemistry on the Short Term, Hydrothermal Aging of Vinyl Ester Matrix and Composites Under Both Isothermal and Thermal Spiking Conditions," *Journal of Composite Materials*, v33 n20 (1999), 1918-1938.

SELECT PRESENTATIONS

- **M.D. Hayes**, "Red Herrings in Polymer Fractography and Failure Analysis", *Materials Science & Technology 2014*, October 15, 2014, Pittsburgh, PA.
- **M.D. Hayes**, "Development Of A Ring Tensile Test For Evaluating The Chemical Compatibility Of Plastic Pipes", *ANTEC 2012*, Orlando, FL, April 2-4, 2012.
- M. E. Stevenson, **M. D. Hayes**, J. L. McDougall, & S. A. Sanders, "Failure Analysis of Hydraulic Fitting Brazed Connections", *Journal of Failure Analysis and Prevention*, Vol 12, Issue 2, pages 118-122, April 2012.
- M.L. Hanks and **M.D. Hayes**, "Product Liability: Understanding the Design Process," CEU Presentation to Hartford, Orlando, FL, August 24, 2010.
- **M.D. Hayes**, M.L. Hanks, F.E. Hagan, D.B. Edwards, and D.E. Duvall, "Challenges in Investigating CPVC Pipes," *American Society for Testing and Materials (ASTM) Symposium on Plastic Pipe and Fittings: Yesterday, Today, and Tomorrow*, Atlanta, GA November 9, 2009.
- F.E. Hagan and **M.D. Hayes**, "Product Evaluation: An Engineer's Perspective," *CPCU I-Day*, Atlanta, GA, October 27, 2009.
- **M.D. Hayes**, "Engineering Tools in Forensic Investigations," *ProNet International, Inc. Continuing Education Conference*, Atlanta, GA, September 10, 2009.
- **M.D. Hayes**, "Investigation Techniques: Material Evidence," *CEU Presentation to Sedgwick Claims*, Knoxville, TN, July 29, 2009.
- **M.D. Hayes**, "The Role of Mechanics in Failure Analysis," *The Mechanics Conference to Celebrate the 100th Anniversary of the Department of Engineering Science and Mechanics*, Blacksburg, VA, May 30, 2008.
- **M.D. Hayes**, "Investigation Techniques: Material Evidence," *CEU Presentation to CNA Insurance*, East Syracuse, NY, March 19, 2008.

- **M.D. Hayes** and J. J. Lesko, "Failure Analysis and Fatigue Life Prediction of a Composite Structural Beam," ASC/ASTM-D30 Joint 19th Annual Technical Conference, October 17-20, 2004 - Atlanta, GA, CD-ROM, MD3 (Session 14: Modeling I, paper 3).
- **M.D. Hayes** and J. J. Lesko, "Assessment of the Timoshenko Shear Stiffness in FRP Structural Beams, SAMPE 2003, May 2003, 11-15, Long Beach, CA, pp. 2089-2103.
- **M.D. Hayes**, T. Schniepp, and J. J. Lesko, "Development of a Stress Analysis For Use In Strength And Life Predictions For A Hybrid FRP Beam," The Second International Conference on Durability Of Fiber Reinforced Polymer (FRP) Composites For Construction, May 29-31, 2002, Montréal (Quebec) Canada.
- **M.D. Hayes** and J. J. Lesko, "Refined Strength and Life Analysis of FRP Beams," Proceedings of the Composites in Infrastructure (ICCI02), San Francisco, CA 8-12 June 2002, CD-ROM, Paper # 050, p.10.
- **M.D. Hayes**, K. Garcia, K. N. E. Verghese, and J. J. Lesko, "The Effects of Moisture on the Fatigue Behavior of an E-Glass/Vinyl Ester Composite," International Conference on Composites in the Infrastructure (ICCI), Tucson, AZ, 1998, pp. 1-13.
- **M.D. Hayes**, J. J. Lesko, T. E. Cousins, and D. Ohanehi, "Static and Fatigue Performance of a Square Tube and Plate Type Fiberglass Composite Bridge Deck System," Proceedings of the International Composites Expo, 1998, pp. 7A1-7.

Peer Reviewed Conference Proceedings

- **M.D. Hayes**, M.E. Stevenson, and D.A. Turnquist, "Failure Analysis of a Glass Filled Phenolic Resin Power Steering Pump Pulley", accepted for publication, ANTEC 2015, Orlando, FL, March 23-25, 2015.
- **M.D. Hayes**, "Development Of A Ring Tensile Test For Evaluating The Chemical Compatibility of Plastic Pipes", ANTEC 2012, Orlando, FL, April 2-4, 2012.
- M.T. Kenner, J.A. Wilkinson, M.E. Stevenson, **M.D. Hayes**, "Uses of Abaqus/Standard in Failure Analysis," SIMULIA Customer Conference, London, England, May 2009
- **M.D. Hayes** and J. J. Lesko, "The Effect of Non-Classical Behaviors on the Measurement of the Timoshenko Shear Stiffness," CICE 2004, December 8-10, 2004 Adelaide, Australia.
- **M.D. Hayes** and J. J. Lesko, "Strength and Life Prediction for a Composite Structural Beam," CICE 2004, December 8-10, 2004, Adelaide, Australia.
- **M.D. Hayes** and J. J. Lesko, "The Effect of Non-Classical Behaviors on the Measurement of the Timoshenko Shear Stiffness," ASC/ASTM-D30 Joint 19th Annual Technical Conference, October 17-20, 2004 - Atlanta, GA, CD-ROM, FF3 (Session 11: Fracture and Failure I, paper 3).

- **M.D. Hayes** and J. J. Lesko, "Failure Analysis and Fatigue Life Prediction of a Composite Structural Beam," ASC/ASTM-D30 Joint 19th Annual Technical Conference, October 17-20, 2004 - Atlanta, GA, CD-ROM, MD3 (Session 14: Modeling I, paper 3).
- **M.D. Hayes** and J. J. Lesko, "Assessment of the Timoshenko Shear Stiffness in FRP Structural Beams, SAMPE 2003, 11-15 May 2003, Long Beach, CA, 2089-2103.
- **M.D. Hayes**, T. Schniepp, and J. J. Lesko, "Development Of A Stress Analysis For Use In Strength And Life Predictions For A Hybrid FRP Beam," The Second International Conference on Durability Of Fiber Reinforced Polymer (FRP) Composites For Construction, May 29-31, 2002, Montréal (Quebec) Canada.
- T. J. Schniepp, **M.D. Hayes**, J. J. Lesko and T. E. Cousins "Design Manual Development for the Strongwell 36-Inch DWB," Proceedings of the Composites in Infrastructure (ICCI02), San Francisco, CA 8-12 June 2002, CD-ROM, Paper # 082, p.10.
- **M.D. Hayes** and J. J. Lesko, "Refined Strength and Life Analysis of FRP Beams," Proceedings of the Composites in Infrastructure (ICCI02), San Francisco, CA 8-12 June 2002, CD-ROM, Paper # 050, p.10.
- C. Waldron, **M.D. Hayes**, E. Restrepo, T. E. Cousins, and J. J. Lesko, "Determining the Design Parameters for an FRP Girder Bridge in Virginia," 6th International Conference on Short and Medium Span Bridges, Vancouver, BC, July 31- August 2, 2002.
- **M.D. Hayes**, J. J. Lesko, T. E. Cousins, C. Waldron, and T. Schniepp, Implementation of the Deep DWB in the Dickey Creek Bridge," SAMPE 2001, Vol. 46 - II, May 6-10, 2001, Long Beach, CA, pp. 1587-1596.
- **M.D. Hayes**, J. J. Lesko, T. E. Cousins, C. Waldron, D. Witcher, G. Barefoot, and J. Gomez, "Implementation of FRP Girders in Short Span Bridge," International Bridge Conference, June 4-6, 2001, Pittsburgh, PA, pp. 472-478.
- **M.D. Hayes**, J. J. Lesko, T. E. Cousins, C. Waldron, D. Witcher, G. Barefoot, and J. Gomez, "Design of a Short Span Bridge Using FRP Girders," Composites in Construction International Conference, October 10-12, 2001, Porto, Portugal, A.A. Balkema Pub. (Swets & Zeitlinger) Lisse, 2001, pp. 707-712.
- J. J. Lesko, **M.D. Hayes**, J. Haramis, J. Hou, T. E. Cousins, J. Gomez, and P. Massarelli, "Laboratory & Field Characterization of the Tom's Creek Bridge Composite Superstructure," International Conference on Composites in the Infrastructure, 1998, pp. 634-644.
- K. N. E. Verghese, **M.D. Hayes**, K. Garcia, J. Wood, J. J. Lesko, and C. Carrier, "The Effects of Temperature Sequencing During Hygrothermal Aging of Polymers and Polymer Matrix Composites: The Reverse Thermal Effect," International Conference on Composites in the Infrastructure, 1998, p.720-738.

- **M.D. Hayes**, K. Garcia, K. N. E. Verghese, and J. J. Lesko, "The Effects of Moisture on the Fatigue Behavior of an E-Glass/Vinyl Ester Composite," International Conference on Composites in the Infrastructure, 1998, pp. 1-13.