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EDUCATION

Ph.D. University of Missouri - Columbia, Columbia, Missouri — **2006 Expected**
Emphasis in numerical methods, sensitivity analysis, and finite element methods.
Major: Mechanical and Aerospace Engineering GPA = 4.0/4.0
Thesis: *Advanced Analysis of Short-fiber Polymer Composite Material Behavior with Higher-order Orientation Tensor Closure Methods*
Advisor: Dr. Douglas E. Smith

M.S. University of Missouri - Columbia, Columbia, Missouri — **2006 Expected**
Development of theoretical models to describe interacting ellipsoidal flow.
Major: Applied Mathematics GPA = 4.0/4.0
Thesis: *Incorporation of Directionally Dependant Diffusion with Polymer Composite Flow Theory*
Advisor: Dr. Stephen Montgomery-Smith

M.S. University of Missouri - Columbia, Columbia, Missouri — **2003**
Emphasis in numerical analysis, reconstruction methods, and moment closures.
Major: Mechanical and Aerospace Engineering GPA = 4.0/4.0
Thesis: *Investigating the Use of Tensors in Numerical Predictions for Short-Fiber Reinforced Polymer Composites*
Advisor: Dr. Douglas E. Smith

B.S. Colorado School of Mines, Golden, Colorado — **2001**
Major: Engineering, Mechanical GPA = 4.0/4.0

B.S. Colorado School of Mines, Golden, Colorado — **2001**
Major: Engineering Physics GPA = 4.0/4.0

AWARDS AND HONORS

- Preparing Future Faculty Fellow (2005-2006).
- Full Member of Sigma Xi, Scientific Research Honor Society (2006).
- Student Member of Sigma Xi, Scientific Research Honor Society (2005).
- National Dean's List (2004).
- GAANN Research Fellow, U.S. Department of Education (2003-present).
- Outstanding Graduate Student, Mechanical and Aerospace Engineering, University of Missouri - Columbia (2003).
- Highest Academic Honors, Colorado School of Mines (2001).
- Outstanding Graduate Student, Engineering Physics, Colorado School of Mines (2001).
- Member of Tau Beta Pi, Engineering Honor Society (1999).

APPOINTMENTS

8/02 - present: Research Assistant, Department of Mechanical and Aerospace Engineering, University of Missouri-Columbia, Columbia, Missouri.

8/03 - 12/04: Teaching Assistant, Department of Mechanical and Aerospace Engineering, University of Missouri - Columbia, Columbia, Missouri.

7/01 - 7/02: Research Assistant, Division of Engineering, Colorado School of Mines, Golden, Colorado.

5/01 - 12/01: Research Assistant, Department of Engineering Physics, Colorado School of Mines, Golden, Colorado.

5/01 - 12/01: Teaching Assistant, Department of Engineering Physics, Colorado School of Mines, Golden, Colorado.

8/96 - 8/01: Store Manager, Mail Boxes Etc. #1537, Evergreen, Colorado.

PUBLICATIONS AND PRESENTATIONS

(i) Refereed Journal Papers

1. Assessing the Use of Tensor Closure Methods with Orientation Distribution Reconstruction Functions. D.A. Jack and D.E. Smith. *Journal of Composite Materials* 38:1851-1872, 2004.
2. An Invariant Based Fitted Closure of the Sixth-Order Orientation Tensor for Short-Fiber Suspensions. D.A. Jack and D.E. Smith, *Journal of Rheology* 49(5):1091-1115, 2005.
3. Sixth-Order Fitted Closures from the Second-Moment of the Fiber Orientation Distribution for Short-fiber Reinforced Polymer Melt Flow Simulations. D.A. Jack and D.E. Smith, *Journal of Thermoplastic Composites*19:217-246, 2006.
4. The Effect of Fiber Orientation Closure Approximations on Mechanical Property Predictions. D.A. Jack and D.E. Smith. In press at *Composites, Part A*, 2006.
5. Material Property Predictions for Short-Fiber Polymer Composites: Part 1, Analytical Forms for Expectation and Variance of the Elastic Properties from Orientation Tensors. D.A. Jack and D.E. Smith. Manuscript to be submitted to *Journal of Composite Materials*, 2006.
6. Material Property Predictions for Short-Fiber Polymer Composites: Part 2, Validation of Analytical Forms of Elastic Properties with the Method of Monte-Carlo. D.A. Jack and D.E. Smith. Manuscript to be submitted to *Journal of Composite Materials*, 2006.

(ii) Conference Proceedings (*=presenter)

1. Assessing the Use of Lower Order Tensors in Numerical Predictions of Flow-Induced Fiber Orientation. D.A. Jack* and D.E. Smith. SPE ANTEC'2003, Nashville, Tennessee, May, 2003.
2. Assessing the Use of Tensor Closure Methods with Orientation Distribution Reconstruction Functions. D.A. Jack* and D.E. Smith. Proceedings of ASME IMECE'03, Washington D.C., November, 2003.
3. A Fitted Closure of the Sixth-Order Orientation Tensor for Short-Fiber Reinforced Polymer Composite Modeling. D.A. Jack* and D.E. Smith. FPCM-7, the 7th International Conference on Flow Processes in Composite Materials, Newark, Delaware, July, 2004.
4. Investigating the Use of Sixth-Order Orientation Tensors in Polymer Composite Melt Flow Simulations. D.A. Jack* and D.E. Smith. NUMIFORM 2004, The 8th International Conference on Numerical Methods in Industrial Forming Processes, Columbus, Ohio, June, 2004.
5. Sixth-Order Fitted Closure Methods for Short-Fiber Reinforced Polymer Composite Systems. D.A. Jack and D.E. Smith*. The 45th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Palm Springs, California, April, 2004.

6. A Statistical Method to Obtain Material Properties from the Orientation Distribution Function for Short-Fiber Polymer Composites. D.A. Jack* and D.E. Smith. Proceedings of ASME IMECE'05, Orlando, Florida, November, 2005.
7. Mechanical Properties from the INV_6 Closure for Short-fiber Suspensions. D.A. Jack* and D.E. Smith. SPE ANTEC'2006, Charlotte, North Carolina, May, 2006
8. Statistical Predictions for Short-fiber Material Property Behavior with the INV_6 Closure. D.A. Jack* and D.E. Smith. SEM Annual Conference and Exposition, St. Louis, Missouri, June, 2006.
9. A Neural Network Based Closure for Modeling Short-Fiber Suspensions. D.E. Smith*, B.K. Schache, and D.A. Jack. National Science Foundation Design, Service and Manufacturing Grantees and Research Conference, St. Louis, Missouri, July, 2006.
10. Computing Elastic Material Properties From Orientation Tensors. D.E. Smith* and D.A. Jack. National Science Foundation Design, Service and Manufacturing Grantees and Research Conference, St. Louis, Missouri, July, 2006.

(v) Other Conference Publications, Presentations and Posters (*=presenter)

1. Muscle Simulation for Musculoskeletal Analysis. M. Mahfouz*, D.E. Smith, R. Komistek, S. Walker, D. Dennis, E. Berg, and D.A. Jack. Presented at American Academy of Orthopaedic Surgeons, New Orleans, Louisiana, 2003.

RESEARCH, TEACHING AND PROFESSIONAL ACTIVITIES

(i) Course Development and Teaching

Computational Methods for Engineers (University of Missouri - Columbia, MAE 3100) Principles of computer-aided design. Analysis and application of numerical methods in Computer aided design of mechanical systems where students develop MATLAB-based computer programs to solve basic engineering problems. Responsibilities included instruction of computer classes, development of course problems, and supplemental instruction (Fall 2003, Winter 2004, Fall 2004).

Physics I and Physics II Labs (Colorado School of Mines PHGN100/PHGN200) Lab supervision for Physics I, Mechanics and Physics II, Electricity and Magnetism. Basic principles of mechanics using vector calculus consisting of a fundamental treatment of the concepts and applications of kinematics and dynamics of particles and systems of particles. An introduction to the fundamental laws and concepts of electricity and magnetism is presented. Responsibilities included development of lab lectures and course syllabus, instruction, grading, and overseeing of lab safety. (Spring 2001, Winter 2001).

(ii) Professional Affiliations

- American Mathematics Society (since 2004)
- American Society of Mechanical Engineers (since 2003)
- Sigma Xi (since 2005)
- Society for Experimental Mechanics (since 2006)
- Society of Polymer Engineers (since 2003)
- Society of Rheology (since 2005)

(iii) Professional and Service Activities

- Journal Reviewer, Physics of Fluids, November 2005.
- Journal Reviewer, Journal of Non-Newtonian Fluid Mechanics, August 2003.
- Boy Scouts of America, Scoutmaster, 2002-present.
- Society of Physics Students, Outreach Coordinator, 1999-2001.

(iv) Professional Training

- *Preparing Future Faculty*, University of Missouri - Columbia, Columbia, Missouri, August 2005 - May 2006.
- *Preparing Engineering Faculty/Professionals*, University of Missouri - Columbia, Columbia, Missouri, August 2005 - May 2006.
- *Hughes-Belytschko, Nonlinear Finite Element Short Course*, San Diego, California, December, 2004.

RESEARCH INTERESTS

My research pursuits center upon the modeling of physical phenomena to advance computational design for industrial applications. The foundations I have built while completing my physics, mathematics and mechanical engineering degrees places me in a position to undertake a wide variety of problems. The record of my past research demonstrates my ability to recognize the existing limitations of scientific understanding, and a desire to perform a systematic investigation to establish facts, methods, and computational tools leading to an understanding of physical phenomena. I believe a research environment incorporating both the theoretical and experimental must be fostered to develop accurate and functional models.

My recent research has been on the development and implementation of methods to accurately predict material property behavior for short-fiber reinforced polymer composites. As discussed in a recent workshop co-sponsored by the U.S. DOE and the NSF, processes to develop lightweight composites are essential to the U.S. DOE initiative to develop fuel cell vehicles with enhanced fuel economy and reduced emissions. Molding simulations of short-fiber polymer composites traditionally rely upon moment closures to perform flow simulations. Previously there existed no method to compare the accuracy of moment closures of varying order, but through my work on distribution function reconstruction functions I have presented an effective method to analyze the accuracy of closures. I demonstrated that fourth-order closures are incapable, by their construction, to model advanced material behavior such as shear-shear and shear-extensional coupling. To satisfy the material behavior limitation, I developed the accurate and effective sixth-order invariant based fitted closure. Currently, I am developing a fully coupled 3D finite element code for short-fiber polymer processes with the sixth-order closure to investigate the applicability of higher order closures.

Future work in short-fiber molding processes will include the development of an analytical model to predict material properties incorporating fiber interaction. Current methods employed in the literature and commercial software typically use models developed for transversely isotropic fiber distributions of non-interacting fibers, whereas many flows introduce anisotropic distributions of dense fiber suspensions. Additional work will investigate wavelet basis functions which capture higher-order phenomena while retaining the rapid computations with orientation tensors. A complete closure of short-fiber polymer composites will be provided through the incorporation of design sensitivity analysis for the flow process with orientation tensors. My past work with polymer processes provides me an overall understanding of the problem, my mathematics background allows me to develop methods to apply wavelet basis functions, and my work in design sensitivity for thermal effects in solids allows the extension of my skills to large scale problems. Collaborative research may be continued with the the high energy laser group of Sandia National Labs who have collaborated with my present research group on short-fiber composite fracture analysis due to laser interactions.

Smart structures using piezoelectric patches is a developing field, and there is a need to develop models to include the full coupling of thermal effects, air flow, and induced internal strains of small scale piezoelectric plates. I believe I can make a contribution based upon my modeling background of fluid flow processes and complex material phenomena. Incorporating the fluid/solid interactions allowing for thermal effects will allow the design of efficient and practical parts. This particular problem can allow advanced design for cooling of computer chipsets and is of interest to the DOE, the NSF and DARPA.

My past research has included the development of methods used to model the hyperelastic material behavior of muscle tissue. My work in anisotropic material behavior will be particulary relevant in full scale models of human muscle tissue. My background will provide a smooth transition into modeling the microstructure of porous bone structure. I want to develop real time methods through CT scans or other available means to analyze the structure of the bone for optimal prosthetic implantation and long term application. Interest for this project comes from the NIH and will require collaborative research between multiple disciplines and the NSF.

Additional future interests include the modeling of turbulent flow. Interest comes from the similarity of the basis functions employed to solve the flow equations as those used to solve the fiber orientation equations. I also desire to investigate the incorporation of magnetized particles into short-fiber polymer processes to effect the final fiber orientation in turn altering the final material property behavior.

TEACHING INTERESTS AND PHILOSOPHY

The teaching process begins by quickly gaining an understanding of the student's preconceptions of a particular subject matter. By engaging their initial understanding I can prevent the failure of the student to grasp new concepts and information as it is taught. I do not believe that a subject should be taught with the sole purpose of the student passing a test and then having them revert to their initial preconceptions, but a subject should be taught with the emphasis being on an encompassing understanding. This complete understanding in the student must have a solid foundation of factual knowledge with the ability to comprehend facts as presented and the ability to organize their knowledge in ways to provide rapid retrieval of information for the given application. I theorize that learning is best undertaken in an environment that encourages active learning through active student participation and team building exercises. I recognize the importance in giving the student control of their own learning, and how students can learn in an effective manner once they recognize when they understand a topic and when they need more information.

Several of my personal teaching interests include, but are not limited to, the following:

- Numerical Methods for Engineers
- Engineering Mathematics
- Mechanics of Composite Materials
- Continuum Mechanics
- Nonlinear Finite Element Methods

I will introduce a course by describing to the collective students my teaching styles and my aims. I want the students to become metacognitive learners in that they can identify and overcome stumbling blocks to their personal learning by providing guidance, suggestions, and encouragement during the learning process. The teaching of self learning skills will focus on emphasizing to students the underlying physical principals at work and encouraging an open environment with students to introduce questions and voice their thoughts. As I present problems, I will present my personal thought process and open it up to discussion thus allowing students to follow my personal approach in problem solving. I believe in the importance of group work, thereby benefitting from the collective knowledge and providing team building experiences for future applications in the industrial work environment.

REFERENCES

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