

# Jeffrey D. Helm

Assistant Professor • Lafayette College

Mechanical Engineering Department  
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## Education:

<b>University of South Carolina</b>	PhD in Mechanical Engineering	1999
Dissertation: "Use of Three-Dimensional Digital Image Correlation for the Experimental Characterization of Buckling in Large, Thin, 2024-T3 Aluminum, Middle-Crack Tension Specimens"		
Advisor: Dr. Michael A. Sutton		
<b>University of South Carolina</b>	MS in Mechanical Engineering	1995
Thesis: "Three Dimensional Digital Image Correlation for Surface Displacement Measurement"		
<b>University of South Carolina</b>	BS in Mechanical Engineering	1992
<b>Lehigh University</b>	BA in Theater	1982

## Professional Experience:

**Lafayette College, Assistant Professor** 2002-Present  
Lafayette College is a liberal arts college located in Easton, Pennsylvania with discipline specific undergraduate engineering programs. The school is known for its student-oriented teaching and research activities. Duties in this tenure track position include teaching a 3/2 schedule, development of a student-centered research program and service to the school.

Courses taught: Statics, Manufacturing and Design, Instrumentation and Data Acquisition, Engineering Design I, Independent Studies, Fundamentals of Finite Element Theory, Senior Thesis, Senior Capstone Project.

Research areas: Digital image correlation, Experimental strain analysis, Structural testing, Material characterization and Fracture.

**General Manager/Lead Engineer, Correlated Solutions, Inc.** 1999 – 2001  
Correlated Solutions was started in 1998 and specializes in the design and sale of non-contacting measurement systems. Duties included: advancement of the current DIC methods, development of new products and system software, customizing current products for user applications, sales, company budget and finances, customer contact, proposal preparation, and purchasing. Over the 2½ years the value of the company increased from \$10,000 to over \$100,000 and the number of employees increased from 1 to 4. Income in 2001 topped \$400,000.

**Instructor-of-Record, University of South Carolina** 1992 – 1996  
Courses taught for the Department of Mechanical Engineering: Fundamentals of Microprocessors and Design of Mechanical Elements. Duties included: the development and presentation of weekly lectures, the creation of new laboratory experiments, upgrading the microprocessor laboratory from the Motorola 6801 microprocessor to the 6811 microprocessor and the assessment of the students. Classes were taught during the following semesters: Fall 1992, Spring 1993, Fall 1993, Fall 1995, Spring 1996.

## Research Activities:

### Nano-film strain measurement

Lafayette College 2009-Present  
Dr. James Ferri of Lafayette College's Chemical and Biomolecular Engineering Department has developed methods to grow nano-films on the inner surface of a water droplet. This project involves the development of the optical system and image correlation methods needed to measure strains in the nano-film as the water drop is pressurized.

**Strain measurement in aqueous solutions**

Lafayette College

2006-Present

The study of many biological specimens, such as soft tissue, is enhanced when the tests are carried out in an aqueous solution. This project involves the development of a simple test system, suitable for undergraduate use, with the capability of measuring full-field three-dimensional surface displacements on submerged specimens.

**Development of a structural testing laboratory employing digital image correlation**

Lafayette College

2003-Present

The experimental investigation of structural responses to applied loads can be enhanced with full-field displacement data. This project involves the establishment and use of a moderate scale structural testing laboratory with digital image correlation as an enhancing data acquisition method. Funding for the laboratory was obtained from National Science Foundation Major Research Instrumentation grant 0319846.

**Advancing the digital image correlation method**

Lafayette College

2002-Present

Digital image correlation is a non-contacting method to measure surface displacement and strain from a series of images of the specimen's surface. Even though the method has been in use for some time, there are still many areas that can be improved. Work at Lafayette includes the development of: two-dimensional image correlation with a single off-axis camera, a method to analyze specimens with multiple, growing cracks and a new framework for DIC based on finite-element like meshes.

**Out-of-plane Buckling of Large, Thin, Middle-Crack Tension Specimens**

NASA Langley Research Center, University of South Carolina

1996-1999

When large, thin, middle cracked tension specimens are loaded, the resulting compressive load across the free surface of the crack can cause significant out-of-plane buckling in the specimen. The goal of this project was to study of the effect of buckling on the crack propagation and load transfer characteristics of the specimen. This project includes both experimental and numerical studies.

**Determining Fatigue Crack Opening Loads from Near-Crack-Tip Displacement Measurements**

NASA Langley Research Center, University of South Carolina

1996-1999

The opening load for a fatigue cracks cycled near the threshold load for steady state growth is difficult, if not impossible, to measure from data taken far from the crack tip. To address this problem a two-dimensional measurement system was developed to measure the opening displacements very close to the crack tip. With this method, the crack opening could be measured within 75 $\mu$ m of the crack tip, allowing accurate measurements of the opening loads.

**Crack Tip Opening Displacement of Thin Single Edge-cracked Specimens under Tension-Torsion Loading**

NASA Langley Research Center, University of South Carolina

1995-1997

Crack tip opening displacement (CTOD) is proving a convenient and accurate crack growth criteria for finite element analysis. Previous experiments have shown that CTOD maintains a constant value for stable crack growth under Mode I and Mode I/II conditions. This work extends the experimental verification of CTOD to thin aluminum specimens under tension-torsion loadings.

**Displacement and Strain Measurements for Selected Areas of a Boeing 727**

The Boeing Company, University of South Carolina

1995

The displacement fields for selected areas of a Boeing 727 were measured on a full size test article under pressure and tail loading. These tests were carried out under true field conditions. The displacement fields were then processed to produce strain fields. The results of the tests were presented in a report to Boeing.

### **Three Dimensional Digital Image Correlation**

NASA Langley Research Center, University of South Carolina

1993-1995

The goal of this project was the development of techniques suitable for non-contact, three-dimensional surface displacement measurements. A two-camera system, incorporating a novel projection/back projection system to correct for perspective distortions, was developed. The system is relatively easy to use and has an accuracy of  $3\mu\text{m}$  when viewing a  $10\text{mm} \times 10\text{mm}$  area. This system has been used successfully on areas from  $4\text{mm} \times 6\text{mm}$  to  $1.2\text{m} \times 1.8\text{m}$ .

### **Digital Camera Calibration**

University of South Carolina

1992-1994

Digital cameras may be used for quantitative measurements only if the working characteristics of the camera are known. An accurate, easy to use, camera calibration system was developed. Because the system was based on known movements of the camera, and not on movements of a calibration standard, it was applicable to a wide range of subject scales.

### **Grants:**

National Science Foundation MRI Grant 0319846.

Awarded August 2003

Co-principle investigator for a \$243,526 NSF MRI grant. The grant, No 0319846 – Acquisition of Instrumentation for Integrated Structural Testing and Digital Image Correlation Laboratory, proposed the creation of a structural laboratory with digital image correlation as one of the primary data acquisition methods. The digital image correlation portion of the grant accounted for \$94,000 of the funding. A DIC laboratory was established and the technique was successfully married with the structural testing aspect of the grant. The combined structures/correlation setup was used to evaluate the failure modes of steel reinforced concrete panels that were externally reinforced, with carbon fiber. The creation of the experimental method is presented in “An experimental testing system for fibre-reinforced-polymer-strengthened concrete panels under uniform pressure loads.” The DIC system continues to be used both with the structural testing system and on unrelated strain measurement projects.

### **Publications and Presentations:**

#### **Peer Reviewed Journal Articles:**

S.R. Hummel and J.D. Helm, “New parameter to compare galling results,” *Journal of Tribology*, submitted September 2008, approved for publication.

J. Helm, S. Kurtz, A-R Salkini and E. O'Brien “An experimental testing system for fibre-reinforced-polymer-strengthened concrete panels under uniform pressure loads,” *Journal of Strain Analysis*, Vol. 43, pp. 761-768, 2008.

J. Helm, “Digital image correlation for specimens with multiple growing cracks,” *Experimental Mechanics*, Vol. 48, No 6, 753-762, Dec 2008.

S. Kurtz, P. Balaguru and J. Helm, “Experimental study of interfacial shear stresses in FRP-strengthened RC beams,” *Journal of Composites for Construction*, Vol. 12, No. 3, 312-322, May/June 2008.

J. D. Helm, M. A. Sutton and S. R. McNeill, “Deformations in wide, center-notched, thin panels, part I: three-dimensional shape and deformation measurements by computer vision,” *Optical Engineering*, Vol. 42 No. 5, 1293-1305, May 2003.

J. D. Helm, M. A. Sutton and S. R. McNeill, “Deformations in wide, center-notched, thin panels, part II: finite element analysis and comparison to experimental measurements,” *Optical Engineering*, Vol. 42 No. 5, 1306-1320, May 2003.

M.A. Sutton, J.D. Helm and M.L. Boone, “Experimental study of crack growth in thin sheet 2024-T3 aluminum under tension-torsion loading,” *International Journal of Fracture*, Vol. 109, No 3, pp. 285-301, June 2001.

J.D. Helm, M.A. Sutton and M.L. Boone, "Characterizing Crack Growth in Thin Aluminum Panels Under Tension-Torsion Loading Using Three-Dimensional Digital Image Correlation," *Nontraditional Methods of Sensing Stress, Strain, and Damage in Materials and Structures: Second Volume*, ASTM STP 1323, pp. 3-14, 2001.

M.A. Sutton, M.L. Boone, F. Ma and J.D. Helm, "A combined modeling-experimental study of the crack opening displacement fracture criterion for characterization of stable crack growth under mixed mode I/II loading in thin sheet materials," *Engineering Fracture Mechanics*, Vol. 66, pp. 171-185, 2000.

M.A. Sutton, W. Zhao, S.R. McNeill, J.D. Helm, R.S. Piascik and W.T. Riddell, "Local Crack Closure Measurements: Development of a Measurement System Using Computer Vision and a Far-Field Microscope," *Advances in Fatigue Crack Closure Measurement and Analysis: Second Volume*, ASTM STP 1343, pp. 145-156, 1999.

W.T. Riddell, R.S. Piascik, M.A. Sutton, W. Zhao, S.R. McNeill and J.D. Helm, "Determining Fatigue Crack Opening Loads from Near-Crack-Tip Displacement Measurements," *Advances in Fatigue Crack Closure Measurement and Analysis: Second Volume*, ASTM STP 1343, pp.145-156, 1999.

J.D. Helm, S.R. McNeill and M.A. Sutton, "Improved Three-dimensional Image Correlation for Surface Displacement Measurement," *Optical Engineering*, Vol. 35, No. 7, pp. 1911-1920, July 1996.

S.R. McNeill and J.D. Helm, "A Required Mechanical Engineering Course in Microprocessors," *Journal of Mechatronics*, Vol. 5, No. 7, pp. 763-774, 1995.

#### **Peer Reviewed Book Chapters:**

M.A. Sutton, S.R. McNeill, J.D. Helm and H.W. Schreier, Trends in Optical Non-Destructive Testing and Inspection, "Computer Vision Applied to Shape and Deformation Measurement", P.K. Rastogi and D. Inaudi, Eds., El Sevier, 571-591, 2000.

M.A. Sutton, S.R. McNeill, J.D. Helm and Y.J. Chao, Photomechanics for Engineers, "Advances in Two-dimensional and Three-dimensional Computer Vision Methods for the Measurement of Surface Shape and Surface Deformations on Simple and Complex Objects", Pramod Rastogi, editor; Springer-Verlag, pp. 323-372, 1999.

#### **Invited Lectures/Seminars**

"An experimental testing system for fiber reinforced polymer (FRP) strengthened concrete panels under uniform pressure loads," University of Kentucky Center for Applied Energy Research, January 2009.

"Fundamentals of digital image correlation," Graduate Seminar, Clarkson University, March 2007.

#### **Conference Proceedings:**

J. Helm, E. O'Brien, "Multi-resolution, finite-element-based, whole-field digital image correlation", *Proceedings of the 2007 SEM Annual Conference and Exposition on Experimental and Applied Mechanics*, Paper 165, June 2007.

J. Helm, "Racing for Designs", *Proceedings of the 2007 SEM Annual Conference and Exposition on Experimental and Applied Mechanics*, Paper 170, June 2007.

J. Helm, S. Kurtz, "A DIC based testing system for fiber reinforced polymer (FRP) strengthened concrete plates," *Proceedings of the 2006 SEM Annual Conference and Exposition on Experimental and Applied Mechanics*, June 2006.

J. Helm and S. Kurtz, "Digital image correlation-based experimental stress analysis of reinforced concrete beams, strengthened using carbon composites," *Proceedings of the IS&T/SPIE 17<sup>th</sup> Annual Symposium, Electronic Imaging*, 2005.

- J.D. Helm and J.R. Deaner, "Off-Axis Two-Dimensional Digital Image Correlation," *Proceedings of the 2004 SEM X International Congress and Exposition on Experimental and Applied Mechanics*, 2004.
- D. Lockwood, J.D. Helm and A.P. Reynolds, "Topographic Measurements on Surfaces Using Digital Image Correlation and the Scanning Electron Microscope", *Proceedings of the SEM Spring Conference on Experimental and Applied Mechanics*, pp. 169-171, 1999
- S.R. McNeill, T.G. Hanna, J.D. Helm, M.B. Simonson and H. Stone, "3-D Digital Image Correlation System for Global and Local Measurements", *Proceedings of the SEM Spring Conference on Experimental and Applied Mechanics*, pp. 33-36, 1999.
- M.A. Sutton, S.R. McNeill, J.D. Helm and H.W. Schreier, "Full-field, Non-contacting Measurement of Surface Deformations on Planar or Curved Surfaces Using Advanced Vision Systems," *Proceedings of the International Conference on Advanced Technology in Experimental Mechanics in Ube, Yamaguchi, Japan*, July 21-24, 1999, Volume 1, pp. 145-151, 1999.
- M.A. Sutton and J.D. Helm, "Measurement of Crack Tip Opening Displacement and Full-Field Deformations During Fracture of Aerospace Materials using 2D and 3D Image Correlation Methods," *IUTAM Symposium on Advanced Optical Methods and Applications in Solid Mechanics*, Vol. 2, pp. L28, 1998 (with M. A. Sutton).
- J.D. Helm and M.A. Sutton, "Quantifying buckling in large, thin sheet, aluminum specimens," *Experimental Mechanics, Advances in design, testing and analysis, Proceedings of the 11<sup>th</sup> International Conference on Experimental Mechanics*, Vol. 1, pp.361-366, 1998.
- J.D. Helm, S.R. McNeill and M.A. Sutton, "Increasing 3-D Correlation Speed by Sub-sampling Subsets and Interpolating Position Values," *Proceedings of the SEM Spring Conference on Experimental and Applied Mechanics*, pp. 441-447, 1998.
- H.L. Stone, S.R. McNeill, M.A. Sutton, J.D. Helm and H.W. Schreier, "Effects of Image Digitization on Digital Image Correlation," *Proceedings of the SEM Spring Conference on Experimental and Applied Mechanics*, pp. 448-451, 1998.
- G. T. Hanna, S. R. McNeill, M. A. Sutton and J.D. Helm "Deformation Measurements of Large Structural Panels", *Proceedings of the SEM Spring Conference on Experimental and Applied Mechanics*, pp. 471-474, 1998.
- J.D. Helm and M.A. Sutton, "Quantifying Buckling in Large, Thin Sheet, Aluminum Specimens Using a Three-dimensional Stereo Vision Technique," *Prognosis of Residual Life of Machinery and Structures, Proceedings of the 52<sup>nd</sup> Meeting of the Society for Machinery Failure Prevention Technology*, pp. 261-269, 1998.
- J.D. Helm, M.A. Sutton and M.L. Boone, "CTOD Measurements in 2024-T3 Aluminum for Residual Strength Modeling," *The First Joint NASA/FAA/DOD Conference on Aging Aircraft*, pp. 1803-1816, 1997.
- J.D. Helm, M.A. Sutton and S.R. McNeill, "3-D Computer Vision Applications for Aircraft Fuselage Materials and Structures," *The First Joint DoD/FAA/NASA Conference on Aging Aircraft*, pp. 1327-1340, 1997.
- J.D. Helm, M.A. Sutton, and S.R. McNeill, "Three-dimensional Image Correlation for Surface Displacement Measurement", *Proceedings of the 1995 Society for Experimental Mechanics Spring Conference and Exhibit*, June, 1995.
- J.D. Helm, M.A. Sutton and S.R. McNeill, "Three-dimensional Image Correlation for Surface Displacement Measurement", *Proceedings of SPIE's International Symposium on Photonic Sensors and Controls for Commercial Applications*, Oct. 1994, (Invited paper).

S.R. McNeill and J.D. Helm, "Teaching Microprocessors to Mechanical Engineers," *Proceedings of the Workshop on Mechatronics Education*, Stanford University, July 1994.

**Conference Presentations:**

"Digital Image Correlation for Specimens with Multiple Growing Cracks", 2008 SEM Annual Conference and Exposition on Experimental and Applied Mechanics, June 2008.

"Racing for Designs", First Patriot League Academic Conference Sponsored by the Provosts of the Patriot League, November 2008

"Multi-resolution, finite-element-based, whole-field digital image correlation", 2007 SEM Annual Conference and Exposition on Experimental and Applied Mechanics, June 2007

"Racing for Designs", 2007 SEM Annual Conference and Exposition on Experimental and Applied Mechanics, June 2007

"Digital image correlation-based experimental stress analysis of reinforced concrete beams, strengthened using carbon composites", IS&T/SPIE 17<sup>th</sup> Annual Symposium, Electronic Imaging, 2005

"Off-Axis Two-Dimensional Digital Image Correlation", 2004 SEM X International Congress and Exposition on Experimental and Applied Mechanics, 2004

"Quantifying buckling in large, thin sheet, aluminum specimens", The 11<sup>th</sup> International Conference on Experimental Mechanics, 1998

"Increasing 3-D Correlation Speed by Sub-sampling Subsets and Interpolating Position Values", SEM Spring Conference on Experimental and Applied Mechanics, 1998

"3-D Computer Vision Applications for Aircraft Fuselage Materials and Structures", The First Joint NASA/FAA/DOD Conference on Aging Aircraft, 1997

"Applications of Three-dimensional Image Correlation", Society of Experimental Mechanics, Student Paper Competition, June 1996. (invited presentation)

"Three-dimensional Image Correlation for Surface Displacement Measurement", Society of Experimental Mechanics, Student Paper Competition, June 1995.

"Full-Field Surface Displacement Measurement", NASA Langley Non-destructive Evaluation Meeting, May 1995.

"Three-dimensional Image Correlation for the Study of CTOD in 2024 T3 Aluminum", Mechanics of Materials Group, NASA Langley, March 1995.

"Three-dimensional Image Correlation for Surface Displacement Measurement", SPIE International Symposium on Photonic Sensors, Oct. 1994.

"Three-dimensional Image Correlation for the Study of CTOD in 2024 T3 Aluminum", Mechanics of Materials Group, NASA Langley, March 1994.

"Stereo Imaging", Society of Experimental Engineering Graduate Student Conference, March 1993.

"Fractal Modeling of Mechanical Processes", ASME Old Guard Competition, 1991.

**Fellowships**

NASA GSRP Fellowship, 1996 – 1999  
South Carolina Space Grant Fellowship, 1993-1995  
Dupont Fellowship, 1992-1996

**Awards:**

NASA Certificate of Recognition  
3-D Image Correlation, 2001  
Strain and Crack-Closure Measurements at High Magnification, 2000  
University of South Carolina Intellectual Properties Awards  
Full-field Surface Strain Measurement via Digital Image Correlation for Determination of Constitutive Properties in Heterogeneous Materials, 1999  
3-D Image Correlation, 1998  
Strain and Crack-Closure Measurements at High Magnifications, 1998  
Graduate School Dean's Award for Excellence in Graduate Study, 1999  
Outstanding Mechanical Engineering Graduate Student, 1996  
Society of Experimental Mechanics Student Paper Competition, 1st Place, 1995

**Professional Organizations:**

SEM - The Society of Experimental Mechanics  
SPIE - The International Society for Optical Engineering  
ASME - American Society of Mechanical Engineers  
SAE - The Society of Automotive Engineers

**Professional Elected & Appointed Positions:**

2009 – Reappointed Associate Editor for Experimental Techniques (2009-2012)  
2007 - Appointed chair of the Society of Experimental Mechanics Education Committee  
2005 – Appointed Associate Editor for Experimental Techniques (2005-2009)  
2005 - Appointed Co-chair of the Society of Experimental Mechanics Education Committee  
2003 - Appointed Vice chair of the Society of Experimental Mechanics Education Committee

**Research Students (Excel students, Individual projects and Honors)**

Tom Boutin – “Design of a powered prosthetic knee assist device.” '08  
Evan O'Brien – “Finite element-based digital image correlation,” '06-'07  
Kaydence Cowley – “Material properties of bovine aorta,” '05-'07  
Evan OBrien – “FRP strengthened concrete panels,” '05-'06  
Varun Mehta – “Improved Off axis two-dimensional digital image correlation”, Summer '04  
Jeremy Deaner – “Off axis two-dimensional digital image correlation”, '03-'04