Mark Fleming, Ph.D., P.E.
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Dr. Mark Fleming, Chief Technical Officer for Fusion Engineering, LLC, is an experienced mechanical engineer specializing in engineering analysis and accident investigation for vehicles and other machines. He is a consultant for accident investigation and reconstruction, failure analysis, design review and evaluation of products, and machinery and product testing. Dr. Fleming has a Ph.D. in theoretical and applied mechanics studying fracture mechanics and computer simulation methods, a M.S. degree in theoretical and applied mechanics studying reliability and fracture mechanics, and a B.S. degree in mechanical engineering. Dr. Fleming is also an Adjunct Professor of Mechanical Engineering at Northwestern University, where he teaches finite element analysis. He is a licensed professional engineer in the state of Illinois and a member of the American Society of Mechanical Engineers (ASME) and Society of Automotive Engineers (SAE).

Profile

- **Stress Analysis:** Applies finite element analysis to compute stress, strain and deformation of mechanical structures.
- **Fracture Mechanics and Fatigue Analysis**: Analyzes effects of pre-existing flaws and cracks in a structure.
- **Vehicle Engineering and Fuel System Crashworthiness:** Conducts analysis of vehicles under service loads and crash loads. Analyzes the effects of vehicle structure, material selection, and crash energy effects on fuel system integrity.
- **Bolted and Welded Joint Design and Analysis:** Provides understanding of how bolts and welds perform in service and analyzes fracture of these components.

Education

Academic Degrees

- **Ph.D. in Theoretical and Applied Mechanics**, Northwestern University, Evanston, IL, 1997
- **M.S. in Theoretical and Applied Mechanics**, Northwestern University, Evanston, IL, 1994
- **B.S. in Mechanical Engineering,** University of Nebraska, Lincoln, Nebraska, 1992

Expertise — Computer Specialization

- Finite element software: ABAQUS/Standard and Explicit, Optistruct, Hypermesh, LS-Dyna
- CAD software: Pro/Engineer, AutoCAD, Solidworks
- Programming Language: Matlab, Python
- Accident reconstruction software: EDCrash, EDSMAC, Simon

Expertise — Equipment and Applications

Accident Investigation and Reconstruction	Fuel System Integrity
Agricultural Equipment	Off-highway equipment
Automotive Engineering	Machinery and Product Testing
Bolt Analysis	Product Design Review and Evaluation
Construction Equipment	Stress Analysis
Crashworthiness	Theoretical and Applied Mechanics
Fatigue and Fracture Mechanics	Vehicle Engineering
Finite Element Analysis	Weld Analysis

Experience

Engineering Analysis, Simulation and Testing/Machinery and Vehicles

- Performed accident investigation and reconstruction.
- Inspected and analyzed more than 100 vehicles involved in crashes.
- Conducted design analysis and reviews of products.
- Specialized in the analysis of rollover protective structures (ROPS) and topology optimization.
- Coordinated analysis activities for three product lines, including planning, budgeting, and holding analysis reviews.
- Developed and deployed advanced simulation technologies for the optimization of agricultural and construction machinery.
- Performed testing and finite element simulations in the analysis of design performance.
- Conducted machinery and product testing.
- Was responsible for a corporate-wide analysis team for manufacturing simulations ranging from manufacturing process simulations to factory layout and factory flow simulations.
- Worked with 20 factories worldwide providing analysis and solutions related to the manufacture of agricultural and construction equipment products.

Studies — Professional Development

Technical:

- Reliability assessment for welded structures, 1999
- Probabilistic Analysis and Design: Computational Methods and Applications, 1999
- Operations research, 2000
- Logistics, 2000
- Fatigue design analysis with MSC.Fatigue, 2000
- Fatigue data analysis using nCode, 2003
- Vehicle Accident Reconstruction Methods, 2005
- HVE Introductory Training, 2005
- Fundamentals and Automotive Fuel Delivery Systems, 2007
- Vehicle Dynamics for Passenger Cars and Light Trucks, 2009
- Advanced Vehicle Dynamics for Passenger Cars and Light Trucks, 2011

Licenses — Professional Registration

- Licensed Professional Engineer in Illinois (License No. 62057502)

Employment — Roles and Responsibilities

Fusion Engineering, Naperville, IL **2014 to Present**
Principal Engineer

Consult on a broad range of products, equipment and structures in the areas of failure analysis, accident investigation and reconstruction, design review and evaluation, and machinery and product testing.

Northwestern University, Evanston, IL **2013 to Present**
Adjunct Professor of Mechanical Engineering

Teach Finite Element Analysis to graduate students.
Core faculty member in the Simulation Driven Engineering (SDE) program.
Research in manufacturing methods and multiscale methods for fatigue, fracture, and damage

ITC Experts, Inc., Sugar Grove, IL **2011 to 2014**
Senior Director of Mechanical Engineering

Manage projects in a broad range of products, equipment and structures for ITC Experts, Inc., a for-profit subsidiary of the Institute of Tribology and Coatings, Inc., which is an advanced Research and Development organization providing technical solutions to the military and industry.

Responsible for consultation in the areas of failure analysis, accident investigation and reconstruction, design review and evaluation, and machinery and product testing.

Packer Engineering, Naperville, IL **2003-2011**
Senior Director, Mechanical Engineering

Performed accident investigation and reconstruction, product design review and evaluation, and machinery and product testing. Utilized finite element analysis for mechanical design evaluation and vehicle crashworthiness analysis.

CNH Global/Case Corporation, Burr Ridge, IL **1997-2003**
Principal Engineer

Advanced Engineering Analysis - 2001-2003

Developed and deployed advanced simulation technologies for the optimization of agricultural and construction machinery. Specialized in vehicle dynamic shake simulations, particle flow methods, and optimization methods. Wrote methodology and "best practices" documents, taught analysis seminars, and coordinated software acquisition and usage.

Manager, Manufacturing Simulations - 2000-2001

Responsible for a corporate-wide analysis team for manufacturing simulations ranging from manufacturing process simulations to factory layout and factory flow simulations. Worked with 20 factories worldwide providing analysis and solutions related to the manufacture of agricultural and construction equipment products.

Engineering Analysis - 1997-2000

Specialized in analysis of rollover protective structures (ROPS) and topology optimization. Introduced a new technology to the design teams such as topology optimization, manufacturing process simulation, and reliability-based design analysis. Coordinated analysis activity for three product lines, including planning, budgeting, and holding analysis reviews.

Affiliations Memberships

American Society of Mechanical Engineers (ASME)
Society of Automotive Engineers (SAE)
SAE Fire Safety Committee member
ASM International
United States Association for Computational Mechanics
Pi Tau Sigma, Tau Beta Pi (engineering honor societies)
Northwestern University Mechanical Engineering Advisory Board member

Publications:

1. "Fatigue Reliability Method with In-Service Inspections, M.S. Thesis (1994).
2. Belytschko T., Krongauz, Y., Fleming, J., Organ, D.J., and Liu, W.K., "Smoothing and Accelerated Computations in the Element-Free Galerkin Method," Journal of Computational and Applied Mathematics, 74:111-126 (1996).
3. Belytschko, T., Krongauz, Y., Organ, D., Fleming, M., and Krysl, P., "Meshless Methods: An Overview and Recent Developments," Computer Methods in Applied Mechanics and Engineering, 139:3-47 (1996).
4. Organ, D., Fleming, M., Terry, T., and Belytschko, T., "Continuous Meshless Approximations for Nonconvex Bodies by Diffraction and Transparency," Computational Mechanics, Volume 18, Number 3, 225-235 (1996).
5. "Meshless Methods of Fatigue Crack Propagation," PhD Thesis (1997)
6. Fleming, M., Chu, Y., Moran, B., and Belytschko, T., "Enriched Element-Free Galerkin Methods for Crack Tip Fields," International Journal for Numerical Methods in Engineering, 40:1483-1504 (1997).
7. Belytschko, T. and Fleming, M., "Smoothing, Enrichment and Contact in the Element-Free Galerkin Method," Computers and Structures, 71(2):173-195 (1999).
8. Roy, S. and Fleming, M., "Non-Linear Subgrid Embedded Element-Free Galerkin Method for Monotone CFD Solutions," Proceedings of the 3rd ASME/JSME FED Conference (1999).
9. Yi, T. and Fleming, M., "Dynamic Simulations for Self-Propelled Sprayer With a Large Flexible Boom," LMS Conference for Physical and Virtual Prototyping (2002).
10. Olson, J., Fleming, M., Krishnaswami, R. and Pellillo, R., "Fuel Filler System Check Valves – Dynamic Evaluation," SAE Technical Paper 2017-01-1350.
11. Liu, Z., Fleming, M., and Liu, W.K., "Microstructural Material Database for Self-consistent Clustering Analysis of Elastoplastic Strain Softening Materials," Computer Methods in Applied Mechanics and Engineering, 330:547-577 (2018).
12. Zhang, G., Guo, T., Guo, X., Tang, S., Fleming, M., and Liu, W.K., "Fracture in Tension-Compression-Asymmetry Solids via Phase Field Modeling," Computer Methods in Applied Mechanics and Engineering, 357 (2019).
13. Han, X., Gao, J., Fleming, M., Xu, C., Xie, W., Meng, S., Liu, W.K., "Efficient multiscale modeling for woven composites based on self-consistent clustering analysis," Computer Methods in Applied Mechanics and Engineering, 364 (2020).
14. Fleming, M., Krishnaswami, R., and Nakamoto, K., "Fuel Tank Strain Measurement using Computer Vision Analysis," SAE Technical Paper 2020-01-0924.

15. Tang, S., Yang, H., Qui, H., Fleming, M., Liu, W.K., Xu, G., "MAP123-EPF: A mechanistic-based data-driven approach for numerical elastoplastic modeling at finite strain," Computer Methods in Applied Mechanics and Engineering, 373 (2021).
16. Liu, W.K., Z. Gan, M. Fleming, *Mechanistic Data Science for STEM Education and Applications*, Springer, January 2022.
17. Huang, H., Mojumder, S., Suarez, D., Al Amin, A., Fleming, M., Liu, W.K., "Knowledge database creation for design of polymer matrix composite," Computational Materials Science, accepted for publication (2022).

Presentations:

1. "Design and Analysis for Optimizing Manufacturing Processes," Design Engineering Conference at National Manufacturing Week (March 18-21, 2002).
2. "Manufacturing Simulations," Northwestern University (October 2000).
3. "Elemento Finitos Sin Malla," Universidad Politecnica de Madrid, Madrid, Spain (December 1996).
4. "The Element-Free Galerkin Method for Fatigue Crack Propagation," University of Nebraska, Lincoln, Nebraska (April 1996).
5. "There is a Substitute – Engineering Perspective on the Use of Computer Simulations," ACMIE SLG Workshop, DRI, Las Vegas, NV (February 2006).
6. "The Good, the Bad, and the Ugly – Computer Simulations for Product Development, Failure Analysis, and Mischief," ASM Material Science and Technology 2006 Conference and Exhibition, Cincinnati, OH (October 2006).
7. "Finite Element Analysis in Products Litigation: What you See is Nice, What's Covered is Vital," E.M. Caulfield, M. Fleming, and K. Schiferl, ABA 2008 Emerging Issues in Motor Vehicle Product Liability Litigation, Phoenix, AZ (April 2008).
8. "A New Approach to an Old Topic – Using Finite Element Analysis to Analyze Spot Weld Claims in Crashworthiness Cases," M. Fleming and A. Jones, ABA 2009 Emerging Issues in Vehicle Product Liability Litigation, Phoenix, AZ (April 2009).
9. "Science and Engineering: from Theory to Application", Arantzazu Alarcon-Fleming and Mark Fleming, North Central College Science Seminar, Naperville, IL (May 2011).
10. "Investigating Fires Involving Plastic Fuel Tanks: The Problem with Self-Consuming Evidence", P.W. Miles IV and M. Fleming, ABA 2013 Emerging Issues in Motor Vehicle Liability Litigation, Phoenix, AZ (April 2013).
11. "Fatigue Fracture Analysis using XFEM Combined with Fracture Surface Analysis", M. Fleming and K. Jones, Advances in Computational Mechanics with Emphasis on Fracture and Multiscale Phenoma *workshop honoring Professor Ted Belytschko's 70th Birthday*, Evanston, IL (April 2013).

12. "Computational Methods for Evaluating Variability in Optimization and Product Performance Evaluation", Key Note Presentation, M. Fleming, Symposium: Multidisciplinary Computer-Aided Design and Simulation-Based Optimization – Recent Applications and Future, Evanston, IL (December 2014).

13. "Investigation of an Automotive Spring Fatigue Fracture with Abaqus XFEM", ASM Material Science & Technology 2015 Conference, Columbus, OH (October 7, 2015).

14. "Elastic Cloud Based Make – A New Frontier for Manufacturing Optimization", M. Fleming, Symposium: Multidisciplinary Computer –Aided Design and Simulation-Based Optimization – Recent Applications and Future, Sponsored by Northwestern University and Altair Engineering, Evanston, IL (December 2016).

15. "Multiscale Analysis Methods for Failure Analysis: Industry and Research Perspective", M. Fleming, WCCM 2018 Short Course: Mechanistic Data-Driven Multiscale Analysis and Applications, New York City, NY (July 2018).

16. "Mechanistic Data Science and Computer Vision for Forensic Engineering", M. Fleming, T. Bundorf, K. Nakamoto, MMLDT-CSET, San Diego, CA (September 2021).

17. "Mechanistic Data Science (MDS) for STEM Education and Applications", short course presented at MMLDT-CSET, San Diego, CA (September 2021).

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