Biography of Mark Horstemeyer

Mark F. Horstemeyer was born in Martins Ferry, Ohio (USA) in 1962. After moving to Weirton, WV at a young age, he graduated from Weir High School in 1981 showing strong interest in physics, mathematics, anatomy, physiology, and chemistry. Just before his senior year in high school Mark became a dedicated follower of Jesus Christ, and from that vantage point his life he has used nature as an inspiration for design ever since. He attended West Virginia University, graduating with a degree in Mechanical Engineering (Magna Cum Laude) in 1985. After marrying his wife Barbara, they returned to Ohio for his Masters in Mechanical Engineering at Ohio State University (OSU). In 1987 he started at Sandia National Laboratories in Livermore, CA., where he worked on systems design, finite element analysis, structural mechanics, shock wave physics, computational fluid dynamics, and multiscale modeling. Under the Doctoral Study Program at Sandia, Mark was able to earn his PhD in 1995 at Georgia Tech with Dr. David McDowell in Mechanical Engineering, where he studied crystal plasticity modeling and bridged length scales from the single crystal level to the polycrystalline level.

After spending several years at Sandia National Laboratories with his final position there being Manager of Fluid/Thermal Modeling Department, Mark jointed Mississippi State University (MSU) as a Chair Professor in the Mechanical Engineering Department in 2002. Two years later, he also joined the Computational Engineering Department of the University, and eventually joined MSU's Agricultural & Biological Engineering as well as the Physics departments on 2010 and 2015 respectively. In 2010 he received a Honorary Professor of Mechanical Engineering position at Xihua University in Chengdu, China, and at 2013 an Adjunct Professor position at the Department of Materials Science and Engineering in Tuskegee University, AL. Apart from his extensive activity in academia and national laboratories, he has also been heavily involved in the industrial industry, having started three start-up companies in trying to put predictive science into engineering designs: Predictive Design Technologies, LLC; Advanced Technology Associates, LLC; and Yobel Technologies, LLC.

In January 2019, Mark joined Liberty University as the Dean of Engineering, bringing 30 years of industrial, national laboratory, and academic experience. Mark is a fellow in the American Society of Mechanical Engineers, American Society of Metals, Society of Automotive Engineers, the American Association for the Advancement of Science and a member of the National Academy of Engineering in the European Union. He has demonstrated strong leadership in creating and implementing multiscale modeling strategies into the research and academic process. He has published over 500 journal articles, conference papers, books, and technical reports with a citation impact h-factor

of over 60 with over 12,000 total citations; he has been invited to give over 160 lectures throughout the world, and has mentored over 200 graduate students and post-doctoral researchers.

Research Activity

Throughout his career, he has coupled multidisciplinary research of solid mechanics, materials, physics, and applied mathematics in three synergistic areas: theoretical modeling, experimentation, and large scale parallel computational simulation. In terms of theoretical modeling, this area develops and employs techniques that capture structure-properties from the quantum scale to the large structural scale in order to simulate the history of a material in order to predict life cycle performance of structural components.

Among other research developments throughout his career, he has been and has contributed to the following:

- First to suggest that the volume-per-surface area length scale size effect in metals is related to dislocation nucleation and not strain gradients as illustrated by molecular dynamics simulations.
- Development of first hierarchical multiscale model to predict failure of structural materials based on microstructure-sensitivity so that each element in a finite element analysis has different grain sizes, void sizes, particle sizes, nearest neighbor distances, and volume fractions of the different entities (trademarked term “From Atoms to Autos”).
- First to use the computational hierarchical multiscale damage model based on the heterogeneities to optimize a structural component (Cadillac control arm: reduced weight 25%, increased strength 50%, increased fatigue life 100%, and reduced cost $2 from a $15 part); won R&D 100 Award.
- First to quantify Nanostructurally Small Crack (NSC) growth for fatigue as illustrated by molecular dynamics simulations.
- Used the “From Atoms to Autos” modeling philosophy to redesign the Corvette cradle from aluminum to magnesium, which is used on all Corvettes since 2006.
- First to garner a stress-strain curve without an experiment by first running First Principles simulations (DFT) to get energies for Embedded Atom Method (EAM) potentials for MD simulations. The MD results were used to get the dislocation mobilities for use in Dislocation Dynamics (DD), which in turn were used to quantify work hardening constants for crystal plasticity simulations (CP). Polycrystal CP simulation results were then used to form the stress-strain curve. Experiments of single and polycrystal aluminum were used to validate the computational results.
- First to show the experimental differences between compression, tension, and torsion stress-strain behavior related to work hardening and failure strains in metals under high strain rates.
- First to write a pedagogical book on Integrated Computational Materials Engineering (ICME), Wiley Press, 2012.

- Connected Hooke's Law to the General Theory of Relativity illustrating that the speed of light is the fastest entity because the space fabric has a Poisson Ratio of unity.

As the first CAVS Chair professor at Mississippi State University since the center opened in 2002, Dr. Horstemeyer was instrumental in creating the scientific and technology foundation for the southern automotive corridor of the nation by setting forth a vision for simulation based design and manufacturing related to the automotive industry that has developed. Dr. Horstemeyer's original vision has not only influenced Nissan and Toyota, which have manufacturing plants in Mississippi, but for Tier 1 and Tier 2 manufacturers such as Hol-Mac Inc., Tower Engineering, SeverStal Steel, etc. Furthermore, The National Academy of Engineering (NAE) released a report stating how Integrated Computational Materials Engineering (ICME) can help transform US industry. Dr. Horstemeyer is a world leader in this endeavor as evidenced by the first pedagogical book (Integrated Computational Materials Engineering (ICME) for Metals: Reinvigorating Engineering Design with Science) on the topic. Dr. Horstemeyers' work with the USCAR (Chrysler, Ford, and GM) Lightweight Metals group in the late 1990s was the foundation for increasing momentum for ICME in the DOE and DoD which led the Materials Genome Initiative announced by President Obama on June 2011. His work has helped bridge the valley of death from research to industrial application by building a culture of technology transfer where research by scientists is more integrated with engineers in the auto industry.

Dr. Horstemeyer has also provided outstanding training opportunities for the next generation of scientists and engineers. He has helped develop graduate curriculum and recruited new faculty focused on graduate research to help grow the Mechanical Engineering program of MSU, CAVS in MSU, and the Chemistry and Materials Process Modeling Department, as well as the Fluid/Thermal Modeling Department at Sandia National Laboratories. As the Society of Automotive Engineering faculty advisor, he was the faculty advisor for the formula car team for several years; oversaw the mechanical engineering students, who led the Challenge X and EcoCar competitions (MSU was the national champion in these competitions); helped create new automotive related courses and worked with other faculty to create an Automotive Certificate program. His former protégé(e)s are professors at Arizona State University, Michigan Tech, University of Alabama, University of Idaho, University of North Carolina, Mississippi State University, University of Missouri S&T, and Georgia Tech; industrial leaders at Eaton, Georgia-Pacific, Harley-Davidson, General Motors, Nissan, etc.; and researchers at Sandia National Labs, Los Alamos National Laboratory, Army Engineering Research and Development Center, and the Naval Surface Warfare Center.

Honors and Awards:

- Mechanical Engineering at Mississippi State University Senior Research Award (2018)
- European Union Academy of Sciences (2017)
- American Association for the Advancement of Science (AAAS) Fellow (2013)
- Society of Automotive Engineering (SAE) Fellow (2012)

- West Virginia University Distinguished Alumni Award (2012)
- Giles Professor (Highest Honor at the University), Mississippi State University (2011)
- Honorary Professor at Xihua University, Sichuan Province, Chengdu, China (2010)
- American Society of Metals (ASM) Fellow (2010)
- Thomas French Alumni Achievement Award, Ohio State University (2009)
- Ralph Powe Award Mississippi State University (highest university research award) (2008)
- American Society of Mechanical Engineering (ASME) Fellow (2006)
- American Foundry Society “Best Paper Award” (2003)
- Chair Faculty position MSU (2002)
- R&D100 Award (2000) microstructure-property modeling
- Sandia Award For Excellence (1992) finite element lethality studies
- Sandia Award For Excellence (1990) weapons experiments
- Sandia Award For Excellence (1989) weapons design