SIAM Great Lakes Section Proceedings

Joint Meeting with the MAA Ohio Section

University of Toledo, April 4-5, 2014

SIAM Plenary Talks

- **Steven J. Goldner**, First Technology Safety Systems

  A Vehicle Impact Test Form Based on a Modified Super-Ellipse

  The physical form and use of an automotive impact testing head is based on a modified super-ellipse of the mathematical form (X/X0)2 + (Z/Z0)3 = 1. A comparison to the shape of an equivalent human head is given. The utility and effects of the tests and the test program on motor vehicle safety are introduced. Comparisons to other uses of standard super-ellipses are discussed.

- **David A. Lamb**, TARDEC

  Protected Mobility Optimization for the Army Ground Fleet

  The Army wants its ground vehicle fleet to be highly mobile, while also protecting the soldiers inside from both enemy activity and automotive accidents. The term for this is "protected mobility," and TARDEC is striving to optimize the portfolio of ground vehicles in this way. A lot of the modeling and simulation (M&S) for ground vehicle engineering is used to design platforms to have optimized protected mobility. Because of the inherent complexity of the problem, the mathematics used for protected mobility optimization is interesting and challenging. This talk will discuss several ways the Army is improving the protected mobility of the ground fleet using mathematical modeling and simulation.

SIAM After-Dinner Panel

"A Mathematics Education, Today's Industrial Opportunities"

- Steve Goldner, First Technology Safety Systems
- David Lamb, TARDEC
- Emmanual Tsimis, Siemens

A mathematics education develops a toolset and a mindset that provide an advantage in any field of employment. The panelists each will briefly describe their journey from being a student to building an industrial career. What they learned on the job. What they brought to the job. Then, they will answer the question: "If you were planning to enter the industrial workforce today, how would you prepare?" Where would you look?

SIAM Contributed Papers

- **Joan Remski**, University of Michigan Dearborn

  A Balanced Moving Mesh Method

  Moving mesh methods are a widely used numerical solution technique for partial differential equations (PDEs) where a transformation maps grid points from a computational domain into the physical domain of the original PDE. The goal is to use this transformation to obtain a non-uniform mesh in the physical domain that better captures the behavior of the solution. In this talk we focus on mesh transformations that are governed by a moving mesh PDE with an associated monitor function. This leads to a coupled system of PDEs, one for the mesh and one for the physical problem that must be solved simultaneously. We show that under certain circumstances and with certain choices of the monitor function, we can balance properties of the solution to the mesh PDE with properties of the physical PDEs. This balance is demonstrated with the Allen-Cahn equations and a reaction problem that exhibits blow-up in finite time.

- **Xiaoming Zheng**, Central Michigan University

  An interface-fitted adaptive mesh method for elliptic problems and its application in free interface problems with surface tension

  This work presents a novel two-dimensional interface-fitted adaptive mesh method to solve free interface problems with surface tension. First, we present a very simple and practical P1 finite element method prove for elliptic problems where both the solution and its normal derivative have nonzero jumps across the interface and prove its nearly second order accuracy. Afterwards, we present its adaptive mesh applications to the evolution of two free boundary problems, a sheared drop in Stokes flow and the growth of a solid tumor.

- **Tong Sun**, Bowling Green State University

  A Discontinuous Galerkin - Front Tracking Scheme and its Optimal-Optimal Error Estimation

  An error estimate of optimal convergence rates and optimal error propagation (optimal-optimal) was given for the numerical solutions produced by the Runge-Kutta discontinuous Galerkin (RKDG) method on the scalar nonlinear conservation laws in the case of smooth solutions before. This talk generalizes the problem to the case of a piecewise smooth solution containing one fully developed shock. A front tracking technique is incorporated in the RKDG scheme to produce a numerical solution with a truly high order error. The numerical smoothness approach of error analysis is generalized to this particular case of a discontinuous solution.

- **Thomas Hern**, Bowling Green State Univ. (Ret.)

  The Geometry of a CVT

  My new Honda Accord, *built in Ohio*, has a CVT: Continuously Variable Transmission. No discrete changing of gears necessary. Conceptually a belt runs over two cones side by side, one inverted to the other, instead of having two meshed gears. The belt is claimed to be of fixed length no matter where on the cones the belt lies, so the 'gear' ratio can be continuously varied without changing fixed gears and all the complexity that involves. We examine that claim.

- **Emanual Tsimmis**, Siemens

  Developable surfaces in Design and Manufacturing

  A developable 3-dimensional surface can be formed from a single planar surface without stretching or tearing. Industrial design has many uses of developable surfaces. Also, the manufacturing of large panels, such as ship hulls and modern architectural structures, requires their segmentation into easily manufactured pieces, resulting to an aesthetically pleasing whole. These segmentation pieces are planar or single-curved (developable) surfaces. Complexity is added to the design with developable surfaces when curved folds (creases) are allowed. Designing with developable surfaces is not a trivial task; that is why the current state of Computer Aided Design (CAD) systems is not mature enough to accommodate such design. This talk will place emphasis on developable surfaces connecting two curves in 3-dimensional geometric space.

- **Vani Cheruvu** – University of Toledo

  Spectral finite volume scheme for PDEs that model atmospheric flow

  In this talk, I will present a high-order scheme (spectral finite volume method) for partial differential equations that model atmospheric flow. Implementation details include third-order explicit strong stability preserving scheme for time integration and efficient limiters (for ex., flux-corrected transport scheme) to enforce monotonicity in the numerical scheme. Examples for which solutions have both smooth features and discontinuities will be discussed. Numerical results demonstrate the efficiency of the spectral finite volume method.

- **Alithea Barbaro –** Case Western Reserve U.

  Flocking models at the microscopic, mesoscopic, and macroscopic levels

  Agent-based models are used in many different fields, and a particular type of agent-based models, called flocking models, have been particularly well-studied by the mathematics community recently. In this talk, I will present an agent-based Vicsek-type model for fish migration; I will then discuss the associated kinetic model for flocking and the derivation of its hydrodynamic limit via the Chapman-Enskog expansion.

- **Ed Moylan –** Ford Motor Co. (Ret.)

  A Brief History of CAD and its Role in the Establishment of the SIAM Great Lakes Chapter

  Development of CAD (Computer Aided Design) was driven by the automotive and aerospace industries. It evolved from initial rudimentary applications to today's sophisticated simulations. The mathematics community continually played an essential role and the SIAM Great Lakes Chapter was formed to provide a forum. Over time, member interests have broadened to include bio-sciences, complex systems, data mining, et al.