

Scott A. Mitchell, PhD

Mail Stop 1316
P.O. Box 5800
Sandia National Laboratories
Albuquerque, NM 87185

Phone: 505-845-7594
FAX : 505-844-9297
E-mail: samitch@sandia.gov
URL: <http://www.cs.sandia.gov/~samitch/>

Education: Ph.D. Applied Mathematics, Cornell University, 1993
M.S. Applied Mathematics, Cornell University, 1991
B.S. Applied Mathematics, Engineering & Physics,
University of Wisconsin-Madison, 1988.

Ph.D. Thesis: *Mesh Generation with Provable Quality Bounds*, S. A. Vavasis, 1993

Positions: *Sandia National Laboratories:*
Principal Member Technical Staff, Computing Research Center, 2007-present
Manager, Optimization and Uncertainty Estimation Dept., 2002-2007
Cubit Project Leader, 2000-2002. Principal Member Technical Staff, 2001-2002.
Senior Member Technical Staff, 1994-2001
AMS Fellow a.k.a. von Neumann Fellow, 1992-1994
Xerox PARC: Summer Research Intern, 1991

Citizenship: United States, Department of Energy Security Clearances

Most Significant Achievements

Mesh Generation Research

- Tetrahedral and higher-d simplicial meshes with provable-quality (151 & 88 citations)
- Whisker Weaving algorithms for hex meshing (multiple papers, one with 177 citations)
- Characterization of surfaces with compatible hexahedral volume meshes (74 citations)
- Hex connectivity changes for quality improvement, Geode-template gluing tet and hex meshes, grafting disparate meshes, patent (multiple papers, one with 61 citations)
- Linear-size nonobtuse triangulations (55 citations)
- Poisson-disk point clouds, extended to provable-quality meshes

Informatics Research

- Flexible approximate counting

Software

- Cubit Mesh generation
- Logistics simulation

Leadership

- Cubit Project PI
- Department manager with line and program roles

Statement of Work

I research algorithms, sometimes develop production software, and occasionally solve applications. My technical work spans discrete math, computational science, and informatics. A focus is mesh generation in computational geometry. A second focus is information algorithms and theory, sometimes with geometric content. I managed Sandia's optimization department, with program and staff direction and evaluation responsibilities.

My research activities of the past 5 years have been diverse. I research random point cloud algorithms, for both mesh generation and design of computer experiments. In data analysis I led a team on "forecasting" (prediction, uncertainty, and statistics) over large-scale informatics graphs. I worked on several aspects of a data analysis pipeline including the geometry of information-theory distance functions, and researched and implemented a flexible approximate counting scheme. In computational topology I lead a small project and hosted a workshop. I designed and prototyped a mobile ad-hoc networking protocol; researched validation guidelines for computer models of humans cognition; and designed and developed the military logistics simulation CoreSim.

I managed Sandia's optimization and uncertainty estimation department from 2002-2007, with line and program responsibilities. I hired people, increasing staff from 5 to 8; mentored career planning; performed merit/salary review. The department's main product is the DAKOTA optimization and uncertainty quantification software, which provides information about ranges of scientific simulation outcomes. This is a key component of DOE's Advanced Simulation and Computing program (ASC), the foundation for Science Based Stockpile Stewardship. My department had DOE NNSA and Office of Science funding, and several commercial and university partnerships. Programmatically, I served on the Laboratory Directed Research and Development (LDRD) Computer and Information Sciences Investment Area Team. I also served on the ASC Algorithms and ASC Validation & Verification programs. We selected which proposals and staff to fund.

I lead Sandia's Cubit mesh generation toolkit from 2000-2002. Cubit, as DAKOTA, is a critical and unique component of the ASC (then ASCI) program. I was responsible for the technical agenda of the group; representing the project internally and externally; and ensuring we provided training and support for our software. I oversaw the technical work of 30 people including 15 full-time Sandians and contractors; several commercial, university, and lab R&D collaborations; and a three-person subteam solving applications with our software. Prior to project leadership, I researched new meshing algorithms and developed production level software. My "existence proof" for hexahedral meshes showed that, contrary to folklore, a topologically-correct hexahedral mesh exists that is compatible with a prescribed boundary mesh, given very mild necessary and sufficient conditions on the boundary mesh.

Prior to 1995, I researched tetrahedral and triangulation algorithms with provable element shape and element count guarantees. My PhD thesis described the first algorithm for tetrahedral meshing with these kinds of theoretical guarantees.

University and Corporate programs

I served as a Sandia representative for research contracts with University of Michigan (2009); University of Iowa (2009); Lawrence Livermore National Laboratory (2006); Harvey Mudd

College Clinic (2004); Brigham Young University (1999-2002); Caterpillar (2001-2002); Goodyear (2001-2002). I host sabbatical faculty, post-docs, summer graduate and undergraduate college students, which includes developing a research project with them and guiding their work. I served on the degree committee of Jason Shepherd (BYU), Steve Jankovich (BYU), and Michelle Hummel (UNM).

Communications

I've represented Sandia technical groups, especially the Cubit project and the Optimization department, in many overview talks, software demonstrations, training classes, project reports, and funding requests given to sponsors, review panels, and potential customers. Examples include Tri-lab conferences; ASCI PI project meetings; Center external review; Cubit overviews to Unigraphics and Coventor; Cubit user tutorials; ASCI, CSRF, LDRD, and MICS reports and funding proposals.

Publications

Most papers, and some software, are available at

http://www.cs.sandia.gov/~samitch/bibliography_2007.html

<http://www.cs.sandia.gov/~samitch/mesh-biblio.html>

<http://www.cs.sandia.gov/~samitch/csstuff/csguide.html>

A Simple Algorithm for Maximal Poisson-Disk Sampling in High Dimensions, Mohamed S. Ebeida, Scott A. Mitchell, Anjul Patney, Andrew A. Davidson and John D. Owens. To appear in Eurographics, 2012.

Uniform Random Voronoi Meshes, Mohamed S. Ebeida and Scott A. Mitchell. Proceedings 20th International Meshing Roundtable, 2011.

Flexible Approximate Counting, Scott A. Mitchell and David M. Day. IDEAS2011, 15th International Database Engineering & Applications Symposium, 2011.

Efficient and Good Delaunay Meshes from Random Points, Mohamed S. Ebeida, Scott A. Mitchell, Andrew A. Davidson, Anjul Patney, Patrick M. Knupp, and John D. Owens. Special issue of Journal of Computer-Aided Design dedicated to proceedings of SIAM Conference on Geometric and Physical Modeling (GD/SPM11), 2011.

Efficient Maximal Poisson-Disk Sampling, Mohamed S. Ebeida, Anjul Patney, Scott A. Mitchell, Andrew Davidson, Patrick M. Knupp, and John D. Owens. ACM SIGGRAPH 2011.

Distinguishing Documents, Scott A. Mitchell. LDRD 149045 Final Report, SAND report SAND2010-6678, September 2010.

Summary of the CSRI Workshop on Combinatorial Algebraic Topology (CAT): Software, Applications, & Algorithms, Janine C. Bennett, David M. Day, Scott A. Mitchell. SAND report SAND2009-7777, 2009.

The RatNest Routing Protocol for Ad-Hoc Circuits Over Fixed Radio Networks, Scott A. Mitchell, SAND report SAND2009-1895C, 2009.

R&D for Computational Cognitive and Social Models: Foundations for Model Evaluation through Verification and Validation, McNamara, Laura A., Timothy G. Trucano, George A. Backus, Scott A. Mitchell. SAND Report SAND2008-6453, September 2008.

Distance-Avoiding Sets for Extremely Low-Bandwidth Authentication, Michael J. Collins and Scott A. Mitchell. Int'l Conf. on Sequences and Their Applications (SETA 2008).

New Processes for Innovative Microsystems Engineering with Predictive Simulation, Scott A. Mitchell, Ann E. Mattsson, and Stephen W. Thomas, SAND report SAND2007-4888, August 2007.

<Manager 2002-2007>

A Technical History of Hexahedral Mesh Generation, Scott Mitchell, 11th International Meshing Roundtable, short course, 2002.

Mesh Generation for High Performance Computing. Part II: Mesh Generation for Massively Parallel-Based Analysis. Scott Mitchell, Patrick Knupp, and Timothy Tautges. Tutorial S6B, Supercomputing 2000.

Cubit Software Demonstration, Department of Energy, Accelerated Strategic Computing Initiative (ASCI), Research Exhibitor Booth R1124, Scott A. Mitchell. Supercomputing 2000.

The Cleave and Fill Tool: An All-Hexahedral Refinement Algorithm for Swept Meshes, Michael Borden, Steven Benzley, Scott A. Mitchell, David R. White and Ray Meyers. Proceedings, 9th International Meshing Roundtable, Sandia National Laboratories, pp. 69-76, 2000.

Methods for Multisweep Automation, Shepherd, Jason, Scott A. Mitchell, Patrick Knupp, and David White. Proceedings 9th International Meshing Roundtable, Sandia National Laboratories, pp. 77-87, 2000.

Interval Assignment for Volumes with Holes, Shepherd, Jason, Steven Benzley and Scott A. Mitchell. International Journal for Numerical Methods in Engineering, John Wiley, Vol 49, Num 1, pp. 277-288, September 2000.

Integration of Mesh Optimization with 3D All-Hex Mesh Generation, Patrick Knupp and Scott A. Mitchell, SAND report SAND99-2852, 1999.

A Method for Controlling Skew on Linked Surfaces, R. A. Kerr, S. E. Benzley, D. R. White, and S. Mitchell. Proc. 8th International Meshing Roundtable, 377- 385, 1999.

Quality Mesh Generation in Higher Dimensions, Scott A. Mitchell and Stephen A. Vavasis. SIAM Journal on Computing Volume 29, Number 4, pp. 1334-1370, 1999.

The Graft Tool: an All-Hexahedral Transition Algorithm for Creating a Multi-Directional Swept Volume Mesh, S. R. Jankovich, S. E. Benzley, J. F. Shepherd, and S. A. Mitchell. Proc. 8th International Meshing Roundtable, 387-392, 1999.

Reliable Whisker Weaving via Curve Contraction, N. T. Folwell, and S. A. Mitchell. Proc. 7th International Meshing Roundtable, 365-378, 1998.

The All-Hex Geode-Template for Conforming a Diced Tetrahedral Mesh to Any Diced Hexahedral Mesh, S. A. Mitchell. Proc. 7th International Meshing Roundtable, 295-305 (1998), and Engineering with Computers, 15: 228-235.

The Geode Algorithm: Combining Hex/Tet Plastering, Dicing and Transition Elements for Automatic, All-Hex Mesh Generation, R. W. Leland, D. J. Melander, R. W. Meyers, S. A. Mitchell, and T. J. Tautges. Proc. 7th International Meshing Roundtable, 515-521, 1998.

- High Fidelity Interval Assignment, S. A. Mitchell. Proc. 6th International Meshing Roundtable, 33-44 (1997), and International Journal of Computational Geometry and Applications Vol. 10, No. 4 (2000) 399-415.
- An Immersive Environment for Exploration of CUBIT Meshes, C. J. Pavlakos, J. S. Jones, and S. A. Mitchell. Proc. 6th International Meshing Roundtable, 47-65, 1997.
- A Global Optimization Approach to Quadrilateral Meshing, J. Jung, C. Dohrmann, W. Witkowski, P. Wolfenberger, W. Gerstle, S. Mitchell, M. Panthaki, and D. Segalman. Proc. 6th International Meshing Roundtable, 155-167, 1997.
- Choosing Corners of Rectangles for Mapped Meshing, S. A. Mitchell. Proc. Thirteenth annual symposium on Computational Geometry, 87-93, 1997.
- Forming and Resolving Wedges in the Spatial Twist Continuum, T. D. Blacker, S. A. Mitchell, T. J. Tautges, P. Murdoch, and S. Benzley. Engineering with Computers 13:35-47 (1997).
- The Spatial Twist Continuum: A Connectivity Based Method for Representing All-Hexahedral Finite Element Meshes, P. Murdoch; S. Benzley; T. Blacker; and S.A. Mitchell. Finite Elements in Analysis and Design, Volume 28, Number 2, 15 December 1997, Elsevier, pp. 137-149(13)
- The Whisker Weaving Algorithm: a Connectivity Based Method for Constructing All-Hexahedral Finite Element Meshes, T. J. Tautges, T. D. Blacker, S. A. Mitchell, Int. J. Numer. Methods Engrg. 39:19 (1996), pp. 3327-3350.
- A Characterization of the Quadrilateral Meshes of a Surface Which Admit a Compatible Hexahedral Mesh of the Enclosed Volume, S. A. Mitchell. Proc. 13th Annual Symposium on Theoretical Aspects of Computer Science (STACS '96), Lecture Notes in Computer Science 1046, Springer, pages 465-476, 1996.
- An Aspect Ratio Bound for Triangulating a d-Grid Cut by a Hyperplane. S. A. Mitchell and S. A. Vavasis. Proc. 12th Annual Symposium on Computational Geometry, (1996) 48-57.
- Progress Report on the Whisker Weaving All-Hexahedral Meshing Algorithm, Timothy J. Tautges and Scott A. Mitchell. 5th International Conference on Numerical Grid Generation in Computational Field Simulations, Mississippi State University, pp. 659-670, April 1996.
- Pillowing Doublets: Refining a Mesh to Ensure that Faces Share at Most One Edge, S. A. Mitchell and T. J. Tautges. Proc. 4th International Meshing Roundtable, 231-240, 1995.
- Hexahedral Mesh Generation via the Dual, S. Benzley, T. D. Blacker, S. A. Mitchell, P. Murdoch, and T. J. Tautges. Proc. 11th Annual Symp. on Computational Geometry, C4-C5, 1995.
- Whisker Weaving: Invalid Connectivity Resolution and Primal Construction Algorithm, Timothy J. Tautges and Scott A. Mitchell. Proceedings, 4th International Meshing Roundtable, SAND95-2130, Sandia National Laboratories, pp.115-127, October 1995.
- Cardinality Bounds for Triangulations with Bounded Minimum Angle, S. A. Mitchell, Sixth Canadian Conference on Computational Geometry, 326-331, 1994.
- Linear-Size Nonobtuse Triangulation of Polygons, M. Bern, S. A. Mitchell and J. Ruppert. 10th Annual Symposium on Computational Geometry (1994), 121-130; and Disc. Comput. Geom. 14 (1995) 411-428.

- CUBIT Mesh Generation Environment Users Manual, vol. 1, T.D. Blacker, S. Benzley, S. Jankovich, R. Kerr, J. Kraftcheck, R. Kerr, P. Knupp, R. Leland, D. Melander, R. Meyers, S. Mitchell, J. Shepard, T. Tautges, D. White. Sandia National Laboratories, Albuquerque, NM, 1994. SAND94-1100
- Refining a Triangulation of a Planar Straight-Line Graph to Eliminate Large Angles, S. A. Mitchell. Thirty-fourth Annual Symposium on Foundations of Computer Science (FOCS '93), 583-591.
- Finding a Covering Triangulation Whose Maximum Angle is Provably Small, S. A. Mitchell, Seventeenth Annual (Australasian) Computer Science Conference, (1994) 55-64; and 1993 ARO/MSI Stony Brook Workshop on Computational Geometry; and International Journal of Computational Geometry and Applications, vol. 7, number 1/2, pp. 5-20, 1997.
- Approximating the MaxMin-Angle Covering Triangulation, S. A. Mitchell. Proc. Fifth Canadian Conference on Computational Geometry (1993), 36-41. Also Cornell CS TR92-1327 (thesis) and Computational Geometry: Theory and Applications 7 (1997) 93-111.
- Mesh Generation With Provable Quality Bounds, S. A. Mitchell, Applied Math Cornell PhD Thesis, Cornell CS Tech Report TR93-1327 (1993).
- Edge-Insertion for Optimal Triangulations, M. Bern, H. Edelsbrunner, D. Eppstein, S. A. Mitchell, and T. S. Tan. Proc. Latin American Theoretical Informatics 1992, 46-60. Also Discrete & Computational Geometry 10:47-65 (1993) Springer-Verlag New York Inc.
- Quality Mesh Generation in Three Dimensions, S. A. Mitchell and S. A. Vavasis, Proc. 8th Annual Symposium on Computational Geometry (1992), 212-221. Also developed a two-dimensional implementation at Xerox PARC and presented it at the SUNY Stony Brook Workshop on Computational Geometry, 1991.

Patents & Technical Advances

Hex mesh grafting

Method for Generating a Mesh Representation of a Region Characterized by a Trunk and a Branch Thereon. Inventors: Jason F. Shepherd, Scott A. Mitchell, Steven R. Jankovich, Steven E. Benzley. U.S. Patent No 7,219,039. Issued 15 May 2007. SD-6533.1 S-93,794

All-Hex Geode-Template Mesh Generation and Apparatus, Sandia Technical Advance, SD-6389, 1999. U.S. Patent Rejected.

Hex mesh Whisker Weaving

Connectivity-Based, All-Hexahedral Mesh Generation and Apparatus, Inventors: Timothy James Tautges, Scott A. Mitchell, Ted D. Blacker, Peter Murdoch. U.S. Patent 5,768,156. Issued June 1998.

Awards

Outstanding Mentor, Sandia, 2012.

Future Force Integrated Support Team, FIST, coin, for CoreSim, 2009.

Department of Energy, Defense Programs Award of Excellence, NNSA, 2006.

Professional Activities

SIAM-UQ 12 minisymposium organizer, speaker, Ensembles of Random Points for UQ, 2012
Adjunct Faculty, University of New Mexico, Math Department, sponsor Vageli Coutsiias, 2010-
Workshop on Combinatorial Algebraic Topology (CAT), chair, 2009.

Intel International Science and Engineering Fair 2007 Grand Awards Judge (Mathematics).
Committee Member, Applied Track, Symposium on Computation Geometry, 2000.

Middle School Math Textbook screener, 1998-1999 Instructional Materials Commission of the
New Mexico Board of Education

Session Chairs

IDEAS 2011.

International Meshing Roundtable (IMR): Discussion chair and invited talk 2002;
session chair 1995, 1997, 1998, and 1999.

U.S. National Congress on Computational Mechanics, August 1999.

Conference Chair, International Meshing Roundtable, October 1996.

Reviewer for journals and refereed conferences:

International Journal of Computational Geometry and Applications (IJCGA);
Computational Geometry, Theory and Applications (CGTA); International Meshing
Roundtable (IMR); Symposium on Computational Geometry (SoCG); Engineering with
Computers; IEEE Transactions on Parallel and Distributed Systems; ASME Journal of
Mechanical Design; Discrete Mathematics; International Journal of Numerical Methods in
Engineering (IJNME); SIAM Journal on Scientific Computing; and Algorithmica.

Professional Memberships

ACM Association for Computing Machinery, Professional Member 1994-, Senior Member 2009-.
SIAM Society for Industrial and Applied Mathematics

Academic Honors Fraternities

Phi Beta Kappa

Tau Beta Pi

Teaching experience

Algorithmic Geometry and Mesh Generation, graduate course, University of New Mexico, 2010.

Graduate Teaching Assistant, Cornell University, Calculus, Game Theory, 1988-1991.

Volunteer Activities

Presidential Volunteer Service Award, 2006-2008

Boy Scouts of America, Scoutmaster 2003-2008, Assistant 2002, 2009

American Youth Soccer Organization, AYSO, Coach 2002-2005, Referee 1997-2003