

## CLIFFORD ALAN SHAFFER

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Date and place of birth: August 15, 1959, Baltimore, Maryland.

### Education:

- BS in Computer Science: University of Maryland, College Park, 1980.
- MS in Computer Science: University of Maryland, College Park, 1982.
- PhD in Computer Science: University of Maryland, College Park, 1986.

Dissertation Title: Application of Alternative Quadtree Representations

Advisor: Hanan Samet

### Professional positions held:

Professor (6/08 – present)

Department of Computer Science, Virginia Polytechnic Institute & State University.

Interdisciplinary Program in Genetics, Bioinformatics, and Computational Biology, 7/04 – present.

Associate Professor (8/93 – 6/08)

Department of Computer Science, Virginia Polytechnic Institute & State University.

Assistant Professor (9/87 – 8/93)

Department of Computer Science, Virginia Polytechnic Institute & State University.

Summer Faculty Fellow (5/90 – 8/90)

NASA/Goddard Space Flight Center, Greenbelt, Maryland.

Research Associate (8/86 – 8/87)

Center for Automation Research, University of Maryland.

### Publications

#### Books:

1. C.A. Shaffer, *Data Structures and Algorithm Analysis in Java: Third Edition*, Dover Publications, Mineola, NY, 2011.
2. C.A. Shaffer, *Data Structures and Algorithm Analysis in C++: Third Edition*, Dover Publications, Mineola, NY, 2011.
3. C.A. Shaffer, *A Practical Introduction to Data Structures and Algorithm Analysis: Second Edition*, Prentice Hall, Upper Saddle River, NJ, 2001.
4. C.A. Shaffer, *A Practical Introduction to Data Structures and Algorithm Analysis: Java Edition*, Prentice Hall, Upper Saddle River, NJ, 1998.

5. C.A. Shaffer, *A Practical Introduction to Data Structures and Algorithm Analysis*, Prentice Hall, Upper Saddle River, NJ, 1997.
6. C.A. Shaffer, Instructor's manual for *A Practical Introduction to Data Structures and Algorithm Analysis*, Prentice Hall, Upper Saddle River, NJ, 1997.

Journal publications:

1. E. Fouh, M. Akbar, and C.A. Shaffer, The Role of Visualization in Computer Science Education, to appear in *Computers in Education*, 2012.
2. C.A. Shaffer, M.L. Cooper, A.J.D. Alon, M. Akbar, M. Stewart, S. Ponce, and S.H. Edwards, Algorithm Visualization: The State of the Field, *ACM Transactions on Computing Education* 10, 3(August 2010), 1–22.
3. R. Randhawa, C.A. Shaffer, and J.J. Tyson, Model Composition for Macromolecular Regulatory Networks, *IEEE/ACM Transactions on Computational Biology and Bioinformatics* 7, 2(April-June 2010), 278–287.
4. T.-H. Ahn, L.T. Watson, Y. Cao, C.A. Shaffer, and W.T. Baumann, Cell Cycle Modeling for Budding Yeast with Stochastic Simulation Algorithms, *Computer Modeling in Engineering and Sciences* 51, 1(2009), 27–52.
5. R. Randhawa, C.A. Shaffer, and J.J. Tyson, Model Aggregation: a building-block approach to creating large macromolecular regulatory networks, *Bioinformatics* 25, 24(2009), 3289–3295.
6. T.D. Panning, L.T. Watson, N.A. Allen, K.C. Chen, C.A. Shaffer, and J.J. Tyson, Deterministic Parallel Global Parameter Estimation for a Model of the Budding Yeast Cell Cycle, *Journal of Global Optimization* 40, 4(April, 2008), 719–738.
7. D. Mishra, C.A. Shaffer, N. Ramakrishnan, L.T. Watson, K.K. Bae, J. He, A.A. Verstak, and W.H. Tranter, S<sup>4</sup>W: A Problem Solving Environment for Wireless System Design, *Software: Practice & Experience* 37, 14(November 2007), 1539–1558.
8. T.D. Panning, L.T. Watson, C.A. Shaffer, and J.J. Tyson, A Mathematical Programming Formulation for the Budding Yeast Cell Cycle, *Simulation* 83, 7(July 2007), 497–514.
9. L. Thomas, C.A. Shaffer, L. Mili, and E. Thomas, Automated Detection of Severe Surface Defects on Barked Hardwood Logs, *Forest Product Journal* 57, 4(April 2007), 50–56.
10. L. Thomas, L. Mili, E. Thomas, and C.A. Shaffer, Defect Detection on Hardwood Logs Using Laser Scanning, *Wood and Fiber Science* 38, 4(October, 2006), 682–695.
11. C.A. Shaffer, Experiences Teaching a Graduate Research Methods Course, *SIGCSE Bulletin* 38, 2(June 2006), 97–101.
12. M. Vass, C.A. Shaffer, N. Ramakrishnan, L.T. Watson, and J.J. Tyson, The JigCell Model Builder: A Spreadsheet Interface for Creating Biochemical Reaction Network Models, *IEEE/ACM Transactions on Computational Biology and Bioinformatics* 3, 2(Apr–Jun 2006), 155–164.
13. N.A. Allen, K.C. Chen, C.A. Shaffer, J.J. Tyson, and L.T. Watson, Computer Evaluation of Network Dynamics Models with Application to Cell Cycle Control in Budding Yeast, *IEE Proceedings – Systems Biology* 153, 1(Jan 2006), 13–21.
14. J. He, A. Verstak, L. T. Watson, C. A. Stinson, N. Ramakrishnan, C. A. Shaffer, T. S. Rappaport, C. R. Anderson, K. Bae, J. Jiang, and W. H. Tranter, Globally Optimal Transmitter Placement for Indoor Wireless Communication Systems, *IEEE Transactions on Wireless Communications* 3, 6(Nov 2004) 1906–1911.

15. M. Vass, N. Allen, C.A. Shaffer, N. Ramakrishnan, L.T. Watson, and J.J. Tyson, The JigCell Model Builder and Run Manager, *Bioinformatics* 20, 18(Dec 2004), 3680–3681.
16. R. Skidmore, A. Verstak, N. Ramakrishnan, T.S. Rappaport, L.T. Watson, J. He, S. Varadarajan, C.A. Shaffer, J. Chen, K.K. Bae, J. Jiang, and W.H. Tranter, Towards Integrated PSEs for Wireless Communications: Experiences with the  $S^4W$  and *SitePlanner* Projects, *ACM SIGMOBILE Mobile Computing and Communications Review* 8, 2(April 2004), 20–34.
17. N.A. Allen, L. Calzone, K.C. Chen, A. Ciliberto, N. Ramakrishnan, C.A. Shaffer, J.C. Sible, J.J. Tyson, M.T. Vass, L.T. Watson, and J.W. Zwolak, Modeling Regulatory Networks at Virginia Tech, *OMICS, A Journal of Integrative Biology* 7, 3(2003), 285–299.
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19. E.J. Rubin, C.A. Shaffer, N. Ramakrishnan, L.T. Watson, R. Dymond, D. Kibler, R. Dietz, J. Chanat, V. Lohani, D. Bosch, and C. Speir, From Landscapes to Waterscapes: A PSE for Landuse Change Analysis, *Engineering with Computers* 19, 1(July 2003), 9–25.
20. A. Verstak, N. Ramakrishnan, L.T. Watson, J. He, C.A. Shaffer, K.K. Bae, J. Jiang, W.H. Tranter, and T.S. Rappaport, BSML: A Binding Schema Markup Language for Data Interchange in PSEs, *Scientific Programming* 11, 3(August 2003), 199–224.
21. J. He, L.T. Watson, N. Ramakrishnan, C.A. Shaffer, A. Verstak, J. Jiang, K. Bae, and W.H. Tranter, Dynamic Data Structures for a Direct Search Algorithm, *Computational Optimization and Applications* 23 1(October 2002), 5–25.
22. L.T. Watson, V.K. Lohani, D.F. Kibler, R.L. Dymond, N. Ramakrishnan, and C.A. Shaffer, Integrated Computing Environments for Watershed Management, *ASCE Journal of Computing in Civil Engineering* 16, 4(October 2002), 259–268.
23. N. Ramakrishnan, L.T. Watson, D.G. Kafura, C.J. Ribbens, and C.A. Shaffer, Programming Environments for Multidisciplinary Grid Communities, *Concurrency and Computation: Practice and Experience*, 13–15(Nov–Dec 2002), 1241–1273.
24. J.M.A. Begole, R.L. Smith, C.A. Struble, and C.A. Shaffer Resource Sharing for Replicated Synchronous Groupware, *IEEE Transactions on Networking* 9, 6(Dec 2001) 833–843.
25. A. Goel, C.A. Baker, C.A. Shaffer, B. Grossman, W.H. Mason, and L.T. Watson VizCraft: A Problem Solving Environment for Configuration Design of a High Speed Civil Transport, *Computing in Science and Engineering* 3, 1(Jan/Feb 2001), 56–66.
26. J. Begole, M.B. Rosson and C.A. Shaffer, Flexible Collaboration Transparency: Supporting Worker Independence in Replicated Application-Sharing Systems, *ACM Transactions on Computer-Human Interaction* 6, 2(June, 1999), 95–132 (also, Computer Science TR 98-12, Virginia Tech, May 1998).
27. S.H Edwards and C.A. Shaffer, An Analysis of a Course-Oriented Electronic Mailing List, *Computer Science Education* 9, 1(April 1999), 8–22.
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29. J. Begole, P.L. Isenhour, and C.A. Shaffer, Can You Share JavaBeans?, *Dr. Dobb's Journal*, 300(June 1999), 121–122, (also, Computer Science TR 98-13, Virginia Tech, 1998).

30. J.B. Begole, C.A. Struble, and C.A. Shaffer, Toward Collaboration Transparency in Java, *IEEE Internet Computing* 1, 2(Mar–Apr 1997), 57–64.
31. S.V. Pemmaraju and C.A. Shaffer, Analysis of the Worst Case Space Complexity of a PR Quadtree, *Information Processing Letters* 49 5(Mar 1994), 263–267 (also, Computer Science TR 92–09, Virginia Tech, April 1992).
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38. D.N. Oskard, T.-H. Hong, and C.A. Shaffer, Real-Time Algorithms and Data Structures for Underwater Mapping, *IEEE Transactions on Systems, Man, and Cybernetics* 20, 6(Nov/Dec 1990), 1469–1475.
39. C.A. Shaffer, H. Samet, and R.C. Nelson, QUILT: A Geographic Information System Based on Quadtrees, *International Journal of Geographic Information Systems* 4, 2(Aug, 1990), 103–131, (also Computer Science TR-1885, University of Maryland, Jul 1987).
40. C.-H. Ang, H. Samet, and C.A. Shaffer, A New Region Expansion for Quadtrees, *IEEE Transactions on Pattern Analysis and Machine Intelligence* 12, 7(Jul, 1990), 682–686.
41. C.A. Shaffer and H. Samet, Set Operations for Unaligned Linear Quadtrees, *Computer Vision, Graphics, and Image Processing* 50, 1(Apr 1990), 29–49, (also Computer Science TR 88-31, Virginia Tech, Sep 1988).
42. C.A. Shaffer and H. Samet, Algorithm to Expand Regions Represented by Linear Quadtrees, *Image and Vision Computing* 6, 3(Aug 1988), 162–168, (also Computer Science TR-1849, University of Maryland, May 1987).
43. C.A. Shaffer, A Formula for Computing the Number of Quadtree Node Fragments Created by a Shift, *Pattern Recognition Letters* 7, 1(Jan 1988), 45–49, (also Computer Science TR-1850, University of Maryland, May 1987).
44. H. Samet, C.A. Shaffer, R.C. Nelson, Y.-G. Huang, K. Fujimura, and A. Rosenfeld, Recent Developments in Linear Quadtree-Based Geographic Information Systems, *Image and Vision Computing* 5, 3(Aug 1987), 187–197, (also Computer Science TR-1578, University of Maryland, Dec 1985).
45. H. Samet, C.A. Shaffer and R.E. Webber, Digitizing the Plane with Cells of Nonuniform Size, *Information Processing Letters* 24, 6(Apr 1987), 369–375, (also Computer Science TR-1619, University of Maryland, Jan 1986).

46. C.A. Shaffer and H. Samet, Optimal Quadtree Construction Algorithms, *Computer Vision, Graphics, and Image Processing* 37, 3(Mar 1987), 402–419
47. H. Samet and C.A. Shaffer, A Model for the Analysis of Neighbor Finding in Pointer-Based Quadtrees, *IEEE Transactions on Pattern Analysis and Machine Intelligence* 7, 6(Nov 1985), 717–720, (also Computer Science TR-1432, University of Maryland, Aug 1984).
48. H. Samet, A. Rosenfeld, C.A. Shaffer, and R.E. Webber, A Geographic Information System Using Quadtrees, *Pattern Recognition* 17, 6(Nov/Dec 1984), 647–656.
49. H. Samet, A. Rosenfeld, C.A. Shaffer, and R.E. Webber, Quadtree Region Representation in Cartography: Experimental Results, *IEEE Transactions on Systems, Man, and Cybernetics* 13, 6(Nov/Dec 1983), 1148–1154.

Book chapters:

1. Clifford A. Shaffer, Jason W. Zwolak, Ranjit Randhawa, and John J. Tyson Modeling Molecular Regulatory Networks with JigCell and PET, in *Systems Biology 500*, Ivan Maly, ed., Humana Press, 2009, 81-111.
2. J. Koenemann, J.M. Carroll, C.A. Shaffer, M.B. Rosson, and M.A. Abrams, Designing Collaborative Applications for Classroom Use: The LiNC Project, in *The Design of Children's Technology*, Allison Druin, ed., Morgan Kaufmann, 1998, 99-122.
3. C.A. Shaffer, Data representations for Geographic Information Systems, in *Annual Review of Information Science and Technology* 27, (Martha E. Williams, Ed.), American Society for Information Science, Medford, NJ, 1992, 135–172.
4. C.A. Shaffer and C.D. Feustel, “Exact Computation of 2-D Intersections” in *Graphics Gems III*, (D. Kirk, Ed.), Academic Press, San Diego, CA, 1992 (also, Computer Science TR 91-29, Virginia Tech, September 1991).
5. C.A. Shaffer, Getting Around on a Sphere, in *Graphics Gems II*, (J. Arvo, Ed.), Academic Press, San Diego, CA, 1991.
6. C.A. Shaffer, Bit Interleaving for Quad- or Octrees, in *Graphics Gems*, (A. Glassner, Ed.), Academic Press, San Diego, CA, 1990, 51–53.
7. C.A. Shaffer, Fast Circle/Rectangle Intersection Checking, in *Graphics Gems*, (A. Glassner, Ed.), Academic Press, San Diego, CA, 1990, 443–447.
8. H. Samet, C.A. Shaffer, and R.E. Webber, Using Linear Quadtrees to Store Vector Data, in *Data Structures for Raster Graphics*, (L.R.A. Kessner, F.J. Peters, and M.L.P. van Lierop, Eds.), Springer Verlag, Berlin, 1986, 91–123 (also Computer Science TR-1550, University of Maryland, Aug 1985).

Invited conference papers:

1. Z. Liu, C.A. Shaffer, U.J. Mobassera, L.T. Watson, and Y. Cao, Multistate Modeling and Simulation for Regulatory Networks, Proceedings of the 2010 Winter Simulation Conference, B. Johansson, S. Jain, J. Montoya-Torres, J. Hukan, and E. Yücesan, eds., December 2010, 631–642.
2. C.A. Shaffer, R. Randhawa, and J.J. Tyson, The Role of Composition and Aggregation in Modeling Macromolecular Regulatory Networks, in *Proceedings of the 2006 Winter Simulation Conference*, L. F. Perrone, F. P. Wieland, J. Liu, B. G. Lawson, D. M. Nicol, and R. M. Fujimoto, eds, Monterey, CA, December 2006, 1628–1635.

3. H.M. Sauro, A.M. Uhrmacher, D. Harel, M. Hucka, M. Kwiatkowski, P. Mendes, C.A. Shaffer, L. Stromback, and J.J. Tyson, Challenges for Modeling and Simulation Methods in Systems Biology, in *Proceedings of the 2006 Winter Simulation Conference*, L. F. Perrone, F. P. Wieland, J. Liu, B. G. Lawson, D. M. Nicol, and R. M. Fujimoto, eds, Monterey, CA, December 2006, 1720–1730.
4. E.A. Fox, N.D. Barnette, C.A. Shaffer, L. Heath, W. Wake, L.T. Nowell, J.A.N. Lee, D. Hix and H.R. Hartson, Progress in Interactive Learning with a Digital Library in Computer Science, in *Proceedings ED-MEDIA 95, World Conf. on Educational Multimedia and Hypermedia*, June 17–21, 1995, Graz, Austria.
5. C.A. Shaffer, Indexing Methods for Area of Interest Retrieval from World Scale GIS, *Proceedings of the International Colloquium on Digital Maps in Geosciences*, Wuerzburg, West Germany, Sep 1989, in *Geologisches Jahrbuch A 122*, 1992, 101–107.
6. C.A. Shaffer, An Empirical Comparison of Vectors, Rasters, and Quadtrees for Representing Geographic Data, *Proceedings of the International Colloquium on the Construction and Display of Geoscientific Maps Derived from Databases*, Dinkelsbuehl, West Germany, Dec 1986, in *Geologisches Jahrbuch A 104*, (1988), 99–115.
7. H. Samet, C.A. Shaffer, R.C. Nelson, Y.-G. Huang, K. Fujimura, and A. Rosenfeld, Hierarchical Data Structures for Geographic Information, *Proceedings of the International Colloquium on the Construction and Display of Geoscientific Maps Derived from Databases*, Dinkelsbuehl, West Germany, Dec 1986, in *Geologisches Jahrbuch A 104*, (1988), 97–98.

Conference papers:

1. C.A. Shaffer, V. Karavirta, A. Korhonen and T.L. Naps, “OpenDSA: Beginning a Community Hyper-textbook Project” in *Proceedings of 11th Koli Calling International Conference on Computing Education Research*, Koli National Park, Finland, November 17-20, 2011, 112–117.
2. C.A. Shaffer, T.L. Naps, and E. Fouh, “Truly Interactive Textbooks for Computer Science Education” in *Proceedings of the Sixth Program Visualization Workshop*, Darmstadt, Germany, June 30, 2011, 97–103.
3. C.A. Shaffer and S.H. Edwards, “Scheduling and Student Performance” in *Proceedings of the 16th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education, ITiCSE 2011*, Darmstadt, Germany, June 27-29, 2011, p. 311.
4. C.A. Shaffer, M. Akbar, A.J.D. Alon, M. Stewart, and S.H. Edwards, “Getting Algorithm Visualizations into the Classroom” in *Proceedings of the 42nd ACM Technical Symposium on Computer Science Education (SIGCSE’11)*, Dallas TX, March 9, 2011, 129–134.
5. E. Fox, Y. Chen, M. Akbar, C.A. Shaffer, S.H. Edwards, P. Brusilovsky, D. Garcia, L. Delcambre, F. Decker, D. Archer, R. Furuta, F. Shipman, S. Carpenter, and L. Cassel, “Ensemble PDP-8: Eight Principles for Distributed Portals” in *Proceedings of JCDL2010*, Australia, June 21–25, 2010.
6. C.A. Shaffer, T.L. Naps, S.H. Rodger, and S.H. Edwards, “Building an Online Educational Community for Algorithm Visualization”, in *Proceedings of the 41st ACM technical symposium on Computer science education (SIGCSE’10)*, March 11-13, 2010, Milwaukee, WI, 475–476.
7. T.-H. Ahn, P. Wang, L.T. Watson, Y. Cao, C.A. Shaffer, and W.T. Baumann, “Stochastic cell cycle modeling for budding yeast,” in *Proceedings of the 2009 Spring Simulation Multiconference: HPC*, G. Wainer, M. Chinni, P. Roman, H. Rajaei, B. Zeigler, and C. Ribbens (eds.), Society for Modeling and Simulation International, San Diego, CA, March 2009, 569–574.

8. Pengyuan Wang, Ranjit Randhawa, Clifford A. Shaffer, Yang Cao, and William T. Baumann, Converting Macromolecular Regulatory Models from Deterministic to Stochastic Formulation, in *Proceedings of High Performance Computing and Simulation 2008 (HPCS 2008)*, Ottawa, Canada, April 2008, 385–392.
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10. R. Randhawa, C.A. Shaffer, and J.J. Tyson, Fusing and Composing Macromolecular Regulatory Network Models, in *Proceedings of the 2007 High Performance Computing Symposium (HPC 2007)*, Norfolk, VA, March 2007, 337–344.
11. C.A. Shaffer, M. Cooper, and S.H. Edwards, Algorithm Visualization: A Report on the State of the Field, in *Proceedings of the 38th SIGCSE Technical Symposium on Computer Science Education (SIGCSE '07)*, Covington, KY, March 2007, 150–154.
12. E. Thomas, L. Thomas, C.A. Shaffer and L. Mili, Using External High-Resolution Log Scanning to Determine Internal Defect Characteristics, in *Proceedings of the 15th Central Hardwood Forestry Conference*, Knoxville, TN, February 2006, 497–505.
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15. L. Thomas, L. Mili, C.A. Shaffer, and E. Thomas, Defect Detection on Hardwood Logs Using High Resolution Three-dimensional Laser Scan Data, in *IEEE International Conference on Image Processing, ICIP*, Singapore, October 24–27, 2004, 243–246.
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17. J. He, M. Sosonkina, C.A. Shaffer, J.J. Tyson, L.T. Watson, and J.W. Zwolak, A Hierarchical Parallel Scheme for Global Parameter Estimation in Systems Biology, in *Proceedings of the 18th International Parallel & Distributed Processing Symposium*, CD-ROM, IEEE Computer Soc., Los Alamitos, CA, 2004, 9 pages.
18. C.A. Shaffer, Buffer Pools and File Processing Projects for an Undergraduate Data Structures Course, *SIGCSE '04: Proceedings of the 35th SIGCSE Technical Symposium on Computer Science Education*, Norfolk VA, March 2004, 175–178.
19. P. Saraiya, C.A. Shaffer, D.S. McCrickard, C. North, Effective Features of Algorithm Visualization, *SIGCSE '04: Proceedings of the 35th SIGCSE Technical Symposium on Computer Science Education*, Norfolk VA, March 2004, 382–386.
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22. M. Vass, J.M. Carroll, and C.A. Shaffer, Supporting Creativity in Problem Solving Environments, *Proceedings of the Fourth Creativity & Cognition Conference*, Loughborough, Leicestershire, UK, October 2002, 31–37.
23. C. R. Anderson, T. S. Rappaport, K. Bae, A. Verstak, N. Ramakrishnan, W. H. Tranter, C. A. Shaffer, and L. T. Watson, In-Building Wideband Multipath Characteristics at 2.5 & 60 GHz, in *Proceedings of IEEE Vehicular Technology Fall Conference*, Vancouver, Canada, 2002, 97–101.
24. K. K. Bae, J. Jiang, W. H. Tranter, C. R. Anderson, T. S. Rappaport, J. He, A. Verstak, L. T. Watson, N. Ramakrishnan, and C. A. Shaffer, WCDMA STTD Performance Analysis with Transmitter Location Optimization in Indoor Systems Using Ray-Tracing Technique, in *Proceedings of IEEE 2002 Radio and Wireless Conference*, Boston, MA, 2002, 123–127.
25. V. Colaso, A. Kamal, P. Saraiya, C. North, D.S. McCrickard, and C.A. Shaffer, Learning and Retention in Data Structures: A Comparison of Visualization, Text, and Combined Methods, in *Proceedings of the World Conference on Educational Multimedia/Hypermedia and Educational Telecommunications (ED-MEDIA 2002)*, Denver CO, June 2002, 332–333.
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30. E. J. Rubin, R. Dietz, J. Chanut, C. Speir, R. Dymond, V. Lohani, D. Kibler, D. Bosch, C. A. Shaffer, N. Ramakrishnan, and L. T. Watson, From Landscapes to Waterscapes: A PSE for Landuse Change Analysis, in *Proc. Integrated Decision-Making for Watershed Management Symposium: Processes and Tools*, Virginia Water Resources Research Center, Blacksburg, VA, VWRRC P7–2001, 2001, 643–659.
31. E.J. Rubin, R. Dietz, S. Lingam, J. Chanut, C. Speir, R. Dymond, V. Lohani, D. Kibler, D. Bosch, C.A. Shaffer, N. Ramakrishnan, and L.T. Watson, From Landscapes to Waterscapes: A PSE for Landuse Change Analysis, in *Proceedings of the 16th IMACS World Congress*, Special Session on ‘PSEs for Scientific Computing,’ Lausanne Switzerland, M. Deville and R. Owens (eds.), CD-ROM, August 2000, 6 pages.
32. C. A. Shaffer, L. T. Watson, D. G. Kafura, and N. Ramakrishnan, Features of Problem Solving Environments for Computational Science, in *Proceedings of the 2000 High Performance Computing Symposium (HPC'00)*, A. Tentner (Ed.), Society for Computer Simulation International, San Diego, CA, 2000, 242–247.

33. A. Goel, C. Baker, C.A. Shaffer, B. Grossman, R.T. Haftka, W.H. Mason, and L.T. Watson, VizCraft: A Multidimensional Visualization Tool for Aircraft Configuration Design, *Proceedings of IEEE Visualization'99*, San Francisco, CA, October 1999, 425–428,555.
34. C.A. Shaffer, L.T. Watson, and D.G. Kafura, Component Frameworks for Problem Solving Environments in Computational Science, in *Proceedings of the 1st Symposium on Reusable Architectures and Components for Developing Distributed Information Systems (RACDIS'99)*, Orlando, FL, August 1999, 653–656.
35. J.B. Begole, M.B. Rosson and C.A. Shaffer, Supporting Worker Independence in Collaboration Transparency, *Proceedings of the 1998 ACM Symposium on User Interface Software and Technology*, November 1998, 133–142.
36. C.A. Shaffer, D.L. Knill, and L.T. Watson, Visualization for Multiparameter Aircraft Designs, *Proceedings of IEEE Visualization'98*, Research Triangle Park, NC, October 1998, 491–494,575.
37. P.L. Isenhour, J. Begole, W.S. Heagy, and C.A. Shaffer, **Sieve**: A Java-Based Collaborative Visualization Environment, *Late Breaking Hot Topics Proceedings, IEEE Visualization'97*, Phoenix, AZ, October 1997, 13–16.
38. J. Begole, C.A. Struble, C.A. Shaffer, and R.B. Smith, Transparent Sharing of Java Applets: A Replicated Approach, in *Proceedings of UIST'97*, Banff, Alberta, Canada, October 1997, 55–64.
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40. C.A. Shaffer, L.S. Heath and J. Yang, Using the **Swan** Data Structure Visualization System for Computer Science Education, in *SIGCSE '96: Proceedings of the twenty-seventh SIGCSE technical symposium on Computer science education*, Philadelphia PA, February 1996, 140–144.
41. J. Yang, C.A. Shaffer and L.S. Heath, **SWAN** – A Data Structure Visualization System, in *Proceedings of Graph Drawing '95*, Passau, Germany, September 1995, *Springer Lecture Notes in Computer Science 1027*, 520–523.
42. J.S. Bright, C.A. Shaffer, P.S. Nagarkatti and M. Nagarkatti, Computer Simulation of the Immune System, in *Proceedings of the Fourteenth Annual Seminar of Cancer Researchers in Virginia*, Blacksburg, VA, March 1994, 17.
43. C.A. Shaffer, J.M.A. Begole, L.W. Carstensen, Jr., R.W. Morrill and E.A. Fox, **GeoSim**: A GIS-Based Simulation Laboratory for Introductory Geography, *Proceedings of the 1994 ADCIS Conference*, Nashville, TN, February 1994.
44. C.A. Shaffer and P.R. Brown, A Paging Scheme for Pointer-Based Quadtrees, in *Advances in Spatial Databases*, (D. Abel and B-C. Ooi, Eds.), Lecture Notes in Computer Science 692, Springer Verlag, Berlin, 1993, 89–104 (also, *Proceedings of the Third International Symposium, SSD'93*, Singapore, June 1993).
45. C.A. Shaffer and M.T. Ursekar, Large Scale Editing and Vector to Raster Conversion Via Quadtree Spatial Indexing, *Proceedings of the 5th International Symposium on Spatial Data Handling*, Charleston, SC, August 1992, 505–513.
46. C.A. Shaffer, A Full Resolution Elevation Representation Requiring Three Bits per Pixel, in *Design and Implementation of Large Spatial Databases*, (A. Buchmann, O. Gunther, T.R. Smith and Y.-F. Wang, Eds.), Springer Verlag, Berlin, 1990, 45–64 (also, *Proceedings of the Symposium on the Design and Implementation of Large Spatial Databases*, Santa Barbara, CA, Jul 1989).

47. D.N. Oskard, T.-H. Hong, and C.A. Shaffer, Real-Time Algorithms and Data Structures for Underwater Mapping, *SPIE Symposium on Sensor Fusion: Spatial Reasoning and Scene Interpretation*, Cambridge MA, Nov 1988.
48. C.-H. Ang, H. Samet, and C.A. Shaffer, Fast Region Expansion for Quadtrees, *Proceedings of the Third International Symposium on Spatial Data Handling*, Sydney, Australia, Aug 1988, 19–38.
49. C.A. Shaffer and H. Samet, An Optimal Quadtree Construction Algorithm, *Proceedings of the Eighth International Conference on Pattern Recognition*, Paris, France, Oct, 1986, 317–319.
50. H. Samet, C.A. Shaffer, R.C. Nelson, Y.G. Huang, K. Fujimura, and A. Rosenfeld, Recent Developments in Quadtree-Based Geographic Information Systems, *Proceedings of the Second International Symposium on Spatial Data Handling*, Seattle, Jul 1986, 15–32, (see also Geographic Information Systems Workshop, Springfield, Virginia, Dec 1985).
51. H. Samet, C.A. Shaffer, and R.E. Webber, The Segment Quadtree: A Linear Quadtree-Based Representation for Linear Features, *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'85)*, San Francisco, Jun 1985, 385–389.
52. H. Samet, A. Rosenfeld, C.A. Shaffer, and R.E. Webber, Use of Hierarchical Data Structures in Geographical Information Systems, *Proceedings of the International Symposium on Spatial Data Handling*, Zurich, Aug 1984, 392–411.
53. H. Samet, A. Rosenfeld, C.A. Shaffer, and R.E. Webber, Processing Geographic Data with Quadtrees, *Proceedings of the Seventh International Conference on Pattern Recognition*, Montreal, Aug 1984, 212–215.
54. H. Samet, A. Rosenfeld, C.A. Shaffer, and R.E. Webber, A Quadtree-Based Geographical Information System, *Proceedings of the Third Scandinavian Conference on Image Analysis*, Copenhagen, Jul 1983, 231–236.

Poster papers:

1. M. Akbar, A.J. Alon, M. Stewart, C.A. Shaffer, S.H. Edwards, “AlgoViz Portal: Lowering the Barriers for Entry into an Online Educational Community,” poster presented at 2010 Conference on Higher Education Pedagogy, Blacksburg VA, February 2010.
2. M. Akbar, Y. Chen, M. Stewart, E.A. Fox, C.A. Shaffer, S.H. Edwards, P. Fan, “Ensemble: Enriching Communities and Collections to Support Education in Computing,” poster presented at 2010 Conference on Higher Education Pedagogy, Blacksburg VA, February 2010.
3. M. Akbar, A.J. Alon, M. Stewart, C.A. Shaffer, S.H. Edwards, “Building an Online Educational Community,” poster presented at 2010 Conference on Higher Education Pedagogy, Blacksburg VA, February 2010.
4. C.A. Shaffer, S.H. Edwards, and M. Akbar, “The AlgoViz Portal: Lowering the Barriers for Entry into an Online Educational Community,” poster presented at NSF NSDL PIs meeting, November 2009.
5. C.A. Shaffer, M. Agarwal, A. Kumar, and S.H. Edwards, Going Beyond Algorithm Visualization to Algorithm Exploration, *39th ACM Technical Symposium on Computer Science Education (SIGCSE 2008)*, Portland OR, March 2008.
6. L. Thomas, E. Thomas, and C. Shaffer, Algorithm for Automated Detection of Surface Defects on Hardwood Logs, *Forest Products Society, 61st International Convention*, Knoxville, TN, June 2007.

7. R. Randhawa, C.A. Shaffer, and J.J. Tyson, Composition and Aggregation for Biological Pathway Modeling, *The Seventh International Conference on Systems Biology*, Yokohama, Japan, October, 2006, poster FI66.
8. P.R. Brown, C.A. Shaffer and R.E. Webber, A Paging Scheme for Pointer-Based Quadtrees, *Proceedings of the Nineteenth Annual ACM Computer Science Conference*, San Antonio, TX, Mar 1991, 687, also second place award winner, Virginia Tech Graduate Student Symposium, 1991.
9. C.A. Shaffer, V. Miranda, J.J.C. Wang, S. Kriss, L.W. Carstensen, Jr., R.W. Morrill, and E.A. Fox, Computerized Simulations for Introductory Geography Instruction, in *Proceedings of Application of Geographic Information Systems, Simulation Models, and Knowledge-based Systems for Landuse Management*, Blacksburg, VA, Nov 12–14, 1990, 479–480.
10. C.A. Shaffer and G. Herb, A Real-Time Robot Collision Avoidance System, *Eighteenth Annual ACM Computer Science Conference*, Washington D.C., Feb 20–22, 1990, 441.
11. H. Samet, A. Rosenfeld, C.A. Shaffer, and R.E. Webber, Quadtree Region Representation in Cartography: Experimental Results, *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'83)*, Washington D.C., Jun 1983, 176–177.

#### Videos:

1. A.J. Alon, M. Stewart, M. Akbar, C.A. Shaffer, “Issues in Algorithm Visualization”, video presented as part of the video program for *41st ACM Technical Symposium on Computer Science Education (SIGCSE'10)*, March 11-13, 2010.

#### Conference Tutorials:

1. C.A. Shaffer, T.L. Naps, S.H. Rodger, S.H. Edwards, “How to Use Algorithm Visualizations in Your Class,” Workshop presentation, *42nd ACM Technical Symposium on Computer Science Education (SIGCSE'11)*, Dallas TX, March 9, 2011.
2. C.A. Shaffer, Efficient Algorithms for Quadtree-Based Geographic Informations Systems in *Quadtrees and Octree Methods*, SIGGRAPH '87 course notes No. 18, Anaheim, Jul 1987.
3. C.A. Shaffer, H. Samet, R.E. Webber, R.C. Nelson, Y-G. Huang, and A. Rosenfeld, An Implementation for a Geographic Information System Based on Quadtrees in *Quadtrees, Octrees and Related Hierarchical Data Structures*, SIGGRAPH '85 course notes No. 25, San Francisco, Jul 1985.

#### Edited Collections:

1. G.A. Wainer, C.A. Shaffer, R.M. McGraw, M.J. Chinni, *Proceedings of the 2009 Spring Simulation Multiconference, SpringSim 2009*, San Diego, California, USA, March 22-27, 2009 SCS/ACM 2009.
2. C.A. Shaffer, Dissertation Abstracts in Computer Graphics, *Computer Graphics 26*, 1(January 1992), 76–96.
3. C.A. Shaffer, Dissertation Abstracts in Computer Graphics, *Computer Graphics 27*, 2(September 1993), 86–98.

#### Software manuals:

1. D.T. Hines, J.B. Raley, J.M.A. Begole, C.A. Klipsch and C.A. Shaffer, *The GeoSim Interface Library (GIL): Programmer's Manual* Version 1.01, Computer Science TR 94-31, Virginia Tech, 1994.

2. J. Yang, C.A. Shaffer and L.S. Heath, *The Swan User's Manual* Version 1.0, Computer Science TR 95-14, Virginia Tech, 1995.

Unrefereed papers and reports:

1. M. Abrams, D. Allison, D. Kafura, C. Ribbens, M.B. Rosson, C. Shaffer, and L. Watson, *PSE Research at Virginia Tech: An Overview*, Computer Science TR 98-21, Virginia Tech, Aug 1998.
2. J.B. Begole and C.A. Shaffer, *Flexible Collaboration Transparency*, Computer Science TR 98-11, Virginia Tech, Apr 1998.
3. J.B. Begole and C.A. Shaffer, *Internet Based Real-Time Multiuser Simulation: Ppong*, Computer Science TR 97-01, Virginia Tech, Feb 1997.
4. J.B. Begole, C.A. Struble, and C.A. Shaffer, *Collaboration Transparency in Java through Event Broadcasting*, Computer Science TR 97-02, Virginia Tech, Feb 1997.
5. J.M.A. Begole, C.A. Shaffer and M. Lattanzi, *The Project GeoSim Graphical User Interface*, *Proceedings of the 23rd Virginia Computer User's Conference*, Oct 1993, 17–28.
6. T.L. Ryan and C.A. Shaffer, *Device Independent Perspective Volume Rendering Using Octrees*, Computer Science TR 92-05, Virginia Tech, Feb 1992.
7. C.A. Shaffer, L.W. Carstensen, Jr., V.F. Miranda, S.K. Kriss, R.W. Morrill, and E.A. Fox, **Project GeoSim: The First Two Modules**, Computer Science TR 91-26, Virginia Tech, Oct 1991.
8. C.A. Shaffer and D.B. Boldery, *The Elevation Pyramid*, Computer Science TR 90-29, Virginia Tech, 1990.
9. G.B. Terrell and C.A. Shaffer, *A "C" Programming Language Software Tutor*, *Proceedings of the 19th Virginia Computer User's Conference*, Blacksburg VA, Sep 1989, 60–68.
10. D.B. Boldery and C.A. Shaffer, *Spatial Data Generation through Interpolation*, *Proceedings of the 19th Virginia Computer User's Conference*, Blacksburg VA, Sep 1989, 69–77.
11. G.M. Herb and C.A. Shaffer, *A Real Time Robot Collision Avoidance Safety System*, *Proceedings of the 19th Virginia Computer User's Conference*, Blacksburg VA, Sep 1989, 84–93.
12. C.A. Shaffer and H. Samet, *An in-Core Hierarchical Data Structure Organization for a Geographic Database*, Computer Science TR-1886, University of Maryland, Jul 1987.
13. C.A. Shaffer, *Application of Alternative Quadtree Representations*, Ph.D. Dissertation, Computer Science Department, University of Maryland, College Park MD, 1986 (also Computer Science TR-1672, University of Maryland, Jun 1986).
14. H. Samet, A. Rosenfeld, C. A. Shaffer, R. C. Nelson, Y.-G. Huang, K. Fujimura, *Application of Hierarchical Data Structures to Geographic Information Systems: Phase IV* Computer Science TR-1578, University of Maryland, Dec 1985
15. H. Samet, A. Rosenfeld, C.A. Shaffer, R.C. Nelson, and Y-G. Huang, *Application of Hierarchical Data Structures to Geographic Information Systems: Phase III*, Computer Science TR-1457, University of Maryland, Nov 1984.
16. A. Rosenfeld, H. Samet, C.A. Shaffer, and R.E. Webber, *Application of Hierarchical Data Structures to Geographic Information Systems: Phase II*, Computer Science TR-1327, University of Maryland, Sep 1983.

17. C.A. Shaffer, QED: A Quadtree Editor, Masters Scholarly Paper, CSC-400, Computer Science Department, University of Maryland, 1982.
18. A. Rosenfeld, H. Samet, C.A. Shaffer, and R.E. Webber, Application of Hierarchical Data Structures to Geographic Information Systems, Computer Science TR-1197, University of Maryland, Jun, 1982.

Professional activities, academic awards, non-local presentations, meetings, and workshops:

May 30, 2011 – C.A. Shaffer, “How Can We Teach Problem Solving?,” keynote presentation to *Finnish Computer Science Days*, Aalto University, Finland.

May 25, 2011 – C.A. Shaffer, “How Can We Teach Problem Solving?,” keynote presentation to *Second Nordic Network of Engineering Education Research Seminar*, Mustio Manor, Finland.

March, 2011 – C.A. Shaffer, T.L. Naps, S.H. Rodger, and S.H. Edwards, “How to Use Algorithm Visualizations in Your Class,” Workshop presentation, *42nd ACM Technical Symposium on Computer Science Education (SIGCSE 2011)*.

March, 2009 – C.A. Shaffer, T. Naps, and S.H. Edwards, “Building a Community for Algorithm Visualization” Birds-of-a-Feather session, *40th ACM Technical Symposium on Computer Science Education (SIGCSE 2009)*.

March, 2008 – C.A. Shaffer, T. Naps, and S.H. Edwards, “Algorithm Visualization” Birds-of-a-Feather session, *39th ACM Technical Symposium on Computer Science Education (SIGCSE 2008)*.

June, 2006 – “Modeling the Cell Cycle with JigCell and DARPA’s BioSPICE Software,” presented at *Pathway Databases and Modeling Tools*, Princeton University, <http://www.cs.princeton.edu/picasso/prime/pdmt.php>.

June, 2005 – L. Thomas, E. Thomas, L. Mili, and C.A. Shaffer, “Locating Exterior Defects on Hardwood Logs Using High Resolution Laser Scanning,” presented at the *59th International Forest Products Society Convention*, Quebec City, Canada (presented by L. Thomas).

May, 2005 – “Beyond SBML,” presented at the 3rd Annual Systems Biology Markup Language Hackathon, Tokyo, Japan.

May, 2005 – DARPA BioSPICE PI Meeting, Washington DC.

March, 2005 – C.A. Shaffer, T. Panning, and R. Randhawa, “JigCell,” a presentation and software demonstration at the *3rd Symposium on Computational Cell Biology*, Lenox Massachusetts.

October, 2004 – DARPA BioSPICE PI Meeting, Washington DC.

May, 2003 – DARPA BioSPICE PI Meeting, Ft. Lauderdale, FL.

April 2003 – “The DARPA BioSPICE Project,” Virginia Biotechnology Institute Seminar Series, Blacksburg VA.

February, 2003 – DARPA BioSPICE PI Workshop, College Park, MD.

April, 2003 – “User Interface Paradigms for Describing Pathway Models,” presented at Formal Languages for Biological Processes, Cold Spring Harbor Lab.

November 2002 – DARPA BioSPICE PI Workshop, San Diego, CA.

September 2002 – DARPA BioSPICE Model Definition Workshop, Boston, MA.

August, 2002 – DARPA BioSPICE PI sub-group coordination meeting, Philadelphia, PA.

May, 2002 – DARPA BioSPICE PI Workshop, Washington, DC.

April, 2002 – Session chair and presenter, 22nd Annual Seminar of Cancer Researchers in Virginia, “BioSPICE and Problem-Solving Environments for Systems Biology,” Blacksburg, VA.

November 2001 – DARPA BioSPICE PI Workshop, Monterey, CA.

January, 2001 – Session chair, Integrated Decision-Making for Watershed Management Symposium: Processes and Tools, Chevy Chase, MD.

May, 1998 – Participant, NSF Invitational Workshop on Distributed Information, Computation, and Process Management for Scientific and Engineering Environments, presented position paper “Collaborative Problem Solving Environments.”

September, 1995 – Participant, NSF CISE/EHR Workshop on a Computer Science Research Agenda for Educational Technology.

1994 *Journal of Geography* award for best article related to teaching in a University or College.

September, 1994 – Undergraduate Computational Science Award, AMES Laboratory for **Project GeoSim**.

July, 1991 – Lecture: A real-time robot collision avoidance safety system, University of Iceland, Reykjavik, Iceland.

August, 1990 – Workshop participant: “Data Structures and Access Software for Scientific Visualization” at SIGGRAPH’90, Dallas TX, August 6–7, 1990.

September, 1989 – Invited lecture: Indexing methods for area of interest retrieval from world scale GIS, *International Colloquium on Digital Maps in Geosciences*, Wuerzburg, West Germany, September 1989.

July, 1987 – Course Speaker, SIGGRAPH ’87: *Quadtrees and Octree Methods*

December, 1986 – Invited lecture: A Comparison of Vectors, Rasters, and Quadtrees for Representing Geographic Data, *International Colloquium on the Construction and Display of Geoscientific Maps Derived from Databases*, Dinkelsbuehl, West Germany, December 1986.

October, 1986 – Invited lecture: Hierarchical Rectangle Representations, CNR, Genova, Italy.

July, 1985 – Course Speaker, SIGGRAPH ’85: *Quadtrees, Octrees and Related Hierarchical Data Structures*

March, 1985 – Invited lecture: A Quadtree-based Geographic Information System, IIMAS-UNAM, Mexico City

#### Research Grants:

2010-2014 J.J. Tyson, W. Baumann, J. Peccoud, S. Hoops, Y. Cao, and C.A. Shaffer, “Stochastic Models of Cell Cycle Regulation in Eukaryotes,” National Institutes of Health, 2-R01-GM078989-05, \$1,986,688.

2010-2011 C.A. Shaffer and S.H. Edwards, “The AlgoViz Portal: Lowering the Barriers for Entry into an Online Educational Community” National Science Foundation NSDL program, DUE-0937863, \$149,999.

2009–2010 C.A. Shaffer and S.H. Edwards, “Building a Community and Establishing Best Practices in Algorithm Visualization through the AlgoViz Wiki,” National Science Foundation CCLI program, DUE-0836940, \$149,206.

2009–2010 C.A. Shaffer and S.H. Edwards, “AlgoViz Project Steering Committee” National Science Foundation, DUE-0946644, \$8,500.

2009 C.A. Shaffer, “TCNP Driving Biological Problem: Year 4 Renewal: Using Composition to Integrate a Cell Cycle Model with Morphological Checkpoints,” University of Connecticut, \$20,925.

2008–2009 C.A. Shaffer and S.H. Edwards, “Steering Committee Workshop to Build a Community for Algorithm Visualization” National Science Foundation, DUE-0839837, \$8,500.

2008 C.A. Shaffer, “TCNP Driving Biological Problems: Using Composition to Integrate a Cell Cycle Model with Morphological Checkpoints,” University of Connecticut, \$17,738.

2006–2010 J.J. Tyson, W.T. Baumann, Y. Cao, M.R. Paul, A. Sandu, C.A. Shaffer, and L.T. Watson, “Stochastic Models of Cell Cycle Regulation in Eukaryotes,” National Institute of General Medical Sciences, 1-R01-GM078989-01, \$1,437,504.

2006–2007 C.A. Shaffer, “Refinement and Analysis of Log Surface Defect Detection Methods Using High-Resolution Laser Scanning,” Wood Education and Resource Center, USDA Forest Service, \$50,000.

2001–2006 J.J. Tyson, B. Novak, F.R. Cross, M.D. Mendenhall, J.C. Sible, K.C. Chen, C.A. Shaffer, L.T. Watson, and N. Ramakrishnan, “The Eukaryotic Cell Cycle as a Test Case for Modeling Cellular Regulation in a Collaborative PSE,” Defense Advanced Research Projects Agency: \$2,442,399.

2001–2003 J.J. Tyson, L.T. Watson, J. Sible, K. Chen, C.A. Shaffer, N. Ramakrishnan, and P. Mendes, “Problem Solving Environment for Modeling the Cell Cycle,” National Institute of General Medical Sciences, R01-GM64339-01, \$211,038.

2001–2002 J.J. Tyson, C.A. Shaffer, J.C. Sible, N. Ramakrishnan, L.T. Watson, and D.G. Kafura, “Biocomplexity Incubation Activity: A Collaborative PSE for Computational Modeling of Eukaryotic Cell Cycle Controls,” NSF: \$99,965, MCB-0083315.

2001–2005 C.A. Shaffer and R. Ehrich, “Detection of Surface Defects on Barked Hardwood Stems and Logs,” USDA Forest Service, \$54,378.

2000–2001 C.A. Shaffer, “Virginia Tech Computer Science Department Support for ADOPTTECH STTR Phase II Proposal,” ADOPTTECH Corp: \$53,374.

1999–2002 T.S. Rappaport, C.A. Shaffer, W. Tranter, L.T. Watson, N. Ramakrishnan, and D.G. Kafura, “A Collaborative Problem Solving Environment for Modeling of Broadband Wireless Communications Systems”: NSF, \$1,000,000.

1999 D. Bosch, L.T. Watson, N. Ramakrishnan, C.A. Shaffer, R. Dymond, D. Kibler, and D. Orth, “Toward Leadership in Problem Solving Environments for Ecosystem Assessment, Management and Policy”: APIRES/Virginia Tech, \$48,600.

1997 F.A. Kamke, L.T. Watson, C.J. Ribbens, D.C.S. Allison, M. Abrams, D. Kafura, M.B. Rosson, and C.A. Shaffer, “Towards Leadership in Problem Solving Environments for Science, Engineering, and Manufacturing”: ASPIRES/Virginia Tech, \$20,000.

1996–1999 C.A. Shaffer, J.B. Campbell, J.M. Carroll, N. Hauenstein, and B. Hertel, “Integrating Statistics and Models across the Social Sciences Curricula”: FIPSE, \$277,801, P116A50674.

1996–1998 J.M. Carroll, C.A. Shaffer, M.B. Rosson and J. Burton, “Leveraging Networks for Collaborative Education in the Blacksburg Electronic Village”: NSF NIE program, \$1,117,128. RED-9554206

1996 R.D. Kriz, M. Abrams, Y.J. Beliveau, D.R. Bevan, J.M. Carroll, W.A. Curtin, R.W. Ehrich, D. Farkas, D.S. Hix, B.M. Kleiner, C.A. Shaffer, R.C. Williges, “Acquisition of a CAVE(tm)\*: Breaking Research and Educational Barriers by Developing and Evaluating 3D Visualization Tools with CAVE\* Technology”: NSF-ARI Equipment Acquisition Grant, \$890,000.

1995–1996 C.A. Shaffer and N.D. Barnette, “The GeoSim Interface Library for Introductory Programming Courses”: NSF Course and Curriculum Development program, \$19,768.DUE-9455403.

1993–1995 E.A. Fox, J.A.N. Lee, H. Rex Hartson, C.A. Shaffer and N.D. Barnette, “Interactive Learning with a Digital Library in Computer Science”: NSF Educational Infrastructure grant, \$449,088, EIA-9312611.

1992–1995 C.A. Shaffer, L.W. Carstensen, Jr., R.W. Morrill and E.A. Fox, “**GeoSim**: A GIS-Based Simulation Laboratory for Introductory Geography”: NSF, \$107,940, USE-9155943; FIPSE, \$149,571, P116B20130.

1992 A.L. Abbot, C.A. Shaffer and J.W. Roach, “Real-Time Planning and Control for Cooperative Manipulators in the Virginia Tech AI/Robotics Laboratory”: NSF equipment grant, \$36,000.

1990 C.A. Shaffer, NASA/ASEE Summer Faculty Fellowship Program participant at Goddard SFC, Greenbelt MD, \$10,000.

1989 C.A. Shaffer, SIGGRAPH Conference Grant for Educators, estimated value: \$1,000.

1989–1990 C.A. Shaffer, “Hierarchical Data Structures for Robot Collision Avoidance”: NASA Goddard, \$27,500.

1989–1990 C.A. Shaffer, L.W. Carstensen, Jr., J.B. Campbell and E.A. Fox, “A Prototype Geographic Information System for Personal Workstations”: General Dynamics \$43,000; Virginia Center for Innovative Technology \$33,890.

1988–1989 C.A. Shaffer, Matching Grants award from Virginia Tech: \$1000.

1987–1989 C.A. Shaffer, Small Grants Pilot Project award from the College of Arts and Sciences, Virginia Tech: \$2400.

#### Major research projects:

2011-present: Principle Investigator for the OpenDSA project to develop a create-commons, open-source active eTextbook for algorithms and data structures courses. See <http://algoviz.org/OpenDSA>.

2006–present: Principle Investigator for the AlgoViz project to develop a community of users and developers of algorithm visualization in computer science education. This includes development of the AlgoViz Portal (<http://algoviz.org>).

2004–2006: Principal Investigator for an investigation of log surface defect detection methods using high-resolution laser scanning.

2001–present: Co-Principal Investigator for the JigCell project, a problem-solving environment for biochemical pathway analysis. With support from DARPA, NSF, and NIH, this is a major multidisciplinary project involving faculty from Biology and Computer Science. My major role is as system architect, primarily for developing user interfaces and visualizations for the system, and overseeing general software development and system integration.

1999–2004: Co-Principal Investigator for the NSF-supported “A Collaborative Problem Solving Environment for Modeling of Broadband Wireless Communications Systems.”

1999–2001: Co-Principal Investigator for Virginia Tech ASPIRES project to develop a Problem Solving Environment for watershed assessment.

1996–1999: Principal Investigator for FIPSE-supported “Integrating Statistics and Models across the Social Sciences Curricula.” This project integrates statistical processing with large databases and tutorials to teach Social Sciences students basic statistics and data visualization.

1996–1998: Co-Principal Investigator for NSF-supported “Leveraging Networks for Collaborative Education in the Blacksburg Electronic Village.” University researchers are working with the local county K12 school system to build a “virtual school” over the internet. Stressing collaborative, interactive courseware and a shared environment, our goal is to allow students from both rural and suburban schools to work together.

1990–1996: Project director for Project GeoSim, a series of software modules that apply geographic information systems and simulation to introductory geography education. This software simulates of various geographic and economic processes, such as migration and population dynamics.

1989–90: Principal Investigator for projects aimed at applying sophisticated GIS techniques to personal workstations. Primary contributions of this project include the elevation pyramid, a method for compressing DEMs by up to 5:1 with little or no loss of accuracy. Supported by General Dynamics Electronics Division and the Virginia Center for Innovative Technology.

1989–1990: Principal Investigator for a real-time robot arm collision avoidance safety system. Supported by NASA/Goddard SFC.

1986–1987: Initial designer for the Combat Information Processor mapping system for Harry Diamond U.S. Army Laboratory.

1986: Designed and implemented the low-level mapping system used on the NBS (now NIST) Autonomous Underwater Vehicle project.

1980–1987: Designer and chief implementor for the **QUILT** project, the first Geographic Information System based on advanced hierarchical data structures.

#### PhD Students Graduated:

Ranjit Randhawa, *Composition and Aggregation in Modeling Macromolecular Regulatory Networks*, April, 2008.

Liya Thomas, *Automated Detection of Surface Defects on Barked Hardwood Logs and Stems Using 3-D Laser Scanned Data*, September, 2006.

Nicholas A. Allen, *Computational Software for Building Biochemical Reaction Network Models with Differential Equations*, November, 2005.

James M.A. Begole, *Flexible Collaboration Transparency: Supporting Worker Independence in Replicated Application-Sharing Systems*, December, 1998.

#### Courses taught:

CS1206 Operating Systems Tools II (freshman CS majors – created new course).

CS1705 Introduction to Programming (freshman CS major first course – including partial revision of course material for semester system; as part of undergraduate curriculum committee, instituted major revision of first year major’s course content).

CS2104 Problem Solving in Computer Science (undergraduate introductory course in problem solving; created and piloted course).

CS3114 (previously, CS2606, CS2604, and CS3301) Data Structures (undergraduate – complete revision of course material for semester system; wrote textbook; most faculty at Virginia Tech teaching this course since 1988 have used my textbook, course notes, and overheads).

CS4104 Data and Algorithm Analysis (undergraduate – developed new course notes).

CS4204 Introductory Computer Graphics (undergraduate – developed new course notes).

CS4944 Advanced UNIX Topics (undergraduate seminar – developed course).

CS5014 Research Methods in Computer Science (graduate – developed new course notes).

CS5034 Models of Computation (graduate – developed course).

CS5114 Theory of Algorithms (graduate – complete revision of course material).

CS5362 Spatial Data Structures and Algorithms (graduate seminar – developed course).

CS6104 Advanced Computer Graphics (graduate seminar – developed course).

CS6604 Advanced Computer Graphics and Computational Geometry (graduate seminar – codeveloped course).

CS6604 Algorithm Visualization (graduate seminar – developed course).

CS6704 Design Patterns and Component Frameworks (graduate seminar – developed course).

#### Educational writings:

“Minimalist UNIX” – an introductory guide to UNIX, used in our introductory courses.

“Your Guide to GNU” – an introductory guide to EMACS and GNU software.

“Elements of Programming Style” – departmental programming style guidelines, used in all programming classes.

“Keeping Your Password Safe: A User’s Introduction to Computer Security” – departmental security guidelines used in all introductory classes, including lecture notes for one hour lecture one basic computer security issues.

#### Professional service:

2008-present: Associate editor, *Simulation: Transactions of the Society for Modeling and Simulation International*

2007-present: Associate Editor, *International Journal of Computational Science*.

2008-present: Member of Editorial Board, *International Journal of Future Generation Communication and Networking*.

2005–present: Member, Editorial Review Board, AACE Journal of Interactive Learning Research (JILR).

2006–present: Member, Editorial Review Board, AACE Journal of Computers in Mathematics and Science Teaching (JCMST).

2005–present: Member, Virginia State University’s Computer Science Advisory Board.

March 2009: Vice General Chair, 2009 Spring Simulation Multiconference (SpringSim’09), San Diego, CA.

April 2008: Program Chair, 2008 High Performance Computing & Simulation Symposium (HPCS), Ottawa, Canada.

March 2007: Program Co-chair for the 2007 Symposium on High Performance Computing (HPC 2007), Norfolk VA.

2010, 2009, 2007, 2005, 2004, 1997, 1994, 1993: Member, NSF program review panels.

2002, 2001, 1999, 1998, 1994: Reviewer, FIPSE Comprehensive Program.

1996, 1997: Judge for ThinkQuest student WWW site competition.

1991–1995: Coordinator, ACM SIGGRAPH Computer Graphics Thesis Abstracts Project.

1992: Member, Department of Energy panel for reviewing DOE National Labs projects in Robotics for nuclear waste cleanup.

1989: Scientist partner for the Bell Atlantic-AAAS Institute for Middle School Science and Technology Teachers

Referee/Reviewer (within past 5 years): *4th International Joint Conference on Computational Sciences and Optimization (CSO 2011)*, *Winter Simulation Conference 2010*, *SIGCSE 2011*, *AACE Journal of Computers in Mathematics and Science Teaching (JCMST)*, *AACE Journal of Interactive Learning Research (JILR)*, *ACM Transactions on Visualization and Computer Graphics*, *ACM Transactions on Computing Education*, *BMC Bioinformatics*, *Routledge Publishing*, *Journal of Computational Chemistry*, *IEEE Transactions on Learning Technologies*, *2nd International Conference on Future Generation Communication and Networking (FGCN 2008)*, *2009 International Joint Conference on Computational Sciences and Optimization (CSO 2009)*, *Journal of Theoretical Biology*, *IET Systems Biology*, *SIGCSE 2008: 39th Technical Symposium on Computer Science Education*, *2007 Conference on Future Generation Communication and Networking (FGCN 2007)*, *Winter Simulation Conference 2006*, *BMC Systems Biology*, *Robotica*, *Simulation Journal*,

Professional Societies: Senior Member of IEEE, IEEE Computer Society. Senior Member of ACM, SIGCSE. Member of ASEE.

#### University and departmental service

2010 to present – Chair, Department of Computer Science Personnel Committee

2008 to 2010 – Member, Department of Computer Science Personnel Committee

2007 to 2010 – Member, University Commission on Graduate Studies and Policies (Vice Chairman, 2007–2008)

2008 to 2009 – Member, Degree Requirements, Standards, Criteria and Academic Policies Committee (DRSCAP)

2006 to 2009 – Member, Department of Computer Science Undergraduate Program Committee  
2007 to 2008 – Chairman, University Graduate Curriculum Committee  
2005 to 2007 – Member, University Faculty Leadership Development Academy Committee  
2003 to 2006 – Representative, College of Engineering Executive Committee  
1998 to 2006 – Chairman, Department of Computer Science Graduate Program Committee  
2004 to 2006 – Member, College of Engineering Graduate Curriculum Committee  
1997 to 2000 – University Faculty Senate (Secretary/Treasurer 1998 to 1999)  
1997 to 2000 – University Transportation and Parking Committee (Chairman 1997–1998)  
1996 to 1998 – Member of four Departmental Faculty Search Committees  
1997 to 1998 – Member, Department of Computer Science Graduate Admissions Committee  
1996 Member, Departmental M.S. Orals Defense Committee  
1995 to 1996 – Chairman, Departmental M.S. Orals Defense Committee  
1992 to 1995; 1997 to 1998 – Member, Department of Computer Science Graduate Program Committee  
1992 to 1993 – Chairman, Departmental Ph.D. Qualifier Committee  
1990 to 1992; 2006 to present – Member, Department of Computer Science Undergraduate Program Committee  
1992 – Chairman, Computer Science Department Security Taskforce  
1989 to 1990 – Member, Departmental Undergraduate PC Taskforce  
1988 to 1990 – Cosponsor of graduate student seminar in computer graphics and computational geometry.  
1987 to 1990 – Member, Departmental Computer Resources Committee  
1987 – Member, Departmental Undergraduate PC Selection Committee

Current research interests:

Computational Biology and Bioinformatics, Problem Solving Environments, Digital Education, Algorithm Visualization, Visualization, Hierarchical Data Structures, Geographic Information Systems, Computer Graphics, Algorithm Design and Analysis, Data Structures.