

# William Marvin Coughran, Jr.<sup>1</sup>

## Business

Sequoia Capital  
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## Residence

Los Altos Hills, California  
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<http://www.coughran.net> (*Web*)

## Interests

Company development. Distributed systems, including Web and data mining services, embedded software, networking, and security. Computational science and engineering. Technology policy and management.

## Education

B. S. (with honors) & M. S., Mathematics, California Institute of Technology, 1975.  
M. S., Computer Science, Stanford University, 1977.  
Ph. D., Computer Science, Stanford University, 1980.

## Experience

CALIFORNIA STATE UNIVERSITY Fresno, California  
1969–1972

Application and Systems Programmer, Computer Center. *Wrote system to maintain and print student transcript data.*

CALIFORNIA STATE UNIVERSITY Los Angeles, California  
1973–1974

Programmer/Analyst, Office of Personnel Services. *Designed and wrote an information system to maintain the employee database.*

STANFORD UNIVERSITY Palo Alto, California  
1975–1980

Research and Teaching Assistant, Department of Computer Science. Numerical Analysis Consultant, Stanford Linear Accelerator Center. *Research on mathematical software, scientific programming environments, and numerical analysis.*

AT&T BELL LABORATORIES Murray Hill, New Jersey  
1980–1993

Member of Technical Staff, Computing Mathematics Research Department. *Research on algorithms for simulation and visualization; computational science and engineering.*

DUKE UNIVERSITY Durham, North Carolina  
1984–1991

Adjunct Associate Professor of Computer Science. *Research and student supervision.*

STANFORD UNIVERSITY Palo Alto, California  
Spring 1991

Industrial Lectureship, Department of Computer Science. *Taught graduate course on algorithms for semiconductor simulation; research and student supervision.*

AT&T BELL LABORATORIES Murray Hill, New Jersey  
1993–1996

Head, Scientific Computing Research Department (until 1994, Computing Mathematics Research Department). *Personal research. Responsible for research program in scientific computing, aspects of network security and services, and computing support. Responsible for interfacing with AT&T's businesses.*

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<sup>1</sup>Curriculum vitae last updated on December 28, 2018.

LUCENT TECHNOLOGIES  
1997–1998

Murray Hill, New Jersey

Internet Software Vice President and Chief Technical Officer, Communications Software Group. *Responsible for carrier and major enterprise TCP/IP security appliances and electronic commerce businesses and strategy.*

DUKE UNIVERSITY  
1991–1999

Durham, North Carolina

Adjunct Professor of Computer Science. *Research and student supervision.*

BELL LABS, LUCENT TECHNOLOGIES  
1996–1999

Murray Hill, New Jersey

Computing Sciences Research Center Vice President. *Personal research. Responsible for a broad research and prototype technology program in computer science including wireless and fiber optic modeling, embedded software systems, and next-generation access platforms.*

BELL LABS, LUCENT TECHNOLOGIES  
1998–2000

Palo Alto, California

Bell Labs Research Silicon Valley Senior Vice President. *Personal research. Responsible for creating an R&D organization focused on new business creation including converged network softswitch & access systems as well as quality-of-service and network-monitoring businesses.*

STANFORD UNIVERSITY  
1998–2001

Palo Alto, California

Consulting Professor of Computer Science. *Computational science and engineering; faculty search committee.*

ENTRISPHERE  
2000–2002

Santa Clara, California

CEO, VP of Engineering, Board Director & Founder. *Conceived converged accessed system concept and developed fundable business case. Secured Series A and B venture-capital funding; the B funding round (in April 2002) was at an increased valuation and was over subscribed. Recruited and organized initial team, growing it to 80+. Delivered initial product prototypes on a budget of less than \$12M. With board members, recruited new CEO.*

ENTRISPHERE  
2002

Santa Clara, California

COO, VP of Engineering, Director & Founder. *Delivered product to first trials. Grew team to 95.*

GOOGLE  
2003–2004

Mountain View, California

Engineering Director. *Responsible for broad systems infrastructure program, consisting of approximately 60 staff.*

GOOGLE  
2004

Mountain View, California

Senior Engineering Director. *Responsible for infrastructure engineering, consisting of approximately 75 staff.*

GOOGLE  
2004–2007

Mountain View, California

VP, Engineering. *Responsible for systems infrastructure engineering including security,*

*consisting of more than 300 staff. Member of Google's Executive Management Group starting in 2005.*

GOOGLE Mountain View, California  
2007–2011

Senior VP, Engineering. *Responsible for engineering of Google's search, client, and video products, and systems infrastructure, at one point with more than 7,000 staff. Member of Google's Operating Committee (formerly the Executive Management Group).*

GOOGLE Mountain View, California  
2011

Senior VP, Research and Systems Infrastructure. *Responsible for engineering of Google's research and systems infrastructure. Member of Larry Page's management team (formerly the Operating Committee).*

GOOGLE Mountain View, California  
2011–2015

Corporate Advisor.

COUGHRAN CONSULTING Los Altos Hills, California  
2003–present

Principal. *Advising and evaluating start-up firms & research institutions.*

SEQUOIA CAPITAL Menlo Park, California  
2011–present

Partner and founders' coach. *Helping founders build engineering-centric product organizations.*

#### Directorships Boards of Directors / Trustees:

- Lucent Inferno venture (1997–1999) — embedded device operating system — acquired by Vita Nuova.
- Netcalibrate, Inc. (1999–2001) — Network quality-of-servicing and provisioning system.
- Entrisphere, Inc. (2000–2002), acquired by Ericsson — Optical and wired access services equipment.
- nSolutions, Inc. (2000–2010) — Network equipment configuration systems.
- Clearwell Systems, Inc. (2005–2011), acquired by Symantec — Intelligent e-discovery systems.
- Metaswitch Networks, Inc. (2011–2014) — Carrier systems and software.
- FireEye, Inc. (2012–2017) — Next generation security threat protection.
- Metanautix, Inc. (2012–2015) — Big data analytics — acquired by Microsoft.
- Altiscale, Inc. (2013–2016) — Apache Hadoop as a service — acquired by SAP.
- Wavefront, Inc. (2014–2017) — Metrics as a service — acquired by VMware.
- Institute for Pure and Applied Mathematics, UCLA (2013–2017) — NSF center.
- TheatreWorks (2012–present) — Non-profit theater company based in Silicon Valley.
- Blue Danube Systems, Inc. (2013–present) — Relieving cellular spectrum exhaustion.
- San Francisco Opera (2013–present) — Non-profit opera company.
- Luminate Wireless, Inc. (2013–2017) — Wireless infrastructure.
- Cohesity, Inc. (2013–present) — Hyper-converged secondary storage.

- Barefoot Networks, Inc. (2014–present) — Programmable, high-performance networking systems.
- Docker, Inc. (2014–present) — Build, ship, and run applications; modernizing traditional applications.
- Orbital Insight, Inc. (2014–present) — Extracting information from satellite and aerial images.
- Tensyr, Inc. (2015–present) — High-performance event processing.
- Vector Launch, Inc. (2017–present) — Low-cost, frequent space access.
- Prismo Systems, Inc. (2017–present) — Transform enterprise security operations.
- Quantum Circuits, Inc. (2017–present) — Modular, error-corrected quantum computers.
- Lilt, Inc. (2018–present) — Interactive, adaptive translation platform.

Advisory Boards:

- Hammerhead Systems, Inc. (2002–2006).
- Caltech Information Science and Technology Council (2012–present).
- Dropbox, Inc. (2015–present).

**Society Memberships** Institute of Electrical and Electronics Engineers (IEEE) and the IEEE Computer Society. Sigma Xi. Society for Industrial and Applied Mathematics (SIAM). Tau Beta Pi.

**Professional Activities** Organizing Committee, AMS-SIAM-IMA Summer Seminar on Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation, Minneapolis, April 30–May 7, 1987.

Academic visitor, Eidgenössische Technische Hochschule, Zürich, June 1–5, 1987; June 5–23, 1989.

Editorial Board, SIAM Frontiers in Applied Mathematics book series, 1987–1993.

Organizer, “Numerical Device and Process Modeling for VLSI Systems” mini-symposium, SIAM Annual Meeting, Minneapolis, July 11–15, 1988.

Organizer, “Numerical Simulation for VLSI Systems” mini-symposium, SIAM Annual Meeting, San Diego, July 17–21, 1989.

Co-organizer with E. Grosse, “Programming Environments” mini-symposium, SIAM Annual Meeting, San Diego, July 17–21, 1989.

Editorial Board, ACM Transactions on Mathematical Software, 1990–1992.

Program Committee, National Center for Computational Electronics’ Workshop on Computational Electronics, University of Illinois, Champaign-Urbana, May 21–22, 1990.

SIAM Editorial Advisory Board, 1991–1993.

Co-organizer with C. Gardner, “Higher-Moment Models for Semiconductor Device Simulation” mini-symposium, International Conference on Industrial and Applied Mathematics, Washington, July 8–12, 1991.

Coordinating Committee, Institute for Mathematics and its Applications’ Summer Program on Semiconductors, Minneapolis, July 15–August 9, 1991; editor, proceedings volumes.

Editorial Board, SIAM Journal on Scientific Computing, 1992–1997.

Editorial Board, Numerical Algorithms, 1992–1994.

IEEE Technical Committee on Gigabit Networking, 1992–1994.

Advisory Committee, National Center for Computational Electronics' International Workshop on Computational Electronics, University of Illinois, Champaign-Urbana, May 27–28, 1992.

Technical Program Committee, 4th Workshop on Numerical Process and Device Simulation (NUPAD IV), Seattle, May 31–June 1, 1992.

Assessment Committee, Department of Mathematical Sciences, Clemson University, Clemson, April 15, 1993.

Advisory Committee, International Workshop on Computational Electronics, Leeds, England, August 11–13, 1993.

Semiconductor Research Corporation Contract Mentor, 1993–1996.

Advisory Committee, 3rd International Workshop on Computational Electronics, Portland, Oregon, May 18–20, 1994.

Technical Program Committee, International Workshop on Numerical Modeling of Processes and Devices for Integrated Circuits (NUPAD V), Honolulu, June 5–6, 1994.

AT&T R&D Business Case course, Lincroft, New Jersey, October 13–14, 1994.

Advisory Committee, 4th International Workshop on Computational Electronics, Tempe, October 30–November 2, 1995.

AT&T Advanced Management Program, Basking Ridge, New Jersey, October 29–November 10, 1995.

Steering Committee, IEEE Workshop on Computational Science and Engineering, Purdue University, October 21–22, 1996.

Advisory Committee, 5th International Workshop on Computational Electronics, University of Notre Dame, May 28–30, 1997.

Co-chair, Organizing Committee, SIAM Annual Meeting, Stanford University, July 14–18, 1997.

Visiting Committee, Department of Computer Science, Stanford University, November 20–21, 1997.

SIAM Task Force on Scientific Computing, 1997–2000.

Site review of the PhD program in Computer and Information Science, Syracuse University, May 12–13, 1998.

Advisory Committee, 6th International Workshop on Computational Electronics, Osaka University, October 19–22, 1998.

National Intelligence Officer for Science and Technology's and the Scientific and Technical Intelligence Committee's Science and Technology Expert Partnership panel on potential threats to US national security by 2015, MITRE Corp., March 8–9, 2000.

Advisory Committee, 7th International Workshop on Computational Electronics, Glasgow May 22–25, 2000.

Lucent Technologies Leadership Excellence Accelerated Development Process, New York City, May 22–26 and July 24–28, 2000.

Organizing Committee, SIAM Annual Meeting, Rio Grande, Puerto Rico, July 10–14, 2000.

Organizing Committee, Computing Research Association (CRA) Conference at Snowbird, June 25–27, 2006.

School of Engineering Advisory Board, University of California, Merced, 2008–2012.

Information Science and Technology Council, Caltech, 2012–present.

Program Committee, High Performance Transaction Systems 2013, Asilomar, California, September 22–25, 2013.

Program Committee, High Performance Transaction Systems 2015, Asilomar, California, September 28–30, 2015.

### **Funding Experience**

Industrial Advisor for principal investigator, J. Jerome (Northwestern), National Science Foundation (NSF) grant for semiconductor modeling, 1986.

High Performance Computing and Communications Grand Challenge Applications Groups Pre-proposal Review Panel, NSF, Washington, April 26, 1993.

Postdoctoral Research Associate Program Panel, NSF, February 4, 1994.

Multidisciplinary Challenge (pre-proposal) Panel, Division of Advanced Scientific Computing, NSF, Arlington, April 10, 1995. Multidisciplinary Challenge (full proposal) Panel, Arlington, July 26–28, 1995.

Co-principal investigator with R. Dutton (Stanford) and M. Pinto (Lucent Technologies), ARPA contract BAA 95-18, “Parallel Shared Computational Prototyping Environment,” 1996–1998.

“Research Effectiveness at Lucent Technologies,” Mathematical and Physical Sciences Advisory Committee Meeting, NSF, December 4–5, 1997.

Raised more than \$55,000,000 in venture financing for Entrisphere from Accel Partners, Benchmark Capital, CDP Capital, Cross Point Venture Partners, Duff, Ackerman & Goodrich, El Dorado Ventures, and Ontario Teachers Pension Plan in late 2000 and in 2002.

### **Invited Presentations**

“Supercomputers in VLSI Technology Development and Device Design,” Workshop on Large Scale Device Modeling, Naperville, Illinois, April 18–19, 1985.

“Computational Circuit Simulation,” IFIP Working Group 10.5 Summer School on VLSI Tools and Applications, Beatenberg, Switzerland, July 21–August 2, 1986.

“Computation of Patterns in Convecting Flows,” Meeting on Computation in the Mathematical Sciences, Northwestern University, March 23–27, 1987.

“Iterative Methods in Semiconductor Device Simulation,” Minnesota Supercomputer Institute’s Workshop on Practical Iterative Methods for Large-Scale Computations, Minneapolis, October 23–25, 1988.

“Iterative Methods in Semiconductor Device Simulation,” Mathematisches Forschungsinstitut’s Conference on Simulation of Electrical Circuits, Oberwolfach, Germany, October 31–November 4, 1988.

“Algorithms for Small Semiconductor Device Simulation,” Workshop on Advances in Scientific Computing, Espoo, Finland, August 21–25, 1989.

“Linear and Nonlinear Algorithms for Small Semiconductor Device Simulation,” Workshop on Computational Electronics, University of Illinois, Champaign-Urbana, May 21–22, 1990.

“Physical Models for Hydrodynamic Device Simulations,” “The Hydrodynamic Model for Semiconductor Device Simulation” mini-symposium, SIAM Annual Meeting, Chicago, July 16–20, 1990.

“Techniques for Scientific Visualization,” Joint Statistical Meetings of the American Statistical Association and Biometric Society, Anaheim, August 6–9, 1990.

“The Role of Numerical Algorithms and Visualization in Complex Semiconductor Device Simulation,” “Fast Computational Methods for Device Design” mini-symposium, International Conference on Industrial and Applied Mathematics, Washington, July 8–12, 1991.

“The Role of Numerical Algorithms and Visualization in Complex Semiconductor Device Simulation,” Institute for Mathematics and its Applications’ Summer Program on Semiconductors, Minneapolis, July 15–August 9, 1991.

“The Impact of Algorithms on Semiconductor Device Simulation,” “Industrial Problems” mini-symposium, SIAM Annual Meeting, Los Angeles, July 20–24, 1992.

“Semiconductor Device Simulation as a Scientific Computing Problem,” Special Technological Session on Semiconductors, First European Conference on Numerical Methods in Engineering, Brussels, September 7–11, 1992.

“Parallel Domain Decomposition Applied to Coupled Transport Equations,” Seventh International Conference on Domain Decomposition Methods in Scientific and Engineering Computing, State College, Pennsylvania, October 27–30, 1993.

“Open Issues in Static Grid Construction for Semiconductor Simulation,” Joint NSF/Sematech Workshop on Gridding in VLSI Technology CAD, Mississippi State University, March 8–9, 1994.

“Domain Decomposition Applied to the Drift-Diffusion Equations,” Third International Workshop on Computational Electronics, Portland, Oregon, May 18–20, 1994.

Panelist, “Hiring in Business, Industry, and Government: The Manager’s Perspective,” Third SIAM Forum on Industrial and Applied Mathematics, San Diego, July 23, 1994.

“Domain Decomposition (Cluster Computing) Applied to the Drift-Diffusion Equations,” ICASE/LaRC Industrial Roundtable, Williamsburg, October 3–4, 1994.

Panelist, “Undergraduate and Graduate Education Issues,” Supercomputing ’94, Washington, November 14–18, 1994.

“Technology to Help Understand Complexity,” Industrial Research Institute Roundtable on the Impact of Information Technology on the Technology Function, Washington, April 7, 1995.

“The Role of Modeling at AT&T,” Strategic Planning Workshop on Modeling and Simulation, National Institute of Standards and Technology, Gaithersburg, September 21, 1995.

“Network-based Scientific Computing via Inferno,” The Quality of Numerical Software: Assessment and Enhancement, Oxford, July 8–12, 1996.

“Distributed Algorithms Impact on Process and Device Simulation,” Workshop on Future Topics in Computational Electronics, University of Illinois, Champaign-Urbana, September 30–October 1, 1996.

Panelist, “Industry’s View of CS&E: Requirements and Results,” IEEE Workshop on Computational Science and Engineering, Purdue University, October 21–22, 1996.

“Computing Technologies Impacting Internet and Intranet Services,” Lucent Technologies’ Web Week ’96, New Brunswick, November 18–20, 1996.

“Trends in Networking and Related Software Solution Technologies,” Lucent Technologies’ 8th Annual Software Symposium, Holmdel, October 27–28, 1998.

“Issues Confronting Industrial Research Labs,” joint Computer Science and Telecommunications Board and Bay Area Research Directors meeting, January 24, 2000.

“Paths to Market: A Bell Labs Perspective,” IBM Almaden Research Center, February 10, 2000.

“Computer Science Research Trends and Paths to Market,” University of California at Davis, May 19, 2000.

“Big data and how it can change your business,” Mu Sigma Conference, Half Moon Bay, February 27–28, 2012.

“Computer Science and Applied Math: Big Data,” The International Conference on the Frontier of Computational and Applied Mathematics: Tony Chan’s 60th Birthday Conference, Institute for Pure & Applied Mathematics, University of California at Los Angeles, June 8–10, 2012.

Panelist, “Distinguished Alumni: Since We’ve Been Gone,” Stanford Computer Science 50th Anniversary: In Service to the World, Stanford University, April 28–2015

“A Darkening Web?,” 24th International World Wide Web Conference Entrepreneurs Track, Florence, Italy, May 19–20, 2015.

## Research Highlights

- *Scientific programming environments* — Language support for scientific data structures; structure editor; program transformation systems; self-documenting file formats. Publications [2, 21, 45, 6, 7].
- *Mathematical software libraries* — Classification schemes; name conflict resolution; selection schema; NETLIB editor [3, 1, 2].
- *Finite difference methods for hyperbolic partial differential equations* — Algorithms for stability verification for noncharacteristic boundary conditions in systems [8, 3, 8].
- *Amplitude equation models for Rayleigh-Bénard convection* — Specialized nonlinear and transient algorithms combined with large-scale biharmonic solvers [4, 6, 7, 16, 9].
- *Circuit simulation* — Problem formulation; approximation of transistor and macromodel characteristics from device simulation and measurement; linear, nonlinear, and transient algorithms; continuation methods [5, 11, 14, 17, 20, 26, 39, 5].
- *Semiconductor process and device simulation* — Model formulation; spatial and temporal discretization; linear and nonlinear algorithms; continuation and grid-adaption techniques; characteristic extraction [9, 10, 12, 13, 15, 17–19, 23–25, 28–31, 34–42, 46, 10, 13, 17].
- *Algorithms for partial differential equations* — Preconditioners for elliptic systems; domain decomposition on workstation clusters; generic one-dimensional codes; specialized iterative schemes for bordered systems; upwinding schemes [22, 43, 48, 15, 16].
- *Scientific animation* — Specialized visualization techniques; data-dependent sound [27, 32, 33, 10–12].
- *Raman amplifiers and lasers* — Model formulation; algorithms for nearly singular boundary-value problems [44].

- *Virtual network protocol and management interfaces* — Distributed computer system architecture to provide highly scalable access network node, fundamental to the Entri-sphere product offering.

### Selected Software

- T scientific programming language (with E. Grosse).
- Discrete hyperbolic initial-boundary-value problem stability analyzer.
- Grove/pine tree editor and programming language (with E. Grosse).
- Prototype CAzM circuit analyzer (with E. Grosse and D. Rose).
- Amplitude/vorticity codes for various geometries and methods (with H. Greenside).
- One-dimensional transient semiconductor device simulator.
- Modular one-dimensional transient PDE code (with N. Schryer).
- Krylov-subspace iterative package (with R. K. Smith).
- Scatter and tensor approximation tools (with E. Grosse).
- Scientific video primitives (with E. Grosse).
- Domain decomposition and generic PDE toolbox (with E. Grosse).

### Publications

1. W. M. Coughran, Jr., J. Rose, T. Shibuya, and V. McKoy. Equations-of-motion method: Potential energy curves for  $N_2$ , CO,  $C_2H_4$ . *J. Chemical Physics*, 58:2699–2709, 1973.
2. W. M. Coughran, Jr. and E. H. Grosse. New languages for numerical software. *SIGNAL Newsletter*, 14:73–75, 1979.
3. T. F. Chan, W. M. Coughran, Jr., E. H. Grosse, and M. T. Heath. A numerical library and its support. *ACM Trans. Mathematical Software*, 6:135–145, 1980.
4. H. S. Greenside, W. M. Coughran, Jr., and N. L. Schryer. Nonlinear pattern formation near the onset of Rayleigh-Bénard convection. *Physical Review Letters*, 49:726–729, 1982.
5. W. M. Coughran, Jr., E. H. Grosse, and D. J. Rose. CAzM: A circuit-analyzer with macromodeling. *IEEE Trans. Electron Devices*, ED-30:1207–1213, 1983.
6. P. E. Bjørstad, W. M. Coughran, Jr., H. S. Greenside, D. J. Rose, and N. L. Schryer. Numerical solution of a model equation near the onset of the Rayleigh-Bénard instability. In G. Birkhoff and A. Schoenstadt, editors, *Elliptic Problem Solvers II*, pages 531–543. Academic Press, 1984.
7. H. S. Greenside and W. M. Coughran, Jr. Nonlinear pattern formation near the onset of Rayleigh-Bénard convection. *Physical Review A*, 30:398–428, 1984.
8. W. M. Coughran, Jr. On noncharacteristic boundary conditions for discrete hyperbolic initial-boundary-value problems. *J. Computational Physics*, 60:135–154, 1985.
9. R. E. Bank, W. M. Coughran, Jr., W. Fichtner, E. H. Grosse, D. J. Rose, and R. K. Smith. Transient simulation of silicon devices and circuits. *IEEE Trans. Computer-Aided Design*, CAD-4:436–451, 1985. Also *IEEE Trans. Electron Devices* ED-32.
10. R. E. Bank, W. M. Coughran, Jr., W. Fichtner, D. J. Rose, and R. K. Smith. Computational aspects of transient device simulation. In W. L. Engl, editor, *Process and Device Simulation*, pages 229–264. North Holland-Elsevier Science Publishers, 1986. Invited.
11. W. M. Coughran, Jr., E. H. Grosse, and D. J. Rose. Variation diminishing splines in simulation. *SIAM J. Scientific & Statistical Computing*, 7:696–705, 1986.
12. W. M. Coughran, Jr., W. Fichtner, and R. K. Smith. Supercomputers in VLSI technology development and device design. In K. Hess, editor, *Large Scale Computational Device Modeling*, page 175. University of Illinois Press, 1986. Invited. Abstract.

13. R. K. Smith, W. M. Coughran, Jr., W. Fichtner, D. J. Rose, and R. E. Bank. Some aspects of semiconductor device simulation. In R. Glowinski and J.-L. Lions, editors, *Computing Methods in Applied Sciences and Engineering, VII*, pages 3–12. North Holland-Elsevier Science Publishers, 1986. Invited.
14. W. M. Coughran, Jr., E. H. Grosse, and D. J. Rose. Aspects of computational circuit analysis. In W. Fichtner and M. Morf, editors, *VLSI CAD Tools and Applications*, pages 105–127. Kluwer Academic Publishers, 1987. Invited.
15. W. M. Coughran, Jr., M. R. Pinto, and R. K. Smith. Computational methods for steady-state CMOS latchup simulation. *IEEE Trans. Computer-Aided Design*, 7:307–323, 1988.
16. H. S. Greenside, M. C. Cross, and W. M. Coughran, Jr. Mean flows and the onset of chaos in large-cell convection. *Physical Review Letters*, 60:2269–2272, 1988.
17. W. M. Coughran, Jr., W. Fichtner, and E. H. Grosse. Extracting transistor charges from device simulations by gradient fitting. *IEEE Trans. Computer-Aided Design*, 8:380–394, 1989.
18. R. E. Bank, W. M. Coughran, Jr., M. A. Driscoll, R. K. Smith, and W. Fichtner. Iterative methods in semiconductor device simulation. *Computer Physics Communications*, 53:201–212, 1989. Invited.
19. W. M. Coughran, Jr., M. R. Pinto, and R. K. Smith. Continuation methods in semiconductor device simulation. *J. Comp. Appl. Math.*, 26:47–65, 1989. Invited.
20. W. M. Coughran, Jr., D. J. Erdman, S. W. Kenkel, G. B. Nifong, D. J. Rose, and R. Subrahmanyam. CAzM: University/industry collaboration in design software. In *Eighth Biennial University-Government-Industry Microelectronics Symposium*, pages 102–105, 1989.
21. W. M. Coughran, Jr. and E. H. Grosse. A philosophy for scientific computing tools. *SIGNUM Newsletter*, 24(2/3):2–9, 1989.
22. R. E. Bank, T. F. Chan, W. M. Coughran, Jr., and R. K. Smith. The alternate-block-factorization procedure for systems of partial differential equations. *BIT*, 29:938–954, 1989.
23. W. M. Coughran, Jr. and J. W. Jerome. Modular algorithms for transient semiconductor device simulation, part I: Analysis of the outer iteration. In R. E. Bank, editor, *Computational Aspects of VLSI Design with an Emphasis on Semiconductor Device Simulation*, pages 107–149. American Mathematical Society, 1990.
24. R. E. Bank, J. Bürgler, W. M. Coughran, Jr., W. Fichtner, and R. K. Smith. Recent progress in algorithms for semiconductor device simulation. In R. E. Bank, R. Bulirsch, and K. Merten, editors, *Mathematical Modelling and Simulation of Electrical Circuits and Semiconductor Devices*, pages 125–140. Birkhäuser, 1990.
25. W. M. Coughran, Jr. and N. L. Schryer. Faster device modeling using adaptive spatial meshes and continuation. In *Workshop on Numerical Modeling of Processes and Devices for Integrated Circuits (NUPAD III) Technical Digest*, pages 85–86. IEEE Circuits and Systems Society and Electron Devices Society, 1990. Extended abstract.
26. P. Lamb, W. Fichtner, and W. M. Coughran, Jr. An object-oriented approach to mixed-mode electrical circuit simulation. In A. Guasch, editor, *Proc. of the SCS Multiconference on Object-Oriented Simulation*, pages 43–48. Society for Computer Simulation, 1990.
27. W. M. Coughran, Jr. and E. H. Grosse. Techniques for scientific animation. In E. Farrell, editor, *Proc. of the SPIE*, volume 1259, pages 72–79, 1990. Associated videotape in 1259-V collection.

28. M. R. Pinto, W. M. Coughran, Jr., C. S. Rafferty, E. Sangiorgi, and R. K. Smith. Device simulation for silicon ULSI. In K. Hess, J. P. Leburton, and U. Ravaioli, editors, *Computational Electronics: Semiconductor Transport and Device Simulation*, pages 3–13. Kluwer Academic Publishers, 1991.
29. J. Bürgler, W. M. Coughran, Jr., and W. Fichtner. An adaptive grid refinement strategy for the drift-diffusion equations. *IEEE Trans. Computer-Aided Design*, 10:1251–1258, 1991.
30. W. M. Coughran, Jr., M. R. Pinto, and R. K. Smith. Adaptive grid generation for VLSI device simulation. *IEEE Trans. Computer-Aided Design*, 10:1259–1275, 1991.
31. A. Benvenuti, M. R. Pinto, W. M. Coughran, Jr., N. L. Schryer, C. U. Naldi, and G. Ghione. Evaluation of the influence of convective energy in HBTs using a fully hydrodynamic model. In *IEDM Technical Digest '91*, pages 499–502, 1991.
32. W. M. Coughran, Jr. and E. H. Grosse. Seeing and hearing dynamic Loess surfaces. In *Interface '91 Proceedings*, pages 224–228. Springer-Verlag, 1991.
33. W. M. Coughran, Jr. and E. H. Grosse. Display of functions of three space variables and time using shaded polygons and sound. In P. W. Gaffney and E. N. Houstis, editors, *Programming Environments for High-Level Scientific Problem Solving*, pages 271–276. Springer-Verlag, 1992. IFIP TC 2 WG 2.5 Proc. of Working Conference on Programming Environments for High-Level Scientific Problem Solving, Karlsruhe.
34. W. M. Coughran, Jr., E. H. Grosse, and M. R. Pinto. Computing folds and bifurcations in current-voltage characteristics of semiconductor devices. In *Workshop on Numerical Modeling of Processes and Devices for Integrated Circuits (NUPAD IV) Technical Digest*, pages 149–153. IEEE, 1992. Extended abstract.
35. A. Benvenuti, W. M. Coughran, Jr., M. R. Pinto, and N. L. Schryer. Hierarchical PDE simulation of nonequilibrium transport effects in semiconductor devices. In *Workshop on Numerical Modeling of Processes and Devices for Integrated Circuits (NUPAD IV) Technical Digest*, pages 155–160. IEEE, 1992. Extended abstract.
36. A. Benvenuti, G. Ghione, M. R. Pinto, W. M. Coughran, Jr., and N. L. Schryer. Coupled thermal, fully hydrodynamic simulation of InP-based HBTs. In *IEDM Technical Digest '92*, pages 737–740. IEEE, 1992.
37. M. R. Pinto, D. M. Boulin, C. S. Rafferty, R. K. Smith, W. M. Coughran, Jr., I. C. Kizilyalli, and M. J. Thoma. Three-dimensional characterization of bipolar transistors in a submicron BiCMOS technology using integrated process and device simulation. In *IEDM Technical Digest '92*, pages 923–926. IEEE, 1992.
38. R. K. Smith and W. M. Coughran, Jr. Computational challenges in simulations of ULSI semiconductor devices. In T. N. Mudge and B. D. Shriver, editors, *Proc. of the 27th Hawaii International Conference on System Sciences*, pages 7–15. IEEE, 1994.
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