

William A. Massey

Contact Information

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Education

- Bachelor of Arts Degree in Mathematics, Princeton University, 1977.
- Graduated Magna Cum Laude, Phi Beta Kappa and Sigma Xi.
- Doctorate of Philosophy Degree in Mathematics, Stanford University, 1981.

Professional Experience

- Professor in the Department of Operations Research and Financial Engineering at Princeton University, 2001 - present.
- Visiting Faculty for the Civil Engineering / Operations Research Department at Princeton University, February - May, 1990.
- Researcher for the Mathematical Sciences Research Center at Bell Laboratories, 1981 - 2001.

Research Interests

- Queueing Theory.
- Performance, Pricing, Priority and Provisioning Models for Communications Services and Systems.
- Stochastic Networks.
- Applied Probability.

Supervised Ph.D.'s

1. Rodney B. Wallace, George Washington University (co-advisor). His thesis work made him a finalist for the INFORMS George B. Dantzig Dissertation Award.
2. Ahmed Ridley, University of Maryland (co-advisor).

Grants, Patents, Honors and Awards

- Awarded 3 year NSF Grant DMI-0323668 on *Telephone Call Centers - Performance, Design and Control of Time Varying Queues*.

- U.S. patent number 5,923,873 titled *Method for determining server staffing in management of finite server queueing systems*.
- Ranked second among a list tabulated by the *Journal of Blacks in Higher Education* (Autumn 2005) on the most highly cited Black mathematicians.
- Bell Labs Cooperative Research Fellowship Award.
- National Science Foundation Postdoctoral Fellowship Award.
- Distinguished Service Award from the National Association of Mathematicians.

Professional Societies

- American Mathematical Society (AMS).
- Institute for Operations Research and the Management Sciences (INFORMS).
- Mathematical Association of America (MAA).
- National Association of Mathematicians (NAM).
- Society for Industrial and Applied Mathematicians (SIAM).

Journal Referee

- Advances in Applied Probability
- Annals of Applied Probability
- IEEE Transactions on Information Theory
- Journal of Applied Probability
- Mathematics of Operations Research
- Operations Research

List of Invited Talks and Addresses

1. **A Dynamical Systems Analysis for Stochastic Models of Call Centers.** *SIAM Applications of Dynamical Systems Meeting*, May 2005.
2. **Call Center Staffing for Profit Optimality.** *Institute for Mathematics and its Applications (IMA) Career Workshop on Minorities and Applied Mathematicians*, April 2005.
3. **The Mathematical Dimensions of Knowledge.** National Association of Mathematicians Undergraduate MATHFest. Morehouse College, October 2004.
4. **Queueing Networks with Time Varying Rates for Modeling Call Centers.** *Call Center Workshop*. Ecole Polytechnique, Montreal, Canada, August 2004.
5. **Motivational Mathematics.** *The 10th Conference for African American Researchers in the Mathematical Sciences*. Co-Sponsored by the Mathematical Sciences Research Institutes and the Lawrence Berkeley Laboratory, June 2004.
6. **An Optimal Design of the M/M/C/K Queue for Call Centers.** *Workshop on Multi-Server Scheduling*, Carnegie Mellon University, May 2004.
7. **An Introduction to the Black Scholes Formula.** *National Society for Black Physicists Conference*, Washington D.C., February, 2004.
8. **Bandwidth Service Models for Provisioning and Pricing.** *SIAM Conference*, Montreal, Canada, July 2003.

9. **Fluid and Diffusion Models for the Queue Lengths and Delay Times of Multi-Server Queues with Time-Varying Rates.** *Wharton School Workshop on Call Centers*, University of Pennsylvania, May 2003.
10. **Mathematics is Four Dimensional.** *Martin Luther King Day Lecture*. University of Iowa, January 2002.
11. **A Tutorial on Stochastic Differential Equations and the Black Scholes Formula.** *7th Conference for African American Researchers in the Mathematical Sciences*, Duke University, Raleigh NC, June 19-22, 2001.
12. **The Language of Science and Technology.** *NSBE Annual Banquet*. University of Cincinnati, May 2001.
13. **Mathematics is Four Dimensional.** *Mathematics for Understanding Conference* at Delaware State University, August 2000.
14. **Tutorial: The Analysis of Queues with Time Varying Rates.** *Fifth INFORMS Telecommunications Conference*, Boca Raton, FL, March 5 - March 8, 2000.
15. **Queues with Time Varying Rates and Their Applications.** *MAA Invited Address, Mathfest 1999*, Mathematical Association of America, Providence, RI, July 30 - August 1, 1999.
16. **Industrial Perspectives on Mathematics.** *Albert T. Bharucha-Reid Lecture for the National Association of Mathematicians, Regional Faculty Conference on Research and Teaching Excellence*. Washington, DC, March 19-20, 1999.
17. **Strong Approximations for Markovian Service Networks.** *Workshop on Analysis and Simulation of Communication Networks, Program in Probability and its Applications*. The Fields Institute for Research in Mathematical Sciences. Toronto, Canada, November 9-13, 1998.
18. **Bell Labs - A Legacy of Commitment.** *Minority Scientist Lecture Series* at Purdue University, September 25, 1998.
19. **A Tutorial on Probability Theory.** *4th Conference for African American Researchers in the Mathematical Sciences*, Rice University, Houston, TX, June 16-19, 1998.
20. **Offered Load Models for Telephony, Wireless, and ATM.** *Seminar on Advanced Stochastic Modelling Applied to Telecommunication-Networks and Distributed Systems*, The Schloss Dagstuhl International Conference and Research Center for Computer Science. Wadern, Germany, March 30 - April 3, 1998.
21. **The Poisson Arrival Location Model: A Stochastic Offered Load Model for Space and Time Dynamics in Wireless Communication Systems.** *Workshop on the Modelling of Communication Networks via Stochastic Geometry*, The Schloss Dagstuhl International Conference and Research Center for Computer Science. Wadern, Germany, March 25 - 27, 1998.
22. **Queueing Theory with Time-Varying Rates.** *Mid-Atlantic Regional Probability and Statistics Day*, Johns Hopkins University Applied Physics Laboratory. Laurel, MD, October 18, 1997.
23. **The Mathematics of Queueing Models for Telecommunication Systems.** *Congreso Nacional de la Sociedad Matematica Mexicana*, San Luis, Mexico, October 7-11, 1996.

24. **Limit Theorems for Time -Varying Queues.** *American Mathematical Society Spring Southeastern Sectional Meeting*, Baton Rouge, LA, April 19-21, 1996.
25. **The Mathematics of Queueing Networks.** *William W. S. Claytor Lecture for the National Association of Mathematicians*, Joint Mathematics Meetings. Orlando, FL, January 10-13, 1996.
26. **Rethinking Queueing Theory with Time-Varying Rates.** *Conference for African American Researchers in the Mathematical Sciences*, Mathematical Sciences Research Center. Berkeley, CA, June 21-23, 1995.
27. **The Poisson-Arrival Location Model: A Tutorial on Networks of Infinite-Server Queues with Non-Stationary Poisson Input.** *ORSA/TIMS (now INFORMS) Conference*, San Francisco, CA, November 2-4, 1992.
28. **The Analysis of Queueing Systems with Non-Stationary Inputs.** *Distinguished Scientist Lecture Series*, 125th Anniversary Celebration for Howard University. Washington DC, April 2, 1992.
29. **Transient Analysis of Queueing Networks via Lattice Bessel Functions.** *The Second Edward Bouchet International Conference on Physics and Technology*, The University of Ghana. Legon, Ghana, August 14-17, 1990.
30. **Stochastic Ordering for Markov Processes on Partially Ordered Spaces with Applications to Queueing Networks.** *International Workshop on Stochastic Orders and Decision Under Risk*. Hamburg, Germany, May 16-20, 1989.

List of Publications

1. **Fluid and Diffusion Limits for Transient Sojourn Times of Processor Sharing Queues with Time Varying Rates.** R. C. Hampshire, M. Harchol-Balter and W. A. Massey (2006). To appear in the special issue of *Queueing Systems and Their Applications* on Fair Resource Sharing, Volume 53, Issue 1/2, June 2006.
2. **An Optimal Design of the M/M/C/K Queue for Call Centers.** W. A. Massey and R. B. Wallace (revised 2006). Submitted to *Queueing Systems and Their Applications*.
3. **Staffing of Time-Varying Queues to Achieve Time-Stable Performance.** Z. Feldman, A. Mandelbaum, W. A. Massey and W. Whitt. (working paper, 2004. Revised 2005). Submitted to *Management Science*.
4. **Variational Optimization for Call Center Staffing.** R. C. Hampshire and W. A. Massey (2005). *Proceedings of the 2005 Richard Tapia Celebration of Diversity in Computing Conference*.
5. **Scheduling Algorithms for Downlink Services in Wireless Networks: A Markov Decision Process Approach.** W. A. Massey, K.G. Ramakrishnan, M. Aravamudan and G. Pai (2004). *Proceedings of the IEEE Globecom 2004 Conference*.
6. **Fluid Approximation of a Priority Call Center with Time-Varying Arrivals.** A. D. Ridley, W. A. Massey and M. Fu (2004). *The Telecommunications Review*, Volume 15, pp. 69-77.

7. **Provisioning for Bandwidth Sharing and Exchange.** R. C. Hampshire, W. A. Massey, D. Mitra and Q. Wang. *Telecommunications Network Design and Management (Boca Raton, FL, 2002)*, 207--225, Oper. Res./Comput. Sci. Interfaces Ser., 23, *Kluwer Acad. Publ., Boston, MA, 2003*.
8. **Threshold Pricing for Selling Network Capacities through Forward Contract,** S. G. Lanning, W. A. Massey, and Q. Wang, *Selected Proceedings of the IMA Workshop - Mathematics of the Internet: E-Auction and Markets*, Brenda Dietrich and Rakesh V. Vohra, Editors, Springer, New York City, NY, 2002, pp. 145-158.
9. **Queue Lengths and Waiting Times for Multi-Server Queues with Abandonment and Retrials.** A. Mandelbaum, W. A. Massey, M. I. Reiman, B. Rider and A. Stolyar (2002), *Telecommunications Systems* **21**, 149–172.
10. **The Analysis of Queues with Time-Varying Rates for Telecommunication Models.** W. A. Massey, (2002), *Telecommunications Systems* **21**, 173–204.
11. **Steady State Analysis with Heavy Traffic Limits for Semi-Open Networks.** W. A. Massey and R. Srinivasan. *Canadian Mathematical Society Conference Proceedings*. Volume 26, 2000, pp. 331 - 352.
12. **Mathematics is Four Dimensional.** W. A. Massey, Council for African American Researchers in the Mathematical Sciences: Volume III. *Contemporary Mathematics*, editors Alfred Noel, Earl Barnes and Sonya A. F. Stephens. Volume 275, 2001, pp. 147-158.
13. **Waiting Time Asymptotics for Time Varying Multiserver Queues with Abandonment and Retrials.** A. Mandelbaum, W. A. Massey, M. I. Reiman, and A. Stolyar, *Proceedings of the Thirty-Seventh Annual Allerton Conference on Communication, Control and Computing*. September 1999, pp. 1095-1104.
14. **Optimal Pricing in Queueing Systems with Quality of Service Constraints,** S. Lanning, W. A. Massey, B. Rider and Q. Wang, *Proceedings of the 16th International Teletraffic Congress – ITC 16 June 1999*, pp. 747-756.
15. **Time Varying Multiserver Queues with Abandonment and Retrials,** A. Mandelbaum, W. A. Massey, M. I. Reiman, and B. Rider, *Proceedings of the 16th International Teletraffic Congress - ITC 16 June 1999*, pp. 355-364.
16. **A Nonstationary Offered-Load Model for Packet Networks,** N. G. Duffield, W. A. Massey, and W. Whitt, *Select Proceedings of the Fourth INFORMS Telecommunications Conference* (accepted for publication in 1999, to appear).
17. **Strong Approximations for Markovian Service Networks,** A. Mandelbaum, W. A. Massey, and M. I. Reiman, *Queueing Systems and Their Applications*, 30 (1998) pp. 149-201.
18. **Uniform Acceleration Expansions for Markov Chains with Time-Varying Rates ,** W. A. Massey and W. Whitt, *Annals of Applied Probability*, Vol. 8, No. 4 (1998) pp. 1130-1155.
19. **Peak Congestion in Multi-Service Systems with Slowly Varying Arrival Rates,** W. A. Massey and W. Whitt, *Queueing Systems and Their Applications*, 25 (1997) pp. 157-172.
20. **A Modified Offered Load Approximation for Nonstationary Circuit Switched Networks,** O. B. Jennings and W. A. Massey, *Select Proceedings of the*

- Third INFORMS Telecommunications Conference (Telecommunication Systems, editors R. B. Cooper and R. Doverspike), 7 (1997) pp. 253-265.*
21. **The Time-Dependent Erlang Loss Model with Retrials**, N. Grier, W. A. Massey, T. McKoy and W. Whitt, *Select Proceedings of the Third INFORMS Telecommunications Conference (Telecommunication Systems, editors R. B. Cooper and R. Doverspike), 7 (1997) pp. 229-251.*
 22. **A Packet Delay Analysis for Cellular Digital Packet Data**, W. A. Massey and R. Srinivasan, *IEEE Journal on Selected Areas in Communications*, 15:7 (Sept 1997) pp. 1364-1372.
 23. **Optimal Profit for Leased Lines Services**, O. B. Jennings, W. A. Massey and C. McCalla, *Proceedings of the 15th International Teletraffic Congress - ITC 15 (editors V. Ramaswami and P. E. Wirth), June 1997, pp. 803-814.*
 24. **Estimating the Parameters of a Nonhomogeneous Poisson Processes with Linear Rate**, W. A. Massey, G. A. Parker and W. Whitt, *Telecommunication Systems*, 5, 1996, pp. 361-388.
 25. **Stationary-Process Approximations for the Nonstationary Erlang Loss Model**, W. A. Massey and W. Whitt, *Operations Research*, 44:6 (Nov-Dec 1996).
 26. **Server Staffing to Meet Time-Varying Demand**, O. B. Jennings, A. Mandelbaum, W. A. Massey and W. Whitt, *Management Science*, 42:10 (October 1996), pp. 1383-1394.
 27. **Stability for Queues with Time-Varying Rates**, W. A. Massey, *Stochastic Networks: Stability and Rare Events (Lecture Notes in Statistics, Editors P. Glasserman, K. Sigman and D. Yao)*, 117 (April 1996), pp. 95-107.
 28. **Sensitivity to the Service-Time Distribution in the Nonstationary Erlang Loss Model**, J. L. Davis, W. A. Massey and W. Whitt, *Management Science*, 41:6 (June 1995), pp. 1107-1116.
 29. **The Spanning Tree Enumeration Problem for Digraphs**, N. Dean, A. K. Kelmans, K. W. Lei, W. A. Massey and P. Winkler, *Graph Theory, Combinatorics, and Applications: Proceedings of the Seventh Quadrennial International Conference on the Theory and Applications of Graphs, Volume I*, 1995, pp. 277-287.
 30. **Strong Approximations for Time Dependent Queues**, W. A. Massey and A. Mandelbaum, *Mathematics of Operations Research*, 20:1 (February 1995), pp. 33-64.
 31. **A Stochastic Model to Capture Space and Time Dynamics in Wireless Communication Systems**, W. A. Massey and W. Whitt, *Probability in the Engineering and Informational Sciences*, 8 (1994), pp. 541-569.
 32. **Traffic Models for Wireless Communications Networks**, K. Leung, W. A. Massey and W. Whitt, *IEEE Journal on Selected Areas on Communications*, 12 (October 1994), pp. 1353-1364.
 33. **An Analysis of the Modified-Offered-Load Approximation for the Nonstationary Erlang Loss Model**, W. A. Massey and W. Whitt, *Annals of Applied Probability*, 4:4 (November 1994), pp. 1145-1160.
 34. **The Highway PALM: A Stochastic Model to Capture Space and Time Dynamics in Wireless Communication Systems**, W. A. Massey and W. Whitt,

- The Fundamental Role of Teletraffic in the Evolution of Telecommunication Networks (14th International Teletraffic Congress)*, June 1994, pp. 503-512.
35. **On the Modified-Offered-Load Approximation for the Nonstationary Erlang Loss Model**, W. A. Massey and W. Whitt, *The Fundamental Role of Teletraffic in the Evolution of Telecommunication Networks (14th International Teletraffic Congress)*, June 1994, pp. 145-153.
 36. **Determining the Exit Time Distribution for a Closed Cyclic Network**, F. Baccelli, W. A. Massey and P. E. Wright, *Theoretical Computer Science*, 125 (May 1994), pp. 149-165.
 37. **Unstable Asymptotics for Nonstationary Queues**, W. A. Massey and W. Whitt, *Mathematics of Operations Research*, 19:2 (May 1994), pp. 267-291.
 38. **The Physics of the M(t)/G/infinity Queue**, S. Eick, W. A. Massey and W. Whitt, *Operations Research*, 41 (July-August 1993), pp. 400-408.
 39. **Networks of Infinite-Server Queues with Nonstationary Poisson Input**, W. A. Massey and W. Whitt, *Queueing Systems and Their Applications*, 13:1 (May 1993), pp. 183-250.
 40. **A Probabilistic Generalization of Taylor's Theorem**, W. A. Massey and W. Whitt, *Statistics and Probability Letters*, 16 (January 1993), pp. 51-54.
 41. **Infinite-Server Queues with Sinusoidal Arrival Rates**, S. Eick, W. A. Massey and W. Whitt, *Management Science*, 39 (January 1993), pp. 241-252.
 42. **Stochastic Ordering for Markov Processes on Partially Ordered Spaces with Applications to Queueing Networks**, W. A. Massey, *Stochastic Orders and Decision under Risk (IMS Lecture Notes - Monograph Series)*, 19 (1991), pp. 248-260.
 43. **A Heavy Traffic Analysis for Semi-Open Networks**, W. A. Massey and R. Srinivasan, *Performance Evaluation*, 13:1 (September 1991), pp. 59-66.
 44. **Acyclic Fork-Join Queueing Networks**, F. Baccelli, W. A. Massey and D. Towsley, *Journal of the Association of Computing Machinery*, 36:3 (July 1989), pp. 615-642.
 45. **A Sample Path Analysis of the M/M/1 Queue**, F. Baccelli and W. A. Massey, *Journal of Applied Probability*, 26 (1989), pp. 418-422.
 46. **Simple, Efficient Computation of the Generalized Throughput of Jackson Networks**, A. G. Greenberg and W. A. Massey, *Proceedings of the 26th Annual Allerton Conference on Communication, Control, and Computing*, (September 1988), pp. 967-968.
 47. **On the Busy Period of Certain Classes of Queueing Networks**, F. Baccelli and W. A. Massey, *Proceedings of the Second International Workshop on Applied Mathematics and Performance/Reliability Models of Computer/Communication Systems*, May 1987, University of Rome.
 48. **Stochastic Orderings for Markov Processes on Partially Ordered Spaces**, W. A. Massey, *Mathematics of Operations Research*, 12 (May 1987), pp. 350-367.
 49. **Calculating Exit Times for Series Jackson Networks**, W. A. Massey, *Journal of Applied Probability*, 24 (March 1987), pp. 226-234.
 50. **A Family of Bounds for the Transient Behavior of a Jackson Network**, W. A. Massey, *Journal of Applied Probability*, 23 (June 1986), pp. 543-549.

51. **A Probabilistic Analysis of a Database System**, W. A. Massey, *Performance Evaluation Review: Proceedings of Performance '86 and ACM Sigmetrics*, 14 (May 1986), pp. 141-146.
52. **Asymptotic Analysis of the Time Dependent M/M/1 Queue**, W. A. Massey, *Mathematics of Operations Research*, 10 (May 1985), pp. 305-327.
53. **The Non-Ergodic Jackson Network**, J. B. Goodman and W. A. Massey, *Journal of Applied Probability*, 21 (December 1984), pp. 860-869.
54. **An Operator Analytic Approach to the Jackson Network**, W. A. Massey, *Journal of Applied Probability*, 21 (June 1984), pp. 379-393.
55. **Open Networks of Queues: Their Algebraic Structure and Estimating Their Transient Behavior**, W. A. Massey, *Advances in Applied Probability*, 16 (March 1984), pp. 176-201.
56. **Nonstationary Queues**, W. A. Massey, Stanford University, Stanford, California, 1981, PhD Thesis.
57. **Calculation of Steady State Probabilities for Content of Buffer with Correlated Inputs**, W. A. Massey and J. A. Morrison, *Bell Sys. Tech. J.*, 57:9 (November 1978), pp. 3097-3117.