May 2024

Resumé

WARD WHITT

Current Employment

Wai T. Chang Professor Emeritus (retired in 2021)
Department of Industrial Engineering and Operations Research
Fu Foundation School of Engineering and Applied Science
Columbia University
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Education

1969 Ph.D., Cornell University
Major Field: Operations Research
Minor Fields: Mathematics and Regional Planning
Thesis: Weak Convergence Theorems for Queues in Heavy Traffic
(Advisor: D. L. Iglehart; Committee Members: H. Kesten and N. U. Prabhu)

1964 A.B., Dartmouth College

Major: Mathematics
(Senior Honors Thesis Advisor: J. G. Kemeny)

Research, Consulting and Teaching Interests

Queues: approximation techniques, limit theorems, heavy-traffic theory, model stability, bounds and inequalities, transient behavior, queues with time-varying arrival rates, numerical transform inversion, fundamental principles such as $L = \lambda W$, stochastic networks, applications to communication networks, manufacturing systems and service systems such as contact centers and healthcare systems

Probability and Stochastic Processes: limit theorems, weak convergence, diffusion processes, stochastic order relations, simulation, numerical transform inversion, stochastic models in operations research.

Telecommunication Systems: performance analysis, internet performance, IP networks, circuit-switched networks, wireless networks, high-speed communication networks, asynchronous transfer mode technology, traffic descriptors, traffic regulators, protection against overloads, staffing telephone call centers, real-time performance prediction and control

Operations Research: applied probability, stochastic models, queues, performance analysis, simulation, dynamic programming, game theory, decision analysis, approximation techniques, telecommunication, computer manufacturing and service systems.

Employment History

Columbia University in the City of New York

2002– Professor, Dept. of Industrial Engineering and Operations Research

SeatLink, Inc., New York

2004-2007 Co-Founder, Advisor and Part-Time Consultant

Avaya Labs Research

2003 Part-Time Consultant, Customer-Contact-Center Algorithms, Data Analysis Research Department, Basking Ridge, NJ

AT&T (Bell Laboratories, 1977-1996; AT&T Laboratories, 1996-2002)

1996–2002 Technology Leader and AT&T Fellow, IP Network Management and Performance Department, Internet and Networking Systems Research Laboratory, Shannon Laboratory, Florham Park, NJ

1987–1996 Member of Technical Staff, Mathematical Sciences Research Center, Murray Hill, NJ

1977–1986 Member of Technical Staff, Operations Research Department, Holmdel, NJ

Yale University

1973–1977 Associate Professor, Department of Administrative Sciences (joint appointment in Department of Statistics)

1969–1973 Assistant Professor, Department of Administrative Sciences (became Department of Operations Research)

Stanford University

1968–1969 Assistant Professor, Department of Operations Research

Cornell University

1965–1966 Instructor and Teaching Assistant, Department of Industrial Engineering and Operations Research

New York Telephone Company

1961–1963 Management Training Program, Engineering (two summers) and Sales (one summer)

Montana State University, Bozeman, Montana

1959–1960 Computer Programmer, Computer Center

White's Pharmacy, Bozeman, Montana

1958–1959 Inventory Control Specialist (stockboy)

Honors, Fellowships and Grants

2016	NSF Research Grant, Data-Driven Queueing Models for Healthcare: Accounting for Stochastic Dependence and Time Dependence
2013	NSF Research Grant, Fitting Time-Varying Queueing Models to Service System Data
2012	Manufacturing and Service Operations Management Society Distinguished Fellow Award
2011	INFORMS Expository Writing Award
2011	NSF Research Grant, Many-Server Queues with Time-Varying Arrival Rates
2010	INFORMS Applied Probability Society Markov Lecture, INFORMS conference, Austin, Texas
2009	NSF Research Grant, Mathematical Models for Large-Scale Service Systems
2007	SEAS Alumni Association Distinguished Faculty Teaching Award
2007	Appointed Wai T. Chang Professor at Columbia University
2007	US-Israel Binational Science Foundation Grant with A. Mandelbaum and others
2005	NSF Research Grant, Stochastic Models of Customer Contact Centers
2003	INFORMS Lanchester Prize for best publication in OR and MS (for 2002 book)
2003	US-Israel Binational Science Foundation Grant with A. Mandelbaum and others
2003	IBM Faculty Award
2002	INFORMS Inaugural Fellow
2002	NSF Research Grant, Stochastic Models for the Design and Management of Customer Contact Centers
2001	INFORMS John von Neumann Theory Prize for fundamental, sustained contributions to theory in OR and MS
2001	Plenary Speaker, INFORMS Applied Probability Conference, July 25, 2001
2001	Harold Larnder Prize for distinguished achievement in operational research, Canadian Operational Research Society
2000	Fulkerson Lecturer, School of Operations Research and Industrial Engineering, Cornell University, October 16–20, 2000
1998	Honorable mention for the INFORMS Lanchester Prize for the best publication in operations research, for a collection of papers on numerical transform inversion (with J. Abate, G. L. Choudhury, K. K. Leung and D. M. Lucantoni)
1998	Member of AT&T Labs Fellowship Program Committee, sharing in the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring
1998	Marcel F. Neuts Best Paper Award, "Fluid and Diffusion Limits for Queues in Slowly Changing Random Environments," *Stochastic Models*, 1997 (with Gagan L. Choudhury, Avi Mandelbaum and Martin I. Reiman).
1998	Plenary Speaker, INFORMS Telecommunications Conference, Boca Raton, FL, March 1998.
1997	Keynote Speaker, 1997 Winter Simulation Conference
1997	Selected to be an AT&T Fellow
1996	Elected to National Academy of Engineering
1993–1996	United States-Israel Binational Science Foundation Grant with Offer Kella of Hebrew University to study stochastic fluid networks
1993	Presented opening lecture at 22nd Conference on Stochastic Processes and Their Applications, Amsterdam, June 1993.
1992	Elected to be a member of the International Federation of Information Processing Working Group on System Modeling, Measurement and Evaluation (IFIP WG7.3)
1992	Presented Keynote Address, *Performance 92*, Newport, RI, June 1992.

Honors, Fellowships and Grants, continued

1991	Outstanding Publication Award, The Institute of Management Sciences College of Simulation for "Planning Queueing Simulations," *Management Science*, vol. 35, pp. 1341–1366, 1989.
1990	A principal invited speaker, SIAM Conference on Applied Probability in Science and Engineering, New Orleans, March, 1990.
1984	Honorable Mention, Best Paper Award for 1983, *Bell System Technical Journal*, "The Queueing Network Analyzer," vol. 62, pp. 2779–2815.
1982	Distinguished Member of Technical Staff Award, Bell Laboratories
1973–1976	NSF Grant GK–38149, Yale University: Applied Probability in OR (Principal Investigator)
1972–1973	Yale University Junior Faculty Fellowship in Social Sciences (year doing research)
1971–1972	NSF Engr. Res. Initiation Grant GK-27866, Yale University (Principal Investigator)
1967–1968	NSF Graduate Fellowship, Cornell University (year spent at Stanford University)
1964–1967	Ford Foundation Engineering Fellowship, Cornell University

Professional Activities

Refereeing manuscripts for research journals and research grant proposals

Advisory Editor:
Mathematics of Operations Research, 1990–
Operations Research, 2006–

Area Editor:
Mathematics of Operations Research, 1987–1990

Associate Editor:
Operations Research, 1974-1976
Mathematics of Operations Research, 1978-1986
Journal of Stochastic Processes and Their Applications, 1979-1984
Queueing Systems: Theory and Applications, 1985-2012
Journal of Applied Probability, 1989-2012
Advances in Applied Probability, 1989-2012
Discrete Event Dynamic Systems: Theory and Applications, 1990–1999
Telecommunications Systems 1992–1994
Journal of the Operations Research Society of Japan 1997–1999

Participation in the activities of the Institute for Operations Research and Management Science (INFORMS), formerly the Operations Research Society of America, and in the Applied Probability Special Interest Group: presentations, session chairman and session organizing. Vice Chairman of Special Interest Group 1986, Chairman 1987.

Member of Search Committee for new Editor of Operations Research, 1981

Chairman of Search Committee for new Editor of Mathematics of Operations Research, 1992; member 2008

Lanchester Prize Committee, 1979, 1985

von Neumann Prize Committee, 1988–1991

Chairman of Nicholson Prize Committee, 1994

Member of the Committee for Conference on Stochastic Processes, the Bernoulli Society, 1979–1983

Co-organizer of Conference on Applied Stochastic Processes, Oberwolfach, W. Germany, 1982, 1985

External Review Committee for Department of Operations Research, Stanford University, 1989, 1993

External Review Committee for Department of Mathematical Sciences, Carnegie-Mellon University, 2002, 2005, 2008

External Review Committee for Department of Operations Research and Statistics, University of North Carolina at Chapel Hill, 2008

Doctoral Dissertations Advised (not always as principal advisor, but significant participation).

Yale University:

Dirickx, Yvo. Dynamic Programming Models with Discount Factor Greater Than One, 1971.

Goodman, David. Modified Sectioning Search Approach to Aggregate Planning, 1972.

Sanghvi, Arun. The Asymptotic Behavior of Some Sequential Games, 1973.

Roth, Carl. A Multiperson Theory of Organizational Decision-Making, 1974.

Winston, Wayne. Optimal Operation of Congestion Systems with Heterogeneous Arrivals and Servers, 1975.

Pomarede, Jean-Michel. A Unified Approach Via Graphs to Skorohod's Topologies on the Function Space D, 1976.

Thomas, Annie. Approximation Procedures for Capacity Expansion Models, 1977.

Sonderman, David. Comparison Results for Stochastic Processes Arising in Queueing Systems, 1978.

Green, Linda. Queues Which Allow a Random Number of Servers Per Customer, 1978.

New York University:

Burman, David. An Analytic Approach to Diffusion Approximations in Queueing, 1979.

George Washington University:

Wallace, Rodney B. Performance Modelling and Design of Call Centers with Skill-Based Routing, 2004.

Columbia University:

Albin, Susan. Approximations for Queues with Superposition Arrival Processes, 1981. (while at Bell Laboratories)

Chen, Yan. Extremal Queueing Theory, 2022.

Gurvich, Itai. Staffing and Control of Many-Server Service Systems, 2008.

Talreja, Rishi. Essays on Heavy-Traffic Approximations for Many-Server Queueing Systems, 2010.

Park, Kun Soo. Applications of Stochastic Modeling to Quantitative Finance and Operations Management, 2010.

Perry, Ohad. Heavy-Traffic Limits via an Averaging principle for Service Systems Responding to Unexpected Overloads, 2010.

Ibrahim, Rouba. Delay Estimation in Many-Server Queues, 2010.

Pang, Guodong. Heavy-Traffic Limits for Many-Server Service Systems with Interruptions and Feedback, 2010.

Liu, Yunan. Many-Server Queues with Time-Varying Arrivals, Customer Abandonment and Non-Exponential Distributions, 2011.

Kim, Song-Hee. Data-Driven Decisions in Service Systems, 2014.

Ma, Ni. Efficient Simulation and Performance Stabilization for Time-Varying Single-Server Queues, 2019.

Sun, Xu. Staffing and Scheduling to Differentiate Service in Many-Server Service Systems, 2019.

You, Wei. A Robust Queueing Network Analyzer Based on Indices of Dispersion, 2019.

Zhang, Xiaopei. Periodic Little's Law, 2019.

Patents

Efficient, Rate-Based Multiaccess Control, U.S. Patent 5,274,644 issued December 12, 1993 (with Arthur W. Berger and Rodolfo A. Milito).

Efficiently Providing Multiple Grades of Service with Protection Against Overloads in Shared Resources, U.S. patent 5,719,854 issued February 17, 1998 (with Gagan L. Choudhury and Kin K. Leung).

Systems and Methods for Estimating a Blocking Probability, U.S. Patent 5,805,681 issued September 8, 1998 (with Rayadurgam Srikant).

Resource Sharing for Book-Ahead and Instantaneous-Request Calls, U.S. Patent 5,878,026 issued March 2, 1999 (with Albert Greenberg and Rayadurgam Srikant).

Method for Determining Server Staffing in Management of Finite Server Queueing Systems, U.S. Patent 5,923,873 issued July 13, 1999 (with William A. Massey).

Method and Apparatus for Predicting Queueing Delays, U.S. Patent 6,023,681 issued February 8, 2000.

Traffic Management in Packet Communication Networks Having Service Priorities and Employing Effective Bandwidths, U.S. Patent 6,160,818 issued December 12, 2000 (with Arthur W. Berger).

Dynamic Staffing of Telephone Call Centers to Provide Substantially Zero-Delay Service, U.S. Patent 6,330,326 issued December 11, 2001.

Method for Preventing Overload Condition in a Circuit Switched Arrangement, U.S. Patent 6,987,848 issued January 17, 2006 (with Gagan L. Choudhury, Alan E. Kaplan and Vaidyanathan Ramaswami).

Contact-Center Routing Based on Incentives and/or Agent Preferences, filed January 14, 2005 (with Michael E. Sisselman).

Contact-Center Routing Based on Games or Contests Involving the Agents, filed February 15, 2005 (with Michael E. Sisselman).

I. Publications

1948 Train Trip, *Jack and Jill*, July 1948, p. 62. (poem)

1961 Hotel Services – Automatic Recording of Guests' Local and Toll Telephone Charges, *New York Telephone Company General Engineering Bulletin*, vol. 11, No. 4, Winter 1961, pp. 29–32. (paper based on summer project)

1969 Weak Convergence Theorems for Queues in Heavy Traffic, Ph.D. Thesis, Cornell University January 1969.

1970 Weak Convergence of Probability Measures on the Function Space C[0,∞), *Annals of Mathematical Statistics*, vol. 41, No. 3, June 1970, pp. 939–944.

Multiple Channel Queues in Heavy Traffic I, *Advances in Applied Probability*, vol. 2, No. 1, Spring 1970, pp. 150-177 (with Donald Iglehart).

Multiple Channel Queues in Heavy Traffic II: Sequences, Networks, and Batches, *Advances in Applied Probability*, vol. 2, No. 2, Autumn 1970, pp. 355–369 (with Donald Iglehart).

Multiple Channel Queues in Heavy Traffic III: Random Server Selection, *Advances in Applied Probability*, vol. 2, No. 2, Autumn 1970, pp. 370–375.

A Guide to the Application of Limit Theorems for Sequences of Stochastic Processes, *Operations Research*, vol. 18, No. 6, November–December 1970, pp. 1207–1213.

1971 Weak Convergence Theorems for Priority Queues: Preemptive-Resume Discipline, *Journal of Applied Probability*, vol. 8, No. 1, March 1971, pp. 74–94.

Weak Convergence of First Passage Time Processes, *Journal of Applied Probability*, vol. 8, No. 2, June 1971, pp. 417–422.

The Equivalence of Functional Central Limit Theorems for Counting Processes and Associated Partial Sums, *Annals of Mathematical Statistics*, vol. 42, No. 4, August 1971, pp. 1372–1378 (with Donald Iglehart).

1972 Complements to Heavy Traffic Limit Theorems for the GI/G/1 Queue, *Journal of Applied Probability*, vol. 9, No. 1, March 1972, pp. 185–191.

Stochastic Abelian and Tauberian Theorems, *Zeitschrift* für *Wahrscheinlichkeitstheorie und verw. Gebiete*, vol. 22, 1972, pp. 251–267.

Limits for the Superposition of m-dimensional Point Processes, *Journal of Applied Probability*, vol. 9, No. 2, June 1972, pp. 462–465.

Embedded Renewal Processes in the GI/G/s Queue, *Journal of Applied Probability*, vol. 9, No. 3, September 1972, pp. 650–658.

1973 Fiat Money in an Economy with one Nondurable Good and No Credit (A Noncooperative Sequential Game), *Topics in Differential Games*, A. Blaquiere (Editor), North-Holland Publishing Co., 1973, pp. 401–448 (with Martin Shubik).

On the Quality of Poisson Approximations, *Zeitschrift* für *Wahrscheinlichkeitstheorie und verw. Gebiete*, vol. 28, 1973, pp. 23–36.

1974 The Continuity of Queues, *Advances in Applied Probability*, vol. 6, No. 1, March 1974, pp. 175–183.

Preservation of Rates of Convergence under Mappings, *Zeitschrift fürWahrscheinlichkeitstheorie und verw. Gebiete*, vol. 29, 1974, pp. 39–44.

Heavy Traffic Limit Theorems for Queues: A Survey, *Mathematical Methods in Queueing Theory*, Proceedings of a Conference at Western Michigan University, Lecture Notes in Economics and Mathematical Systems, No. 98, Springer-Verlag, New York, 1974, pp. 307–350.

1976 Bivariate Distributions with Given Marginals, *Annals of Statistics*, vol. 4, No. 6, September 1976, pp. 1280–1289.

1978 Approximations of Dynamic Programs, I, *Mathematics of Operations Research*, vol. 3, No. 2, May 1978, pp. 231–243.

1979 Approximations of Dynamic Programs, II, *Mathematics of Operations Research*, vol. 4, No. 2, May 1979, pp. 179–185.

Comparing Probability Measures on a Set with an Intransitive Preference Relation, *Management Science*, vol. 25, No. 6, June 1979, pp. 535–511.

A Note on the Influence of the Sample on the Posterior Distribution, *Journal of the America Statistical Association*, vol. 74, No. 366, June 1979, pp. 424-426.

A Priori Bounds for Approximations of Markov Programs, *Journal of Mathematical Analysis and Applications*, vol. 71, No. 1, September 1979, pp. 297–302.

1980 Representation and Approximation of Noncooperative Sequential Games, *SIAM Journal on Control and Optimization*, vol. 18, No. 1, January 1980, pp. 33–48.

Some Useful Functions for Functional Limit Theorems, *Mathematics of Operations Research*, vol. 5, No. 1, February 1980, pp. 67–85.

Uniform Conditional Stochastic Order, *Journal of Applied Probability*, vol. 17, No. 1, March 1980, pp. 112–123.

Approximating the Admissible Set in Stochastic Dominance, *Journal of Economic Theory*, vol. 23, No. 2, October 1980, pp. 218–235 (with Daniel Goroff).

Continuity of Generalized Semi-Markov Processes, *Mathematics of Operations Research*, vol. 5, No. 4, November 1980, pp. 494–501.

The Effect of Variability in the GI/G/s Queue, *Journal of Applied Probability*, vol. 17, No. 4, December 1980, pp. 1062-1071. (Correction Note, *Journal of Applied Probability*, vol. 21, No. 2, June 1984, pp. 445–446.)

1981 Resource Sharing for Efficiency in Traffic Systems, *Bell System Technical Journal*, vol. 60, No. 1, January 1981, pp. 39–55 (with D. R. Smith).

Comparing Counting Processes and Queues, *Advances in Applied Probability*, vol. 13, No. 1, March 1981, pp. 207–220.

The Stationary Distribution of a Stochastic Clearing Process, *Operations Research*, vol. 29, No. 2, March—April 1981, pp. 294-308.

On Stochastic Bounds for the Delay Distribution in the GI/G/s Queue, *Operations Research*, vol. 29, No. 3, May–June 1981, pp. 604–608.

Approximating a Point Process by a Renewal Process: The View Through a Queue, An Indirect Approach *Management Science*, vol. 27, No. 6, June 1981, pp. 619–636.

Heavy-Traffic Limits for Queues with Many Exponential Servers, *Operations Research*, vol. 29, No. 3, May–June 1981, pp. 567–588 (with Shlomo Halfin).

1982 Approximating a Point Process by a Renewal Process: Two Basic Methods, *Operations Research*, vol. 30, No. 1, January–February 1982, pp. 125–147.

Existence of Limiting Distributions in the GI/G/s Queue, *Mathematics of Operations Research*, vol. 7, No. 1, February 1982, pp. 88–94. (Erratum Note, *Mathematics of Operations Research*, vol. 9, No. 4, November 1984, p. 634.)

On the Heavy-Traffic Limit Theorem For GI/G/∞ Queues, *Advances in Applied Probability*, vol. 14, No. 1, March 1982, pp. 171–190.

Multivariate Monotone Likelihood Ratio and Uniform Conditional Stochastic Order, *Journal of Applied Probability*, vol. 19, No. 3, September 1982, pp. 695–701.

Refining Diffusion Approximations for Queues, *Operations Research Letters*, vol. 1, No. 5, November 1982, pp. 165–169.

The Marshall and Stoyan Bounds for IMRL/G/1 Queues Are Tight, *Operations Research Letters*, vol. 1, No. 6, December 1982, pp. 209–213.

1983 Queue Tests for Renewal Processes, *Operations Research Letters*, vol. 2, No. 1, April 1983, pp. 7–12.

Untold Horrors of the Waiting Room. What the Equilibrium Distribution Will Never Tell About the Queue-Length Process, *Management Science*, vol. 29, No. 4, April 1983, pp. 395–408.

Approximations for Networks of Queues, *Proceedings of the Tenth International Teletraffic Congress*, Montreal, June 1983, 4.1.1.

Book Review: *Stochastic Monotonicity and Queueing Applications of Birth-Death Processes* by Erik van Doorn, Lecture Notes in Statistics 4, Springer-Verlag, New York, 1981. *Journal of the American Statistical Association*, vol. 72, No. 382, June 1983, pp. 501–502.

Comparing Batch Delays and Customer Delays, *Bell System Technical Journal*, vol. 62, No. 7, September 1983, pp. 2001–2009.

Toward an Approximation Theory for Point Processes and Networks of Queues, *Newsletter of the ORSA/TIMS Applied Probability Group*, Fall 1983, pp. 2–4.

The Queueing Network Analyzer, *Bell System Technical Journal*, vol. 62, No. 9, November 1983, pp. 2779–2815.

Performance of the Queueing Network Analyzer, *Bell System Technical Journal*, vol. 62, No. 9, November 1983, pp. 2817–2843.

Comparison Conjectures about the M/G/s Queue, *Operations Research Letters*, vol. 2, No. 5, December 1983, pp. 203–209.

1984 On Approximations for Queues, I: Extremal Distributions, *AT&T Bell Laboratories Technical Journal*, vol. 63, No. 1, January 1984, pp. 115–138.

On Approximations for Queues, II: Shape Constraints, *AT&T Bell Laboratories Technical Journal*, vol. 63, No. 1, January 1984, pp. 139–161 (with John G. Klincewicz).

On Approximations for Queues, III: Mixtures of Exponential Distributions, *AT&T Bell Laboratories Technical Journal*, vol. 63, No. 1, January 1984, pp. 163–175.

Book Review: *Queues and Point Processes*, by P. Franken, D. König, U. Arndt and V. Schmidt, Wiley, 1982. *American Scientist*, vol. 72, No. 1, January–February 1984, p. 91.

Minimizing Delays in the GI/G/1 Queue, *Operations Research*, vol. 32, No. 1, January–February 1984, pp. 41–51.

The Asymptotic Behavior of Queues with Time-Varying Arrival Rates, *Journal of Applied Probability*, vol. 21, No. 1, March 1984, pp. 143–156 (with Daniel P. Heyman).

Heavy Traffic Approximations for Service Systems with Blocking, *AT&T Bell Laboratories Technical Journal*, vol. 63, No. 4, May–June 1984, pp. 689–708.

The Amount of Overtaking in a Network of Queues, *Networks*, vol. 14, No. 3, Fall 1984, pp. 411–426.

Open and Closed Models for Networks of Queues, *AT&T Bell Laboratories Technical Journal*, vol. 63, No. 9, November 1984, pp. 1911–1979.

Departures from a Queue with Many Busy Servers, *Mathematics of Operations Research*, Vol. 9, No. 4, November 1984, pp. 534–544.

Approximations for Departure Processes and Queues in Series, *Naval Research Logistics Quarterly*, vol. 31, No. 4, December 1984, pp. 499–521.

1985 The Renewal-Process Stationary-Excess Operator, *Journal of Applied Probability*, vol. 22, No. 1, March 1985, pp. 156–167.

The Best Order for Queues in Series, *Management Science*, vol. 31, No. 4, April 1985, pp. 475–487.

Uniform Conditional Variability Ordering of Probability Distributions, *Journal of Applied Probability*, vol. 22, No. 3, September 1985, pp. 619–633.

Blocking When Service is Required from Several Facilities Simultaneously, *AT&T Technical Journal*, vol. 64, No. 8, October 1985, pp. 1807–1856.

Characterizing Superposition Arrival Processes and the Performance of Multiplexers for Voice and Data, *Proceedings of IEEE Global Telecommunications Conference*, New Orleans, December 1985, vol. 2, pp. 25.4.1–7 (with K. Sriram).

Queues with Superposition Arrival Processes in Heavy Traffic, *Stochastic Processes and Their Applications*, vol. 21, No. 1, December 1985, pp. 81–91.

1986 Deciding Which Queue to Join: Some Counterexamples, *Operations Research*, vol. 34, No. 1, January–February 1986, pp. 55–62.

Book Review: *Comparison Methods for Queues and Other Stochastic Models*, by D. Stoyan (ed. D. J. Daley), Wiley, 1983. *Journal of American Statistical Association*, vol. 81, No. 393, March 1986, p. 266.

Partial Solution to Problem 6482. *The American Mathematical Monthly*, vol. 93, No. 6, June–July 1986, pp. 488–489 (with D. R. Smith).

Characterizing Superposition Arrival Processes in Packet Multiplexers for Voice and Data. *IEEE Journal on Selected Areas in Communications*, vol. SAC-4, No. 6, September 1986, pp. 833–846 (with K. Sriram).

The Influence of Service-Time Variability in a Closed Network of Queues. *Performance Evaluation*, vol. 6, September 1986, pp. 219–234 (with Andreé B. Bondi).

A Central-Limit-Theorem Version of $L = \lambda W$. *Queueing Systems: Theory and Applications*, vol. 1, No. 2, September 1986, pp. 191–215 (with Peter W. Glynn).

Stochastic Comparisons for Non-Markov Processes. *Mathematics of Operations Research*, vol. 11, No. 4, November 1986, pp. 608–618.

1987 Book Review: *Asymptotic Methods in Queueing Theory* by A. A. Borovkov (translated by D. Newton), Wiley, 1984. *American Scientist*, vol. 75, No. 2, March–April 1987, pp. 210–211.

Sufficient Conditions for Functional Limit Theorem Versions of $L = \lambda W$. *Queueing Systems: Theory and Applications*, vol. 1, No. 3, 1987, pp. 279–287 (with Peter W. Glynn).

Transient Behavior of the M/M/1 Queue: Starting at the Origin. *Queueing Systems: Theory and Applications*, vol. 2, No. 1, 1987, pp. 41–65 (with Joseph Abate).

Transient Behavior of Regulated Brownian Motion I: Starting at the Origin. *Advances in Applied Probability*, vol. 19, No. 3, September 1987, pp. 560–598 (with Joseph Abate).

Transient Behavior of Regulated Brownian Motion, II: Non-Zero Initial Conditions. *Advances in Applied Probability*, vol. 19, No. 3, September 1987, pp. 599–631 (with Joseph Abate).

1988 Stochastic Ordering, *Encyclopedia of the Statistical Sciences*, vol. 8, S. Kotz and N. L. Johnson eds., Wiley, New York, 1988, pp. 832–836.

Transient Behavior of the M/M/1 Queue Via Laplace Transforms. *Advances in Applied Probability*, vol. 20, No. 1, March 1988, pp. 145–178 (with Joseph Abate).

Estimating Average Production Intervals Using Inventory Measurements: Little's Law for Partially Observable Processes. *Operations Research*, vol. 36, No. 2, March-April 1988, pp. 208–223 (with Ardavan Nozari).

The Correlation Functions of RBM and M/M/1. *Stochastic Models*, vol. 4, No. 2, 1988, pp. 315–359 (with Joseph Abate).

Approximations for the M/M/1 Busy Period. *Queueing Theory and its Applications, Liber Amicorum for J. W. Cohen* North-Holland, Amsterdam, 1988, pp. 149–191 (with Joseph Abate).

Simple Spectral Representations for the M/M/1 Queue. *Queueing Systems*, vol. 3, No. 4, 1988, pp. 321–346 (with Joseph Abate).

Ordinary CLT and WLLN Versions of $L = \lambda W$. *Mathematics of Operations Research*, vol. 13, No. 4, 1988, pp. 674–692 (with Peter W. Glynn).

An LIL Version of $L = \lambda W$. *Mathematics of Operations Research*, vol. 13, No. 4, 1988, pp. 693–710 (with Peter W. Glynn).

A Light-Traffic Approximation for Single-Class Departure Processes From Multi-Class Queues. *Management Science*, vol. 34, No. 11, 1988, pp. 1333–1346.

1989 Indirect Estimation Via $L = \lambda W$. *Operations Research*, vol. 37, No. 1, 1989, pp. 82–103 (with Peter W. Glynn).

Spectral Theory for Skip-Free Markov Chains. *Probability in the Engineering and Information Sciences*, vol. 3, No. 1, 1989, pp. 77–88 (with Joseph Abate).

A Queueing Network Analyzer for Manufacturing. *Teletraffic Science for New Cost-Effective Systems, Networks and Services, ITC 12* (ed. M. Bonatti), North-Holland, Amsterdam, 1989, pp. 1146–1152 (with Moshe Segal).

Dependence in Packet Queues: A Multi-Class Batch-Poisson Model. *Teletraffic Science for New Cost-Effective Systems, Networks and Services*, *ITC 12*, (ed. M. Bonatti), North-Holland, Amsterdam, 1989, pp. 1450–1454 (with Kerry W. Fendick and Vikram R. Saksena).

Measurements and Approximations to Describe the Offered Traffic and Predict the Average Workload in a Single-Server Queue. *Proceedings of the IEEE*, vol. 77, No. 1, 1989, pp. 171-194, (with Kerry W. Fendick). (Reprinted in *Stochastic Analysis of Computer and Communication Systems* (ed. H. Takagi), North-Holland, Amsterdam, 1990, pp. 3–56.)

Extensions of the Queueing Relations $L = \lambda W$ and $H = \lambda G$. *Operations Research*, vol. 37, No. 4, 1989, pp. 634–644 (with Peter W. Glynn).

An Extremal Property of the FIFO Discipline Via An Ordinal Version of $L = \lambda W$. *Stochastic*, em Models, vol. 5, No. 3, 1989, pp. 515–529 (with Shlomo Halfin).

On Reinforcement-Depletion Compartmental Urn Models. *Journal of Applied Probability*, vol. 26, No. 3, 1989, pp. 477–489 (with Peter Donnelly).

Calculating Time-Dependent Performance Measures for the M/M/1 Queue. *IEEE Transactions on Communications*, vol. 37, No. 10, 1989, pp. 1102–1104 (with Joseph Abate).

Dependence in Packet Queues. *IEEE Transactions on Communications*, vol. 37, No. 11, 1989, pp. 1173–1183 (with Kerry W. Fendick and Vikram R. Saksena).

Planning Queueing Simulations. *Management Science*, vol. 35, No. 11, 1989, pp. 1341–1366.

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