In Memoriam: Kenneth C. Sevcik

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ABSTRACT
Kenneth C. Sevcik – a leader of the computer system performance evaluation community for more than 30 years, recipient of the 2004 ACM SIGMETRICS Achievement Award, Chairman of IFIP Working Group 7.3 from 1985-89, and arguably the most successful mentor of students in the field – passed away on October 4, 2005, at the age of 61. This paper surveys Ken's contributions.

Categories and Subject Descriptors
A.0 [**General**]
C.4 [**Performance of Systems**]

General Terms: Measurement, Performance, Design.

Keywords: Sevcik.

1. INTRODUCTION
For more than 30 years, Kenneth C. Sevcik was one of the leading figures in the SIGMETRICS and IFIP W.G.7.3 communities. His contributions were sustained, long-lasting, and high-impact. They were remarkable for their diversity: affecting both theory and practice; encompassing fundamental research results, a seminal textbook, and software; advancing performance evaluation methodology, the application of performance evaluation to fields such as data management systems, and these other fields themselves. Finally, Ken was unsurpassed as a mentor of students who themselves have contributed to the field.

Ken received a B.S. from Stanford in 1966 and a Ph.D. from the University of Chicago in 1971. His bachelors degree was in mathematics and his Ph.D. advisor was Linus Schrage, an "OR-type"; his thesis concerned optimal processor scheduling under hyperexponential service times and non-negligible preemption overhead.

Upon graduation, Ken joined the rapidly expanding University of Toronto computer science faculty in the newly-formed Computer Systems Research Group, with a mandate to collaborate in the design of the SUE Project operating system.

Thus, by background Ken was perfectly positioned for the then-emerging field of computer system performance analysis using queueing network models, by employment choice was firmly committed to collaborating with a wide range of systems-oriented faculty and students, and by his open nature fostered professional relationships widely among both researchers and practitioners in many fields – all characteristics that distinguished his career.

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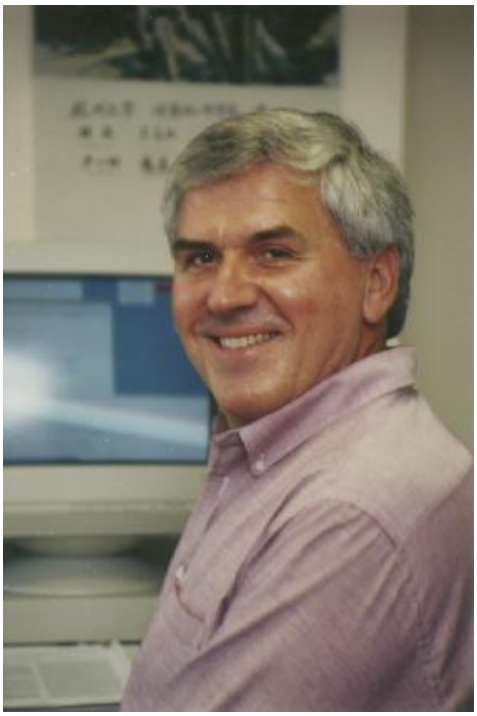

Kenneth C. Sevcik
May 7, 1944 – October 4, 2005

2. TECHNICAL CONTRIBUTIONS TO THE PERFORMANCE ANALYSIS FIELD
Ken's major areas of technical contributions to performance analysis (excluding contributions to other fields of computer systems, such as operating system security and medical database applications) include:

- Scheduling results for single queues and simple queueing network models (early to mid 1970s). This thread of work grew out of Ken's thesis research at the University of Chicago under Linus Schrage; see, for example, [6].
- Studies of the impact of various simplifying assumptions on the accuracy of performance models (mid 1970s and on); see, for example, [7]. Ken was a voice of reason and scholarship in the sometimes heated debate concerning Operational Analysis that took place in the late 1970s and early 1980s.
- The design and performance analysis of database systems and file structures (late 1970s and on). A later paper with Koudas [3] is typical: an award-winning paper in the database community which proposes a new approach to an important problem (in this

case, the Multidimensional Spatial Join algorithm for multidimensional joins in data repositories that include a variety of data types) and intelligently applies performance analysis techniques to demonstrate the superiority of the proposed approach.

- Early iterative approximation techniques for non-separable queueing networks, e.g., priority scheduling (late 1970s to mid 1980s). For example, [8] introduced the "shadow CPU approximation," one of the earliest iterative approximation techniques for important computer system characteristics that violated the conditions required for the efficient exact solution of queueing network models. This approach stood the test of time and became the model for many others.
- Understanding and exploiting separability and decomposability (late 1970s to mid 1980s); for example, [9] explores a variety of approaches to improving the accuracy of representing aggregated subsystems in performance models.
- Fundamental insights into the behavior of separable queueing networks; for example, [10] proves a key relationship between arrival instant queue population distributions for a given network and the equilibrium measures for the same network with one fewer customer. This relationship is key to the Mean Value Analysis computational technique for solving separable networks, and to the explosion of approximate solutions that followed this result, using the clear intuition it provided.
- Performance bounding techniques: balanced system bounds, bound hierarchies, and multi-class bounds (mid 1980s). For example, [2] is the third in a sequence of papers with Eager and others that conveyed tremendous intuition about computer system performance and computer system performance model behavior by extending traditional asymptotic bound analysis to balanced system bounds, bound hierarchies, and multi-class bounds.
- Performance analysis of multiprocessor hardware and software, including a myriad of central issues, such as cache coherence, processor scheduling, and memory allocation (early 1990s and on). For example, [5] presents formal results exposing the inter-dependence of memory and processor allocation decisions, and then uses the insights obtained to propose and analyze a practical, robust combined strategy.
- Performance analysis of communication networks, networks of workstations, and streaming media servers (mid 1990s and on). As one example, [1] analyzes issues of capacity, efficiency, and fault tolerance in an experimental system providing variable bit-rate encoded streams.

These are highly substantial contributions, reflecting a career dedicated to advancing the theory, practice, and application of computer system performance analysis.

3. BROADER CONTRIBUTIONS TO THE PERFORMANCE ANALYSIS FIELD

Four more "general" contributions combine with these to truly set Ken apart:

- Ken's contributions to the text/reference *Quantitative System Performance: Computer System Analysis Using Queueing Network Models* [4]. This book was a landmark in many respects, and highly influential. It was devoted to the theory, practice, and application of queueing network models. It advanced the field in a number of dimensions, as the authors sought to "fill the gaps" in understanding and achieve integration among techniques that conflicted with one another. It utilized Mean Value Analysis and the Operational approach. It progressed through the entire "menu": Little's law; bounding analysis; single and multiple class separable models; the representation of memory, I/O, and processor subsystems; and (in more cursory treatment) extended applications such as communication networks, software resources, and concurrency control. It was focused on the practitioner, including extensive discussions of parameterization for existing systems, evolving systems, and proposed systems. The fact that Ken and his co-authors were concurrently developing the MAP queueing network modeling software package and its RMF parameterization tool meant that the techniques described in the book were "battle tested." (BEST/1 preceded and exceeded MAP – we cite MAP for its impact on the direct applicability of the techniques described in the book.)
- Ken's continuous leadership of the performance evaluation field, and the hugely positive impact of this leadership. Ken established himself as a leader of the field in the late 1970s. His influence derived not just from being smart, but from being conscientious, honorable, non-judgmental, and always open towards new ideas. For example, although a stochasticist by inclination and training, he refused to be drawn into the rhetoric and politics of Mean Value Analysis and Operational Analysis. Rather, he buckled down and did a great deal of technical work to deeply understand the relationships. His "conversion" thus had significant impact (and educational value). Specific examples of Ken's leadership contributions include serving on the SIGMETRICS Board of Directors, serving as Chair of IFIP W.G.7.3, serving as Editor of *Performance Evaluation*, serving as co-Editor of an *IEEE Transactions on Computers* Special Issue on Computer System Performance, serving as General Chair of Performance '80, serving as Program Chair of the 1988 SIGMETRICS Conference, and serving as a Program Committee member for nearly 50 conferences in the performance evaluation, database, and distributed processing fields.
- Ken's role as a mentor in the field. Ken graduated 22 Ph.D. students, most of whose dissertations were in the performance evaluation field – very likely a record both in quantity and in impact. The topics of their dissertations include scheduling (Zaw-Sing Su), characterizing distributions (Ed Lazowska), approximate solution techniques (Satish Tripathi, John Zahorjan, Robbe Walstra), performance bounds (Derek Eager), distributed system performance (Ernie Chang), database system performance (Stavros Christodoulakis, Bruce Galler, Alaa Serry, Ignacio Casas-Raposo, William Hyslop, Daniel Zilio, Nikolaos Koudas), software system performance (Jerry Rolia), multiprocessor performance (Hui Li, Karim Harzallay, Eric Parsons), and network performance (Michalis Faloutsos). He also graduated 50 M.Sc. students, many of whom (e.g., Martin Kienzle) made significant contributions to the field. The same characteristics that made Ken an outstanding leader made him an outstanding mentor: he was conscientious, honorable, non-judgmental, and always open towards new ideas.
- Ken's success at bridging academia and industry, theory and practice. As exemplified by the *Quantitative System Performance* text/reference and the MAP queueing network modeling software package, Ken always worked diligently to translate his research results into practice. He taught or co-taught more than sixty short courses directed towards industrial audiences. He served as a consultant on computer system performance issues to a wide

range of corporations, both within and outside of the computing industry. His success in these endeavors was honored with the prestigious *Award for Excellence in Research* from the Information Technology Association of Canada (ITAC) and the Natural Sciences and Engineering Research Council of Canada (NSERC), recognizing research excellence of benefit to both academia and industry.

4. PH.D. STUDENTS

Ken lives on through the students he mentored. He graduated 22 Ph.D. students, the first in 1975 and the last in 2004:

1. Su, Zaw-Sing, *Dynamic Scheduling with Preemption: A Deterministic Approach* (1975)
2. Lazowska, Edward D., *Characterizing Service Time and Response Time Distributions in Queueing Network Models of Computer Systems* (1977)
3. Tripathi, Satish K., *On Approximate Solution Techniques for Queueing Network Models of Computer Systems* (1979)
4. Chang, Ernie, *Decentralized Algorithms in Distributed Systems* (1979)
5. Zahorjan, John, *The Approximate Solution of Very Large Queueing Network Models* (1980)
6. Christodoulakis, Stavros, *Estimating Selectivities in Data Bases* (1981)
7. Galler, Bruce *Concurrency Control Performance Issues* (1982)
8. Eager, Derek *Bounding Algorithms for Queueing Network Models of Computer Systems* (1983)
9. Serry, Alaa, *An Analytical Approach to Modelling IMS Systems* (1984)
10. Walstra, B. Robbe J., *Iterative Analysis of Networks of Queues* (1985)
11. Casas-Raposo, Ignacio, *PROPHET: A Layered Analytical Model for Performance Prediction of Database Systems* (1986)
12. Hyslop, William, *Performance Prediction of Relational Database Management Systems* (1991)
13. Rolia, Jerome, *Predicting the Performance of Software Systems* (1991)
14. Li, Hui, *Software Approaches to Memory Latency Reduction on NUMA Multiprocessors* (1995)
15. Harzallah, Karim, *Impact of Memory Contention in Large Scale Multiprocessors* (1996)
16. Parsons, Eric, *Coordinated Allocation of Processors and Memory in Multiprocessor Operating Systems* (1997)
17. Zilio, Daniel, *Physical Database Design Decision Algorithms and Concurrent Reorganization for Parallel Database Systems* (1998)
18. Koudas, Nikolaos, *Fast Algorithms for Spatial and Multidimensional Joins* (1998)
19. Faloutsos, Michalis, *The Greedy, The Naive, and The Optimal Multicast Routing: From Theory to Internet Protocols* (1998) [co-supervised with A. Banerjea]
20. Anastasiadis, Stergios, *Supporting Variable Bit-Rate Streams in a Scalable Continuous Media Server* (2001) [co-supervised with M. Stumm]
21. Nguyen, Uyen Trang, *Congestion Control for Multipoint Communications in ATM Networks* (2003) [co-supervised with I. Katzela]
22. Hai Wang, *Concise and Accurate Data Summaries for Fast Approximate Query Answering* (2004)

5. M.SC. STUDENTS

Ken graduated 50 M.Sc. students, the first in 1972 and the last in 2004:

1. Tran, Tuan Khan, *The Response Time Distributions of Some Computer Scheduling Disciplines* (1972)
2. Lester, Eleanor A., *The Investigation of Service Time Distributions* (1973)
3. Lazowska, Edward D., *Scheduling Multiple Resource Computer Systems* (1974)
4. Lam, Lettice Hung, *Comparison of Three Logical Views of Data in Hospital Information Systems* (1974)
5. Schumacher, Helmut, *The Synthesis of Optimal Decision Trees from Decision Tables* (1974)
6. Tripathi, Satish, K., *Approximate Models of Multi-Programmed Computer Systems with Paging* (1975)
7. Lum, Wade C., *Data Collection, Reduction and Analysis of Computer System Measurement* (1975)
8. Cheung, Stephen Chun-Lap, *A Computer Method for Cyclical Scheduling of Shift Workers* (1975)
9. Shen, Helen *The Effect of Interarrival Times in Scheduling* (1975)
10. Spirk, Franz *An Analysis of Different Deadlock Control Schemes* (1975)
11. Lin, Hing-Lung *Closed Queueing Network Models: Computational Algorithms with Application to Computer System Performance Evaluation* (1976)
12. Dubien, Ronald J., *Extending a Commercial Database System to Provide Data Independence* (1977)
13. Kienzle, Martin G., *Measurements of Computer Systems for Queueing Network Models* (1977)
14. Kidd, Robert John, *A Common Model for Multi-Key Access Performance Evaluation* (1978)
15. Lai, Chi Sang, *Patient Identification and Record Linkage* (1979)
16. Au, Matthew, *Some Properties of Queueing Network Models* (1981)
17. Bell, Barbara, *Database System Performance Prediction: The First Two Levels of a Multi-level Modelling Framework* (1981)
18. Casas-Raposo, Ignacio, *Analytic Modelling of Database Systems: The Design of a System 2000 Performance Predictor* (1981)
19. Eager, Derek, *Robust Concurrency Control in Distributed Databases* (1981)
20. Bobrowski, Christoph, *The Principle of Maximum Entropy in Some Computer System Modelling Problems* (1983)
21. Vopalensky, Jan *The Scheduling Problem in Distributed Computer Systems: Its Definition and Partial Solution* (1983)

22. Martin, Vickie, *SPIRAL ONE - Dynamic Hashing Scheme* (1983)
23. Aldwinkle, John, *A Scheduler for UNIX* (1984)
24. Gelblum, Michael, *Some Results of the File Placement Problem* (1984)
25. Rolia, Jerome, *Performance Estimates for Multi-tasking Software Systems* (1987)
26. Coatta, Terry, *Queueing Networks With State-Dependent Service Rates* (1987)
27. Clarke, Graeme, *Performance Properties of the FDDI Token Ring* (1987)
28. MacLean, Richard *Performance Characteristics of the FDDI Token Ring Priority Mechanism* (1989)
29. Lee, Jei-min, *Concurrency Control Through Hierarchical Synchronization* (1989)
30. LeBel, Edgar, *Sparse Undistributed Memory: A Local Storage Model for Pattern Matching* (1990)
31. Cupit, Brian, *Parse Tree Based Revision Control and Program File Compression* (1990)
32. Verma, Raj, *A Metric Approach to Isolated Word Recognition* (1991)
33. Srikantiah, Nandini, *Processor Scheduling in Hierarchical NUMA Multiprocessors* (1991)
34. Bacque, Ben, *SUPERMON: Flexible Hardware for Performance Monitoring* (1991) [co-supervisor with K. C. Smith]
35. Marwood, Simon, *Performance Comparison of Concurrency Control Techniques in Partitioned Systems* (1993)
36. Wu, Chee Shong, *Processor Scheduling in Multiprogrammed Shared Memory Computer Systems* (1993)
37. Larson, Johan *Domain-Partitioned Parallel Sort-Merge Join* (1995)
38. Wang, Corina, *An Adaptive Rendering and Display Model for Networked Applications* (1996) [co-supervisor with M. van de Panne]
39. Tam, Anita, *Performance Prediction for Parallel Applications* (1996)
40. Anastasiadis, Stergios, *Parallel Application Scheduling on Networks of Workstations* (1996)
41. Soreanu, Gabriel, *A Comparative Study of Interconnection Networks in Large-Scale Multiprocessors* (1996)
42. Wang, Hai, *Approximate MVA Algorithms for Solving Queueing Network Models* (1997)
43. Gibbons, Richard, *A Historical Application Profiler for Use by Parallel Schedulers* (1997)
44. Kennedy, Brett, *Declustering Spatial Data for Range and Join Queries* (1999)
45. Piegaze, Peeter, *Incorporating Time into Computer Cartography: A Digital Atlas of History* (2001)
46. Lu, Jingjing, *Fast Algorithms for Distance-Based Spatial Queries* (2001)
47. Garcia Arellano, Christian, *Quantization Techniques for Similarity Search in High-Dimensional Data Spaces* (2002)
48. Tjioe, Wei, *Finding Structure in Data* (2003)
49. Pham, Hang, *Accurate Two-Dimensional Histograms for Fast Approximate Answers To Queries on Real Data* (2004)
50. Dong, Junfeng, Indexing High-Dimensional Data for Main Memory (2004)

6. RECOGNITION

In June 2004, shortly after his 60th birthday, Ken received the ACM SIGMETRICS Achievement Award "for a career devoted to sustained, long-lasting, and high-impact contributions to computer system performance evaluation in the technical, leadership, and mentoring dimensions."

At that time, many of Ken's SIGMETRICS and IFIP Working Group 7.3 friends gathered at a 60th birthday Festschrift held in his honor at Columbia University, featuring technical presentations and celebrations.

Ken's life ended four months later – on October 4, 2005 – following an extended battle with prostate cancer. ACM SIGMETRICS has named its Outstanding Student Paper award in Ken's honor, a fitting tribute to a person whose greatest contribution, among many great contributions, was the guidance and inspiration he imparted to so many others in our field. A student scholarship in his name has been established at the University of Toronto by his many colleagues and friends.

7. REFERENCES

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[5] Parsons, E.W, and Sevcik, K.C. Coordinated Allocation of Memory and Processors in Multiprocessors. *Proc. 1995 ACM SIGMETRICS Conf. on Meas. and Mod. of Comp. Sys.* (May 1995), 57-67.

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[7] Sevcik, K.C. Computer System Modeling and Analysis: Assessing Some Common Assumptions. *Proc. Seventh Hawaii Int'l. Conf. on Systems Sciences* (January 1974), 37-39.

[8] Sevcik, K.C. Approximations for Priority Scheduling Disciplines in Queueing Network Models. *Proc. IFIP '77 Conference* (August 1977), 565-570.

[9] Sevcik, K.C., Levy, A., Tripathi, S, and Zahorjan, J. Improving Approximations of Aggregate Queueing Network Subsystems. *Proc. Int'l. Conf. on Computer Systems Measurement, Modelling and Evaluation* (August 1977), 1-22.

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