CanQueue 2006: 8th Annual Conference for Canadian Queueing Theorists and Practitioners

Diane Bischak (University of Calgary),
Van Enns (University of Calgary),
Armann Ingolfsson (University of Alberta)

September 14–16, 2006

1   Overview of the Field

Queueing theory is concerned with developing and investigating mathematical models of systems where "customers" wait for "service." The terms "customers" and "servers" are generic. Customers could, for example, be humans waiting in a physical line or waiting on hold on the telephone, jobs waiting to be processed in a factory, or tasks waiting for processing in a computer or communication system. Examples of "service" include a medical procedure, a phone call, or a commercial transaction. Queueing theory started with the work of Danish mathematician A. K. Erlang in 1905, which was motivated by the problem of designing telephone exchanges. The field has grown to include the application of a variety of mathematical methods to the study of waiting lines in many different contexts. The mathematical methods include Markov processes, linear algebra, transform theory, and asymptotic methods, to name a few. The areas of application include computer and communication systems, manufacturing systems, and health care systems. Introductory treatments of queueing theory can be found, for example, in [1] and [2].

2   Recent Developments and Open Problems

Many recent developments in queueing theory have been driven in large part by a greater interest in applications that involve human customers, for example in the rapidly growing call centre sector (see [3]). Humans behave in less predictable ways than, say, jobs in a factory or tasks in a computer system. For example, they may *renege* (abandon the queue), and *retry* later. The needs of human customers are likely to be heterogeneous (motivating the use of *skills-based routing* to connect different customers to different servers) and to vary with time (sometimes requiring transient rather than steady-state solutions). All of these complications lead to interesting mathematical challenges. The interest in modeling reneging has led to a substantial literature by now, for example see [5]. Asymptotic analysis, which in the past typically considered situations where the arrival rate approached the capacity of a system with fixed number of servers, has been rejuvenated by a focus on situations where the arrival rate and the number of servers approach infinity simultaneously (see [4] for the first such analysis). Such many-server asymptotic analysis has resulted in a collection of simple-to-use formulas for recommended staffing, consisting of a linear term (minimum staffing for stability) and a square root term ("safety staffing," to protect against random fluctuations).

In addition to the focus on the call centre sector, applications in health care are becoming increasingly important, for example see [6]. Successful health care applications are likely to require further extensions to

the queueing theory toolkit to accomodate "customers" that are given different priorities and have different needs and "servers" that may group together to work on one "service" and then move on to other tasks. Typical queue performance measures, such as average wait or average cost, will also need to be re-examined, and a greater focus on measuring equity as well as quantification of the medical consequences of waiting may be neccessary.

3   Presentation Highlights

- Carey Williamson (University of Calgary) gave an intriguing keynote lecture on performance modeling of stochastic networks, with a focus on modeling stochastic variation in the number of servers; an issue that is often overlooked in queueing theory.

- Sunil Kumar (Stanford University) discussed some of the economic implications of customer waiting, and models that include such implications.

- David Stanford (University of Western Ontario) described preliminary work on how queueing theory might inform the difficult choice involved in managing organ transplant waiting lists.

- Marvin Mandelbaum (York University) gave an after-dinner lecture about the history of queueing theory in Canada, highlighting important contributions from Canadian researchers in the last few decades and the role of the CanQueue workshops in continuing that trend.

- The workshop included a poster session with several poster presentations; something that has not been tried at past CanQueue workshops. This was a useful addition that facilitated conversations about research during coffee breaks and allowed all participants to present their work while scheduling sufficient time for discussion after each lecture.

- An unplanned highlight was an informal get-together to celebrate the career of Winfried Grassmann, one of Canada's most distinguished queueing theorists, who retired recently. Despite his retirement, Dr. Grassmann shows no signs of slowing down, as evidenced by the two lectures that he presented or co-authored during the workshop.

4   Scientific Progress Made

As at past CanQueue meetings, the unique feature that facilitiates progress on research is that these workshops attract both queuing theorists, who focus on developing new methodology, and researchers who apply queueing theory in various settings. Thus, it provides opportunities for theorists to learn about new application areas and the types of models that are needed for these areas and opportunities for researhers with a more applied bent to get suggestions from queueing theory specialists on potentially useful methodologies or approaches. As well, the 2006 workshop brought together theorists with different foci, for example those that focus on asymptotic analysis versus those that focus on matrix analytic methods, and the interchanges between these groups brought valuable insights on what each of these fields can add to the other. The workshop also provided a forum for graduate students to present their work, even when it is in the beginning stages. Funding from the School of Business at University of Alberta and the Schools of Business and Engineering at the University of Calgary allowed us to provide travel funding to graduate students to attend the workshop.

Although it is too early to mention specific instances, we know that conversations during the workshop have led to collaboration between researchers and changes in research direction. The organizers know from personal experiences that such interchanges during past CanQueue workshops have helped them advance their research.

5   A Note of Appreciation

The organizers would like to thank BIRS staff for their very competent assistance in organizing this workshop. Many participants commented favourably on the superb BIRS facility. The location and the amenities made it considerably easier for us to attract the group of distinguished researchers that attended the workshop.

References

[1] L. Kleinrock, *Queueing Systems, Volume 1: Theory*, Wiley, New York, 1975.

[2] D. Gross and C. M. Harris, *Queueing Theory*, third edition, Wiley, New York, 1998.

[3] N. Gans, G. Koole, and A. Mandelbaum, Telephone call centers: Tutorial, review, and research prospects, *Manufacturing & Service Operations Management* **5** (2003), 79–141.

[4] S. Halfin and W. Whitt, Heavy-traffic limits for queues with many exponential servers, *Operations Research* **29** (1981), 567–588.

[5] S. Zeltyn and A. Mandelbaum, Call centers with impatient customers: many-server asymptotics of the M/M/n + G queue, *Queueing Systems* **51** (2005), 361–402.

[6] L. Green, Capacity planning and management in hospitals. In *Operations Research and Health Care: A Handbook of Methods and Applications (M. L. Brandeau, F. Sainfort, W. P. Pierskalla, eds.)*, Kluwer, Boston, 15–41.