QED Queues: Quality- and Efficiency-Driven Call Centers

Euro Working Group on Stochastic Modeling
Koc University, June 23-25, 2008

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Through examples of Service Operations, with a focus on Telephone **Call Centers**, I review empirical findings that motivate or are motivated by (or both) interesting research questions. These findings give rise to features that are prerequisites for useful service models, for example customers' (im)patience, time-varying demand, heterogeneity of customers and servers, over-dispersion in Poisson arrivals, generally-distributed (as opposed to exponential) service- and patience-durations, and more. Empirical analysis also enables validation of existing models and protocols, either supporting or refuting their relevance and robustness.

The mathematical framework for my models is **asymptotic queueing theory**, where limits are taken as the number of servers increases indefinitely, in a way that maintains a delicate balance against the offered-load. Asymptotic analysis reveals an operational regime that achieves, under already moderate scale, remarkably high levels of *both* service quality and efficiency. This is the **QED Regime**, discovered by Erlang and characterized by Halfin & Whitt. (QED = Quality- and Efficiency-Driven).

My main data-source is a unique repository of call-centers data, designed and maintained at the Technion's **SEE Laboratory**. (SEE = Service Enterprise Engineering). The data is unique in that it is *transaction-based*: it details the *individual operational history* of all the calls handled by the participating call centers. (For example, one source of data is a network of 4 call centers of a U.S. bank, spanning 2.5 years and covering about 1000 agents; there are 218,047,488 telephone calls overall, out of which 41,646,142 where served by agents, while the rest were handled by answering machines.) To support data analysis, a universal data-structure and a friendly interface have been developed, under the logo **DataMOCCA** = Data MOdels for Call Centers Analysis. (*I shall have with me DataMOCCA DVD's for academic distribution.*)

Background Reading

1. Gans, N., Koole, G., Mandelbaum, A. "Telephone Call Centers: Tutorial, Review and Research Prospects." Invited review paper by Manufacturing and Service Operations Management (M&SOM), 5 (2), 79141, 2003.

   http://iew3.technion.ac.il/serveng/References/Gans-Koole-Mandelbaum-CCReview.pdf

2. Brown, L., Gans, N., Mandelbaum, A., Sakov, A., Zeltyn, S., Zhao, L. and Haipeng, S. "Statistical Analysis of a Telephone Call Center : A Queueing-Science Perspective." Journal of the American Statistical Association (JASA), 100, 36-50, 2005.

   http://iew3.technion.ac.il/serveng/References/JASA_callcenter.pdf