Proceedings of the 1999 Winter Simulation Conference
P. A. Farrington, H. B. Nembhard, D. T. Sturrock, and G. W. Evans, eds.

CALL CENTER SIMULATION IN BELL CANADA

Oryal Tanir

Bell Canada
1050 Beaver Hall, 2nd floor
Montreal, QC H2Z 1S4
CANADA

Richard J. Booth

Bell Canada
483 Bay Street, 5th floor North
Toronto, ON M5G 2E1
CANADA

ABSTRACT

Call centers have relied historically, on Erlang-C based estimation formulas to help determine number of agent positions and queue parameters. These estimators have worked fairly well in traditional call centers, however recent trends such as skill-based routing, electronic channels and interactive call handling demand more sophisticated techniques (see Cleveland and Mayben 1997). Discrete event simulation provides the necessary techniques to gain insight into these new trends, and helping to shape their current and future designs. This paper relates the experiences of designing call center simulations in Bell Canada. We the experience of constructing, executing and analysing a large call center model. Problems that we faced are identified and potential solutions are given. The examples are taken from large and small call centers alike in the attempt to bring forth some common problems that a simulationist will face.

1 INTRODUCTION

As is in most businesses, Bell Canada's relationship with its customers is a mission critical part of its success. It is the customer call center where customers experience the real personality of our business. This is key to their overall perception of Bell Canada's value as a services provider. We meet here to understand their needs, and offer product and service solutions and support. We must create a positive experience (quality of service), promptly (speed of answer), serving many customers (average wait time, customer serving time, and large variable call volumes), at their convenience. Understanding this complex relationship is strategically important. Discrete event simulation provides a way to search deeper into this relationship.

We believe the call center environment contains interesting opportunities and challenges for simulation. There are many viable problems within a simulation context. We find simulation can add value to:

- Customer queuing strategies,
- Agent versus electronic channel utilisation,
- Load analysis,
- Scheduling impacts,
- Process redesign,
- Executive Learning,
- And many other related problems.

There are common steps to follow and hurdles to overcome in all these problem areas. The following sections will identify some of the major learning and understandings that was achieved during the design of simulation models in Bell Canada.

1.1 Background

Before discrete event simulation was first considered, Bell Canada's consumer and small business client centers had returned to a provincial alignment (Ontario, Quebec) under regional Vice Presidents. These Vice Presidents reported to a new Customer Care Services Group Vice President. Her focus was to restore operational excellence to the centers while building flexibility and depth by bringing together the other call center teams like the Direct Marketing and Collections Centers.

At that time service levels were borderline, but improving from many months of sub standard performance. Previous company initiatives had a strong cost focus. Service had become a variable rather than a given. The result was service chaos and disheartened personnel.

Each of the centers struggled to redefine their business processes. Traditional projection and scheduling techniques were proving limited as the nature of our business was changing. These business drivers altered calling patterns and serving times as the complexity of the call mix and contact increased. Business Transformation projects were underway to redefine the call center and force management processes.

Business strategy drove initiatives designed to leverage Integrated Voice Response (IVR) technologies linked with sophisticated self serve applications. The very nature of the customer contact was now different. Optimistic utilisation targets coupled with continued financial pressures further complicated the planning of the live answer part of the business.

Leadership began to focus on integration and redefinition of the customer serving processes. A vision emerged focusing on the customer's perception of the value with their entire experience. Simulation opened a new avenue of exploration. The integrated business system needed to be understood better than before. Conventional wisdom had to be challenged or validated. Broader inter-relationships were in play and needed to be studied. Linear cause and effect were not enough. We wanted to deal with the whole system in a dynamic real time setting based on the discrete drivers of work and we could not afford to test these new ideas on our customers. It was time to consider simulation in our system of business processes.

1.2 The Customer Experience

The Group Vice President of Customer Care Services shared her vision involving simulation*: A full end-to-end working model of the entire Customer experience*. She wanted to be able to assess the impacts of any major change on the whole system from a service and resource perspective. She believed that leadership needed this tool to develop a systems understanding of each business scenario.

The customer experience (refer to Figure 1) begins at the point in time they are in contact with us and identify their need, to the point in time their need is completely fulfilled to their satisfaction, measured from their point of view.

Customer contacts are categorised by the nature of the request. We would say the customer needs:

- product and service information,
- to order products and services,
- order status information,
- instruction,
- to pay their bill,
- to report discrepancies or troubles, and
- to comment.

Some needs are satisfied with a simple single contact while others require a more sophisticated series of tasks involving many systems and personnel. These needs define key attributes (customer serving time, resource type, probabilities associated with process sequences, etc.) of the initial discrete event, the customer contact.

Customers contact us through their choice of entry point. We provide basic telephone access through our branded 310-BELL, and campaign specific access through advertised 1-800 numbers. We also provide more sophisticated access through screen-phones, mall kiosks, and Internet. All of these will be included in the final end-to-end model.

2 BELL CANADA'S APPROACH TO SIMULATION

From the onset, the Bell Canada model was envisioned as a *living model*. This implies that it would be one where it is used and reused to assess the impacts of business decisions within different operations groups. Unlike traditional simulation models which are built and then discarded, this one was intended for use in long term support to the business decision making process.

The scope of the simulation project was therefore to model the entire customer experience. We began our modelling with a subset of the business system, the consumer call centers. They represent a significant portion

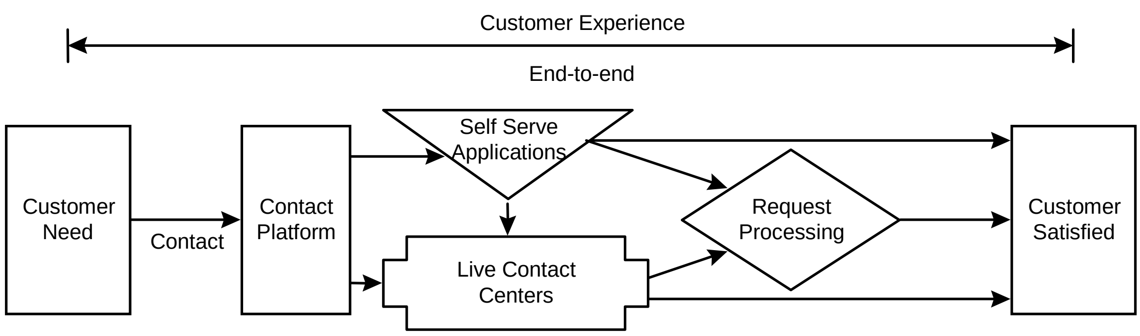

Figure 1: The Bell Canada Customer Experience

of our end-to-end business model from both a service and cost perspective. Other project teams were focusing on new customer contact handling process designs, and new call routing and force management algorithms. Since various groups were already using data for their own purposes, collecting data for simulation was thought to be straightforward. This proved to be much more challenging (this is elaborated upon in later sections).

Calls would arrive, in our initial model, from the Integrated Voice Response (IVR) system and enter the Automatic Call Distribution (ACD) systems looking for the next available agent. The major queue groupings were broadly defined as Sales, and Sales & Service. The call distribution system provided our time based call detail and half-hourly service detail we required. Staffing detail was also available from our line admin groups. Later on we incorporated the IVR data which provided precise time detail. This greatly improved the accuracy of the simulation.

To construct business simulations, a basic process was followed (outlined in Figure 2). First, the problem was identified and scoped. Then a data collection phase was undertaken. Dependant upon the nature of the data, the model was then designed. The model underwent several iterations as new data was made available. Finally an experimentation phase was undertaken where different scenarios using the model could be played out. Again, the model may be refined and changed depending upon the experiments to be executed. Sometimes the experimentation activities may invoke a need for further data (hence the dashed feedback arrow in the figure).

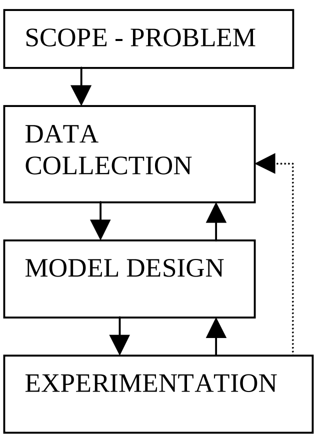

Figure 2: The Call Center Simulation Process

The scope and problem has already been outlined in the preceding section. Each of the other steps is elaborated upon in the following sub-sections.

2.1 Data Collection

One of the first steps in designing a model is assessing and gathering the required data. This task is often underestimated in terms of the time and effort that it consumes. There is a close relationship between the available data and the eventual shape the model will take. This section identifies some of the key considerations when undertaking a significant call center modelling exercise.

There can be many different types of data to consider as input to a model. Commons to call centers are:

- Call volumes: This type of data refers to arrival rates of incoming calls. These can be calls per period of time, time between calls, call spread across a day, and call arrivals based upon a particular random distribution.
- Service times: This type of data identifies delays in processing calls. Hence data can be, customer service time, talk time / call handling time, or routing delays.
- Routing data: Many data is comprised of a portion of total volumes that translate into percentages. For example, 10% of calls may be of a particular type. This could then identify a routing probability in the model for this particular call type. Another example is percent transfers between agent groups.
- Schedules: Identification of when and how many resources are available throughout a time period is important in accurately modelling resource requirements.
- Financial data: Data related to the cost of using resources, fixed costs, overhead costs and Activity based Costs.

The data will have numerous fields, requiring understanding and interpretation. The simulationist has the arduous task of meeting with the data owners to extract the relevant meanings from the data for the model. In creating the Bell Canada model, these activities were exceptionally tedious. The data pool, while rich in content, is immense and distributed across a heterogeneous computer network. The legacy nature of many of the systems in existence required manual intervention in order to extract data. Database queries were also written to extract other portions of the data. At the end of the data collection phase, approximately 10% of the raw data was distilled and eventually used in the model.

It is very important to understand where the lowest level of granularity in the model should be. Adding too much detail into the model may not provide additional insight into the business system’s behaviour and is also hard to keep current.

In the Bell Canada model some assumptions were made to limit the granularity of the data as well as focussing on the areas that were of interest:

- The workforce that is modelled is approximately 50% of the real one. This is due to the fact that the model does not capture training times, vacation times, different competency levels of agents, and managerial time.
- Financial input to the model was limited to hourly resource costs associated with the agents based upon an average wage.
- Initial call volumes were based upon Automatic Call Distribution (ACD) data collected at half-hour increments.

Data integration into the model involved several steps:

First, the data was moved into a spreadsheet. This involved extracting and formatting the data from databases, or in some cases hard-copying data fields manually into a spreadsheet. The data covered a wide range of periods. There were many samples of daily data, abnormal events and sub-normal periods. Initially we were interested in a typical daily data set. What was quickly discovered was that call patterns for each day were generally the same. What varied was the volume. By identifying inter-day and then inter-week factors, a correlation was made to depict any typical day of activities in Bell Canada.

The call volume data was first fitted into three different statistical distributions using the ACD data. The statistical variables for the distributions were all parameterised so that the volume can be changed to simulate any given day.

2.2 Model Design

The intent in creating the initial model was to create one that represents how the business currently operates. The output of the baseline model would then be verified against the available data to provide a comfort level in the model. Once the confidence level with the model is achieved, it can then be used to explore various scenarios through experimentation.

Once the relevant data sources were identified and acquired, a model was created reflecting the principle activities of the call centers. SIMPROCESS (a product of CACI inc.) was used as the simulation tool for constructing and running the models. The principle activities were derived from existing process maps and subject matter experts.

In the case of process maps, and abundance of information was available from past business transformation initiatives. However, for our purposes most of the information was at a very low-level of detail. The low-level information was translated into a more abstract representation in the model. This is a normal occurrence when moving process map related information into a simulation model. Generally, one does not want to simulate at the lowest most levels of detail that is outlined in a process map. Simulation provides a means for abstracting away micro details in favour of macro information.

For example, a process map that represented the activities of a part of a call center typically contained over 60 process map nodes. These were abstracted to create a simulation model shown in Figure 3. As can be seen the simulation model can present a far more visually simplified view of the system (it contains less than 20 modelling elements).

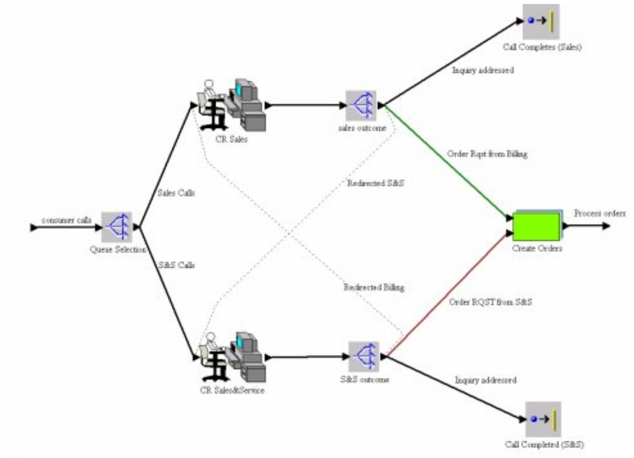

Figure 3: A SIMPROCESS Snapshot of a Sub-model

Information is obviously lost when moving into a more abstract representation. However, if care is taken, the critical decision points identified by the process maps will be captured in the simulation model. A simple example of this is a case where a process map may describe six decision nodes to determine what a customer needs. These six nodes can be represented by one six output branch where the branching is based on a probability of a given decision occurring.

Consulting subject matter experts is necessary to refine and validate the model. Unfortunately this can also be a complicated task. It may not be apparent who the right people are and in many cases there may be reluctance to share information. In creating the Bell Canada model, there were some additional difficulties to overcome.

- Firstly, since Bell Canada operates across two provinces, it employs slightly different sets of processes for the two geographic regions. This necessitates the construction of two regional models versus one.

- Secondly, two official languages are spoken across the provinces, hence data sources will utilise both English and French acronyms. This creates an additional step in trying to understand the data.
- Finally, the statistics gathered and interpreted in the two regions are slightly different and need careful understanding before they can be entered into a model.

The Bell Canada model was designed in a top-down fashion – identifying first the high level processes and then drilling down to lower level ones. A top down approach, versus a bottom-up is highly recommended for complex models (Tanir 1997) since:

- Entering high level processes early on permits process owners to quickly identify incorrect interpretations of the processes. It is therefore a great step in the validation of the model.
- Adding more detail as required permits one to quickly establish a feel of the level of granularity required in the model to achieve meaningful results. A bottom-up approach commences with a presumed level of detail, which may or may not be sufficient to capture the required behaviour of the system.
- A hierarchical modelling tool naturally fits well with a top down design approach.

The model was run through multiple replications of daylong scenarios to achieve a good confidence interval and then compared to the actual data. A parameter that was of particular interest was the call volume. Hence this parameter along with others was used to measure the accuracy of the simulation. The results of the runs are shown in Figure 4.

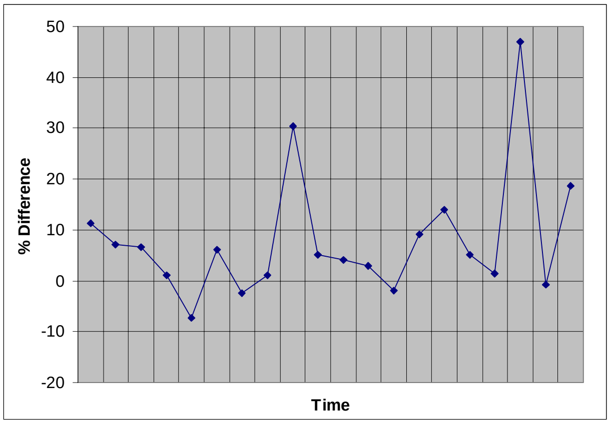

Figure 4: Simulated Results Using ACD Data

The figure identifies the differences between the empirical and simulated values. As can be observed in the figure, there are points in the day where the difference in simulated versus actual data is quite significant At times the difference can be as high as 48%. This was an indication that during those portions of the day, there was substantial variability in the call volumes. The average variation across a day was 7.9%.

To improve the simulation, a tighter fit of data was required. This was achieved by using IVR data. IVR data creates records at a much finer level. Hence call volumes for a given day could be represented within 5-minute increments (rather than 30 minutes with the ACD). This capability permitted us to model the daily variability more closely. The improved representation of call volumes is given in Figure 5. As can be seen the difference between empirical versus simulated runs is much smaller. The overall variation was 3.7% for the day.

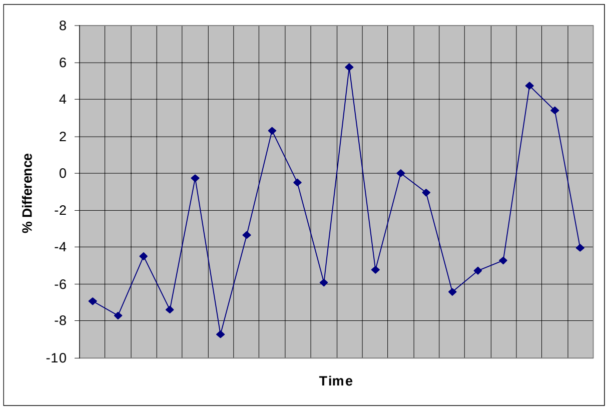

Figure 5: Simulated Results Using IVR Data

Using a similar approach, daily patterns and comparisons of the simulated versus empirical results for other key indicators were examined and the model was further enhanced. Finally the model was developed to a degree of accuracy required for experimentation.

2.3 Experimentation

One of the key motivators for simulation is the capability for experimentation. This topic deserves far more attention than can be provided here. In the context of the Bell Canada model, the model has been used to provide insight in many different scenarios and will continue to do so.

Call center models in general can be useful in creating what-if-scenarios such as:

- "what happens when there are abnormal call volumes?",

- "what happens if we provide an alternate access point for our customers?",
- or "can we handle the call requests from a new marketing campaign?".

Some points to consider when doing what-if-type scenarios are:

- One may want to use actual call volumes to replicate a given day as a base, and use it as a benchmark against proposed changes. This provides a mechanism for reasoning along the lines "If we had done things this way back in (a given date) this is how the business system would have reacted…".
- Alternatively, using random variables and statistical distributions, a more generalised scenario could be examined. Such experimentation is invaluable for understanding the effects of variations external or internal to the business system. An example of a problem that can be addressed is "This is the relative increase in customer response times if we decrease the number of available customer agents. " The dynamic nature of the model can be extremely helpful in gaining insight into the effects of changes to the system.

For example, our first working model demonstrated the sensitivity of service to changes in available resources. It was shown that the lack of resources at key moments in the day can cause service (percent of calls answered within 20 seconds) to be lost and not recovered for the remainder of the day. Our model did not take into account the impact of extreme variations in this service indicator. We know that when wait times exceed certain parameters, the abandon rate increases as well as the customer serving time, further exacerbating the situation. In a situation where there is adequate staffing (refer to Figure 6), service is always better than 100%. A service level higher than 100% implies that there is overstaffing. For example, a level of 120% indicates that on average 20% of the resource were not utilised effectively for that period of time.

The model was used to examine the effects of using 4% less agents throughout the day. The cumulative daily average indicated that the overall service level could still be acceptable. However when the simulated service level was examined across a day, it was shown that the company would actually provide unacceptably poor service to customers for the latter part of the day (refer to Figure 6). Hence the susceptibility of service levels to minor changes to the number of available agents was an important understanding.

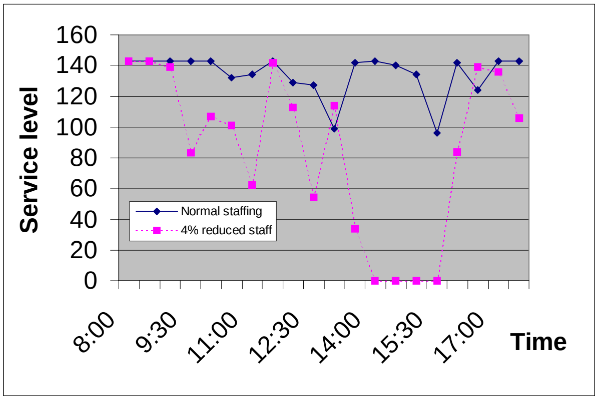

Figure 6: Service Level Example

3 LESSONS LEARNED

In this paper we related some of the insight gained using a simulation of a customer services model configured around call center services. While the natural benefits of simulation such as experimentation was utilised in the Bell Canada model, the modelling process resulted in a deeper understanding of the system. This is an often-overlooked benefit of simulation. The process of simulating a something leads to a better awareness of the system. This aspect of simulation has helped bind different groups in the company to forge a better understanding of the overall business process. With an end-to-end customer view of the business, the different organisations can appreciate the impact their changes will have on the bottom line.

In Bell Canada's case, additional findings and outcomes were:

- Consolidations of disperse data sources were undertaken. The simulation process made clear that operational data was not being used effectively. Consequently, consolidating the various data sources and extracting meaningful and a much better understanding of how sensitive the business processes are.
- Data was truly a bottleneck in the model design. Hence mechanisms or effort spent on automation of data gathering and filtering is generally well worthwhile.
- When crossing across multiple organisations to extract modelling information, there can be a wariness of process experts. This stems from fears that data is knowledge that can be misinterpreted or used incorrectly. These are issues that must be resolved and concerns addressed.
- Data is also contagious. It was found that multiple data sources often build the foundation for a new understanding and subsequently a new data source. Often new

relationships are discovered in the business system-giving rise to a better understanding of the overall system.

- In the course of simulating the business, overlaps, bottlenecks and other opportunities were uncovered. This has paved the way to addressing these and subsequently improving the overall process.
- A managerial issue that is also overlooked is the communication aspect of simulation. A good communication strategy, outlining what simulation is, its benefits and applications is needed to educate potential business units. Also, as a part of this package, key information concerning the model and examples of its use should also be included.

One more topic that requires the attention of model designers is the tools at their disposal. A standard simulation tool should have a set of features that permit easy construction and execution of the model (refer to Tanir and Sevinc 1994 for a more detailed treatment of this topic). We have identified a few capabilities that we believe are highly beneficial and improve the productivity of the overall simulation process:

- Hierarchical model construction and display is essential to creating a complex design. This feature eases debugging of the model and manages the complexity of the information presented.
- A strong capability to read and write to popular database and spreadsheet formats is also necessary. Most scenarios require modifications in the call volumes or other parameters, which are mostly available within a data source. Hence simplifying the link between the simulator and these sources with good I/O hooks in the tool greatly reduces tedious manual work.
- The speed of the simulator is important. When running multiple replications of the same scenario, the length of execution time quickly becomes a concern.
- Animation/Visualisation is a highly useful feature. There are many benefits. At the early stages of design, it provides a quick form of verification. When the model matures, it quickly becomes a presentation tool for interested parties.
- Closely linked with visualisation is graphical model construction. This capability permits the rapid construction of models by limiting the need for learning details of the underlying simulation language.
- Statistical tools for analysing distributions, controlling experiments, establishing the appropriate number of replications needed for specified confidence intervals are all helpful.

4 CONCLUSION

The Bell Canada model has grown to become an operational business design and decision tool. It is currently in its first phase of development and will be further enhanced and refined to present a more complete picture of the customer experience. As the success of simulation is communicated in the company, more groups are becoming willing to use the model(s) to help solve their specific problems.

Future work on this model is on tightly integrating the database systems to the simulator so that a virtually automatic data entry mechanism is created for the model. Also further enhancements to the model are under consideration, which better reflect the customer experience (such as satisfaction levels and abandonment). We anticipate that the model will be a valuable contribution to the Bell Canada operations decision making process.

ACKNOWLEDGEMENTS

Many individuals within Bell Canada have contributed in building the model presented in this paper. We would like to give our special thanks to Martine Corriveau-Gougeon, who has provided the needed executive support and vision for the project. We would also like to acknowledge the work of Tim Noble and Pierre Locas for co-ordinating the data gathering activities for Ontario and Quebec.

REFERENCES

Cleveland B., and J. Mayben, 1997. *Call Center Management – On Fast Forward*, Maryland, Call Center Press.

Tanir O., 1997. *Modelling Complex Computer and Communication Systems – A Domain-Oriented Design Framework*, New York, McGraw-Hill.

Tanir O., and S. Sevinc, 1994. Defining the Requirements for a Standard Simulation Environment, *IEEE Computer Magazine*, 28-34, Institute of Electrical and Electronic Engineers, Piscataway, New Jersey.

AUTHOR BIOGRAPHIES

ORYAL TANIR is Director of the Business Engineering and Simulation organization at Bell Canada in Montreal. He has been an employee of Bell Canada since 1986. He holds a Ph.D. and a Master's degree in Electrical Engineering from McGill University in Montreal. He is also an Adjunct professor at McGill University's Electrical

Engineering department where he pursues research on simulation environments. He is an active researcher within the discrete even simulation milieu and has published a book and numerous papers on the subject. He is past chairman of the IEEE P1173 working group on simulation as well as member of the ACM, IEEE computer and IEEE communications societies and Senior Member of the Society for Computer Simulation International.

RICHARD JOHN BOOTH is the Director of Client Services in Bell Canada. He is a graduate of McMaster University, where he holds a Bachelor of Science degree in Biochemistry. Since graduating in 1975, he has been an employee of Bell Canada within numerous different groups. During the last 10 years he has been an internal consultant and practitioner in strategic and business planning. His current work is focussed on developing strategies and metrics in the Customer Care Operations of Bell Canada.