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# THE ROLE OF SIMULATION IN CALL CENTER MANAGEMENT

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## ABSTRACT

With recent advances in technology and the changing nature of business, call center management has become a rapidly growing industry. Both technical issues, such as call routing strategies, and management issues, such as forecasting and scheduling, need to be addressed on a regular basis. This presentation will cover how simulation is used to address some of these issues, and when it is not used and why. Strengths and weaknesses of call center management software for forecasting, staffing, and scheduling will be discussed along with the use of discrete event simulation to overcome these critical deficiencies. Experiences with and applications of forecasting, staffing, and workforce management systems at AAA Michigan are included.

## 1 INTRODUCTION

With recent advances in technology and the changing nature of business, call center management has become a rapidly growing industry. The days of the “one size fits all” call center is fast eroding. With mass customization becoming the rule versus the exception, calls can now be easily prioritized and routed to specific agents with multiple skill sets. For example, some banks score their customers on a profitability basis with the most profitable ones being classified as “Gold” customers. These gold customers receive preferential treatment. When their phone number is recognized, the call goes to the front of the queue and is then routed to agents specially trained to handle these customers. In contrast, the least profitable customers follow the traditional first-come-first-served (FCFS) process with no special treatment.

To deal with this myriad of issues now faced by call center managers, many organizations use Work Force Management Systems as a key analysis tool. These systems forecast volumes, determine staffing levels and schedules, and monitor adherence to these schedules. However there are some real difficulties with these systems due to their static nature. In contrast, discrete event simulation is a more flexible and dynamic tool that can be of significant value in developing strategies and analyzing alternatives. This paper addresses some of these key call center management issues, including the strengths and weaknesses of workforce management systems, how and when simulation is used as an analysis tool, and when it is not used and why. Simulation and modeling alternatives used at AAA Michigan will be provided as examples.

## 2 BACKGROUND

A membership organization which has been in business for 80 years, AAA Michigan has over 1.6 million members in its auto club and insures over 1.2 million automobiles. Besides competing in the insurance market in Michigan, AAA also provides Club and Travel services. Club services include auto touring and emergency road service, while the Travel area provides Cruise packages, airline travel, and other vacation packages.

In addition to an extensive branch office network throughout the state, seven call centers operate to provide the following services to members:

- Emergency Road Service (1 center)—Dispatches towing contractors to stranded motorists.
- Member Services (1 center)—Provides insurance service and sales, group insurance service, cellular phone sales, and other general assistance.
- Claim Service Centers (4 centers)—Takes initial reports on all claims taken by phone and handles all smaller claims to completion.
- Central Travel (1 center)—Takes orders for Triptiks, Tourbooks, and Maps by phone and provides airline ticket sales service.

Within this environment, simulation has been a key analysis tool for process re-engineering and continuous improvement, and for providing critical information for management decisions. Although the focus of this paper is on call center applications, discrete event simulation is used for projects throughout the organization from the design of branch offices to the determination of road service equipment and location requirements.

## 3 THE CALL CENTER MANAGEMENT PROCESS

### 3.1 Steps

The effective management of a call center operation generally involves four major steps as shown below. In this process, “Trunk Space Requirements” refers to the determination of the number of phone lines required to receive the volume of incoming calls and the number of queue slots needed to hold the calls during peak time periods.

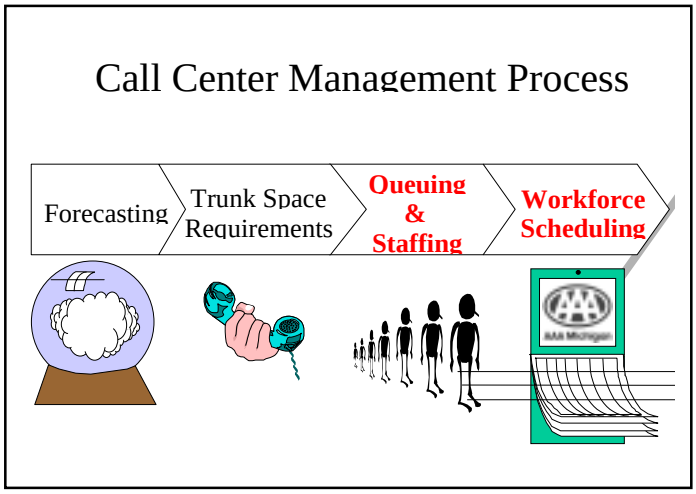


Figure 1: Call Center Management Process

Of the four steps, the business forecast is the most critical. It is the basis upon which trunk space and staff calculations will be made which are used to schedule the workforce to meet service levels and other performance criteria.

### 3.2 Performance Measures

A key performance measure is the Service Level which is defined as the percentage of time (% of half hour periods) that a specified service goal is met. The 80/20 rule is generally used as the service goal where 80% of the calls are to be answered within 20 seconds. Thus a 90% Service Level means that the 80/20 rule is met for at least 90% of the half-hour periods. This service level goal is critical to the determination of appropriate staffing levels when using Erlang C. One of the problems with using the Service Level criteria as defined is that during slow periods of a day (or season) where only a minimum staff is required (e.g. late afternoons and midnights), the 80/20 goal is almost always met. These large number of half-hour periods at low volumes are then weighted equally with the fewer half-hour periods where volumes are high and service levels are low, giving a distorted picture of the true quality of service.

Other key performance measures include:

- Average Speed of Answer (ASA)
- Agent Utilization
- Abandonment Rate (Reneging)
- Average Length of Call
- Percent Answered Without Waiting

## 4 WORK FORCE MANAGEMENT SYSTEMS

### 4.1 Forecasting

In order to effectively run a call center, forecasts are generally needed at several levels: yearly, monthly, weekly, daily, and even every half hour. Longer term forecasts, such as yearly and monthly predictions, are used for budgeting and staff planning, planning operational changes, training, and scheduling vacations. Mid-term forecasts, such as weekly and daily forecasts, are needed for workforce staffing and scheduling. Short term forecasts such as hourly predict how well a call center is staffed for the current day.

Most Work Force Management Systems use exponential smoothing to include trend and seasonal components (Winter's Model). This approach is fine if the time series is relatively stable which is more true for longer term forecasting (monthly or yearly). However, in many call centers, including Emergency Road Service (ERS), these volumes are highly volatile in the short term, resulting in large forecast errors for operational purposes. These large errors eventually lead to considerable over and under staffing and poor customer service. Thus causal relationships (regression analysis) are more appropriate if the causal variables can be identified. These differences in approaches have a significant bearing on how forecasts are handled in simulation models.

### 4.2 Queuing and Staffing

From a recent survey (1997) of the major Workforce Management System vendors, all use the Erlang C model for staffing, with all but one using the basic model. One uses a variation to adjust for abandonments. This Erlang C is the basic M/M/c queueing model which assumes:

- Poisson arrival process
- Exponential service times
- Multiple servers (c) in parallel with a single queue
- All servers are identical, i.e. same distribution (exponential) with the same mean
- Service is FCFS and consists of a single phase
- Unlimited queue length
- No balking or reneging (abandonments)

The M/M/c queueing model is reasonably robust so minor departures from these assumptions for the "one size fits all" call center were not all that significant, the key concern being the exponential assumption. However, in today's technology driven environment, many of these assumptions are invalid and continued use of the Erlang model results in considerable over staffing. Additionally, this model cannot be used for all of the "what if" scenarios that address call handling strategies, call center design, and call routing options. Simulation is a far superior modeling approach which overcomes many of the difficulties of analytical models and assumptions. Another key advantage of simulation for queueing and staffing is that it provides information on variability and extremes, unlike the queueing models that mostly provide averages for key performance measures.

### 4.3 Workforce Scheduling

This module is the main strength of Workforce Management Systems. Given forecasts, desired service levels and associated staffing levels, and operating rules (shift schedules, breaks, lunches periods, meetings, vacations, productivity levels, etc.) staff schedules are developed based on various optimization criteria such as cost/revenue or a balance between over and under staffing.

### 4.4 Analytical Modeling

A Workforce Management System is like a large spreadsheet in that it can analyze scenarios by manipulating a series of inputs through a static model to produce a desired output. These systems along with queueing models can quickly provide reasonable approximations for mid to long term planning scenarios. Some examples would include staffing approximations for budgeting purposes, and "what if" analyses of changes to AAA National quality standards. Building simulation models for these purposes not only takes longer but also may not provide any additional significant or accurate information. On the other hand, many scenarios may have to be generated for a Workforce Management System whereas a single simulation model could answer all of the questions and issues under consideration. Key strengths and weaknesses of Workforce Management Systems are summarized below.

| Pros | Cons |
|---|---|
| • Good at forecasting if variability is low<br>• Assist in entire call center management process<br>• Analytical models are all "built in<br>  ➢ Good for "what if"<br>  ➢ Good at schedule development<br>• Provide a data archive | • Assumes Erlang C<br>• No skill-based routing capability<br>• Limited forecasting capability<br>  ➢ High Variability<br>  ➢ No cause-effect<br>• Cannot handle randomness<br>  ➢ Only provides averages<br>  ➢ Simulation provides variability<br>• Must create multiple scenarios<br>  ➢ One simulation model may answer questions |

## 5 SIMULATION

### 5.1 When to Simulate

There are a number of reasons for using simulation versus analytical models which deal with the deficiencies of the models themselves such as:

- Analytical models not available
- Existing analytical models are too complex
- Static results of analytical models are insufficient
- Analytical models only provide averages, not variability and extremes
- Analytical models cannot identify process bottlenecks or recommend design changes
- Analytical models often cannot provide sufficient detail nor identify interactions
- Animation is a better method of demonstrating results to management

As previously discussed, there are many deficiencies with Erlang-C and the classic queueing models. With the movement towards skill-based routing of calls due to advances in technology, Erlang-C is basically outdated since it assumes that agents have a single skill and there is no call priority (FCFS). Even with partial cross training, using Erlang-C can cause considerable overstaffing. This problem is compounded when it comes to scheduling the workforce. With skills-based scheduling, the call types an agent will handle is dependent upon both other schedules and upon call routing rules. Different call routing rules may be used:

- to protect skill groups
- for time of day or day of week business policies
- to set different call priorities
- to escalate call priorities dependent on the time a call has been in queue
- to queue calls to backup skill groups

With these complexities, simulation has become the best alternative for developing operational strategies for call centers.

### 5.2 Applications

*Emergency Road Service (ERS).* As a result of a re-engineering effort in the ERS call center, several changes were proposed. Prior to the re-engineering effort, a centralized calling center handled mostly Detroit metro area calls while AAA members outside the area had to locate and call a road service contractor directly. For the metro area, the call would be answered by a AAA staff person who would obtain and input key information. This information was then sent electronically to another staff person who would manually (using maps) determine the callers location and the nearest available towing contractor. This information would then be sent to yet another AAA staff person who would then call the independent towing contractor and relay the information for the contractor to assist the member. This process typically took between 10 and 15 minutes with much of the time being spent in various queues.

As part of the re-engineering effort, four key recommendations were to be analyzed.

- Implementation of an electronic spotting system that would automatically determine which contractor to dispatch based on member location (similar to 911 emergency calls).
- Implementation of a call handling system where a single service representative handles the entire process from receiving the call to dispatching a contractor.
- Implementation of a 1-800 number to be used by members statewide.
- Implementation of a system that would dispatch call information to contractors electronically.

The objectives of the project were threefold:

- Quantify how the proposed changes would affect staffing levels and call handling times.
- Verify that the proposed system would actually improve customer service.
- Determine the necessary reduction in mean processing time such that the anticipated volume could be handled with no increase in staff levels.

Initially, M/M/c queueing models were used to get a rough cut of staff levels. One of the dangers with using just the queueing models was that processing time could no longer be approximated by an exponential distribution. The expectation was that a Gamma would be a better approximation which in the end turned out to be the case.

Simulation models (with animation) were structured and validated. Call volumes for metro area operations were first utilized to show the initial effects of the new call handling process on customer service. Additional models were then built to include projected call volumes for statewide operations, learning curve effects, and variances in volume by day of week and season. Each of these scenarios was used to test different staff schedules.

These models of the old and proposed processes demonstrated and quantified the following benefits:

- Statewide operations were possible since automated spotting and dispatching helped to offset the need for higher staff levels.
- Consolidation of the call handling process eliminated queues between servers and reduced call throughput time by up to seven minutes.
- The mean processing time had to be reduced to five minutes in order to handle statewide calls with no increase in staff levels.
- The models provided an effective method of evaluating alternative staff schedules.
- Animation models provided a very effective way to demonstrate the benefits to management.

After two years of operation and additional process improvements, the average handling time goal of five minutes was achieved.

*Claims*. This simulation project was the result of a re-engineering study of the entire insurance claim handling process, including the establishment and operation of additional call centers. Under the initial re-engineered environment, low service levels and high abandonment rates were the general rule leading to a significant decrease in member satisfaction levels. A possible source of these service level problems was in the routing of incoming calls to the claim representatives. One key concept to be tested was that of organizing calls by length versus the more traditional approach where calls are grouped by type. In scheduling theory, a method of maximizing throughput is to use the SPT rule (Shortest Processing Time). This is basically the same concept used by retail establishments with express lines for “10 items or less, cash only.” In call center management, this can be accomplished by the creation of a short-duration gate. However, a key issue with this new approach was the higher skill level required by some groups of claims representatives since a wider variety of call types must be handled.

Simulation models were created of both the current and proposed operations and the models verified. Verification included a comparison of:

- Simulated call volumes to Rockwell data (by time of day)
- Staffing levels to current call center staff (vacations, breaks/lunch, and training schedules)
- Simulated service levels to Rockwell reported service levels
- Abandon rates to Rockwell reported abandon rates (by time of day)
- Call handling times to Rockwell phone reports, MSS pilot study, and claim quality surveys
- Work time to Rockwell phone reports
- Call breakdowns to Claims Processing Systems reports (by type and time of day)

Results of the simulation models provided insights into two key areas, the first being the improvement in service without adding staff and the second being the identification of other process improvement opportunities. The short duration gate provided only slight improvements in the service level measurement criteria (percent of call answered in a specified time period) but significant improvement in queue length and average waiting time. Additionally, as new call centers open, and more staff becomes available, the impact of this short duration gate will be greater than that shown below.

| | Model | |
|---|---|---|
| | Current | Short Duration Gate |
| Abandon Rate | 20% | 15% |
| Service Level (95/60) | | |
| Gate A | 43% | 41% |
| Gate B | 69% | 70% |
| Gate C | 67% | 69% |
| New Gate | | 60% |
| Number Waiting in Queue | | |
| Gate A | 2.74 | 0.84 |
| Gate B | 0.27 | 0.23 |
| Gate C | 0.21 | 0.20 |
| New Gate | | 1.29 |

The results of the simulation also highlighted two process improvement options that needed further investigation. First, what approaches were available to reduce after call work time for the "Generalist" category, and second, what would be the impact of decreasing the number of inquiry calls if certain actions were taken that could increase the average length of calls.

## 6 SUMMARY/CONCLUSIONS

This paper has reviewed the call center management process and key performance measures used to evaluate call center effectiveness. The use of Workforce Management Systems was then addresses, highlighting some of the strengths and weaknesses of these systems and analytical models in general. The advantages of simulation as an analysis tool for call centers was highlighted along with some specific call center applications. From the comparative analysis and example applications some important conclusions can be drawn concerning simulation and the call center management process.

- Forecasting is the most critical step in the call center management process
- Analytical models and specifically Erlang-C
  - are often sufficient for general planning purposes
  - are generally sufficient for the traditional "one-size-fits-all" call center if the assumptions are reasonably met
  - have a tendency to overstaff even the traditional call center as key assumptions are often violated
  - are becoming an obsolete methodology as communications and call center technology advance
- Simulation is a superior analysis tool when
  - dealing with detailed operations
  - accuracy is important
  - demand variability is high
  - animation is needed to sell concepts to management
  - more than just averages are needed to understand the implications of process changes
  - process bottlenecks are to be identified

- Simulation can be used to experiment with new designs or policies without disruption to current operations, allowing call centers to prepare for
  - changes in call volumes
  - introduction of new products and services
  - process improvements
  - revisions to service level goals
- Workforce Management Systems are a mixed bag, working well for scheduling and as an assist to the entire call center management process, but limited in forecasting capability and the ability to deal accurately with advancing technologies such as skill-based routing.

When considering the future role of simulation in the call center management process, Call$im becomes a consideration. Currently it is a standalone product that greatly simplifies the call center simulation process, significantly reducing the development time and allowing for more flexibility in modeling. However, it is an intermediate step in the entire process of making simulation a standard module in Workforce Management Systems. With current and forthcoming technologies leading the change to more skill-based call routing, the entire call center management process is becoming much more complex. Current Workforce Management Systems are not capable of dealing with this complexity. They will have to be redesigned to deal with the new realities. As part of this redesign process, they will have to include simulation. Thus a new Workforce Management System approach might look as follows:

- Generate forecasts by call type
- Generate a system schedule by assigning agents to call types (skill-based)
- Run simulation of system design
- Automatically review forecasted service levels by call type
- Automatically identify agents with needed skills
- Automatically optimize schedules and agent utilization
- Re-run simulation until no further improvements can be made
- Implement and monitor schedule

## AUTHOR BIOGRAPHY

**ROGER KLUNGLE** is the manager of the Business Operations Analysis unit at AAA Michigan. He is responsible for the direction and development of the Management Science function, with emphasis on simulation, forecasting, queuing, scheduling and business process reengineering. His experience with simulation began in graduate school while developing complex simulations of assembly line systems. At AAA Michigan, he was instrumental to incorporating this methodology in service systems with emphasis on Call Center Management. Prior to working at AAA, Roger spent eleven years with American Natural Resources, and fourteen years with the Department of Defense. He is also an adjunct professor at the University of Michigan-Dearborn. He received his B.S. in Industrial Engineering from the University of Michigan, and M.S. and Ph.D. in Operations Research/Statistics from George Washington University.