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OPTIMAL TELEPHONE LINE ALLOCATION OF VOICE ADS SYSTEM

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Introduction

Find-It is a computer driven, interactive voice response (IVR) system. A caller can dial into Find-It to retrieve information from a database or record his own advertisement. With Find-It, a caller can avoid the delay of putting advertisement in a newspaper. In addition, a caller can modify or withdraw her/his advertisement at any time.

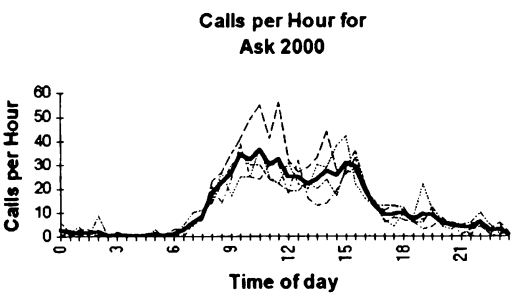
A simulation study was conducted based on the assumption that the calling distribution during the day will be similar to those of ASK 2000, a telephone inquiry system of the State of Hawaii. Different calling volumes were generated based on the calling volume of ASK 2000. A simulation model was developed for *Find-It* allowing us to study different calling volumes from 10% (60 calls per day) to 200% (1200 calls per day) of that of ASK 2000. Line configurations were allowed to change from 4 lines to 20 lines. The simulation model was implemented with the INSIGHT simulation package.

Data Collection & Calling Stream Generation

Our goal was to set up a relationship between caller volume and the number of lines in order to estimate the optimal number of lines for a given caller volume. There are several random variables in the system. It would have been almost impossible to realize our goal with only mathematical and statistical methods. Therefore, simulation was an ideal way to solve this problem.

The random factors of this system are: the caller arrival rate, the length of different calls and the time it takes a customer to complete the call. There are three control variables in our experiment: the caller volume, number of lines and maximum number of messages a customer can listen to. Call length is dependent on the number of calls a caller chooses to listen to, among other things.

To model incoming calls, data was collected from ASK-2000. This state-supported organization which answers community-related questions was kind enough to provide us with data sheets of their calling distribution over time. The information from the data sheets is shown in Chart 1.



<Chart 1>

The average of the days was smoothed on hourly bases. The means of these hourly numbers of calls were then used to calculate Poison streams for the calling volume. Twenty-four of these mean numbers of calls were computed for calling volume generation.

The collection of this information was most critical to the simulation project. Since similar systems do not exist yet, it was not possible to use any other 'real' data. However, we are confident that modeling our incoming calls after the ASK-2000 system provided us with a good estimate. While the peak times for incoming calls may have occurred at different times, this does not affect the general recommendation based on this study.

To control the caller volume in the simulation experiment, we modeled the caller arrivals as a random variable based on the operational data we collected from ASK-2000. First, we defined twenty-four Poison calling streams, one for each

hour. We then assumed the means of each Poison stream to be twice the mean number of calls of that hour from ASK-2000 data. Therefore, we generated twenty-four Poison streams with 200% volume of the ASK-2000 calling volume for each specific hour. At last, we used the thinning technique [Roberts 1987] to fine tune the arrival streams from 200% to 10% of the original ASK-2000 calling volume.

All parameters for other random factors were collected either by manually measuring the time for voice scripts or the time of inputting digits over the phone key pad. We decided a maximum, minimum and average times, then used either a uniform or triangular distribution.

Modeling

A *transient* simulation model was developed because telephone calls have clear patterns of start and end everyday. The calling volume starts low in the middle of the night and gradually reaches a peak from 7:00 a.m. to 6:00 p.m. and goes down rapidly in the evening. (see also Chart 1).

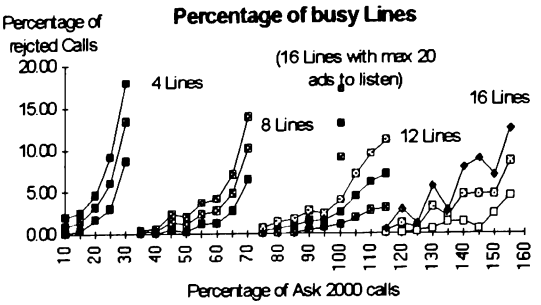
An INSIGHT simulation model was constructed with the following assumptions based on our experiences and observations:

a) Every day has the same calling pattern.
b) Among the calling population, 80% of the callers are first-time callers.
c) All new callers and 10% of old callers will refer to the help menu before proceeding with any options.
d) When a caller punches in codes from a touch tone phone pad, there will be 10% chance that he makes a mistake and tries again.
e) Up to 3% of credit cards cannot be confirmed for various reasons which causes operation to terminate.
f) There is only one modem in the system used for confirming the caller's credit.

For the initial simulation we restricted callers to a maximum of *ten* recordings that could be listened to during each call.

Results and Conclusion

The results with 50 replications for each parameter setting are shown in Chart 2. We can clearly see the relationships between the number of lines and the caller volume. On the basis of these results, we calculated a 95% confidence interval for every test point (the mean of percentage busy from the 50 means of each repetition).



<chart 2>

To examine the impact of callers being allowed to listen to more than 10 recordings, we ran one simulation with 50 repetitions and a maximum of 20 recordings to be listened to. (also shown in Chart 2). The mean time on the system rose from 5 min. 11 sec to over 7.5 minutes resulting in an increase of busy lines of almost 20%. Other simulation results, such as modem utilization (0.2%), were not significant and are negligible.

Based on the risk that management is willing to take, the following guidelines are recommended:

Minimum required lines	Calling volume per Day	
	conservative (95% conf. int.)	risky (mean)
4	120	150
8	360	400
12	600	660
16	720	780

These recommendations are based on the assumption that the maximum number of recordings a caller can retrieve is limited to 10 recordings during peak calling times.

The first version of Find-It has been developed based on this recommendation. The system used four lines and expected to have 120 to 150 calls per day. Our experience of monitoring the system during the first two months shows that our recommendations are valid, although conservative.

References:

Law, A. M. and Kelton. W. D., 1991 *Simulation Modeling and Analysis, 2nd edition.* McGraw-Hill

Roberts, D. S., 1987 *Simulation Modeling and Analysis with INSIGHT*, SysTech