The Center for Hospitality Research

Hospitality Leadership Through Learning

Restaurant Table Simulator

Version 2012

Cornell Hospitality Tools

Vol. 3, No. 3 (April 2012)

by Gary Thompson, Ph.D.

20th ANNIVERSARY 1992 - 2012

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Cornell Hospitality Tools,
Vol. 3, No. 3 (April 2012)

Cornell Hospitality Report is produced for the benefit of the hospitality industry by The Center for Hospitality Research at Cornell University

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Restaurant Table Simulator, version 2012

by Gary Thompson

EXECUTIVE SUMMARY

Restaurant Table Simulator (RTS) is an Excel-based model for simulating table usage in restaurants. RTS, which includes a charts and results tables, can be used to improve a restaurant's mix of tables. While the CHR already has a web-based tool for identifying restaurant table mixes, this version of RTS is useful in that it runs in Excel. The tool contains fill-in tables that will allow restaurant managers to run "what-if" scenarios for different table mixes, using different assumptions. Additionally it provides graphical information that the web-based tool doesn't. Finally, it allows for situations where customers select their own tables, instead of being assigned to a table by a host or hostess, a scenario common in many restaurants. These features make this version of interest and more accessible to a wider group of restaurant managers and hospitality educators.

ABOUT THE AUTHOR

Gary M. Thompson, Ph.D., is a professor of operations management in the School of Hotel Administration at Cornell University, where he teaches graduate and undergraduate courses in service operations management. Prior to joining Cornell in 1995, he spent eight years on the faculty of the David Eccles School of Business at the University of Utah. His current research focuses on restaurant revenue management, food and beverage forecasting in lodging operations, workforce staffing and scheduling decisions, wine cellars, scheduling conferences, and course scheduling in post-secondary and corporate training environments. His research has appeared in the *Cornell Hospitality Quarterly*, *Decision Sciences, Journal of Operations Management, Journal of Service Research, Management Science, Naval Research Logistics,* and *Operations Research*. He has consulted for several prominent hospitality companies and is the founder and president of Thoughtimus® Inc., a small software development firm focussing on scheduling products. From July 2003 through June 2006 he served as executive director of the school's Center for Hospitality Research.

Restaurant Simulator v. 2012

by Gary Thompson

Model Purpose: This model is designed to simulate a restaurant, for the purposes of evaluating and improving upon the restaurant's table mix. Based on an Excel platform, it allows users to input their data to model various table combinations under a variety of assumptions. This document explains how the simulator works and gives examples of various screens, including both inputs and outputs.

Exhibit 1

Input Screen 1

	A	B	C	D	E	F	G
1	Assumptions:				Service Duration (minutes)		Max Tolerable Wait
2	Party Size	Probability	Cumulative Probability	Party Value	Mean	Standard Deviation	
3	1	0.08	0.08	10	60	12	30
4	2	0.25	0.33	20	65	13	35
5	3	0.11	0.44	30	70	14	40
6	4	0.19	0.63	40	75	15	45
7	5	0.16	0.79	50	80	16	50
8	6	0.11	0.9	60	85	17	60
9	7	0.06	0.96	70	90	18	65
10	8	0.02	0.98	80	95	19	75
11	9	0.01	0.99	90	100	20	75
12	10	0.01	1	100	105	21	80
13	11	0	1	110	110	22	80

Summary Instructions

To use the model, please do the following:

(1) Specify the data in the light blue colored cells on first input screen (Exhibit 1).

(2) If customers will be picking their own tables, specify the data in the light blue colored cells on the 'Inputs, Part 2' sheet (Exhibit 2).

(3) Enter the starting table mix in the dark blue colored cells (Exhibit 4).

(4) Click "Clear Results Tracking" to delete any results information from previous trials stored on the "Alternatives Tried" sheet (Exhibit 10).

(5) Click "Simulate the Restaurant" to bring up the simulator interface form, where you specify additional parameters (Exhibit 5).

(6) After running the simulation, review the results in the Utilization Chart (Exhibit 7), on the Results sheet (Exhibit 8), and in the Alternatives Tried sheet (Exhibit 10). If desired, change the table mix in the dark blue cells, and return to step 5.

(7) Through trial and error, you should be able to find improved table mixes, though you will probably reach a point where additional improvements cannot be found. The 'Alternatives Tried' sheet can be helpful for reviewing your progress.

Inputs

In this model, inputs are shown in light-blue colored cells. There are a variety of inputs related to parties, by size:

- the proportion of all parties which that party represents;
- the value of the party (average check, for example);
- the mean and standard deviation of the service duration; and
- a limit on how long the party will wait for a table before departing.

These are illustrated in Exhibit 1.

If you select the option of parties selecting their own tables, you must also specify the likelihood that each size party will choose various table sizes. You do this on the "Inputs, Part 2" sheet, a screen capture of which is shown in Exhibit 2.

Exhibit 2

Input Screen 2

	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
	Probability of the Party Self-Selecting a Table of the Specified Number of Seats															
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
6		0.15		0.05		0.03		0.01								
4		0.2		0.1		0.05		0.01								
		0.77		0.15		0.05		0.03								
		0.65		0.2		0.1		0.05								
				0.8		0.15		0.05								
				0.7		0.2		0.1								
						0.85		0.15								
						0.8		0.2								
								1								
								1								

Exhibit 3

Party arrival specification screen

L	M	N
	Expected Party Arrivals, by Period	
	15-Minute Interval	Expected Arrivals
	1	1
	2	1
	3	1.5
	4	2
	5	2
	6	2
	7	2.5
	8	3
	9	3
	10	3
	11	3
	12	2.5
	13	2
	14	2
	15	2
	16	1
	17	1
	18	1
	19	1
	20	1
	21	0

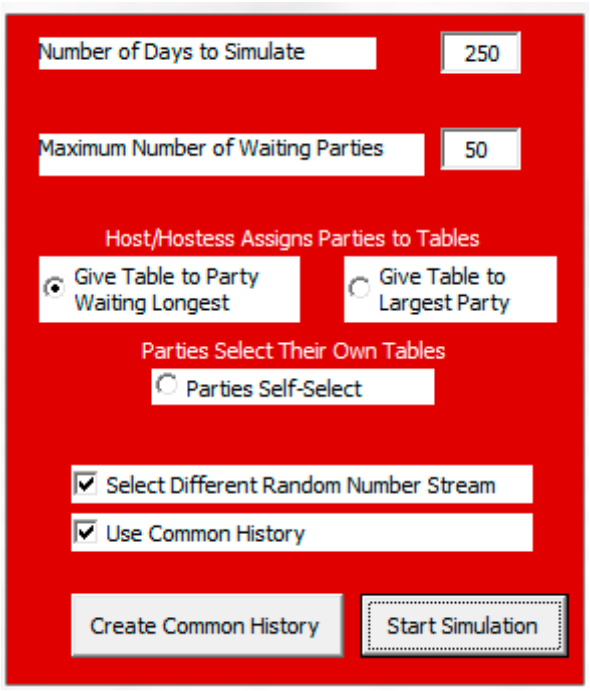
Exhibit 4

Table specification screen

Table Data		
# Seats	Space Reqd	Number
1	1.63	0
2	3.25	0
3	4.88	0
4	6.5	5
5	8.13	0
6	9.75	5
7	11.4	0
8	13	0
9	14.6	0
10	16.3	0
11	17.9	0
12	19.5	0
13	21.1	0
14	22.8	0
15	24.4	0
16	26	0
17	27.6	0
18	29.3	0
19	30.9	0
20	32.5	0
Total Seats:		50
Total Space:		81.25

Exhibit 5

Simulator interface screen



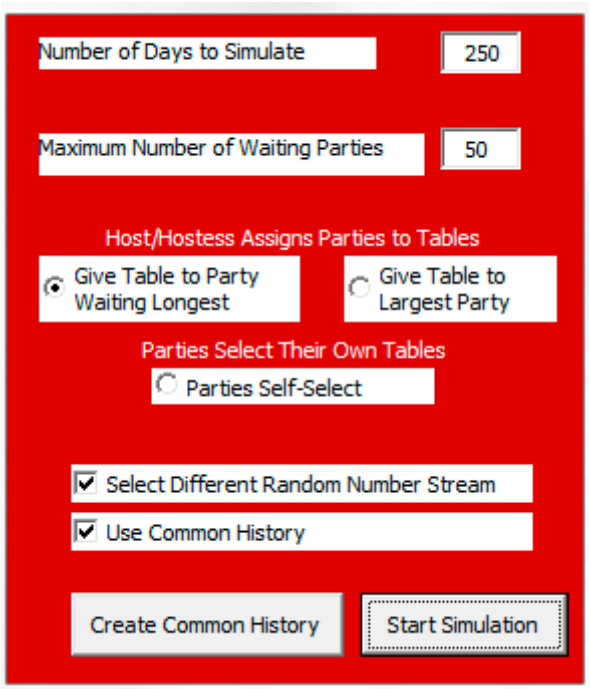
The simulator requires that you specify the number of parties that you expect to arrive, by 15-minute time period, during a peak period of up to 7 hours, as shown in Exhibit 3. You must also specify the space requirements of each size of table being considered, as shown in Exhibit 4.

Also illustrated in Exhibit 4 are the cells, colored in dark blue, where you specify the mix of tables you wish to evaluate. These dark blue cells are the decision cells for this model.

After specifying the data on the "Inputs, Part 1" sheet (and, if appropriate, on the "Inputs, Part 2" sheet), clicking the "Simulate the Restaurant" button will bring up the simulator interface form, which I describe on the next page. I show a screen capture of this form here and on the next page.

EXHIBIT 6

Simulator interface screen and description of parameters



Decisions

After simulating a specific table mix, you can review the results (as I describe on the following pages) and perhaps identify a different table mix to evaluate. You would enter that new mix in the dark-blue cells of the screen in Exhibit 4. Through trial and error, you should be able to find improved table mixes, though you will probably reach a point where additional improvements cannot be found.

Number of Days to Simulate	Number of days that will be simulated. More days require more time to run, but give a better estimate of the true performance.
Maximum Number of Waiting Parties	Think of this as a waiting area in the restaurant, for example. If a party arrives when the limit on the number of waiting parties has been reached, that party will be lost.
Give Table to Party Waiting Longest	If a table frees up, this rule will assign it to longest waiting party that will fit in the table.
Give Table to Largest Party	If a table frees up, this rule will assign it to the largest waiting party that fits in the table (ignoring waits).
Parties Self-Select	An arriving party will select their own table, from those available, based on the probabilities in the "Inputs. Part 2" sheet, Exhibit 2.
Select Different Random Number Stream	Selecting this option will give you different results when you run the model a second time because it will use different random numbers.
Use Common History	This option is useful for comparing different table mixes or table-assignment options, since it uses a common set of information on parties when conducting the simulation. To use this option you should run the "Create Common History" function only once.
Create Common History	This function will create a common set of randomly generated party information (arrival time, size, wait tolerance, service duration) that can then be used to evaluate different table mixes or table assignment options.

Exhibit 7

Sample utilization chart

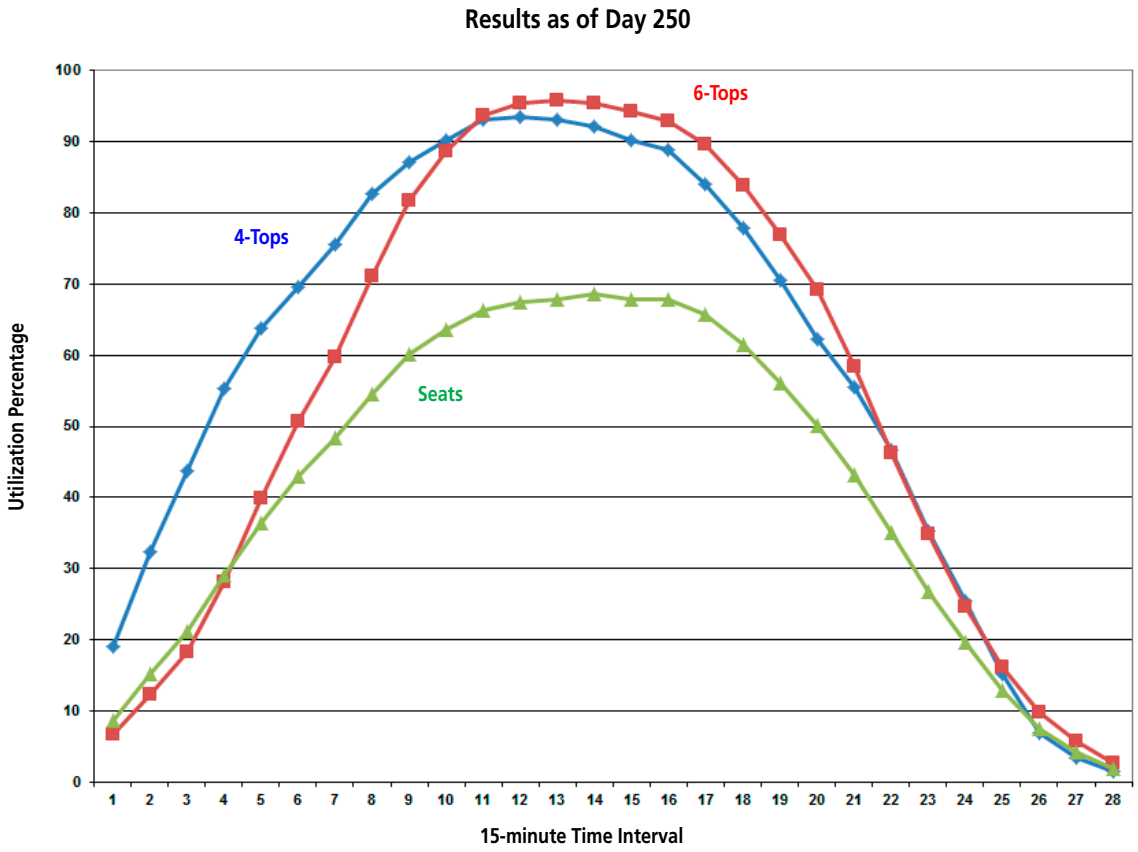


Exhibit 8

Sample utilization chart

22				
23	KEY:	Labels	Inputs	Outputs
24				
25			Customers	Value
26		Lost	35.90	$ 359.00
27		Served	112.97	$ 1,129.70
28		Served Per Available Seat	2.26	$ 22.59
29		Served Per Space Unit	1.39	$ 13.90

Key Outputs

There are three parts of the spreadsheet where useful results are presented: the Utilization Chart, the Results sheet (Exhibit 8), and the Alternatives Tried sheet. A screen shot of the Utilization Chart is shown in Exhibit 7.

In general, one would like to see high utilizations of all table sizes being considered. In addition, when the table mix is well-balanced with the customer mix, seat utilizations typically approach or exceed 80 percent.

To evaluate the existing table mix, one would obviously desire to have a high value of customers served, and a low value of customers lost. The information in Exhibit 8, which shows that about a quarter of the potential business is being lost, suggests that it could be useful to try improving the table mix.

The simulator also gives detailed information on results by party size, as shown in Exhibit 9.

Exhibit 9

Detailed information by party size

	A	B	C	D	E	F	G	H
1	Party Size	Number Served	# Parties Lost	# Still In Service	# Still Waiting	Avg Wait (min)	Avg Daily Longest Wait	Customers Lost
2	All	32.22	5.41	0.14	0.00	8.96	NA	34.37
3	1	2.68	0.24	0.00	0.00	4.93	17.84	0.24
4	2	8.73	0.62	0.01	0.00	6.05	23.29	1.24
5	3	4.06	0.14	0.03	0.00	7.01	21.90	0.42
6	4	7.20	0.11	0.01	0.00	7.75	24.21	0.43
7	5	5.63	0.36	0.04	0.00	13.37	35.79	1.78
8	6	3.93	0.11	0.04	0.00	16.05	36.19	0.65
9	7	0.00	2.23	0.00	0.00	NA	NA	15.62
10	8	0.00	0.82	0.00	0.00	NA	NA	6.59
11	9	0.00	0.37	0.00	0.00	NA	NA	3.35
12	10	0.00	0.40	0.00	0.00	NA	NA	4.04

Exhibit 10

Alternatives tried screen

	A	B	C	D	E	F	G	H	I	J	K
1				Customers				$			
2	Trial	# Seats	Space Used	Lost	Served	Served per Seat	Served per Space	Lost	Served	Served per Seat	Served per Space
3	1	50	81.25	35.9	112.97	2.2594	1.3904	$ 359.00	$ 1,129.70	$ 22.59	$ 13.90
4	2	50	81.25	24.22	123.84	2.4768	1.524185	$ 242.20	$ 1,238.40	$ 24.77	$ 15.24
5	3	50	81.25	21.68	126.29	2.5258	1.554338	$ 216.80	$ 1,262.90	$ 25.26	$ 15.54

To get an idea about how you might reallocate capacity in the restaurant, look at the "Customers Lost" column. In this case, many customers are being lost from party sizes bigger than 6 people (because the table mix being evaluated only had 4-tops and 6-tops). Thus, it would probably be good to evaluate reallocating capacity toward a larger table, perhaps an 8-top or a 10-top.

Exhibit 10 shows a screen shot from the "Alternatives Tried" sheet, taken after three table mixes had been evaluated.

Columns L through AE of this sheet record the specific number of tables that were used in each trial, but they were omitted from this exhibit for brevity. In examining the results above, there is a clear improvement in the effectiveness of the table mixes from trial one through three. Again, the goal should be to make the Served value (column I) as high as possible, which also drives high values of Server Per Space, or make the Lost value (column H) as low as possible.

Notable Limitations

This simulator has a number of assumptions:

- Tables cannot be combined.
- Parties will not split—if a large enough table is not available, the party is lost.
- Arrival distribution is Poisson, with a stable mean within each 15-minute period.[1]
- The "Maximum Tolerable Wait" applies to waiting parties, not to parties arriving (i.e., applied to actual, not estimated wait). ■

[1] A Poisson distribution specifies the probability of the occurrence of independent events having a known average rate. This mimics a restaurant where business could die off entirely or you could be slammed during a particular meal period, but the average arrival rate is consistent over time.

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