Optimizing a Restaurant's Seating Capacity

Use Dedicated or Combinable Tables?

In general, restaurant tables that can't be pushed together to serve large parties are superior to combinable tables because of the loss of productive time that occurs when combinable tables are placed "on hold" while awaiting adjacent tables to become available.

BY GARY M. THOMPSON

This article focuses on restaurants with only walk-in customers (i.e., no reservations are taken), where a host or hostess seats the parties and where parties are seated separately. These restaurants are common in the United States, since they represent the customer-service process in many large, full-service restaurant chains (e.g., Applebee's, Chili's, TGIF). Specifically, this paper examines whether such restaurants should be configured with tables dedicated to particular party sizes or configured with tables that can be combined to seat larger parties. To illustrate the differences in these arrangements, consider a restaurant that can accommodate parties of one through eight people. Using dedicated tables, one might use a mix of 2-, 4-, 6- and 8-top tables, where parties of one and two people are served at 2-tops, parties of three and four people are served at 4-tops, parties of five and six people are served at 6-tops and parties of seven and eight people are served at 8-tops. On the other hand, if tables are combinable, the restaurant might be composed entirely of 2-tops. I measure performance in this paper based on the RevPASH—the revenue per available seat hour—that is delivered by the restaurant based on its ability to seat and process customers.[1]

One can make arguments for either type of configuration. One could predict that configurable restaurants are better, because of the flexibility offered by combinable tables (i.e., tables that may be pushed together to serve a large group). However, a disadvantage of having flexible tables is that sometimes empty tables must be placed "on hold" so that they can

[1] S.E. Kimes, R.B. Chase, S. Choi, E. N. Ngonzi, and P.Y. Lee, "Restaurant Revenue Management," *Cornell Hotel and Restaurant Administration Quarterly*, Vol. 40, No. 3 (June 1998), pp. 40–45.

be combined later with adjacent tables where parties are still dining (after that dining party departs). Thus, combining tables imposes idle, nonproductive time on some tables. By contrast, dedicated tables, though not flexible, do not require the idle, "on hold" time that configurable tables require. Having dedicated tables necessitates that a restaurant's table mix match its customer mix, for if not the restaurant runs the risk of having to seat a one-person party at a 6- or 8-top.

Thus I arrive at my goals for the current investigation:

- Determine which is better: dedicated or configurable (i.e., combinable) tables;
- Determine the extent of RevPASH differences between dedicated and configurable tables; and
- Examine how the ideal mix of tables differs under dedicated and configurable table designs.

To answer those questions, I performed an experiment using a restaurant-table-simulation model. In the remainder of this article I discuss relevant literature, introduce the simulation model, describe the experiment, present my results, and offer conclusions.

Literature Review

Restaurants' table management fits within the conceptual framework of revenue management, since its focus is on maximizing the revenue that a restaurant can achieve. Restaurant revenue management has only recently begun to receive attention in the literature. Kimes and her co-authors introduced the time-based revenue performance measure—RevPASH—that I use in this paper.[2] In another paper Kimes *et al.* presented strategies for restaurant revenue management,[3] and elsewhere she suggests steps for implementing revenue management in restaurants.[4]

The literature on restaurant-table optimization is scant. In fact, I am not aware of any research that addresses the particular issues that I examine in this paper. The closest study is one that looked for the ideal table mix for a particular mid-scale, full-service restaurant.[5] That research allowed tables to be combined and found that the ideal table mix would enable the restaurant to process approximately 50-percent more customers, without increasing wait times, than would the restaurant's existing table mix.

TableMix Simulation Model

A restaurant-table simulation model I developed was a key component of that previous research. This model, which I call TableMix, simulates how customers move through a restaurant. Its focus is on the table resources. TableMix was developed with Microsoft's Visual Basic 6.0® and runs under Windows operating systems. TableMix can be run in a visual mode, in which case it will visually display the status of the restaurant—showing which tables are occupied, the number of seats at each table that are occupied, which tables are "on hold" and the number, size, and expected waiting time of parties waiting for tables. On-hold tables are those that will be combined with an adjacent table to seat a large party (for example, two adjacent 4-tops can be combined into an 8-top), when the party at the adjacent table completes dining.

Model assumptions. TableMix assumptions attempt to model the situation in an actual restaurant, to wit: that the time between party arrivals is exponentially distributed; the space occupied by a table is proportional to the number of its seats; and unrelated parties are not combined at tables (so, for example, two separate two-person parties would not be seated together at a 4-top).

The model has a number of input variables and provides a number of performance measures. TableMix's input parameters include: the number and duration of peak dining periods to be simulated; the expected number of party arrivals

[2] *Ibid.*

[3] S.E. Kimes, D.I. Barrash, and J.E. Alexander, "Developing a Restaurant Revenue-management Strategy," *Cornell Hotel and Restaurant Administration Quarterly,* Vol. 34, No. 5 (October 1999), pp. 18–30.

[4] S.E. Kimes, "Implementing Restaurant Revenue Management: A Five-step Approach," *Cornell Hotel and Restaurant Administration Quarterly,* Vol. 34, No. 3 (June 1999), pp. 16–21.

[5] S.E. Kimes and G. M. Thompson, "Restaurant Revenue Management at Chevy's: Determining the Best Table Mix," working paper, Center for Hospitality Research, School of Hotel Administration, Cornell University, 2002.

EXHIBIT 1

Probability of different size parties, under the three levels of mean party size

	Mean Party Size		
Party Size	**2.5**	**3.5**	**4.5**
1	0.16	0.05	0.02
2	0.51	0.17	0.12
3	0.15	0.34	0.16
4	0.10	0.27	0.20
5	0.04	0.08	0.23
6	0.02	0.04	0.13
7	0.01	0.03	0.09
8	0.01	0.02	0.05

by 15-minute intervals for the dining period; the number of days to simulate; the probabilities of different-size parties; the maximum number of waiting parties; the distribution of dining durations (normal or lognormal); and the table-assignment rule (assign an available table to the largest party or to the party waiting the longest).

TABLEMIX inputs that are specified for each size party include the mean and standard deviation of dining time by party size, the maximum wait the party will tolerate, and the party's contribution value (potential revenue).

TABLEMIX can be used to evaluate a specific restaurant configuration or it can be used to search for the best restaurant configuration. When simulating a specific restaurant configuration, one must specify the number of tables and the number of seats and position of each table, and identify which tables can be combined with other tables. If TABLEMIX is used to identify the best restaurant configuration, one must specify which size tables can be used and the limit on the number of seats in the restaurant. In this case, TABLEMIX will enumerate and evaluate all possible table configurations that use the full complement of seats—or as close as possible to the full complement of seats, given the allowable table sizes.

TABLEMIX outputs include the average wait by party size, the number and value of parties served and lost, the number and value of customers served and lost, the actual use of each size table by 15-minute periods, and actual seat use by 15-minute periods.

Experimental Design

The experiment I designed had one factor that could be controlled by the restaurant manager, namely, the degree of combinability of tables (5 levels)—and two uncontrollable environmental factors, namely, the number of restaurant seats (2 levels) and the mean party size (3 levels). The two sizes of restaurants I considered were 50 and 200 seats. The three levels of party size—expressed as means—were 2.5, 3.5, and 4.5 people per party. The probabilities I used for each size party are presented in Exhibit 1.

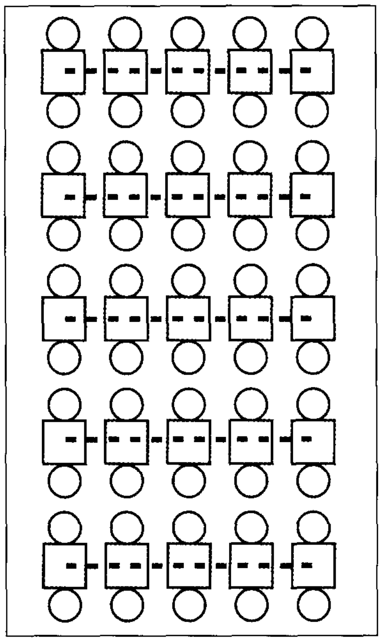
The largest party size—eight people—required that the largest tables be 8-tops, given that dedicated tables were being considered. For both size restaurants, I allowed the use of 2-, 4-, 6- and 8-tops. For the 50-seat restaurant, this results in a total of 185 unique table mixes, all of which use the full complement of 50 seats.[6] For the 200-seat restaurant, there is a staggering total of 8,037 unique table mixes that use the full complement of seats.[7]

Combinability—the single experimental factor under the manager's control—had five levels, varying from no combinability (dedicated tables) to high combinability. I measure combinability as follows: measure the number of table pairs that can be combined as a percentage of the maximum number of table pairs that could be combined given no facility constraints. The five levels of combinability are: 100 percent, 50 percent, 30 percent, 10 percent, and 0. Exhibit 2 shows an example of the combinability levels for a 50-seat restaurant, where all the tables are 2-tops. Tables that can be combined are shown linked by the colored dashed lines.

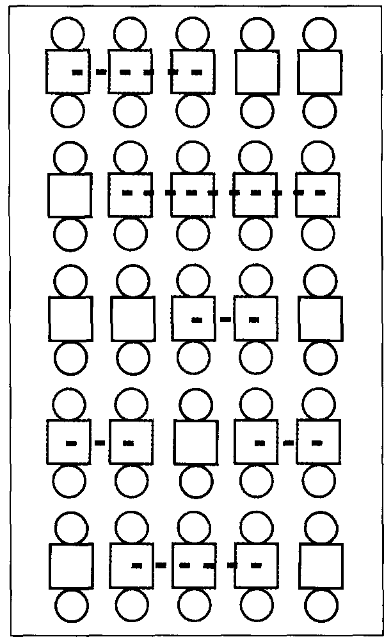
When TableMix evaluates one of the enumerated table mixes, it randomly places the tables in rows in the restaurant (keeping the restaurant as close to square as possible). It then randomly makes adjacent pairs combinable, unless the desired proportion of combinable tables has been achieved (based on the level of the table-combinability factor). For example, with any of the 8,037 unique table mixes in the 200-seat restaurant, there can be a large number of different configurations, based on which tables are placed adjacent to which other tables, and which tables are combinable. By randomly placing each table and by randomly specifying which tables are combinable, I am, in effect, simply sampling one of the possible configurations with that mix of tables. As a way to reduce the effect of purely random variation that this sampling might introduce on the results, when I report which table mix worked best, I do so based on an average of the top 5 percent of the table mixes for each combinability level (i.e., 9 and 402 table-mix configurations for the 50- and 200-seat restaurants, respectively). Compared to simply pick-

EXHIBIT 2

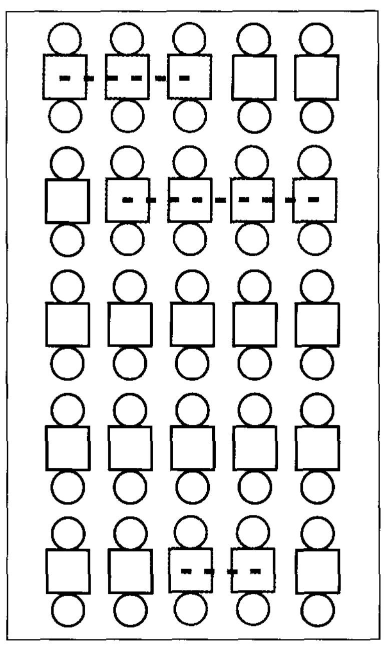
Examples of 50-seat restaurants comprising 25 2-tops, with differing degrees of table combinability



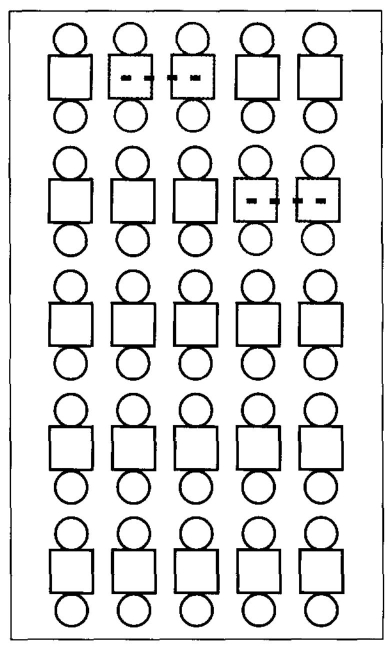
Tables are 100-percent combinable



Tables are 50-percent combinable



Tables are 30-percent combinable



Tables are 10-percent combinable

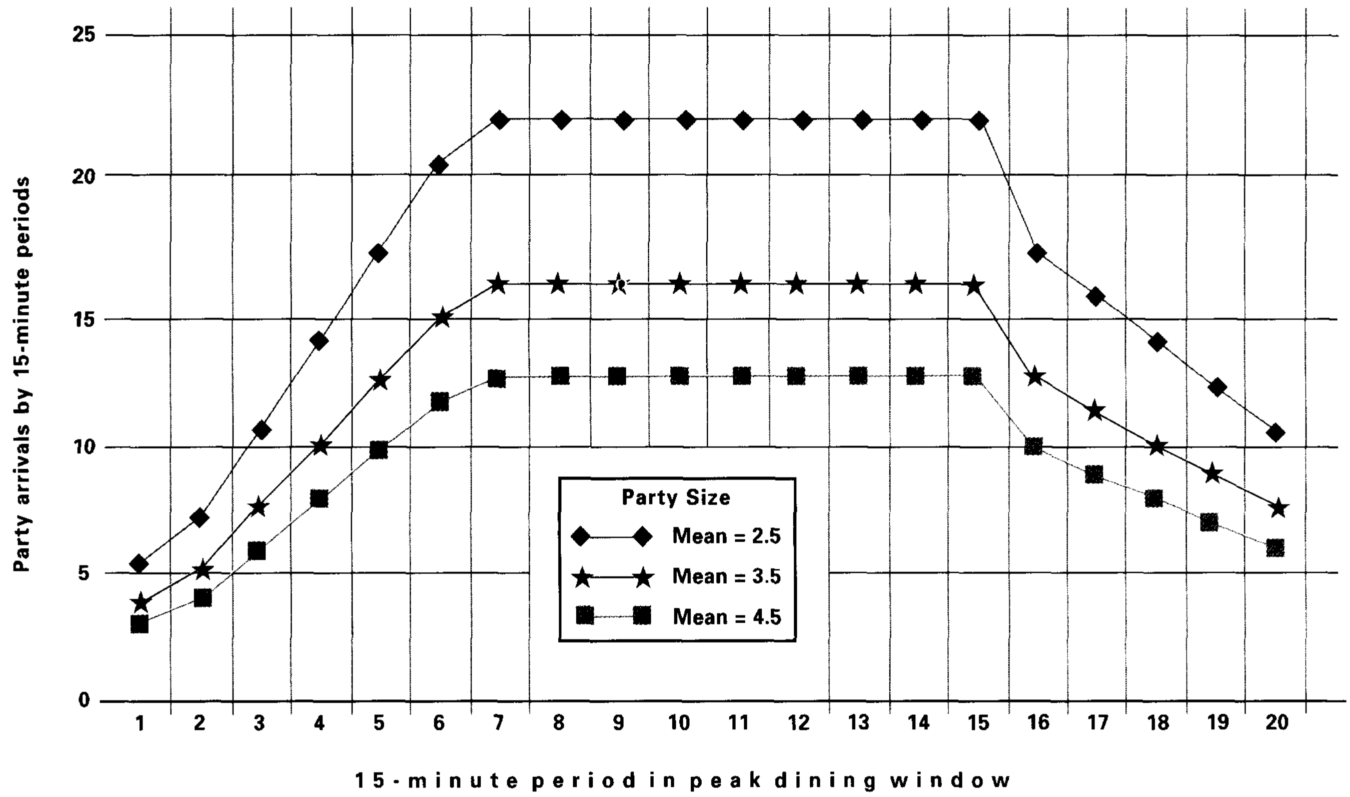
The lines between tables represent tables that can be combined to serve large parties.

[6] An example of a table mix resulting in 50 seats would be 25 2-tops. Another would be six 8-tops plus a 2-top.

[7] An example of a table mix resulting in 200 seats would be 100 2-tops. Another would be 25 8-tops.

EXHIBIT 3

Party arrival rates, by 15-minute period, for the 200-seat restaurant



ing the best-performing table mix, averaging the results for the top 5 percent of table mixes enables one to get a better sense of the effects of table combinability.

The study's assumptions. Assumptions that I made in the experiment included: using a 55-minute mean dining time for all parties; a log-normal distribution of dining times;[8] a $10-per-person dining value for all parties; a maximum tolerable wait of 90 minutes for all parties; a table-assignment rule that assigned available tables to the largest waiting party; simulating 150 days of at-capacity operation (equivalent to 1.5 year's worth of business when there were two peak days per week); that no more than 10 parties would be waiting at the 50-seat restaurant or 40 parties waiting at the 200-seat restaurant; and that tables would only be combined for party sizes of five and larger. I also assumed a peak unconstrained-demand level that would result in 100-percent seat use. That demand level guarantees that some parties will not be served, but it does ensure that any differences resulting from combinability will be apparent. Finally, I used a five-hour peak dining window (but measured RevPASH only after the first 90 minutes of operation, since the first

[8] Log-normally distributed service times occur quite commonly in restaurants. Log-normal distributions look much like a typical normal distribution, except that one tail is longer (from, in this case, the higher probability of longer dining durations than would occur with a standard normal distribution).

90 minutes represent the "ramp up" to the peak dining period). The party-arrival rates I used for the 200-seat restaurant are shown in Exhibit 3.[9]

A base table mix, which I call the Naïve Ideal Table Mix, can be determined using the following formula:

$$T_s = \frac{TPP_s}{\sum_{j \varepsilon S} j \times TPP_j} \times SEATCAP$$

where:

T_s = Naïve ideal number of tables with s seats

TPP_s = Number of tables of s seats required per party

$SEATCAP$ = Total seats in the restaurant

S = The set of allowable table sizes

If dedicated tables are used, then the number of tables of S seats that are required per party (TPP_s) is given by:

$$TPP_s = \begin{cases} \sum_{i=1}^{s} PROBParty_i, & \text{if } S = \text{smallest allowable table size} \\ \sum_{i=nxtsml_s+1}^{s} PROBParty_i, & \text{otherwise} \end{cases}$$

where:

$nxtsml_s$ = largest table size with fewer than s seats

Exhibit 4 presents the calculation of the naïve ideal table sizes for the mean party size of 2.5 people and a 50-seat restaurant, while Exhibit 5 presents the naïve ideal number of tables for the three levels of mean party sizes and the two restaurant sizes.

Results

Exhibit 6 (on the next page) graphs the RevPASH by mean party. With the 50-seat restaurant and small- or medium-mean party sizes, RevPASH increases as table combinability increases to the 50-percent level, but declines at 100-percent

[9] The party-arrival rates for the 50-seat restaurant are one quarter of those for the 200-seat restaurant.

EXHIBIT 4

Calculation of the naïve ideal number of tables required for a 50-seat restaurant and a mean party size of 2.5 people

	Table Size (number of seats)			
	2	4	6	8
Tables Required Per Party	0.67 [a]	0.25 [b]	0.06 [c]	0.02 [d]
Naïve Ideal Number of Tables	11.713	4.371	1.049	0.350

[a] Equal to the sum of the probabilities of party sizes 1 and 2 (= 0.16+0.51)
[b] Equal to the sum of the probabilities of party sizes 3 and 4 (= 0.15+0.10)
[c] Equal to the sum of the probabilities of party sizes 5 and 6 (= 0.04+0.02)
[d] Equal to the sum of the probabilities of party sizes 7 and 8 (= 0.01+0.01)

EXHIBIT 5

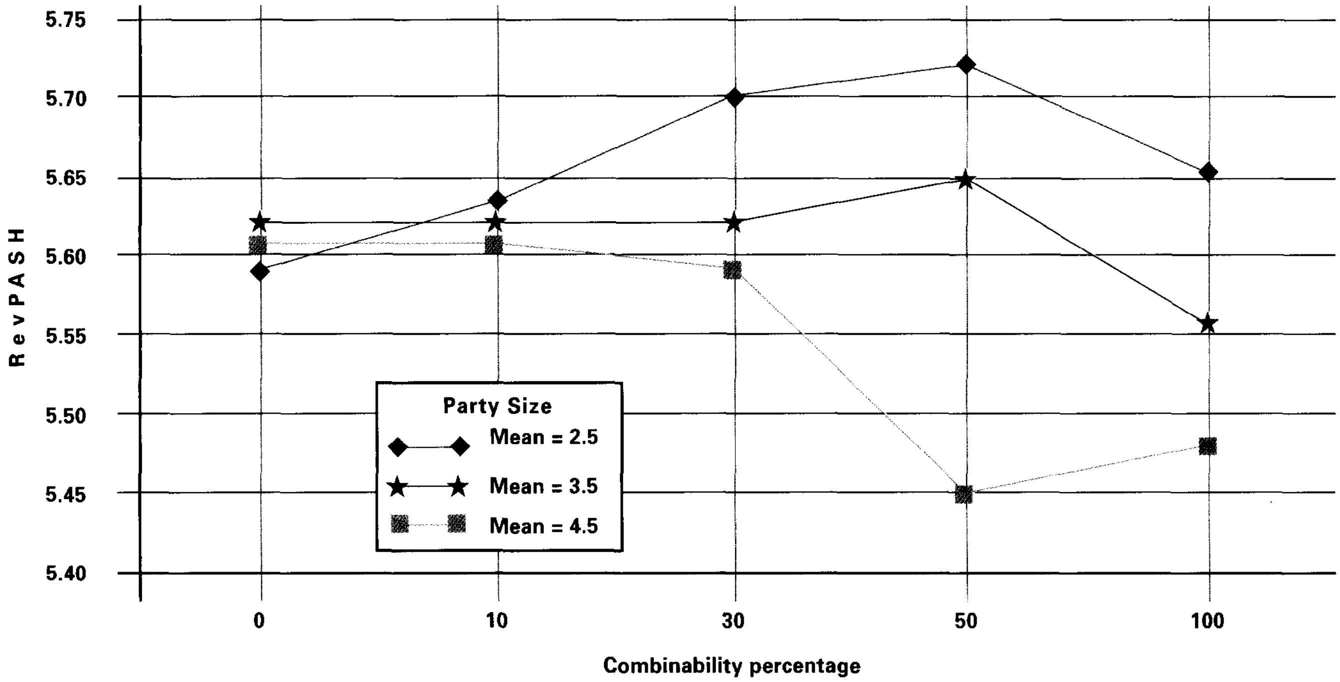
Naïve ideal number of tables for the three mean party sizes and the two restaurant sizes

Restaurant Size	Mean Party Size	Table Size (number of seats) 2	4	6	8
50	2.5	11.713	4.371	1.049	0.350
50	3.5	2.750	7.625	1.500	0.625
50	4.5	1.400	3.600	3.600	1.400
200	2.5	46.853	17.483	4.196	1.399
200	3.5	11.000	30.500	6.000	2.500
200	4.5	5.600	14.400	14.400	5.600

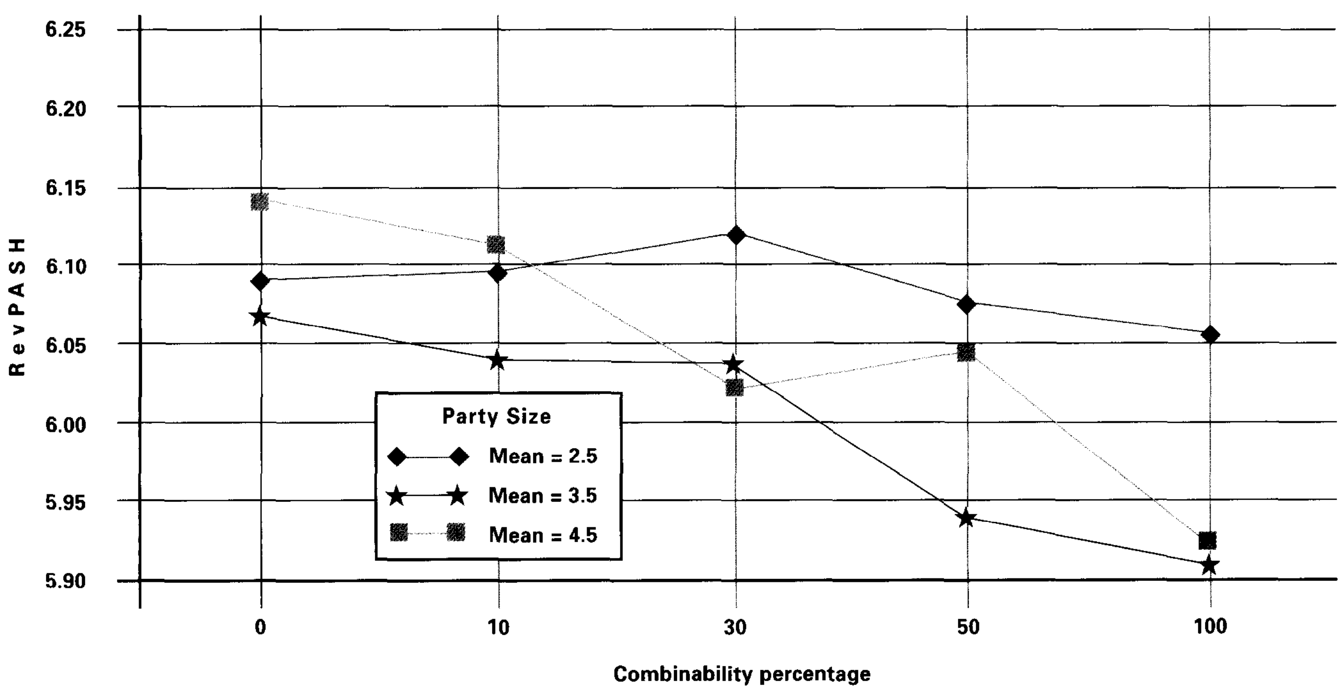
EXHIBIT 6

RevPASH, by party size, for two restaurant sizes (50 and 200 seats)

50-seat restaurant



200-seat restaurant

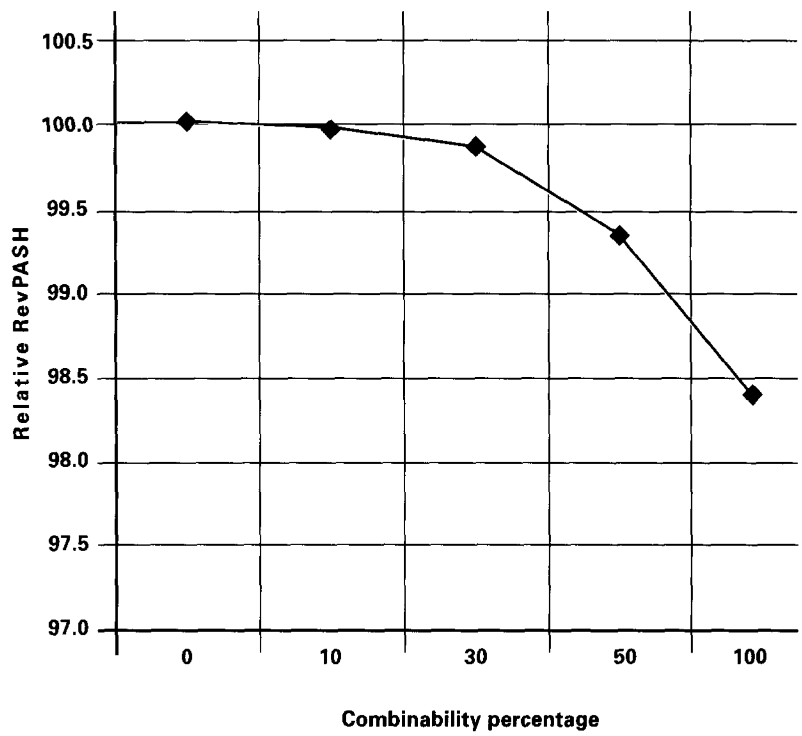


combinability. With the 50-seat restaurant and the largest mean party size and with the 200-seat restaurant, RevPASH generally declines as the level of combinability increases. Exhibit 7 shows the average RevPASH for the combinability levels expressed as a percentage of the RevPASH for dedicated tables. High combinability levels lower the relative RevPASH, with complete combinability yielding a 1.5-percent lower RevPASH compared to dedicated tables.

The best table mixes are illustrated in Exhibit 8 (on the next page). Note the following four points in particular. First, the naïve ideal table mix is similar to the best table mix with dedicated tables. This result was what I expected, since the naïve ideal table mix was calculated assuming dedicated tables. Second, mean party size had a large effect on the best table mix. Third, high combinability increased the number of 2-tops, a result particularly noticeable with the largest mean party size. Fourth, when the party size was small, the table mixes were similar across all combinability levels.

EXHIBIT 7

RevPASH under the combinability levels, as a percentage of the RevPASH for dedicated tables (0% combinability), averaged across all environmental experimental factors



What It All Means

First, I must address the question of why combinable tables worked best with the 50-seat restaurant that served mainly small- and medium-mean party sizes. With a 50-seat restaurant, seats are at a relative premium. When the mean party size is small or medium, having a dedicated 8-top is not efficient because there are just not enough large parties to keep the seat use high. However, if the largest table is a 6-top, any party comprising more than six people would be lost.[10] Combinable tables in this case allow the restaurant to serve parties larger than six without incurring the excess capacity that a dedicated 8-top would require.

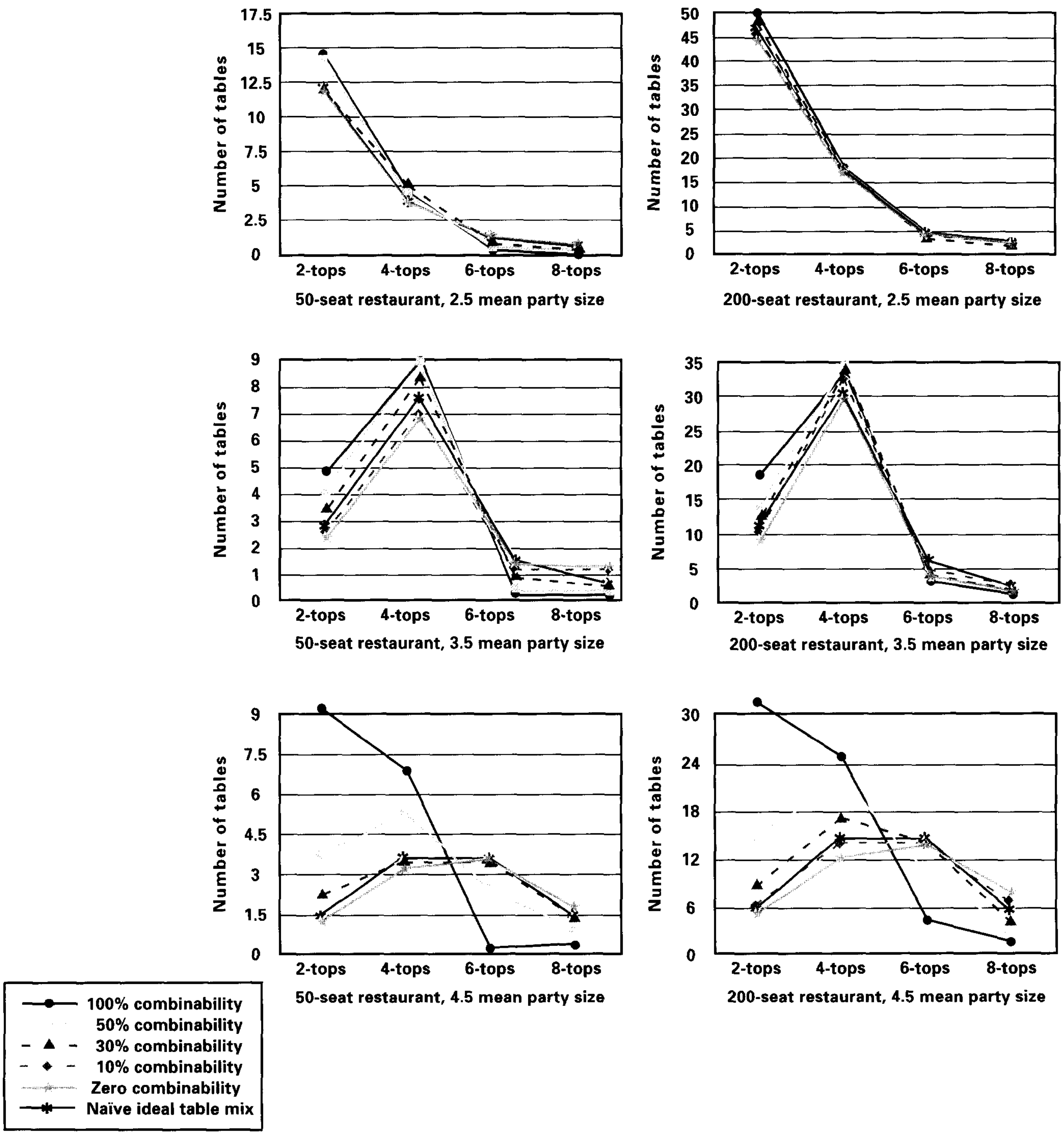
The question then becomes, Why are dedicated tables better with a 200-seat restaurant and with 50-seat restaurants that often serve large parties? The explanation is, in those cases there are a sufficient number of large parties to justify at least one 8-top. When the restaurant has an 8-top, it will not have to send any parties away because they are too big. Thus, having combinable tables does not allow the restaurant to serve any additional customers. Combinable tables, though, do require that tables be placed on hold and it is this loss of productive capacity that hurts them in those cases.

There are two considerations that can further reduce the value of combinable tables. First, I assumed that seats would be conserved. This means, for example, that combining two 4-tops yields an 8-top. In some restaurants there will be a seat-loss: combining two 4-tops might yield only a 6-top. In such cases, combinability is less attractive because of the loss of effective capacity that occurs when tables are combined. Another consideration is the time required to combine tables on the fly. I assumed that no time was required. Obviously, combining tables does require time, and so again combinable times would re-

[10] Given the assumptions of the investigation.

EXHIBIT 8

Naïve ideal table mixes and the best performing table mixes by combinability level, for the six combinations of restaurant size and mean party size



quire a loss of effective capacity. The net effect of my assumptions, then, is to create an environment that *should* be favorable for combining tables. The fact that my results showed a slight advantage in only a small number of situations should give one serious pause before considering the use of combinable tables.

The importance of finding the table mix that is appropriate for one's restaurant cannot be overstated. My previous discussion is based on the assumption that one has been able to identify (and use) the best mix of tables for the customer mix in one's restaurant. Another way to look at the results is to consider a particular table mix and see which is better: dedicated or combinable tables. For the 50-seat restaurant, the 50-percent combinability level yielded higher RevPASH than did dedicated tables in 332 of the combinations of a specific table mix and mean party size. (By comparison, RevPASH was lower in 222 of the possible table combinations.) For the 200-seat restaurant, the 50-percent combinability level yielded higher RevPASH than did dedicated tables in 13,035 of the combinations of a specific table mix and mean party size. (By comparison, RevPASH was lower in 11,074 of the possible table combinations.) The results suggest that, in general, if one does not have the best mix of tables in one's restaurant, it is better to have combinable tables.

Readers should be wary of relying exclusively on my results, for two reasons. First, the paper has not considered how customers may react to the esthetics of the designs—its aim has been to simply analyze restaurants from the perspective of a productive system. Second, the best table mix will vary, as we have seen, with the size of the restaurant and the mean party size. Thus, an important determinant of the most effective table mix depends on the mix of customers. One never knows with certainty what that mix will be until a restaurant is constructed and customers begin to arrive. How, then, is it possible to design a table mix before the restaurant is constructed? Chain restaurants are fortunate, in that they can use party-size information from other restaurants in locations with similar demographics, but independent-restaurant owners will have a more difficult time. In any case, it would seem prudent periodically to evaluate whether the table mix in one's restaurant is consistent with the restaurant's patronage patterns.

Several issues raised in this paper remain for future researchers. The first is the effect of the table-assignment rule on restaurant performance. For example, is it better to use the table-assignment rule I used—assigning available tables to the largest waiting party—or should some other rule be used? The second is identifying which tables should be located adjacent to and combinable with which other tables. For example, is it better to have two 6-tops as combinable tables or a 6-top and a 2-top? The third issue is the size of parties for which tables should be combined. In this research I combined tables only for parties of five and larger, but better performance may be achieved by allowing tables to be combined for smaller (or only for larger) parties. Finally, I suspect that combining tables may be more desirable when the restaurant has a number of peak demand periods where the mix of customers is quite different. ■

Gary M. Thompson, Ph.D., is an associate professor of operations management at the Cornell University School of Hotel Administration (gmt1@cornell.edu).