Simulated dining offers tasty options

Cheaper, expanded testing allows restaurants to innovate with menus and services

By Juan Martinez

Industrial and systems engineers have been applying simulation in general industry for a long time. Decades ago, spreadsheets, operations research models and computer simulation using GPSS (general purpose simulation system) were considered cutting-edge techniques. More advanced principles and simulation technologies have been developed since then, and comparing the two eras is like comparing an abacus to a calculator.

In food service, Burger King started applying simulation through its industrial engineering department in the early 1980s. This group pioneered the application of industrial engineering and ergonomics in the restaurant industry. Considering how costs, especially labor costs, keep creeping up in the industry at a fast pace, applying industrial engineering principles in restaurants can drive significant impact to bottom-line profits and sales processing capacity in restaurants.

These days, some universities start their simulation courses with the application of spreadsheets, but they quickly move into using a simulation software system. Simulation software definitely has come a long way. In the old days, the output was just numbers, perhaps, for us old-timers, with inputs done with punch cards. As time went on, graphical capability was added to the outputs, followed by visual capabilities, graphical capabilities in the runs (in two dimensions) and now 3-D capabilities.

As evolution has taken its place, not only has this made simulation software more friendly to the users and more powerful in using modeling for analysis, it also has facilitated understanding and acceptance by nontechnical and management personnel. There are many options, including Simio, FlexSim, Arena, AnyLogic, Extend and AutoMod, and software is almost an imperative in the practice.

FIGURE 1

Process is important in food service, too

Industrial and systems engineers who use simulation in food service should follow a rigorous and disciplined design process.

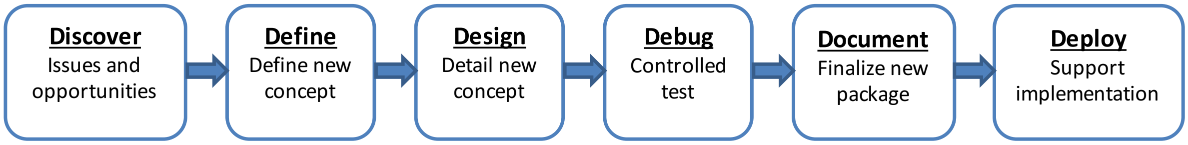
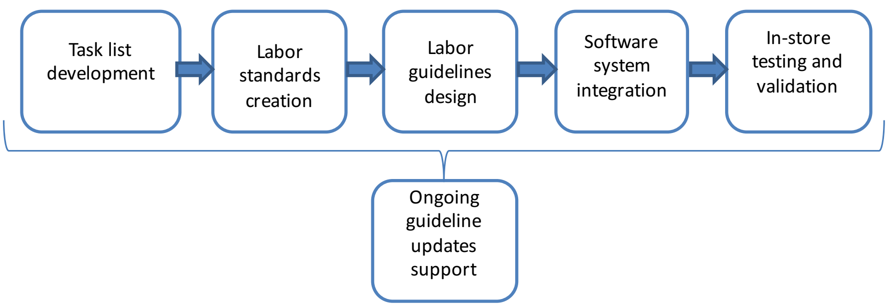


FIGURE 2

Keep it working

Computer simulation adds real-time information to labor guidelines development in food service.



How simulation benefits food service

Figure 1 shows the rigorous and disciplined design process that industrial and systems engineers in food service should follow.

Without simulation, the typical testing (debug) phase involves real-life testing through a controlled kitchen mockup or actual testing inside a functioning restaurant. Both of these options take time and significant capital. In the case of in-store testing, it may inhibit the operator's willingness to test more risky options, since the testing would affect the customer. Computer simulation is a less expensive and more flexible way to test many options rapidly since it affords a nondestructive, controlled way to analyze options. This technique can replace or augment mockup or in-store testing.

The areas that could be simulated include customer service flow, kitchen line production, drive-through and other modes of service, dining room seating capacity, ordering capacity (eat-in, online, delivery, etc.) and other areas.

The typical inputs that could be used, among others, include:

- Customer arrival patterns
- Customer order patterns (order configuration)
- Production times (cook times, assembly times, hold times, etc.)
- Employee deployment
- Equipment cycles

Typical outputs could be:

- Customer service
- Peak hourly throughput
- Product quality (holding/transfer time, component synchronization, etc.)
- Equipment utilization and requirements
- Labor utilization and requirements

Another significant area where industrial and systems engineers can apply simulation is in developing labor deployment guidelines for restaurants. Computer simulation enables you to add the dynamic (service) aspect to labor guidelines development since the system runs in real time, including delays in production and service times. As shown in Figure 2, a typical labor project involves creating labor guides, starting with creating a task list and labor standards. The simulation application would be applied during the labor guidelines design step within Figure 2's sequence of steps.

Although many may look at undertaking a labor project as an effort to reduce labor costs, the best goal in a labor initiative is to develop guides that facilitate the deployment of the right labor in the right place at the right time to drive sales, throughput, quality and an optimum customer hospitality experience. Considering that the minimum wage keeps going up and up, and the restaurant industry relies a lot on this source of labor, this is a critical way to ensure the best "unit economics" for the concept that drives maximum return-on-investment for shareholders.

Let's examine a few applications of simulation in food service environments. All the following case studies applied simulation software to model the system being studied and develop the new, more efficient design that met the goals of the project.

Better options in hospital dining

The objective of this initiative was to test and validate different designs that the architect, Smith-Group-JJR, was considering.

FIGURE 3

Alternative working realities

Different design scenarios produce different metrics for Virginia Commonwealth University's hospital cafeteria, including average queue (AVG Q), speed of service (SOS) and station throughput.

VCU CAFETERIA

		Baseline Order Configuration with 27-30 sec register time		10% Higher Grill and 25% faster register time		
		Existing (5 POS)	New Design (6 POS)	Existing (5 POS)	New Design (6 POS)	New Design (6 POS)
Peak half hour throughput	Total	326	383 (+17.5%)	445	496 (+11.5%)	548 (+23.1%)
Speed of service (minutes)	Avg	4.7	2.3	2.7	1.9	2.7
	Max	12.1	5.8	7.6	4.0	7.0
Hot entrée	Avg Q	16	3	5	3	12
	Max Q	27	15	19	15	29
	Avg SOS (min)	7.3	2.6	3.7	2.0	4.0
	Max SOS (min)	11.5	5.0	5.7	3.3	7.0
	Throughput	85	103	84	94	111
Salad	Avg Q	1	1	1	1	1
	Max Q	2	1	1	1	1
	Avg SOS (min)	4.1	2.2	3.3	1.9	2.3
	Max SOS (min)	5.4	3.3	4.0	2.5	3.4
	Throughput	84	87	82	89	84
Pizza	Avg Q	1	1	1	1	1
	Max Q	2	1	1	1	2
	Avg SOS (min)	2.3	1.5	1.6	1.2	1.8
	Max SOS (min)	3.0	2.3	2.1	1.8	2.6
	Throughput	41	32	42	39	48
Grill	Avg Q	10	1	1	1	1
	Max Q	23	3	11	3	4
	Avg SOS (min)	6.2	2.3	2.0	1.5	1.9
	Max SOS (min)	9.0	3.0	3.4	2.6	3.2
	Throughput	83	108	192	178	240
Soup	Avg Q	1	1	1	1	1
	Max Q	2	2	3	2	1
	Avg SOS (min)	2.1	1.8	1.6	1.7	2.1
	Max SOS (min)	3.0	2.3	2.3	2.3	2.8
	Throughput	45	45	58	58	70
Register	Avg Q	3	1	2	1	3
	Max Q	6	3	5	3	6

The architect and hospital wanted to select the design with the greatest throughput to meet the location's customer processing needs. The design was required to meet more than 400 transactions during the peak hour.

Virginia Commonwealth University's hospital management team specifically required that an industrial engineer be included in the validation of the design. This integrated project necessitated that the retail design (customer journey) was in balance with the functional design (peak hourly capacity).

As the team plowed through the different design options, a key metric was to understand the service bottlenecks in each of the stations that could hamper throughput. A few examples of these included decoupling the condiment station from the grill and from the hot entrée station. These moves meant that customers applying condiments to their plates would not delay employees who were serving plates at each of the serving stations.

The location and design of the soup and the salad stations were also important. The design team needed to make sure that there was redundancy at each of these stations so that several guests could serve themselves simultaneously.

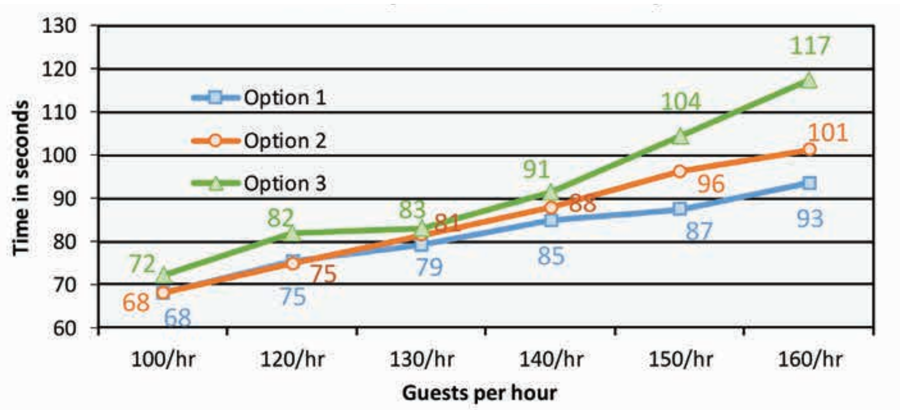
Another key parameter to analyze was the number of pay registers in the design. At the end of the day, one could design speed at each of the production stations, but if the system did not have enough capacity to process the final payment, a bottleneck would be stuck at the last point in the service chain.

Figure 3 shows a number of metrics at each of the stations, along with the corresponding queues, for several design scenarios. The top line in the chart shows a throughput comparison of the current design, to the new design options with five and six registers (POS stands for point of sale device), along with other design parameter changes (e.g., grill processing capacity and register time). You can also read the impact to some of the key metrics in each of the stations, including average queue (AVG Q) and speed of service (SOS), along with station throughput.

FIGURE 4

Order placed to pickup

The time from when customers order until they can pick up their food is a key metric in food service simulations, particularly in the case of this fast casual restaurant chain.



Aiming to please seafood lovers

Red Lobster, a full-service seafood restaurant, wanted to change the cooking platforms used to prepare a variety of their dishes to improve the taste and texture of the food the chain was serving its guests. At the same time, the service time and labor deployment had to be similar or better than the baseline.

This was a collaborative effort where the culinary team provided different metrics, including cooking and assembly times for each of the options being considered. For three different cooking platform combinations, different kitchen options were tested. Each cooking platform had different menu item routings, cooking times and hands-on labor time for each dish. Another challenge came from the fact that menu promotions affect kitchen performance a great deal. These promotions are cyclical, as seasons change, and could affect stations differently. So each promotional period had to be tested to ensure success for the entire year.

Some of the key metrics, among others, that were tracked in the simulation were:

- Labor utilization to balance out the production responsibilities in the design for the different deployment schemes (e.g., two to seven employees in the line)
- Equipment utilization to understand the level of equipment resources needed and ensure that the employee had access to the equipment when he or she needed it
- Product routing to balance the demand on the station and ensure that the work demand was spread through the labor deployment that was being tested

Using simulation allowed the team to test several equipment lineups and deployment strategies until a good solution was found. The final solutions were then rolled out in the system. Simulation enabled the team to take the construction philosophy of "measure twice, cut once" to a whole new level. With simulation in food service, you actually can "measure hundreds of times" and account for hundreds of variables. Only then do you have to "cut once."

30 percent higher throughput

In this case, a fast-casual restaurant chain wanted to test different service systems, along with kitchen layouts and labor deployment setups, that would enable its franchisees to process more guests using the same number of employees. Fast casual restaurants generally refer to restaurants that offer customer service similar to fast-food restaurants but often with higher quality and more expensive menu items.

The service systems tested affected the inside customers as well as the drive-through guests, making testing in a real restaurant expensive, time-consuming and very limiting in the number of options that could be examined. For this particular concept, the time of the year (season) and the part of the country (region) significantly affected customer orders, so the options had to be tested for those variables as well.

The team used simulation software to create the model, which provided quantifiable differences between tested options and types of guests for service times, resource utilization and labor utilization. The simulation also was used to do sensitivity analysis to determine the impact of how well the guests would accept the new technology that was being applied. The model was used to determine the ideal number of order points needed as well as the number of new equipment pieces required to meet a targeted throughput volume, all while maintaining or improving service times.

The simulation was used to run options for different labor staffing levels ranging from two to eight people, along with different task assignments or slide deployment practices to determine the best use of the labor resource for new and existing stores. According to the simulation's results, an alternative ordering system could achieve up to 30 percent higher throughput with the same number of employees, all while maintaining or improving service times.

One key metric tracked during the simulations was the time from when the guest placed the order until the order was ready for pickup, as shown in Figure 4. This is a key metric in restaurants that for the most part can be managed with the right design.

FIGURE 5

Separation in the preparation

This chart tracks key metrics when the order and pay activities are decoupled (the O+P column) versus the same crew doing both activities (the OP columns).

	Option 1 (O+P)	Option 2 (OP)	Option 1 (O+P)	Option 2 (OP)	Option 1 (O+P)	Option 2 (OP)
Checks/Hr	120/hr	120/hr	140/hr	140/hr	160/hr	160/hr
Order Line Time (sec)	7.6	12.6	11.7	23.9	18.8	44.3
Order Time (Order + Cash for Option2)	49.0	89.0	49.0	89.0	49.0	89.0
Finish Order Start Cash Time (sec)	17.5	NA	23.3	NA	33.9	NA
Finish Cash Receive Food*	85.0	142.5	85.6	148.8	97.6	160.6
Finish Order Receive Food*	142.4	182.5	149.0	188.8	171.5	200.6
Total	**199.0**	**244.1**	**209.7**	**261.6**	**239.3**	**294.0**

Streamlining for a smaller footprint

This fast casual restaurant chain needed to develop a more streamlined prototype that would facilitate growth in smaller locations. In addition, the group's managers wanted to develop a service system that would enable more throughput and better customer service while producing some key items to order. In other words, they wanted to increase the output (sales capacity) while decreasing the input (capital and operating costs). Several options were tested, including changes in the service sequence, employee deployment schemes and product cooking and holding times, among other variables.

Figure 5 shows the results for some of the simulation runs done. A key design feature analyzed during the simulation was separating the order and pay activities, a move that helped provide the kitchen time to assemble and cook the item to order while the guest was still in the line. The numbers shown in the (O+P) column are the results achieved when decoupling the order and pay function. The results in the (OP) columns are the results achieved when the order and pay function was done by the same crew, as is typical in most fast casual restaurant concepts.

The key metrics shown in Figure 5 included the different service components the customer experiences. These include "line time" before ordering the items as well as "finish order to receive food," a key metric that was used to understand an important (kitchen) bottleneck in the new design. The simulation measured and changed many other parameters not shown in this figure, including holding levels and deployment responsibilities.

Target: Operating and capital costs

Another fast casual restaurant chain wanted to develop a prototype that could significantly improve the "unit economics" of the concept by reducing operating costs significantly. Managers also wanted to trim capital costs by more than 20 percent.

To achieve this goal, both the front-of-house and back-of-house areas had to be streamlined, including the kitchen line production system.

Simulation was applied to test many different kitchen line layouts in order to derive one that balanced all the key metrics of the design. These metrics included labor deployment, equipment placement and cost, production and assembly times, some product quality metrics and other variables.

In this case study, the full sequence of customer service and production was tested. The simulation team measured the speed of service the guests received, including line time, order and pay, and time for the customers to receive the food, the key output metric that the team was trying to control. To meet a specific speed of service goal, the simulation team varied the design in the back production line, taking into account the location of the equipment, the type of equipment and cooking

Seeing helps belief

In the dark old days, simulation outputs often were sets of numbers derived from spreadsheets. Video technology has advanced to the point that people can "see" the outputs of your simulation. This helps nonengineers, such as restaurant CEOs and managers, understand how changes will affect operations.

Click the links for a couple of examples of restaurant simulation:

- *http://bit.ly/Martinezsimulation1*
- *http://bit.ly/Martinezsimulation2*

And for a look at how simulation can boost ergonomics in the food service industry, check out "Doing it your way" from the March 2010 issue of this magazine, then known as *Industrial Engineer*. Here is the link: *www.iise.org/ISEmagazine/Mar2010/Martinez.*

FIGURE 6

The center of it all

Putting the employee at the center of an ergonomic design is the key for how simulation can improve customer service and drive profit and sales.

characteristics for each, the deployment responsibility for each employee and other variables.

Once the design was finished, the restaurant chain gave it a real-world test by implementing the model in a location that was due for renovation.

Simulation allows concepts to change continuously

In the food service industry, once operators find a model that works, they have a tendency to continue with the same concepts over and over again. But building and operating the same way makes it difficult for restaurant chains to test new ideas, layouts, equipment and schedules.

Managers fear what changes could do to their guests. This is a natural concern when testing new concepts involves building an entire new unit and learning from those mistakes or creating a "real" model or mockup of the operation. Both options are expensive, and they limit the amount of changes that restaurant owners are willing to test. However, simulation in food service provides a noninvasive way to test many different alternatives without affecting customers, providing the restaurants with a way to evolve their concepts at minimum testing cost.

Simulation in food service is ideal, because even though superficially restaurants seem like simple operations, the reality is that due to all the moving parts, especially the heavy reliance on manual labor, they are anything but simple.

In reality, restaurant operations and design are "simply complex." For starters, customers arrive randomly without any schedule, and their rate of arrival varies throughout the day. These guests come with all kinds of "special orders" and typically with a short tolerance for lengthy waiting times. Customers dealing with the hustle and bustle of life expect fast food and fast casual restaurants to live up to the word "fast."

On top of that, menus continuously change and include highly customizable options, because that is what guests demand these days. All these order dynamics need to be prepared in seconds with materials (food) that have short shelf lives and come from different workstations. The food items then need to be combined into an order to be delivered to guests in whatever service mode they chose (eat in, takeout, delivery, drive through, online, etc.). The time expectation of the guests keeps getting shorter each day, while the menu requirements keep growing and getting more complex. Operators who don't innovate their menu can die as a brand, but if they make the wrong menu decisions, they can kill themselves. So "efficient menu innovation" is a must. The application of computer simulation can help with this quandary.

As shown in Figure 6, starting with the employee in the center of the design, the application of computer simulation can help industrial engineers design food service concepts that optimize the customer hospitality delivered, resulting in sales gains that drive profits that support healthier brand growth.

Dynamic computer simulation is without a doubt an innovative way to test and validate food service designs. This technique has been around for some time, but it has taken a while to garner mainstream application. The benefits include:

- The ability to test more options rapidly
- The ability to test riskier options
- Less destructive and simpler testing
- The ability to continuously test on a permanent basis
- The flexibility to make changes
- The ability to add a dynamic extension to a deterministic process

The bottom line is that dynamic computer simulation provides an easy way to design and test the complexity inherent in restaurants and the different options that should be considered to grow the brand. With the use of this technique, you can develop and expeditiously test "the design of the future" today at lower risk and lower cost compared to other testing options, all while considering innumerable variables. ❖

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