



A handmade appetizer

The Restaurant as Hybrid: Lean Manufacturer and Service Provider

Christopher Muller

Restaurants are considerably more sophisticated as manufacturing and service delivery systems than most uninitiated observers and users may recognize. Dining in a restaurant, whether one is served at the venerable Union Oyster House in Boston or at the window of a new food truck in Portland, requires a contextualized understanding of procedures. What looks simple is not. Restaurants are complex organizations that have evolved over an extended period of human history into heuristic mechanisms, which enable the practical application of many business theories.

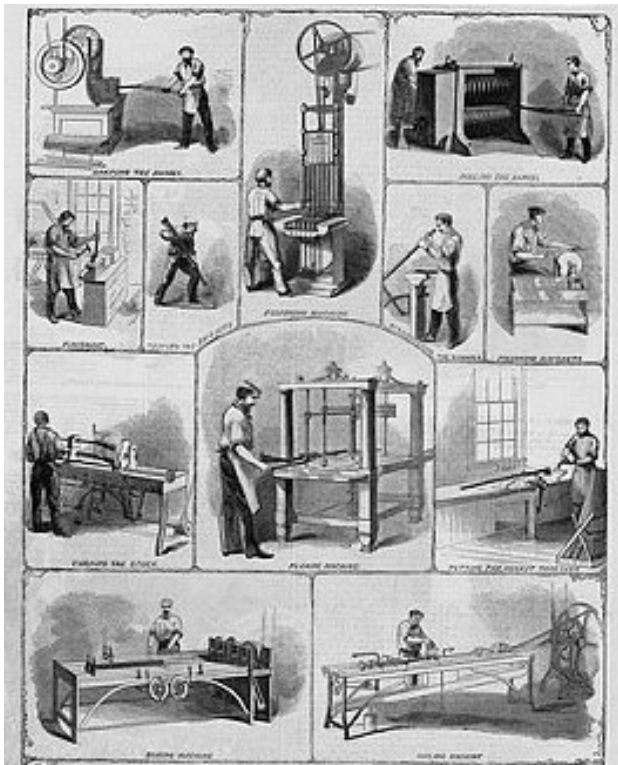
Models of Production

Uniquely positioned as both consumer service providers and tangible finished goods manufactur-

ers, restaurants sell at retail an inventory that is fabricated from raw materials at the site of consumption. While it is now generally accepted that service firms are characterized by the provision and consumption of a *service* at its point of delivery, rarely do service providers physically manufacture a consumer *good* on the premises for immediate utilization. This simultaneous combination of service and production would be analogous to an automobile showroom being at the end of the assembly-line floor, but only if the new car came with a single tank of gas and was discarded after one use. In a restaurant, both the service and the product are ordered, cooked, assembled, purchased, and consumed in less than a day.

This melding of two dissimilar functions means that restaurants perform as hybrid organizations,

Manufacturing
at Springfield
Armory
(1861)



with the unique opportunity to reveal theoretical principles from both service and manufacturing. In many respects, generations of restaurant managers have been using practices that have been recently defined by business theorists for use in manufacturing, such as just-in-time production and supply chain management. Rarely, though, do these production theories appear in describing service business models, and restaurant organizations are most often thought of as service businesses. Restaurants act as hybrids of these two systems, and may be unique in the ability to take advantage of both the efficiencies of manufacturing and the customized user engagement of service management.

More than three decades ago, much of the credit for the remarkable advances made by Japanese manufacturing companies was given to their adoption of two integrated manufacturing principles, 'just-in-time production' and the philosophy of 'total quality management.' Since then, these two principles have been the cause of a major revolution in production management thinking throughout the industrialized world. As the two movements moved together, a new model was formulated called 'lean manufacturing.' Remarkably, the core concepts of lean manufacturing – customer pull to determine production quantity, and total quality control at the point of production to guarantee the customer experience – have been fundamental practices of restaurant operators for every meal served for centuries.

The object here is to illustrate how restaurant managers have historically been using the funda-

mentals of just-in-time and lean manufacturing production, often without understanding the power for efficiency and profit each brings on a daily basis. Once identified, the goal is to encourage restaurateurs to seek a better understanding of where these principles interface with service management theory, so they may find competitive advantage in their application.

Just-In-Time Manufacturing

Before Henry Ford conceived of the automobile assembly line, there was Eli Whitney. While better known as the inventor of the cotton gin, a labor saving device that helped accelerate the Southern economy prior to the Civil War, Whitney was a champion for the system of interchangeable parts used in the manufacture of rifles and handguns. When widely adopted across New England by other armorers, it became known as the 'American System of Manufacture.' This relied on machine-made standardized parts that could be assembled quickly by semi-skilled workers into tens of thousands of finished goods.

The American System required that large stockpiles of components be collected in work-in-progress inventories. The parts were inexpensive to produce, as was the labor used to assemble quantities of weapons, making warehousing of interchangeable parts cost effective. It was better to have extra parts in inventory than to lose a day of production.

Using essentially the same approach, Henry Ford was able to create his breakthrough 'Assembly Line' system. Ford's contributions to mass production are well documented, but one of the most important was moving work-in-progress component parts inventories as close to the shop floor as physically possible. Steps were saved and production time reduced when small batches of interchangeable parts were kept within arm's reach of the worktables and finishing lines, so they could be used as they were needed. Productivity soared as manufacturing moved from craft-based batch production to semi-skilled continuous mass production.

After the Second World War, as part of the rebuilding process, this system was presented by American industrial strategists Edwards Deming and Joseph Juran to Japanese leaders Eiji Toyoda and Taiichi Ohno. The system was refined, repackaged, and renamed 'just-in-time' or 'stockless' production. With low cost labor, low cost component parts, and a system that limited the capital costs of stockpiled inventory, productivity across manufacturing segments exploded throughout Japanese factories. The 'Japanese Miracle' quickly became the envy of the industrialized world.

Goals for a Just-In-Time System

The new just-in-time (JIT) manufacturing system was built upon three simple goals. First, production batch sizes should be small, ideally equaling one unit at a time. Second, by shifting from a 'production-push' to a 'demand-pull' system, there could be zero work-in-progress or finished goods inventories. Third, because productivity and quality are directly related, there should be a 100% acceptable run at each step on the production line.

The JIT system is intended to decrease work-in-progress inventories, increase productivity by the reduction of waste and rework, lower production and retooling cycle times, quicken response time to the customer, and empower individual workers to correct defects whenever and wherever they occur in the production line.

In order for batch sizes to be small, the second of the three goals listed above must be introduced. There is a significant difference between demand-pull and production-push manufacturing. A traditional production-push system, similar to the original Ford River Rouge assembly line, injects raw materials at one end of a factory line and, as workers complete tasks, pushes finished products out at the other end. Finished goods inventories might not have a specific customer waiting for them, so they are shipped to company warehouses, to distributor storerooms, or to retailer sales floors. Like a flooding

FURTHER THOUGHTS

Just-in-Time Production

- Short manufacturing cycle times
- Batch sizes identical to customer-order quantities
- Flexibility to make products in various sequences
- Ability to rapidly find and fix deviations from quality standards
- Raw materials requested as late as possible

Just-in-Time Production for Restaurants

- Production cycle time 1-15 minutes
- Batch size is one customer order
- Flexible enough to make products in menu sequence
- Instantaneous rejection of failed items
- Raw materials delivered daily

river, over-stocked finished goods inventories tend to get pushed into every available space that can accommodate them.

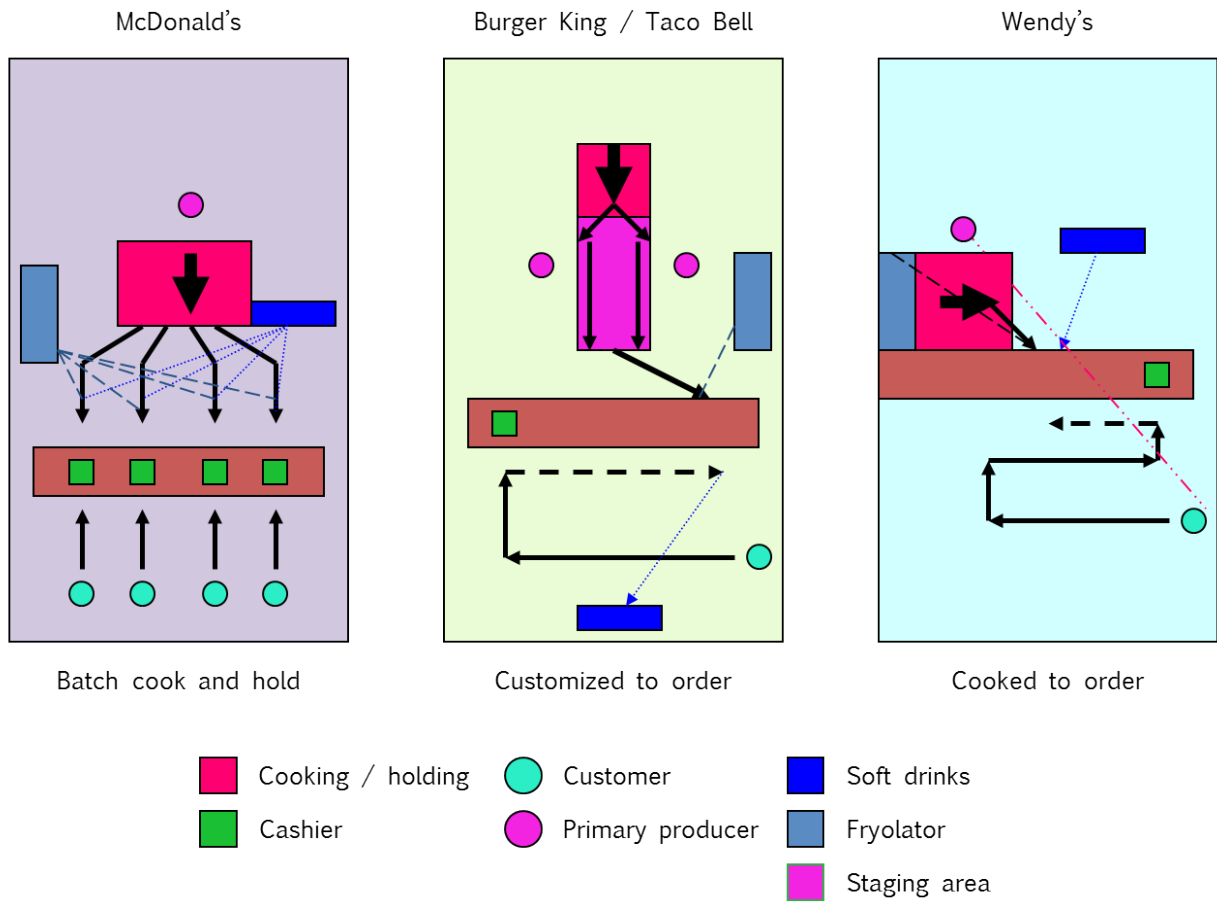
The restaurant equivalent should be apparent. The original McDonald's batch production system of full bin slots and 'have it our way' choices is built on a production-push model, with no direct link between a single order and the cook who makes it.

Alternately, a demand-pull system requires that no product gets worked on until a customer places an order for that specific product. As is generally accepted in service management, a 'customer' is any user of a product or service downstream from the



Assembly line at Ford River Rouge Factory (circa 1930)

EXHIBIT 1
TRADITIONAL QUICK SERVICE PROCESS SYSTEMS



point of provision. For example, on an automobile assembly line, the immediate customer for a tire is the wheel assembler, not necessarily some future owner of the car.

A necessary component of the demand-pull system is described by the Japanese word *kanban*, which translates as 'visible record.' In order for the demand-pull concept to work efficiently, there must be a form of notification from each customer, when he or she has demand that is unmet. This visible record can take the form of an order card, a sales voucher, a requisition, or a designated 'box' or work area on the shop floor of a manufacturing plant.

When a *kanban* is received, or when sufficient supplies are not visible in the *kanban* box, a single batch must be produced to fill the request to acceptable levels. Until the *kanban* has been received, no work is begun on any product or component assembled. Quite literally, because there is nothing waiting on the shelf to be shipped, there is nothing that can go to the next stockpile. All work-in-progress inventories have disappeared. This works especially well

with a mass customization or postponed differentiation model, such as that used to produce Dell personal computers.

It will hopefully be apparent that this system is also evident in some modern quick service restaurant chains. The ability for consumers to 'have it your way' at Burger King was enabled by their service and production system, in which orders were called over a microphone from the order line to the cooks. Wendy's advanced the process, by using the visual signal of an arriving customer as the *kanban* to start the cooking process for each fresh hamburger.

It becomes apparent that the selling function is significantly more important in a demand-pull system than in a production-push system for two reasons. First, where durable finished goods inventories are allowed to accumulate, especially where stored labor inventory is a hidden cost inside the value-added good itself, it is always possible to put items 'on sale' to recover the costs of component ingredients. Examples include automobile sell-a-thons,

furniture closeouts, clothing markdowns, remainder bins of books or wine, and even day-old bread in supermarkets. Second, factory workers will sit idle if there is no customer demand. Production comes to a halt when no customer orders are present, and both fixed cost coverage and semi-variable labor costs skyrocket. Think of a traditional white tablecloth restaurant at 5:45 pm, with waiters standing idly in an empty dining room anticipating customer arrivals.

The third goal, a focus on total quality management (TQM) throughout the production system, builds in large part on the previous goal. Just as a lack of demand creates a shutdown of production, so will a lack of quality parts. The Ford assembly line could absorb the costs of waste from poor quality parts in the system flow because of rapid increases in productivity elsewhere. However, as the costs of sophisticated and more detailed interchangeable parts become greater, the problem of rejection for lack of quality along the line also grows.

Deming called for the adoption of statistical controls in the manufacturing process, ultimately requiring the lowering of the percentage of acceptable variance in quality to zero. This 'zero defects' rule applies to the interchangeable parts, but also extends to finished products delivered to the end user. Customer satisfaction and future demand should increase as the cost of rejection of products reaches zero and greater 'pull' for new products expands.

In a full-service restaurant, the worst disruption on a busy night is for a customer to send a meal back to the kitchen because it was not prepared correctly. Food production normally moves in a unidirectional manner and 'bounced' steaks break the system flow, often irreparably affecting the entire restaurant for the remainder of the evening.

The Move to Lean Manufacturing

Once the principles of JIT and TQM became well accepted across manufacturing, it was inevitable that refinement would occur. This updating has become known as 'lean manufacturing,' which focuses not only on just-in-time inventory and total quality management, but also on significantly reducing waste in the production system.

This refinement identifies work production not only in terms of component parts, but also of systems of workers. Small groups attending to specific areas of the work-in-progress inventory become specialized cells in an integrated holistic network of interdependent processes.

As the *kanban* system pulls semi-finished prod-

ucts through the line, these cells respond by producing just the amount needed for the next customer's requirements. The adoption of six sigma, or any other system of quality management, is intended to ensure that this process has as close to zero defects as possible, and identifies bottlenecks and disruptions along the entire line.

In order to maximize consumer demand for customized products, retooling of the production line needs to be as rapid as possible. Where in a traditional system retooling might be seasonal or only when new products are introduced, retooling in lean manufacturing can often be accomplished in days, if not hours, to respond to changing market needs.

Finally, the lean manufacturing model requires constant development of workers. Teams meet as quality circles, for efficiency reviews, and for continuous training and development. New product improvements and even new products themselves often originate from these team sessions.

The Restaurant as Lean Manufacturing System

To any restaurant operator, the descriptions above might be quite obvious. In the restaurant environment, the customer for a steak is typically thought to be the consumer of the meal provided by the grill cook on the line. But it also means that the grill cook is the customer of the prep cook in the back kitchen, who has responsibility to cut a strip loin into useable portions. In turn, that prep cook is the customer for



McDonald's hamburgers



Bread delivery
(circa 1960)

the receiving clerk, who has checked and stored the whole strip loin in the walk-in refrigerator. And the receiving clerk is the customer for the driver of the delivery truck that brought the strip loin from the warehouse.

Two important ideas gather from this. First, the definition of customer is expanded and refined. Second, the unique nature of the manufacturing process for a ready-to-eat meal makes application of these principles different than for other industries.

Unlike automobile wheel assemblies, which are built using physical products that keep much of their value while held in inventory, the entire work-in-progress inventory in a restaurant is a 'wasting asset.' This means the product, most of its components, and many of its ingredients have a limited shelf life and cannot be stored.

In addition, the entire production system in a restaurant, which includes the seat in the dining room or the spot in the drive-through lane, can only be provided at this time, at this meal, now. Products delivered need to be consumed within days, because as they sit in storage, quality diminishes quickly. Likewise, since a consumer can only eat lunch or dinner at a single moment in time, if a seat remains empty or the line is too long, the asset value of the service moment disappears forever.

Since the nineteenth century, when Auguste Escoffier conceived and introduced the 'brigade' concept into the kitchen production system, all restaurants have been organized into stages and stations.

This cellular model of production, with work done in multiple steps and held in various levels of completion, is crucial to the timeliness of meal preparation.

Whether as basic as the making of a soup-and-salad combination at the local Panera Bread, or as complicated as the *glace de viande* needed to finish a plate of Beef Wellington at the Chatham Bars Inn, no restaurant meal can be assembled, cooked, or served if components are not produced in advance. Labor in the kitchen is actually stored in this manner. The *mise en place* that is so crucial for rapid production at the immediate point of demand is not just food in semi-finished form, but is the value of the cook's work in the ready-to-use food products within easy reach. Every chopped garnish, portioned steak, blanched vegetable, or pre-made hamburger patty is both food and labor.

As everyone who has experience in a restaurant knows, the key to the efficiency of the traditional kitchen flow is the concept of the duplicate guest check, the 'dupe slip.' This is the primary means of communication between the customer and the cook, whether a waiter's pad or an electronic POS system. The dupe slip is the *kanban*, pulling the meal order through the kitchen work stations and toward the point of consumption by the guest. In a demand-driven restaurant system, component ingredients and semi-finished food items are stored in a par-stock at various locations throughout the kitchen. No menu item will be completed unless and until a dupe slip is produced calling for it.

FURTHER THOUGHTS

Lean Manufacturing

- Manufacturing without waste
- Pull scheduling
- *Kanban* signaling
- Six sigma quality
- High levels of customization
- Cellular organization
- Team development

Lean Manufacturing in Restaurants

- Production without waste
- Preparation after order
- Duplicate guest check
- Customer as quality control agent
- Daily specials and off-menu requests
- Stages and stations
- Empowered servers

Embracing the Lean Manufacturing Model

While intuitive to many, this application of lean manufacturing is not simple. Moving from the historic and practical reliance on the principles of just-in-time, to a more fully engaged system comprised of total quality control and consumer-driven demand-pull, will not be accomplished overnight. In many cases, systemic operating inefficiencies are hard-wired into any restaurant operating environment. Though when implemented, the rewards will be significant and will change the nature of competitive contemporary restaurant management.

The restaurant business is a complicated mix of service and manufacturing paradigms. The restaurant as an organizational form has a long history of adapting systems and technology for use in everyday operations. Unfortunately, these systems are often used with limited knowledge of how they have been applied in other business and industrial areas, or even how they were originally developed. As the restaurant industry continues to become more sophisticated, and systems for production and service delivery become more complicated, it is imperative that this knowledge be expanded to encompass a broader and more robust theoretical base. ■



Diner receipts

IMPLEMENTING THE LEAN MANUFACTURING MODEL

The following are some specific implementation practices that restaurant leaders may adopt.

- Change the role of forecasting to reward accuracy at the unit level, for individuals in all ranks and functions (including managers, department heads, chefs, kitchen managers, and purchasing agents). Accuracy of forecasts about menu mix and units sold is more important than whether forecasts are higher or lower than projected.
- Put into place a measureable complaint tracking system for all types of customers, internal and external, beginning at the receiving dock and at every step until final payment is tendered at the cash register. A complaint is measured as any deviation from acceptable standards, no matter how trivial. All complaints need to be addressed by management as serious.
- Integrate quality and delivery time standards along every step of the production line, beginning with suppliers, including rewriting all specifications in partnership with purveyors. Raw materials need to be delivered at the exact time needed to complete the upcoming process work. Work-in-progress quality variations need to be identified immediately by the next assembler in line, from the receiving dock to the line

cook, from the expediter to the waiter delivering the finished meal to the diner.

- Identify all process and quality bottlenecks. Make design and system modifications to reduce bottlenecks to zero levels. Bottlenecks include par stocks that are too low or storerooms that are too full.
- Switch to an all-cash purchasing payment plan (net 10 days maximum) to integrate production and cost reductions, and link all inventory directly to payments made to partner suppliers. This will have a significant positive impact on profitability goals.
- Lower all par stock levels to minimums based on the new accuracy of forecasts. Reduce storeroom and walk-in sizes to increase operating efficiencies. Invest in digital inventory technology including RFID and standard coding systems.
- Switch to single cost allocation for inventory values. Ideally, inventory is only what gets delivered and received at the back door, with all physical inventory calculated continuously from *kanban* tickets. There is no longer any need to expend labor dollars physically counting items at the end of a calendar month. Waste, theft, or other shortages become immediately observable where par stocks are kept at minimum acceptable levels. Controls are less about preventing theft and more about reinforcing efficiency.
- Change all menu offerings and menu produc-

tion processes to reflect lean manufacturing systems. Cross utilization of products, postponed differentiation, and customization are hard-wired into all menu design processes.

- Commit to training across all levels, and for each individual production cell, to integrate zero defects production policies into the entire operating culture.

When these practices are in place, and operating in a systematic manner, benefits should include:

- Immediate lower inventory, control and monitoring costs.
- Lower overall cost of goods sold, with less opportunity for loss from waste and spoilage.
- Continuous quality improvements, better customer response time and loyalty of patrons.
- Increased productivity, lower payroll, less staff turnover, and higher profitability.

STEPS OF LEAN MANUFACTURING IN RESTAURANTS

Looking at this model of the restaurant production process, note that the steps are described from right to left, from A to E.

Point A

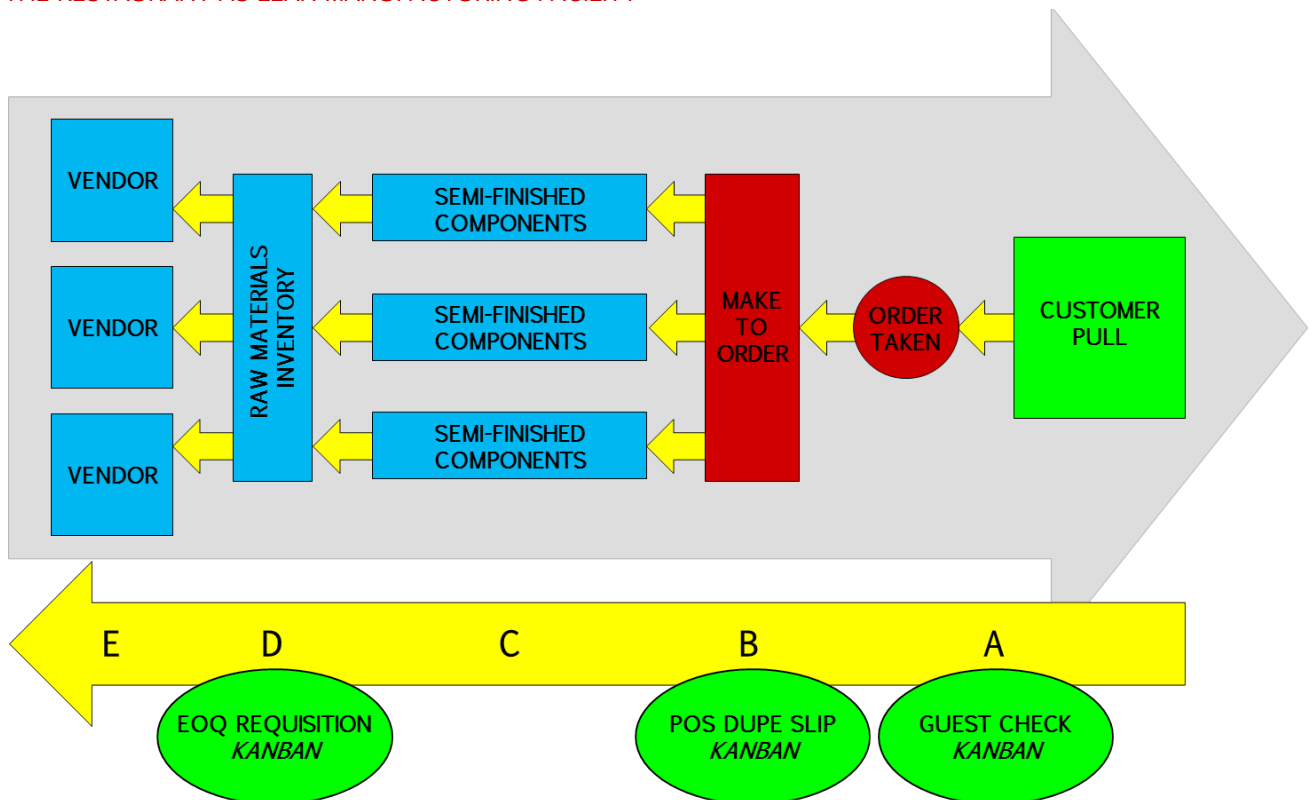
A customer enters the system (an event that is broadly predictable but individually random) and begins the process of pulling a finished menu item through the kitchen production line. This could be as simple as walking up to a street cart and asking for a hot dog, or

as complicated as ordering lobster at a seafood restaurant. The verbal or written order is the *kanban* that sets the assembly process in motion.

Point B

At the appearance of a 'dupe slip' or verbal directive, a cook or other kitchen worker begins the next production step by pulling some kind of pre-portioned raw or semi-cooked collection of items out of a chilled or heated inventory container. The slice of pizza at a takeout counter is tossed into the deck oven to be reheated, or the tuna steak at an oyster bar is gently

EXHIBIT 2 THE RESTAURANT AS LEAN MANUFACTURING FACILITY



placed in a pan to sear, but in either case the work will not begin until the ticket appears.

All of the other necessary components to complete the dish, such as the pepperoni slices and mushrooms or the tomato garnish, are taken from the stored inventory. These had to be sliced, chopped, reduced, clarified, and put into portioned containers in advance to be ready to throw into a sauté pan, arrange on a plate, or simply place on a hamburger bun. At the end of the shift, as the clean-up and reset are completed, the cook will conduct a visual count of products that were depleted and create a plan for restocking prior to the next shift. A verbal or written list of items to be prepped will be handed to the chef or placed on a clipboard near the walk-in. The next *kanban* pulling the food through the system has been filed.

Point C

Every kitchen has someplace referred to as the 'prep area.' In large production kitchens, this could be an area behind the main pickup line. In smaller kitchens, it might be a stainless steel table with a cutting board, where a cook can peel onions. In all cases, this is the production space where totally raw ingredients are broken down into usable portions, or bulk items are split and made ready for final assembly. This is when bones are roasted with vegetables to make stocks, or beef is ground and seasoned to make taco filling, or pizza dough is left to rise above the oven. This is the heart of the production system. No quick service or *à la minute* kitchen could operate without semi-finished components being made ready for instantaneous completion.

The primary reason the restaurant industry is considered to be so labor intensive is that the physical inventory of perishable goods is effectively replaced by a stored labor inventory in the form of a perishable service. It only takes 7-10 minutes to assemble, cook, and send a finished dish of scallops or duck breast to the dining room, because the actual preparation took hours of invested labor during the day. The important consideration is that this preparation would not occur if

a customer had not ordered a similar dish during lunch or dinner yesterday, and the portions had to be replenished. The par-cooked duck breast with its cranberry coulis has been literally 'pulled' through the system by the cook's work order for restocking from the previous shift.

Point D

As the day's prep work is completed, the cooks will finish every shift by reviewing what is depleted from the refrigerators and the supply room, and make a plan to bring it all back to 'par stock' with the next day's order. Rarely will this depletion be allowed to run down for more than a few days, and only on special occasions will it last more than a week.

What is not immediately recognizable is that the work that goes into this process becomes stored labor inventory, and is perhaps the most significant value-added step of all. Commercial kitchens keep very little physical inventory compared to the high volumes of revenues produced. It is not uncommon for both the value and the physical quantity of food inventories to turnover completely anywhere from 12 to 52 times per year, an astonishing level compared to most other manufacturing systems.

Point E

The final *kanban* notification, which brings the system to conclusion, is the order placed with an approved vendor. The visible record may be started by the executive chef who leaves a voice message over the phone before she goes home at night, or by a purchasing agent at dawn the next morning with a purveyor's salesman, or by an ordering protocol using sophisticated EOQ (economic order quantity) modeling software and RFID chips to signal inventory depletions. In each scenario, there is no delivery of raw food or other materials to the restaurant's back door until this last 'pull' is initiated. Nothing will happen until it is required, often within hours of the order being placed with the supplier of the needed raw product.



Christopher C. Muller is Dean of the School of Hospitality Administration at Boston University. He was previously Professor in the Rosen College of Hospitality Management at the University of Florida, and Associate Professor in the School of Hotel Administration at Cornell University. Each year, he moderates the European Food Service Summit, a major conference for restaurant and supply executives. He holds a bachelor's degree in political science from Hobart College, and two graduate degrees from Cornell University, including a Ph.D. in hospitality administration. Email cmuller@bu.edu