SPECIAL REPORT: LITANY OF FACTORS TO CONSIDER IN FACILITY SITE SELECTION PROCESS

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Starbucks brews up advanced technologies

Modern times call for modern processes, and Starbucks has invested in 21st-century facilities and equipment to produce a modern, soluble coffee that puts the old instants to shame.

Wayne Labs, *Senior Technical Editor*

A Starbucks operator works with an X-ray inspection system on the VIA Ready Brew line to ensure product quality specifications are met. Photo: Robert Pepple, Pepple Photography.

When you think "instant coffee," you may have memories that you'd like to forget. Somehow, even when "freeze-dried" coffees came out, they just didn't measure up to the freshly brewed flavor of the same brand you enjoyed in a drip format. Often, these instant coffees lacked flavor or were bitter, and it seemed like they never dissolved completely. For sure, instant coffee is "so last century" (actually it was invented in 1890), but all that has changed with Starbucks' latest soluble coffees—like its VIA Ready Brew brand—made in a new, modern plant with sophisticated continuous process controls and packaging.

Starbucks found the methods it previously used to produce its soluble coffees were cumbersome and needed to be improved. Relying on two or three vendors/co-manufacturers—located in South America, Europe and Asia—is no way to get consistency and control of a product. Why not start from scratch and create a 21st-century facility with the latest customized process controls and packaging systems designed to produce great-tasting coffee, keep it fresh and meet customer delivery schedules?

And that's just what Starbucks did when it decided to design and build a brand-new facility in Augusta, GA. Starbucks reasoned it might have been 15 to 20 percent cheaper to operate a plant in Central America or Asia due to lower labor costs. However,

much of that gain would have been lost in transportation costs, slower order fulfillment and the lack of complete quality control.

Why instant coffees?

Most instant coffees seem so last century, because the primary technologies used to produce them haven't changed much since World War II. Starbucks management thought that with the right tools, the company could make a soluble coffee that would change the way consumers feel about instants and compete successfully in the soluble coffee market segment, especially if it could replicate the flavor of coffee freshly brewed in its stores.

By designing, building and operating the Georgia-based facility from top to bottom, Starbucks could tap into new technologies to create a more efficient, automated process. Starbucks set out to create a facility with a proprietary design, not a single outside vendor's off-the-shelf system.

Getting started

After choosing Stellar as its design-build firm, Starbucks broke ground in July 2012 on a 100-acre site in Augusta, GA. Construction on a 160,000-sq.-ft. building began shortly thereafter. The $172 million plant can produce and package 4,000 metric tons per year of ready-to-brew, water-soluble coffee, including both VIA and non-VIA products. Because of its flexible design, the facility can be easily expanded to accommodate an additional 2,000 tons of instant coffee per year. Not only is the new facility Starbucks' first company-owned and operated soluble coffee facility, it's the company's fifth US plant.

Once the beans are unloaded into this green bean receiving area, they're never again touched by human hands. The beans are entered into process pipes and equipment for the duration of the soluble process. Photo: Robert Pepple, Pepple Photography.

Since the plant is heavily automated, Starbucks located it in an area where a labor force with technical expertise was available. Of the 144 new positions created by the plant, 75 percent require engineering and technical maintenance know-how. Three schools in the area—Augusta Technical College, Augusta State University and Paine College—serve as a resource for technical staff.

Starbucks relied upon three groups for the plant's process engineering, design and construction. These included Starbucks' own team, Stellar, which han-

LEED Gold design innovations

The Augusta facility's design features several LEED innovations. These include:

• **Converting spent grounds to energy**—Starbucks didn't want to burn the grounds or send them to a landfill, so it struck a deal with Augusta Renewable Energy (ARN), a division of Columbia-based First Generation Energy. ARN agreed to spend $20 million to build its first anaerobic digestion facility in Georgia and to take Starbucks' spent grounds, mix them with other food products and generate heat, biogas and combustible material.

• **Low VOC paint**—The floors and other painted areas of the facility are coated in low volatile organic compounds (VOC) paint, keeping outgassing at a minimum and providing a safe environment for workers.

• **Building**—The facility has EPDM roofing, which is made from oil and natural gas, and has a white, reflective design that reduces cooling costs. The building also contains insulated metal panels (IMPs) that provide a high R value of thermal resistance. In addition, the structure features 11 different roof elevations with mezzanines throughout to produce a smaller footprint.

• **Lighting**—The walls in the packaging and receiving areas are constructed of translucent panels, allowing high levels of natural light. All exterior office walls have windows, and employee workspaces are equipped with task lighting. All lighting is controlled by motion sensors.

• **HVAC**—Per LEED requirements, the system is subjected to functional performance testing and regularly inspected for low-energy usage. HVAC systems use chilled water, and all areas of the plant have individual controls.

• **Multiple cooling media**—For efficient operation, the facility uses multiple cooling media (ammonia, ammonia to glycol and tower water).

• **Water recovery**—Water is reused throughout, and heat is recovered wherever possible.

• **Green roasting equipment**—New technology destroys odors, while heat is recovered for other areas of the plant.

Starbucks VIA Ready Brew, a modern soluble coffee, is produced in a sophisticated plant that features continuous process control and packaging systems. Source: Starbucks.

dled process engineering and facility design-build, and the OEMs that helped in the design of various unit operations. Starbucks led all the teams, relying on Stellar for design-build operations and OEMs for the expertise in specific areas, including freeze and thermal concentration, roasting and spray-drying. "We brought in a wide range of experts who had worked in the soluble field and challenged them to innovate the industry's long-standing technologies to improve performance and flavor," says Jeff Strong, Starbucks director - engineering—TLA.

To ensure no competitor could replicate the process, all the vendors were restricted to their own unit operations and were required to sign nondisclosure agreements. After the OEMs completed their individual projects, Stellar and Starbucks put the pieces together to form a single proprietary process.

Need technical people? Local colleges can help

In an era when it's difficult to locate qualified technical staff, working with local colleges is a great way to find people who can grow with an organization and make the entire community stronger.

In spring 2013, the Starbucks Augusta soluble plant team received an enormous amount of support from Augusta Technical College, with the help of Terry Elam, president of Augusta Tech; and Lisa Palmer, vice president-economic development. "The faculty and staff notified students of our job openings and allowed us to use the school's office space and technical labs to conduct interviews on campus," explains Starbucks' Jeff Strong. "The career service department assisted us when we held Interview Blitz sessions and invited 60+ potential candidates to a 'speed dating' screening process."

Going for the Gold—LEED that is!

The new plant was designed with the smallest possible environmental footprint and to achieve LEED Gold certification. Starbucks already tops the retail sector in LEED certifications globally: It has LEED-certified stores in 19 countries and integrates green building strategies into all renovations and new building projects.

Green innovations were designed into nearly every aspect of the Augusta facility, from the site location to the roof. Some of these innovations include: the conversion of spent grounds to energy, low VOC paint, building systems, lighting, HVAC, water recovery and roasting equipment. (For more details, see page 36.)

The plant also utilizes multiple cooling media. For example, it uses tower water for condensing processes—using air instead of ammonia compressors to cool the water—achieving greater energy efficiency. Using air in this way also improves worker safety, since it reduces the likelihood of personnel coming into contact with ammonia and decreases the amount of ammonia stored onsite. In addition, the plant saves energy by equipping its low NOx boilers with economizers that use exhaust to preheat incoming water.

Water is both reused and heated/cooled throughout the plant. For example, instead of using steam to heat 100 percent of the water required for extraction (also known as brewing), cold water is run through the condensers on aroma recovery, to cool down the liqueur, and is then preheated for extraction. Water from the thermal process is also reused for first rinses in the CIP system.

"The facility's roasting process features newer technology to destroy exhaust produced by the roasters," explains Strong. Regenerative thermal oxidizers burn the exhaust, while recovering part of the heat to use in other areas of the process.

Safe and untouched by human hands

Although producing soluble coffee doesn't fall under any governing body of food safety guidelines. Starbucks is pursuing the British Retail Consortium's (BRC) food safety standard. BRC has certified more than 23,000 suppliers in 123 countries around the globe.

The plant's advanced food safety design is immediately apparent when someone enters the facility. Con-

spicuous in their absence are coffee beans. "Once the beans are unloaded in the green bean receiving area, they are never touched again by human hands, other than for quality-control checks," says Strong. Instead, the beans are contained inside the process pipes and equipment; the coffee powder is blanketed by nitrogen after extraction.

The plant's facility-wide system is integrated with the Starbucks' office network. Almost everything in the plant is connected by the system, including the 30+ HMI terminals and all the equipment, computers, phones, paging, security, printers, cameras, card readers and servers. Built on the Wonderware ArchestrA platform and Rockwell Automation hardware, the system allows operations, QA and maintenance personnel to access accurate, real-time information from any machine in the facility. Plus, operators in the control room on the second floor can use data from any area in the plant to troubleshoot and quickly resolve issues, notes Strong.

Unlike a typical instant coffee plant, where everything is cleaned at once after the last bit of powder has been made, the Starbucks plant has a CIP system that enables cleaning to begin right after each step is finished, says Strong. Instead of manual switchover, mix-proof valve technology enables fast, efficient, highly sanitary operations. Plus, rather than draining and wasting the water used in each CIP cycle, Starbucks recovers and reuses it as solution for the first rinse of the next cycle.

The plant also is designed to prevent the occurrence of cross-contamination. The raw or green side of the plant is completely separated from the cooked or finished side, as are the traffic patterns and waste streams, to eliminate the possibility of pathogens migrating from the raw to cooked side of the plant.

Since a plant's dock doors often present the greatest threat of energy loss and air filtration (including airborne contaminants), Starbucks created a barrier between the outside world and the dock. As trucks approach the Augusta facility, they back into a rubber-sealed door. Then, employees open the truck from inside the plant and lower the dock leveler into the truck.

Integrating worker safety into the plan

Due to the facility's level of automation, the total number of workers has been reduced to one-fourth the number at Starbucks' co-manufacturing facilities. The new operations are safer, too. With operations managed in control rooms, employees do not have direct involvement with the machinery and can focus their efforts on more important issues, such as quality.

By roasting to a time-temperature curve, Starbucks can control where the coffee "rides on the curve" and how much heat is applied over a less-than-15-minute process to achieve a desired flavor. Photo: Robert Pepple, Pepple Photography.

Although the operations were set to begin in October 2014, hiring began a year earlier, since Starbucks wanted to ensure managers would be aligned to the operation's objectives—developing an innovative coffee process and delivering Starbucks' flavor in a soluble format. Becoming familiar with the process long before startup gave managers time to understand the objectives and examine how they would achieve them.

Stellar located supervisory offices and research labs within the heart of the plant, central to the process. Besides providing efficiency, the layout keeps partners comfortable in the places where they spend most of their time.

During construction, Starbucks held weekly safety meetings focusing on potential hazards to eliminate reportable incidents. Any near-miss or safety incident that occurred onsite was subject to root-cause analysis, and safeguards were immediately put in place. Starbucks also implemented a rigorous hazard review process to look in-depth at every aspect of partner safety, including their tasks, the location of sampling points, equipment access, the use of stairways instead of ladders, etc.

Nitrogen is used throughout the plant to keep the product fresh and food safe. Since nitrogen can also present a safety hazard, the facility's design features a pressure relief system that releases gases outside, away from the people in the plant. All the other systems with high temperatures and pressures feature

The Augusta soluble plant houses Starbucks' very first extraction system, a proprietary and highly confidential process. Pictured here is the distributor valve used for extraction. Photo: Robert Pepple, Pepple Photography.

similar outside relief systems. In addition, oxygen sensors are placed throughout the plant to detect any nitrogen release, and ammonia sensors are located in the engine room to detect any ammonia leaks. The possibility of a combustible dust incident was carefully considered, prompting the addition of an explosion duct that allows a spray dryer to vent an explosion outside, if one were to occur.

Automating the process

The Starbucks Augusta facility's automated, proprietary process took over a year of fine-tuning. The result was a new level of innovation in the soluble industry, according to Strong. To get the flavor of its brewed coffees, the Starbucks team knew it needed a custom-designed plant—and that would require the experience and expertise of many different parties. So, Starbucks recruited artisanal engineering companies to design custom, automated, state-of-the-art pieces of equipment for the new facility.

After extraction, coffee settles in liqueur weigh tanks. The tanks are nitrogen blanketed to preserve freshness. Photo: Robert Pepple, Pepple Photography.

Because the new facility would consolidate the processing capabilities of three separate co-manufacturers' plants into one processing system, it had to be flexible. Advanced process design, proprietary programming, and a unique configuration of valves and pipes provide flexibility for future variations. With additional valves and piping, Starbucks can change process paths. For example, it can skip step B and go directly to step C. Plus, parameters such as temperature, pressure and cycle times can be easily modified and tailored to a specific product.

To comply with EPA Title V guidelines, Starbucks' roasting systems were redesigned to improve performance, as well as reduce greenhouse gas emissions (levels of sulphur oxides [SOx] and nitrogen oxides [NOx]). While Starbucks' co-manufacturers used an older technology (catalytic converters that needed to heat exhaust to higher temperatures and required more natural gas), the Augusta plant opted for newer regenerative thermal oxidizers (RTOs) that destroy the roasters' exhaust.

The roasting systems were designed to be gentler on the environment and to create a higher-quality coffee product. Starbucks' roasting process allows the fine-tuning of flavors by controlling the time-temperature curve.

After roasting, the beans enter the cooling portion of the process. In the co-manufacturers' process, beans were dumped from the roaster onto a perforated steel plate where a stream of air cooled them as they rolled across. However, the Augusta facility has a fluidized bed where beans are suspended individually in a stream of air, to improve thermodynamic cooling and reduce bean breakage. Starbucks has found keeping the beans whole until they are ground yields a better flavor.

Probably the most critical—and the most proprietary—step in the process is the new extraction (or brewing) process. While the old extraction technology was somewhat similar to a drip coffee maker, more advanced technology was required to extract the best of the beans. Think of this process in terms of an espresso machine—with higher temperatures and pressures—allowing more extraction of solids from

the beans than could be achieved with the earlier process. The new, tightly controlled system uses a vacuum and high-pressure steam.

As exacting as the new extraction process is, both good and bad flavors emerge. To create a pleasurable smell and taste, Starbucks developed a proprietary process that removes bitter and acidic flavors, while preserving flavors that are rich and robust.

Following extraction, Starbucks uses both freeze and thermal concentration to remove water from the product to create a thick liqueur. The thermal concentration process uses equipment typically found in high-end chemical processing, but through rigorous R&D testing, it has been converted for coffee processing. The specialized equipment uses a different geometry and design to reduce temperature and pressure profiles, in order to be gentler on the product. Heat destroys flavor, so lower heat preserves more of it.

The thick coffee liqueur is then pumped over to tanks. Next, the liqueur is pumped to the top of the spray dryer and sprayed, after which, it floats down through hot air with powder emerging from the bottom. Spray-drying both creates flavor and dries out the product.

Although freeze-drying doesn't allow soluble coffee to reconstitute easily in water, spray-drying actually cooks the product, so there are none of the grounds typically at the bottom of a cup.

While making preliminary adjustments to the spray-drying process, the Starbucks engineering team noticed the powder was coming out a burnt-orange color and still contained liquid. Most soluble coffees are that color, but Starbucks required a dry, black hue to match the color of a traditionally brewed cup of coffee. To get a darker roast, the liquid needed to be cooked more, staying within the dryer for a longer period of time. Therefore, the team increased the height of the spray-dryer by 40 feet to lengthen the amount of time the particles would remain suspended. To further enhance the flavor, Starbucks developed a patented process of adding micro-ground Turkish or Greek coffee grounds to give its product a mouth-feel similar to that of a French press coffee.

Packaged while fresh

The Augusta plant's packaging area consists of four lines: one each for Refreshers beverages, VIA, pouches and bulk packaging. Once the coffee is in powder form, it's packaged within 12 hours of production.

The Starbucks Augusta facility is a continuous process, rather than a batch operation, so there are no open bins or powder storage; product moves directly to packaging. The packaging lines are highly automated, and the only manual intervention required is to feed raw packaging materials to the lines.

After spray-drying, the powder is stored temporarily in silos, from which piping pneumatically transfers it to be mixed and blended, and then transports it to the fillers where the packages are formed, filled and sealed. X-ray units inspect the packages for any foreign materials, while a checkweigher ensures appropriate weights. The packages are automatically laned for accumulation before they are put into cartons and sent via robots to be palletized and stretchwrapped.

To the future and beyond

The Starbucks Augusta facility currently produces and packages VIA Ready Brew. However, the plant was designed with a technological platform and the capacity for additional products in the future. The proprietary programming and installation of the pipes and valves allow the plant to run different processes without following the same path.

The plant is an investment for now and in the future. "We've made an investment in soluble coffee unlike any made in the US in 50-plus years," says Scott McQuiston, Starbucks quality assurance manager-supply chain operations. "We're ready to serve the market today, and we have this great facility we can use to produce future Starbucks products as well." ❖

Spray-drying both creates flavor and dries the product. During this process, the liqueur is pumped to the top of the spray-dryer and sprayed before floating down through hot air with powder emerging from the bottom. Photo: Robert Pepple, Pepple Photography.

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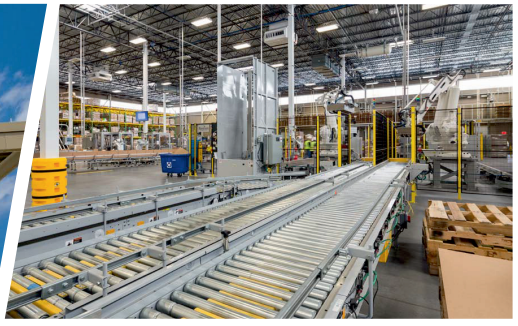

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