Plant of the Year
Efficiency and Excellence Abound at Blue Diamond Growers
Efficiency and excellence abound at Blue Diamond Growers

Built from a foundation of emerging collaboration tools and a unique, cross-functional, interdisciplinary approach, Blue Diamond Growers achieves its manufacturing goals with its new “dream” plant.

Sacramento, CA-based Blue Diamond Growers, the world’s largest producer of almonds and almond ingredients, reached a point where additional processing capacity was required to meet increased global demand and attain long-term growth targets.

A cooperative owned by half the almond growers in California, Blue Diamond made the largest single investment in its 104-year history when it constructed a new multi-million dollar processing facility in Turlock, CA that sets new standards of excellence for food safety, processing and building innovation.

The California almond business is big business, according to Blue Diamond, which reports the tree nut is marketed to every US state and more than 90 foreign countries, and stands as the sixth-largest US food export and the number one specialty crop in America. The California almond crop has quadrupled in the past 30 years, with the crop currently valued at more than $6 billion dollars.

Blue Diamond has experienced double-digit growth the last four years, driven by burgeon-
ing demand in new investment markets and the continued diversification of products containing almonds, says Ulli Thiersch, plant manager and director of projects and construction, industrial operations. The company has a dominant position in snack almonds, almond milk and gluten-free almond crackers in North America, and is a leading supplier of almond ingredients to major food companies. It has introduced 15 new products in the past year, including iced coffee made from almond milk and a line of gourmet crackers. Blue Diamond processes and sells almonds grown by its 3,000 grower-members.

“The Turlock plant represents phase one of a 15-year growth strategy developed three years ago that helps Blue Diamond answer the question on how we will compete in the future,” says Thiersch. New principles of project design and delivery were implemented in the building of the plant, with the owner, architect and general contractor, as well as process designers, operations experts, a supply chain manager and QC/QA managers, at the table from the start.

The cross-functional, interdisciplinary team was led by Whiting-Turner Contracting. The plant incorporates the principles of Integrated Project Delivery and Lean Design and Construction in a design-build contract. Collaboration in the planning, design, scheduling, budgeting and construction of the facility has resulted in the most efficient almond producing plant in the world, says Blue Diamond.

**Breaking ground**

Blue Diamond purchased 88 acres of land in Turlock in 2010. After creating a three-phase facility and capacity expansion schedule, the company broke ground for the plant in April 2012. Studies on environmental impact, water and wastewater capacity, traffic patterns and a range of infrastructure needs were completed beforehand, says Bruce Lish, general manager, industrial operations at Blue Diamond Growers.

Phase one entailed the construction of a 175,000-sq.-ft. manufacturing facility with three almond processing lines. A natural line, which pasteurizes almonds without de-skimming, started up in April 2013; two blanching (scalding) lines that pasteurize and then de-skin the almonds started up in June of last year.

Current production at the Turlock plant is designed in part to replace Blue Diamond Growers’ existing almond blanching and cutting operations at its Sacramento facility. The building to be shuttered is not conducive to high-volume, high-efficiency production, says Lish. The older building challenged output rates and required additional lines of defense to ensure product quality and safety. “A clean room environment with production taking place under one roof was a key consideration in the Turlock plant’s design. We are better able to keep product safe and in a pristine environment to improve rates while maintaining quality,” says Lish.

The production rate of blanched product at the Turlock facility is three times the output of the line at the older building. Output is further enhanced through technology and automation that reduces manual tasks done on the line.

**Branching out**

Nearly all the production at the Turlock facility serves Blue Diamond’s global ingredients manufacturing business as part of the company’s phase
one strategy to supply almonds as an ingredient to major and global consumer product groups.

Phase two will focus on meeting the growth needs of Blue Diamond’s North American consumer group and will include the expansion into a wider range of packaging forms such as cans, flexible pouches, standup pouches and other forms of packaging. Additional processing technologies being considered include oil roasting, dry roasting, coating and milling for almond milk.

Phase three will revisit Blue Diamond’s focus on enhancing products and processes that serve its global ingredients manufacturing division, says Thiersch.

Blue Diamond operates almond processing plants in Sacramento and Salida, CA, in addition to the new Turlock facility. The Salida location is the largest receiving plant in California, capable of processing approximately one million pounds of raw (brown) almond product daily.

New generation design-build
To build a state-of-the-art plant that would meet Blue Diamond’s goals while being completed on time and on budget, Jovan Petrovic, project manager at Whiting-Turner Contracting, brought the principles of Integrated Project Delivery (IPD) and Lean Design and Construction into the design-build process.

According to The American Institute of Architects, IPD is a method of project delivery distinguished by a contractual arrangement among a minimum of an owner, design professional and builder that aligns the business interests of all parties to motivate collaboration and the construction process. According to the project team, most companies are accustomed to working with different groups and being collaborative. These tools help define and manage the process, and deliver certainty in the quality of the product, the schedule and the budget.

With IPD, all the involved parties are fully committed to its core contractual and behavioral principles and have an equal stake in the success or failure of the project. Major contractual principles include: shared financial risk and reward based on project outcome; fiscal transparency between key participants; early involvement and collaborative decision-making by key participants; and joint development of project target criteria and liability waivers between key participants.

Blue Diamond’s IPD team included Lish and experts from Lish’s operations team. According to the project team, when an idea is introduced, every person at the table can analyze it from his or her point of view. It is an invaluable tool to the process because it gives all parties a chance for instant feedback on design ideas and perspective.

Lean for design
Lean philosophy was applied to the planning, design, scheduling, budgeting and construction of the Turlock plant. The application of lean project management, where the key participants are at the table, streamlines the draft design process and minimizes mistakes.

The cost portion of the design-build project was incorporated into the IPD and lean production management concepts with a target value
design (TVD) concept to maximize the value of the project’s design within a set construction budget.

Putting key participants on the project team and then including IPD, lean and TVD concepts changed the design process on a fundamental basis. At the initial meeting with Blue Diamond, there were preliminary design criteria regarding layout and basic building materials, but the team put that idea aside and asked what their dream plant would look like.

When Thiersch and the other project members arrived at their dream design, the price tag was well above the budget limit. “The idea was to identify the items in the design that had to be included in the blueprint,” says Thiersch. Second-tier “dream” items (those that would be nice to have but were of lesser urgency) were addressed differently: The design-build team either value-engineered each item for less cost or gave up on that aspect of the dream plant, says Thiersch.

The approach not only helped Blue Diamond prioritize design changes, it demonstrated how these decisions could free up money for higher-end items.

Many aspects of the plant design—from the product and processing areas to walls, roofs and offices—were imagined using building information modeling (BIM), a 3-D visualization approach that helps food plants make better decisions and catch problems during a design review (see “Building information modeling allows better decisions based on workflow, budget and energy costs,” FE, Tech Flash, January 14, 2014).

With BIM, a project team can view every valve, pipe, elbow joint and window position in real time as they walk the plant. BIM is becoming a standard in facility design, but users don’t need to model everything. If the project is simple but features a couple of congested, complex areas, those areas can be modeled in a targeted BIM approach.

**Building value**

Thiersch was project manager during the design-build of the plant and is currently plant manager. “A project manager is traditionally concerned only with using what meets all codes and is cheaper because he or she gets to leave when the project is completed. However, to a plant manager, design absolutely matters. If I want longevity, I would choose concrete instead of metal for a building shelter, which can rust over time, potentially causing food safety concerns. And I would not want equipment on the roof, which can increase the chance for holes and leaks in the roof, adding costs related to roof and equipment maintenance,” says Thiersch.

Blue Diamond offset the additional cost of higher-value finishes and construction materials/methods by creatively streamlining and modularizing all building and equipment systems. Mechanical, electrical, fire protection and equipment utility piping was fabricated off-site by subcontractors and consolidated into 40-ft. long pre-mounted assemblies.

Typically, the mechanical plumbing technician, electrician and fire protection installer would create individual solutions. At Turlock, they worked together to design common modular pipe racks, where only the final connection between assemblies and branch lines was done in the field, drastically reducing installation time and costs. The electrical service and associated systems in the central utility plant, adjacent to the main plant, have additional built-in capacity for future expansion.

One of the most unique building innovations to emerge from the design-build process is the use of removable, reusable, 35-ft. tall concrete panels that span the entire west wall of the receiving warehouse, process area and shipping ware-
This almond scalding unit comes through a wall separating Blue Diamond's wet pasteurization stage from the sterile and dry processing area of the RTE. Photo by Mikell Knights.

House. The panels are designed to be detached from the existing structure and relocated 50 or 100 ft. away and reused as the outer wall when the plant undergoes an expansion. Blue Diamond initially budgeted for a less expensive frame structure with insulated metal panel skin (insulation sandwiched between two sheets of corrugated metal), but IPD led to a more inspired choice.

The precast wall is designed to be disassembled piece by piece using a single crane and reassembled for future construction. “It seamlessly connects the future expansion areas to existing building spaces without the operational limitations of traditional knockout openings, while saving operational costs and some future construction costs,” says Thiersch.

### Interstitial installation

Structural developments addressed two major equipment issues facing Blue Diamond. Thiersch wanted the company’s pasteurizing processing space to be free of burners, fans, filtration units and MEP-related equipment. He also wanted to locate all HVAC equipment inside the building, not on the roof or outside. This would extend the longevity of the roof and the equipment while improving serviceability, food safety and employee safety. “The typical approach of a roof-hung equipment area, isolated with insulated metal panel ceilings, was impractical due to the length and width, says Thiersch.

Removing MEP equipment from the RTE processing space allowed Blue Diamond to use more conventional MEP equipment and eliminate more than 7,500 sq. ft. of stainless steel hoods. Blue Diamond also was able to downsize its HVAC requirements for the RTE area, since the heat- and moisture-generating equipment was moved to the interstitial space. The interstitial space is not climate controlled, another plus for energy savings. “The longevity of the equipment in the interstitial space will be substantial over the life of the facility because it is in a dry environment, and can extend beyond the equipment maker’s estimate of useful life. Savings are estimated in millions of dollars,” says Lish.

The entire floor of the interstitial space was precast. Every hole in the floor six in. or larger had to be known before the floor was constructed so equipment in the RTE area could be connected to equipment in the interstitial space. To accurately lay out and drill smaller holes, a 3-D model of the floor was uploaded to Trimble Total Station, where more than 500 holes two in. or smaller were drilled through the installed precast interstitial floor before any of the equipment below was put in place.

The exterior of the plant features drought-tolerant plants and an external irrigation system that measures the moisture and temperature of the air load requirements of the wall,” explains Thiersch.

In a major change in design direction, the project team decided a structural second floor should be constructed above the entire process area to house secondary equipment and the separate control rooms for each of the processing lines. A 260- by 170-ft. interstitial floor structure was designed using different precast concrete and rebar elements.

The six massive air handling units that serve the three production lines are the tallest pieces of equipment in the interstitial space. They have custom enclosures developed by the project team to maximize the available height, making up for the required volume in the building.
and adjusts landscape irrigation automatically, as required by the industrial park. In addition, the exterior lighting (e.g., parking lot area) reduces night sky pollution, so the plant appears darker from the street.

Pending a few remaining activities, Blue Diamond expects the Turlock plant—even while in phase one—to obtain LEED Silver certification later this year. It will be Blue Diamond’s first LEED-certified plant.

**Processing progress**

Raw materials enter the building at the receiving area, move through a three-room production area and then are transferred to the packaging and shipping area, all in a linear, single-floor layout. Although this is not a standard required by the industry, this almond processing plant is likely the first to completely separate raw materials from finished goods, eliminating any chance for cross-contamination.

Blue Diamond’s Sacramento processing facilities use gravity-fed material systems that operate within multi-story buildings. “Moving away from a gravity-feed system was a key consideration, [since] trying to move materials to each of the floors can be difficult and energy consuming,” says Lish.

The production area currently operates one natural product line (brown almonds with skin) and two blanched product lines where the skin is removed. Each line operates in its own 50-ft. wide bay adjacent to each other. “Each of the three lines is set up to produce whole almonds, as well as sliced, slivered or diced product of different specifications, by engaging or bypassing components of the cutting system,” says Thiersch.

The production lines boast several advantages over previous system designs, including the ability to operate continuously rather than batch processing. Plus, the Turlock lines can switch from dicing, slicing or slivering on the fly, whereas prior lines had to shut down and retool for product changeovers.

“The four different types of cutting finishes are integrated within each of the three lines. The lines are also integrated with five packaging lines, so the plant can produce any type of product in any type of packaging and switch to a different product or packaging type at a moment’s notice. This is also said to be an industry first. The process controls [featuring Allen Bradley 700 controls, with local PLCs and an Ethernet backbone through the plant] are fully automated,” says Thiersch.

Almond meats arrive in Blue Diamond’s own fleet of trucks from the Sacramento or Salida campus in sealed 2,000-lb. gaylord boxes. (The trucks drop off raw material in the receiving area and then drive to the opposite end of the plant to pick up finished goods for transport back to the Sacramento site to maximize transportation efficiency.)

The gaylords are picked up hydraulically by mass-flow bins dedicated to each line, and the product is discharged onto its own mass-flow, loss-in-weight feeder that features a vibratory conveyor underneath. PLC controls monitor the flow of the product onto the conveyors, generally at rates ranging from 1,000 to 10,000 lb./hr.

Product is conveyed through an opening in the wall and into a “wet” process area, the first stage of the production process. This stage, where pasteurization and pathogen kill take place, is unique in that it is completely enclosed and separate from the dry production areas.
Natural almond processing involves pasteurization with steam, while products targeted for blanching and skin removal are scalded with water. With natural almonds, the challenge is how to pasteurize with steam while keeping the nuts’ skin intact.

The project team developed a low-moisture thermal process, in essence dry steam, which kills microorganisms on the surface of the nuts while keeping moisture low enough to avoid damage to the skin. Steamy almonds then enter an oven to raise their temperature. The enclosed system is a fine balance of steam delivery, temperature, belt speed control and a host of other factors.

For blanching, the almonds are submerged in a bath of scalding water to both pasteurize them and raise their temperature so they are more pliable. According to the Technical Expert Review Panel, a California agency that governs the definition of pasteurization, blanched lines must submerge the nuts in 190°F water for a minimum of two minutes. (All three lines have been tested and certified by TERP for efficacy and meet or exceed mandatory requirements.) The almonds’ final moisture level can be no higher than 6 percent to ensure they are safe for consumption and will not decay or spur bacteria growth when stored and handled properly.

Whether pasteurized with steam or water, the almonds then move by conveyor through an opening in the wall to the central processing area of the plant, where the RTE section is located. Almonds treated with scalding water actually remain in the scalders as they move into the sterile room. These almonds drop into an enclosed de-skinning unit that features a set of special rubber-covered rollers to strip the softened skin from the nuts.

Natural or blanched almonds are transported on their lines through separate foreign contaminant detection systems and to an oven for temperature and moisture conditioning prior to any required process cutting. A small team of quality control personnel stationed at the end of each processing line manually inspects the almonds for damage or skins remaining on blanched product. The control system is designed to stop and discharge product if any variable violates set parameters.

Allen-Bradley controls are used throughout the plant, with PLC stations strategically placed at key process points. Photo by Mikell Knights.

Forty-foot-long pre-mounted assemblies of the mechanical, electrical, plumbing and fire protection piping were fabricated off-site. Photo by Candy Padilla.
Blue Diamond can slice, dice and sliver product in three different ways. Product exiting the processing line is conveyed to the cutting system. Whole almonds pass down channels that direct them to a particular cutting device or are bypassed if whole almonds are required.

“Hot and moist almonds are ideal for slicing, where pliability provides a little give in them for a smoother cut. Almonds for dicing are kept cool and dry so the kernel explodes and breaks apart,” says Thiersch.

Finished almond product—whether whole or cut—is transported by conveyor up and out of the main RTE processing area through a wall and into the final RTE packaging/processing zone, located on a mezzanine above the packing and shipping section. Product is moved by an air-cooled vibratory conveyor to ensure its ideal temperature. Then, it is transferred by conveyor to a material handling unit that dispenses product out of the RTE and into one of five bulk scale/dribble scale packaging presses in the packaging and shipping station. Product is packaged into 25- or 50-lb. boxes or 2,000-lb. totes, and weighed for accuracy before being sealed, labeled and palletized.

**More efficiencies**

Due to the high efficiency of the plant layout and automated systems, Blue Diamond can run at desired production rates with approximately 30 plant personnel per eight-hour shift (five days a week), says Thiersch. A plant this size would typically require 500 people.

The company instituted rigorous hiring practices at the plant. In Turlock, the ideal candidate is an electrical and mechanical technician with PLC skills. Operators require a minimum of two years’ prior experience; four years of food operations experience is required to work in the RTE. Blue Diamond brings continuous improvement to its workers as well, offering training and testing for certification in their area of expertise.

Several other significant pieces of equipment help Blue Diamond operate more efficiently and cost-effectively. For instance, the plant is powered by two 750 KVA transformers that deliver maximum energy efficiency and ideal energy consumption levels.

In the central utility plant, two 700-ton chillers generate glycol-mixed chilled water, used for both the building and indirect product cooling. All pumps and chillers in the plant are equipped with variable frequency drives to minimize the primary variable loop energy loss.

Five 5 million BTU boilers tied together by computer operate optimally to supply process steam to the wet production stage for pasteurization activities. A separate system delivers hot water to the plant.

Plant wastewater is directed to two 3,000-gallon tanks housed in an adjacent building. The blending tanks conduct a primary screen to remove solids, sending the wastewater to a mixing tank to adjust the pH level. Water recycling in the wet process room delivers added energy savings. A custom material handling and disposal system takes care of the almond skins removed during processing.

Control instruments measure product flow rates, temperatures, moisture, bin levels and equipment speeds to provide feedback for stable production. Control panels are strategically positioned throughout the plant to provide instant access to current data and to make adjustments to utilities, process equipment and packaging systems. The controls architecture, based on Allen Bradley, was custom built for the plant.

**For more information:**

Bruce Lish, Blue Diamond Growers, 916-446-8420, blish@bdgrowers.com

Jovan Petrovic, The Whiting-Turner Contracting Co., 916-355-1355, jovan.petrovic@whiting-turner.com