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Al's Role in Preventative Maintenance

As part of its State of Industrial Maintenance report, MaintainX recently surveyed maintenance professionals across the U.S. and Canada with the goal of understanding the obstacles they face in 2025 and beyond.

MAINTENANCE PROFESSIONALS HAVE AN INCREDIBLY IMPORTANT JOB: keeping production lines and facilities running no matter what challenges are thrown at them.

But what do those challenges look like? And how can they be overcome?

MaintainX aims to find out. As part of its State of Industrial Maintenance report, the maintenance and asset management platform recently surveyed 1,320 professionals across the U.S. and Canada with the goal of understanding the obstacles they face in 2025 and beyond.

Co-founder Nick Haase, who recently discussed SOP generation on The Food Engineering Podcast, notes organizations want to move to a predictive maintenance approach, but that's often easier said than done.

"They're struggling to break free from firefighting," Haase writes. "Preventive maintenance is a goal for most teams — 71% say it's their primary strategy — but reality often falls short. Less than 35% actually spend most of their time on planned tasks. This isn't laziness or lack of ambition. It's because their best intentions keep colliding with challenges like aging equipment and talent shortages."

Specifically, 13% of survey respondents note they spend 60% or more of their time conducting planned maintenance activities. Just over a fifth (22%) say they spend 41-60% of their time on planned maintenance, while 26% spend 21-40% of their time on scheduled maintenance. The majority of surveyed professionals — 32% — say they spend less than 21% of their time on planned maintenance.

Unplanned downtime is a major concern, but MaintainX has good news to report there: 74% of surveyed respondents reported stabilization or decrease in unplanned downtime over the last year.

However, 31% of survey respondents note their downtime costs had increased, while 49% say their downtime costs remained the same. Just one in five survey respondents say their downtime costs decreased, despite experiencing a drop in unplanned downtime. MaintainX points to three main drivers for increasing downtime costs: machine wear and tear, rising costs of parts and shipping, and labor costs.

What can organizations do to make the most of their maintenance time and decrease downtime costs? MaintainX recommends embracing artificial intelligence (AI). For example, AI can help with work order management and scheduling, maintenance cost tracking and optimization, and predicting equipment failures before they happen.

Organizations are already exploring the use of AI in their operations — 14% of survey respondents report evaluating AI options, 7% plan to implement it within the next 12 months, and 12% are in pilot program testing. Meanwhile, some manufacturers have more experience with AI, as 15% use AI in specific areas, while 17% use it across multiple maintenance processes.

Those who utilize AI are experiencing benefits. Nearly 40% cite knowledge capture and sharing as the top advantage, but they also point to reduced unexpected equipment failures, improved maintenance scheduling, more efficient work order completion, improved safety compliance and making data-driven decisions as other benefits.

Certainly there are barriers to implementing AI — budget constraints, lack of technical expertise and cybersecurity concerns — but as organizations seek to optimize their maintenance operations, AI appears to be a critical option to



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WAREHOUSES

The future of warehousing lies in intelligent automation, and the path to success requires a strategic and comprehensive approach that integrates operational assessment, process design, commissioning, and well-executed go-live and ramp-up phases.

Designing The Automated Warehouse

Photo courtesy: Getty Images / onurdongel

BY JORDAN KOPP AND DAVID CAMPBELL

THE AUTOMATED WAREHOUSES OF THE FUTURE WILL BE MORE THAN MERE STORAGE SPACES; they will be dynamic nodes in global networks, orchestrating the flow of goods with unprecedented precision and speed. Developing an automated warehouse is a complex endeavor that requires a holistic approach to create operations that are not just automated, but also intelligent, adaptable and future-proof.

When master planning, operations should be designed from the inside out. That starts with putting process first. Following this approach helps produce designs for facilities that are more sustainable, safer and more efficient.

Design should begin with reviewing current operations, documenting historical data and developing projected growth plans. These are critical steps that will form the foundation of the automated warehouse functions. Utilizing historical and forecasted data to understand the required throughput and capacity is essential and cannot be emphasized enough.

Determining the number of daily shipments and the amount of on-hand inventory a warehouse should carry, along with defining the material to be handled, significantly impacts the choice of automated technologies for the ultimate warehousing solution. Recognizing that changing business factors and additional opportunities can influence business requirements and should be considered for flexibility and growth must be considered early in the operation assessment.

> **David Campbell** leads design and construction for automated warehousing solutions throughout the U.S. He has over two decades of experience in delivering turnkey automation projects in several industries. Dave's deep understanding of facility operations, automation technology, intelligent warehouse logistics and materials handling allow him to bring unique perspective to the challenges clients face when implementing turnkey automation projects.

ROADMAP FOR AUTOMATED WAREHOUSE EFFICIENCY

To achieve a successful process design that drives operational excellence, it is important to define clear, measurable objectives. Understanding the performance targets of the automated system, aligning technology with business requirements, and planning for future growth and flexibility allows you to establish robust specifications for the warehouse process.

Every effective design begins with identifying the optimal process flow. Consider the following steps as you work to integrate automation technology into your operation:

- Define a flow that minimizes delays and achieves the ideal cycle time.
- Identify potential risks and develop comprehensive mitigation strategies.
- Revise the process flow to reduce risks or introduce effective control measures.
- Infuse safety into every stage of the design by documenting risks, applying risk-reduction measures and verifying compliance with all applicable safety standards.
- Evaluate the necessary integration of system devices, warehouse execution systems (WES), warehouse management systems (WMS) and enterprise resource planning (ERP) software.
- Incorporate data tracking systems that provide real-time feedback on system health because such tools support informed decision-making and enable thorough root cause analysis.

Choosing the appropriate automation technologies requires a data-driven approach that aligns with business needs. This involves verifying the selected automation tools addressing specific operational pain points while balancing cost and complexity. Be sure to opt for systems that enhance operational efficiency and can grow with your business. Additionally, collaborate with reliable automation partners who can help optimize technology implementation.

> Jordan Kopp is a project manager and industrial automation specialist at Burns & McDonnell. With a background in biotechnology and experience as an automation engineer and consultant, he manages all stages of automation projects, including planning, design and installation.

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SYSTEM VALIDATION AND QUALITY ASSURANCE

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For successful commissioning of an automated warehouse system, the business needs of the end user must align with the capabilities of the automated system. Commissioning the automated warehouse breathes life into the system, confirming that all system elements function as designed. Due diligence must be taken to test all devices and all aspects of the software functionality and integration.

When commissioning an automated warehouse system, it is important to have a clear plan containing the functional requirements of the system's hardware and software, as well as the testing procedures that will be utilized to verify the system. Seeing to it that all systems are installed and connected to specifications is the first step. The automated warehouse system must be validated for compliance with all governing safety regulations.

Testing communication among system components, control networks and software systems is a necessity, as is assessing functional specifications related to the data exchange of the WES, WMS and ERP software. The data must be verified for accuracy, inventory tracking and order processing. Being able to validate the data exchange and the physical outcome of the commands supports successful system commissioning.

Contractually, commissioning is crucial. Collecting accurate data on system performance — such as throughput speed, load handling capacity, inventory accuracy, system reliability and uptime — is essential for determining the effectiveness of system design. Completing testing and commissioning is the first step to a successful go-live.



TRANSITIONING TO FULL-SCALE OPERATIONS

The go-live and ramp-up phase is critical for transitioning your automated warehouse from testing to full-scale operations. This stage sets the foundation for seamless automation deployment and operational excellence through meticulous testing, comprehensive training, proactive communication and gradual scaling. Factors to keep in mind before going live with the automated system include:

1. TESTING AND COMMISSIONING

- Test and commission all systems thoroughly.
- Acknowledge and resolve punch-list items to confirm system readiness.
- Validate all systems to minimize concerns and confusion among stakeholders.

2. COMPREHENSIVE TRAINING AND COMMUNICATION

- Develop and execute a detailed training schedule covering process-specific operations, safety protocols and troubleshooting procedures.
- Create a communication strategy that includes IT teams, maintenance staff, automation vendors, logistics partners and customers. Keeping everyone informed reduces risks and clarifies the path for issue resolution.

3. PHASED RAMP-UP AND CONTINUOUS IMPROVEMENT

- Allow time for a controlled ramp-up window, which allows fine-tuning the system and reduces future downtime.
- Incorporate clear milestones to track progress, document issues and conduct root cause analyses early in the ramp-up period.
- Use milestones to celebrate successes and identify areas for improvement.
- Create a structured approach that not only minimizes risks, but also optimizes performance, providing a successful transition from testing to full operational capacity.

RELIABLE, AUTOMATED NEXT-GEN FACILITIES

The future of warehousing lies in intelligent automation, and the path to success requires a strategic and comprehensive approach that integrates operational assessment, process design, commissioning, and well-executed go-live and ramp-up phases. A successful project begins with a deep understanding of current operations and future goals, followed by the optimization of workflows, seamless system integration and rigorous testing to validate performance.

The end goal of an efficient operation hinges on thorough training, clear communication and a phased ramp-up that minimizes disruptions and builds stakeholder confidence. Ultimately, the automated warehouses of tomorrow will not only enhance productivity, accuracy and cost-effectiveness, but also position businesses to thrive within increasingly dynamic global markets. **FE**

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GRAS

Self-affirmed GRAS determinations are being called into question at federal and state levels, even without health or safety concerns associated with substances that are designated as GRAS.

Photo courtesy: fcafotodigital / Getty Images

BY SAM JOCKEL, PARTNER AT ALSTON & BIRD, AND ASHLEY YULL, SENIOR ASSOCIATE AT ALSTON & BIRD

What's Ahead for

WHILE THERE ARE NUMEROUS PATHWAYS FOR COMPANIES TO BRING SUBSTANCES intended for use in or in contact with human food to market, a recent directive from the U.S. Department of Health and Human Services (HHS) to the U.S. Food and Drug Administration (FDA) to begin rulemaking could result in changes to the generally recognized as safe (GRAS) pathway that will impact the food and beverage industry. Beyond FDA, we've also seen state action aimed at reforming the GRAS pathway.

USE OF THE GRAS PATHWAY

While FDA premarket review and approval is required for food additives, substances that are GRAS for the intended use are explicitly excluded from these requirements.

Under the Federal Food, Drug and Cosmetic Act, the definition of "food additive" excludes any substance that is generally recognized "among experts qualified by scientific training and experience to evaluate its safety" to be safe under the conditions of its use. Demonstrating that a substance is GRAS for the intended use requires "common knowledge throughout the scientific community knowledgeable about the safety of substances directly or indirectly added to food that there is reasonable certainty that the substance is not harmful under the conditions of its intended use."

For substances that were not used in food before Jan. 1, 1958, this knowledge must be based on "scientific procedures" and "require[s] the same quantity and quality of scientific evidence as is required to obtain approval of a food additive."

While the FDA has historically "strongly encouraged" using the voluntary GRAS notification program, companies are permitted to reach their own position that a substance is GRAS for the intended use without premarket consultation or review by the FDA, known as a self-affirmed GRAS position. The same quantity and quality of scientific evidence is required to support a GRAS determination, regardless of whether a notification is submitted to the FDA.

In 2021, a federal court in New York upheld use of the GRAS pathway by the food and beverage industry, including the FDA's authority to permit the industry to rely on self-affirmed GRAS positions, noting that the FDA retained the power to take enforcement action if it disagreed with a GRAS determination.

RISKS AND BENEFITS FOR INDUSTRY

A company is ultimately legally responsible for ensuring that its food and beverage products do not raise a health or safety concern, no matter what was relied upon to establish a suitable FDA regulatory status for the products' ingredients and packaging materials.

Reliance on a self-affirmed GRAS position allows for the immediate use of a new ingredient or component of packaging material upon concluding that it is GRAS for the intended use, while use of the GRAS notification program requires waiting until the FDA acknowledges the notification via a "no questions" letter (though it is also possible that the FDA could conclude that the notice does not provide a sufficient basis for a GRAS conclusion or cease evaluating the GRAS notice at the notifier's request).

While the FDA is required by law to respond to submitted GRAS notifications within 180 days, it can extend that statutory deadline by 90 days if needed. In practice, it can take much longer to receive a response from the FDA, resulting in delays in bringing new ingredients and packaging materials to market.

PROPOSED CHANGES

We have already seen the FDA become more active in reconsidering the safety of approved food additives. The FDA has also proposed new approaches for its post-market assessment of substances present in human food and published a discussion paper outlining its proposed approach for identifying and targeting substances that are currently in the food supply for post-market review.

States have taken similar actions. Most recently, West Virginia passed new legislation that will ban the use of certified color additives and two preservatives in food and beverage products beginning January 1, 2028, adding to the myriad existing and proposed state-specific restrictions on food additives.

Self-affirmed GRAS determinations made by industry, which have been permitted since 1997, are also now being called into question at federal and state levels, even without any type of health or safety concern associated with the intended use of the substances that are designated as GRAS.

• *Federal*: The Secretary of HHS, Robert F. Kennedy Jr., has called for heightened government oversight of ingredients used in food as part of the "Make America Healthy Again" agenda. This includes reconsideration of the FDA's food additive standards, including rulemaking to eliminate industry's ability to rely on a self-affirmed GRAS position for substances used in or in contact with food and beverage products.

On March 10, HHS issued a notice indicating that the FDA was directed "to take steps to explore potential rulemaking to revise its Substances Generally Recognized as Safe (GRAS) Final Rule and related guidance to eliminate the self-affirmed GRAS pathway." The aim is to "require companies seeking to introduce new ingredients in foods to publicly notify the FDA of their intended use of such ingredients, along with underlying safety data, before they are introduced in the food supply." Legislation is another option being explored to eliminate the self-affirmed GRAS pathway.

State: There are also proposed changes at the state level that would require industries to share information used to support GRAS determinations for substances used in or in contact with food and beverage products. For example, the Food Safety and Chemical Disclosure Act was proposed in New York, which would require a report containing specified information about "any new use of any GRAS substance" to be submitted to the commissioner of the New York State Department of Agriculture and Markets (and included in a state database). Among other items, that report would have to include details about "certain characteristics of the data and information being used as the basis for the manufacturer's conclusion that the substance is GRAS."

RECOMMENDATIONS FOR INDUSTRY

- Proposed changes to the GRAS pathway could significantly impact the way new substances intended for use in or in contact with human food are brought to market. To prepare for federal or state actions that could affect the use of the GRAS pathway, the food and beverage industry should consider taking these actions:
- Identify a point person at your company to evaluate all ingredients and packaging materials used for your food and beverage products. Special attention is required for substances that are used in or in contact with food and beverage products already on the market based on a self-affirmed GRAS position.
- Consider the potential need to reformulate or repackage new and existing food and beverage products in response to state and federal requirements.
- Start thinking ahead about new ingredients and packaging materials for food and beverage products in your portfolio, as changes to the FDA's food additive standards and the GRAS pathway could result in delays in your ability to bring new products to market.
- Continue to track developments in the administration's "Make America Healthy Again" agenda and state-specific developments related to food additives and substances that are designed as GRAS for the intended use, including notices of proposed rulemaking and opportunities for input from industry. FE

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AR

Augmented Reality Is Shaping Manufacturing

Understanding these trends isn't just about having a competitive edge — it's also about preparing for the transformation that augmented reality will bring to manufacturing workflows.

Photo courtesy: Getty Images / Thinkhubstudio

HÉLÈNE DRUET, SENIOR OFFER MARKETING MANAGER AT DELMIA

AUGMENTED REALITY (AR) IS NO LONGER JUST A FUTURISTIC TECHNOLOGY TO MONITOR — it has become a powerful tool reshaping the manufacturing industry.

From enhancing worker productivity to bolstering operational efficiencies, AR solutions are proving their worth across manufacturing environments. But what does the future hold?

Five key trends have emerged for AR in manufacturing. These trends promise to redefine how manufacturing professionals and organizations leverage AR for innovation and growth. They also represent new and tangible advancements users can experience and benefit from today.

1. FLEXIBILITY IN AR HARDWARE USE

Gone are the days of being locked into one specific AR hardware provider. By 2025, manufacturers will enjoy increased flexibility in their choice of devices, effortlessly switching between AR platforms or systems. This interoperability makes AR adoption more scalable and cost-effective, providing businesses with the agility to leverage the best tool for every task.

Imagine using smart glasses for assembly operations one day and projection systems the next — all without compatibility issues or extended downtimes. This ability to adapt will empower manufacturers to maximize the value of their AR investments.

2. LEVERAGING ARTIFICIAL INTELLIGENCE (AI) FOR SMARTER AR APPLICATIONS

AR increasingly depends on artificial intelligence (AI), and the two are becoming closely integrated. AR involves connecting the real world with the virtual, helping users understand their environment through localization and contextual definitions. AI enhances this by analyzing reality and interpreting environments at an advanced level, aligning and synchronizing the virtual twin of a product with the real world.

By 2025, we anticipate a stronger reliance on AI, particularly for quality inspection applications. AR systems enabled with AI will quickly and reliably identify defects. Another area where AI will bring a lot of value is in its ability to improve tracking initialization, enabling rapid and accurate alignment of the digital 3D data and the real part for straightforward visualization of AR instructions.

Al's role will go beyond troubleshooting or identifying flaws. Predictive algorithms and machine learning will enhance workflows, providing operators with actionable insights in real time. This integration will make AR tools more intuitive, reducing complexity while improving outcomes.

3. AUTOMATED AR WORK INSTRUCTION CREATION

Creating AR work instructions for manufacturing processes can be labor-intensive, especially in the case of frequent changes in the 3D model and configurations of the parts. However, automation is set to streamline this in 2025. Advanced software will generate AR-guided instructions directly from CAD models and processes definition, supporting automated updates. Additionally, AI will contribute to enhancing processes and work instructions definition, further accelerating the automation of the content creation process.

This innovation will reduce implementation time while ensuring instructions are always up-to-date with the latest designs or processes. Workers will benefit from accurate, clear and visually immersive directions that reduce errors and improve precision on the shop floor.



4. ENHANCED INTEGRATION OF AR WITH CONNECTED TECHNOLOGIES

By 2025, AR in manufacturing is expected to allow greater integration with third-party technologies, resulting in an enhanced and immersive experience. This development will go beyond displaying work instructions and will allow for increased interaction with work cells and the surrounding environment.

For instance, we anticipate seamless connections to smart tools and voice modules, which will expand the possibilities for connected workers. Voice modules will allow workers to interact with AR systems simply by speaking, enabling hands-free operation. Meanwhile, smart tools — such as sensors, torque wrenches or IoT-enabled equipment — will feed real-time data into the AR interface, creating a unified and smarter workspace. Leveraging the AI capabilities mentioned earlier, these technologies become more intuitive by integrating multi-modal interactions through vision (AR) and dialogue (voice), paving the way for a virtual assistant.

This level of connectivity will reduce cognitive workload, enhance comfort and allow workers to focus on decision-making rather than repetitive tasks. This will result in improved productivity and safer, more intuitive work environments.

5. IMPROVED AND EXTENDED COLLABORATION

As manufacturers continue to adopt AR systems, together with the use of the virtual twin, we are witnessing an exciting trend toward improved and extended collaboration. With an increasing number of interconnected AR platforms, professionals will soon collaborate across multiple devices, operators and even machines, such as robots. Powered by the virtual twin, which serves as a reference point and ensures digital continuity, this connectivity will enable real-time information sharing, synchronized actions and coordinated decision-making, significantly boosting productivity and efficiency.

By connecting multiple AR devices, several operators can work together on the same task simultaneously, improving coordination. For example, technicians could collaborate on complex assembly processes, such as those in aerospace or automotive manufacturing. This trend not only increases productivity, but also enhances teamwork, reduces errors and is particularly valuable in industries where precision and collaboration are critical.

Enhanced AR system collaboration can also foster cross-departmental coordination for faster problem-solving. For instance, if an operator identifies a defect, they can immediately report it to a quality inspector, who can then provide real-time AR guidance for diagnosis and correction. This rapid response cycle helps resolve issues quickly and efficiently, ensuring smoother production.

This real-time collaborative model could also extend to interactions with production teams spread across multiple sites, further strengthening the agility and overall efficiency of the manufacturing process.

WHY AR TRENDS MATTER

Understanding these trends isn't just about having a competitive edge — it's also about preparing for the transformation that AR will bring to manufacturing workflows. Whether you're leading a digital transformation initiative, managing IT strategies or heading AR-based projects, staying ahead of these trends will be critical for driving progress. **FE**



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ENGINEERING

Engineering the Future

Exploring the Impact of Women Engineers on the Food Industry

To recognize the growth, and encourage more young women to consider engineering, the UK-based Women's Engineering Society is marking the 12th International Women in Engineering Day on June 23.

Photo Courtsey of serts / Getty Images Plus

BY ALYSE THOMPSON-RICHARDS

A LOVE FOR SCIENCE AND GOOD CHEMISTRY TEACHERS brought Samara Heaggans and Shalima Sreenath to engineering, but they've had very different paths into the food industry.

Heaggans, director of process quality engineering for Feastables, and Sreenath, head of downstream processing for Cellibre, are among the growing legion of women pursuing careers in science, engineering, technology and mathematics (STEM).

To recognize the growth, and encourage more young women to consider engineering, the UK-based Women's Engineering Society is marking the 12th International Women in Engineering Day on June 23.

In celebration, Heaggans and Sreenath recently shared their educational experiences, their work in the food industry and their recommendations for fostering diversity in the engineering field.



Shalima Sreenath



Samara Heaggans

WOMEN IN STEM

More women have sought careers in STEM over the last 50 years, but data from the U.S. Department of Labor's Women's Bureau show the engineering category has lagged behind the others.

In 1970, women represented 7% of all workers in STEM fields, and by 2023, that had grown to 26%. Women represented 14% of life and physical scientists in 1970, growing to 45% in 2023.

The mathematics field saw similar growth — ballooning from 15% in 1970 to 36% in 1980 – and reaching 44% in 2023. Women have also turned to the social sciences, occupying 15% of the field's jobs in 1970, and as of 2023, they represent 61% of the workforce.

Women have also pursued computer occupations, increasing from 17% in 1970 and peaking at 34% in 1990. As of 2023, women occupied 24% of computer-based roles.

Meanwhile, women represented 3% of the engineering category in 1970, quadrupling to 12% in 1990, and then growing to 16% in 2023.

Gender distributions also vary across engineering disciplines. The U.S. Census Bureau's 2023 American Community Survey illustrates the estimated breakdown as follows:

Gender Breakdown in Engineering Subcategories

Occupation	Male	Female	Total	% Female
Aerospace Engineers	139,951	22,538	162,489	14
Agricultural Engineers	3318	344	3,662	9
Bioengineers and Biomedical Engineers	15,965	6,903	22,868	30
Chemical Engineers	65,134	18,202	83,336	22
Civil Engineers	442,676	84,801	527,477	16
Computer Hardware Engineers	50,829	10,878	61,707	18
Electrical and Electronics Engineers	255,823	28,064	283,887	10
Environmental Engineers	25,172	11,784	36,956	32
Industrial Engineers	245,669	71,564	317,233	23
Marine Engineers and Naval Architects	12,338	1,206	13,544	9
Materials Engineers	49,814	11,599	61,413	19
Mechanical Engineers	330,299	37,916	368,215	10
Mining and Geological Engineers	6,712	523	7,235	7
Nuclear Engineers	8,216	884	9,100	10
Petroleum Engineers	18,601	1,262	19,863	6
Engineers, all other	578,747	107,399	686,146	16

Source: U.S. Census Bureau American Community Survey 2023, Tables B24115 and B24116. Margin of error not included.

The U.S Census Bureau also tallied the number of people holding leadership positions within the architecture and engineering sector. Roughly 13% of the 233,592 management positions in these categories are held by women.

Many women engineers experience this gender disparity beginning in their college careers. Heaggans, who attended Hampton University for her bachelor's degree in chemical engineering, saw the number of women in her classes dwindle as she progressed in the program. However, she notes women continue to pursue chemical engineering.

"It was very male dominated," she says. "It still is, but there are more women joining. There are always a few more women in chemical engineering, which is great to see. We did have female professors, which was great. Not everybody had that."



Percentage of Women Occupying Engineering Roles

Source: U.S. Census Bureau American Community Survey 2023, Tables B24115 and B24116. Margin of error not included.

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"It was very male dominated," she says. "It still is, but there are more women joining. There are always a few more women in chemical engineering, which is great to see. We did have female professors, which was great. Not everybody had that."

Heaggans also pointed to one instance in which a classmate was less than supportive, but she says the encounter pushed her to find confidence in her own abilities.

"At one point, we were in a study group, and one guy went down the row and said, 'you're going to drop, you're going to drop, you're going to drop, 'and pointed at me and said, 'you're definitely going to drop," Heaggans says. "It motivated me to say, 'no, I'm not.' He ended up dropping, but it made me realize, just because they've been there, or they're used to it, or they know someone who was a chemical engineer, doesn't mean they're the smartest in the room. It doesn't mean they know everything. And a lot of times, I ended up being the top of the class. It made me find my voice, own that, speak up for myself, and realize you have to learn how to work with people in all their different personalities."

Sreenath, who earned a bachelor's degree in chemical engineering from Birla Institute of Technology and Science in Pilani, India, says her class had more female students than was typical, but would often find herself as the only woman in project groups.

"I felt like most of my classmates and peers were extremely smart, supportive and respectful," she says. "Most of the time there, I didn't really feel like being the only woman in the group. I think that helped build the confidence to ask questions and speak up, anything technically related or anything like that, so that helped."

WORK IN THE FOOD INDUSTRY

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Heaggans reached the food industry through a process of elimination. While pursuing her bachelor's degree, she interned at NASA working on superconductors, at AT&T Bell Labs measuring the viscosity of viscoelastic fluids — which would later

become fiberoptic lines — and at an Exxon pilot plant with basic chemicals. Heaggans didn't like any of it.

During her graduate program at Johns Hopkins University, she realized she didn't enjoy being in academia. Heaggans also interned at Dow Chemical, working on agricultural chemicals, and she didn't like that, either. She then turned toward the pharmaceutical industry, but ultimately, she decided it wasn't for her.

"After a year and a half, I was like, 'I cannot do this one more day," she says. "I literally — it felt like to me — tried every industry except for food."

One of her friends, who had recently landed a job at Frito-Lay in Texas, encouraged her to apply and interview. With less inherent danger than other chemical engineering fields, the food industry appealed to Heaggans.

"A potato chip, a corn chip — nobody ever died from that," she says. "The chemicals weren't harsh. There weren't any accidents. Nobody caught fire. I ended up going to work for Frito-Lay. I've been in the food and beverage industry for decades now. It clicked. It finally clicked."

Heaggans began in Frito-Lay's research and development division, installing equipment and redesigning process lines. She worked on the ill-fated WOW chips, which were made with the fat substitute Olestra, as well Santitas tortilla chips. Heaggans also holds a patent for part of the process for manufacturing Tostitos Scoops.

"By the time I left Frito-Lay, five-and-a-half, almost six years later, I was responsible for all of tortilla chip manufacturing across the United States, which at the time was 42 different manufacturing plants," she says.

Looking to move back to the East Coast, Heaggans then became a process research and development engineering for The Campbell's Company in New Jersey. She worked on everything from soups and sauces to crackers and frozen layer cakes. Before she left the company, she served as the director of commercialization for its C-Fresh division.

"I got the chance to work on a lot of different types of products, processes, equipment, which was incredible," she says. "Just the breadth of experience, the breadth of different processes — a lot of engineering goes into food."

After a brief period of only consulting, Heaggans became employee No. 8 of Do Good Foods, a startup that aimed to reduce waste by upcycling unsold protein, vegetables and fruit into animal feed. Heaggans built a lab piece by piece and then developed the company's pilot plant in North Dakota during the COVID-19 pandemic. However, the company filed for bankruptcy in June 2023 and later shut down.

Heaggans now works for Feastables, the chocolate brand created by YouTuber MrBeast, also known as Jimmy Donaldson. There she's testing and scaling up processes, locating the right equipment and tracking production after its introduced to a co-manufacturer.



Heaggans tests and scales up manufacturing processes for Feastables, MrBeast's chocolate brand. Image courtesy of Feastables

Meanwhile, Sreenath began exploring the food industry while working on her master's degree from Cornell University. She took a few courses in food engineering.

"I was really drawn to food because it's something very fundamental and something which affects people's lives daily," she says. "Just the idea of being able to contribute to that, it resonated really well with me. And at that time also, I had just moved to the U.S. I was really fascinated by all the options available at the stores and all the processes which made it possible. I just wanted to know more about the processes behind that."

Sreenath first served as a process engineer with Kerry Ingredients, initially working on yield improvements and cost savings for a plant that made fermented ingredients. She also participated in a spray dryer optimization project that led to building a second dryer.

Sreenath then took on a broader role supporting plants across Kerry's network that supported Kerry's Wellmune business, which involved deriving beta-glucan from yeast. She served as engineering lead, working with plants to develop and optimize processes.

Later, Sreenath became a project engineer, leading the multimillion-dollar installation of sauce and soup lines at a Texas facility. She saw the project through from concept to completion, with the added complexities of the COVID-19 pandemic.

"Managing a fast-paced project through all of that was kind of challenging, but looking back, I feel really proud of having managed that project and successfully run it to completion," she says.

Sreenath moved to Beyond Meat, installing process lines across the U.S. and Canada and improving throughput. Now,



she leads downstream processing for Cellibre, a precision fermentation company. It involves purifying and isolating small molecules from fermentation broth. Sreenath was involved with the design and equipment selection for the company's pilot plant in San Diego.

Shalima Sreenath was involved with the design and equipment selection for Cellibre's pilot plant in San Diego. Image courtesy of Cellibre



SUPPORTING DIVERSITY AND PROFESSIONAL DEVELOPMENT

Sreenath and Heaggans say they have encountered situations in the field where people may not realize or accept that they held leadership roles, but they say it's improving.

"Sometimes when working with non-engineers, I felt they won't expect a woman to be the technical lead," Sreenath says. "That can come across as dismissive or they may be skeptic, but I feel like that will change as more women enter these engineering roles and thrive in it, that's going to change. I'm really hopeful it's on a really good path there."

But when it came to advancing her engineering career, Sreenath notes having managers who entrusted her with major projects early on helped her prove her mettle.

"They were really supportive and put me in charge of important projects, which gave me the confidence and it also showed their trust in me to carry out a huge project," she says. "I feel like that went a long way in letting myself know that this is something I could do. Without giving that opportunity, I would never know what was possible. That is a big thing putting women other minorities in charge of high-stakes projects so that they get a chance to prove themselves out that goes a long way."

Mentorship is crucial to career success, whether it happens organically or it comes through an organization-sponsored program, Heaggans adds. Both Heaggans and Sreenath serve as mentors to those just starting their journeys.

"Having a mentor is invaluable," Heaggans says. "Having an advocate — they're not always the same person — also invaluable. And it makes a world of difference. I think people should, even if you're paired with someone formally, also go find someone in addition to that. You can never have too many mentors."

Sreenath also recommends women engineers build a professional community, diversify their skillsets and remain open to any opportunities that come along.

"I've always been curious of the different skills involved and the different roles," she says. "As I was navigating through my career, just being open to new opportunities and new projects. Whenever I'm put in a new project or something new comes by, I think 'what can I learn from it? And how does that help me grow my knowledge?"

Heaggans, who explored many fields before coming to the food industry, also suggested being flexible and letting go if something isn't the right fit.

"If you don't like something, move on," she says. "There are tons of areas to work in. You don't have to stay in an area where you're miserable or you have absolutely no interest because you won't be doing your best, you won't be giving your best and people can pick up on that. Be willing to relocate."

Heaggans would also like to see outreach to girls in middle school and high school so they know careers in the food industry, engineering and manufacturing are options.

"Let the girls, the females know 'you can do this," Heaggans says. "And just because you're the only one in the room doesn't mean that you will always be the only one in the room. There are more coming after you." **FE**

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AUTOMATION

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Windows 10 Support Ends in 2025 but Industrial and Enterprise Users Have Options

Because Windows 11 requires newer hardware to run successfully, the combination of that hardware plus additional cybersecurity features built into the OS makes it well worth an upgrade, especially in the industrial environment and for those with sensitive data on easily stolen portable equipment.

Photo courtesy: <mark>Hispanolistic</mark> / Getty Images

BY WAYNE LABS

I AM WRITING THIS ARTICLE ON A WINDOWS 11-BASED COMPUTER. Had it been two weeks earlier, this machine — which I designed and built two years ago to support the more stringent hardware requirements of Windows 11 — was comfortably running Windows 10 Professional on a high-end Intel processor. Feeling the pressure to upgrade to Windows 11 before Windows 10's support runs out in October, I finally got up the nerve to press the "Update" button and hope for the best.

Surprisingly, the upgrade went pretty smoothly except for a couple of minor glitches that were fixed after upgrading the graphics and network drivers, plus reinstalling one scanner driver.

Why do the upgrade — other than staying current or wanting new features? "Security" in one word — or even better, "Secure by Design" as CISA has devoted a special website to support the concept. Microsoft has embraced the philosophy in developing Windows 11 with built-in security from bottom to top.

While you may not worry about someone running off with a cumbersome desktop computer, consider a Windows laptop or tablet left in a car with sensitive corporate data. Should a Windows 11 laptop be stolen, a thief will have a much harder time logging in and prying out encrypted data as long as users aren't lazy about security. Windows 11 also makes it more difficult for hackers to break into system drive boot sectors and take over a computer. Still, for users not so much concerned about security, Windows 11 seems like a forced upgrade to sell new Windows 11-compliant hardware.

WINDOWS HOME AND PROFESSIONAL USERS FORCED TO UPGRADE — INDUSTRIAL USERS GET A REPRIEVE

Unless Microsoft officially downgrades its Windows 11 hardware requirements, millions of Windows 10 users will be left in the lurch for continued security updates when Windows 10 support expires in October. Microsoft, according to Copilot, estimates that in March, Windows 10 still held a 54% market share and Windows 11, 43%. Windows 10 users can opt to pay for three more years of security updates, but it will be pricey.

It's not that Windows 11 needs more compute power to run; it's the additional hardware requirements to support cybersecurity that older PCs don't have.

Minimum Hardware Requirements to Run Windows 11			
Processor:	1 gigahertz (GHz) or faster with two or more cores on a compatible 64-bit processor or		
	System on a Chip (SoC).		
RAM:	4 gigabytes (GB)		
Storage:	64 GB or larger storage device. See the Microsoft link (bottom) for more information on		
	storage space to keep Windows 11 up-to-date.		
System	UEFI, Secure Boot capable. Check for information on how your PC might be able to		
firmware:	meet this requirement.		
TPM:	Trusted Platform Module (TPM) version 2.0. Check for instructions on how your PC		
	might be enabled to meet this requirement.		
Graphics	Compatible with DirectX 12 or later with WDDM 2.0 driver.		
system:			
Display:	High definition (720p) display that is greater than nine inches diagonally, 8 bits per		
	color channel.		
Note: Most computers running Windows 10 already meet the specifications in blue. The specs in pink,			
designed to support cybersecurity, will typically require new computers, probably not more than about five			
years old. It will depend on the mother board and microprocessor specs.			
Source: Microsoft			

Microsoft has been trying to beef up cybersecurity — thus the move to a "trusted planform module" version 2 (TPM 2.0) and Secure Boot, which can only be supported by relatively new motherboards. However, industrial hardware and software suppliers — and enterprise users —have more flexible options than home and small business users using Windows 10 Home or Professional.

"Starting Oct. 14, 2025, Windows 10 will no longer receive support updates or free software updates," says Andrew Bollinger, Beckhoff USA industrial PC product manager. "Microsoft has announced that the consumer versions of Windows 10 will reach the end of support on Oct. 14, 2025."

"While this is a major consideration for users of mainstream Windows 10 devices, users of industrial PCs (IPCs) and controllers with Windows 10 from Beckhoff will have far more time to address this issue," Bollinger says. "As one of many operating system choices available, Beckhoff supplies IPCs with Windows 10 Long-Term Servicing Channel (LTSC). Microsoft will continue to support Windows 10 2021 LTSC until 2027, and Beckhoff will offer service and support the OS until 2032."

Beckhoff has already announced support for IPCs with Windows 11 IoT Enterprise LTSC 2024. This newer Windows operating system offers long-term availability with guaranteed update support until Oct. 10, 2034, exceptional stability and real-time capability. It also includes the latest security features and functions to harden industrial systems.



Long-term availability is crucial for industrial control systems. This applies to the Windows operating system, which Beckhoff implements in its LTSC version (Long-Term Servicing Channel) as one of its many OS offerings. Photo courtesy of Beckhoff USA

"With Windows 11 out since October 2021, we are seeing increased adoption from our customer base," says Kyle Reissner, VP, product management, MEIDS – Mitsubishi Electric Iconics Digital Solutions. The GENESIS SCADA and the Hyper Historian platforms by MEIDS have both supported Windows 11 in a workstation capacity since v10.97.1, which was released shortly after Windows 11 and 10.97.2 in a full capacity (which was released the following summer of 2022). "We aim to have our systems certified with the latest Windows OS as soon as they go generally available," Reissner adds.

"Our customers tend to use server operating systems, like Windows Server 2025, but we are seeing some Windows 11 used in new projects: typically, smaller standalone projects," Reissner says. "When either a server or Windows 11 class OS is coupled with our latest release, GENESIS version 11, it becomes a more secure and performant system. GENESIS version 11 (also referred to as GENESIS) takes advantage of the latest technology on Windows 11/Server 2025 including .NET 8.0 and security features that make it the most secure system we can make. Of course, GENESIS works on older OSs, but we're seeing customers move to Windows 11 coupled with GENESIS version 11 in the name of security."



Maintenance screens from Mitsubishi Electric Iconics Digital Solutions run on Windows 11 laptops, which are inherently secure through Windows technologies such as BitLocker, Secure Boot and a UEFI-based computer BIOS. Photo courtesy of MEIDS – Mitsubishi Electric Iconics Digital Solutions

DRIVERS NOT THE ISSUE THEY USED TO BE

Ever since the first major iteration of Windows going back to Windows 3.1, software drivers were always a concern — getting hardware to talk to software — and were often a weak link in security. Today driver support is becoming a non-issue for several reasons, especially with Windows LTSC OSs.

"Only driver and software components that have undergone real-time and functional testing are integrated into Windows LTSC," Bollinger says. "These drivers are meticulously matched to Beckhoff hardware, and all operating system settings are precisely configured for TwinCAT. This optimization enhances the real-time capabilities of the controller and minimizes machine downtime. Windows 11 LTSC, with its inherent stability, complements Beckhoff's approach, which results in a robust and reliable automation platform."

Windows 11 system requirements include Trusted Platform Module (TPM) version 2.0 and secure boot. This ensures that your computer boots only using software trusted by manufacturers, and 8th-Generation Intel processors and above, Bollinger adds.



GENESIS includes seven major drivers out of the box: OPC (OPC UA & OPC classic DA, HDA, AE), BACnet, Mitsubishi FA connector, SNMP, Web Services, SQL Databases and Modbus, Reissner says. "In addition, we are close partners with Takebishi for their DeviceXPlorer OPC Server, which provides hundreds of more drivers and supports all other OPC servers such as Kepware KEPServerEX, Top Server and more."

"For our customers we offer support for Windows 11 across the board and encourage it for security purposes," Reissner adds. "While our partners have generally updated their software and their individual drivers to support Windows 11, I'm sure there are certain older drivers that rely on specific hardware interfaces that may be stuck in the past. The great thing is that the GENESIS system can be distributed, and we have a component called the data broker that can tunnel OPC data from remote nodes or separate VM's that may need to stay on old operating systems for specific drivers, so they can be securely added to the overall solution."



Plant monitoring powered by GENESIS from MEIDS. Credit: Mitsubishi Electric Iconics Digital Solutions (MEIDS)

SECURITY, FUTURE-PROOFING AND PERFORMANCE GAINS

In making the case for upgrading systems to Windows 11, Microsoft suggests three good reasons: enhanced security, future-proofing and performance gains. "We concur with these points Microsoft is making," says MEIDS' Reissner. "Security is an endless game where you must keep updating your systems, both from an OS and vendor software perspective. We have invested heavily in the latest release of our product to make the updates much simpler and for the software to be as secure as we can get it. We're also releasing updates every 8-12 weeks to keep up with security vulnerabilities. If your software vendor isn't doing this, they aren't keeping up with closing the software vulnerabilities. It's 2025, and these are coming rapidly and consistently."

Beckhoff has been using Windows operating systems as a stable basis for the TwinCAT automation software for many years, Bollinger says. "Only tested driver and software components that are regularly subjected to intensive real-time and functional tests are integrated. The drivers used are optimally matched to the Beckhoff hardware. We have very deep control over the manufacturing of our IPCs — this even extends to the motherboards which are designed and built by Beckhoff."

Do developers upgrade with Microsoft, stay put or go with another OS such as Linux?

"Upgrading versus staying put is an interesting question," Reissner says. "We believe that updates increase resilience in the software and add more reliability to it versus the 'if it isn't broken don't fix it mentality' of the past of keeping this 'put.' Each software vendor is different, but at MEIDS, we aim to provide new features and functions in every release as well as security fixes so we can continuously add value for our customers. Of course, these features don't apply to all customers and systems, but we encourage all customers to update their software at a high frequency to keep it as secure as possible. In today's world, the only way to keep both connected and non-connected systems secure is frequent updates, and vendors must change the way their software is built and managed to do this effectively, just like we have with GENESIS version 11."

Switching to Linux can be explored, however, just because Linux has less frequent updates, doesn't mean it's more secure, Reissner adds. "There are other benefits to Linux, such as a lower footprint and higher levels of customization, but we're not seeing customers move to Linux en masse as a way to avoid Windows updates."

"In addition to Beckhoff's long history of leveraging different versions of Windows as a stable OS for the TwinCAT automation software, we also offer alternatives to Microsoft Windows operating systems based on customer requirements," Bollinger says. This includes TwinCAT/BSD, the operating system from Beckhoff. TwinCAT/BSD is available for a variety of Beckhoff PC models. It combines the TwinCAT runtime with FreeBSD, an industrially tested and reliable open-source operating system.

Beckhoff is also now offering new application possibilities for real-time control with Linux. The TwinCAT runtime for real-time Linux is based on our own Linux distribution, which expands the existing spectrum of operating systems beyond Windows and TwinCAT/BSD.

Using container technologies such as Docker, Podman, or LXC, several TwinCAT runtimes can be executed on a single IPC to achieve modularity in machine control and other automation applications, Bollinger adds. The individual execution of several TwinCAT runtimes on a single IPC facilitates hardware consolidation with corresponding cost advantages due to the improved utilization of the available computing capacity.

THE BLOAT AND MINIMIZING IT WITH LTSC

Many home and office users have commented on Windows 11 containing shovel-ware and bloatware. But is it possible to do a "lean installation" of Windows 11 on the plant floor for embedded systems without all the junk that comes with it? Can Windows 11 IoT LTSC be tuned as a lightweight version? Fortunately, yes to both.

Microsoft Windows 11 IoT Enterprise 2024 LTSC is optimized for resource-constrained environments, making it efficient for embedded devices, Bollinger says. This addresses the need for lean OS installations.

"Windows 11 LTSC is tailored for enterprise deployments demanding maximum stability and extended support," Bollinger adds. It offers feature updates on a two-to-three-year cadence, prioritizing security patches and essential fixes. This makes it particularly suitable for sectors like packaging, food and beverage manufacturing, among many others where minimizing operational disruptions is vital.

"We don't frequently see specialized editions of Windows, like IoT Enterprise, being adopted by our customers," Reissner says. "Perhaps this is a result of more and more powerful capabilities at the edge. When we do see pre-installed Windows systems from hardware vendors, those have bloatware, and we encourage customers to do a fresh GENESIS installation to eliminate the bloat. More and more, even for easy HMI type applications, we see software installed in a server room, and users access it via web browsers on isolated plant floor networks."

This centralization is possible because of the improvements and lower costs over the last 20 years to plant networks and the unlimited client models with modern software like GENESIS, Reissner adds. "We also continue to see the prices for computing fall. Our customers generally don't think twice about putting in the necessary compute and memory to run full windows 11 systems or server-based OSs."



Hotpatch updates for Windows 11 Enterprise, version 24H2 for x64 (AMD/Intel) CPU devices are now available. With hotpatch updates, IT professionals can quickly take measures to help protect their organizations from cyberattacks while minimizing user disruptions. Hotpatch updates take effect immediately upon installation, providing rapid protection against vulnerabilities. Image source: Microsoft

TO A MORE SECURE FUTURE

While it's unknown if Microsoft will be more lenient when it comes to its Windows 10 non-industrial users, they can actually purchase security updates after October 2025. However, the cost structure has been set up to encourage migration to Windows 11 supported hardware.

Microsoft's Extended Security Updates (ESU) program for Windows 10 will provide paid security updates for up to three years after official support ends on Oct. 14, 2025.

- Year One (2025-2026): \$61 per device for businesses, \$30 for individuals.
- Year Two (2026-2027): Price doubles from Year One.
- Year Three (2027-2028): Price doubles again.

The ESU program only includes security updates — no new features or general support. It's available for Windows 10 version 22H2 and can be purchased through Microsoft Volume Licensing for businesses.

RESOURCES:

"Quick guide to Windows as a service," Microsoft, 7-17-24

"Windows 11 Security Book," Microsoft, 11-18-24

Secure By Design: Shifting the Balance of Cybersecurity Risk, CISA, NSA, FBI, et al; 2023

"How Does Your OT Cybersecurity Stack Up? Tips and Techniques for a Safer and More Secure Operation," FE, 2-13-2025

Microsoft Digital Defense Report 2024: The foundations and new frontiers of cybersecurity, Microsoft, 2024

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FOOD

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ΗΡΡ

Hiperbaric recently announced the installation of its 400th HPP system worldwide. The milestone installation, a Hiperbaric 525i model, was completed at Instinct's 150,000-sq.-ft. Nebraska raw pet food facility. The 525-liter system can process approximately 8,030 pounds per hour with a speed of 10.7 cycles per hour. Robots do the heavy lifting loading and unloading. Credit: Photo courtesy of Hiperbaric

BY WAYNE LABS

HIGH PRESSURE PROCESSING (HPP) ISN'T SUITED TO EVERY FOOD OR BEVERAGE APPLICATION, but for those special products that need this intervention to inactivate bacteria without affecting taste or other properties, no other technique will do.

While basic HPP technology hasn't changed all that much over the last few years, capacity keeps increasing, robotics assist loading and unloading, enhanced automation manages the process, and in some cases, additional thermal process capability widens product reach. Automation software — enabled by AI and machine learning — is smoothing out scheduling bumps, providing accurate processing and determining when maintenance needs to be done so there aren't any surprise shutdowns.

At the same time, HPP has expanded into new product areas such as pet food and specialty health products — and the number of tolling centers has increased to help startups and processors who need more capacity during holiday seasons.

SIZE AND THROUGHPUT KEEP INCREASING

Quintus Technologies' portfolio of HPP presses is available in 150-, 400- and 600-liter capacity, says Keenan Drenning, director of high-pressure processing, Americas. "The 600-liter machine, launched in 2025, is the largest capacity and most productive HPP press ever built." Within those model sizes, Quintus allows processors to add high pressure pumps, which speeds up the pressurization and thereby improves the throughput of the machine. In this way, a user could buy an entry-level machine and add more productivity later with a small upgrade rather than needing another capital equipment investment.

"Using a toller initially is always an option of course, but our 150L smallest press has a very attractive payback period for initial production volumes," Drenning adds.



The Quintus Model QIF 600L (600-liter) HPP system was released earlier this year and has a 18.5-in. diameter vessel diameter to improve load efficiency and accommodate more packages per cycle. Equipped with up to 12 intensifiers, the scalable system can process 9,140 lbs. (4,150 kg.) per hour to meet demanding production needs. Photo courtesy of Quintus Technologies

Hiperbaric offers a comprehensive range of HPP equipment, with models tailored to meet the needs of academia research and emerging brands to medium and large-scale food processors, says Roberto Peregrina, Hiperbaric – High Pressure Processing executive director. "Our machines range from the compact Hiperbaric 55, which processes up to 800 lbs. per hour, to the high-capacity Hiperbaric 525, capable of handling up to 8,000 lbs. per hour."

"Beyond just size, processing speed is a critical factor for throughput and efficiency — and this is where Hiperbaric excels," Peregrina adds. "Our machines are engineered for shorter cycle times, maximizing product output and minimizing bottlenecks in production lines."



ISO, a Miami-based beverage company, recently launched a line of cold-pressed electrolyte beverages. Developed at the Hiperbaric High Pressure Processing (HPP) Incubator, these hydration products combine food science with whole-food ingredients to create a unique drinking experience. Each bottle contains over 700 mg of essential electrolytes to support optimal hydration. Photo courtesy of Hiperbaric

The range of vessel sizes does seem to be an advantage to HPP customers who want to tailor their production needs to HPP equipment, says Dr. Errol Raghubeer, JBT Marel (Avure) VP microbiology & food science. "However, the primary goal of manufacturers is the product output per cycle. Production output is mainly determined by the time to come up to operating pressure and the diameter of the vessel that is being used. Having a larger vessel does not necessarily mean larger output."

"For example," says Raghubeer,"if looking at two different vessels with the same size but with two different diameters and the same come-up time to pressure, the vessel with the larger diameter will have a greater output. JBT Marel's 525-L system has a larger diameter than other 525-L systems, allowing for less dead space (unused space) in the vessel, thereby delivering more product per cycle. Large capacity vessels will have longer come-up time to pressure, which will increase cycle time. This can be resolved by either using multiple pumping systems (high pressure intensifiers) or with significant engineering improvement in high-pressure pumping systems with the latter being available to JBT Marel customers shortly."

JBT Marel offers a range of commercial HPP equipment:

- The AV10 (100 liters) with a production of 10 million pounds per year using 87,000 psi and a hold time of 3 minutes,
- AVM upgradable (350 liters)
- AVX upgradable (525 liters)
- AVS vertical system that is used primarily in the seafood industry.

In addition, JBT Marel offers an HPP water filtration system which helps in the reuse of water without debris. The AVM model is available as an AV-20M, AV-30M and AV-40M by varying the number of pumping systems to meet customer production needs. As production needs increase, users can add pumping systems instead of buying an entirely new HPP system. Similarly, the AVX system is upgradable to meet production needs with Models AV-40X, AV-50X, AV-60X and AV-70X. Production volumes range from 40 million to 70 million lbs. per year operating at 87,000 psi with a hold time of 3 minutes.



While not a robotic system, JBT Marel's Tilt Basket Unloading system makes loading and unloading of baskets easier than manually doing the work. Photo courtesy of JBT Marel TOLLING CENTERS A POTENTIAL SOLUTION FOR NEW APPLICATIONS

For food and beverage companies entering the HPP space, tolling centers are an excellent way to begin, says Hiperbaric's Peregrina. These facilities allow processors to gain market traction and better understand demand before committing to equipment. Tollers also play a critical role for established brands looking for additional capacity or market expansion without upfront capital investment.

Tolling operations are important not only for small manufacturers to get into HPP production, but for larger companies to use HPP technology on many of their product lines without having to change their operation to accommodate installation and operating HPP systems, says JBT Marel's Raghubeer. Additionally, many companies that own HPP systems also use HPP tollers when seasonal demands for products are high. To gain control of their production, several companies that have used HPP tollers have decided to bring HPP in-house as production needs increase, coupled with a reduction in cost compared to tollers.

"Typically, customers prefer to work with someone local to their processing location, but it depends on their distribution footprint, services offered, etc., so it would need to be considered case by case to find the right solution," says Quintus' Drenning. "We are happy to share with any company trying to get into HPP or improve their results."

"Our tolling partners are strategically located across five continents, with many facilities situated in or near major metropolitan areas known for food production and distribution," Peregrina adds. In the United States, some of the largest and most established HPP tollers include Universal Pure, HPP Food Services, American Pasteurization Company, and Green Plant. These tollers operate multiple Hiperbaric units across several locations, offering high-volume capacity and rapid turnaround.

"In addition to HPP services, many of these facilities provide value-added solutions such as co-manufacturing, cold storage, refrigerated transport, labeling, packaging, inventory management and tempering," Peregrina says. This integrated approach makes tolling providers an efficient, scalable option for both established brands and new market entrants.

AUTOMATION ADDS TO HPP FUNCTIONALITY

Robotics, automation, AI and ML plus predictive maintenance (PdM) are some of the new functionalities added to HPP systems. Quintus has delivered HPP equipment with automated infeed and outfeed robotics, Drenning says. "We have several ready-made concept designs but can also cater to the scope for the customers' needs... Our machine learning programs are focused on predictive maintenance and issue resolutions to plan or prevent machine down time events around production to maximize throughput."

JBT Marel has worked with a number of companies to provide varying degrees of automation to HPP production from pick-and-place robotics, unloading and basket return systems, Raghubeer says. In addition, JBT Marel offers a Tilt Basket Unloading system. JBT OmniBlu is a digital program that provides parts and service availability by monitoring HPP system and other critical analytic data, reducing downtime and increasing productivity of the system.

Hiperbaric offers a range of automation functionalities to support high-efficiency operations, Peregrina says. "Our equipment can be configured with automated loading and unloading systems, including robotic arms, conveyors and basket-handling systems — all designed to optimize line performance, reduce manual labor and maintain hygienic standards."



In terms of software, Hiperbaric is actively incorporating smart automation tools and data analytics into its control systems. The user interface includes PdM algorithms, cycle optimization and real-time diagnostics that improve timing, throughput and

HPP companies make it easy to move heavy loads into and out of their machine with robotic arms. Photo courtesy of Hiperbaric

machine uptime.

"Our systems are also Industry 4.0-ready, with remote monitoring capabilities and integration with plant-wide SCADA systems

 — laying the foundation for future applications of AI and machine learning to further enhance performance, product quality and resource efficiency," Peregrina adds.

"To date, we have integrated more than 25plus automation systems," Peregrina says. Companies include Bay Center Foods (Subsidiary of Chick-fil-A), Evolution Fresh, Krusteaz, Lineage Logistics, Cava and HPP Belgium Services. Hiperbaric's latest installation took place at Instinct Raw Pet Food, featuring a turn-key HPP automation solution with loading and unloading robots and material handling. This is Hiperbaric's 400th installed HPP system.

FOODS AND BEVERAGE TYPES EXPAND

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The growth of HPP is influenced by the expansion of current food and beverage categories as the market for those products increases across the globe, says JBT Marel's Raghubeer. However, there are a few new product categories that are gaining traction because of health and safety. These include raw and further processed pet food, primarily because of food safety and regulatory needs for both pets and pet owners.

Coupled with the food safety benefits is the fact that nutritional components remain intact after HPP, Raghubeer adds. After the Covid-19 pandemic, consumers looked at nutrition to improve immunity and their overall health. Since HPP does not affect nutritional components and the taste of food and beverage products, many manufacturers have begun to offer highly concentrated fruit-based beverages with heat-sensitive bioactive compounds to boost immunity, such as polyphenols, carotenoids, vitamins and antioxidants. Compared to thermal treatment, commercial application of HPP has no effects on covalent bonds, so nutrition and taste are largely unaffected. Other newer HPP products in the market are nut-based dips and sauces, baby foods, avocado-based products, grain-based puddings and high protein soups.

Besides pet food and seafood (raw and RTE), other HPP foods include RTE meals and meal kits, dairy products (including cheese and dips), children's nutrition — and functional shots with adaptogens, probiotics or superfood blends.

The results have been overwhelmingly positive, says Hiperbaric's Peregrina. HPP has allowed brands in these categories to extend shelf life significantly while maintaining the nutritional quality, flavor and freshness that consumers expect. In many cases, HPP has enabled companies to eliminate preservatives, support clean-label claims and expand into larger retail and export markets that require extended shelf life and strict food safety standards.

The versatility of HPP is helping companies not only differentiate their offerings but also scale more efficiently while preserving the integrity of their formulations, Peregrina adds.

ADDING HEAT TO HPP...REALLY?

OK, this sounds counter-intuitive to HPP. This process goes by two names, each with its own acronym. "Combining high pressure processing with moderate temperature — known as High Pressure Thermal Processing (HPTP) — unlocks additional capabilities beyond traditional HPP," Peregrina says. While conventional HPP is highly effective for acidic and refrigerated products, HPTP is designed to extend the benefits of pressure-based processing to low-acid foods, which typically require more intensive microbial reduction due to the risk of Clostridium botulinum and other pathogens.

"At the core of HPTP is a canister compatible with Hiperbaric HPP machines, invented and patented by CSIRO, the Commonwealth Scientific and Industrial Research Organization, Australia's national science agency," Peregrina adds.

Advantages of the HPTP Technique

Advantages of the HPTP Technique

The advantages of combining technologies include:

- Enhanced lethality: HPTP enables the inactivation of more heat-resistant spores and pathogens that wouldn't be fully addressed by pressure or heat alone.
- Shelf-stable products: HPTP makes it possible to produce shelf-stable foods without preservatives, offering clean-label benefits and ambient storage.
- Retention of quality: Compared to traditional retort or UHT processing, HPTP delivers better flavor, texture and nutritional preservation, thanks to reduced thermal load.
- New product categories: It expands HPP's reach into low-acid ready meals, soups, purees, baby foods and protein-based products that traditionally relied on heavy thermal processing.

This hybrid approach is ideal for food processors looking to develop safe, high-quality, shelf-stable alternatives to conventional canned or retorted products — without compromising on freshness or label transparency.

Hiperbaric is pioneering this space with HPTP systems, enabling food manufacturers to explore entirely new market opportunities.

– Roberto Peregrina, Hiperbaric

The combined HPP/thermal process is also commonly referred to as Pressure Assisted Thermal Sterilization (PATS), says Quintus' Drenning. "The U.S. Army tested the viability of this process with several large food companies and academic institutions. Adding heat (121°C or 250°F), allows this to be considered a thermal retort process, which increases effectiveness against bacterial spores. This is important for the effectiveness of HPP for higher pH foods – products which are otherwise more challenging to treat with HPP alone. Meanwhile, the organoleptic quality of the product is better with HPP plus heat than with traditional higher temperature processing."

JBT Marel tested the PATS process funded mainly by the U.S. Army Dual Use Science and Technology (DUST) program with participation of several large food, pharmaceutical and packaging companies, Raghubeer says. The project was headed by JBT Marel and coordinated by the National Center for Food Safety and Nutrition (NCFST) now IFSH and the National Food Lab with guidance and collaboration from the FDA. Both PATS and HPTP are thermal processes where retort temperature (at least 121°C min) need to be achieved over the hold time. PATS required a preheating step followed by treatment at 121°C. To achieve this temperature, a special HPP was built that reaches at least 7,000 bars (over 100,000 psi) to generate the adiabatic temperature rise with preheating to reach 121°C.

More than six years of research resulted in the FDA granting approval for one product: mashed potato. Two major PATS issues were accurately measuring temperature distribution in the vessel and the cost of the equipment for operating above 100,000 psi.

SEAFOOD AND HPP

HPP is mainly used in the seafood industry for shucking lobsters and oysters, says Quintus' Drenning. "High pressure shucking yields higher meat extraction than manual (hand) shucking. All of our HPP presses are versatile for both seafood (mollusk and crustacean) shucking and for pathogen elimination. The Vibrio bacteria is inactivated by HPP at lower pressures than are needed for other microorganisms in different types of food products, which can be achieved in the same cycle as shucking."

In the shucking process, live bivalves (such as oysters and clams) or crustaceans (like lobsters and crabs) are loaded directly into the HPP machine, says Hiperbaric's Peregrina. The application of high pressure separates the meat from the adductor muscle, allowing for clean, raw meat separation from the shell.



With HPP applied to seafood, after processing, the meat slips out easily from the shell with less waste than other methods. Photo courtesy of Quintus Technologies

For this application, "Hiperbaric integrates a specialized seafood kit, which includes a filtration system designed to capture shell fragments and organic debris during processing," Peregrina says. This ensures a cleaner product environment, reduces maintenance needs and helps maintain equipment hygiene and performance.

Other than the shucking applications, a disadvantage of using HPP for seafood products is that several products cannot be sold in the retail market in the U.S. and Canada due to the FDA Seafood HACCP regulations, says JBT Marel's Raghubeer. The potential risk of toxin production by non-proteolytic Clostridium botulinum strains (Types B, F and E) exists as these can grow at refrigeration temperature.



The JBT Marel Model AV-S HPP system is specifically designed to handle seafood products. It produces increases in shellfish and crustacean meat separation of up to 80% compared to other meat extraction methods. The unit is capable of producing annually 23.8 million pounds with a three-minute hold and 32.9 million pounds with a one-minute hold. Photo courtesy of JBT Marel

"The disadvantage for HPP with seafood products is that it is a requirement of the FDA seafood HACCP that refrigerated products be packaged in 10,000 OTR films, which will create an oxygen rich environment (aerobic)," Drenning says.

While an aerobic environment slows Clostridium botulinum growth, it supports the growth of spoilage mechanisms such as Pseudomonas spp, Shewanella putrefaciens, and molds and yeast, which reduce shelf life and negate the benefits of HPP.

However, some HPP seafood-based wet salads and dips are in the market since pH can be adjusted below 5.0, which prevents the growth and toxin production of these Clostridium botulinum strains, Raghubeer says. To maximize the shelf-life benefits of HPP products, products are usually packaged with the exclusion of oxygen, which favors the growth of anaerobes.

RESOURCES

"Getting Pressure to Remove the Heat?" Food Engineering, Dec. 26, 2023

"Hiperbaric: HPP Tolling," Web page, accessed 30 April 2025

"JBT: Find an HPP Tolling Center," Web Page, accessed 30 April 2025

Quintus Technologies (Food Processing) Web page accessed 30 April

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PMMI

Digitizing Food Safety:

Technology's Role In Safer, Smarter Food Production

Today's safety practices are increasingly enabled by sensors, software and cloud platforms, which not only improve compliance and traceability, but also reshape how the industry thinks about readiness, training and operational excellence.

Photo courtesy: Getty Images / Mindful Media

BY JORGE IZQUIERDO, VICE PRESIDENT OF MARKET DEVELOPMENT FOR PMMI, THE ASSOCIATION FOR PACKAGING AND PROCESSING TECHNOLOGIES

IN THE WORLD OF FOOD PROCESSING AND PACKAGING, safety has always been paramount. But as technologies evolve and consumer expectations rise, food safety is undergoing a digital revolution.

No longer confined to clipboards and manual logs, today's safety practices are increasingly enabled by sensors, software and cloud platforms. This shift is not only improving compliance and traceability — it's reshaping how the industry thinks about readiness, training and operational excellence.

SMART SYSTEMS PREVENT PROBLEMS BEFORE THEY BEGIN

A major trend in modern food processing is the use of digital tools to enable predictive and preventive maintenance. As noted in the 2024 State of the Industry US Packaging Machinery Report produced by PMMI, The Association for Packaging and Processing Technologies, predictive maintenance for packaging machines involves installing sensors on various machine parts to monitor their condition in real time. This proactive approach means fewer unexpected shutdowns, less downtime and more consistent production quality — critical outcomes in maintaining food safety.

The same report highlights how preventative maintenance subscription plans are gaining traction, helping facilities mitigate the skilled labor shortage by outsourcing complex servicing to OEMs. This approach, while driven by economic pressures, also ensures consistent machine performance, reducing contamination risks from malfunction or breakdown.

TRAINING FOR SAFETY, POWERED BY TECH

Digital transformation doesn't stop at machinery. Operator training — historically a weak link in food safety — has become more robust and dynamic, thanks to technology. The 2025 Embracing Operational Readiness white paper from PMMI emphasizes the growing use of videos, interactive manuals, augmented reality (AR) and tablet-based instructions to support workforce training and knowledge retention.

According to the same report, 69% of participants agreed that intuitive human-machine interfaces (HMIs) are essential for empowering operators, especially in an industry where workforce turnover remains high. One participant remarked that "training must be embedded into daily operations rather than treated as a one-time event," and this is where technology proves invaluable — offering ongoing, on-demand learning opportunities that adapt to workforce realities.

DATA-DRIVEN DECISION-MAKING AND TRACEABILITY

Digitization's impact on traceability and compliance is perhaps its most transformative feature. As PMMI's Data Acquisition, *Sharing and Utilization* white paper notes, 63% of companies want to use data to improve overall equipment effectiveness (OEE), and 20% aim to support predictive maintenance.

But beyond productivity, these real-time data systems are increasingly essential for food safety auditing and recall readiness. By capturing machine data on speed, output and quality, processors gain actionable insights that can be instantly shared with quality teams or regulators.

MANAGING THE INTEGRATION CHALLENGE

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Integrating digital systems — especially into legacy operations — remains a hurdle. Yet the Data Acquisition, Sharing and Utilization white paper suggests that "implementing only what's needed to get the job done" is often the smartest path forward. Low-cost sensors and modular programmable logic controllers (PLCs) allow even older machines to become part of a connected network.

To support broader adoption, PMMI's *State of the Industry* report advises scaling data strategies gradually and ensuring every stakeholder, from maintenance leads to executive teams, understands how data translates to safety, uptime and regulatory compliance.

TECHNOLOGY AND REGULATORY ALIGNMENT: WHY ONE DEPENDS ON THE OTHER

The effectiveness of new technologies in food safety — whether sensors, data analytics or automation — depends on how well they align with existing regulatory frameworks. These frameworks, including the Hazard Analysis and Critical Control Points (HACCP) system and standards recognized by the Global Food Safety Initiative (GFSI), define the minimum requirements processors must meet to ensure food safety.

While HACCP provides a structured, preventive approach to identifying and mitigating risks (such as biological, chemical or physical hazards), and GFSI benchmarks third-party audit schemes like SQF and BRCGS, technology now plays a critical supporting role. But it must do so in a way that enhances — not replaces — compliance with these systems.

This is where digital tools, such as Statistical Process Control (SPC) and AI-assisted HMIs, come into play.

SPC uses real-time data to monitor and control manufacturing processes. In food safety, SPC enables processors to detect deviations in equipment performance or product quality early — before they lead to non-compliance or contamination. This is particularly useful in validating preventive controls, as required by HACCP.

Al-assisted HMIs, on the other hand, represent a new generation of user interfaces. These systems don't just display process data — they can also offer intelligent guidance, flag anomalies and help less-experienced operators make safe decisions quickly. In some cases, AI can even suggest corrective actions or flag patterns that could lead to a failure or contamination event.

These tools help bridge the gap between regulatory compliance and digital modernization, ensuring that data collected from machines or quality checks are actionable, accurate and align with audit requirements.

THE HUMAN FACTOR: USABILITY AND INCLUSIVITY IN DESIGN

As food manufacturing facilities increasingly rely on diverse and often-transient labor forces, the complexity of interfaces and documentation can create barriers to effective operation and sanitation. This human element is a growing concern, as even the best-designed systems are vulnerable to user error if the workforce cannot understand or apply them correctly.

To address this, PMMI's *Embracing Operational Readiness* white paper emphasizes the need for user-centric design. This includes:

- MULTI-LANGUAGE HMIS to support workers for whom English is not a first language
- VISUAL-BASED INSTRUCTIONS (such as iconography, diagrams or animated graphics) to reduce the need for reading comprehension
- **SIMPLIFIED TOUCH INTERFACES** modeled on common consumer devices, such as tablets or smartphones

These aren't just conveniences — they are essential food-safety controls. Poorly understood instructions can lead to improper sanitation, missed critical control points or incorrect machine settings — all of which increase risk.

A particularly telling quote from PMMI's Operational Readiness report captures this need: "We just took out their HMI and

PLC and reprogrammed it so that we could understand it."

This was shared by a director of engineering who had inherited a machine with overly complex controls. The comment underscores a broader trend: technical sophistication must be matched by usability. No matter how advanced a system is, if frontline operators or maintenance staff can't intuitively use it, the risk of error increases.

This shift toward user-friendly design also reflects a new reality in food production: technology must support the skill levels and learning curves of real-world teams — not just idealized users.

In short, the future of food safety isn't just digital — it's also human-centered and regulation-aligned. Technologies, such as SPC, AI-enhanced HMIs and automation platforms, can make food production safer and more compliant, but only when designed and deployed within frameworks that recognize both the industry's regulatory standards and the operational realities of a modern, diverse workforce.

Food safety in 2025 is no longer just about physical barriers to contamination — it's also about digital foresight, integrated training and data clarity. For food processors, investing in these systems isn't just about compliance — it's also about resilience, efficiency and reputation.

The data is clear: success in this new era depends on holistic operational readiness. That means putting people at the center of your tech strategy; fostering strong OEM-end user collaboration; and building systems that learn, adapt and prevent — before a single product leaves the line.

Explore the latest systems and technology to ensure food safety at PACK EXPO Las Vegas 2025 (September 29–October 1). Join 35,000 industry professionals from 40-plus vertical markets and explore innovations from 2,300 exhibitors across 1 million net sq. ft. of exhibit space. Engage with new solutions, participate in more than 100 educational sessions and forge connections. Register now to connect with industry leaders, discover innovations and gain a competitive edge. Visit packexpolasvegas.com to learn more and register.

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MUST SEE PRODUCTS

A compilation of the newest food engineering technology and plant products.

SCOTT TECHNOLOGY

BladeStop K800

The BladeStop K800 safety bandsaw doubles the cutting capacity of previous models and introduces a major advancement in operator safety – with the capability to stop the blade within five milliseconds – setting a new industry benchmark. Built for lamb, venison, beef, pork and seafood, the K800's 800 mm cutting capacity allows processors to handle larger primal cuts and entire carcasses without compromising safety or efficiency. The bandsaw integrates Scott's latest dual-safety systems: GloveCheck Vision System and Body-Sensing Technology, capable of stopping the blade within five milliseconds when glove or skin proximity is detected.





PROVISUR

Weiler Mixer Grinder Dominator 14 360B

The Weiler Mixer Grinder Dominator 14 360B now comes with an add-on inline reclaim system that helps processors get more meat out of their grind operation. Used in tandem with Provisur's Dominator Max inline reclaim system, it allows processors to maximize output and deliver a product with texture. The technology in the grinding head provides clean cuts without increasing the temperature, and Dominator Balanced Flow Technology balances the flow of material, maximizing throughput efficiency. Technical leakage and losses during the process are kept to a minimum.

MĀKUSAFE

MākuSafe Scout

MākuSafe Scout enables forklifts to detect workers wearing the MākuSafe Ally armband, providing operators with realtime risk indicators based on pedestrian density nearby. Unlike traditional collision-avoidance systems that rely on sudden stops or alarms, Scout's data-driven approach enhances operator awareness without disrupting operations. The system also provides comprehensive analytics, helping safety leaders understand where and when the highest risk interactions occur — allowing for smarter decision making and proactive safety interventions.



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KRONEN GMBH

CAP 350

The CAP 350 cabbage cutting machine is designed to cut entire cabbage heads and can process up to 5,000 kg per hour, achieving quality with red and white cabbages measuring up to 350 mm in diameter. The large feeding hopper enables the machine to be filled continuously. The CAP 350 is an upgraded version of the CAP 68 cabbage cutting machine. It is able to process large heads of cabbage and offers an increased processing capacity. The cutting machine features an open, user-friendly and hygienic design. Its wide infeed tube ensures continuous filling, while angled blades on the cutting disk and the specially shaped product infeed guarantee optimal intake of the cabbage head, preventing any possible uncontrolled movement of the cabbages. Shred shorteners can be used to cut strips to specific lengths. A variety of cutting disks are available for different thicknesses.

KOEHLER PAPER

Koehler NexPlus Tea Packaging

With Koehler NexPlus Tea Aroma and Koehler NexPlus Tea Flavor, the company is offering two types of heat-sealable packaging paper with both a grease and oil barrier and a special aroma barrier, which is suited for essential oils and aromatic tea varieties. Meanwhile, Koehler NexPlus Tea Pure and Koehler NexPlus Tea Coat can be used for heat-sealed teabag wrapping and flow packs with a natural feel or glossy surface. Koehler NexPure Tea and Koehler NexCoat Tea Matt are suitable for knurled teabag wrapping where barrier properties are not required.





POWER KNOT LLC

BCG-150

The BCG-150 is engineered to grind bones, fruit pits and tough, fibrous materials, making it easier to process through food waste digesters or for eco-friendly disposal. The BCG grinder is capable of shredding challenging waste materials such as pineapple heads and lemongrass. It features a custom stainless steel hopper and heat-treated knives (HRC 45-52) designed for durability and long-lasting performance. Suitable for use with the LFC-1000 and LFC-2000 biodigesters, the BCG grinder can process up to 100 kg (200 lb.) per hour and can accommodate items up to 40 cm (16 in.) long. By processing all food stuffs before putting them into these large biodigesters, it is possible for them to exceed their nominal capacities of 1000 kg (2200 lb.) and 2000 kg (4400 lb.) per day of food waste. **FE**

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REGULAT

FDA Approves Natural Color Options Following Move to Phase Out Petroleum-Based Dyes



Photo courtesy of Getty Images Plus / vld.enc

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In alignment with the FDA's aim to phase out petroleum-based dyes, the agency has approved three color additives from natural sources for use by food manufacturers.

The U.S. Department of Health and Human Services and the U.S. Food and Drug Administration (FDA) has announced a series of new measures to phase out all petroleum-based synthetic dyes from the nation's food supply.

The FDA is initiating the process to revoke authorization for two synthetic food dyes, Citrus Red No. 2 and Orange B, within the coming months.

A national standard and timeline for the food industry to transition from petrochemical-based dyes to natural alternatives will be established and the FDA will work with the industry to eliminate six remaining synthetic dyes — FD&C Green No. 3, FD&C Red No. 40, FD&C Yellow No. 5, FD&C Yellow No. 6, FD&C Blue No. 1, and FD&C Blue No. 2 — by the end of next year.

The announcement comes on the heels of the agency's announcement earlier this year to revoke Red Dye No. 3. HHS Secretary Robert F. Kennedy, Jr. says the agency is requesting food companies remove FD&C Red No. 3 sooner than the 2027-2028 deadline previously required.

The FDA has since granted three new color additive petitions that will expand the palette of available colors from natural sources for food manufacturers. The color additive petitions approved are for:

• **Galdieria Extract Blue**, a blue color derived from the unicellular red algae Galdieria sulphuraria. The FDA has approved the color additive for use in nonalcoholic beverages and beverage bases, fruit drinks, fruit smoothies, fruit juices, vegetable juices, dairy-based smoothies, milk shakes and flavored milks, yogurt drinks, milk-based meal replacement and nutritional beverages, breakfast cereal coatings, hard candy, soft candy and chewing gum, flavored frostings, ice cream and frozen dairy desserts, frozen fruits, water ices and popsicles, gelatin desserts, puddings and custards, and whipped cream, yogurt, frozen or liquid creamers (including non-dairy alternatives) and whipped toppings (including non-dairy alternatives).

• **Butterfly Pea Flower Extract**, a blue color that can be used to achieve a range of shades including bright blues, intense purple and natural greens. Produced through the water extraction of the dried flower petals of the butterfly pea plant, this color additive is already approved for use in sport drinks, fruit drinks, fruit and vegetable juices, alcoholic beverages, dairy drinks, ready to drink teas, nutritional beverages, gums, candy, coated nuts, ice creams and yogurt.

The approval of a petition by St. Louis-based Sensient Colors LLC expands the approved use for coloring readyto-eat cereals, crackers, snack mixes, hard pretzels, plain potato chips (restructured or baked), plain corn chips, tortilla chips, and multigrain chips.

• **Calcium Phosphate**, a white color approved for use in ready-to-eat chicken products, white candy melts, doughnut sugar, and sugar for coated candies. **FE**



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