ENGINEERING TOMORROW'S POULTRY INDUSTRY



### Researchers Explore Rotational Motion and Ice Slurry to Enhance Poultry In-Line Immersive Chilling

The U.S. poultry industry uses thermal cooling systems to ensure product quality and safety. Typically, during processing chicken carcasses are immersed in screw augers of chilled water, which lowers their core temperature to a degree that inhibits pathogen growth. Though effective, the process usually requires carcasses to be removed from a shackle line for immersion. This unshackling results in lost traceability, sequence, and single-carcass control; increased cross-contamination risks due to direct contact between carcasses; and subsequent re-hang labor as the carcasses must be re-hung onto processing line shackles after chilling. Researchers with the Georgia Tech Research Institute (GTRI) are exploring ways to alleviate these issues by keeping the carcasses shackled during immersive chilling. This attempt at in-line immersion is being enhanced by using an alternative chilling medium and/or incorporating rotational kinematics.



Comas Haynes, GTRI principal research engineer (left), and Saikamal Srinivas, GTRI graduate research assistant, test in-line immersive chilling of poultry carcasses in a laboratory test rig that incorporates ice slurry and rotational kinematics. Also pictured (background): Aklilu Giorges, GTRI principal research engineer.

"Effective in-line immersive chilling avoids the poultry processing burden of re-hang, as well as lost product sequence, traceability, and repeatability typically associated with unshackled screw-auger immersive chilling," says Comas Haynes, Ph.D., GTRI principal research engineer and project director. "Our goal is to afford a new, better automated means of poultry process chilling via alternative 'media and motion' options, specifically ice slurry and rotational spin patterns."

The team's approach is to add rotational motion to typical translational line speeds experienced by shackled carcasses. According to Haynes, the optimized addition of rotation can significantly increase the amount of chilling that occurs between the carcasses and the chiller fluid because it is effectively adding another dimension of motion beyond translational line speed (i.e., rotational agitation is superimposed unto line speed). This rotational effect significantly improves chilling via conventional liquid water; however, the option of using ice slurry as chiller media provides the additional latent chilling effects of ice while retaining a liquid-like coolant that flows around and touches all parts of the carcasses, resulting in higher rates of cooling.

Here, it is noteworthy to mention that the rotational effects and ice slurry interventions do not depend on each other for effectiveness, but they can complement each other.

"The rotational effects have been shown to significantly assist cooling in chilled water, but we also believe optimized rotation should magnify the

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### MANAGER'S CORNER

Springtime always ushers in new beginnings, from budding flowers and greening leaves on trees to the refreshing of spaces with spring-cleaning activities. But, this spring takes on an even more hopeful beginning ... turning the corner on COVID-19.

During the past year like most organizations around the globe, the Agricultural Technology Research Program (ATRP) adapted to a new normal. We adjusted work schedules, worked remotely, held virtual meetings, and our research teams that were able to safely perform in-lab testing successfully weathered the pandemic. I am truly grateful to our researchers and staff who stayed the course. And now, like every springtime, we burst with enthusiasm to discover new possibilities.

One of our research teams is working on a project specifically targeted at helping the poultry industry identify architectural and operational parameters that potentially impact transmission of diseases like COVID-19. Led by Olga Kemenova, the team is developing agent-based spatiotemporal models of processing plant common spaces (hallways, break rooms, etc.), airflow, people pathways/interactions, and design layouts that can be used to pinpoint potential hot spots in both existing and new facilities. The goal is to provide alternative options for managing personnel interactions that could reduce the risk of infection.

On a broader scale, ATRP will once again co-host the International Food Automation Networking (IFAN) Conference on September 19-21, 2021, at the Georgia Tech Hotel and Conference Center in Atlanta (see below for registration information). As most in the food sector know, this past year highlighted the importance of a steady and reliable food manufacturing base. Challenges with recruiting, training, and retaining a reliable labor force have shown that moving forward, R&D in food automation will be even more critical for maintaining a resilient food supply. This year's conference theme, "Securing the Future: Designing Robustness and Resilience into the Food Production System," seeks to do just that with presentations and thought-provoking discussions covering the topic areas of Robotics and Automation, Data Analytics, and Social and Human Interaction.

Now more than ever, I am excited to see where our R&D journey takes us. ATRP's vision is to transform poultry, agribusiness, and food manufacturing through advanced technologies. I would especially like to take this opportunity to thank our Poultry Industry Advisory Committee members who participated in virtual meetings during the past year. Your continued support and guidance help us collectively pursue that vision.

Day Batton

Doug Britton, Ph.D. ATRP Program Manager

### International Food Automaton Networking (IFAN) Conference

Securing the Future: Designing Robustness and Resilience into the Food Production System

### September 19-21, 2021 Georgia Tech Hotel and Conference Center – Atlanta, Georgia

Targeted toward corporate food manufacturing engineering leaders, equipment suppliers, and end customers of such technologies, the IFAN conference seeks to provide meaningful networking opportunities, highlight tangible research and development activities, and provide broader context for automation deployment in the food manufacturing sector.

To register, visit ifan.gtri.gatech.edu



### ECHNOLOGYFOCUS

### Using Virtual Reality to Remove Workers from Harsh Conditions BY COLIN USHER

Working in a poultry processing plant is a tough gig. The environment is cold, humid, and the tasks are highly repetitive. This leads to repetitive motion injuries and high turnover rates. What if you could have workers perform their duties in comfortable office environments, or better yet, from their own homes? This This is performed by using cameras and 3D sensors to capture real-world information and pipe it into a virtual environment (Figure 1). In the case of cone loading, this would be a scene of the bin full of chicken front halves to be loaded onto cones. Using the virtual environment, the user defines the orientation of the

Colin Usher is a GTRI senior research scientist.



is just one aspect of virtual reality technologies that researchers in the Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program are currently exploring.

There are several tasks in poultry processing that stand to benefit from robotic automation. However, current state-of-the-art automation systems typically only work with 80-90 percent accuracy. With accuracy at these levels, automation systems are unattractive to industry at large. In most cases, the failure of these systems is related to sensing capabilities. With a malleable, deformable product, it is very difficult to implement robust sensing systems that are as accurate as humans.

Researchers are developing and testing an "expert-in-the-loop" robotics solution that allows human operators to provide key information to robot systems enabling their operation. Essentially, the human is performing the sensing task, and telling the robot what to do, all

from a virtual reality environment. There is potential for this type of operation to impact several areas of poultry processing. For these efforts, the team is focusing first on re-hang and cone loading type of operations.



Figure 1. Real world to virtual environment. (Illustration credit: Matthieu Daley)



Figure 2. Virtual workers on a processing line. (Illustration credit: Matthieu Daley)

chicken for the robot to grasp (Figure 2). Once identified, the robot can automatically move to, pick up, and load the front half onto a moving cone. For this operation, the grasping and cone loading is relatively trivial. The complicated part of this task is having a way to provide the pose information of the chicken to the robot. This is where the human operator in the virtual environment is used.

With workers and robots in the same virtual space, operations in real-world environments can be enabled remotely. Workers assist and guide the robotic solutions. Time and space are not as significant because the work can be performed from anywhere and at any time virtually across the globe. The technology can also cater to other groups of workers such as people with disabilities.

The goal is to create a next-generation workspace consisting of a general approach to human and machine collaboration. This will be performed via a flexible interface to provide collaborative automation solutions. This development can also be extended to support development of solutions (design, development, and deployment in the same environments) as well as support training of new workers. Perhaps most

impactful of all is this system can democratize the workforce allowing for remote workers across the globe to be able to perform high-value operations for local processors, possibly eliminating the labor issues as they exist today.

## RESEARCH O&ZA

### **PAA Decay Kinetics**

Daniel Sabo, Ph.D., senior research scientist in the Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program, discusses his project "PAA Decay Kinetics," which investigates the effects of pH, organic carbon, and salt on the stability and breakdown of peracetic acid (PAA) within chiller media. PAA is an antimicrobial agent commonly used in poultry processing plant chillers to reduce and eliminate foodborne pathogens.

## Q: PoultryTech – What industrial challenge is the project addressing?

A: Sabo – We are attempting to understand how the organic loads (total suspended solids, TSS; total dissolved solids, TDS; fats, oils, and grease, FOG) change throughout a typical processing day and their effects on PAA stability and decay. It is suspected that certain organic species present in the chiller will speed up PAA decay, resulting in PAA concentrations dropping below target levels or requiring additional PAA to be added to maintain target levels within the chiller.

## Q: PoultryTech – How is the project addressing this challenge?

A: Sabo – This project is collecting chiller media throughout a shift from multiple processors. This allows us to characterize the media for TSS, TDS, and FOG, in addition to chemical oxygen demand (COD) and total keldal nitrogen (TKN). From this data, we can optimize benchtop tests that investigate which of these species have effects on PAA stability and decay. Once we identify the species that has the largest effect on PAA decay, we can then look to isolate which chemical component within that species is the culprit. A strategy to neutralize this chemical can then be devised to reduce the effects on PAA decay, allowing it to become stable and thus reducing the amount of PAA required within chillers.

## Q: PoultryTech – What are the results to date and next steps?

A: Sabo – There were several organic species that were tested in the lab (whose concentration match that of industrial counterparts) for their effects on PAA decay. For reference, the team tested PAA in tap water with nothing present to break it down and observed a half-life of 5,400 minutes. (Half-life is the time for half of the starting amount to be consumed or decay). When the pH of the water is adjusted to 7, the half-life dropped to 1,900 minutes. At pH 8.5, a half-life of 200 minutes was observed. And finally, at pH 10, a 90-minute halflife was seen. The current results show the effects of the following constituent materials:

• Proteins – It has been reported in the past that proteins are expected to have the largest effect on PAA stability. We used a protein segregate, bovine serum albumin (BSA), to represent protein levels typically seen in chillers. The BSA had an effect on the PAA stability in a fashion similar to that of tap water



Daniel Sabo, GTRI senior research scientist, measures PAA levels using a DPD colorimetric-based method.

with pH 8.5, meaning the PAA had a half-life of ~140 minutes at BSA protein levels of ~1,800 ppm.

- TSS For this, we suspended hydrolyzed chicken feather meal (powdered) in tap water to produce a mixture with TSS in the range of what would be seen in a typical industrial chiller. Results indicated a slight effect on PAA stability, with an observed half-life of ~80 minutes for a TSS mixture of ~2,000 ppm.
- TDS To produce this mixture, we agitated 4 gallons of water with air that contained chicken WOGs (without giblets). This produced a mixture with a TDS level close

to amounts seen in chillers with a very small amount of TSS. TDS was observed to have the largest impact on PAA stability, with a half-life of ~3 minutes for a TDS mixture of ~3,500 ppm.

• NH4OH – We are now investigating what components/chemicals present within the TDS cause the rapid decay of PAA. One component being investigated is hydrolyzed proteins, which will cause the amount of ammonia in the solution to increase. The effects of NH4OH (ammonia dissolved in water) on the stability of PAA are being evaluated using levels of NH4OH that match the amount of nitrogen present in chillers,

~200 ppm. Like TDS, NH4OH had a noticeable effect on PAA stability, with an observed half-life of only ~2 minutes.

#### Q: PoultryTech – What are the potential benefits for poultry processors?

A: Sabo – The primary benefit is a better understanding of the overall effects that these materials have on the stability of the PAA in the process. By understanding these decay mechanisms, processors can better optimize PAA use by possibly reducing the amount of PAA being used while

still achieving desired antimicrobial outcomes. This could also reduce the overall operational costs associated with PAA.

## Q: PoultryTech – Is there anything else you would like to add?

A: Sabo – Understanding the effects that various organic species (FOG, TSS, TDS, TKN) have on PAA stability is complicated, and separating the various component effects is convoluted. Despite this, we are focusing on those components that have the largest effects, which will allow us to investigate how to best mitigate them, allowing for better PAA stability.

### Konrad Ahlin Named First R. Harold and Patsy Harrison Research Faculty Fellow in Poultry Technologies

Robotics engineer Konrad Ahlin has been named the R. Harold and Patsy Harrison Research Faculty Fellow in Poultry Technologies at the Georgia Tech Research Institute's (GTRI) Agricultural Technology Research Program (ATRP).

The fellowship, made possible through an endowment from the R. Harold and Patsy Harrison Foundation, recognizes innovative, promising early-career research faculty interested in exploring breakthrough applied engineering and science research to address poultry industry challenges. Ahlin is the first recipient of the newly established three-year fellowship.

Ahlin, who earned a Ph.D. in Robotics from Georgia Tech and joined GTRI in 2018 as a Research Engineer II, will focus his research efforts on enabling robots to handle uncertain and unpredictable objects like poultry products with the same reliability and repeatability as human operators.



An expert in robotics, controls, and path planning, Ahlin aims to figure out exactly how to identify, grasp, and manipulate products from the birds coming into the poultry plant to the chicken nuggets going out. Successful implementation

#### **HOW TO GIVE**

The R. Harold and Patsy Harrison Foundation endowment also provides foundation for a broader fundraising effort to further support the Abit Massey Student Internship Program and other research programs within ATRP.

The Abit Massey Student Internship Program provides Georgia Tech undergraduate students the opportunity to gain unique knowledge and experience by working alongside researchers on projects in the areas of robotics, sustainable systems, food safety, and/or advanced sensing technologies. The goal is to prepare the next generation of researchers and professionals to innovatively tackle the challenges of building the poultry plant of the future. The program honors Massey, president emeritus of the Georgia Poultry Federation, who was instrumental in ATRP's founding more than 45 years ago and remains a dedicated supporter to this day.

To inquire about making a gift, contact Ricardo Hubler at ricardo.hubler@dev.gatech.edu or 404-894-6007.

of more advanced robotics in the industry will not only increase production efficiencies but will also alleviate some of the labor concerns of manual operations while ultimately giving a boost to food security.

"It is truly an honor to be recognized in this way. Thank you to the R. Harold and Patsy Harrison Foundation, GTRI, and ATRP for this opportunity. I'm looking forward to tackling the poultry robotics challenge," said Ahlin.

Established in 1973, ATRP develops advanced technology in support of Georgia's multibillion-dollar poultry industry, the state's leading agricultural sector. The technologies help poultry processors optimize operations and improve efficiency, safety, product yields, and environmental sustainability.

The R. Harold and Patsy Harrison Foundation was founded by the Harrisons' daughter, Bobbie Ann Harrison Reynolds, and her husband, Raymond H. Reynolds, Jr. (a Georgia Tech industrial engineering alumnus), in honor of her late parents with a primary goal to strengthen and support education. Her father founded Harrison Poultry in 1958 in Bethlehem, Georgia.

"The entire ATRP team is grateful to the R. Harold and Patsy Harrison Foundation for the confidence they've placed in us and their generosity in helping us continue our decades-long mission of bringing cutting-edge R&D to Georgia agribusiness, especially our great partners in the poultry sector," said Doug Britton, ATRP program manager.

## INDUSTRY NEWS

### **Biosecurity Needs to Be in the Forefront**

BY RAFAEL RIVERA, MANAGER, FOOD SAFETY & PRODUCTION PROGRAMS, U.S. POULTRY & EGG ASSOCIATION REPRINTED FROM THE SPRING 2021 EDITION OF USPOULTRY'S NEWS & VIEWS PUBLICATION

These last few months have seen highly pathogenic avian influenza (HPAI) outbreaks throughout Europe and several Asian countries. The strains that are being identified are related to the HPAI virus strains that ravaged the poultry industry in the Midwestern and Western United States in 2014-2015. The U.S. Department of Agriculture (USDA) Animal & Plant Health Inspection Service (APHIS) reported that migrating birds that are set to start passing by during the migration period in the spring have a high probability to come in contact with birds that could carry the virus up to the northernmost regions between Asia and North America. Since the 2015 outbreak, several changes have been implemented as part of the USDA HPAI indemnification process. Today, commercial poultry farms must have a biosecurity program in place that follows the National Poultry Improvement Program's (NPIP) Biosecurity Principles, and they must be audited every two years. The regulation became effective September 2020.

Biosecurity is the first line of defense against disease, and biosecurity plans contain a set of established practices designed to prevent the introduction of diseases on farms. The recent cases of HPAI are highly concerning, and it is necessary to ramp up prevention efforts throughout the industry. We should be taking the necessary precautions to prevent the introduction of any disease into our farms. We all have to elevate our awareness during the migration seasons, keeping in mind that a solid biosecurity program will keep you protected year-round.

The U.S. Poultry & Egg Association (USPOULTRY) has developed materials to help companies and their growers establish effective biosecurity programs. USPOULTRY and USDA APHIS collaborated by developing and providing access to a biosecurity selfassessment tool that helps determine the level of biosecurity preparation an operation needs, guiding the user through a list of biosecurity principles developed to emphasize the elements for improving biosecurity. The materials include three concepts that may be new to existing biosecurity plans: a biosecurity officer, a line of separation for each building, and a perimeter buffer area. In conjunction with these three concepts, biosecurity plans should establish and maintain the following:

- Biosecurity Officer Each production site (or integrated system) should have a biosecurity officer capable of designing and implementing effective biosecurity procedures. The biosecurity officer should review the biosecurity program at least once during each calendar year and make revisions, as necessary.
- Training of Employees/Other Personnel The biosecurity officer ensures that farm employees, contract crews, truck drivers, and service personnel are trained on site-specific biosecurity standard operating procedures.
- Line of Separation The line of separation is a critical control point for preventing disease exposure of poultry. A plan must address how this line will be defined and defended for each poultry house or set of connected houses.
- Perimeter Buffer Area The perimeter buffer area concept is aimed at reducing virus entering and contaminating the production site. The perimeter buffer area should be clearly delineated and located so that personnel do not leave the buffer area in the course of their daily tasks; or if they do, they use a specified entrance.
- **Personnel** Personnel and their clothing/footwear may become contaminated through a variety of activities and contacts when they are offsite. Showering and changing into clean clothes immediately prior to arriving at a poultry site, or upon

arrival, will greatly reduce disease introduction. This would apply to anyone who will enter the perimeter



buffer area or cross the line of separation at a minimum.

- Wild Birds, Rodents, and Insects Poultry operations should have control measures to protect poultry from wild birds, their feces, and their feathers. Rodent and insect control programs should be in place.
- Equipment and Vehicles Equipment and vehicles should be effectively sanitized between uses. Sharing of equipment should be minimized. Define equipment and vehicle storage, access, and traffic patterns to minimize contamination at the farm.
- Dead Bird Disposal Dead birds should be disposed of in a manner that prevents the attraction of wild birds, rodents, and other animals and avoids the potential for cross contamination with dead birds from other facilities.
- Manure and Litter Management Manure and spent litter should be removed in a manner to prevent exposure of susceptible poultry (either on or off the farm of origin) to disease agents.
- Replacement Poultry Replacement poultry should come from sources with documented biosecurity practices. The introduction of replacement poultry needs to be handled properly. While birds may come from a facility with welldocumented biosecurity practices, the risk of disease introduction increases if they are transported in improperly cleaned and sanitized vehicles. It is important to monitor the maintenance of the biosecurity chain every step of the way.

- Water Supplies Water should come from deep wells or sources that have been treated to eliminate any potential contamination with live virus. If water comes from a surface water source, experts in water treatment should be consulted on how to continuously treat the water to eliminate viable virus.
- Feed and Replacement Litter Feed, feed ingredients, and fresh litter can be contaminated if they have been exposed to the outside environment, wild waterfowl or other birds, or if they contain insects or rodents that might be carrying disease vectors. Grain, feed, and fresh litter should be stored and handled so that they cannot be contaminated.
- Reporting of Elevated Morbidity and Mortality – Elevation in morbidity and/ or mortality above expected levels, as defined by the biosecurity plan, should be reported as required in the site-specific biosecurity plan. Unusual increases in mortality could be a sign of disease, and reporting allows one to take the appropriate actions to rule out reportable disease agents.
- Auditing Audits should be conducted at least once every two years or a sufficient number of times during that period by the Official State Agency to ensure the participant is in compliance. Each audit should require the biosecurity plan's training materials, documentation of implementation of the NPIP Biosecurity Principles, corrective actions taken, and the biosecurity coordinator's annual review to be audited for completeness and compliance with the NPIP Biosecurity Principles.

USPOULTRY'S "Infectious Disease Risk Management: Practical Biosecurity Resources for Commercial Poultry Producers" DVD describes the elements that address biosecurity principles. In addition to the DVD, USPOULTRY has a NPIP Biosecurity Principles Template created as a 'fill in the blanks' document to guide producers in the design and monitoring of their program. USPOULTRY's animal husbandry webpage also provides key elements in the areas of cleaning and disinfection, traffic control, pest control, depopulation, and disposal. For information on these resources, visit **uspoultry.org.** 

## **RESEARCHER PROFILE**

### Walker Byrnes

#### Job title: Research Engineer I

*Education:* B.S., Mechanical Engineering, Georgia Institute of Technology; currently pursuing a master's degree in Computer Science at Georgia Tech

Areas of research expertise: Robotic control and integration, development of novel automation solutions, and computer vision techniques



List of any poultry industry projects you're working on and your role: I have worked on a number of poultry-related projects in my time working with GTRI. My primary contributions have been to the Growout House Robotics and Virtual Reality Cutting projects, consisting of mobile manipulation within poultry houses and virtual reality visualization of cutting techniques for processing, respectively. My role with the Growout Robot has included implementing behavior routines to locate and collect eggs on the house floor and aiding in troubleshooting localization within the house using ultrasonic tracking beacons. For the virtual reality cutting project, I have worked to integrate multi-user support with the simulation to allow for collaboration and demonstration learning within the simulation. I have also created software to add additional interaction between the user and the simulation through a number of user interfaces and panels within the virtual environment.

What I find most rewarding about working on poultry industry projects: Poultry is a rewarding field to work in as it is so essential to the production of food, both in the USA and globally. The ubiquity of poultry in the food space underscores the need for efficient and reliable automated solutions to remove the burden off laborers for undesirable or dangerous tasks.

A talent I wish I had: Neat handwriting; mine is terrible!

Another occupation I'd like to try: Travel Photography. I don't have a ton of experience with photography, but it sounds like a fun job.

*My first job:* Part-time administrative assistant at a law firm. My role included filing, bookkeeping, and basic accounting.

If I could meet someone famous, who would it be and why: Adam Savage. The TV show Mythbusters was a huge inspiration to me as a child and sparked my interest in STEM and robotics, starting me on the path I'm on today.

One thing people may not know about me: Before starting as a full-time employee, I had worked with GTRI as a student intern for three years primarily in the poultry and agriculture domains.

My day would not be complete without: Brewing coffee in the mornings

The last book I read: Fahrenheit 451 by Ray Bradbury

The last movie I saw: Tenet by Christopher Nolan

*My favorite song*: "End of It" by Friday Pilots Club

*My motto:* "When the snows fall and the white winds blow, the lone wolf dies but the pack survives." – George R.R. Martin, *A Game of Thrones* 

*My hobbies*: Board/card games, hiking, craft coffee, cinema, Formula One, and football

#### Researchers Explore Rotational Motion and Ice Slurry to Enhance Poultry In-Line Immersive Chilling continued from page 1

chilling benefit of ice slurry by means of greater convective heat transfer," notes Haynes.

In fact, using a test rig and thermal time constants, the team experimentally simulated the proposed addition of rotational patterns to normally translating shackles in chilled water. While not equivalent to chilling time, the thermal time constant is a direct indicator of chilling time. Early results indicate that required chilling times for in-line immersive chilling can be reduced by 30 percent to 40 percent (ice slurry chilling media results are pending). For example, in one set of experiments, the projected dwell time for chilling a weight class of carcasses from 40°C down to 4°C decreased from approximately 75 minutes to approximately 45 minutes, which represents a 40 percent reduction.

Faster chilling of carcasses also means that plant spatial requirements for a chiller can be reduced to the same extent.

"Less time in the chiller means less space needed for the chilling process," says Haynes.

Recently, the team began building a new carousel-type test rig that better mimics real-world conditions; i.e., the shackled carcasses are actually moving instead of being stationary with the chilling medium pumped past them. The team has filed a provisional patent on the addition of a rotational enhancement. "We are accomplishing passive rotation by way of translation; we are not having to use motors to cause this rotation to occur," says Haynes.

With the new test rig, the team will extend thermal testing and optimization of rotational spin patterns in both conventional chilled water and ice slurry as an alternative chilling medium.



### August 16-18, 2021

### Hilton Sandestin Beach Golf Resort & Spa – Destin, Florida

The 2021 National Safety Conference for the Poultry Industry is designed specifically for poultry facility and corporate safety personnel. The three-day event features key presentations on important industry topics and updates on government policy. Other highlights include breakout sessions for discussing best practices and current challenges, as well as networking and knowledge exchange opportunities with other safety and health professionals.

To register, visit uspoultry.org/educationprograms

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#### facebook.com/ATRP.GTRI

# PoultryTech

Published by the Agricultural Technology Research Program of the Georgia Tech Research Institute, a program conducted in cooperation with the Georgia Poultry Federation with funding from the Georgia Legislature.

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PoultryTech is published twice a year (Spring and Fall) and delivered free of charge to subscribers. To subscribe, visit atrp.gatech.edu/subscribe.html or scan our QR code.



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