FY 2020 PROGRAM HIGHLIGHTS

[July 1, 2019 - June 30, 2020]

BY THE NUMBERS

8 RESEARCH PROTOTYPES IN VARIOUS STAGES OF DEVELOPMENT

9 EXPLORATORY RESEARCH PROJECTS FUNDED TO DEVELOP CONCEPTS AND IDEAS FOR LATER TRANSITION INTO FULL-SCALE RESEARCH PROJECTS

2 PATENTS

28 PUBLISHED ARTICLES, PAPERS, AND PRESENTATIONS ON RESEARCH DISCOVERIES

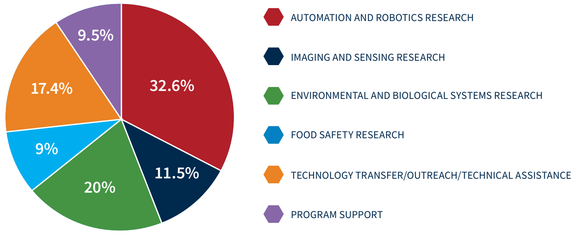
17 INDUSTRY AND ACADEMIC PARTNERS PARTICIPATED DIRECTLY IN ONE OR MORE RESEARCH PROJECTS

23 TECHNICAL ASSISTANCE SERVICES PROVIDED TO COMPANIES OR INDIVIDUALS THAT HELPED SOLVE A PROBLEM OR PROVIDED USEFUL INFORMATION

FINANCIAL SUMMARY

Total Funding: $1,989,561

[Annual funding provided by the State of Georgia]



OUTREACH ACTIVITIES

COORDINATED
Poultry World
EDUCATIONAL EXHIBIT AT THE GEORGIA NATIONAL FAIR

PRODUCED
PoultryTech
NEWSLETTER

CO-HOSTED
WITH THE U.S. POULTRY & EGG ASSOCIATION

EXHIBITED AT
IPPE
PRODUCTION & PROCESSING EXPO

Georgia Tech Research Institute | AGRICULTURAL TECHNOLOGY RESEARCH PROGRAM

TRANSFORMING POULTRY, AGRIBUSINESS, AND FOOD MANUFACTURING THROUGH ADVANCED TECHNOLOGIES

ADVISORY COMMITTEE

The Agricultural Technology Research Program is conducted in cooperation with the Georgia Poultry Federation with input from an external Advisory Committee consisting of representatives from leading poultry companies and allied organizations.

MEMBERS

Steve Snyder, Claxton Poultry (Chair)
Matt Nelson, Boehringer Ingelheim
Randy Segars, Boehringer Ingelheim
Joe Cowman, Cantrell-Gainco Group
Mark Hamby, Cobb-Vantress
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AGRICULTURAL TECHNOLOGY RESEARCH PROGRAM

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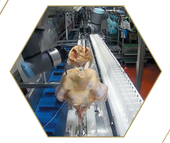


2020 ANNUAL REPORT

MESSAGE FROM THE PROGRAM MANAGER

At the beginning of FY 2020, few could have predicted how this year would change so many aspects of both our personal and professional lives. For the Agricultural Technology Research Program (ATRP), we began the year full of optimism with 10 full-scale and nine exploratory research projects and a strong slate of outreach activities. In addition, several research teams started the process of transitioning technology developments to the commercial sector through industry partnerships. However, in early 2020, the global landscape shifted amid the coronavirus pandemic, and ATRP had to pivot and learn to adapt to new work environments, communication tools, restricted in-person interactions, and reduced abilities to conduct both laboratory research and field-based trials and testing. That said, I am always amazed at the resiliency of the human spirit, which ATRP research and program teams brilliantly showed as they sought new ways to achieve prior goals or migrated research project objectives to fit the new realities. While we may not have been able to meet all of our initial goals, significant progress was made, and I could not be prouder to share with you the results of these efforts in this FY 2020 Annual Report. As difficult as FY 2020 may have been, we learned many new things and are excited to carry this new knowledge with us as we strive to achieve the ATRP vision of driving transformational innovation in poultry, agribusiness, and food manufacturing in the years to come.

Notably, a shining light in support of ATRP's vision was the announcement of the Abit Massey Student Internship Program and the generous anchor donation by the R. Harold and Patsy Harrison Foundation that allowed us to launch this effort. This program supports university students interested in using science, engineering, and technology to solve critical challenges facing the poultry industry. In addition, the Harrison Foundation established the R. Harold and Patsy Harrison Research Faculty Fellowship Endowment to support early career faculty working on innovative technology and science solutions for the poultry industry. We are extremely grateful to the Harrison family and to the many other individuals and companies who have stepped forward to support and grow this program.

ATRP could not exist without the generosity, support, and input from all of our industry partners and institutional collaborators. So, thank you for helping us make ATRP a success!

Doug Britton, Ph.D.
ATRP Program Manager

THANKS TO OUR INDUSTRIAL AND ACADEMIC PARTNERS

Industrial collaborators support research projects by providing industry expertise and access to facilities for data collection and systems testing and contributing in-kind and cash support on an "as needed" basis. Academic partners collaborate with research teams by providing cross-disciplinary expertise and experience as well as access to university research facilities.

AudioT
Claxton Poultry
Clemson University
  Animal Co-Products Research and Education Center
Cobb-Vantress
Darling Ingredients
Fieldale Farms
Georgia Institute of Technology
  College of Sciences
  School of Civil and Environmental Engineering
  School of Earth and Atmospheric Sciences
  School of Electrical and Computer Engineering
  School of Industrial Engineering
Georgia Tech Manufacturing Institute
Gwinnett County Department of Water Resources
Harrison Poultry
KWJ Engineering
Marel
Mar-Jac Poultry
TechnoCatch
University of Georgia
  Department of Poultry Science
USDA-ARS Richard B. Russell Research Center
Wayne Farms

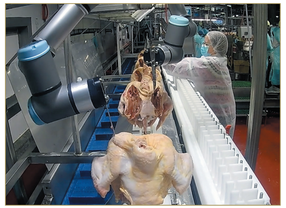
FULL-SCALE RESEARCH PROJECTS
ADDRESSING CRITICAL ISSUES FACING POULTRY PROCESSING AND PRODUCTION

AUTOMATED CONE LOADING WITH LOW-COST MANIPULATION
Researchers continued development of a low-cost, non-robotic system to automatically load front halves onto cones for deboning operations. During FY 2020, researchers designed mechanisms to grasp front halves as they are cut from whole birds and then capture the cut front halves and load them onto a cone conveyor without human intervention. Initial laboratory testing shows promise, but further work is needed to improve reliability and speed. Successful implementation could replace the current labor-intensive manual process.

ICE SLURRY CHILLING: SALT INTERACTIONS AND TRANSPORT PHENOMENA MANAGEMENT
Researchers continued to investigate the use of ice-water slurry to enhance immersive chilling in poultry processing. FY 2020 work investigated two predominant sub-themes. The first focused on the extent of salt's role in the degradation of the antimicrobial peracetic acid (PAA). Salt, which is included as a freezing point depressant in ice-water slurry, was generally suspected to accelerate the deterioration of PAA. Different salinities with and without adjustments to pH values were thus tested. Results showed substantially greater PAA degradation given salt; however, researchers believe further study is warranted. Additionally, methods for characterizing heat transfer between carcasses and the chiller media were developed. Computational and experiential simulations were formed that will be used to evaluate designs for optimizing in-line immersive chilling with chilled water or ice slurry media.

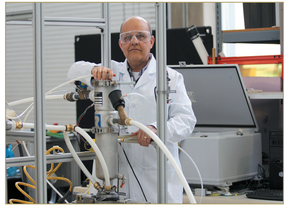
INTELLIGENT CUTTING 2.5
Researchers began the transition of the Intelligent Cutting System for automated bird front half deboning from a laboratory prototype to a plant-ready system. Preparations were made for an in-plant trial scheduled to take place during summer 2020 at a local processing plant.

VIRTUAL REALITY-BASED OPTIMIZATION OF SYSTEMS
Researchers continued to evaluate the feasibility of using virtual reality (VR) technologies to create frameworks for testing, evaluating, and optimizing systems in a poultry processing environment. One example application is the automation of chicken carcass deboning. During FY 2020, additional high fidelity 3D bird models were generated, and the VR cutting application was refined to allow editing of cutting trajectories with the knife models. A new pipeline was also created that quickly transfers the cutting trajectories from the VR application to a physical robot to make a cut on a real bird. Researchers believe these accomplishments validate the use of VR technology for initial testing and evaluation of automated solutions, eliminating the need to use real product or build and test actual hardware.



BIRD RE-HANG
Researchers began development of a robotic system to mechanically singulate, pick up, and place chicken front halves onto cones for processing. Specifically, a custom shaker table was designed and built. The table was combined with additional hardware and software elements as well as an off-the-shelf robotic manipulator and vision equipment. In all, the system performed well during laboratory testing, where a bin of birds was successfully singulated, identified, localized, and manipulated onto cones. Researchers believe the system shows promise, but further improvements and modifications are needed to handle the varying deformable nature of chicken front halves in an actual industrial setting.

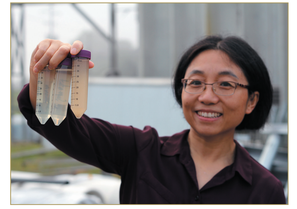
NOVEL SEPARATION TECHNOLOGIES FOR POULTRY PROCESSING LIQUID STREAMS
Researchers continued to optimize a Dynamic Filtration System to improve yield, food safety, and quality for poultry processing operations through value-added byproduct recovery and water recycling. During FY 2020, researchers showcased a pilot-scale system in advance of deploying it for on-site testing. The patented prototype has validated a design that enables a small footprint with 90 percent volumetric throughput efficiencies while still providing filtration proficiencies evaluated down to 75 microns. Researchers are working to demonstrate the system's ability to capture food grade fine suspended solids (fats and proteins) before wastewater treatment. Additional validation tests are pending, and a commercialization partner has been identified.



MULTI-FUNCTION SENSORY SYSTEM FOR SMART POULTRY FARMING
Researchers continued to optimize a multi-function micro-sensor system for measuring levels of ammonia in a farm environment with minimal interference from other sources. During FY 2020, an automated test bed was developed for sensor evaluation and calibration, along with programming for excitation, timing, and signal processing. Researchers also designed a new electrical circuit with high temperature accuracy for stabilization. The sensor was tested with a consequent exposure of 25 ppm ammonia with ± 0.5% ppm of temperature stability. Initial results showed an ammonia detection limit of 1 ppm.

REMOVAL OF FREE FATTY ACIDS FROM RENDERED OIL
Researchers continued to investigate the removal of free fatty acids (FFAs) from various oil systems using functionalized magnetic nanoparticles (MNPs). In FY 2020, they successfully removed FFAs from rendered oil volumes of up to one gallon, with indications of higher volumes possible. A fast and chemical-free method for regenerating the MNP surface was also developed, with no decrease in removal efficiency. Researchers also investigated the effects of FFA removal on oil stability and found the oil can be stabilized for up to five months at 50°C with slower FFA formation when compared to control oil samples. Additional tests also showed oil can be re-exposed to MNPs multiple times without loss of oil quality while also cumulatively removing FFAs.

PHOSPHORUS REMOVAL/RECOVERY USING MAGNETIC NANOPARTICLES
Researchers continued to evaluate the use of magnetic nanoparticles (MNPs) to remove and recover phosphorus from poultry processing wastewater. During FY 2020, a six-week pilot test was conducted at a local poultry plant to compare the efficacy of the patented MNP-based treatment method to the plant's on-site DAF (dissolved air flotation) system. Nearly 10,000 gallons of wastewater were treated with three differing dosages of MNPs. Phosphorus removal was observed for all dosages, with the highest and lowest dosages achieving more than 95 percent and 80 percent phosphorus removal, respectively, which was significantly better than the DAF system's average of 25 percent. The MNPs can be regenerated and reused more than 20 times, making the method an effective and low-cost treatment alternative.



IDENTIFYING AND REMOVING MORTALITY USING AN AUTOMATED ROBOT
Researchers continued to investigate the use of a ground robot to perform broiler and broiler-breeder rearing and management tasks in growout houses. FY 2020 efforts focused on the robot's ability to detect and remove mortality. Researchers designed a low-cost robot arm for picking up full-sized chickens, and successfully demonstrated the capability during laboratory testing. Work is ongoing, with system refinements underway and field tests in an actual growout house planned.

EXPLORATORY RESEARCH PROJECTS
HIGHER RISK, SMALLER SCOPE EFFORTS THAT SEEK TO DEVELOP CONCEPTS AND IDEAS FOR LATER TRANSITION INTO FULL-SCALE PROJECTS

3D REASONING FOR ROBOTIC MANIPULATION
Researchers continued to develop state-of-the-art algorithms that use sensor data to predict a deformable object's pose and the best way to manipulate it for poultry processing tasks. During FY 2020, they evaluated a deep learning-based approach that takes a 3D point cloud as input and extracts geometrical and color features to perform task-specific predictions based on those 3D features. The integration of the developed components will improve the accuracy of robotics for poultry processing tasks such as cone loading and deboning that require prediction of target point, trajectory, or chicken pose.

COUNTERING BACTERIAL AGENTS AT THE CELLULAR LEVEL
Researchers analyzed the volatile organic compounds (VOCs) released from several strains of Shiga-Toxin producing *E. coli*. Testing results identified different VOC profiles between the strains. These differences can help in differentiating bacteria and identifying the organisms' growth cycle. However, further testing is needed to characterize each *E. coli* strain during each of the four exponential growth phases and to identify if microbial VOC profiles change when attached to meat and/or skin. Researchers believe the work shows promise for using VOCs in the development of food safety sensors tailored to specific pathogens.

DYNAMIC LASER SPECKLE IMAGING FOR DETECTING LIVING BACTERIA
Researchers continued to investigate a rapid and non-contact imaging system that analyzes time-varying granular or speckle patterns in images to identify living bacteria. Additional analyses of experimental time-lapse laser speckle images show clear distinction between the presence and absence of bacteria. However, the difference between low, medium, and high concentrations was not discernable, most likely due to hardware and setup limitations. Researchers believe there is opportunity to consider more approaches to data analysis.

FARM PROCESSING AND TRANSPORT (FPaT) SYSTEM
Researchers continued to evaluate the suitability, effects on processing, and economic feasibility of using the FPaT system for on-farm bird harvesting and transport tasks. During FY 2020, researchers tested the proposed system's impact on processing. Initial results showed carcasses had no physical damage during transport, and processing operations at the test facility did not show large deviations in processing parameters such as picking, meat quality, and pH levels between FPaT and traditionally processed carcasses.

CALIBRATION-FREE SENSOR FOR MONITORING AMMONIA IN POULTRY HOUSE
Researchers developed a proof-of-concept sensor array for real-time and calibration-free monitoring of ammonia concentration in poultry houses. The designed platform contains interdigitated electrodes with a functional layer of single-walled carbon nanotube sensing film deposited on top, enabling high sensitivity in resistance and capacitance sensing. Individual sensors of differing sizes are printed on polyimide, a flexible polymer substrate that can endure high temperature and corrosive environments. Simulation testing showed the signals from the different-sized sensors cross-validate each other, increasing the fidelity of measurements and providing a calibration-free sensing system.

VISUAL ASSESSMENT OF CHICKEN GAIT SCORE
Researchers explored the use of a vision-based algorithm to remove the subjectivity from gait scoring and monitoring poultry welfare. Researchers used 2D video processing techniques to evaluate normal and abnormal chicken gaits data obtained in a commercial chicken house. More than 60 samples were collected and analyzed, showing significant differences between birds with normal versus modified gaits. These initial results are promising in that they confirm the ability to track foot location with high fidelity.

PAA LIFETIME IN POULTRY CHILLER MEDIA
Researchers investigated the effect of organic carbon on the concentration of PAA (peracetic acid) within chiller media throughout the processing day. Specifically, they used a standard method for making carbon-loaded water, where PAA concentrations were measured as a function of time. From the data, a half-life of the PAA under different conditions (pH and organic loading) was calculated. Initial results indicate a compounding effect of pH and organic loading on PAA concentration and stability within a chiller, with initial PAA gone within 15 minutes. This indicated PAA may not be at target concentrations as carbon content within chillers increases throughout a processing shift.

POULTRY SKINNING PROCESS
Researchers evaluated the feasibility of skinning poultry carcasses after slaughter and bleeding using a novel poultry skinning technique as an alternative to the current scalding and de-feathering processes. Four skin-slicing approaches were investigated: front incision, back incision, front incision gas-assisted, and back incision gas-assisted. Initial testing showed each method as a potential alternative. In particular, in the gas-assisted approach, the skin detached from the muscle beneath, making skinning even easier. More work is needed to quantify the force needed to remove the skin as well as address potential further processing issues.

AUDIO/VIDEO DATA PROCESSING ENGINE
Researchers developed a system that acquires and processes data from audio and video sensors to monitor and document activities. The system supports the management of birds reared in confined environments by providing information for better control of conditions that affect their well-being.