The Georgia Tech tagline, “Creating the Next …,” succinctly captures the essence of the Agricultural Technology Research Program (ATRP). Our vision is to transform poultry, agribusiness, and food manufacturing through advanced technologies.

I am excited to give you a snapshot of ATRP’s latest pursuits of Next Creations in this FY 2018 Annual Report. Over the course of the year, the program continued to push the boundaries of applied research by supporting a combined 19 full-scale and exploratory research projects. Some of these focus on near-term opportunities, while others seek to address larger and more challenging applications that are longer term with respect to potential commercialization. Regardless, each effort pursues a novel idea that, if successful, will provide transformative benefits for the industry.

In addition to research, ATRP’s mission includes our very important outreach, technical assistance, and educational programs. These are intended to directly support you, our stakeholders, by disseminating relevant research and information, providing assistance with immediate technical challenges, and facilitating the training of the next generation of industry leaders.

In an effort to drive meaningful collaborations, we continuously seek partners who bring unique skills and perspectives to our various research efforts. Many of you graciously serve in this partnership role, sometimes officially and other times unofficially, and we want you to know that we are extremely grateful for all you do in “Creating the Next …” with us.

I hope you find this year’s report inspiring, and as always, please do not hesitate to share your thoughts and ideas with us.

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.

American Proteins
Auburn University
    Department of Poultry Science
Case Farms
Darling Ingredients
Enviro Tech Chemical Services
Fieldale Farms
Georgia Institute of Technology
    Georgia Center for Medical Robotics
School of Chemical and Biomolecular Engineering
School of Civil and Environmental Engineering
School of Electrical and Computer Engineering
Harrison Poultry
Mar-Jac Poultry
Perdue Farms
TechnoCatch
Tyson Foods
University of Arkansas
    Department of Poultry Science
University of Georgia
    College of Veterinary Medicine
    Department of Poultry Science
USDA-ARS Richard B. Russell Research Center
Wayne Farms
FY 2018 PROGRAM HIGHLIGHTS
[ July 1, 2017 - June 30, 2018 ]

## 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
- **4** INVENTION DISCLOSURES
- **48** PUBLISHED ARTICLES, PAPERS, AND PRESENTATIONS ON RESEARCH DISCOVERIES
- **16** INDUSTRY AND ACADEMIC PARTNERS PARTICIPATED DIRECTLY IN ONE OR MORE RESEARCH PROJECTS
- **27** TECHNICAL ASSISTANCE SERVICES PROVIDED TO COMPANIES OR INDIVIDUALS THAT HELPED SOLVE A PROBLEM OR PROVIDED USEFUL INFORMATION

## FINANCIAL SUMMARY

Total Funding: $2,072,460

[ Annual funding provided by the State of Georgia ]

![Pie chart showing funding distribution]

- **20%** AUTOMATION AND ROBOTICS RESEARCH
- **9%** IMAGING AND SENSING RESEARCH
- **21%** ENVIRONMENTAL AND BIOLOGICAL SYSTEMS RESEARCH
- **11%** FOOD SAFETY RESEARCH
- **16%** TECHNOLOGY TRANSFER/OUTREACH/TECHNICAL ASSISTANCE
- **23%** PROGRAM SUPPORT

## OUTREACH ACTIVITIES

- **COORDINATED**
  - Poultry World: EST. 1995
  - Educational Exhibit at the Georgia National Fair

- **PRODUCED**
  - PoultryTech Newsletter

- **CO-HOSTED**
  - National Safety Conference for the Poultry Industry

- **EXHIBITED AT**
  - International Production & Processing Expo

WITH THE U.S. POULTRY & EGG ASSOCIATION
AUTOMATED CONE LOADING WITH LOW-COST ROBOT BAXTER
Researchers continued to investigate the feasibility of using a Baxter research robot by Rethink Robotics to work alone or alongside humans while performing the cone loading task. Testing showed Baxter successful at recognizing the orientation and cavity of a bird front half and then placing it on a stationary cone at a speed faster than initial testing. Researchers also designed an improved conveyor and an orientation device that reduced the possible positions of the bird cavity, which significantly improved the accuracy of placement on the cone.

ADVANCED SENSING AND FIELD TESTING OF A POULTRY HOUSE MANAGEMENT ROBOT
Researchers continued to develop and field test the ability of a ground robot to perform broiler and broiler-breeder rearing and management tasks in poultry houses. During FY 2018, the system underwent a 6-week broiler growout trial where the robot successfully operated autonomously for more than 80 hours. In addition, researchers tested the robot’s ability to autonomously pick up floor eggs in a broiler-breeder house. Initial tests were conducted in a laboratory environment and resulted in a pick accuracy of more than 95%. Researchers believe they can achieve close to 100% egg picking capability with minor modifications.

DEEP LEARNING FRAMEWORK FOR THE AGRICULTURAL DOMAIN
Researchers developed a machine learning framework to address computer vision tasks in the poultry industry. It includes such tasks as object detection, object tracking, and semantic segmentation. The framework can be integrated into systems that perform manipulation, assessment, or monitoring of product.

UTILIZING CHICKEN PARTS CHILLING TO IMPROVE PROCESS EFFICIENCY (POULTRY PARTS PROCESSING AND CHILLING)
Researchers evaluated the feasibility of cooling chicken parts after cut-up instead of the whole carcass. Air and water chilling data was generated and analyzed; results can be used to estimate the chilling time for product and to gauge the impact of potential process modifications to accommodate chicken parts chilling. Furthermore, researchers believe air chilling of chicken parts presents an opportunity to achieve water savings compared to currently used water chilling methods.
POULTRY SYSTEM SIMULATION MODEL
The Poultry System Simulation Model (nicknamed PRYSSM by researchers) can be used to simulate a typical poultry processing plant’s water, energy, and labor usage. During FY 2018, researchers evaluated two ATRP technologies under development: On-Farm Production System and Phosphorus Removal/Recovery Using Magnetic Nanoparticles. PRYSSM was used to simulate the effects of each technology during various stages of poultry processing, resulting in detailed case studies. Results proved PRYSSM’s effectiveness as a tool that plant management can use to identify areas for usage reductions and process improvements, including the implementation of new technologies.

INTELLIGENT CUTTING 2.0 (EXTENSION)
Researchers updated key components of the Intelligent Cutting System to meet processing plant speed requirements for chicken deboning on a moving cone-conveyor line. Specifically, a more robust and accurate image processing method for detecting key features on bird exteriors and an advanced robotic arm were added. Further refinements are underway in preparation for potential system commercialization.

PHOSPHORUS REMOVAL/RECOVERY USING MAGNETIC NANOPARTICLES
Researchers continued testing of a magnetic nanoparticle (MNP)-based treatment method to remove and recover phosphorous from poultry processing wastewater. During FY 2018, researchers tested the nutrient bioavailability of recovered phosphorous in green algae, ryegrass, and broiler birds. No toxicity was observed. In fact, the phosphorous-laden MNP was consumed by all testing species. Additional benefits such as the attached protein, fat on the surface of the MNP, and the iron source from the MNP will need to be further characterized.

INTELLIGENT TRIMMING
Researchers explored the use of intelligent automation for chicken trimming tasks. During FY 2018, a trimming experimental testbed was created, along with the development of fat detection image processing algorithms and a prototype trimming tool. Initial testing of a collaborative robot arm’s force sensing capability was also conducted, yielding promising results.

FULL ROBOTIC PROCESSING
Researchers investigated the potential of fully automating the poultry deboning process prior to evisceration. The general steps needed in a fully robotic process were identified, and a preliminary cost-benefit analysis was completed. Further development of the concept is underway.

LIVE PATHOGEN CAPTURE
Researchers developed a magnetic nanoparticle-based method to capture live bacterial cells for rapid pathogen detection in food samples. While bacteria binding was achieved, overall experimental results proved confounding, noting the need for further investigation and optimization.
NOVEL SEPARATION TECHNOLOGIES FOR POUлярITY PROCESSING LIQUID STREAMS
Researchers successfully demonstrated the scalability of the separation surface and holder (i.e., filter and filter chamber) of the Dynamic Filtration System by modifying commercially available mesh strainers used in sanitary holders. The current system validated a working prototype for steady-state filtering at 100 micron, and capture of finer material is possible. Researchers believe the system shows promise as a new tool for not only wastewater treatment but also increased recovery of fine suspended solids (fats and proteins). They anticipate increased beneficial high-value product recovery or high-solids capture in advance of wastewater discharge.

MULTI-FUNCTION SENSORY SYSTEM FOR SMART POULARITY FARMING
Researchers continued optimization of an ammonia micro-sensor system that is targeted to measuring levels of ammonia in farm air with minimal interference from other sources. During FY 2018, they refined the sensor’s design to provide greater tolerance to changes in the environment such as humidity and temperature at microwatt operation power. As a result, the system is anticipated to have a longer shelf life in the poultry house with a significantly low number of false alarms. Preliminary tests showed the system was able to detect 1-100 ppm of ammonia.

AMMONIA CRACKING FOR ENERGY GENERATION AND POLLUTANT DISCHARGE ELIMINATION
Researchers developed a highly active and durable electrocatalyst for decomposing ammonia into hydrogen and nitrogen. Industry use of this type of catalyst could potentially eliminate ammonia discharges from poultry housing while reducing power usage by converting ammonia to hydrogen-based fuel.

ANTIBIOTIC RESISTANCE IN CONCENTRATED POULARITY FEEDING OPERATIONS
Researchers collected samples from concentrated animal feeding operations (CAFOs) to understand the impacts on the transfer of antibiotic-resistant (AbR) genes and organisms in the surrounding environment, particularly the waterborne transmission pathway. Data analysis is underway, with the goal of estimating AbR prevalence. Results could be used to develop surveillance tools to monitor pathogens and AbR genes in CAFOs.
VIRTUAL REALITY APPLICATIONS IN POULTRY PRODUCTION AND PROCESSING
Researchers continued to evaluate the feasibility of using virtual reality (VR) technologies to create frameworks for testing, evaluating, and optimizing various systems in a poultry processing environment. During FY 2018, researchers tested cutting trajectories on VR models, which resulted in the development of new cutting and manipulation approaches. These approaches can be used in simulations to test and evaluate techniques for responding to variations due to genetic phenotypes.

ON-FARM PRODUCTION SYSTEM
Researchers continued to evaluate the feasibility of using novel techniques for on-farm bird processing and related tasks. FY 2018 activities focused on designing, building, and testing a shackled transport system post-kill. An experimental trial conducted at the University of Georgia’s Poultry Diagnostic and Research Center provided insight on what can be expected for the shackled broiler transport. The trial, however, raised questions that will require further investigation.

SALT MANAGEMENT TECHNIQUES FOR VIABLE ICE-WATER SLURRY WITHIN POULTRY PROCESSING
Researchers continued to investigate the feasibility of using ice-water slurry (where salt is used as a freezing point depressant) as an alternative chilling medium. FY 2018 work investigated salt uptake tendencies. Researchers found that salt uptake tends to be constrained to the skin without significant penetration into muscle tissue. More investigation is underway, with a focus on determining if salt concentration in the slurry has any effect on PAA (peracetic acid) efficacy as well as product labeling implications based on current regulations imposed by the U.S. Department of Agriculture’s Food Safety and Inspection Service (FSIS).

AUDIO PROCESSING FOR ANIMAL WELLNESS AND WELL-BEING ASSESSMENT
Researchers continued to enhance the data acquisition and analysis capability of the Growout Monitoring System through an audio characterization technique known as sparse coding. The technique enables the system to label the daily cycle or rhythm of the growout house. Researchers can then analyze the resultant data and determine any deviation from normal environmental occurrences that could potentially affect bird well-being. This would include the early detection of disease and environmental stressors.

REMOVAL OF FREE FATTY ACIDS FROM RENDERED OIL
Researchers further developed a novel method for the removal of free fatty acids (FFAs) from various oil systems using functionalized magnetic nanoparticles (MNPs). MNPs of various sizes continued to be produced using a modified thermal decomposition method and were shown to withstand harsh recycling conditions that allow for repeated use without any loss in adsorption capacity. Specifically, an adsorption capacity of 880 mg/g in yellow grease was reached using temperature and conditions similar to rendering industry standards. This is five to 10 times larger than currently used adsorbent materials.
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
John Wright, Fieldale Farms (Chair)
Jonathan Green, American Proteins
Steve Snyder, Claxton Poultry
Heath Jarrett, CMS Solutions & Logistics
Mark Hamby, Cobb-Vantress
Bill Crider, Crider Foods
Michael Carr, Darling Ingredients
Kelly Horne, Darling Ingredients
Paul Breure, Foodmate US
Scott Hazenbroek, Foodmate US
Humberto Hernandez, Gainco
Bill Verner, Georgia EMC
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Greg Heck, Georgia Power
Carolyn Tynan, Georgia Power
Blake Wikle, Gold Creek Foods
David Bleth, Harrison Poultry
Greg Nichols, John Soules Foods
Bob Dowdy, Keystone Foods
David Sewell, Keystone Foods
Matt Brass, Marel
Phillip Turner, Mar-Jac Poultry

John Weeks, Mar-Jac Poultry
Randy Segars, Merial
Roger Huezo, Meyn Poultry Processing Solutions
Wally Hunter, Perdue Farms
Craig Pugh, Perdue Farms
Lucas Hill, Pilgrim’s
Ken Long, Pilgrim’s
Mike Gasbarro, Prime Equipment Group
Kirk Reis, Prime Equipment Group
Dwayne Holifield, Sanderson Farms
Gus Arrendale, Springer Mountain Farms
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Ross Dunn, Tyson Foods
Steve Schimweg, Tyson Foods
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Todd Applegate, University of Georgia
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