Agricultural Technology Research Program
2013 ANNUAL REPORT

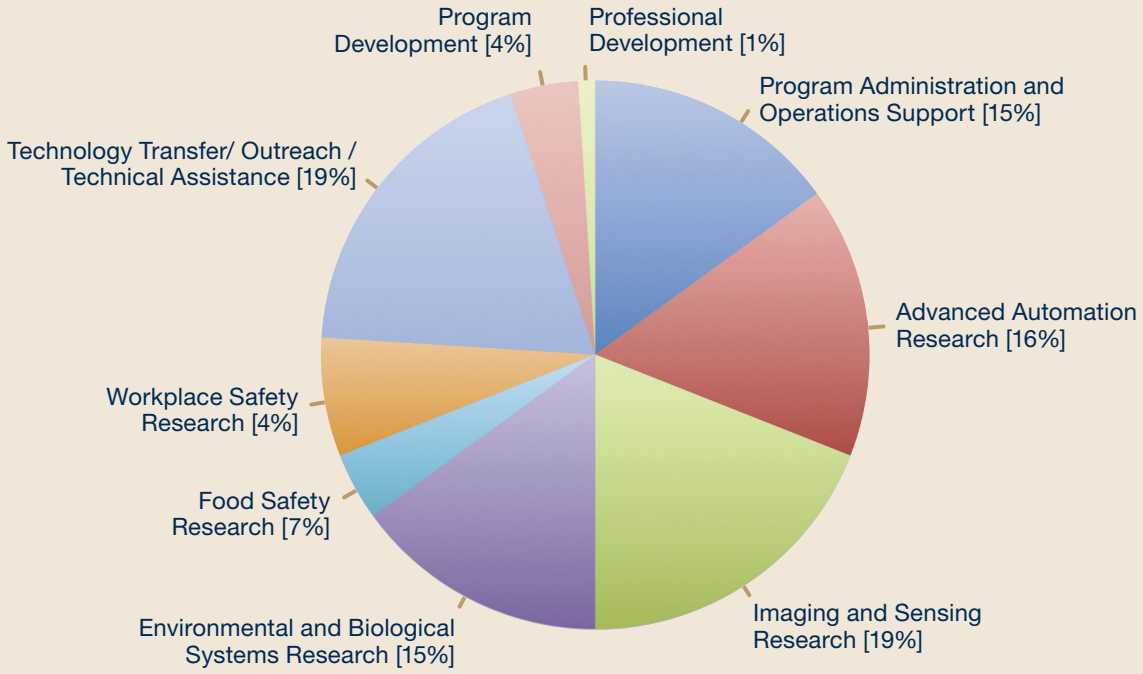
Georgia Tech Research Institute

Agricultural Technology Research Program

Recognized as one of the leading programs of its kind in the country, the Agricultural Technology Research Program (ATRP) works closely with Georgia agribusiness, especially the poultry industry, to develop new technologies and adapt existing ones for specialized industrial needs. These innovations are designed to maximize productivity and efficiency, advance safety and health, and minimize environmental impact. The 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.

FY 2013 Financial Summary

Total Funding: $1,606,084
(Annual funding provided by the State of Georgia)



Advisory Committee

Members:

David Bleth, *Harrison Poultry (Chair)*
Jonathan Green, *American Proteins*
Mark Ham, *American Proteins*
Mikell Fries, *Claxton Poultry*
Steve Snyder, *Claxton Poultry*
Bill Crider, *Coastal Meats*
Charlie Westbrook, *Cobb-Vantress*
Phillip Rehberg, *Crider Poultry*
Bob Dowdy, *Keystone Foods*
Gus Arrendale, *Fieldale Farms*
John Wright, *Fieldale Farms*
Joe Cowman, *Gainco*
John Daley, *Gainco*
Ed Harmon, *Georgia Power*
Kelly Horne, *Griffin Industries*
Chad Ware, *Marel Stork Poultry Processing*
John Weeks, *Mar-Jac Poultry*
Joel Williams, *Mar-Jac Poultry*
Roger Huezo, *Meyn Equipment*
Spencer Mabe, *Meyn Equipment*
Jeramie Martin, *Meyn Equipment*
Wally Hunter, *Perdue Farms*
Ken Long, *Pilgrim's Pride*
Ken Suber, *Pilgrim's Pride*
David White, *Pilgrim's Pride*
Jim Bowling, *Prime Equipment Group*
Joe Gasbarro, *Prime Equipment Group*
David Austin, *Tip Top Poultry*
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Lisa Blotsky, *Tyson Foods*
Angela Bradach, *Tyson Foods*
Lance Brown, *Tyson Foods*
Andy McLeod, *Tyson Foods*
Russ Dickson, *Wayne Farms*
Bryan Miller, *Wayne Farms*
Tom Frost, *Wayne Farms*

Advisors:

Louise Dufour-Zavala, *Georgia Poultry Laboratory Network*
Mike Giles, *Georgia Poultry Federation*
Abit Massey, *Georgia Poultry Federation*
Mike Lacy, *University of Georgia*
John Glisson, *USPOULTRY Harold E. Ford Foundation*

Message from the Program Manager

2013 has been another great year for the Agricultural Technology Research Program (ATRP) as we celebrated 40 years of service to the poultry and agriculture industries in Georgia and across the country. As we look back on 40 years of research, projects ranging from early automated farm systems and improved environmental processes to robotics and sensing technologies in processing plants clearly show just how far the poultry industry has come. Many of these technologies and best management practices are now commonplace and the expected norm in the industry, and it has been great to see ATRP's contribution to this remarkable growth.

The past 40 years would not have been possible without the unwavering support of our industry partners and stakeholders and our great friends at the Georgia Poultry Federation. The program started as a result of a phone call from Abit Massey, then president of the Federation, to Craig Wyvill, who would become the ATRP director, and I am pleased to say that we still get those calls today through our Technical Assistance program.

Looking to the future, ATRP is committed to being the technology innovation and development provider that enables Georgia to be the undisputed leader in poultry, agribusiness, and food processing. To accomplish this mission, it is clear that we will need to continue to strengthen our existing relationships with industry and our academic and federal colleagues. And together we must seek new opportunities for collaboration across the varied disciplines if we hope to be successful in addressing our current challenges as well as those that loom just over the horizon. As Georgia Department of Agriculture Commissioner Gary Black so eloquently stated during remarks at the 40th Anniversary Celebration, ATRP is an investment in the future and one that we hope will continue to pay dividends for many years to come.

So, as we embark on the next 40 years, I invite you to read this Annual Report, which highlights a slate of research projects and other efforts that seek to drive transformational innovation for a resilient future.

Doug Britton, Ph.D.
ATRP Program Manager

FY 2013 Program Highlights

- 8 research prototypes in various stages of development
- 5 exploratory research projects funded to develop concepts and ideas for later transition into full-scale research projects
- 1 patent and 1 provisional patent
- 11 industry partners participated directly in one or more research projects
- More than 40 published articles, papers, and presentations on research discoveries
- 24 technical assists provided to companies or individuals that helped solve a problem or provided useful information

FULL-SCALE RESEARCH PROJECTS

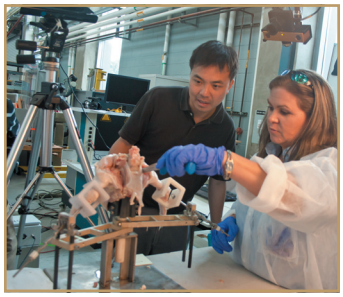
Full-scale research projects address critical issues facing poultry production.

PRODUCT QUALITY AND FOOD SAFETY

Cone Line Screening System

The Cone Line Screening System automatically inspects the chicken frame on the deboning line for missing bones and remaining meat (yield), providing immediate feedback to deboners on their individual performance and the overall efficiency of the line. The system uses a special cone and illumination/imaging configuration resulting in an image that clearly shows any bones remaining on the frame. Yield loss is estimated by the system's software algorithms, which correlate image characteristics with the amount of meat left on the frame. Recent field tests showed a detection accuracy rate of 95% for clavicle bones, 80% for fan bones, and between an 80% to 90% correlation with yield measurements performed manually. These results show the system can be used as a pre-screening and statistical process control tool.

Intelligent Cutting and Deboning System



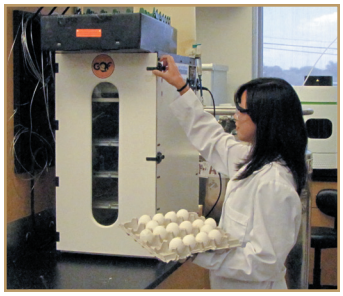
ATRP's Intelligent Cutting and Deboning System uses 3-D imaging and a robotic cutting arm to automatically perform precision cuts that optimize yield while eliminating the risk of bone fragments in finished poultry products. Recent efforts have focused on leveraging past work while making substantial enhancements to both hardware and software components. Specifically, the system now incorporates a six-degree-of-freedom knife robot increasing its dexterity. Image processing algorithms were re-written to more robustly identify external bird features that, in turn, help define correlations between the bird's external features and its internal joint structure. In addition, a graphical user interface was developed that streamlines the various processes of a bird cut. Researchers also worked with deboners in a local poultry processing facility to capture data of cutting motions. The data is being analyzed to determine optimum knife paths with the hopes of enhancing the system's ability to make precision cuts.

ANIMAL HEALTH AND WELL-BEING

Monitoring Bird Status in Broiler Housing Using Audio

The Growout Monitoring System analyzes bird vocalizations to determine whether or not deviations from normal behaviors are occurring due to environmental conditions, disease, or other stressors. Recent results indicate that there are features in the audio data that could be used to support management functions needed in rearing poultry in confined housing. Specifically, it appears that Kurtosis (a statistical computation on the raw audio signal) correlates strongly to temperature stress and that machine learning techniques in conjunction with features typically used for voice recognition are useful for detecting the symptoms of disease. During experiments, researchers identified features that seem to correlate to IB (Infectious Bronchitis) as well as temperature stresses. They also designed and tested a hardened system for field data acquisition as well as initiated an evaluation of the potential of using a smartphone platform for data acquisition.

Chicken Egg Fertility Detection

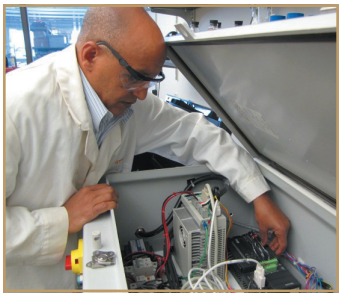


The Chicken Egg Fertility Detection System uses noninvasive and rapid spectrophotometric techniques to track the changing embryo in-ovo or inside the egg, providing insight into a number of practices from animal health and well-being to the inoculation regime. During FY 2013, research centered on determining which chemical species indicate fertility and which component of the egg contains them. Researchers explored several spectral methods as well as chromatography techniques. Analyses showed distinct chemical species that were consistently present in significantly higher concentrations in fertile versus infertile eggs. Specific results of these analyses are being withheld as

intellectual property rights are pursued. Researchers also worked on the development of a low-cost hatchery management tool, which can determine the effect of variables such as temperature, humidity, turning, etc., on chick hatch times and embryo development. Overall, experimental results to date are promising, and further research is underway to refine techniques and establish standard metrics.

ENVIRONMENTAL MANAGEMENT

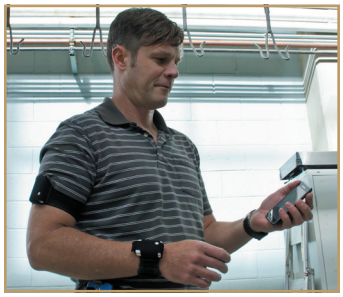
Novel Separation Technologies for Poultry Processing Liquid Streams



Dynamic Filtration research is investigating techniques to more selectively capture target impurities from poultry processing liquid streams in a way that facilitates the recovery of value-added byproducts while still meeting or exceeding water reuse guidelines. During FY 2013, a proof-of-concept bench-scale dynamic filtration device was constructed, commissioned, and operated to gather preliminary filtration efficiency data. As a result, a provisional patent was filed. Data showed that organic solids and proteins from chiller water and marination solutions could be concentrated in filter backwash waters that comprised less than 20% of the overall flow. Future efforts will focus on fully characterizing the system for scale-up potential. This includes establishing the capabilities and limits of the existing component materials to deliver consistent throughput and backwash cycles at specific removal targets. Concurrently, preliminary scale-up designs for a 100-gpm system will be generated.

WORKER SAFETY

Mobile Motion Capture (MiMiC) System



Worker safety-related research efforts continued to focus on the creation of the new motion recording and analysis system known as MiMiC (Mobile Motion Capture). Designed to be a tool for more objective measurements of the ergonomics of the poultry plant workplace, MiMiC consists of a smartphone recording device written as an Android app and kinematic sensor modules that connect over the Bluetooth wireless protocol. The system uses Shimmer Research kinematic modules, allowing it to record acceleration, gyroscopic, and magnetic compass data, all in three dimensions. During FY 2013, software for converting the raw movement data to absolute angular data was developed and tested. Initial design of a test protocol to perform in-plant testing of MiMiC was also accomplished, with plans to begin the tests in a partner processing plant in early FY 2014.

Project Collaborators

Industrial collaborators help provide direction and support to the specific research projects undertaken. They also participate directly in research projects by providing access to industry facilities for data collection and systems testing and contributing in-kind and cash support on an "as needed" basis. In addition, academic partners collaborate with research teams by providing cross-disciplinary expertise and experience as well as access to university research facilities.

Cone Line Screening System — Cantrell Machines, Gainco, Keystone Foods, Mar-Jac Poultry, Perdue Farms

Intelligent Cutting and Deboning System — Claxton Poultry, Mar-Jac Poultry, USDA-ARS Richard B. Russell Research Center, UGA Department of Poultry Science

Monitoring Bird Status in Broiler Housing Using Audio — Georgia Tech School of Electrical and Computer Engineering, Harrison Poultry, UGA Poultry Diagnostic and Research Center, UGA Department of Poultry Science

Chicken Egg Fertility Detection — Auburn University Department of Poultry Science, Georgia Tech School of Chemistry and Biochemistry, Pilgrim's Pride

Novel Separation Technologies for Poultry Processing Liquid Streams — Mar-Jac Poultry

Worker Safety Research for the Poultry Industry — Harrison Poultry

Adaptive Perception During Manipulation — Georgia Tech College of Engineering, Georgia Tech College of Computing

Preparation of Magnetic Beads for Low-Level Pathogen Preconcentration — Georgia Tech George W. Woodruff School of Mechanical Engineering

Ultrasonics for Poultry Processing Chiller Water Disinfection — Enviro Tech Chemical Services, Harrison Poultry, Tip Top Poultry, USPOULTRY Harold E. Ford Foundation

EXPLORATORY RESEARCH PROJECTS

Exploratory research projects seek to develop concepts and ideas for later transition into full-scale research projects.

Encoding Expert Knowledge

This project is exploring how expert human knowledge can be encoded to teach robots to perform manual tasks more efficiently and cost effectively. A low-cost sensor system consisting of a hand coordinate frame, a Kinect motion sensing gaming device, and a Shimmer wireless sensing platform has been developed that is able to effectively measure hand motions of a human while performing a manual demonstration task. Bird re-hang was chosen as the initial demonstration task. It was shown that the sensor system could be used to obtain demonstration data for designing dynamic movement primitives that are capable of discerning motion nuances to distinguish between a proficient practitioner and a novice. The method is currently being applied to the task of bird deboning, which relies heavily on human finesse.

Adaptive Perception During Manipulation

Researchers are developing perception algorithms that will learn, model, and track deformable poultry objects for robotic manipulation. The expected result of this work, a multi-year goal, is a system that can learn an object model and track that object in video while it is being manipulated, specifically demonstrated with a chicken breast and bird front half. During FY 2013, researchers developed the needed algorithms and captured sample 3-D images of a chicken model during manipulation along with its corresponding simulated model.

Preparation of Magnetic Beads for Low-Level Pathogen Preconcentration

Researchers have developed a prototype sampling system that uses coated magnetic beads to capture and hold pathogens/bacteria in fluid samples. The prototype allows continuous cleaning of water, as well as re-suspension of bacteria-nanoparticle aggregates. When the prototype was tested with contaminated deionized water, above 80% of the bacteria was captured and re-suspended in approximately a tenth of the original volume in 5 minutes. This capture efficiency matches the typical capture efficiency of the nanoparticles used in the experiment. Approximately 80% to 90% of the bacteria cells were recovered from the experiments performed. The capture efficiency of the nanoparticles appeared to be approximately 70%. Researchers believe the system shows promise as a viable and simple method for capturing bacteria in food safety applications.

Advanced Enrichment Reactor

Researchers are studying hastening enrichment culturing and better preconcentration methods to improve pathogen prevention and control interventions in large-volume poultry processing samples. The underlying question is, can one decrease the amount of time needed to culture a sample, while concurrently capturing more pathogens from larger sample volumes? During FY 2013, the research focused on developing and refining an advanced enrichment reactor that provides multiple exposures of these larger sample volumes using both broth enrichment and direct plating. Future work will continue to explore reactor designs and configurations for increasing cell capture capabilities while examining the potential for embedding sensors for direct detection.

Ultrasonics for Poultry Processing Chiller Water Disinfection

Researchers are evaluating the effectiveness of ultrasound for the inactivation of *Salmonella* in poultry processing chiller water. Experiments were conducted to determine disinfection trends based on ultrasound energy, volume, and exposure time. Results showed a correlation between an increase in energy, increase in exposure time, and decrease in volume that led to better disinfection of *Salmonella*-inoculated water. Researchers believe this correlation proves that ultrasound can be used to inhibit *Salmonella* growth. However, the amount of disinfection was not significant enough to be used as the only means of disinfection. In addition, ultrasound had antimicrobial effects when combined with chemicals. Overall, the ultrasound plus chemical disinfection system had better efficiency than the ultrasound or chemical system alone.

To learn more about any of these projects and other research work, please visit www.atrp.gatech.edu

TECHNOLOGY TRANSFER

Three issues of ATRP's *PoultryTech* newsletter were published in FY 2013, with several articles reprinted in the trade press. The Intelligent Cutting and Deboning System was featured in the April 2013 issue of *Popular Science* magazine's How It Works series in an article titled Robotic Chicken Butcher. A front-page article headlined Agricultural Tech Research Celebrates Four Decades of Service, highlighting the program's 40th Anniversary, appeared in the May 20, 2013 issue of *Poultry Times*, the nation's only poultry industry newspaper. Research staff also generated more than 40 articles and technical presentations, filed one provisional patent, and received one patent (a complete listing of these Technology Transfer activities can be viewed at www.atrp.gatech.edu/publications.html). The FY 2012 Annual Report was published, and the program continued its online presence through the ATRP website and Facebook page.

OUTREACH ACTIVITIES

ATRP exhibited at the International Poultry Expo, Georgia Ag Week Kick-off Celebration, and the Georgia Poultry Federation's Spring Meeting and annual Night of Knights fundraiser. ATRP also helped coordinate a staff of more than 150 volunteers for the Poultry World educational exhibit at the Georgia National Fair in Perry, Georgia.

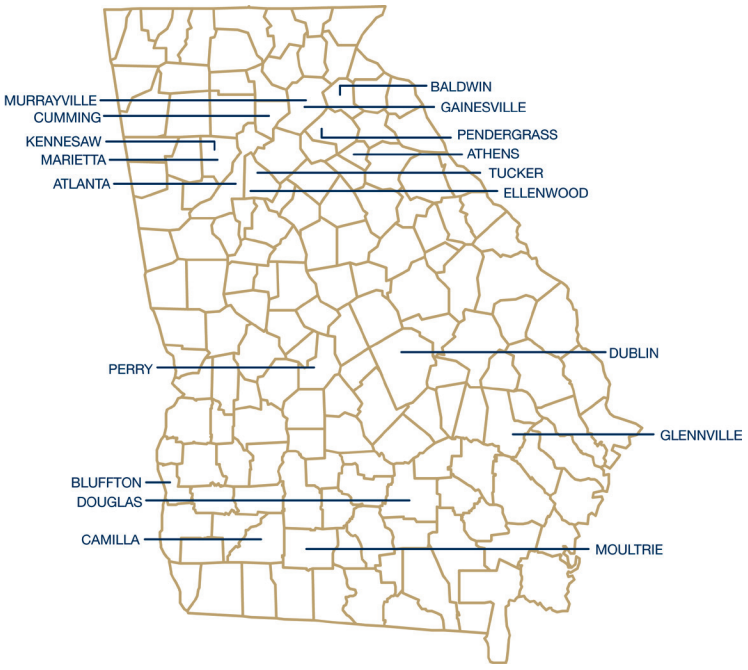
Together with the U.S. Poultry & Egg Association, ATRP hosted the 2013 National Safety Conference for the Poultry Industry in Amelia Island, Florida. More than 100 safety professionals and vendors representing 62 companies and organizations from 24 states and the District of Columbia attended. A highlight of the conference was an address and Q&A session by remote broadcast with Dr. David Michaels, Assistant Secretary of Labor for the Occupational Safety and Health Administration (OSHA). The annual conference is supported by the Georgia Poultry Federation, the National Chicken Council, and the National Turkey Federation.

TECHNICAL ASSISTANCE

ATRP staff provided 24 technical assists to companies and individuals in the poultry industry across the state. These assists included simple inquiries regarding information or help needed to address a problem and extensive on-site consultations in which researchers collected data and provided a full report on their findings and recommendations. ATRP uses input from all assists to gauge situations calling for new research initiatives.

Categories

Automation	3
Energy	1
Environmental	11
Food Safety	3
Live Production	2
Worker Safety	2
Other	2



ATRP

AGRICULTURAL TECHNOLOGY RESEARCH PROGRAM

OUR VISION

To be the technology innovation and development provider that enables Georgia to be recognized as the undisputed leader in poultry, agribusiness, and food processing

OUR MISSION

To promote the economic growth of Georgia agribusiness (especially the poultry industry) through:

- Research focused on the development of new technologies that improve productivity and efficiency
- Exposure of students to the challenges of developing and adapting these technologies
- Technical assistance to Georgia-based industry members with special problems
- Release of information on emerging technologies and improved operational management through newsletters, articles, seminars, and presentations to speed ultimate commercial use

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