

ATRP

AGRICULTURAL TECHNOLOGY
RESEARCH PROGRAM

2012

ANNUAL REPORT

MESSAGE FROM THE PROGRAM MANAGER

During Fiscal Year 2011, the Agricultural Technology Research Program (ATRP) launched a new vision statement:

To be the Technology Innovation and Development provider that enables Georgia to be recognized as the undisputed leader in Poultry, Agribusiness, and Food Processing.

This encapsulates our aspirations to serve the state of Georgia and the greater poultry and agriculture communities through our strengths in technology and innovation. It has challenged us to think more boldly and creatively as we seek to not only develop solutions for current industry challenges, but to consider future processing needs as well. The latter has sparked an active conversation with other key academic, state and national association, and industry leaders about the rethinking of future poultry production and processing operations. Interest in this subject is growing, and we are excited to play an active role in furthering the effort.

In support of this newly refined vision, the ATRP mission remains to provide technical assistance, outreach, education, and research in the fields of automation and robotics, workplace safety, advanced fluid separations, energy and water conservation, and advanced sensing systems. In FY 2011, this included efforts on 8 full research initiatives with prototype systems at various levels of development and 4 special projects funded to develop concepts and ideas for later transition into full research projects. In addition, these research activities resulted in 2 invention disclosures and more than 40 published articles, papers, and presentations on discoveries and work being conducted through ATRP.

As part of ATRP's technical assistance component, researchers and staff responded to 32 requests from Georgia-based companies or individuals seeking information or help in addressing a specific issue.

In terms of outreach, the program once again hosted the annual National Safety Conference for the Poultry Industry; coordinated the annual Poultry World Exhibit at the Georgia National Fair; participated in the International Poultry Expo and other trade association events; and provided technology

demonstrations to a variety of industry, government, and school groups.

ATRP had the privilege of co-hosting the interdisciplinary National Science Foundation Workshop on Novel Sampling and Sensing for Improving Food Safety. More than 130 participants from academia, industry, and state and federal agencies participated in breakout sessions punctuated by key presentations from renowned experts on the topics of current food safety regulations and methods for product testing, novel sampling and preconcentration strategies, and emerging transducer technologies for food safety sensing. Overall response to the workshop was very strong with many

participants commenting on the need for more conversations and collaborations between the engineering and microbiology/food safety disciplines.

The continuing decline in economic conditions for FY 2011 resulted in an 8% reduction of the ATRP budget for a third year in a row. This funding contraction was accommodated by cutting back on research projects and reducing efforts in our outreach activities. Despite these difficult times, the leadership within the Georgia Tech Research Institute and ATRP are committed to serving the poultry and agribusiness industries in Georgia. We also sincerely appreciate the continuing collaboration and support from our industry, academic, and state partners, and we look forward to building on these relationships to pursue new opportunities together. After all, our vision is to

help make Georgia the "undisputed leader in poultry, agribusiness, and food processing."



Doug Britton, Ph.D.
ATRP Program Manager

FY 2012 PROGRAM HIGHLIGHTS

(JULY 1, 2011 - JUNE 30, 2012)

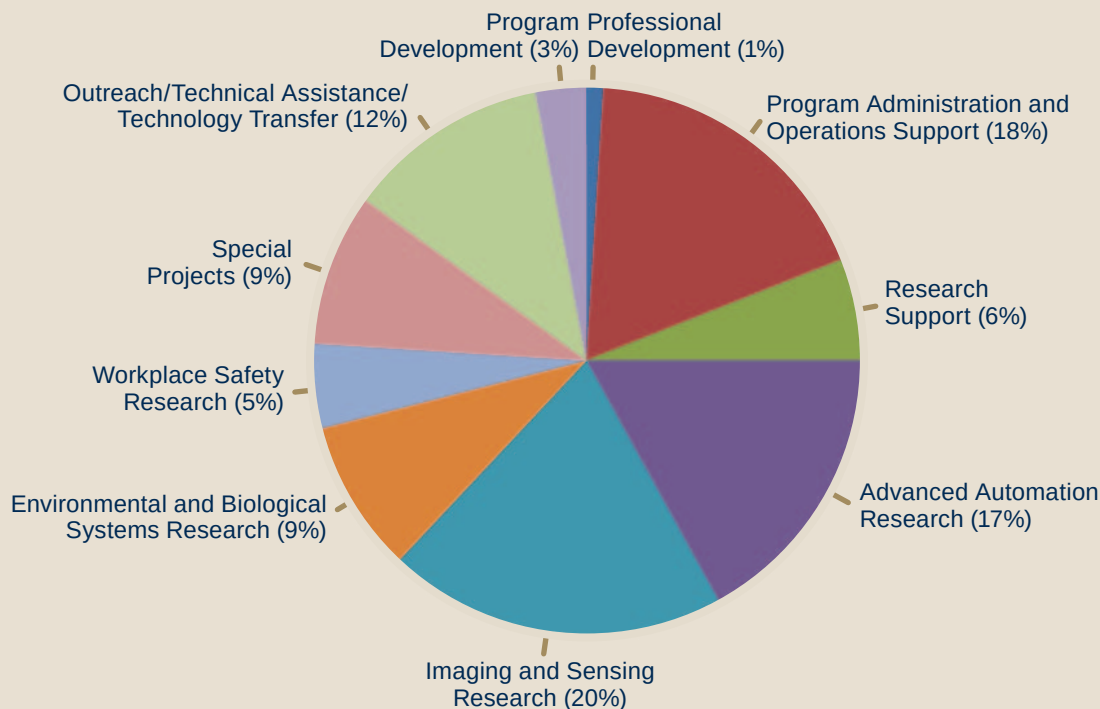
- 6 research prototypes in various stages of development
- 4 special projects funded to develop concepts and ideas for later transition into full research projects
- 1 patent and 4 invention disclosures
- 7 industry partners participated in one or more projects
- More than 30 published articles, papers, and presentations on research discoveries
- 29 technical assists provided to inquiring companies or individuals that helped solve a problem or provided useful information

AGRICULTURAL TECHNOLOGY RESEARCH PROGRAM

As part of the Governor's Strategic Initiative for a Growing Georgia, the Agricultural Technology Research Program receives annual funding from the Georgia Legislature to serve the state and greater poultry community through education, outreach, technical assistance, and research in the fields of workplace safety, advanced fluid separations, adaptive robotic systems, novel audio and signal processing, energy and water conservation, and food safety screening systems. The program is conducted in cooperation with the Georgia Poultry Federation with input from an external Advisory Board consisting of representatives from leading poultry companies and organizations.

FY 2012 FINANCIAL SUMMARY

Total Funding: \$1,556,084



ADVISORY BOARD

Members:

Joel Williams, *Mar-Jac Poultry (Chair)*
Jonathan Green, *American Proteins*
Mikell Fries, *Claxton Poultry*
Steve Snyder, *Claxton Poultry*
Bill Crider, *Coastal Meats*
Charlie Westbrook, *Cobb-Vantress*
Phillip Rehberg, *Crider Poultry*
Gus Arrendale, *Fieldale Farms*
John Wright, *Fieldale Farms*
Joe Cowman, *Gainco*
Gary Floyd, *Georgia Power*
Kelly Horne, *Griffin Industries*
David Bleth, *Harrison Poultry*
Shaun Morris, *Keystone Foods*
Jeff Barrentine, *Marel Stork Poultry Processing*

Jamie Usrey, *Marel Stork Poultry Processing*
John Weeks, *Mar-Jac Poultry*
Jeramie Martin, *Meyn*
Wally Hunter, *Perdue Farms*
Tom Lee, *Perdue Farms*
Ken Long, *Pilgrim's Pride*
Ken Suber, *Pilgrim's Pride*
David White, *Pilgrim's Pride*
David Austin, *Tip Top Poultry*
Angela Bradach, *Tyson Foods*
Lisa Guilmet-Blotsky, *Tyson Foods*
Andy McLeod, *Tyson Foods*
Russ Dickson, *Wayne Farms*
Tom Frost, *Wayne Farms*
Bryan Miller, *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*

AGRICULTURAL TECHNOLOGY RESEARCH PROGRAM FY 2012 ANNUAL REPORT

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

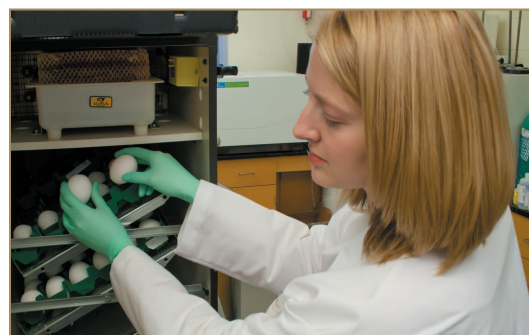
ATRP's research program continues to define the poultry processing plant of the future. During FY 2012, seven projects focused on novel types of engineering and technology research activities that address critical issues facing poultry production from the growout house to the processing plant.

IMPROVING ANIMAL HEALTH AND WELFARE



Reliable sensors to monitor the condition and welfare of birds being reared in confined housing are not readily available. The goal of ATRP's **GROWOUT MONITORING** project is to investigate the use of bird vocalizations to determine whether or not they are under stress due to environmental conditions or disease. In collaboration with fellow researchers at Georgia Tech and the University of Georgia, the ATRP project team developed an experimental monitoring system. The system was installed at UGA's Poultry Science research growout facilities where several studies were conducted. First, the team studied environmental effects such as temperature, ammonia, and crowding. Results showed that features extracted from bird vocalizations strongly correlated with higher ambient room temperatures and the presence of ammonia. The correlations for crowding were not as strong. Second, the team explored the effects of disease. Two experiments were conducted at the Poultry Disease Research Center in Athens, Georgia, which investigated the effects of Infectious Bronchitis and Laryngotracheitis (LT) in broilers. In both experiments, it appeared that features of the vocalizations could be extracted that strongly correlate with the progress of both diseases. Moving forward, the team will attempt to replicate these studies and improve the existing algorithms and tools to enhance the extraction and classification features used to assess bird welfare.

Under the **CHICKEN EGG FERTILITY DETECTION** project, ATRP researchers together with colleagues at Auburn University developed a noninvasive and rapid spectrophotometric technique to track the changing embryo in-ovo or inside the egg. This method allows researchers to predict when individual eggs will hatch, which in turn, should provide insight into a number of practices from animal health and welfare to the inoculation regime. Hatchability experiments were conducted where eggs were taken all the way to hatch and spectral readings were recorded at approximately the same time daily for 21 days. Different temperatures, humidity levels, and with/without egg turning were examined. Analysis of the spectral data showed fertile, developing eggs changed at a greater rate than infertile eggs. A number of eggs were removed from the process and placed at a lower temperature to determine if the spectral changes continued. The previously observed spectral changes slowed significantly for the cooled eggs. The results showed that at a very early point spectral data indicates the rate of embryonic development for each egg if the hatchery is running consistently. Currently, the team is expanding the study to investigate whether the spectrophotometric technique can be used to determine the sex of the embryo. This has productivity value as males could be selected for broiler production and females for layer production. It also has animal welfare implications in that male layer chicks would not have to be disposed of because they would not be hatched.



REDUCING WATER USAGE AND ENVIRONMENTAL IMPACT



ATRP's **DYNAMIC FILTRATION** project is investigating techniques to more selectively capture target impurities from liquid streams in a way that facilitates the recovery of value-added byproducts while still meeting or exceeding water reuse guidelines. Researchers are focused on three primary applications: poultry chillers, marinades, and brines. A bench-scale dynamic filtration device was constructed and evaluated in FY 2012. The system employs greater filter flux rates ($L/m^2 \cdot hr$) and solids removal as compared to a traditional poultry secondary screening system utilizing an approximately 300-micron screen. Preliminary results are promising; however, additional work is needed to complete the assembly of a backwash system. Here, the team is using a servo motor with programmable logic controller (PLC) so that motor RPM and torque can be used for feedback. In addition, the team is augmenting the existing piston pump setup to eliminate liquid flow back to the piston arm so that the overall pressure profile within the pumping system can be monitored. Continued progress will advance the ability of processors to improve water reuse and food safety initiatives.

IMPROVING PROCESS EFFICIENCIES AND/OR PRODUCT QUALITY AND FOOD SAFETY

Deboning represents a particularly labor-intensive operation in the poultry industry. Due to the natural deformation and variation of bird carcasses, automation of the cutting process has proved to be very challenging and has resulted in significant yield losses and bone chips. ATRP's **INTELLIGENT CUTTING AND DEBONING SYSTEM** uses 3D imaging and a robotic cutting arm to automatically perform precision cuts. Cuts are focused on severing the tendons and joints on bird front-halves in preparation for the removal of the wings and breast meat. FY 2012 efforts focused on integrating three separate components (trajectory generation for each individual bird, bone detection, and force control) into a single functioning system. Initial performance results were encouraging, and the team is currently refining the system by designing and fabricating an improved knife end-effector and expanding the use of force control. The team also plans to perform a more extensive statistical study of bird features and further explore active wing manipulation.



Screening deboned poultry product for bones is an intensive manual process. In addition, estimating yield loss due to process inefficiencies is difficult to perform during production. ATRP's **CONE LINE SCREENING SYSTEM** project team has developed a vision-based approach to address these issues. FY 2012 efforts focused on developing and evaluating routines for performing bone detection and yield estimation on deboned poultry products. Researchers collected approximately 2,600 images of deboned product at a poultry processing plant. This included 2,500 images of product taken directly from the deboning line, and 100 samples of birds before and after performing a manual yield assessment process. Several hundred additional frames from different processing facilities were imaged in the laboratory. During testing the system was able to classify 100% of missing clavicle bones from the lab test data. However, there was a high false positive rate of 20%, primarily due to broken clavicles without missing bone chips. Fan bone detection accuracy was 82%. More promising were the yield results, giving a correlation of 90% with the field test data. However, testing the yield estimation routines on birds from a different producer only yielded a correlation of 72%. This approach shows promise for detecting bones as well as monitoring process yield in real time. Research is under way to refine the yield estimation and bone detection routines and perform robust field testing on the final pre-production prototype system.

DEVELOPING WORKPLACE SAFETY METHODS AND TECHNOLOGIES

ATRP's **WORKER SAFETY** project investigated the use of the WiiFit gaming system as an intervention method to reduce the risk of lower back injuries during lifting compared to the traditional methods of strengthening hip flexor muscles. Analysis comparing the leg and back motions of the study subjects measured during the lifting tasks conducted before and after the training program showed that using the WiiFit as an intervention improved lifting technique by reducing the change in back and knee angles and increasing the change in hip angle. In addition, participants found the WiiFit to be enjoyable and reported improved cardiovascular endurance over the Traditional and Control groups. Researchers also used MotionPlus Wiimotes to record human kinematic motion data on a laptop PC. The rate gyro data of the Wiimotes was processed to examine the joint angles of the participants performing the lifting tasks. Overall, the WiiFit gaming system shows promise of being a low-cost and yet effective physical conditioning program for poultry plant workers. Researchers are currently focused on creating a low-cost, portable, and easy-to-use Mobile Motion Capture (MiMiC) system. The new MiMiC system is intended to be a tool for ergonomists and plant managers to use in the plant environment to assess workers' movements as they perform their jobs without needing assistance from experts and expensive equipment. The envisioned prototype will use a smartphone to record kinematic data from wireless motion modules. Data collection from Bluetooth 6-degree-of-freedom inertial motion units (IMUs) is under way with the ultimate goal of creating a field-testable prototype.



ENVISIONING THE POULTRY PLANT OF THE FUTURE

Working with industry and academic partners (particularly the University of Georgia), ATRP researchers began to lay the framework for a major initiative focused on developing innovative approaches for improving the overall performance and efficiency of poultry processing. The strategy consisted of three primary tasks: (1) form an enthusiastic and capable team of industry, government, and academic partners; (2) begin to develop relationships with potential sponsor agencies (USDA, NSF, etc.); and (3) draft a compelling argument for the need for this kind and level of research investment in poultry. A small working group met several times to discuss ideas and approaches for building such an initiative, and meetings were held with many of the key industry stakeholders to discuss and receive input on the direction of the initiative. The coalition of participants is growing, and it is expected that a program proposal around this concept will be drafted in the near future.

SPECIAL PROJECTS

ATRP special projects are funded to develop concepts and ideas for later transition into full research projects. Four special products were conducted in FY 2012.

ENCODING EXPERT KNOWLEDGE

Although plants are increasingly automated, in the food processing industry there remain many manual operations that require expert knowledge to function efficiently and cost-effectively. The goal of this project is to encode this knowledge so it may be effectively taught to a robot. Researchers are considering bird re-hang as an initial expert knowledge problem. In the re-hang task, the worker grasps the bird by the breast (usually from an unstructured pile), lifts it, and then “flicks” the bird such that its legs are each directed into a pair of moving shackles. A motion capture system is needed to quantify the kinematics and dynamics of the manual operation. The project team implemented a motion capture capability using the Microsoft Kinect (to obtain both kinematic and dynamics data). The Kinect is a sensor that is highly capable of tracking human motion. Its widespread use in the consumer gaming industry has resulted in a low-cost device that has gained popularity in other creative applications. The accuracy results from the developed motion capture system are on the order of 1 millimeter and can adequately accommodate motion speeds (up to about 200 in/s) greater than what can be expected from typical poultry plant operations. Preliminary results show that the motion of a plastic mock-up bird can be made to closely match that of a real bird.

POULTRY SYSTEM MODELING

This project seeks to better define future research agendas, with researchers examining how emerging technologies that impact poultry processing should be assessed. Researchers identified similarities between systems theory, design thinking, and mechanical product design, although the path from innovation to invention is still ambiguous. Why? Because scientists tend to focus on systems as abstract concepts needing better quantification, while engineers typically see systems as concrete arrangements that achieve better quantification. Regardless, as global markets and distributed information exchange increase, industry needs scientists and engineers to better align their definitions of systems so that innovation can quickly be converted into a mechanical product design. Moving forward, researchers plan to discuss current results with experts associated with Professional Master's Degree in Applied Systems Engineering and Certificate Programs at Georgia Tech. They also will continue to engage other university colleagues and industry to better define research agendas to address future challenges facing the poultry and allied industries.

ULTRASONICS FOR DEBONING

This project explores the feasibility of using ultrasonic technology to improve poultry meat deboning. Researchers first studied the potential effects of ultrasound on bone, muscle, and tendon, and then designed an experiment to test these effects. They found that High Intensity Focused Ultrasound could possibly assist in loosening the meat from the bones and frame. However, test

results were preliminary. In addition to the challenge of focusing the ultrasound on just the target areas, one potential drawback is the amount of heat generated by the ultrasonic source. While this may have a negative effect on the quality of the meat, it does show promise as a food safety mechanism for controlling *Salmonella*.

VIP ROBOTICS

ATRP researchers have partnered with the Georgia Tech Vertically Integrated Projects (VIP) Program to form a student-faculty/researcher robotics team. The VIP program is an undergraduate education program that operates in a research and development context. Undergraduate students that join VIP teams earn academic credit for their participation in design efforts that assist faculty and graduate students with research and development issues in their areas of technical expertise. Through the VIP Robotics team, ATRP researchers are teaching/advising a group of undergraduates on robotics research centered on food and agriculture robotics and the technical fields of perception, controls, planning, learning, manipulation, and robot design.

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.

Growout Monitoring

Georgia Institute of Technology
Poultry Diagnostic Research Center
University of Georgia

Chicken Egg Fertility Detection

Auburn University
Pilgrim's Pride

Dynamic Filtration

Mar-Jac Poultry

Intelligent Cutting and Deboning System

Marel Stork Poultry Processing
Mar-Jac Poultry

Cone Line Screening System

Cantrell Machines
Keystone Foods
Mar-Jac Poultry

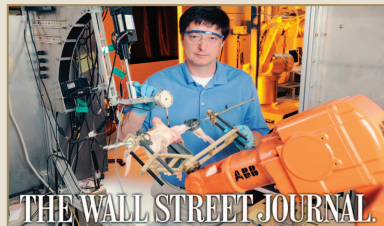
Worker Safety

Cagle's
Mar-Jac Poultry
Tyson Foods

TECHNOLOGY TRANSFER, OUTREACH, AND TECHNICAL ASSISTANCE

TECHNOLOGY TRANSFER

ATRP continued an active Technology Transfer Program in FY 2012. Three issues of the program's newsletter *PoultryTech* were published, with several articles reprinted in the trade press. In addition, subscriptions for the new electronic edition of the Summer issue continued to increase. Research projects also received external coverage in several trade and research magazines as well as national newspapers. In particular, a front-page story headlined: Robots Can Perform Surgery, But Can They Debone a



Chicken?, highlighting the Intelligent Cutting and Deboning System, appeared in the May 30, 2012, issue of *The Wall Street Journal*. Research staff also

generated more than 40 articles and technical presentations, filed four invention disclosures, and received one patent. (A complete listing of these Technology Transfer activities can be viewed at www.atrp.gatech.edu/publications.html.) The FY 2011 Annual Report was published, and the ATRP website was updated.

TECHNICAL ASSISTANCE

ATRP staff provided 29 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. In addition, working with the Georgia Poultry Federation and the University of Georgia, environmental engineers conducted a 6-hour workshop on Georgia's industrial storm water permit at the Georgia Poultry Lab in Oakwood, Georgia, which was attended by 36 individuals representing 13 poultry processing and rendering plants with locations across 22 cities. ATRP uses input from all assists to gauge situations calling for new research initiatives.

Categories:

Automation	3
Energy	1
Environmental	13
IT & Sensors	4
Worker Safety	4
Other	4

OUTREACH ACTIVITIES

ATRP once again participated in the International Poultry Expo, the Georgia Poultry Federation Spring Meeting, and the Night of Knights, preparing exhibits for all three. Poultry World continued to be a major draw at the Georgia National Fair in Perry, Georgia. Working with the Georgia Poultry Federation, Georgia Tech helped coordinate the more than 150 volunteers who staffed the exhibit.



In conjunction with the Georgia Poultry Federation, the National Chicken Council, and the National Turkey Federation, ATRP hosted the 2012 National Safety Conference for the Poultry Industry in Ponte Vedra Beach, Florida, attracting 83 safety professionals and vendors representing 46 companies and organizations from 22 states.



The program also provided support to the Information Systems Seminar for the U.S. Poultry & Egg Association.



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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http://en.wikipedia.org/wiki/Agricultural_Technology_Research_Program



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