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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; and
- Release of information on emerging technologies and improved operational management through newsletters, articles, seminars, and presentations to speed ultimate commercial use.

The program is conducted in cooperation with the Georgia Poultry Federation with funding from the Georgia Legislature.
Fiscal Year 2003 was a challenging and productive year for the Agricultural Technology Research Program (ATRP). Despite the lingering effects of an economic downturn, which impacted our overall research funding, exciting progress continued to be made on a number of research fronts, including the movement of several developments toward near-term commercial release. At the same time, construction began on the new Food Processing Technology Research Building, which promises to be ready for occupancy in the summer of 2004. And the program’s initiatives helped secure Georgia Tech a Top 10 ranking among the universities serving the meat and poultry industry, according to a poll published by *Meat & Poultry* magazine.

Three of our developments edged ever closer to near-term commercialization this past year. The systemic imaging system not only continued to perform well in continuous, on-line field trials, but also secured licensing agreements with two companies. BOC-Thinkage signed a use agreement giving it access to the system for its in-plant process improvement service. Later, four companies competed for the manufacturing and marketing rights to the design, and Gainco, Inc. was awarded an exclusive license. The x-ray enhancement imaging system also performed well in limited field trials and secured a licensing agreement from Spectral Fusion Technologies. Spectral intends to manufacture and market the design as part of its new TQUIS product line. Finally, the robotic case packer successfully completed limited field trials that demonstrated that it could pack at sustained speeds of over 50 individual trays per minute. One of our development partners, CAMotion, Inc., subsequently built a second-generation system that is more robust and simpler to operate than the unit that was tested. The unit is called the “ProductPacker,” and CAMotion is in the process of offering it commercially. Our design team is working with CAMotion to produce an integrated cell for long-term, in-plant performance trials this coming year.

We also continued to make excellent progress in our efforts to develop “intelligent” processing systems for live poultry handling and deboning operations and in our efforts to introduce mobile data-collection to the industry. Our biosensor development project began to broaden its focus into multi-assay screening approaches, and our environmental research thrust made strong progress in finding ways to reduce water usage and to control odor and VOC air emissions. It also initiated work on an advanced, high-efficiency, UV disinfection design with potential to work on both water and marination recycling. And, research was initiated on a new sensor designed to automatically determine the core temperature of cooked product.

On January 23, 2003, the Food Processing Technology Research Building officially broke ground. At the groundbreaking ceremony, state and university leaders alike praised the project for its spirit and display of public/private partnership. In all, 16 companies were recognized for their commitment of funds to the project. The firm of W.G. Yates & Sons Construction Company subsequently was selected to build the facility and is currently well underway with the task. Live images of the construction activity can be viewed at http://foodbldgcam.semr.gatech.edu.

Being recognized as one of the top universities serving the meat and poultry industry, quite frankly, is an honor, due in no small part to the very active support and interaction of our state and industrial partners. As we look ahead, we remain excited by the potential of new technology to positively impact the future of this industry and committed to the potential our new research facility can have as a catalyst for even greater exploration and innovation.

J. Craig Wyvill
ATRP Director
FINANCIAL SUMMARY

ATRP budget dollars supported four major research focus areas in Fiscal Year 2003: advanced automation technologies, food safety technologies, environmental engineering and management, and information systems technologies. In addition, monies were set aside for outreach and technical assistance/technology transfer, special projects, professional and program development, administrative and operations support, and repair and maintenance functions.

More than two-thirds of the Fiscal Year 2003 program budget was channelled toward research in the four major research focus areas. In addition, nearly half of the remaining program budget was channelled toward outreach and technical assistance/technology transfer and special projects.

FISCAL YEAR 2003 BUDGET MIX: $1,740,142

- Automation Research - 43.5%
- Food Safety Technology Research - 8.7%
- Information Systems Research - 10.5%
- Environmental - 8.2%
- Administration and Operations Support - 13.2%
- Outreach and Technical Assistance/Technology Transfer - 10.7%
- Special Projects - 2.7%
- Professional Development - 0.2%
- Program Development - 1.6%
- Repair and Maintenance - 0.7%
ATRP’s Poultry Advisory Committee is made up of poultry industry leaders who give their time to help the program identify research topics that best address priority industry needs. The committee meets semiannually to hear updates on program research efforts and to discuss challenges and future direction with program personnel.

Poultry Advisory Committee (Fiscal Year 2003)

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<tr>
<th>Name</th>
<th>Company</th>
<th>Role</th>
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<tr>
<td>George Winn</td>
<td>Gold Kist Inc.</td>
<td>(Chairman)</td>
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<td>Dirk Arp</td>
<td>Gold Kist Inc.</td>
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<tr>
<td>Gus Arrendale</td>
<td>Fieldale Farms</td>
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<td>Denny Artley</td>
<td>Dutch Quality House</td>
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<td>Glen Berry</td>
<td>Gold Kist Inc.</td>
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<tr>
<td>Bill Crider</td>
<td>Crider Poultry</td>
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<tr>
<td>Kevin Custer</td>
<td>American Proteins, Inc.</td>
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<tr>
<td>Joe Gardner</td>
<td>ConAgra Poultry</td>
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<tr>
<td>Jerry Gattis</td>
<td>Cagle’s Inc.</td>
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<tr>
<td>Tom Hatley</td>
<td>ConAgra Poultry</td>
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<tr>
<td>Wayman Hollis</td>
<td>Hall Equipment</td>
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<td>Pete Martin</td>
<td>Mar-Jac Poultry</td>
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<tr>
<td>Allen McManus</td>
<td>Gold Kist Inc.</td>
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<td>Larry Miller</td>
<td>King’s Delight</td>
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<td>Vernon Owenby</td>
<td>Tyson Foods, Inc.</td>
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<tr>
<td>Gene Parets</td>
<td>Gainco, Inc.</td>
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<tr>
<td>Keith Rudowske</td>
<td>Tyson Foods, Inc.</td>
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<td>David Sewell</td>
<td>Cagle’s Inc.</td>
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<td>Doug Spritzky</td>
<td>Griffin Industries</td>
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<td>Greg Tatum</td>
<td>American Proteins, Inc.</td>
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<tr>
<td>Max Volk</td>
<td>Stork Gamco Inc.</td>
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<td>Mike Welch</td>
<td>Harrison Poultry</td>
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Ex Officio:

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<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Mike Giles</td>
<td>Georgia Poultry Federation</td>
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<tr>
<td>Abit Massey</td>
<td>Georgia Poultry Federation</td>
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<tr>
<td>James Scroggs</td>
<td>Georgia Poultry Processors Association</td>
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<tr>
<td>Craig Wyvill</td>
<td>Georgia Tech Research Institute</td>
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Industrial collaborators provide the direction needed to tailor research and development activities to specific industry challenges. They also participate directly in research projects by providing technical assistance as well as offering in-kind and cash contributions. Below is a list of industrial collaborators by project for Fiscal Year 2003.

Industrial Collaborators (Fiscal Year 2003)

Advanced Environmental Concepts
American Proteins, Inc.; Gold Kist Inc.; Suzanna’s Kitchen

Dynamic Automated Cone Loader
Tyson Foods, Inc.

Robotic Case Packer
CAMotion, Inc.; ConAgra Poultry; Cryovac, Inc.; Gold Kist Inc.

Systemic Imaging System
BOC-Thinkage; Gainco, Inc.; Gold Kist Inc.; Tyson Foods, Inc.

X-ray Enhancement Imaging System
Cagle’s Inc.; Spectral Fusion Technologies; Sylvest Farms; Tyson Foods, Inc.

Intelligent Cutting System for Deboning Meat
Tyson Foods, Inc.

Automatic Intelligent Transfer System
Gold Kist Inc.; Stork Gamco Inc.

Biosensor Enhancement and Evaluation
Gold Kist Inc.

Core Temperature Monitoring of Cooked Product
ConAgra Foods; BOC-Thinkage
Research efforts in the environmental area focused on expanding the research team’s understanding of critical issues facing the industry in this area, and channeling that knowledge into technology development thrusts that tackle these issues head on. Integral to this work was the initiation of multi-disciplinary research approaches that allow the team to work with facilities in better understanding current barriers to improving processor water use and quality, wastewater treatment, and air emissions. For example, WARP® The Water Auditor software was upgraded to better assist managers with tracking water use during user-defined periods, which then allows researchers to target specific shortcomings of existing treatment technologies. Wastewater capacity studies continued to assess the impact on biological wastewater systems of antioxidants used to stabilize DAF skimmings. Air emissions research further examined odor and VOC control mechanisms. The research team also supported studies to develop a high-efficiency UV disinfection technology. Built on the Taylor vortex concept, the new design is expected to enhance UV disinfection of process wastewaters and marination fluids to allow more efficient recycle options. The unit is also serving as a research platform for studying surface adhesion properties related to fecal rinse stations.

Project Director
John Pierson, 404.894.8059, john.pierson@gtri.gatech.edu
Fiscal Year 2003 research activities continued to focus on handling irregular non-rigid materials for cone loading. In the handling of such products, a grasping mechanism was designed to react to variations in the product such as shape and size and to surface properties such as texture, adhesion, and wet conditions. An end effector was designed to address all complications derived from such an application. This grasper was then mounted on a research robot to demonstrate its ability to match the accuracy of the manual process. As part of the test, birds were presented both in the cavity-up and cavity-down positions and the results recorded. The grasper or end effector had a success rate of 93.6%. Out of a sample of 110 birds, only 7 birds were misplaced on the cone based on predefined industry placement criteria guidelines. The major mode of failure for the end effector was related to the inability of the system to have the keel pin hit its intended target. In such cases, the carcass was grasped correctly and placed on the cone; however, the keel pin did not puncture the center of the fatty pocket. This failure was attributed to the inability of the robot and end effector to effectively adjust for the variability in the product’s shape. Typically, manual cone-loading operations operate at a success rate of 92.0% for placement of the bird onto the keel pin. The research team next plans to focus its efforts on implementation issues that include robotic platform design.

Project Director
Gary McMurray, 404.894.8057, gary.mcmurray@gtri.gatech.edu
Working with CAMotion, Inc. and Cryovac, Inc., the research team completed upgrades to the robotic case packer. CAMotion inserted its proprietary control technology into the system to streamline the robot’s movements and dampen any vibrations created by high-speed movements. Cryovac designed and built a box-feeding conveyor system for the robot, which is capable of moving a new empty box into loading position in less than 1 second. The redesigned case packer was field tested at ConAgra’s poultry processing plant in Gainesville, Georgia. During the tests, the case packer operated in an actual production environment for 7 days and achieved packing speeds over 50 trays per minute. The field tests demonstrated that the case packer is capable of competitive feed rates, for example, 20,000 trays per 8-hour shift. Further interface refinement to the control software was identified by the ConAgra test and was implemented in the spring. CAMotion has since revised the system design to make it more robust and simpler to use than the prototype tested at ConAgra. CAMotion is currently marketing the system under the name “ProductPacker.” Long-term in-plant trials are scheduled for fall 2003 at Excel Corporation’s case ready plant in Newnan, Georgia.

Project Director
Gary McMurray, 404.894.8057, gary.mcmurray@gtri.gatech.edu
Two imaging developments were field tested this past year.

SYSTEMIC IMAGING SYSTEM

Twin systemic imaging systems were field tested on-line at the Gold Kist-Carrollton poultry processing plant to demonstrate the ability of their design to withstand the continued rigors of the processing environment while effectively detecting systemic defects and other operational information, such as bird counts and rates of broken wings, that could be utilized for potential feedback control. Over the course of the year, modifications were made to the software to improve its detection accuracy on skin tears, bruising, and broken wings. Improvements were also made to the user interface to allow the plant to focus on hourly versus daily performance data. Based on these changes, the plant has begun evaluating the potential benefit of using the software for process control decision making. It is anticipated that this system can also be used as an integral part of future HIMP-type plant operations.

A patent was applied for on the techniques used for defect detection in the system, and two commercial license agreements were signed. One, a use agreement with BOC-Thinkage will allow the company to use the system as part of its service offerings. The other, a manufacturing licensing agreement with Gainco, Inc. gives the company exclusive manufacturing and marketing rights to the design.

X-RAY ENHANCEMENT IMAGING SYSTEM

Researchers field tested the x-ray enhancement imaging system (designed to detect fan bones on the surface of product) at Tyson Foods in Union City, Tennessee, and conducted laboratory comparison testing to evaluate its performance accuracy. The team also signed a manufacturing agreement with Spectral Fusion Technologies, giving the company non-exclusive manufacturing and marketing rights to the design.

Project Director
Wayne Daley, 404.894.3693, wayne.daley@gtri.gatech.edu
In this project, researchers are investigating the potential for dynamic in-motion wing cuts as part of the breast deboning process. The study team has integrated a testbed that incorporates an ABB research robot and an imaging cell. With this testbed, they are using two-dimensional and three-dimensional imaging to locate anchor points for cutting from which the cut paths are determined by empirically developed trajectories. Modification of the cut paths by monitoring cutting forces is also being implemented to accommodate product variability. This past year considerable work took place on modifying the robotic testbed to effectively handle the transfer of three-dimensional imaging coordinates in directing cutting trajectories. Entry cuts at the shoulder using image guidance continued to show strong promise for improving accuracy. However, trajectory cuts beyond the shoulder were hampered by the influences of incidental change of motion forces on the cutting blade observed by the force feedback control mechanism. Further refinements are planned in the test setup.
The project team made strong progress in its ongoing efforts to develop an automated system for transferring live birds from a moving conveyor to shackle line. This year’s research activities focused more on handling multiple bird sequences. Motion control algorithms were developed for the grasping fingers to provide flexibility in varying the transfer rate while accommodating birds that weigh more than 4 pounds. Studies were also conducted on the effect that leg size has on the successful shackling of a bird. Beginning initially with the rigid shackle design of the initial prototype system, the team then modified the shackle mechanism to incorporate compliance in all three orthogonal directions. Experiments showed that the added compliance effectively minimized jerking motions due to premature leg contact from larger birds. Follow-up tests on the revised shackle design and motion control algorithms are still ongoing.

The research team also worked closely with researchers at the University of Georgia (Dr. Bruce Webster) and the Russell Research Center (Dr. Jeff Buhr) to explore electrical stunning and neck-cut techniques that can be incorporated as a part of the automatic transfer process. Because birds tend to flap their wings when inverted while conscious, the concept being explored is to stun the bird just at the end of the automatic shackling process before it is inverted. It is believed that such a move will alleviate the potential stress the animal feels while being inverted (a target of current animal rights concerns) and help to keep electrical stunning as a suitable alternative to the gas stunning method currently being touted by animal rights groups. It is also believed that this technique will help reduce broken and damaged wings from the wing flapping motion.
The research team completed a second version of the mobile data-collection software. The second version is extremely flexible and allows for data collection beyond HACCP data, including quality, production, and maintenance data. This custom software allows plant personnel to make changes to their data-collection procedures as necessary. In addition, graphing packages were evaluated and one was selected that can provide various types of graphs (e.g., control charts). This software is now available for distribution to food processors. Other work this past year included conducting an initial investigation into the feasibility of using augmented reality (AR) to provide database-generated task information to plant employees. AR superimposes computer-generated instructions onto real work environment scenes either through the use of a head-mounted display or laser technology. As plants move to greater use of automated data capture systems, AR has the potential to heighten worker interface with critical need-to-know data. A prototype system is in design and will be tested next year.
The biosensor research team continued to make strong progress in its efforts to develop a rapid food-borne pathogen detection sensor. The team’s work this year continued to focus on an assay for the detection of *Salmonella*. Optimization of the assay, by careful selection of antibodies and reagents, as well as development of protocols, have resulted in continuing enhancements in sensitivity, selectivity, reproducibility, and simplicity of detection. With a goal of developing a multi-analyte assay, the team also implemented an assay for *Campylobacter* and achieved detection sensitivities of 1,000 cells/ml (a factor of 100x better than conventional enzyme-linked immunosorbent assay [ELISA] methods) using commercially available polyclonal and monoclonal antibodies. At the same time, the team has also begun to design and fabricate the optical waveguide chips and assemble the optical and electronic components to accommodate up to six independent, simultaneous assays; this effort will be continued in the Fiscal Year 2004 program.

To complement the biosensor work this year, a study was also undertaken to develop and validate a rapid (8-hour) most probable number (MPN)-ELISA for the detection of *Salmonella Typhimurium* in poultry washes. This abbreviated assay (which has been submitted for publication) will allow for increased product sampling and more rapid movement of food between production and processing, resulting in reduced spoilage and quality losses.

Project Director
David Gottfried, 404.894.7300, david.gottfried@gtri.gatech.edu
Fiscal Year 2003 research activities focused on core temperature monitoring of cooked product on institutional lines. Researchers conducted an extensive literature search that considered patents, published literature, commercial offerings, and inputs from cook line operators. The results of this investigation focused the remaining research activities on the feasibility of a non-contact monitoring system. Two technologies, RF probes and IR surface temperature change, were selected for more detailed consideration. Non-contact IR surface temperature monitoring is fast, relatively inexpensive, and a proven technology for uniform product. RF and NMR techniques are slower and more expensive, but potentially more accurate than the IR method. Based on cost and throughput considerations, a system outline was developed based on the IR technique.

After a cooked product leaves the oven, its surface begins to cool rapidly. One factor in the rate of cooling is how much heat is conducted from the center of the product to the exterior. This relationship can be exploited to determine the core temperature of a given product. Computational models were adapted from literature to model the cooling process and were used to help set requirements and feasibility. Limited cooking tests were conducted to verify modeled data and identify implementation issues. The method requires an accurate three-dimensional image of the product, so stereo three-dimensional vision systems were evaluated in conjunction with other ATRP projects. Finally, the research team began designing an enclosure for the screening cell capable of meeting the requirements of the highly sterile environment of a fully cooked line. Specialized lighting and communication subsystems were identified and tested for inclusion in this design.
ATRP engineers continued to provide engineering technical assistance at no charge to members of the Georgia poultry industry.

Designed to help companies and individuals who do not otherwise have access to engineering expertise, this program draws upon engineers and consultants from the Georgia Tech community in a variety of specialized areas, such as automation, waste management, ergonomics, economic impact, and plant safety and health.

Twenty-six technical assists were provided this past year to firms and individuals across the state. These assists ranged from simple inquiries regarding information or help needed to address a problem to extensive on-site consultation, in which researchers collected data and provided a full report of their findings and recommendations. The program uses input from these assists to gauge situations calling for new research initiatives.
Subscriptions to the *PoultryTech* newsletter remained steady at more than 1,700 subscribers, including more than 250 subscribers from foreign countries. The systemic screening, intelligent transfer, and environmental research programs were featured in more than five trade journals. The program as well as the entire division was featured in a news segment for the Atlanta Business Chronicle, which aired on public television. The program helped Georgia Tech achieve a No. 10 ranking among the Top 10 Universities Serving the Meat & Poultry Industry, according to an industry survey conducted by *Meat & Poultry* magazine. The ATRP Annual Report was published for the second year in a more streamlined, corporate-like format. The ATRP website was also redesigned with a more corporate-like look, and research project overviews were updated.

Licensing agreements were signed by BOC-Thinkage (use), Gainco, Inc. (manufacturing), and Spectral Fusion Technologies (manufacturing) related to the systemic screening and x-ray screening systems, respectively. In addition, collaborative agreements were signed with CAMotion, Inc. and Cryovac, Inc. to commercialize the robotic case packer.

ATRP once again participated in the International Poultry Exposition, the Georgia Poultry Federation Spring Meeting, and the Night of Knights, preparing exhibits for all three. The Poultry World exhibit was operated for the second year in its new home (a permanent structure resembling a miniature poultry house) at the Georgia National Fairgrounds in Perry. Recognition awards were given to corporate and individual contributors who played a vital role in building and equipping the award-winning exhibit.

In conjunction with the Georgia Poultry Federation, the National Chicken Council, and the National Turkey Federation, ATRP hosted the 2003 Safety Workshop for the Poultry Industry in Savannah, Georgia, attracting 90 safety professionals from across the United States; there was one international participant from Accra, West Africa. A highlight of the workshop was the participation of the Honorable John L. Henshaw, assistant secretary of labor for OSHA, who delivered the keynote address, unveiling OSHA’s draft ergonomics guidelines for poultry processing.
Georgia Tech’s Food Processing Technology Research Building officially broke ground on January 23, 2003. At the ceremony, Richard Royal, chairman of the Georgia House Ways and Means Committee called the project a “great example of a public/private partnership that will be important for the state of Georgia.” Dr. Wayne Clough, president of Georgia Tech; Dr. Dan Papp, senior vice chancellor for Academic Affairs of the University System of Georgia; Dr. Ed Reedy, vice president and director of the Georgia Tech Research Institute; Abit Massey, executive director of the Georgia Poultry Federation; and David Lee, chairman of the Food Processing Advisory Council, all praised the collaboration that made the project possible. After the groundbreaking ceremony, a recognition ceremony was held honoring the 16 companies who had committed funding to make the project possible.

Phase I of a scheduled two-phase construction effort will be a 35,000-square foot structure with laboratory and office facilities for research and development in the areas of automation technology, information technology, and environmental systems. The structure will also have a 48-seat auditorium and a large conference room for industry and other meetings. In addition, the structure will have a lower lobby outfitted with interactive computer kiosk systems to entertain and inform school and visitor groups about the growing role of technology in the poultry and food processing industries. Phase II, which will be completed at a later date, will house additional laboratory and office facilities for human factors, food safety, and bioprocessing research.

After a slight delay while securing title to the old city street property on which the building will be constructed, full approval was given in March 2003, by the Board of Regents to proceed with the project. On June 26, 2003, the firm of W.G. Yates & Sons Construction Company was selected to build the facility. Construction was scheduled to begin in July 2003 with completion expected in approximately 11 months.
PUBLICATIONS AND PRESENTATIONS

Books, Chapters, Monographs

Trade Publications

Journal Articles

Theses/Dissertations
Conference Proceedings


Lectures and Presentations


Invention Disclosures

Forney, L. and J. Pierson. Advanced UV disinfection technology.

Lee, K.-M. Automated feet-gripping system for continuous transfer of live broilers to shackle.
The five-year goal of the Agricultural Technology Research Program (ATRP) at Georgia Tech is to continue to provide state-of-the-art applied engineering research and service to the poultry industry. The research program will continue to focus on automation, information technology, environmental, and safety areas, while service activities will continue to concentrate on broad information dissemination and one-on-one general assistance.

Automation/electronics research studies over the next five years will begin focusing more heavily on integrated automation systems. These technologies offer major opportunities to further enhance productivity in the poultry industry. Research is also needed in developing advanced sensor technologies. With computerized process control rapidly emerging in the industry, information management is another area where better technology development is needed to address the specific demands of the industry.

Information technology research studies will expand their focus on enterprise integration and internal support services. Wearable computers will continue to form the backbone of efforts to link operations across the factory floor. In addition, work will begin toward developing artificial reality tools to assist in transferring information for dynamic support and training.

Environmental research studies will continue to focus on emerging technologies that help to reduce water usage and waste generation. Furthermore, these studies will focus on enhancing our understanding of how operations work and ways to further optimize them. Water usage is an area that has experienced rapid growth in recent years as plants turn to additional product-rinsing steps to control product microbial quality. Minimizing this additional water demand is essential as water resources continue to be squeezed around the state. Waste minimization also continues to be a national focus area, and the poultry industry has an opportunity to further enhance its image as an efficient user of resources.

Safety research will continue to take two paths. Personnel safety research will focus on continuing to find ways to reduce the risk of worker injury. The current research into risk quantification is a bold initiative and one that should pay dividends for years to come. The industry needs a better scientific base for assessing the true risk of injury. Product safety research, on the other hand, will attempt to develop technologies to improve control over process and product quality. The development of new HACCP control technology has become a major new program thrust area.

Finally, ATRP will continue to actively support industry needs through its technical assistance program and will use newsletters, seminars, research reviews, topical reports, research reports, technical papers, and articles in industry trade publications to transfer its research findings. The program will also work to promote a better understanding of and appreciation for Georgia’s dynamic poultry industry and will work to promote the increasing opportunities for engineering and technical careers in the industry.
ACKNOWLEDGEMENTS

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Proofreader Lucy Johnson

Project Reviews provided by ATRP Research Project Directors

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ATRP staff
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