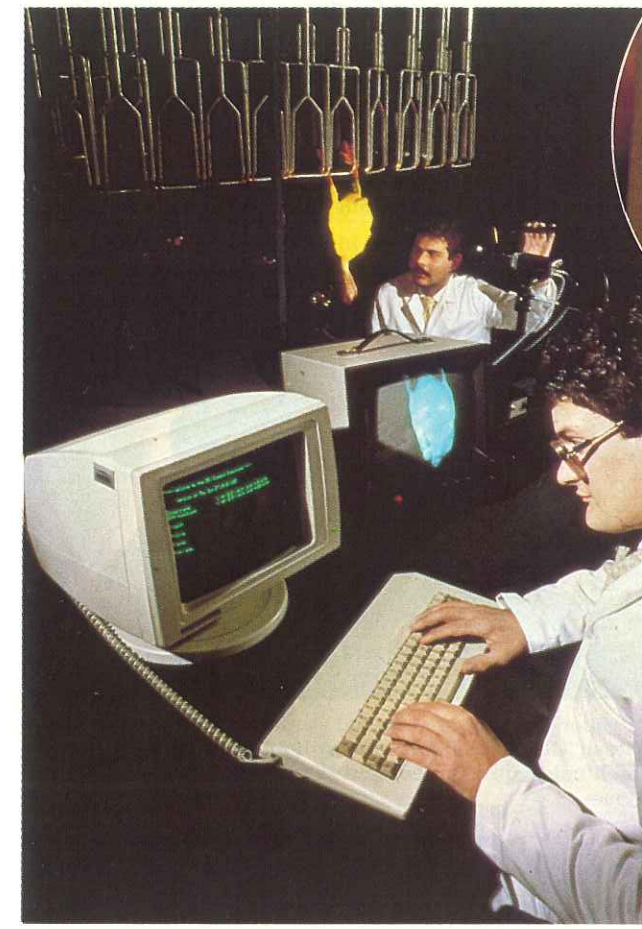
Machine Vision: Poultry Quality Control By Computer

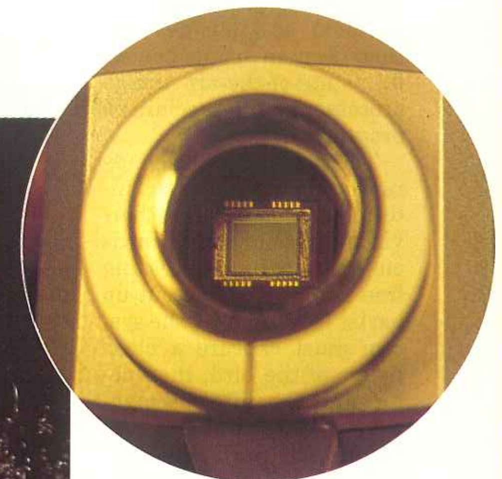
Like most mechanically automated industries, the poultry industry is looking for ways to use computers in production to add control and increase productivity. One of the newer computer technologies available for these applications is machine vision, a process that allows a computer to examine the physical traits of a product and to make decisions based on these observations. While many food processing industries have adopted machine vision for product evaluation, the poultry processing industry has been unable to take advantage of this technology until recently, largely because of harsh plant conditions. Engineers at Georgia Tech in Atlanta, Georgia, USA, are now working on machine vision systems that will size and grade birds as they move along the processing line, identify and grade cut-up parts, and, ultimately, perform on-line, post-mortem inspection.

Machine vision technology has several advantages. It allows a computer to perform repetitive examination tasks accurately, often in less time than a person. The equipment is expensive, but payback can be quick when an employee is freed from a boring, repetitive job to do something more productive. Machine vision systems are particularly useful because they are consistent: they do not get bored or distracted by evaluation tasks, like people.



Machine vision shows great promise as a quality control aid for the poultry industry. Proper system design, careful consideration of lighting requirements and thorough programming can result in a very consistent system that finds defects with greater accuracy than most humans.

Photo courtesy of Charles Haynes.



The machine vision system Georgia Tech has developed utilises a rugged industrial camera which features a sophisticated, solid-state sensor. Located inside the camera body just behind the lens mount, the sensor converts video images into electronic signals for computer evaluation.

In order to make decisions about a product, a computer has to be able to detect and analyse the smallest visual chacteristics. However, even the most powerful computer cannot see like humans. Machine vision is accomplished only through the interaction of several pieces of equipment, and through extensive computer programming.

An ordinary video camera can produce images for computer analysis. The camera must be linked to an image processor, a specialised machine which converts the camera image into signals the computer can read. The image processor receives the camera image in units referred to as picture elements, or pixels. Then, in a process called digitising, the image processor assigns each pixel a number, known as a grey level, depending on how light or dark the pixel is. The simplest (binary) image processors assign two grey levels: black and white. Most complex processors can detect finer differences in shading than the human eye. The Georgia Tech system, for example, can detect 256 grey levels; the human eye can detect only 64 shades of grey.

Once the image processor has digitised the array of pixels, the vision system computer can examine the image for patterns and quality standards that have been programmed into its memory. For example, a computer programmed to examine ball bearings would scan a digitised image for a recognisable bearing shape, then compare the shape with pre-programmed data to decide if the bearing was irregular.

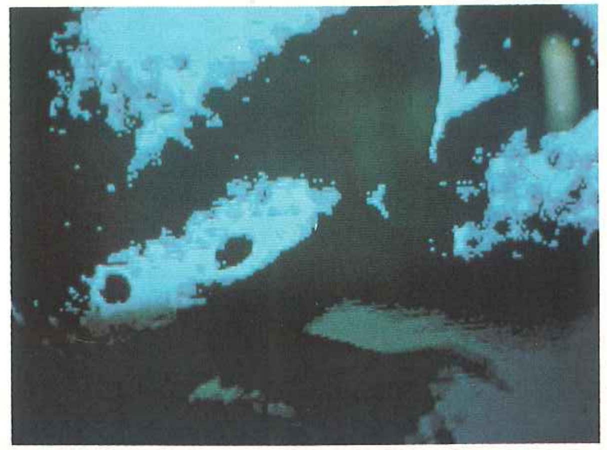
Programming a computer

to recognise patterns this way is a complicated task. Poultry poses a real challenge to programmers; no two birds are exactly the same, and they are hard to define in a way the computer will recognise. Georgia Tech engineers are attempting to overcome this problem as they develop their system using powerful, state-of-the-art image processors and specialised programming.

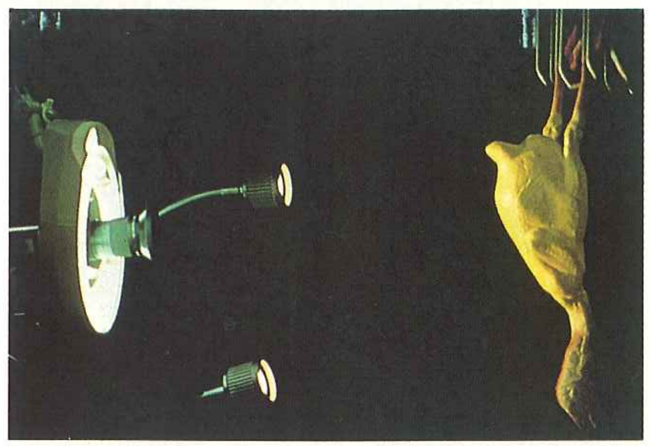
The researchers are currently working on two intermediate goals for their vision system; sizing birds on the moving processing line and identifying cut-up parts. To size a bird, the system must capture a clear image of the bird, then determine the bird's dimensions and calculate its size. Identifying parts is somewhat more complicated. Not only does the computer have to be programmed to tell the difference between a leg and a wing, but it has to recognise the different parts even though they never pass under the camera in the exact same position.

During system development, the researchers must also keep in mind the plant conditions in which the vision systems will have to survive. Processing plants pose many hazards to an electronic system. Some of the most serious are splattering water and grease, dirt, heat and the water blasts from daily washdowns. These conditions have been harsh enough to put computerised production systems beyond the reach of poultry processors for many years.

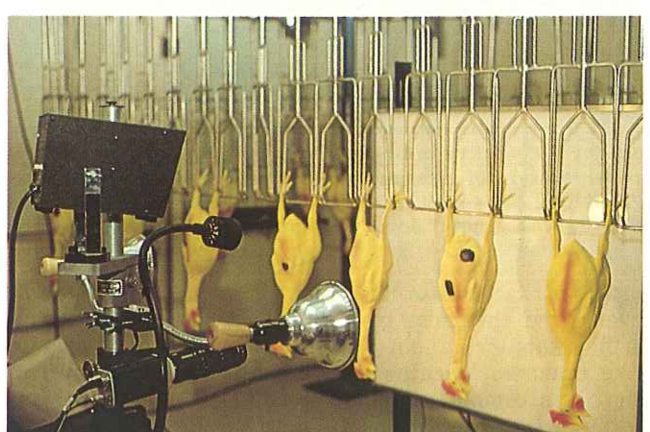
Fortunately, only one major component of a vision system has to be on the plant floor - the camera. The system's computers can be located safely away from the processing area, with data tranmission cables connecting the camera and the computers. This is not to say, however, that water cannot damage the camera. Being electronic, it also requires protection. Our engineers have developed a special enclosure for their system's camera. The front panel of the cover is clear plastic and will be treated with a nonfogging agent. The cover is watertight when sealed. If this method does not provide enough protection, they plan to try mounting the camera high above the processing line, leaving a lens, with protective covering, at bird level. A waterproof fibre-optic conduit will relay signs up to the camera.



Some machine vision systems can perform enhancement operations to emphasise parts of an image. This photo shows grey level enhancement, which makes discolourations or tumours stand out as obvious black spots on a lightly coloured image.



Proper lighting is essential to the operation of a vision system. Glare or shadows result in poor quality images, which can cause the computer to make less reliable decisions.



Georgia Tech engineers have constructed a computer-controlled processing line for use in developing their machine vision system. Using artificial birds painted to simulate bruised chickens, the engineers are programming an automatic grading system that will operate at normal line speeds.

Photos courtesy of Stephanie Babbitt.

The engineers have studied other complications the processing plant environment might cause in the vision system. For example, computers that must send data over long distances sometimes have trouble with interferences, or noise, on the data lines. A common cause is an electric surge from other machines running in the plant. However, video signals run on coaxial cables, which are less likely to pick up noise than are other types of data transmission lines; therefore, vision systems would tend to be less vulnerable than other types of in-plant systems. Also, from previous experience with electronic systems, the researchers have learned techniques for isolating data signals from interfering plant noise.

In addition to tolerating the plant environment, a truly useful vision system must operate in conjunction with existing processing plant equipment. For their prototype sizing and grading system development our engineers have installed a laboratory-scale computer processing line. They have also acquired a 5-foot conveyor, which they use for parts identification and grading work. The vision system will need to operate at speeds that would allow in-plant lines and belts to convey birds at their present rates, or faster.

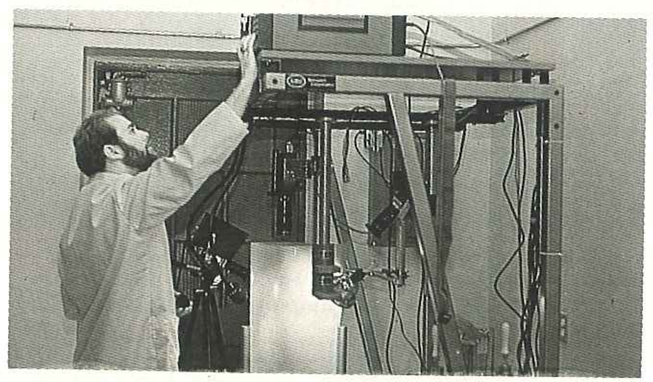
We believe that our research efforts in vision system programming will help pave the way for additional development of highly automated control systems for the poultry industry. "It's easier to expand or borrow from an established system than to start from scratch,"; observes project director Chris Thompson. "Our progress with these smaller-scale systems will be reflected in larger projects and possibly in commercial systems. Even though the development process is difficult and time consuming," he adds, "the returns in increased plant productivity with vision systems should be substantial.

The Future?

Over the past year, our machine vision system has received increasing attention from the poultry industry. One result is a question the researchers have begun hearing more often from industry members: "This system is interesting and applicable, but where will it go from here?" Using information on the industry's expected needs and keeping in mind the technology that will be available, our engineers have offered some predictions as to what machine vision will do for the poultry industry in the years to come.

Thompson suggests several potential uses for the developing technology. "In the near future," he says, "machine vision will likely be used for x-ray detection of bone chips and splinters in deboned meat." He explains that several commercial firms have expressed intent to develop an x-ray enhanced machine vision system that can be applied to in-plant bone detection, but that no such system has appeared on the market. "If the commercial sector does not begin developing this type of system soon," he adds, "then Georgia Tech may seek funding to begin research in this area." The biggest problem facing this type of system at the present time is the processing plant environment. "This sytem would require x-ray equipment to be located right on the deboning line," says Thompson. "Without extensive protection, water and humidity would quickly ruin the equipment."

Programming a vision system is a demanding task. Engineers began programming their cut-up parts identification system by placing parts under the camera and capturing the resulting images into the computer's memory. From those images, they defined patterns the computer will use when examining a new image.



A spectroradiometer is used to analyse the vision system camera's ability to record reflected light. Subtle differences in light reflected from a bird's skin can indicate a fault, which a good vision system should recognise.

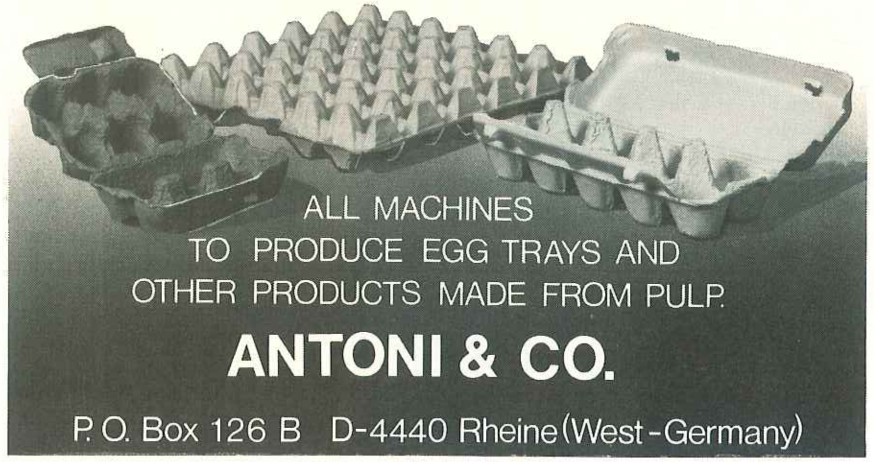
Poultry industry leaders have developed a strong interest in the potential that machine vision holds for increasing productivity. Here, engineer Chris Thompson demonstrates the automatic sizing system to three leaders of the Georgia State poultry industry. Photos courtesy of Stephanie Babbitt.

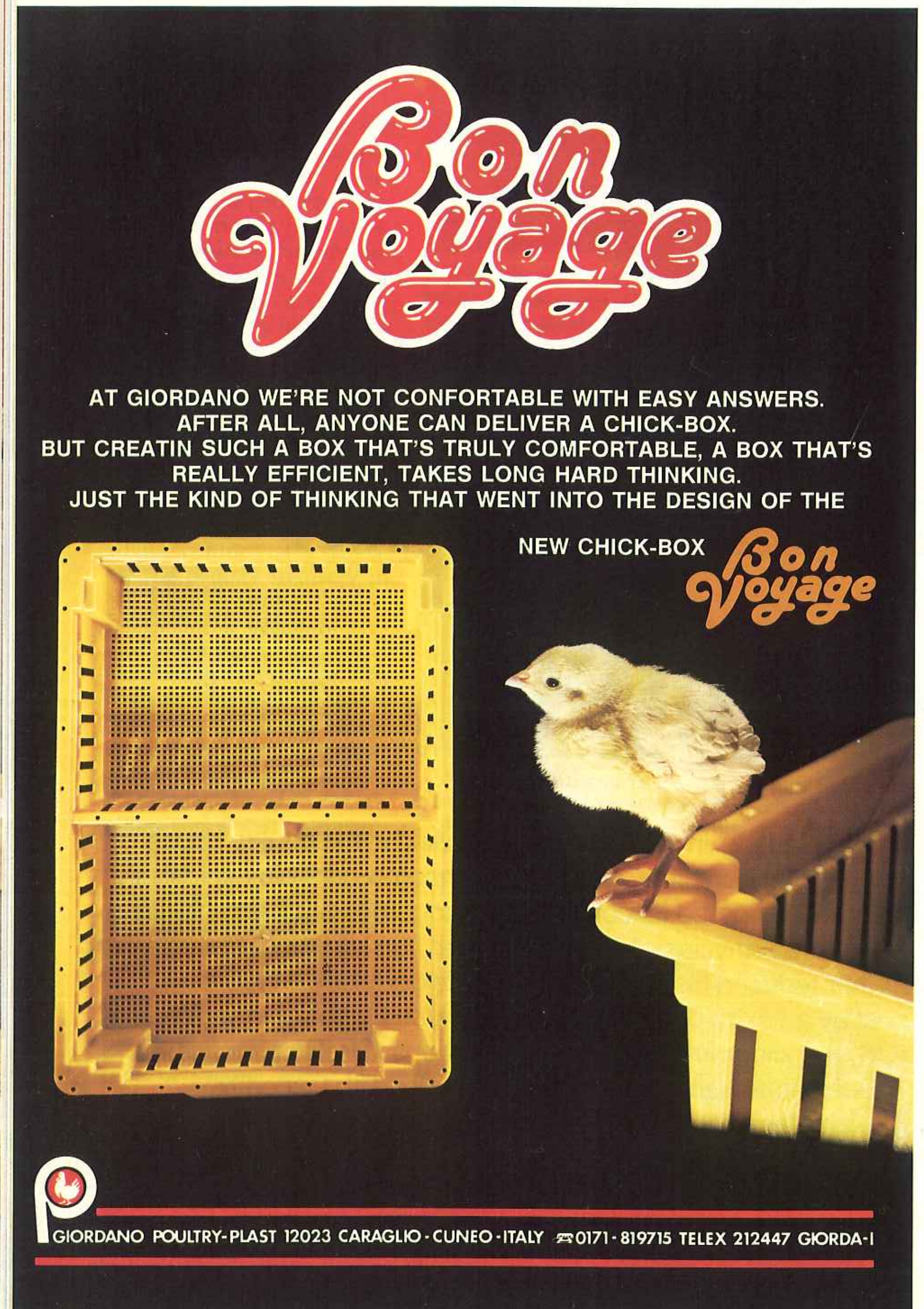
We believe machine vision holds potential for regulating product quality in other aspects of poultry products production, such as egg candling. "A machine vision system could inspect eggs as they pass on to a conveyor for cracks, abnormal shapes, or discolouration," says Thompson. Such a system would be more accurate than human candlers because it would inspect every egg with the same degree of thoroughness. The egg breaking industry also could benefit from machine vision quality inspection. "Machine vision could discover foreign matter, such as blood or eggshell bits, in the egg product," he explains.

If integrated with robotics technology, machine vision could provide even greater benefits, the engineers say. "In the candling example" says Thompson, "a robot could co-ordinate with the vision system to remove eggs that have been designated irregular. For another example, if combined with the Georgia Tech parts identification system, robots could sort cut-up parts into packages as they come down a conveyor."

As is the case with x-ray equipment, the biggest barrier to bringing robots into the plant is the problem of protecting them from the water and other damaging elements present in the plant. "Robots would have to be right on the line to sort product," notes Thompson. "That location makes them quite vulnerable. However, protection methods are improving, so robotics for poultry processing is no longer considered out of reach."

Integration of machine vision systems with other computer systems will provide additional speed and control in poultry processing. For





example, a machine vision system measuring bird sizes could instruct another computer controlling eviscerating equipment to adjust the depth of the spoon. This continuous adjustment would reduce faecal contamination from machine-ruptured intestines. Other combinations of computer technology could provide powerful and timely management information systems, which give managers continuously updated information crucial to decision-making.

Industry members have expressed curiosity about the use of machine vision to detect microbial contaminant levels in processed birds. Thompson explains that vision technology is currently not able to provide an effective decision in this area. "The microorganisms are so small, the magnification level necessary to allow the system cameras to 'see' them would have to be tremendous," he says. "To complicate matters, different types of microbes often look quite similar. Identifying undesirable ones would be very difficult,". However, he does not rule out the possibility that upcoming technology will lead to methods that could make microbial inspection possible in the future.

Machine vision shows immediate promise for providing fast, accurate parts identification, parts and whole bird grading, sizing, and eventually full post-mortem inspection. However, these functions seem to be just the beginning of the ways vision technology could benefit the poultry industry. The technology necessary to allow the functions we have envisioned is not that far out of reach. Perhaps as soon as the early 1990's, industry managers will be able to select and implement machine vision systems that will increase the quality, consistency and productivity of their operations. — *Stephanie Babbitt, Georgia Tech Research Institute, Atlanta, Georgia, United States of America.*

$1.2m Research Boost

Australian and Malaysian veterinary researchers have received a $1.2m Australian Government boost for a collaborative programme to further the development of the technique of vaccinating flocks against Newcastle disease by applying the virus vaccine as a coating on feed pellets. The technique has already shown promising results and could offer the opportunity for a major step forward in eliminating pockets of disease infection in rural flocks.