

MANUFACTURING INSIGHTS
Machine vision & Error Proofing

NARRATION (VO)

MANUFACTURING INSIGHTS, MANUFACTURING ENGINEERING MAGAZINE'S VIDEO SERIES FOR PROCESS IMPROVEMENT. THIS PROGRAM WILL EXPLORE MACHINE VISION AND HOW IT IS HELPING COMPANIES REDUCE THE COSTS OF QUALITY.

FIRST, WE VISITED BORGWARNER TURBO SYSTEMS, A COMPANY USING MACHINE VISION TO ERROR-PROOF THE ASSEMBLY OF THEIR TURBO CHARGER BEARING HOUSING CORES.

NEXT, WE WENT TO FORD MOTOR COMPANY'S WINDSOR ENGINE PLANT WHERE THEY ARE INTEGRATING MACHINE VISION WITH ROBOTICS FOR BIN-PICKING OF ENGINE CYLINDER HEADS.

AND FINALLY, WE WENT TO GOLDKIST, A LEADING SUPPLIER OF POULTRY. GOLDKIST HAS BEEN WORKING WITH THE GEORGIA TECH RESEARCH INSTITUTE AND BOC THINKGATES TO USE MACHINE VISION TO HELP THEM IMPROVE THE GRADING PROCESS.

-- TOUCH TO BLACK --

NARRATION (VO)

MACHINE VISION TECHNOLOGY HAS BEEN AROUND SINCE THE 1970'S. HOWEVER, IN THE EARLY 80'S A COMMITTEE OF SME MEMBERS COINED THE TERM 'MACHINE VISION'.

THE TECHNOLOGY HAS EVOLVED ALONGSIDE OF THE TWO MAJOR COMPONENTS OF A VISION SYSTEM: THE CAMERA AND COMPUTER PROCESSER

AS THESE UNDERLYING COMPONENTS HAVE IMPROVED IN BOTH PRICE AND PERFORMANCE, SO HAVE MACHINE VISION SYSTEMS. THE RESULT IS THAT OVER 40,000 SYSTEMS ARE INSTALLED ANNUALLY IN NORTH AMERICA ALONE. WHILE THERE ARE MANY DIFFERENT TYPES OF MACHINE VISION SYSTEMS, MOST ARE BASED ON CAPTURING A PICTURE OF A PART OR AN ASSEMBLY AND THEN ANALYZING THAT PART BASED ON THE APPLICATION REQUIREMENTS TO DETERMINE IF THE PART OR ASSEMBLY MEETS SPECIFICATIONS.

THESE DECISIONS CAN BE BASED ON DIMENSIONS, SURFACE ANALYSIS/COSMETIC CONDITIONS, COMPLETENESS AND PATTERNS SUCH AS TWO DIMENSIONAL SYMBOLS.

VISION SYSTEMS THAT PERFORM ONE HUNDRED PERCENT INSPECTION WILL DETECT BOTH SYSTEM AND RANDOM ERRORS. THOUGH SPC SYSTEMS WILL EVENTUALLY FIND

SYSTEM ERRORS, VISION SYSTEM CAN FIND ALL MAN OR MACHINE PRODUCTION ERRORS.

DIRECT SAVINGS WILL COME FROM THE ELIMINATION OF SCRAP, REWORK, WARRANTY REPAIRS, PRODUCT RECALLS AND IMPROVED PRODUCT RELIABILITY. IN SOME CASES PRODUCTIVITY GAINS ARE POSSIBLE WITH INCREASED MACHINE SPEEDS AND FEWER EQUIPMENT BREAKDOWNS.

THIS PROGRAM WILL DEMONSTRATE THREE APPLICATIONS OF MACHINE VISION. EACH MACHINE VISION SYSTEM IS USED TO ERROR-PROOF A PRODUCTION LINE RESULTING IN INCREASED QUALITY AND ECONOMIC PAYBACKS OF LESS THAN A YEAR.

-- TOUCH TO BLACK --

NARRATION (VO)

BORGWARNER, LOCATED IN ASHEVILLE NORTH CAROLINA, IS A LEADING PRODUCER OF TURBO CHARGERS FOR THE COMMERCIAL DIESEL INDUSTRY. THEY MADE A DECISION TO REDUCE WARRANTY COSTS AND REWORK FOR THE BEARING HOUSING CORES FOR THE TURBO CHARGERS THEY MANUFACTURE.

THE DECISION TO ERROR-PROOF THIS LINE WAS DRIVEN BY BORGWARNER'S DESIRE TO CHANGE FROM BATCH PRODUCTION TECHNIQUES TO SINGLE PIECE FLOW.

BRIAN GADDY, ON CAMERA

The old method of building turbos, we would build in batch sizes. We used shadow boards and we would build five bearing housing cores at a time. We would lay five bearing housings out, drive in five roll pins, drive in five filter cups, and just pick up five parts at a time, and do the installation on five pieces. Then we'd go pick up the next piece part and install it on five pieces.

Now we've basically gone with a single process flow. We load a bearing housing on the pallet and we actually build it completely, which adds to lean manufacturing. It's decreased our WIP.

We make a wide variety of turbo chargers for the commercial industry. Basically we're still building turbo chargers that we built 20 years ago. Overall we probably build over 2,000 different part numbers. What we've decided to do on these new assembly lines, we have dedicated them to product families.

In those families we have about 300 different part numbers, so it puts things in a realm we can control. During an eight hour shift we can produce 200 to 225 turbo chargers.

NARRATION (VO)

THE BORGWARNER VISION SYSTEM IS INTEGRATED INTO A "PICK-TO-LIGHT" SYSTEM

BRIAN GADDY, ON CAMERA

The vision system is enabled through the PLC. We have product files for all of our 300 different part numbers that are stored in the PLC.

Every time the operator loads a pick, then the PLC loads a new vision program into the camera.

The PLC loads the vision programs into the camera, and it also is telling the Pick to Light system what pick the operator needs to make next.

NARRATION (VO)

THE VISION SYSTEM'S LIGHTING ARRANGEMENT IS COAXIAL WITH THE COGNEX CAMERA. IT CONSISTS OF AN ARRANGEMENT OF RED LIGHT EMITTING DIODES DESIGNED TO ILLUMINATE THE INTERIOR OF THE BEARING HOUSING.

BRIAN GADDY, ON CAMERA

The PLC is telling the operator which part they need to pick to place into the unit. The operator picks that part, puts it into the unit. Then they activate a palm button, and that palm button actually triggers the camera to take its picture. Then it sends back a good part signal or a bad part signal. If it's a good part signal, then the PLC proceeds with the build sequence. If it's a bad part signal, then the operator sees it's a bad part and they have to try to take the picture again by hitting the palm button again.

NARRATION (VO)

THE VISION SYSTEM PERFORMS INSPECTIONS TO VERIFY CORRECTNESS OF ASSEMBLY AFTER EACH ASSEMBLY STEP IS PERFORMED BY THE ASSEMBLER.

BRIAN GADDY, ON CAMERA

The camera systems specifically check for the correct internal components in our bearing housings. It also checks to make sure they're placed properly. We do some distance measurements and things like that. Some of our parts are very similar across our different models, so we have to make sure that somewhere down the line our supplier didn't send us a mixed batch of parts.

We run the assembly cell three shifts a day. Normally we run five days a week, but within recent months we've been running a lot 6 days a week.

The reliability of our assembly lines has been very good. Since we started producing parts on the line about a month and a half to two months ago, we've had very few problems with it. To my knowledge we haven't received a customer return yet off those assembly lines.

So basically the reason we decided to go with vision systems was to improve the reliability of the parts going to our customer. When you don't produce a lot of parts, if you do have a defect it really hurts, and that really shows in your PPM rating. If we built 15,000 units a day and we made one bad part a day it wouldn't be extremely bad. But when you're only producing 2,000 or 3,000 parts a day and you have a bad part, it looks a lot worse on your PPM rating.

The way we were able to justify going with vision systems is because of the customer returns we were getting. We were getting back a lot of bearing housing cores that had incorrect components in them, had misassembled components.

NARRATION (VO)

WITH THIS MACHINE VISION INSTALLATION AT BORGWARNER, THE ERRORS ASSOCIATED WITH THE PRODUCTION OF BEARING HOUSING CORES HAS BEEN REDUCED FROM 700 PARTS PER MILLION TO VIRTUALLY ZERO.

IN ADDITION TO ELIMINATING THE COSTS ASSOCIATED WITH WARRANTY REPAIRS, FIELD RETURNS, REWORK AND SCRAP, ELIMINATING ERRORS HAS RESULTED IN MORE SATISFIED CUSTOMERS.

BECAUSE OF THE QUALITY GAINS AND THE ECONOMIC PAYBACK FROM THESE EARLY INSTALLATIONS, BORGWARNER TURBO SYSTEMS PLANS TO PURCHASE THREE MORE ASSEMBLY LINES WITH INTEGRATED VISION SYSTEMS.

-- TOUCH TO BLACK --

NARRATION (VO)

AT FORD MOTOR COMPANY'S WINDSOR ENGINE PLANT, CORRECTLY POSITIONING HEAVY PARTS DURING ASSEMBLY APPLICATIONS NEEDS TO BE DONE RIGHT EVERY TIME.

WHEN YOU FACTOR IN THE GOAL TO BE FLEXIBLE WITH THE MATERIAL HANDLING SO THAT THE EQUIPMENT CAN BE EASILY ADAPTED TO NEW PARTS OR PARTS WITH DIFFERENT DESIGNS, THE USE OF ROBOTICS IS THE RIGHT CHOICE.

HOWEVER, WHEN REPLACING PEOPLE WITH ROBOTS YOU LOSE THE VISION THAT PEOPLE USE WHEN THEY MOVE PARTS AROUND. SO IN MOST CASES, THERE IS A NEED TO PROVIDE THE ROBOT WITH VISION TO DO THE JOB RIGHT.

WHEN THE PARTS IN A WORKSTATION ARE DELIVERED LOOSE IN BINS, 3-DIMENSIONAL MACHINE VISION IS GENERALLY REQUIRED. TO OPTIMIZE PERFORMANCE. EVEN WHEN THE PARTS ARE NESTED, THERE ARE STILL CHALLENGES WITH ORIENTATION AND POSITION.

FRANK MASLAR, ON CAMERA

The initial application for this technology was for the handling of cylinder heads. The cylinder heads come into the engine assembly cell in a box, a pallet, and they're not very tightly constrained as far as their position goes. They can move in the X and Y plane, and they can shift and bounce and come in actually crooked off the floor of the box. We use the vision system to determine the real 3D pose of the part in the container. Then the robot goes and acquires the part and decks it onto the engine in that station.

Before we were using machine vision for this application, it was a very labor intensive operation. We had a human, an operator, remove the cylinder heads from the containers, and actually place them onto a custom high-precision pallet. That would be indexed into an assembly cell where they would be automatically loaded onto an engine by a gantry-type robot, a very simple, blind robot. But we had to have the operator in the loop, because the position of the cylinder heads was variable, and it could move around quite a bit, and we needed the human's ability to adapt and recognize where the parts are and actually pick the parts up without damaging the machine surfaces.

NARRATION (VO)

FORD REALIZED THAT BY MINIMIZING THE HUMAN INTERACTION WITH THE CYLINDER HEADS THERE WAS AN OPPORTUNITY FOR ERROR-PROOFING THE OPERATION.

FRANK MASLAR, ON CAMERA

Our main driver in implementing these systems is quality, and we want to eliminate those possible defects caused by mishandling, where we damage the sealing surfaces, and eliminating any skin contact on our sealing surfaces. Our second main driver is actually ergonomics. Cylinder heads are relatively heavy, and if the operators are picking them up, it can cause injuries due to repetitive motions.

NARRATION (VO)

HOWEVER, QUALITY AND ERGONOMICS WERE NOT THE ONLY REASONS.

FRANK MASLAR, ON CAMERA

In between machining operations, between our suppliers, between engine assembly, there's a few thousand containers. One of the main drivers in the overall project was to minimize the cost of the containers. We had considered going with a blind robot and using precision dunnage. The issue got to be that the precision dunnage would wear out over time and need to be replaced, and it was a lot more expensive to build in the first place. By going with a low cost, low accuracy container design, and using machine vision to guide the robot to acquire the part, we were able to reduce the overall cost.

NARRATION (VO)

IN ORDER TO IMPLEMENT THE VISION SYSTEM PROPERLY FORD FIRST HAD TO UNDERSTAND THE IMPACT OF SURFACE FINISH AND CYCLE TIME REQUIREMENTS.

FRANK MASLAR, ON CAMERA

We do have some part to part variation with the appearance of the surface, whether it's reflective, oily or dry, for example, and that can affect the performance of the vision system as well. We're tackling a lot of these challenges through redundancy. The way the system operates is we acquire one image, and we recognize 15 features on the cylinder head.

We really only need about 6 to calculate the position of the part, but by acquiring 15 we have a lot of overlap and a lot of redundancy. Then the way the system actually works is we use all 15 features to calculate the position of the part. Then once we have that position, we back-calculate where the vision system should have found the features. If the features are not where we think we ought to be, then we throw them out of the population and we recalculate the position again, so we can tell what features are true and what features are false. Another thing we do is we actually go through that whole routine twice. We program the robot to look at the part where we think it ought to be if it was in a perfect location and a perfect bin, and we calculate where the part is. Then we move a little bit to be exactly perpendicular over where the part actually is, and then we calculate the position again. That's how we're getting our very good accuracy, repeatability and robustness, is through all the built-in redundancies of the system.

The final position and accuracy of the pickup location is determined by the tooling. We're actually picking up the cylinder heads by going into four bolt holes with expandable pins. The clearance between the pins and the bolt holes is about half a millimeter. So the tolerances are very tight. We can go plus or minus a quarter millimeter in X and Y, and the rotation is limited to under half a degree.

The total cycle time of the process... again, the robot is first positioned over the rough position where we think the part ought to be, and then we calculate its position, and that takes about a second and a half. Then we adjust the robot position, acquire another image, and calculate the true position of the part once again, and that takes another second and a half. Then we acquire the part and move it and deck it onto the cylinder head, and that takes quite a bit longer, about 10 seconds for the whole acquiring the part and placing it onto the engine and moving back to that home or pounce position. So the whole vision cycle itself is under 5 seconds, more like 3 seconds.

NARRATION (VO)

THE VISION SYSTEM HAS TO ACCOMMODATE DIFFERENT VARIATIONS OF CYLINDER HEADS WHILE INTERFACING TO A LINE PLC THAT TELLS THE COMPUTER WHICH PART IS COMING DOWN THE LINE.

FRANK MASLAR, ON CAMERA

when a stack of parts is delivered to the robot cell, the first thing the robot does is read the RF tags to make sure the right parts were put in the right place. Once that's verified, then we just go ahead and blindly pick out of those using the vision system to tell us where the parts are. But we use a combination of the PLC to tell us our mix and our next requirements, along with the RF tags on the pallets to make sure we have the right parts. There are also some algorithms in the vision that can determine if we have the proper part or not. So even if the RF tag is programmed wrong, for example, and the wrong parts are delivered but the RF tag thinks they're correct, the vision system can detect if the wrong parts are in the bins, and it won't pick them up.

NARRATION (VO)

FORD ALSO TAKES ADVANTAGE OF OTHER CAPABILITIES INHERENT IN THE VISION HARDWARE.

FRANK MASLAR, ON CAMERA

While we have our cameras mounted on the robot arm that are pretty much dedicated to the part acquisition routine, there are additional inputs on the frame grabber board that we can take advantage of. In some stations we have added cameras as assembly verification aids. For example, on our cylinder heads in the decking operation, there is a locating pin that's about 10 inches long that is manually inserted into the engine block before the head is decked. We do that so that after the head is decked, it doesn't slide off the deck face on the V engines. So we added a vision system into the cell to check for the presence of the pin. If the pin is not there, then we're not going to assemble a cylinder head onto the engine block.

NARRATION (VO)

INTERFACING WITH THE SYSTEM ON SEVERAL DIFFERENT LEVELS IS STRAIGHTFORWARD.

FRANK MASLAR, ON CAMERA

For our line operators and low skill level people that might be interfacing with the cell, most of the operations and interaction are done either with a robot teach pendant or through the cell controller PLC screen.

There is a separate vision PC that runs all of the vision algorithms and such, and associated with that PC is a separate, normal monitor and keyboard, and that's what we use. We use the interface software that Braintech developed to help identify features and map the vision processing strategy and their interface software. It's very graphical in nature and very easy to use.

The part training, or the training and programming of a new part, is relatively straightforward. It's basically acquiring the images and then identifying features that we can use for location. Each of the feature recognition algorithms is actually a correlation technique that's done on the part feature. The programming is basically sizing and positioning the regions of interest around the features that we're going to use.

The training for the system was really quite easy. We have it in several different phases, and the normal production operator is not even really aware that there's a vision system in the cell. So to them it's really no different. We've given a higher level of training to our skilled trades and maintenance personnel so they can know if there is a failure of the system, how they can diagnose the system and do some troubleshooting, to see if we have a dirty lens for example.

NARRATION (VO)

FORD HAS DESIGNED THE SYSTEM TO BE RELIABLE AND HAS BEEN SATISFIED WITH THE PERFORMANCE.

FRANK MASLAR, ON CAMERA

I believe the system is now working in production around the clock, so we have it running three shifts at least five days a week. It's proven to be very robust. Throughout North America we have about 40 of these systems deployed, so this is not just a single instance.

NARRATION (VO)

CALIBRATION INVOLVES INTEGRATING THE COORDINATES OF THE ROBOT AND VISION SYSTEM.

FRANK MASLAR, ON CAMERA

With vision guided robots, calibration of the system is very important, and it's a very big deal. It's traditionally been a long, excruciatingly painful process. It involves a lot of high accuracy targets and things like this. We knew going into this project that having that kind of calibration routine was not going to be good in production, that we needed something that was very simple, very fast, and very easy to do. So I worked together with ABB and with the Braintech people, and we have an automatic calibration feature for these cells. Each of the cells with the vision guided robots has a calibration target permanently mounted in the cell.

We have made this and brought it up to a very high level function, and now calibrate the camera is actually a one-button push on the robot teach pendant. That's all the maintenance technician has to do is push one button on the teach pendant, and it's calibrated. It does it all by itself, automatically.

NARRATION (VO)

THE VISION SYSTEM HAS PAID FOR ITSELF IN SEVERAL WAYS.

FRANK MASLAR, ON CAMERA

Our savings were through the fact that we use a relatively standard, off the shelf, six axes robot, compared to a dedicated gantry, which was a custom design, custom build, and all the costs associated with that. Operational costs, including labor savings, ergonomic savings, by automating the manual operation. And we also have the savings associated with the dunnage, the fact that we can use low tolerance dunnage, and cheap, reusable dunnage, there's a real savings there. So we actually did the business case several different ways, and the payback for the vision guided robot system was less than a year. So we had a very good return on our investment.

-- TOUCH TO BLACK --

NARRATION (VO)

GOLDKIST, A LEADING SUPPLIER OF CHICKENS, HAS WORKED WITH THE GEORGIA TECH RESEARCH INSTITUTE AND BOC THINKGATES TO INTRODUCE MACHINE VISION INTO THEIR PRODUCTION OPERATIONS TO GRADE CHICKENS.

TOM BRADFORD, ON CAMERA

The installation of the vision system was originally a joint venture between Gold Kist and Georgia Tech. Gold Kist handled the physical installation of the equipment, and Georgia Tech handled the technical part of the installation. The only thing we did during the process was the line had to be elevated to have separation in the birds for the camera to actually photograph individual birds. We had to break down and elevate the line so when the birds went up they had a separation for the camera.

COLIN USHER, ON CAMERA

It's kind of a process verification tool, so you can go back and look at... the idea for it is to be an inspection unit that would carry out the inspection tasks and that would do prescreening and presorting to speed up the inspection tasks. But due to USDA regulations such as they are right now, it's not being used that way because they still have to have 100% inspection by inspectors on the line. So we're using it now as kind of a verification tool. If you make process changes up the line, you're able to see those effects through the system, you're able to judge whether or not you've reduced broken wings for instance, when you change the picker settings or you change some of your upstream processes, you can verify whether or not you're improving that process with the system.

NARRATION (VO)

THE SPECIFIC CONCERNS THAT HAD TO BE DETECTED MOSTLY HAD TO DO WITH SURFACE CONDITIONS.

COLIN USHER, ON CAMERA

There are certain defects that the vision must identify and must handle, such as septicemia toxemia, which is a disease that affects the entire bird. These defects are called systemic defects. Things like cadavers or overscalds, these are birds that were going through a scald bath too long and it burned red into the tissue, so the product is unacceptable to go into further processes. Other defects such as broken wings, mis-hung birds, bruises and skin tears, are defects that affect the plant, but they are not critical defects.

NARRATION (VO)

AS CAN BE APPRECIATED THERE WERE MANY VARIABLES THE VISION SYSTEM HAD TO BE ABLE TO HANDLE.

COLIN USHER, ON CAMERA

The system is designed to accommodate any size of chicken in any processing plant. The different things you can do is change the field of view of the camera, or even moving the system further or closer to the product itself will allow it to handle larger chicken. Variable input, such as the field of view and dimension of the field of view, allow you to calibrate the system to handle birds from the smallest you can get, even quail, up to birds as large as turkey.

The vision system needs to be installed at a 90 degree angle, just basically facing straight onto a processing line. As the product goes by it, we achieve separation by having a rise in the line that causes the birds to separate. That means we need to have some rotation with the camera, where we can handle up to about a 45 degree angle rotation, to basically align the camera's view up with the product itself.

Depending on the user's determination of what types of defects they want to identify, for instance the size of bruises that they want, the system can be adjusted to identify and classify any types of size defects area that it covers.

The current line rate of the vision system is running at 140 birds a minute right now. We have run the system on a 180 birds a minute and we have also run the system on a 90 bird a minute line. So the detection rate is a variable rate.

NARRATION (VO)

THE APPLICATION ENGINEERING ASSOCIATED WITH THE MULTIPLE DISCIPLINES OF LIGHTING, OPTICS, CAMERAS AND ALGORITHMS LEAD TO THE SUCCESS EXPERIENCED.

COLIN USHER, ON CAMERA

The current lighting arrangement has been custom designed to accommodate for the angles and the features of the chicken, in order to establish lighting in areas that might be more shadowed, just because of the shape of the product that we're looking at. It's a regular fluorescent, high frequency lighting, but we're actually looking at using strobed lighting and using LED lights in order to reduce power and heat in the box itself.

NARRATION (VO)

EACH INSPECTION STEP THE VISION SYSTEM PERFORMS IS RATHER SIMPLE. THE REAL CHALLENGE WAS BEING ABLE TO HANDLE THE SPEED REQUIRED TO KEEP UP WITH THE LINE.

COLIN USHER, ON CAMERA

As each product comes in to be presented to the vision system, a beam switch trigger will fire the vision system in order to take a picture of the product as it's passing. Then the product is digitized, a variety of algorithms are processed on it, outputs are determined, and then the process repeats for each chicken that goes by. The trigger is fired off of the shackle itself as it passes the system.

NARRATION (VO)

TO THE SHOP FLOOR USER, THE UNDERLYING TECHNOLOGY IN THE VISION SYSTEM IS TOTALLY TRANSPARENT.

COLIN USHER, ON CAMERA

So the user interface has been setup to let the user to define how dark does a bruise need to be before we can detect it; how big does a bruise need to be before we flag it. These types of settings are set through the user interface. However, during normal operation, there essentially is no user interface. The data is fed through a database system and is used in an alarming system. For instance, if broken wing rates pass a certain threshold variable, some alarm will be set to notify someone, and they are able to address the situation.

NARRATION (VO)

ULTIMATELY, THE VALUE IN THE VISION SYSTEM STEMS FROM UNDERSTANDING AND USING THE DATA GENERATED. THIS REQUIRED A TEAM EFFORT.

HARLEY MOORE, ON CAMERA

What BOC is doing, we're trying to be able to help the plant to take specific faults or quality issues and bring them back to the beginning, whether the problem was done during the picking process, during the transportation process, or just something that was done at the farm. So it gives some accountability to the plant to be able to track back through data where things have happened to the birds.

We're trying to put together some information that will allow them to actually be able to come back and put specific faults to specific events. Like tears in certain sections of the skin or bruising with different coloration, we can say this was a bruise that happened during transportation, or this was a bruise that happened during stunning, or this was a tear that happened during the picking process. Really to put it back to cause and effect.

JOHN RENAUD, ON CAMERA

That data comes in real time, and we're monitoring that as it comes in, along with a lot of other data. The reason we're looking at that is so we can react quickly to things we see and find, whether it's coming from the vision sensor or another sensor in the network.

COLIN USHER, ON CAMERA

Currently the system is cataloguing and databasing everything that goes by. For each defect that goes by, it is recorded and you can go back to verify it. The system is designed to be able to remove a systemic defect, or defects that can't go further into processing, if a proper device is installed on the line. One of the important aspects of the system is it can be used as a tool to give you a quick alarm on your process.

NARRATION (VO)

THE PLANT HAS SEVERAL FACTORS THEY CONSIDER WHEN LOOKING AT PAYBACK FOR THE SYSTEM.

COLIN USHER, ON CAMERA

The payback in the system should be by improving your yield, and increasing yield by verifying changes in your process to make sure they're right. Also, with an installed device for removing the line, plants that have moved to the Hemp system would be able to have fewer inspectors or have lighter loads on the inspectors, because it can operate as a pre-screener. This would allow fewer personnel or improved job reliability.

The vision system as it is currently installed is part of a management system that looks at different variables and different settings on plant equipment. Theoretically you could take the vision systems log data and identify at what period in time a particular defect began happening, or a large increased number of defects began happening. You can then cross reference that to your settings of your different process variables, and you can identify where change is happening in the plant, which may allow you to identify where that defect was caused. A good example of that could be picker settings. Adjustments made in the picker settings may increase or decrease number of broken wings. When you're talking half a percent, it's very difficult for a manual inspector to notice anything like that, but a vision system that's looking at 100 percent of the product would be able to notice that.

-- Touch To Black --

NARRATION (VO)

WE HAVE SEEN MACHINE VISION INSTALLATIONS IN A NUMBER OF INDUSTRIES. THESE COMPANIES ARE USING MACHINE VISION AS PART OF A COMPREHENSIVE

ERROR-PROOFING PLAN THAT CAN YIELD SIGNIFICANT PAYBACK. THE PRICE/PERFORMANCE OF TODAY'S MACHINE VISION SYSTEMS CAN PROVIDE REPEATABLE, CONSISTENT AND RELIABLE PERFORMANCE AT PRICES THAT CAN RESULT IN QUICK PAYBACKS. AS OBSERVED, TODAY'S SYSTEMS CAN OPERATE SUCCESSFULLY IN VERY DEMANDING ENVIRONMENTS WHEN ATTENTION IS PAID TO DETAILS.

AS AN ERROR-PROOFING SENSOR, MACHINE VISION WILL RESULT IN BETTER YIELD FROM PRODUCTION PROCESSES BY SENSING CONDITIONS THAT CONTRIBUTE TO SCRAP OR CONCERNS THAT WOULD IMPACT A CUSTOMER. THE SIGNIFICANCE IS TO RECOGNIZE THAT MACHINE VISION IS ANOTHER SENSOR THAT ACTS AS A DATA COLLECTOR AND TO RECOGNIZE THAT THERE IS VALUE IN THAT DATA.

MACHINE VISION SYSTEMS AUTOMATE DATA CAPTURE AND CAN BE INSTRUMENTAL IN PROCESS CONTROL. BY RECORDING THE DATA FROM VISION SYSTEMS, INPUT ERRORS ARE SIGNIFICANTLY REDUCED AND HUMAN INTERACTION MINIMIZED. THE DATA CAN PROVIDE MORE THAN JUST ACCEPT/REJECT NUMBERS AND CAN INCLUDE TRENDS AND EARLY WARNINGS ON CONDITIONS THAT MAY RESULT IN REJECTS SO OPERATORS CAN BE ALERTED TO TAKE CORRECTIVE OR PREVENTATIVE ACTION. THE DATA CAN BE USED TO SORT BY CONDITIONS THAT CAN BE REWORKED AND THE REASON FOR REWORK.

MACHINE VISION CAN BE QUANTITATIVELY JUSTIFIED BASED ON THESE CONDITIONS: SCRAP AND REWORK REDUCTION, SCRAP DISPOSAL COSTS, INCREASED EQUIPMENT UTILIZATION, REDUCED INVENTORY ASSOCIATED WITH REWORK, REDUCED MATERIAL HANDLING COST AND DAMAGE AND REDUCED WARRANTY COSTS.

MACHINE VISION SYSTEMS REDUCES BOTH OF WHAT HAVE BEEN CLASSIFIED AS THE COSTS OF QUALITY: THE COST OF PREVENTION AND THE COST OF FAILURE. PREVENTION COSTS ARE GENERALLY ASSOCIATED WITH INSPECTION COSTS OR THE COSTS OF EXISTING PRACTICES IN PLACE TO AVOID QUALITY PROBLEMS. THE COST OF FAILURE INCLUDES BOTH INTERNAL FAILURE COSTS THAT ARISE FROM NONCONFORMING MATERIALS BEFORE THEY ARE SHIPPED AND EXTERNAL FAILURE COSTS OR THE COSTS INCURRED WHEN A CUSTOMER HAS PROBLEMS WITH THE PRODUCT AFTER IT HAS LEFT THE MANUFACTURER. IN ADDITION, IT VIRTUALLY GUARANTEES THE CONSISTENCY AND PREDICTABILITY OF QUALITY.

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