NEW GATE TECHNOLOGIES
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Automated inspection centers for automotive catalysts

NEWSLETTER :: SEPTEMBER 2011

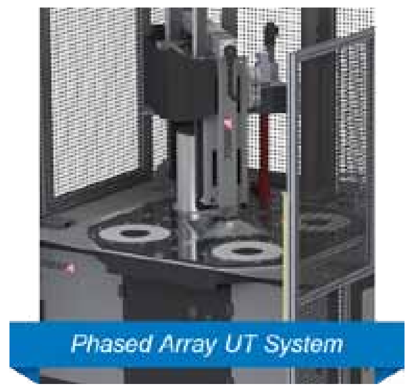
This month's in-depth article, Building an Automated Phased Array UT Inspection Center, reviews a case study where New Gate developed an innovative solution for automating a customer's ultrasonic inspection process. Be sure to chech out our YouTube channel (**youtube.com/newgatetech**) to watch this month's feature video: the CATPRO VP1520, an automated inspection solution for the detection of cell channel blockage in flow-through catalysts and leakage in DPF substrates. Finally, learn why quality has value in our President's Letter.

We're pleased you could take a few minutes to join us. Remember, we are always looking for your feedback on the type of content that is relevant and real for you. Enjoy!

Building an Automated Phased Array UT Inspection Center

This is part 2 of a 2-part series. Part 1 examined moving from random sampling to 100% inspection.

In Part 1, we discussed our phased array solution for a customer who wanted to automate their ultrasonic testing (UT) inspection process. In Part 2, we'll describe the phased array solution in more detail and break down the resulting data.



Phased Array UT System

The Project: Understanding the Customer's Needs

To review, our customer was performing manual pulse echo profiling of diesel particulate filters (DPFs) and they approached New Gate Technologies about automating the process. They thought automation might not be possible because of costs and the fact that previous in-house attempts had failed.

The customer needed to:

- reduce the 10-minute per piece inspection cycle to 45 seconds.
- execute entire automated scans rather than the partial manual scans they had been performing.
- employ a robust production-line-based testing solution in order to achieve 100% inspection of every piece.
- increase the accuracy, repeatability, and amount of data collected in the inspection.
- combine the desired results in a system that could be managed by production line operators.

The Process: Defining a Complete Solution

The customer thought that an array of nine (9) pulse echo probes should be adapted for automated scanning but New Gate Technologies wanted to take a different approach. After substantial research and discussions with the customer, New Gate engineers determined that phased array UT, if applied properly, would provide more consistent results and better lend itself to the automated process, but there were significant challenges in designing a phased array solution.

Overcoming Unique Design Challenges

In any ultrasonic inspection processes, it is critical that the inspection probe come into complete contact with the work piece. In normal UT applications, a coupling media—usually water, gel, or an elastomeric material formulated for signal continuity and air gap elimination (combed with gel)—is used to intimately couple the probe with the part. The first challenge the engineers confronted in this project was the need to create a probe-work piece contact without water or gel because the work piece could not be exposed to moisture. This was coupled with the issue in phased array UT of moving the probe across the surface of the part. Through research and experimenting, the team came up with an ingenious solution to keep the part dry in the coupling process while moving the probe across the part.

After overcoming the part coupling and probe moving issues, the engineers engaged a UT supplier to provide a specially-designed phased array probe that met the requirements and specifications for the application. Next the team turned their focus to designing the probe "head," which would need to engage the part, then scan and release it within the 45-second cycle time, without compromising the inspection repeatability, accuracy, or work piece quality. After the engineers determined that the defined system could achieve the required cycle time, they went to work building the test system they would use to validate the method.

Building the Test System

Sometimes design engineers tend to focus on the fundamental elements of the process, instead of the relative design considerations. Our team has extensive build experience and knew that developing this test method meant investigating how each individual component worked together. Not surprisingly, many of the initial design challenges appeared in new forms as the system started to take shape. One such challenge was the size of the "scan head." It was designed to work on parts up to 15" in diameter, meaning the probe and related components had to be larger than any ever made up to that point. Another consideration was building a support structure as the system applied pressure to the piece. In order to create stability and decrease the system's sensitivity to the natural frequency of its surroundings, it needed a solid framework that would help absorb external vibrations. Once these and several other complex issues were solved, the team had a reliable, well-built test system which they used to validate scanning capability and evaluate different control scenarios. Control mechanisms and code were developed to precisely move the probe at the maximum allowable speed without causing voids in the data. The team ran thousands of cycles and settings in order to achieve the best combination of speed and accuracy.

Adding Automation

With the method well proven, the engineers turned to the development of automation systems which would need to interface with other automation on the line (robots, process equipment) and run in an environment that was not necessarily always monitored by people. In the customer's application, a 6-axis robot would place the part onto our system's "load platform," then the system would read a 2D data-matrix code to identify the part for traceability. The team had to consider several factors, such as: was the work piece the anticipated part (identified by height and diameter)? Was the part placed properly onto the load platform? Were there any other unexpected features on the part that could cause damage to the part or the system? In any automated part handling system, a great deal of effort goes into ensuring that the system is operating correctly and the parts are being properly handled.

In the final stages, much of the process was focused on protecting the system from itself, other equipment, and technicians who might work with the equipment as it operated. The team created a system of sensors, safety equipment, and control code which would work in any scenario and ensure continuous operation, handled variability, and provide repeatable and accurate results.

You might be wondering: if it was so difficult to apply the technology in this inspection application, is phased array worth it? The answer is yes. The amount and quality of data achieved using phased array is orders of magnitude greater compared to conventional single probe pulse echo scans. If the challenges can be overcome, phased array is also better suited for an automated approach.

As a result of the development effort, the complete solution included well thought-out strategies for inspection, mechanical, electrical, and control systems, delivered reliable data which ensured the quality of parts flowing down-line, and assisted in controlling upstream processes. The solution met all of the customer's needs and enabled them to collect (and continue to collect today) the kind of data that can be analyzed and understood by those who may not be trained in UT analysis.

Speaking of data, our extensive experience in data collection and management has taught us that in order to create a system that provides useful and understandable data, we must educate ourselves on the data first.

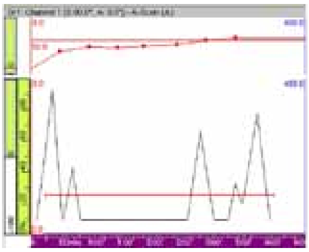
Developing Useful and Understandable Data

In the process of defining an automated inspection solution it's easy to forget that people must interface with the system every day and that the data and interfaces have to be useful and understandable. In the UT world, this is especially important to remember because UT data can be very confusing and appear to have no value. After all, what does a user see? If all an operator has to look at is a graph of a scan (common in single probe UT), it can be very difficult to draw any conclusions.

Advantages of Phased Array UT Data

In order to understand the value of phased array UT data in this application, we need to point out the differences between it and conventional single probe UT data. In a single transducer probe application, a single transducer sends a pulse into the work piece at one point on the surface of the part. The resulting "echo" from that pulse is then received at the same point by the probe. Because the data is isolated to that one point on the surface of the work piece, the inspected surface area is very small. In addition to the limited coverage of the single probe, the data displayed is only one-dimensional, known as an "A" Scan view (Fig. 1). While this data is generally adequate for lab tests, it is difficult to translate into an easily understood visual representation.

The A Scan is a side view of the work piece with a signal spike indicating where a defect has occurred over the length of the part. This data is from one single point on the work piece. The signal spikes at left indicate the "front wall" of the part and the spikes at right indicate the "back wall." The spike in the middle that breaks the gate (the red threshold line towards the



bottom) indicates an early return signal that could be coming from a defect. As you can see, using this data by itself can be very subjective.

In contrast to single transducer inspection, the phased array UT probe is made up of a number of transducers in a row. These transducers act together in groups that are pulsed in phase with one another. This phased approach provides a "wave front" that covers the entire surface as the probe moves across the work piece. This wave front and the resulting echo provide a 3D view of the part. The four views relevant to this application are the "A" Scan (Fig. 1), "B" Scan (Fig. 2), "C" Scan (Fig. 3), and "D" Scan (Fig. 4). These four views in phased array UT can be analyzed and combined to provide a comprehensive 3D look into the work piece and defect data can be shown in its spatial location within the part.

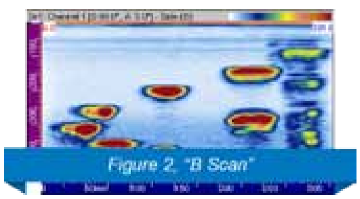


Figure 2, "B Scan"

The B Scan displays defects at varying depths, as though the viewer is looking through the side of the work piece. Notice the different levels of the defects within the part.


Figure 3, "C Scan"

The C Scan shows defects at different locations as though the viewer is seeing the piece from above. These particular defects are at different levels within the work piece as seen in Fig. 2.


Figure 4, "D Scan"

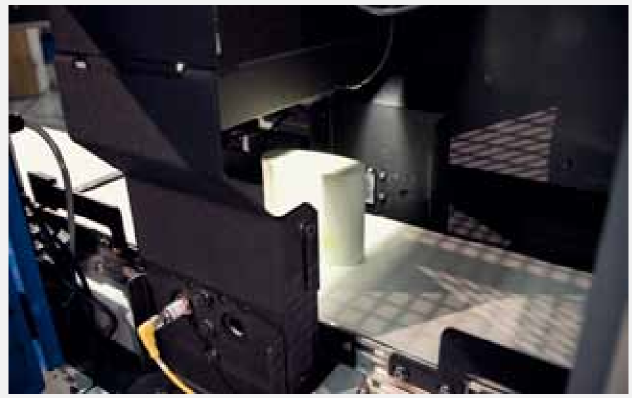
The D Scan is a "second" side view of the work piece. In this example, the part being tested is round and therefore the "end" view is not as applicable. It does however show the defects from a different perspective at the different depths.

As you can see, the data from phased array UT inspection is much more comprehensive and allows for a complete analysis of the work piece, reducing the likelihood of missed defects. What's more, the output data can be analyzed and understood by those who may not be familiar with UT inspection, making the system useful in a real world application.

Recommendations

Automated solutions in NDT systems can bring increased efficiency and production, but anyone considering automating a manual process should consider partnering with both equipment designers and component suppliers in the discovery phase. The purpose of this collaboration is to gather as much information as possible to accurately evaluate the feasibility of the project. Whether or not automation is possible depends on your ability to 1) produce repeatable, reliable, accurate results, 2) effectively manage the data produced and 3) achieving the desired ROI. If you have any questions about automating your inspection process, please contact us at 406-548-6010 or dbrekhus@newgatetech.com.

PHOTO GALLERY: CATPRO VP1520


The inspection area in fully enclosed with an air management system for reliable results


Our simplified scanning mechanism makes alignment easy

CATPRO software is recipe-driven for rapid, error-free part change-over

Dear Friend of New Gate Technologies,

We hear it all the time: "Our QUALITY is our trademark", "You can depend on our QUALITY", "Our QUALITY guarantees your QUALITY", and on and on. But when it comes to actually checking for quality, why do so many manufacturers see it as a "non-value add?" OEMs see quality checks as a huge value add—damaged parts stay out of the supply line, keeping costs low and profits high. While I believe that the industry has come a long way in the area of product quality, it is still the lowest priority on a lot of to-do lists.

Several potential customers have expressed the misconception that spending time and money on quality checks is something that adds nothing to the bottom line, and instead slows down production and decreases profits.

The conversation typically goes like this:

» **Potential customer (PC):** "We'd like to incorporate your equipment but it really doesn't add any value to our product so it's tough to define any tangible ROI"

» **NGT:** "What does your customer want?"

» **PC:** "Oh, they want 100% inspection."

» **NGT:** "What are you doing now to ensure part quality?"

» **PC:** "Well we have a couple of people looking at the pieces as they are packed for shipping."

» **NGT:** "Are they able to detect all of the potential defects at a rate that is consistent with the line speed?"

» **PC:** "No, not really, but they catch the major stuff."

» **NGT:** "So, your customer wants 100% inspection, but implementing comprehensive, high-speed inspection is a "non-value add"?"

» **PC:** "Well… it's hard to justify the expense."

» **NGT:** "It sounds like you're saying there is NO tangible value in delivering quality. Our data disputes that and so does your customer."

I've had this conversation numerous times and it really makes no sense. I have been in the capital equipment business in some form or another for 30 years and have developed all sorts of NPV/ROI/PAT analysis and it's funny how people think. If an automated system is moving a part from one point to another (i.e. a robot) it is seen as having value and a tangible ROI. Yet that robot is doing nothing different than an automated inspection system: it is performing a task that is highly repetitive and may require more precision or capability than is humanly possible. This is exactly what an automated inspection platform does and that has value.

At New Gate Technologies we are intensely focused on our own quality. We have numerous processes and procedures to ensure our quality continues to improve every day. We do this for two reasons: 1) we believe we owe it to our customers to provide the best quality possible; and 2) our customers expect high quality products and we want to exceed our customers' expectations.

CATPRO… Because quality is NOT optional.

Sincerely,

Eric Pierson

President/CEO
New Gate Technologies