

# The NDT Technician

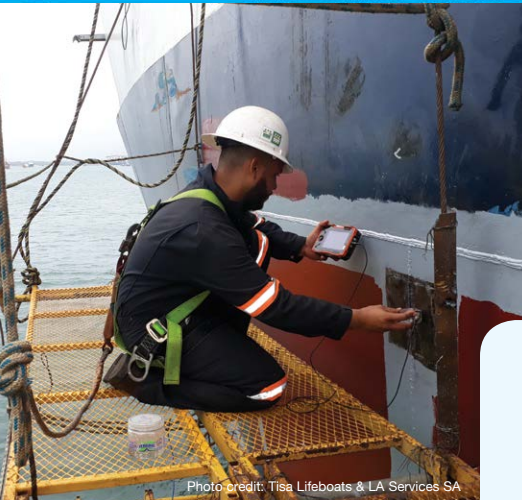
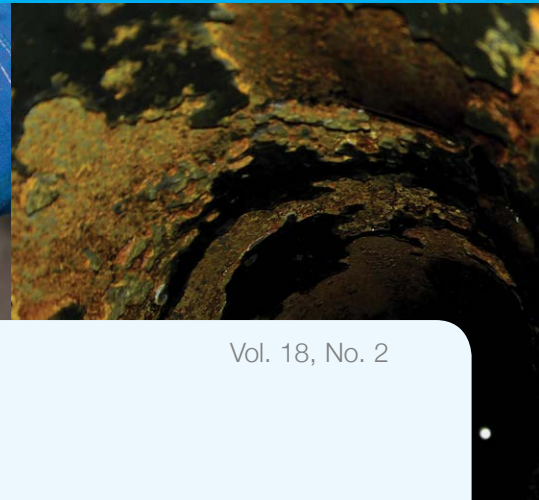


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## FYI

### Reducing False Calls When Scanning for Internal Corrosion Using the Echo to Echo Technique with Compression Ultrasonic Waves: Part 1

by Kervan Govender

Although it may seem simple at first, detecting and correctly classifying internal corrosion has proven to be quite a complex skill to acquire and master, even to the most experienced of technicians. Time and resources are used to re-inspect false calls. The problem lies when the NDT technician detects a reduction in wall thickness on the vessel or piping and is unable to supplement the finding with an alternative method or technique such as radiographic or visual testing. Using two or more methods/techniques to confirm an indication is good engineering practice. Since most false calls are attributed to laminations and inclusions, we will look at ways of differentiating laminations and inclusions from internal corrosion. These laminations and inclusions existed in the component from the initial manufacturing stage so are not necessarily detrimental to the component's service life.

In this first part of a two-part series, we will look at the basic outline of corrosion

detection theory and what practical options are available to an ultrasonic technician working in the field.

#### Overview of Corrosion Detection

The inherent difficulties of extracting oil and gas from subsea reserves are numerous. One of the most notable is the vast amount of seawater that is pumped up together with the crude oil. The seawater acts as the perfect electrolyte to initiate and sustain internal corrosion in associated piping and vessels. As stated in the text *Corrosion for Science and Engineering*, "sodium chloride (NaCl) in water is an extremely aggressive corrosion medium. Corrosion is the degradation of a metal by an electrochemical reaction with its environment" (Trethewey and Chamberlain 1995, pp. 28 and 30).

There are many mechanisms of corrosion that may cause wall loss: for example, galvanic, crevice, pitting, or intergranular

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corrosion. Flow-induced erosion corrosion is expected in oil extraction systems, due to high flow rates pumping out of the subsea oil reserves together with solids such as sand. Knowing which type of corrosion to expect may help the NDT technician in determining which areas are of more concern to test, meaning when flow-induced erosion corrosion is suspected, then bends and reducers are typical areas of interest due to impingement of particles on the inner wall.

As stated in the text *Corrosion for Science and Engineering*, “a sudden change in inner diameter or a change in direction of pipe will result in turbulence and

therefore an increase in likelihood of flow-induced erosion corrosion” (Trethewey and Chamberlain 1995, p.192).

Compression (longitudinal) waves are used extensively in the oil and gas industry for the detection of internal corrosion in process piping and pressure vessels. It has proven to be a successful technique when performed by competent technicians.

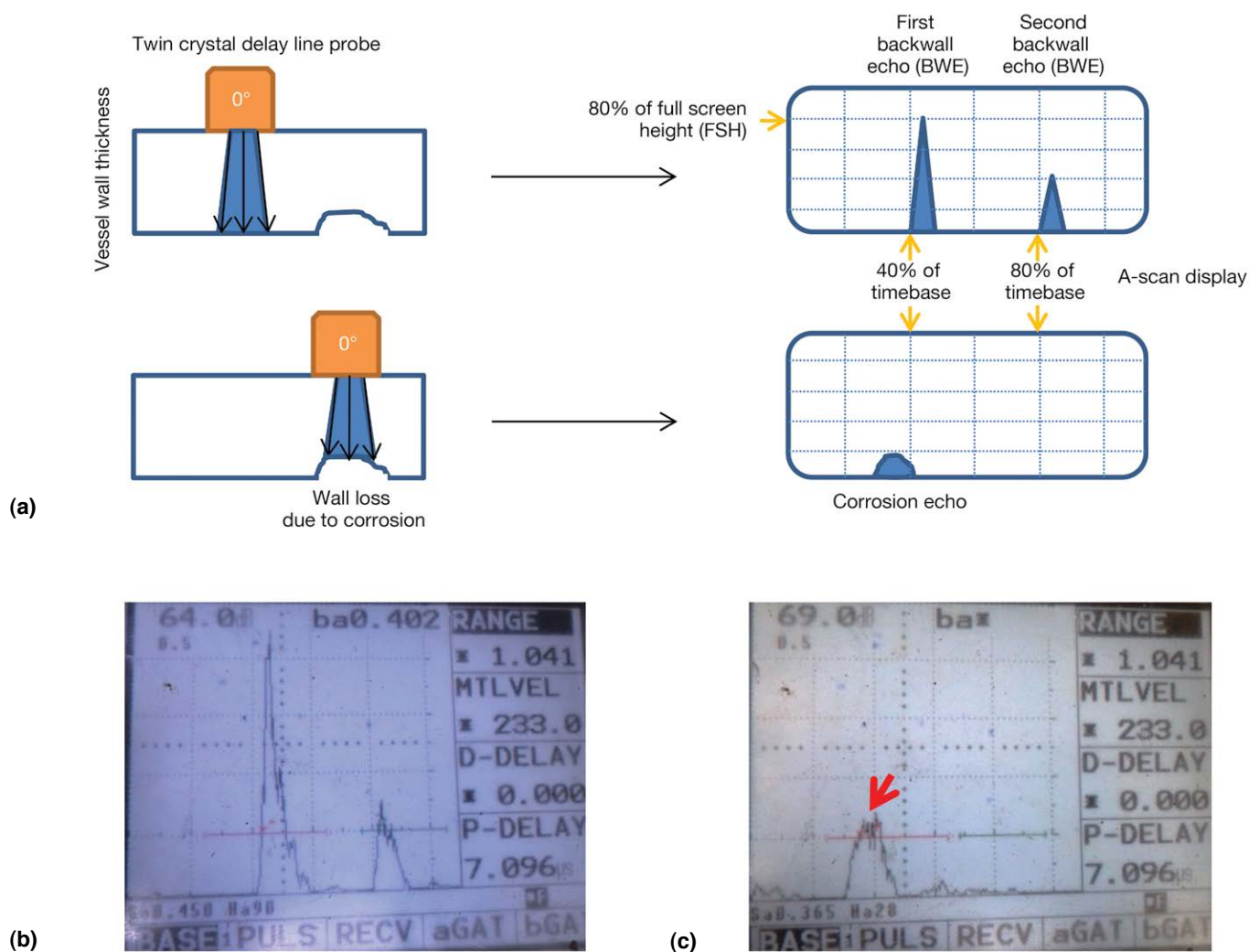
Ultrasonic waves are high-frequency mechanical vibrations transmitted by the probe, which travel through the test part, bounce back off the opposite surface or anything in between (discontinuities), and are then detected again by the probe. It is

similar to striking a ball off a flat surface and then catching the ball on the rebound.

Corrosion detection, on the other hand, may be compared to bouncing a ball off a bumpy surface; the ball (here, the signal) could possibly rebound in any direction. Low corrosion signal or even no corrosion detection at all would result.

The ideal reflector (discontinuity) would be parallel to the outside scanning surface and have a smooth contour. But internal corrosion is much more difficult to detect due to its irregular profile (Drury 1997).

Note in Figure 1 the corrosion echo is lower in amplitude and more “rounded”



**Figure 1.** How compression waves are used for corrosion detection: (a) process; (b) normal first and second backwall echoes; (c) corrosion echo.

compared to the normal first backwall echo (BWE), meaning the first BWE is of higher amplitude and has a sharp peak. Also note that the rounded corrosion echo is more to the left of the screen when compared to the first BWE, meaning it's shorter on the time base, indicating a reduction in measured thickness.

Another telltale sign of corrosion is the loss of the second BWE. As stated in the *Nondestructive Testing Handbook*, third edition: Vol. 7, *Ultrasonic Testing*, "corrosion testing ideally uses the same principle of operation as thickness testing," but corrosion testing is more complicated because with corroded materials, the series of backwall echoes and the corrosion signal itself rarely shows above the system's noise level (ASNT 2007, p. 445). According to the same text, "Ultrasonic scattering from inside surface pits produces a noisy reflected signal" (p. 467).

Careful consideration should be given by the technician during corrosion testing due the fact that the only indication of internal corrosion is a loss of repeat backwall echoes. Suspected areas must be interrogated and other possible causes for the loss of signal eliminated (for example, insufficient couplant, loose cable connections, or an irregular or rough outer surface). Codes that regulate the industry, such as API 510 (American Petroleum Institute), require vessels to be visually inspected internally within specified time frames (for example, 5 or 10 years).

Under certain conditions the internal inspection may be substituted with an alternate on-stream inspection, which uses ultrasonic or radiographic testing to determine the remaining thickness of the vessel. Ultrasonic (UT) and radiographic testing (RT) are considered volumetric NDT methods, meaning the full through thickness of the test part is tested as compared to magnetic particle testing, where basically only the surface

is inspected. When an indication that may hinder the service life of the vessel is detected with UT or RT, then the responsible inspector may shorten the inspection time periods (for example, six months).

In-service inspection is much favored by the client compared to internal visual inspection since the latter would require stopping the production process to allow entry into the vessel. The costs and labor hours can raise quite considerably—for example, to allow for labor to open up flanges, high pressure cleaning for internal inspection, and pressure tests upon completion—not to mention any delays in production will result in a loss of revenue for the oil producer.

Most training schools and international certification bodies, such as ASNT and BINDT, have set guidelines on the training and certification of UT technicians. Certification is further subdivided into smaller categories for which the technician may seek competence (for example, butt welds in plate, pipe or nozzle welds, and the like). The training and examination samples have discontinuities similar to those found in new fabrications, such as lack of fusion, lack of penetration, and slag inclusions. But rarely do we find training or certification samples that are specific to in-service discontinuities such as internal corrosion. This poses its challenges as competency in corrosion testing falls solely on the employer's in-house training program.

Some shortfalls that may be encountered with regard to this include the following scenarios:

- The Level III technologist might be based in a different area/country other than where testing is carried out by Level I and II technicians
- No clear transfer of knowledge from mentor (Level II technician) to trainees or Level I technicians, meaning trainees have to rely solely on company

procedures to acquire skills for corrosion detection

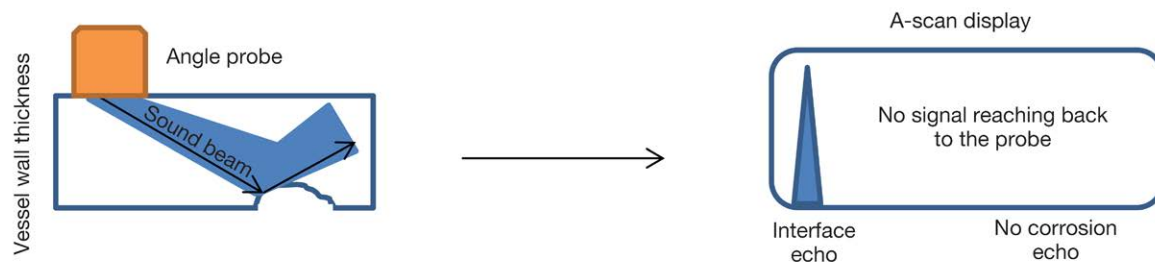
- Trainees not taking the initiative to seek knowledge themselves or ask questions related to their field
- In-house or client competency checks may not be adequate enough to simulate real corrosion conditions found in the field (meaning the examination sample is fabricated from scratch and not an actual in-service corrosion failure sample)

Due to the nature of internal corrosion it is well suited for detection with UT and RT from the outside of the vessel, but the basic forms of liquid penetrant, magnetic particle, magnetic flux leakage, laser profilometry, and eddy current techniques cannot detect this in-service degradation from the outside surface (ASNT 2007, p. 437). Some possible alternatives to complement corrosion testing are:

- Phased array – zero-degree
- Phased array – dual array
- Tangential radiographic testing (digital or conventional film)
- Visual testing (a last resort since this requires equipment to be shut down to allow for internal inspection)

"Phased array dual transducers are an improvement in ultrasonic detection and characterization of internal corrosion compared to conventional transducers" (Pellegrino and Nugent 2015). Phased array is possibly one of the best alternatives to confirm corrosion detected with conventional UT, since access to only the external side of the vessel is needed (unlike visual testing), and it does not matter if the vessel is full of seawater or oil, which may hinder radiographic testing. The drawback is the client is going to have to cover the additional costs involved with phased array, which may require more specialized technicians, purchase of new equipment, and probes.

Another option is profile radiography. Tangential radiography is popular for corrosion detection (ASNT 2002, p. 519).



**Figure 2.** Illustration of why shear waves are not usually suitable for corrosion testing.

Due to the large source-to-film distances needed, this technique is not practical for large-diameter vessels; however, tangential radiography is practical for small- to medium-diameter piping.

As stated in the *Nondestructive Testing Handbook*, third edition: Vol. 4, *Radiographic Testing*, radiography does not work very well for in-service examinations as the vessel is likely to contain water or product of some type, which would attenuate the radiation beam and cause an unsatisfactory radiographic image.

Random spot thickness readings on a vessel are not enough to detect internal corrosion on a vessel. The vessel should be scanned in 300 mm × 300 mm (12 in. × 12 in.) grids at areas where internal corrosion is suspected.

Also, each grid should not be scanned slowly but rather with a fast back-and-forth motion (while ensuring probe overlap), since we humans are much better at detecting a change in pattern when it happens sharply. According to research by Drury, this fast “windshield wiper action” is quite efficient at detecting small diameter pitting due to a sudden drop in the echo pattern (Drury 1997).

Ultrasonic angle beam examinations are more suitable in most instances because

they need access to one side only, and the water in the vessel would not pose a problem (ASNT 2002, pp. 526–527).

Angle beam inspection would be suitable to detect an in-service discontinuity such as fatigue cracks but as illustrated in Figure 2, angle beam inspection is not a very reliable technique for corrosion testing (ASNT 2007, p. 220). The corrosion indication gives a very low signal response or even no echo at all (ball bouncing off bumpy surface).

In Part 2 of this article series, we will try and develop a solution to have fewer false calls of detected indications using conventional UT alone with compression waves and also analyze two cases where wall loss was reported initially as internal corrosion but later was reviewed as either inclusions or laminations after numerous follow-up inspections by various technicians. For the client, to send out different technicians to retest components multiple times is a very costly expense (requiring helicopters, boats, accommodation, and so on), so it is imperative that during the initial inspection the technician classifies any detected indications correctly, thus avoiding any unnecessary follow-up visits. ●

## AUTHOR

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## OUTREACH

### NDE Institute Works with Local Government to Develop Opportunities in the Community

by TNT Editor Haley Cowans

*In this new series, we will explore different innovative ways that individuals, businesses, and schools are working to spread awareness about NDT, broaden and diversify the workforce, and help foster and develop technicians in their careers. If you have an interesting story about outreach and development, please contact the editor at [hcowans@asnt.org](mailto:hcowans@asnt.org).*

*The information in this article comes from Jarrus Mitchell, who is the responsible Level III (MT, PT, UT, and RT) at OranoTN as well as the founder and owner of NDE Institute.*

When Jarrus Mitchell began his career in nondestructive testing in the construction industry, he quickly realized the variety of opportunities and the ability to advance one's career that was present in the field. He also realized that this lucrative career path was not something that many of the people around him knew or understood. He would often get questions from people who were working in other areas of construction on-site with him.

"I realized, wow, how many people know about this?" Mitchell said.

His transition into teaching started with just one friend, who was frustrated in a career that lacked growth opportunities and was looking for a change. This friend would come over to learn about different NDT concepts from Mitchell. During this time, Mitchell also became a Certified Welding Inspector, and his passion for teaching grew. Eventually, the friend he had been informally teaching landed a job in the NDT industry and began advancing his own career.

"Before I knew it, I had five guys coming to my house," Mitchell said.

This success led Mitchell to begin thinking about how to turn his burgeoning passion for teaching into a more official, brick-and-mortar business, a project that first saw him move back closer to his home in Charlotte, North Carolina, to establish NDE Institute. Early on, he sought out relationships with local governments, working to become an SC Works Eligible Training Provider (SC Works is an organization that works in partnership with the South Carolina Department of Employment and Workforce to provide career services to job-seekers and employers [DEW 2019]). According to Mitchell, this designation enabled SC Works to send students who came through their unemployment office to NDE Institute, and SC Works was able to fund these first students as part of programming connected to the Workforce Innovation and Opportunity Act (WIOA). The WIOA is legislation that "is designed to help job seekers access employment, education, training and support services to succeed in the labor market" (US Dept. of Labor 2019).

Mitchell notes that the success of his program caught the attention of David Warner, the director of The Technology Incubator at Knowledge Park in Rock Hill, South Carolina. The Technology Incubator seeks to support entrepreneurs of technology companies, in part to help develop new job opportunities for workers in Rock Hill (City of Rock Hill 2019). "It is through Mr. Warner that the relationship with the City of Rock Hill was established," Mitchell said. (By this point, NDE Institute had moved to Rock Hill.) For Mitchell, this was the beginning of a drive to help not only develop the skilled technicians that the community of Rock Hill needed, but to help individuals discover the advancement and lifestyle changes that could be available to them through a career in nondestructive testing. Locally, Mitchell saw that companies



such as C.M. Steel Inc., Trinity Meyer Utility Structures, FOMAS Inc., Siemens, Duke Energy, Mistras, Acuren, Capstone Structural Engineering and Consulting, and many other engineering firms utilized NDT technicians.

“I saw that, really, I can help people change their lives through socioeconomic means by helping them get a better job,” Mitchell said. “Every time I [see] a student succeed, that’s more motivation.”

NDE Institute is a STEM career vocational facility, which means, as Mitchell puts it, that in addition to exposure to concepts in science, technology, engineering, and math, the school is designed to give students a foundational understanding of NDT as a career and help them to see the variety of opportunities available. As Mitchell notes, often NDT education is done through job-specific avenues, such as corporate training, which can mean that students learn according to a specific company’s needs and procedures. Mitchell’s goal is to give students access to the breadth of the NDT field. The school’s training model combines live online courses with in-person classroom sessions, and the program requires hands-on sessions before completion. This hybrid approach means that the program can service students throughout the state (NDE Institute 2019a).

## Partnering with Local Government

One of the most effective ways that Mitchell has been able to pursue his goal of getting people into the workforce and on track for advancement in NDT has been through his relationships with the local government in Rock Hill. The mayor, John Gettys, and other city officials have partnered with Mitchell because, as he puts it, they see the need for NDT inspectors in the business community and realize that training options are limited. In partnering with his local government, Mitchell has been able focus on the parts of the community where opportunities for career development will make the most difference. As he notes, he was able to zero in on the unemployment rate, especially for demographics that tend to fall into an unemployment pool (such as people not on track to go to a four-year university or who are looking for a career change). Through this relationship with local government, he’s been able to make city departments that are addressing unemployment aware of the needs in NDT—the high demand for NDT inspectors, and the requirement for them to be educated and certified.

“The City of Rock Hill has sponsored community awareness events highlighting workforce development and other city



Students at NDE Institute receive a hands-on lesson in ultrasonic testing from visiting Level III instructor Tommy Boyers (photo provided by Jarrus Mitchell).



Jarrus Mitchell (left) poses with Reginald Henson, an alumnus of the NDE Institute who currently works as a weld inspector at Trinity Myers (photo provided by Jarrus Mitchell).

initiatives. They have been instrumental in publicizing NDE Institute as a vocational education option for local communities,” Mitchell said.

One direct way that this relationship has helped Mitchell provide opportunities to burgeoning technicians is by helping finance students’ educations. While the school is licensed by the South Carolina Commission on Higher Education, it is not eligible to provide tuition assistance through FAFSA (Free Application for Federal Student Aid). However, Mitchell says that the program works hard to develop payment plans and provide need-based scholarships—for Mitchell, it is more important that students have access to the program than for him to make as much money as possible. While sometimes funding comes from the school itself, often students have been able to utilize the workforce development resources in the community. In the past, Mitchell has had students come to him through the Department of Labor who have been able to have their tuition paid for by the WIOA program. Since NDE Institute is a WIOA Eligible Training Provider, often students are able to receive full funding through that service (NDE Institute 2019b). The city also has grant writers who work to find tuition scholarships and other means of financial assistance for NDE Institute students.

Mitchell has also been able to work with a variety of programs to generate opportunities for students hoping to enter the workforce as technicians. As he says, his goal is not only to educate students but also to give them the tools they will need to find meaningful

employment in the career. Mitchell observed that while many companies have apprenticeship programs, there were limited opportunities in NDT in South Carolina. Through the program Apprenticeship Carolina™, he was able to set up a federally registered apprenticeship program through his company Integrity Special Inspections, where he assigns apprentices to C.M. Steel Inc. to get on-the-job training hours in specific NDT methods.

Another program that has proven beneficial to workforce development is the Black Economic Leadership League (BELL), a local committee in Rock Hill designed to be a resource for economic growth and job creation (BELL 2019). Mitchell notes that the students he has served have been predominantly African-American, making this relationship a perfect fit. Through Mitchell’s involvement, he has seen the ability of this committee to serve as a mentorship opportunity, where individuals can be directed to resources that provide soft skills. By getting to represent NDT in this forum, Mitchell has noticed that he is able to show interested job seekers the benefit of investing in a career as a NDT technician.

The benefit of these relationships has been reciprocal, with the local community benefitting as much as the individuals receiving job training and the NDT community getting an influx of the skilled workers it needs. And as Mitchell notes, the success of students that come through his program in securing jobs and advancing their careers promotes the efforts of the local government in developing a skilled workforce and assisting their citizens in finding gainful employment.

“At the forefront of every community’s goals is economic development. No city can see growth and prosperity for all of its people without having a talented workforce that can meet the demands of our business community. This is why the City of Rock Hill’s relationship with NDE Institute and the Black Economic Leadership League is so important—getting underemployed 18- to 30-year-olds the mentoring, support, and training they require to become engaged wealth builders is paramount. We are excited about our relationship and the benefit NDE brings to the broader Rock Hill community,” said Rock Hill Mayor John Gettys.

## Conclusion

The passion and goals that Mitchell developed from coaching his friend into a career in NDT have proven to align with a need in both his community and the NDT industry: developing a skilled workforce of technicians who are excited to establish a meaningful NDT career. Since 2014, NDE Institute has graduated 53 students. Mitchell notes that he often gets to see pictures of new houses or cars shared by former students, and he always feels rewarded to see how their lives are changed.

“They’re realizing that there’s more to having a career than just accepting a job you don’t like,” he said.



By working with his local government and business community organizations, Mitchell has been able to reach out to underemployed populations and help provide them with resources and opportunities. And by seeking out mentorship and assistance from these government programs, individuals have been able to develop life-changing careers as NDT technicians. For anyone hoping to pursue a similar path, Mitchell says that the biggest key to success that he's observed has been sincerity—a commitment to success and a desire to help others succeed.

"Whether it's a student, [or] whether it's a professional that's looking to help a student [...] without that sincerity, the intention won't last," Mitchell said. ●

#### ACKNOWLEDGMENTS

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## WORKING SMARTER

### Storing Quantitative Quality Indicator Test Piece Shims

by Zachary Staniewicz

Quantitative quality indicators (QQIs) are often “thin steel shims with etched patterns in circular and cross shapes” that are used in a variety of inspection situations within magnetic particle testing to “demonstrate both field strength and direction within a part” (Magnaflux 2018). Among other uses, QQIs can be utilized for performance checks of equipment and setting up magnetization parameters and multidirectional fields (Magnaflux 2018). Handling thin shim QQIs is oftentimes difficult, as maintaining their pristine condition is paramount. For this reason, they are often coated with a slick corrosion inhibitor—this will have little or no affect on the test results, but may require a methodology for handling prior to any production testing. They can be difficult to get out of the plastic sleeves that they are often packaged in, especially when there is a slick corrosion preventive fluid on your gloves or on the actual QQI. Then there is the problem with mishandling them and bending them and returning them back to their original configuration. This is a real concern, as they are usually used to validate the

equipment and the process or technique. A simple solution I have found is to store your QQIs in one of those weekly medication organizers (see photo). QQIs fit perfectly in them, they protect corners from damage, and you can add a little lubricant vehicle to the container to prevent corrosion. The cost of one of these organizers is minimal when you consider the aggravation avoided or the replacement cost of a lost QQI. You can find these medication holders at any pharmacy or retail store that sells over-the-counter medicine. I hope this is as much help for you as it has been for me. ●

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Demonstration of how medication holders can be used to store QQIs.



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## Practitioner Profile

### Glenda Kedibone Molope



*Glenda Kedibone Molope is the director and company Level III for Basadi Ba Dithakga Services in South Africa. Among other certifications, she holds ASNT NDT Level III certification in MT and PT. She is also the section secretary for the Southern Africa Section of ASNT.*

*Q. How did you first become involved in NDT?*

A. I was introduced to NDT through an on-the-job training program, which included rotation through different departments. Coming from a chemistry background, I found common concepts and terminologies. I then decided to start a career in NDT.

*Q. Can you tell us about your certification and training?*

A. My training started as on-the-job training, followed by ASNT certification. I am certified in the following: ASNT NDT Level II VT General Industry, ACCP Level II Visual Testing General Industry Sector Remote Technique, and ASNT NDT Level III in MT and PT.

*Q. Describe the work you do.*

A. I am the director and company Level III for an SMME (small, medium, and micro enterprise) business named Basadi Ba Dithakga Services in South Africa. My responsibilities range from marketing, overseeing NDT operations, and training NDT personnel.

*Q. What is your educational background? How do you keep up with changes in technology?*

A. My educational background is in chemistry, engineering, and business management, and materials and metallurgical engineering. The latter was part of a welding engineering program at WITS University (University of the Witwatersrand, Johannesburg). To keep up with changes in technology, I subscribe to NDT forums, where new technologies are discussed. Then I research the topics.

*Q. What characteristics do you think define a good NDT technician?*

A. The key quality for a good NDT technician: integrity.

*Q. What have been the biggest challenges of your career?*

A. Working with individuals who lack integrity. Their work needs to be checked and that is double work.

*Q. What areas of NDT would you like to learn more about? What are your professional goals?*

A. I would like to learn more about advanced methods of RT and UT. Specifically, I'm interested in being trained more in phased array and computed radiography. These methods are not common in South Africa, and there are a lot of opportunities identified for them in the plastics and electronic industries that I would like to pursue.

*Q. What's the best part of NDT?*

A. Knowing that I am contributing to saving lives, saving organizations money, and making a difference to people's lives.

*Q. What can industry, or individuals, do to encourage careers in NDT?*

A. One thing industry can do is introducing new and exciting technologies that might encourage the younger generation to consider NDT as a possible career choice.



*Q. What is the best way for a technician to advance his or her career in NDT?*

A. Shadowing senior technicians who will guide them according to their abilities rather than what they like. For example, I have seen a trend where people who are new to NDT want to start a career in NDT with the ultrasonic testing (UT) method. They have been advised by friends or family to choose UT because "that is where the money is." For some people this ends up being a costly and fruitless exercise. Their abilities (initially) are not in line with the method they have chosen to start with. They needed to start with on-the-job training (mentored by a senior technician) to get the exposure and experience first, then attempt the classroom training.

*Q. What can ASNT do to assist/encourage technicians in their careers?*

A. ASNT can assist by giving them more training opportunities so that they can advance that knowledge or skill.

*Q. Tell me about your involvement in your Section. Has ASNT membership/Section involvement benefitted your career?*

A. Yes it has, through technical evenings, workshops, and seminars. These activities advanced my professional career. ASNT members are invited to these activities so they can learn new skills, meet other technicians (network), and share knowledge. Personally, as a Section committee member, the benefits [also] include management skills through section management.

*Q. Can you tell me about your experience as an international member of ASNT? What are some benefits and challenges? What can ASNT do to support its international members?*

A. One benefit of ASNT membership has been the discounts for examinations and examination materials. One challenge, however, is that rates for individual membership are too high for developing countries. It becomes a challenge when recruiting. One way ASNT could support more international members would be to offer special membership rates to members from developing countries.

*Q. What's the best piece of advice you've received?*

A. YOU CAN DO IT! And do it for yourself.

*Q. What advice would you offer to individuals considering careers in NDT?*

A. Choose a career because you have a passion for it and not for the money involved.

You can reach Glenda Molope at [info@basadibds.com](mailto:info@basadibds.com). ●



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