The Criticality of Being Critical
by William C. LaPlante

Being critical to ensure compliance should be brought to bear, as the performance of high value weldments is dependent upon the integrity of their welds. Consider the volume of welds in the construction of bridges, skyscrapers, marine vessels, and so forth. Or, on a more personal level, think for a moment about a heart patient with an implanted pacemaker. The sensitive internal electronics of the pacemaker are reliant upon the hermetic seal quality of the casing seam weld to remain contamination free. Within various industries such as marine, oil and gas, aerospace, nuclear, defense, and medical, pivotal weldment performance relies upon the integrity of the welds (Figure 1). Regardless of the industry, the criticality of being critical reflects a seriousness of purpose to ensure compliance such that welds and weldments meet intended service design and performance requirements.

Figure 1. Weld integrity is critical in high performance applications such as oil and gas pipeline and pipework welding: (a) gas tungsten arc welding of an oilfield facility pipe for gas transmission; and (b) gas tungsten arc welding of an oilfield facility stainless steel pipe for water transmission.
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Being Critical to Ensure Compliance

Being critical does not mean you inspect to fail; or review to reject a procedure qualification record (PQR) or welding procedure specification (WPS); or perform a supplier weld audit to wittingly secure findings. Being critical means you have an attitude to exercise professional objectiveness (that is, obtaining objective evidence that can be substantiated). Namely, that entails employing a fact-finding mind to diligently perform, and with integrity, an objective evaluation of welds, weldments, contractors, documentation, and so on such as: providing a thorough assessment of welds during a weld inspection task, reviewing PQRs/WPSs for sufficient technical content where details and accuracy matter, and/or during a supplier audit obtaining objective evidence relative to a supplier’s capabilities and competencies. During an audit it is important to determine whether PQRs/WPSs, nondestructive testing (NDT) procedures, and NDT personnel qualifications are in compliance with respective codes and/or client specifications. Being critical also encompasses utilizing

Figure 2. Weld failures observed during onsite inspection activities: (a) an aluminum weld crack; (b) a structural angle iron weld crack; and (c) a fillet weld toe crack in a titanium pipe.

Figure 3. Faulty welding and fabrication production practices: (a) surface rust as the result of iron contamination from the use of a carbon steel wire wheel power brush to clean type 316L stainless steel pipe welds; (b) one of many unacceptable structural steel welds on a project; and (c) another of many unacceptable structural steel welds on a project. In Figures 3b and 3c the galvanized coating on the structural I-beam columns and attached plate members was not removed prior to welding. There was no in-process visual testing weld inspection/supervision performed during fabrication activities.
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Figure 4. Fillet weld toe crack. Crack propagation and the risk thereof represent a weldment service life liability and performance deterioration mechanism, which could result in a weldment failure. Based upon subsequent magnetic particle testing inspection, the weld toe crack measured 35.56 cm (14 in.) in length.

trained, razor sharp eyes during auditing, construction site walkthroughs, pipeline hydrostatic testing, manufacturing oversight/surveillance activities, and so on, where weldment discrepancies and/or weld failures may be identified. Catastrophic weldment failure (for example, crane collapse) and service life deterioration are prejudiced by the type and extent of weld defects present. Weld defects that could potentially lead to a crack/fracture due to load stresses are the most severe (Figure 2).

In addition to recognizing weld defects, identifying faulty welding and fabrication practices as they occur during production is crucial. Adverse welding and fabrication practices not identified during production pose a potential and hidden threat to user/public safety and to the service life and operational characteristics of a weldment. Examples include: the exposure of a stainless steel weldment to the harmful effects of carbon steel fabrication tools/processes and the ensuing negative impact on its aesthetic and corrosion resistance properties; or the welding of galvanized steel without first removing the galvanized coating prior to welding and the resulting injurious effects of welder exposure to zinc fumes and in weld pool contamination (Figure 3).

Ensuring Compliance through Experience, Knowledge, and Integrity

As noted previously, the criticality of being critical represents an attitude that reflects a seriousness of purpose to ensure compliance such that welds and weldments meet intended service design and performance requirements. However, to ensure compliance relative to meeting weldment drawing provisions and weld code, production contract, consent decree requirements, and so on, highly qualified and competent personnel are required. Insurance companies, municipalities, accreditation agencies, engineering authorities, and governmental agencies, among others, represent jurisdictional and governing body authorities that employ
The Importance of Being Critical

There is a disparaging saying within industry that you inspect not to achieve quality, but to achieve profits. However, weld quality can never be taken for granted or be assumed to be “good enough.” Being critical could save someone’s life, or prevent injuries, property damage, and/or an environmental disaster from transpiring. Faulty welding or fabrication practices and weld defects all contribute to undermining the structural integrity and operational characteristics of a weldment. Based upon this author’s forensic experience and research, in many cases when a weld fails in a large weldment (that is, cracks/fractures), catastrophic things occur, for example, the Alexander L. Kielland North Sea platform collapse in 1980 (Hayes and Phaal, 1998). Why? Because when a weldment is in service, weld joints/welded connections are enduring some measure of stress via mechanical loading (cyclically or statically). During a weld inspection task or while performing manufacturing oversight/surveillance, auditing, PQR/WPS reviews, and so on, if something is not in compliance or is suspect then it is important to speak up. The adage “If you see something, say something” is key. Being critical facilitates the identification of nonconformities/nonconformance, which could otherwise remain undetected, possibly resulting in a terrible accident. For instance, as the following storylines denote, it is important to be critical (Allen, 2010; Ricard, 2011).

Essential Onsite Practices

To be critical, responsible “boots on the ground” and “roll up your sleeve” NDT personnel, engineers, welding inspectors, and the like are required to provide vital onsite skills, trained eyes, and knowledge during weldment construction, manufacturing, repair, and inspection activities (Figure 4). Welding workmanship quality and fabrication training, the performance of diligent in-process weld and post-weld inspection, as well as vigilant oversight and surveillance are essential practices to achieve a high-level weldment. For welding endeavors, it is best to do the right thing by doing things right.

Conclusion

There is a criticality to being critical in order to ensure compliance. Being critical verifies the integrity, or lack thereof, of a weld, thereby mitigating the potential tragic consequences of a weldment failure.

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Blended Learning Approach: The Future is Here Now

by Michael W. Allgaier

Introduction

In September 2010, a feature was published in *Materials Evaluation*, titled “NDT Education and Training: Today and in the Future” (Allgaier, 2010). It was based on the 2009 ASNT Fall Conference and Quality Testing Show plenary address (Allgaier, 2009). The essence of both the feature and address was that the traditional techniques of nondestructive testing (NDT) education were evolving from classroom and laboratory instructor-led training (ILT), with a manageable number of students engaged into a blend of web-based training (WBT) and ILT. The advantage being that much greater numbers of students could be “instructed” in knowledge factors via WBT in any place, at any pace, and anytime, with greater efficiency and less cost per student. However, it was still necessary to transfer skills via hands-on training with ILT in the lab and on-the-job training (OJT) as a requirement.

This article explores the blended learning progress to date and clarifies some issues that have been misinterpreted or omitted from the basic concepts of this approach.

Challenge

Industry needs more NDT technicians who are trained and qualified more efficiently using fewer human resources in both instructors and qualified candidates. A 2014 article in *Quality Magazine* states:

- “New analysis from Frost & Sullivan (www.testandmeasurement.frost.com), Analysis of Global Nondestructive Testing (NDT) Training Services Market, finds that the market earned revenue of $237.6 million in 2013 and estimates this to grow to $293.5 million by 2018 at a CAGR of 4.3%. The most important trend witnessed in the market is a migration from American Society for Nondestructive Testing’s (ASNT) employer-based certification scheme, SNT-TC-1A, to centralized certification schemes that are compliant with International Organization for Standardization ISO 9712, which is predominantly impacting the Middle Eastern, African, South Asian, and Southeast Asian markets.

- “Although there is a huge demand for trained technicians, growth of NDT training service providers is further being hindered by a lack of quality instructors to impart training courses. Growth and revenue for every NDT training service provider depends on the number of instructors available, since there is a maximum threshold on not only the number of courses an instructor can teach, but also the number of students that can be accommodated in a course without compromising on the quality of the training” (Frost & Sullivan, 2014).

Recent ASNT Board of Directors decisions have put ASNT on the path to meeting ISO 9712 requirements through the Society’s ASNT Central Certification Program (ACCP) (ISO, 2012). First, ACCP is a third-party qualification program independently administered by ASNT. Secondly, more hours of training and experience will be required compared to existing SNT-TC-1A or CP-189 requirements (ASNT, 2006; ASNT, 2011).

Additionally, the American Society of Mechanical Engineers (ASME) is making progress on establishing its unique performance requirement for the ASME Nondestructive Evaluation/Quality Control Personnel Certification Program (ASME, 2015). Additional training in both knowledge and proficiency demonstration are not required but may be necessary to achieve central third-party options for qualification and certification.

One advantage to this third-party qualification system is the transportable credentials afforded to the individual. This will meet the third-party certification requirements of some jurisdictions. However, the cost may not be borne by the employer if the individual gains transferable credentials. This is also true of ACCP third-party certifications.
For the time being, many end customers still allow employer-based personnel qualification and certification (PQ&C) programs. These programs are met by employer written practices that comply with SNT-TC-1A (a recommended practice) or CP-189 (a standard). In either case, training content needs to meet CP-105 (ASNT, 2006).

Alternatively, many government contracts and aerospace applications must meet NAS-410: Certification and Qualification of Nondestructive Test Personnel, which is technically equivalent to the European Standard, EN 4179: Aerospace Series – Qualification and Approval of Personnel for Non-destructive Testing (AIA, 2014; BSI, 2009). Note that NAS-410 does not require central certification even though it meets the technical requirements of the program that in Europe does have central certification (third-party) as a requirement.

The American Petroleum Institute (API) references ASNT documents for PQ&C but additionally requires API QUTE – Qualification of Ultrasonic Testing Examiners (Detection), API QUSE – Qualification of Ultrasonic Testing Examiners (Sizing), API QUAPA – Qualification of Ultrasonic Testing Examiners (Phased Array), and API 510 – Pressure Vessel Inspector certificate holders to demonstrate their skills in performing ultrasonic examinations. In many cases this meets the customer’s needs.

In most cases, the new training requirements are growing in content, duration, and industry specific qualifications including proficiency demonstrations. Note: some areas are being reduced.

So, how can the needs of the ever expanding and daunting initial NDT training requirements be met without diminishing the ability to provide qualified technicians in the various industries?

Solution

To meet the need for a greater quantity and higher quality of NDT inspectors, more flexible training services are needed, that is, blending learning techniques.

Many large NDT service companies recognize a shortage of qualified instructors. Either they are qualified to instruct but are not available due to pressures to be billable, or they may not have additional qualifications desired to transfer knowledge or skills. Some codes also require instructors to have 40 or more hours of instructor training, for example, ASME Boiler and Pressure Vessel Code, Section XI (ASME, 2015). CP-189:2006 requires additional experience based on education to be an instructor. Therefore the specialized instructor resource needs to be utilized more expeditiously and wisely. If formally qualified instructors or Level III personnel are allowed to approve WBT, more instructors can be dedicated to providing ILT with hands-on expertise in a laboratory environment. Note that it is allowed for OJT to be given by Level II or III personnel, as described in SNT-TC-1A and CP-189 levels of qualification, to direct trainees and Level Is. In this way, a broader bandwidth of personnel can provide training at different stages and for different reasons. Professional trainers who are experts at transferring knowledge via computer-based training and/or WBT need not be Level IIIs even though it should be required that technical experts, that is, Level IIIs in that method, should approve all WBT/ILT.

The benefits of taking this approach are:

- reduced time commitments of Level IIIs or qualified instructors;
- reduced costs to the end customers;
- increased flexibility in the utilization of the students’ time.

One large personnel challenge is the difficult in freeing inspectors from production/billable time to take 100% ILT courses in the traditional format. If students are allowed to take online training, they may take it at any time, anywhere, and at any pace. Once the basic knowledge has been transferred by evidence of online examinations, they can then move on to scheduled ILT with hands-on skill transfer activities.

One of the drawbacks to accepting WBT is the method by which credit hours are granted for online training. Opposing arguments can be made on how to do the calculations. One is the actual time utilized by each student online. Two is to give credit for body of knowledge (BOK) hours per the training tables the WBT was intended to satisfy. Third is an approach that is more reasonable and pragmatic, for example, to grant the hours that on average a student takes to complete the WBT for a given BOK meeting the content requirements of the governing document.

The current process of achieving this goal is represented in the NDT PQ&C typical process flowchart, shown in Figure 1.

![Figure 1. Nondestructive testing personnel qualification and certification typical process flowchart.](image-url)
and demonstrations. It is necessary to ensure that a student has gained the necessary knowledge transfer before proceeding with skill transfer activities. One way to do this is for the instructor to meet with the individual before beginning the WBT to provide an overview of the overall approach to the blended learning concept. At this time the individual taking WBT should be encouraged to study in an area free of distractions similar to a classroom. After WBT has been completed the instructor and the student can review the material to ensure it was understood. Then, any questions the student has can be addressed before proceeding to ILT.

A second point that has not been emphasized previously is the flexibility of scheduling regarding order of training. It is not mandatory that OJT be done after ILT. It is a point of much discussion between Level IIIIs and NDT instructors. Some companies prefer that at least Level I training be given prior to sending the trainee into the field to gain OJT. Others argue that field experience is invaluable to helping the student to better understand the classroom presentations if previously exposed to real-world applications.

Thirdly, OJT needs to be structured so as to be “sufficiently organized” as recommended by SNT-TC-IA or CP-189. The new developments still needed in greater detail are “competency qualification” forms, task/sub-task lists, or practical factors, which spell out the various activities that would have been done historically in the laboratory environment as class exercises. If lab exercises are sufficiently structured they can be performed in the laboratory in conjunction with the classroom sessions or in the field with qualified Level IIIs or IIIIs after completing knowledge training in the classroom through ILT or WBT.

The new blended approach for WBT and many fewer hours of direct ILT allow the following possible scheduling (note: this example assumes a 40 h training outline structure or traditional formal training course for one week, for example, radiographic testing/ultrasonic testing/electromagnetic testing, and so on.

- Day 1: WBT (no instructor/proctor after first meeting with instructor)
- Day 2: WBT (no instructor/proctor)
- Day 3: half-day day WBT (no instructor/proctor)

Note: these first ~20 h of WBT may be taken over any reasonable time frame.

- Day 3: half-day competency qualifications (Level II/III OJT)
- Day 4: procedures and forms ILT (Level II/III instructor)
- Day 5: review and exams, written – proctor (non-Level III)
- practical (with Level III)

Conclusion
The blended approach to training incorporates some efficiencies and adds flexibility, and allows fewer human resources to accomplish more for a larger target audience. It does this by reducing waiting time for initial training in theory and principles to begin. This approach provides more options when scheduling how and when to conduct hands-on training to transfer skills. Various time slots and changing targets of opportunity for both the instructor and students can be maximized. Structured competency qualifications make the OJT more applicable, standardized, and useful when it can be done in the traditional laboratory setting or in the field conducted by qualified technicians of superior skillsets.

The new emphasis not to be omitted is for the Level III and/or NDT instructor to validate knowledge transfer before proceeding to skill transfer activities. It is at this intermediate stage that remedial training can be provided to shore up misunderstandings or shortfalls in knowledge as evidenced in the exam results. Then the student and instructor can proceed with the skill transfer exercises confident of adequate knowledge levels.

Optimum efficiency would be gained if the instructor ensures adequate transfer of knowledge or skills by conducting student evaluations at the end of each training method prior to proceeding to final written or practical proficiency exams leading to certification.

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Practitioner Profile

Mike Diaz

Mike Diaz is an up-and-coming technician and active board member in the San Diego Section of ASNT. He got his start performing shop radiography, moving into field radiography and other testing fields.

Q: How did you begin your career in NDT?
A: I began my career in NDT through my father, Juan R. Diaz. He owns a special inspection and materials testing laboratory, in San Diego, California. Among other fields, the company includes an NDT department.

Q: Do you have NDT certification?
A: I have obtained company and third-party NDT certification/hours in radiography, ultrasonic testing, liquid penetrant, and film interpretation. I have also achieved certification as an AWS CWI, ICC Structural Welding and Bolting, ACIA Registered Construction Inspector Public Works Div. IV, ACI Concrete Field Testing Technician Grade I, and ACI Concrete Strength Testing Technician I.

Q: Describe the work you do.
A: In the shop, I am the quality control manager for the Materials Testing Laboratory and assistant Radiation Safety Officer for the RT department, making sure equipment and manuals are up to date and technician performance is done correctly. I lead in the inspection of our facilities from the different accreditation societies. I am in charge of training new employees and maintaining test records, and I am also a special inspector performing welding or high-strength bolting inspection on projects in the field or shop. NDT goes hand in hand with the welding field so, if needed, I can perform ultrasonic testing or liquid penetrant testing on welds.

Q: What is your working environment?
A: I may be in the field or in a lab depending on the project. I have been able to be involved in all levels, from a technician with a lot of hands-on time to a supervisor role, monitoring technicians.

Q: Is your work focused on a particular field?
A: My work can be shifted in different directions depending on the projects our company is working on in that moment, but with my certifications I have been more geared toward welding inspection and NDT of welds/materials.

Q: What’s been your most interesting application of NDT?
A: There have been a few but the most interesting would have to be the unique dome structure for the San Diego New Central Library, as seen below. The structure was put together in pieces on a platform on the ground level and raised up in sections called “sails.” I performed ultrasonic testing on the 4-inch diameter pipe-to-pipe, full penetration weld connections on the platform and then, as the sections got raised and welded into place, I climbed up the structure to the top and performed ultrasonic testing on those joints. I would get as high as approximately 12 stories up in the air overlooking the San Diego skyline, Padres Petco Park, and Pacific Ocean. It was quite a sight.
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Q: What kind of structures/materials are you testing?
A: I have come across different structures and materials such as: steel beams and columns of buildings with moment connections that need ultrasonic testing of the full penetration welds, to steel water pipelines with lap joints that need liquid penetrant testing. I have done ultrasonic thickness readings on the aluminum hull of a ship and lab radiographic testing on stainless steel turbine components. I also have performed field radiography on full penetration welds of steel water pipelines and reinforcing steel for concrete walls.

Q: What codes must you be knowledgeable of?
A: My library of codebooks includes: AWS D1.1, 1.2, 1.3, 1.4, 1.5, 1.6, and 1.8; ASME B 31.1, B 31.3, and B 31.9; International Building Code; California Building Code; AISC Steel Construction Manual; ASTM International standards; and ACI 318, to name a few.

Q: How has NDT changed during your career?
A: Ultrasonic machines have gotten smaller, lighter, and are capable of performing the calculations for you. Computed radiography is really making a push; it has helped with the speed of getting the results of shots taken. I am starting to see the water authorities ask more for phased array for speed and accuracy.

Q: What part of your work do you enjoy most?
A: I enjoy the interaction with the other trade workers on the job as well as other inspectors in my field. You would be amazed how much you learn about your field from other people that may not be directly in your line of work.

Q: What’s the most difficult part of NDT?
A: I feel the most difficult part of NDT is trusting yourself and your training; the fear of rejecting something that isn’t there or not rejecting something that is there. This is where experience definitely comes in handy. Trusting your machine and procedures, I have learned, is key.

Q: What characteristics do you think define a good NDT technician?
A: Some characteristics are having a good head on your shoulders, knowing your plan of attack for performing the test, being prepared for the job with materials you will need, and always wanting to learn more. Education to support the technician is crucial.

Q: How are you involved in your ASNT Section?
A: I am currently a director for the San Diego Section; our purpose is to provide San Diego with information regarding ASNT and get the word out to others who may not know about NDT.

Q: What advice would you offer to individuals considering careers in NDT?
A: I would recommend going to your local ASNT section meeting and asking questions. These meetings have new and experienced members that can give you the direction you’re looking for.

Q: What’s the best career advice you’ve received?
A: Always keep learning, be humble, and enjoy what you do.

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