THE VALUE OF DICONDE IN MULTI-MODAL NDT ENVIRONMENTS

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Abstract: DICOM, driven from the medical industry, has greatly advanced how hospitals communicate and the way in which they operate. The evolution of DICONDE from DICOM now provides the NDT industry with a standard imaging data format and communication protocol. As an ASTM standard, DICONDE will be the imaging communication standard for the industry as it continues to drive to make both DICONDE complaint hardware and software.
As we experience the increases in digital adoption, the industry is faced with new problems, specifically how to store and manage all this digital data. Digital data-archiving provides this capability from saving files on local drives to server based long-term storage options. Through archiving, inspection data now becomes available to multiple users with various data sharing capabilities, and opens the opportunity for managing "in-service" assets.
Whether using CR, DR, Visual, Ultrasonic, or Eddy current inspection techniques, inspection data management software allows one to share the image and its metadata with experts, speeding up the evaluation. Storing of this digital data using DICONDE provides data integrity for the lifetime of an asset. It also allows inspection planning to be more pro-active, by allowing one to review previous inspection data and determine where the "hot spots" are or compare trends on key components of the asset.

History

The early development of software to process and transfer radiographic images was carried out in the medical field. This resulted in the creation of the DICOM standard (Digital Imaging and Communication in Medicine). Healthcare carried much of the pioneering work out over the past 12 years and virtually every medical profession that utilizes images now uses DICOM.

DICONDE

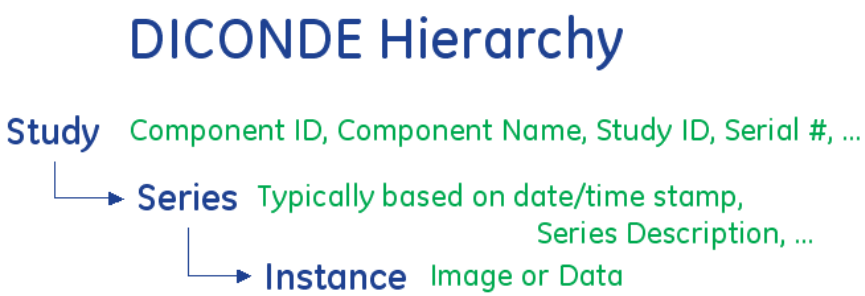
The industrial sector has benefited from this Medical pioneering work with the development of DICONDE (Digital Imaging and Communication in Non-Destructive Evaluation). This relies very much on the DICOM standard and incorporates many structures, which are purely NDE- focused. ASTM released the first version of the DICONDE standard in 2004.

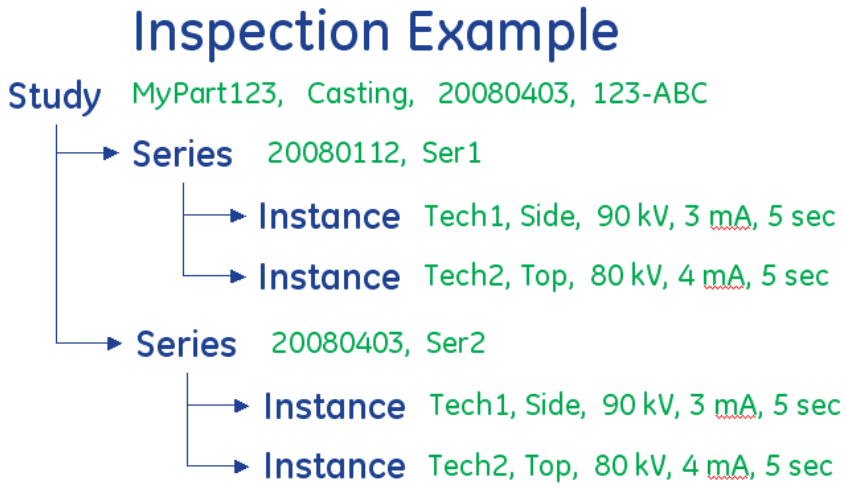
Essentially, DICONDE is a dictionary that describes all the necessary syntax, attributes, data elements and protocols to allow users to acquire, store, archive, transmit and receive image data in a way that is universally compatible. It is a system that allows images to be saved with its meta-data. All the technique information plus information on location, date and inspector is saved with the image. Such information can then be included in any report generated, and since the metadata is stored with the image, it means that database searches can be carried out on a variety of criteria to search across modalities or points in time for the same asset.

Moreover, DICONDE images can be included on a disk with a standard DICONDE viewer, which allows them to be displayed on any standard PC, allowing for easy data sharing of not just the image but the image and all relevant post inspection information.

Hierarchy

The DICONDE format itself organizes the data in a way that creates a hierarchical, systematic structure for the data. Following the DICOM standard, data is organized in Study, Series and Instance hierarchy. Allowing inspections to be grouped and categorized within a system.





In this inspection example, you see that a Component might be inspected once on one day and then again with the same Component information at a later date. The DICONDE formatting helps organize this data hierarchically, so when you pull back that Component in a DICONDE system you get one Study, but see both times that it was inspected as two separate Series within that Study. DICONDE also provides some security benefits, due to the complex nature of the data organization (behind the scenes) it does not lend itself to allow a user to readily go into a windows folder, find and delete data, providing one the ability to control who and when inspection history is deleted, if ever.

Value of DICONDE

DICONDE compliancy ensures that operators are not limited by custom or proprietary formats, eliminating the need for future data conversion and simplifying data integration from other NDT information sources, such as pipe management databases. This ensures that customers can choose the best in breed hardware and software platforms while always ensuring the continuity of their data and its format.

The phrase a picture is worth a thousand words comes true with DICONDE; the image and all the key information about that asset and inspection is stored right with the image. This provides a standard

structure for querying on images and opens up the opportunity for advanced trending and data analysis based on inspection history ultimately leading to better asset management and improved asset uptime.

New Challenges to Digital Data

Today, there are no areas of industry and commerce, which remain untouched by the digital evolution. This is especially the case in the NDT field, where development in digital radiography, automated ultrasonic & eddy current instrumentation and remote visual inspection systems have been made possible only by significant advances in digital technology.

One of the features of this new technology is the vast amount of information which is generated and the challenge has been to develop software systems to acquire the information, share it, analyse it and then manage it in an intelligent, fast and accessible manner. Companies are faced now with the challenge of managing multiple vendor software programs in order to not only view current inspection data but be able to review historical results or invest in large data conversion efforts to maintain all data on a single platform. Storing data in DICONDE format prevents these scenarios from occurring.

Other Benefits from DICONDE: Remote Experts & Data Sharing

Figure-1 Rhythm Remote View

As the demand for skilled experts increases around the globe, we have to become smarter with the allocation of resources and leverage the advantages made possible with digital data. Implementation of a software data management platform enables you to seamlessly share data across users in multiple locations, allowing improved utilization of expert resources by bringing the data to the experts versus taking the experts to the data. Using a standard imaging protocol like DICONDE allows for not only the image to be shared but all critical information on how the data was collected and at what asset they are looking. Providing this information along with the image gives the expert everything he needs to make the inspection call at the first analysis without requiring dialogue back and forth at the inspection site to clarify what inspection is occurring and how the image was collected.

Data Management and Archive

Figure-2 Rhythm Enterprise Archive

Data Management starts with the ability to digitally store inspection data in replacement of paper reports, film, photos, etc. yet the question is how to effectively manage this increased volume of digital data and how to make it more productive in driving better quality inspection and in turn asset management.

A DICONDE software data management platform provides searchability for inspection data from all modalities; it can control image information workflow so that data can be routed to other experts for further analysis. Quick access to previous inspection data can boost productivity output by as much as 50%. Pre-inspection plans can now be formulated more efficiently by taking actual inspection history into account. A similar order of productivity improvement can also be achieved in post-inspection, as only relevant inspection data needs to be sent for further analysis.

The power of the new archiving capabilities also opens up the way for the implementation of database techniques such as data mining and data fusion, so that data can be compared from different databases while information can be fused from sensors of different NDT modalities. This will assume greater importance and relevance as data management platforms extend into other NDT modalities.

A DICONDE based archival solution ensures that multi-modal inspection data will never become obsolete or inaccessible. It simplifies tagging of information without elaborate naming conventions, and allows rapid filing and facilitates data retrieval. Data can now be readily accessed from a central storage source by any number of remote interrogation sites.

In order to protect present and future investments, the interface of the archiving solutions needs to support a wide range of cutting edge technology and long-term data storage solutions. It needs to be scalable, reliable, and provide a foundation for data mining. In other words, Operators must be able to quickly extract information and carry out all different types of analysis using different inspection modalities. When deploying an archiving structure, one needs to keep in mind the following criteria:

- Data has to be quickly retrieved independent of when the information was generated. In some NDT industries data is kept for up to 2 years; in others, it is required to store data 50 years or more
- Enable inspectors to share data with others located outside their organization and to view / review inspection data reports, studies or images from any PCs that have Internet access.

- Architecture needs to be scalable / expandable without negatively impacting the daily activities. Solution may need to expand from standalone departmental to a large-scale multi-enterprise, global solution.

In summary, a DICONDE based software data management platform can assist inspectors in improving dramatically the communications through the inspection process (i.e. from pre- to post-inspection stages), perform on-going asset management and evaluation thru the life of the assets independent of its origins (i.e. modality source) as well as extend knowledge with users like experts or customers who are not on a DICONDE network, enabling you to bring in the data to the experts instead of taking the experts to the data.

Multi-modal Use Cases

As different as inspection tasks are there is not one modality that provides a convenient usage and a high probability of detection (POD). In some cases [1] it is the combination of different techniques that provide high POD. Another criterion for the selection of the inspection modality is the accessibility of components under inspection. Conducting weld inspections in a refinery during an outage can require the use of time-of-flight-diffraction (TOFD) for dual sided access, phased array for single sided access and digital radiography if neither is possible. The DICONDE data format would allow an inspector to look at a PAUT scan and digital X-ray of the same weld within the same software and give them 2 different techniques for analyzing the same weld. One can where a series of pipe welds could be inspected with different techniques but all the inspection records and measurements are maintained in one system giving one the flexibility to input different inspection techniques as needed but maintaining asset data integrity.

Performing multi-modal inspections will create a lot of different pieces of information available in different formats. We think that this is one reason why the benefits of multi-modal inspections are used so rarely.

DICONDE as such is multi-modal from its inception. The workgroup inside ASTM E07.11 has chosen an approach to the definition that aims at a high degree of reuse from DICOM [2]. DICOM has been defined to store the following modalities:

- X-Ray
- Ultrasound
- Computed tomography
- Endoscopy
- Magnetic resonance

The ASTM standard practice E2339 [3] describes the changes that are necessary to adapt the DICOM standard to industrial applications. The basic definitions apply to all modalities such that common information object definitions (IOD) and common information modules (IM) exist. It contains definitions of information modules for components, NDE equipment, indications, and geometry.

Modality specific standard practices will extend the basic practice for specifications that relate to that modality only. E2663 [4] was approved in December 2008 for the Ultrasonic modality. It defines the information modules for Ultrasound images, Ultrasound equipment, and equipment settings. Similar efforts are under way to provide standard practices for computed tomography (CT), digital radiography (DX) and eddy current (EC).

Benefits of multi-modal workflow

With DICONDE the benefits of a digital workflow as described above include a common format for all NDE modalities. This allows establishing a common workflow across modalities.

The inspection task will remain dependent of the modality and the specific equipment used. The transfer of the results into DICONDE will be dependent on the generation of the instrumentation used. Next generation equipment will be able to directly output the results in DICONDE.

Table 1: Benefits of a digital workflow with DICONDE
Tried and proven technology based on DICOM
A modality independent workflow
Investments in digital technology are future proven
Vendor independent workflow
Vendor independent archive

References

[1] Edward Ginzel, Henk van Dijk, and Merv Hoff. TOFD enhancement to pipeline girth weld inspection, April 1998. http://www.ndt.net/article/0498/ginz_tof/ginz_tof.htm.

[2] Patrik Howard, Llyod Arrowood, John Hansen, and Matthias Jobst. A standard practice for digital ndt data exchange and storage. ASNT Fall conference, 2009.

[3] ASTM Standard E 2339-08. Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE). ASTM International, West Conshohocken, PA, 2008. www.astm.org.

[4] ASTM Standard E 2663-08. Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) for Ultrasonic Test Methods. ASTM International, West Conshohocken, PA, December 2008. www.astm.org.