Possibilities of the Link between Portable NDT Equipment, Mobile Telephone and Internet

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Abstract. Twenty years ago the first portable and digital ultrasonic equipment controlled by microprocessors came into the market. Despite the reluctant acceptance at the beginning, today those devices represent the standard for ultrasonic pulse-echo equipment. They made the inspection easier and more reliable. Nobody would therefore expect to return the older analogue techniques.

Development of modern communication technologies, the cell phone and the Internet, enable a further step toward a faster and more reliable communication and evaluation of NDT data. It therefore seems an appropriate time to discuss the utilization of these technologies by NDT users and service companies, who will thereby be able to satisfy much better the ever-increasing demands of clients.

The age of analogue techniques

You may remember, that a long time ago, but after the disappearance of the dinosaurs the first UT instruments appeared some 40 years after the arrival of other NDT techniques. Of course during the last 40 years the instruments have seen a tremendous development. Their size and weight have been dramatically reduced and due to advances in battery technology and greatly reduced power consumption. Many instruments have been introduced that are free from the power cables. Despite these significant improvements some most important steps had not yet been realized: the operator had still to manually adjust the instrument settings and then frequently verify the equipment calibration on site with the help of heavy test blocks. In addition, he had to record manually the results of the inspection perhaps also accompanied with some drawings of the signals displayed by the cathode ray tube screen. If better equipped, he could take photographs of the screen with a specially adapted camera.

The digital age

And then, in the mid eighties, the first fully digital UT instruments became available. Although still relatively heavy and bulky, they offered fundamental innovations of special interest:

- Storage of the instrument adjustments (set-up) to facilitate fast, accurate and repeatable results
- Automatic self calibration, which guarantees the stability of all the adjustments during an inspection and thus there is not anymore a need for periodic recalibration (except as required by inspection code) which avoids also the need to transport heavy test blocks on site
- Copy and storage of screen images

(Thus a traditionally weak point of UT compared to RT had been mastered)

- For wall-thickness meters the storage and the transfer of measured values became possible immediately followed by an organization of the data into complex files. This stopped the handling of a lot of paper pages on site under all weather conditions
- Access to the adjustments by an environmentally sealed keyboard thereby minimizing the risk of internal contamination when working in radioactive areas of nuclear power stations.

Despite those undeniable advantages offered by this new class of digital instrumentation, which are today seen as commonplace, the reluctance or even the hostility toward these advances in technology have been numerous. Surprisingly, we found that the resistance to the new technology was not limited to one special generation of technicians. According to the registry office some 60–year-old technicians embraced the technology while some 30-year-old technicians resisted it. !

More Steps ahead

Step by step, thanks to the advantages that cannot be denied by even the strongest traditionalists and to the clairvoyance of old father Christmas who for many years has distributed powerful electronic toys in all chimneys (thus embarrassing not only a few number of parents), the labour market saw soon the appearance of a new generation of technicians and operators for whom digital novelties were merely commonplace.

The progressive, general availability and popularity of the new digital techniques, which were developed and introduced to the public by the way of fast and powerful game consoles enabling an increasing number of features in small, lightweight, battery powered packages has familiarized the public and therefore prospective technicians with the advantages of digital technology. These technologies as applied to UT instrumentation have allowed important progress in the reliability of the adjustment (thanks to the storage and the permanent self check of the adjustments) and a gain in productivity of an inspection from which the commissioners may benefit. The basic benefits are achieved in the following domains:

- Reduced time for the execution of the inspection
- Reduction of the outage time of the inspected installations
- Reduced time for the preparation and presentation of the report

Considering the pressure of the actual economic situation the question is asked how to gain even more in reliability and speed of execution of an inspection and the presentation of a written report. This is not a problem for fixed installations designed or configured for the inspection of pieces of a given kind as in a production line. Those installations have used automatic interpretation of test results and accept/reject criteria for a long time.

For portable equipments the question is generally asked and several paths to progress seem to be possible. For manual inspections, the competence and honesty of the operator still remain of fundamental importance. One must have the certainty that e.g. an indication of the apparatus corresponds well to a certain defect, which means that the transducer had been placed at the right position and had been properly oriented. Even if a transducer position encoder is used, has the correct reference applied? There remains a close relationship between the test information received and the person who collected it and the Quality Assurance organisation of the company charged with conducting the inspection. The integrity and experience of the technician conducting the inspection and of the reporting organization will remain the weakest link of the chain for a long time to come.

Nevertheless, it seems that considerable progress can still be achieved paying close attention to matters such as:

- Reduction of recording errors or errors during copying of the results
- Preparation of the inspection report as much as possible in advance and as close as possible to the top of the chain (the inspection itself)
- Maximizing the speed of data transfer to the person or facility responsible for interpretation of the results (e.g. to enable a possible repetition of doubtful measurements before the operator leaves the inspection site).

How to reach those goals?

It seems advisable to work on two items:

-The possibility of storing in memory a report format adapted to the actual inspection either in the UT equipment itself or in a Laptop computer to which the equipment could linked and where the operator could enter all useful information

- Fast transfer of the data to the center of person or facility responsible for interpretation of the results either via mobile telephone or via the Internet

Obstacles to overcome

In the case of wall thickness measurement the most typical error consists in the confusion of two measuring points. This could be avoided by the use of an electronic marker that may help to find and positively identify each point or at least each scanning line. This idea which may utilize barcodes used in many other applications is not new, but it has been hampered in the past by a number of obstacles (the markers should remain readable over longer time period in spite of being exposed to bad weather, to chemical agents and to extreme temperatures; their fixation should be reliable and non aggressive). This idea has not been generally used due to the to high cost of equipment for generating and applying on site the large number of markers. One should also take into account the fact that very often an ultrasonic point measurement is preceded by a radiographic examination; that means that the radiography should be able to use the same markers to document the position of the film. In future one may expect, that the European geo-positioning system named after Galileo could be a great help if the anticipated precision of far less than a meter is really obtained. Of course this potential solution will have certain limitations when the measurements need to be taken within buildings particularly if the building is of steel construction.

Another unexpected difficulty is due to the large variety of data processing modes. This seems to be a normal situation between different industries; but it is surprising to observe within one industry, even at different sites of one company and for comparable or identical installations, the use of different data evaluation software for e.g. such simple inspections like the wall thickness measurement.

Both mentioned difficulties escape the attention of the system developer as well as of the NDT service company who apply it.

Concerning the data transfer by mobile phone one has to take into account limitations by restrictions for its use in certain sites, as e.g. at nuclear power plants, due to the risk of interference with other instrumentation. As a consequence the transfer by an Internet connection with file transfer protocol (ftp) seems to be the preferable solution, although less immediate than a transfer by mobile phone directly from the inspection site. The Internet permits in addition a data transfer by a secured network, which is a priori more difficult when using a mobile phone link. The same trouble with the protection of the confidentiality of the data should dictate a careful application of the so-called WiFi technology or the data transfer between a computer and an access point by RF-waves. In order to save a maximum of time and to avoid the difficulties due to the great variety of requirements concerning the presentation of a report, would it perhaps be the best solution to offer the possibility to load into the equipments the forms adapted to the specific inspection, which should then be completed by the operator at the appropriate spaces with the measurement results and findings, perhaps accompanied with special commentaries, the whole could then be transferred by an Internet link? Those requirements could also be satisfied by a Laptop Computer, loaded with the form (layout) of the report corresponding to the requirements and customs of the client and loaded with the acquired data.

A raw data transfer in real time or at regular intervals seems only be necessary to be applied for the Acoustic Emission.

But is the fast and efficient communication of test results and reports the primary concern of users? Even if they are not hostile to or far from having the possibility to create and edit the inspection report quickly thereby minimizing the cost and reducing the risk of copy errors, it is astonishing to see that the service companies seem to be complacent about these matters. Usually very sensitive concerning timesaving, service companies tend to place as the top of their wishes the enhancement of the equipment autonomy and the battery lifetime. Those wishes implicate to work on two points:

- Reduction of the energy consumption of the equipment
- Choice of a battery technology linking a strong capacity with reduced weight and dimensions and lifetime (as well as the number of recharges supported by a battery) as long as possible.

Another wish expressed by the users contains a contradiction that makes it difficult or even impossible to be satisfied.

Since many inspections have to be executed in restricted areas or with difficult access, there is a strong demand for more and more compact equipment, which basically is enabled by the modern technology. Where this wish is associated with the requirement for large visualisation screens readable without magnifying glasses and in low as well bright light conditions and with the necessity of keyboards scaled to human fingers often forced to be protected by safety gloves, there is a natural limit for the miniaturization of the equipment.

This requirement becomes paradox with the appearance of the new multi-technique equipments (Eddy current and ultrasonic pulse-echo), although those instruments manage the challenge of control with only some thirty keys sufficiently tailored for an on site inspection thanks to especially well configured menus.

Conclusion

We have not yet reached the end of the equipment development. The performance and the possibilities of the actually available equipments are globally judged to be satisfactory. The prior expectations that dealt with the management of the equipment (weight, battery performance, and ergonomics) have largely been met. The increase of the capacity to handle and transfer the data after the inspection should not be neglected, but it is actually limited by an obstacle which practically can't be handled by the users and the developers: that is the presentation of the results. A typical example is the one of the ultrasonic wall thickness meters, for which the measurement centers are have allowed, for about a decade, measurements to be organized and stored within the instrument according to complex rules for two or three dimensions. This sophistication doesn't avoid the demands for special reporting formats by certain users.

No doubt that the possibilities mentioned in connection with a prior data treatment "in situ" and with better options for a fast data transfer to the ordering institution are causing, by themselves, some reluctance and even strong objections. We have tried to point out that the digital design of the latest NDT instrumentation combined with robust, field portable computers and telecommunication equipment offer the potential for real improvements in efficiency, accuracy and cost savings for both service providers and their clients. In the interest of realizing this potential, these opportunities should not be ignored.