How Digitisation is Shaping the Future of Asset Integrity Management

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Digital and robotic solutions have been the Holy Grail for offshore asset integrity.

The dramatic changes in oil prices have had a profound effect on the way our industry will do business in the coming years.

Operators and service providers are determined to make permanent reductions in cost, by increasing efficiency in every aspect of their businesses. One area where such efficiencies are being sought is asset integrity.

Complex offshore assets such as FPSOs, FLNG, FSRU and MODUs are made up of many thousands of structural, pressure system and electrical components which need monitoring, inspecting, and maintaining to achieve optimum safety and efficiency.

Inspection is a high cost item but, apart from being needed to meet regulatory requirements, it also brings benefits when used to prioritise maintenance scopes. It is not practical to inspect every component, so an existing approach has been to use some form of risk based inspection (RBI), or priority based methodology to focus scope and periodicity of inspections.

Digitisation of pressure system data can save 50% of inspection costs

RBI is well developed for pressure systems, but less so for electrical equipment and structural inspections, although this is rapidly changing. However, even the more advanced RBI methods generally achieve a detection rate of anomalies per inspection campaign of around 5%.

The question must be asked…..are we 'wasting' 95% of our inspection cost and, if so, what can we do about it?

Digitisation and statistical analysis can be like radar or a microscope, as they enable you to see things you wouldn't normally see. This means that you can hit the target without much reconnaissance, and be much more effective and efficient.

Clearly a step change is needed to safely reduce costs. We have collected digitised pressure system inspection data on fifteen assets over a seven year period. Traditionally, most of the data is discarded because it contains no anomalies, but we have developed statistical analysis methods which use this data to prove that future inspections can be reduced without compromising integrity. We are confident that cost savings of 50% or more are achievable.

The statistical analysis concept was first conceived in 1986, but lacked sufficient verifiable data and understanding of how the data related to corrosion mechanisms, in order to implement the appropriate statistical methodology.

In effect, the Big Data analysis enables us to project how a component will age, and how much inspection data is required to assure the operator and regulator that the risk is within a pre-agreed level.

Using robotics is more efficient, effective, economic, and safer than putting people at risk

Robotics are the natural improvement to asset integrity activities, and are more efficient, effective, and safer than putting people at risk of working in hazardous environments - at height, in confined spaces or underwater.

Several organisations including the FPSO Research Forum have been studying how to improve structural inspections, especially of confined spaces, such as tanks and the underwater hull. One of the JIPs set up within the forum is the Hull Inspection Techniques and Strategy JIP (HITS) which has representation from all the major class societies, regulators, the oil majors, lease companies, and service providers, and is managed by EM&I.

HITS was initiated around five years ago and has been successful in introducing robotic methods of underwater hull inspections and inspections of cargo, ballast, and other confined space tanks and pressure vessels without man entry.

These methods are now well established, and have been used on more than 20 assets to date for diverless inspections, and for repairing damaged valves and piping.

This has been proven on many occasions, including the recent completion of a class approved underwater hull and twenty one sea valve inspections, with three sea valves repaired on a drillship offshore Angola, whilst the vessel was on station and in operation, saving 10 days off-hire time.

Bladder repair using ODIN inspection tool

Remote optical inspection of cargo oil tank

Robotic methods work well in combination with data digitisation, but require quite significant changes in many aspects of how we do business. If we compare current and future methods of inspecting a cargo oil tank we would see more onshore engineering, and planning to pinpoint high risk areas and expected failure modes, derived from Big Data analysis.

The site team would be reduced to one or two engineers driving robotic systems using remote cameras, lasers or other advanced detection methods, often linked to an onshore support team in real time. Inspection data would be analysed and information provided to the maintenance and operational management, which they would use to optimise integrity and operating costs.

Far-fetched?......Not at all - during recent cargo oil tank inspections on an FPSO in the North Sea using NoMan remote camera systems the work was completed in four man days to the satisfaction of the client and the class society. The client estimated that it would have taken over 100 mandays to have achieved the same result using traditional methods with higher risk, cost, POB and out of service time.

Typical camera system deployed in a confined space

These advanced optical / laser methods can meet the class and regulatory requirements with equivalent inspections to conventional methods including, a General Visual, Close Visual, Distortion Structural Survey, pitting measurements and remote thickness readings, without man entry, and in a fraction of the out-of-service time.

Although the technology appears to be a simple ‘camera on a stick’ this is far from the reality!

The cameras used need to have a proven ability to detect and measure anomalies defined as being above the ‘defect tolerance standard’ both at long range (General Visual Inspection) and close up (Close Visual Inspection) which is defined as ‘arm’s length’.

Knowing where to look is of course crucial, and this requires a deep knowledge of the specific structure and the kinds of anomalies expected, an area where classification societies have extensive knowledge.

Other challenges also need to be met for example, where to position the camera system to avoid ‘shadow areas’, correct lighting, managing electrical hazard safety and avoiding movement of the camera.

There is also often a need to confirm wall thickness of the steel structure for hull girder strength calculations, and to measure pit sizes and depths. The inspection and cleaning requirements for these methods have been defined by the HITS JIP.

However, the much more arduous task of making the tank safe for man entry is not necessary.

<u>Ex equipment is probably one of the most vital elements to be inspected, as they can cause explosions</u>

Deciding on the optimal inspection and maintenance programmes for maximum efficiency and safety is also critical when dealing with Hazardous Area Equipment (HAE).

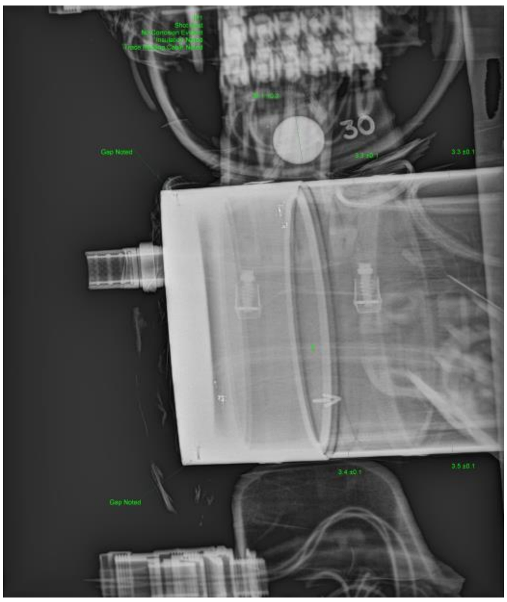
With many of the larger assets having around 20,000-30,000 items of HAE equipment, it is vital to know what to inspect and when. Current methods are largely prescriptive, and it is difficult to meet the inspection requirement because of the large volume of components.

Inspection efficiency is improving with prioritised workscopes, suitable databases, hand held 'palmtop' data loggers and Radio Frequency Identification (RFID) Tags which help record, update, and store the data.

Conventional RBI could be used to improve the process if sufficient data can be gathered to link failure mechanisms (probability) to consequence, and this task is clearly one where ‘Big Data’ analysis can be effective.

Because some of the failure mechanisms are linked to incorrect assembly rather than time related degradation, much of the inspection cost relates to having to isolate systems for equipment strip down, and the shut-down which is in itself a costly exercise.

We are confident that there is good information out there which can be analysed to improve the inspection process, and we are working on this as well as using non-intrusive methods to ‘see’ inside critical components such as connectors, junction boxes and switches, to enable us to assess component integrity, without having to isolate systems as is currently required for traditional inspection.



Digital image of Hazardous Area Equipment (HAE)

We are approaching the time when digital and robotic solutions will be the norm

Whilst we are currently able to apply these methods to existing assets, there are already plans on how to design new generation assets that will incorporate digitised and robotic integrity systems.

There is an apocryphal story of a newly digitalised and autonomous offshore oil facility, manned by a crew of two - a man and a dog - the man's job is to feed the dog, and the dog's job is to bite the man if he dares to touch any of the controls!

Whilst amusing, the story touches lightly on the shape of future digital platforms, and the profound impact of the digitisation transformation that is now being felt in the asset integrity management of oil and gas facilities around the world. Though not a panacea for effective asset integrity, leading global asset integrity companies are now changing their business models to harness the potential of digitisation.

The changes to how we deal with asset integrity will touch all organisations in our industry including regulators and classification societies, operators, service companies, training organisations and research & development academics.

For example, the regulators will adapt their rules and guidelines to recognise that inspection scopes will be far more risk based, and that they will need to ensure that new data gathering methods are validated as being equivalent. Guidelines on engineer and inspector competency will also need to be developed.

Training and certification organisations will need to develop programmes and facilities to deal with the new requirements.

Service companies must rethink their business models, type, and competencies of personnel, levels of in-house engineering expertise, investment in buying and managing new equipment, and, of course, training.

The days of sending a multi person inspection team with rope access capability to inspect a tank, piping or hazardous area electrical, equipment or a twenty man diving spread, each producing swathes of unused data that sit on a shelf, will fade.

Instead we will see inspection used as a leading edge tool used to confirm condition, accurately predicted by onshore engineers using statistical digitised tools, and verified by a one or two man team of engineering inspectors with robotic tools. Much less time will be spent offshore, and a greater proportion onshore planning and analysing data.

Operators will adapt their operational and procurement practices to take advantage of the benefits of digitisation and robotic methods.

Costs will reduce, not just because of the lower inspection costs, but because of the time it takes to prepare for inspection, the extra POB and the out-of-service time for critical equipment, all of which have been accepted as part of the normal ways of doing business in the past.

Safety and environmental risks will also reduce, with fewer people placed in harm’s way, and by improved reliability of equipment leading to fewer loss of primary containment events, repairs or unnecessary maintenance.

To summarise, in an increasingly digitised world, we predict the future of asset integrity management, and the associated inspections, to be even more engineering-led than it is at present with statistically based risk based inspection (RBI) coupled with robotic inspection methods and non-intrusive inspection techniques.