Digital data from critical connections

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How can the value of data from bolted joint connections deliver a competitive advantage across the wind industry? During the construction and operation of wind farms, there are lots of data being collected for various purposes. When it comes to the most important elements in the entire structure, the nuts and bolts that are holding the turbine structure together and securing electrical conductivity, the documentation so far has been very manual, using pen and paper.

and electronics in recent years through implementation of smart connected assembly solutions.

Wind energy is catching up with the use of smart tooling, i.e., tools with inbuilt intelligence for critical assembly, in most new manufacturing plants such as nacelle or gearbox production, and these tools are connected to MES systems to enable traceability, error proofing and process optimisation. But what happens when the turbines are installed in the field?

There is a significant amount of critical bolting operations that take place in construction, commissioning and maintenance which have a direct impact on the turbine performance, reliability and cost.

However, the reality is that in many cases conventional bolting methods, such as conventional hydraulic wrenches, bolt tensioners and rather basic forms of battery or electric tools are still being used.

This is primarily due to old work processes remaining in place, outdated tool fleets, and a general lack of awareness exactly how smart factory thinking can really be applied in the field with the technology and solutions available on the market today, not only as stand-alone tools, but also with the capability to record, interpret and share data from the bolted joints in the field.

For example, intelligent tightening tools, often referred to as 'Smart tools' like the Tensor SRB battery nut runner, provide full torque and angle documentation. Smart tensioning tools like the STS system measure force (kN) as well as the torque and angle applied to lock the nut

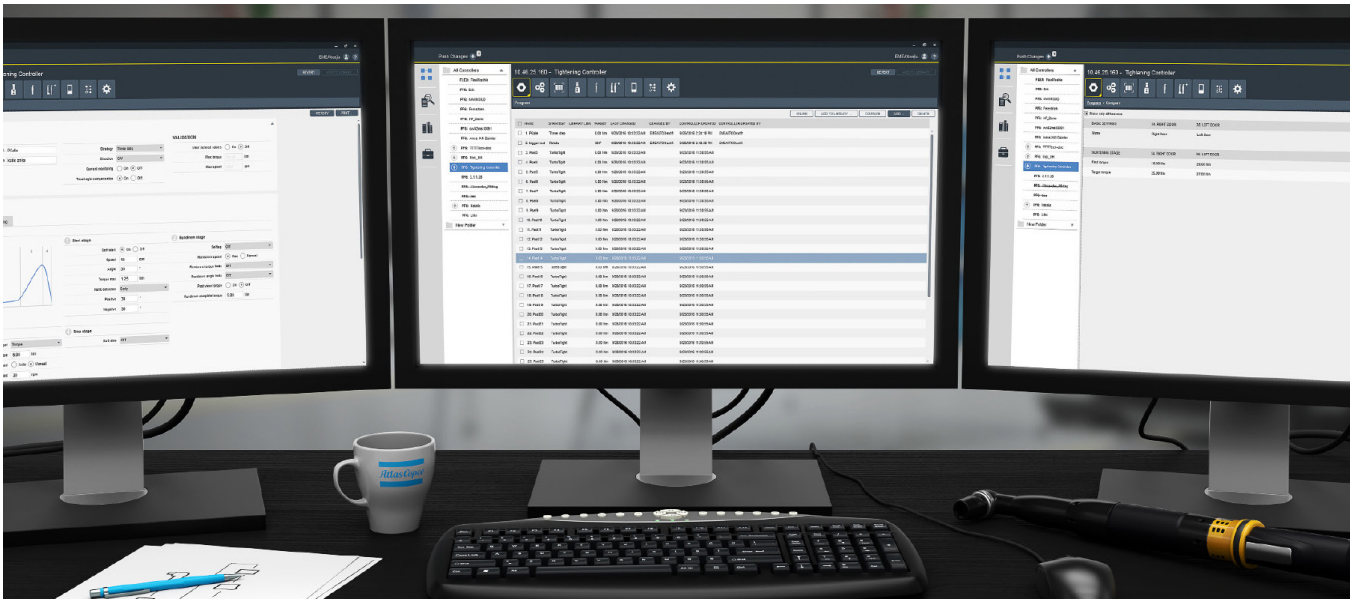
In a typical wind turbine today around 10,000 bolts are assembled and all of them are critical to the structural integrity and long-term performance of the turbine. But for how many of them do we have real data records confirming how they were assembled or by whom and with what components.

This poses a few interesting questions, such as why is it that digitalization has not reached further to include the bolting operations in construction or service of wind turbines? What would the benefits be to the wind industry with a wider adoption of digital solutions when assembling bolted joint connections? What is the current cost of missing data, and for how much longer can the industry afford it?

Smart factory is common, but what about the field operations?

The smart factory is a term we all know well and is used in reference to the implementation of Industry 4.0 in the manufacturing environment.

Significant benefits such as improved quality, higher productivity and cost reductions have transformed industries such as automotive



in situ. These tools are designed to guide the operator, control the process, and secure the quality of the joint but they also provide a digital record of the job done. In this article we'll look at how to unlock the value of the data provided by these tools.

The wind industry is well positioned for change

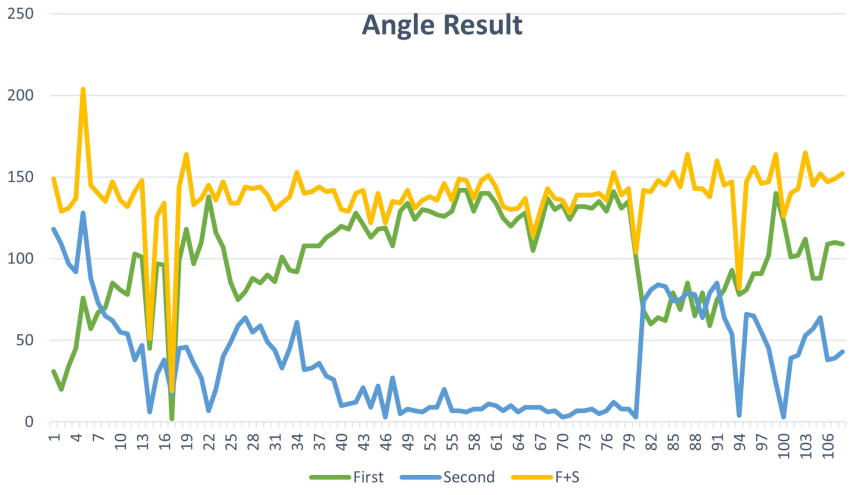
A challenge in any digitalization endeavour is undefined ways of working. If it's not clear what should be digitised, the chances of success are slim at best. The wind industry on the other hand is well positioned. Operating procedures are well defined and documented already, however the challenge is that this documentation is handled in a manual way today which relies heavily on the human factor which can be influenced, and furthermore it is not very efficient as it takes time. These are clear areas where digitalisation of data records could deliver immediate advantages.

Mobile connectivity, cloud computing and smart devices like phones and tablets are enablers for digital transformation in all areas, including operational sites. As true smart bolting tools, i.e., those with real sensors built into the tools, now start to have a stronger presence in the market, there is a great opportunity to improve quality control, work smarter and lower cost across the industry.

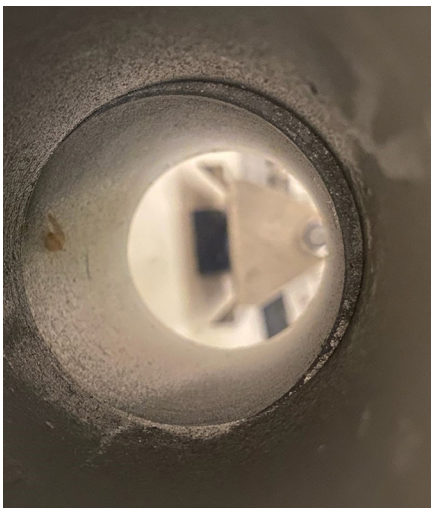
Digitalization in manufacturing for the last 20 years

The last two decades have seen a revolution in terms of digitalization in manufacturing. Global competition is driving waste reduction and bad quality is simply not accepted. In some areas digital documentation has even been accelerated by regulatory requirements. Atlas Copco has been part of this journey, ever since the launch of its first connected tightening controller, the Power Focus 3000, more than 20 years ago. Its ToolsNet database software is the backbone for digital documentation at hundreds of manufacturing plants around the world in all types of industries, from automotive, electronics, aerospace, and today also renewable energy.

Digital documentation on bolted connections has evolved from simply replacing manual markings, for example with paint, and paper documentation of fasteners into a vital tool for data driven process optimization and decisions making. Service campaigns, process changes and investment decisions are supported by real time taken from information provided by large databases with tightening data.



The graph shows angle values for First and Second pass. The first pass angle is too low for a section of the flange and was indicated as NOK to the operator. The second round shows higher than expected rotation for the corresponding bolts that brings the total rotation up to the expected level. The second pass angle indicates flange settlements due to initial misalignment



Misalignment of the flange

Customers of everyday products from the industries mentioned above, such as automobiles, phones, and appliances have enjoyed the benefits of increased quality and lowered costs.

Case study: flange misalignment

Atlas Copco was recently involved in a case of analysing abnormal flange tensioning results together with a customer. The flange was tensioned with Smart Bolt Tensioners supplied from Atlas Copco so digital documentation was available.

The technicians on site were frustrated, the Tensioning tools did not allow them to continue to the next bolt. The Angle values measured when securing the nut after pressurisation were below the specified limit, i.e., indicating that studs had not been sufficiently elongated. They tried everything at their disposal, including changing out bolts, but the tools continued to indicate low angle.

There were several theories as to what caused the problem. Was it caused by the technician's way of working, bolt material problems or issues with the tension tools?

A thorough analysis, supported by the available recorded data taken from the smart tensioning tool, revealed flange misalignment to be the root cause. As a direct result of the findings, pre-assembly instructions were changed and communicated in the organisation. It was also concluded that the technicians on site had followed given instructions and there were no bolt material or tooling issues.

In the end, hours of rework could be avoided and focus given to get the right actions in place.

Smarter ways of working

The construction and maintenance of wind turbines involve OEMs, certifying bodies, contractors and service providers, regulators, and owners, etc. Digital documentation gives transparency and a 'right from me' in every step of the way. With trusted documentation available, sub optimization can be avoided with cross industry cost savings as a result.

Digital bolting tools that provide pressure, torque and angle documentation are now making their way into the wind industry. That enables digital documentation on a large scale, but the real value is unlocked when data is shared, analysed and improvements are implemented across the industry.

The wind industry is a tough business. Time pressure, cost, weather conditions and rough work environments pose a constant threat to projects and are cause for concerns. Have technicians followed instructions? Do the instructions provide enough guidance? Do technicians have the right tools for the job? Are bolts and other components according to specification?

The benefits of digital documentation are clear. Less time spent on paperwork as digital documentation simply replaces the need for it. Tightening data is only a few clicks away. Instant access and sharing of data speeds up the resolution and approval time for flanges with issues. With transparent information focus is given to the right improvement actions. When a problem has been identified, finding the rest of them is a case of browsing through a database for similarities, not sending crews on missions up tower or out to sea to check bolts. Less service campaigns and checks are required and therefore significantly reduced service costs can be achieved when correct bolt status is secured at the time of initial assembly.

Inspiration: automotive, an industry transformed

The automotive industry can serve as positive inspiration. That industry has come a long way since the introduction of the moving assembly line by Henry Ford in 1908. Modern cars come in a vast variety of models to attract unique customer groups and they have never been more complex to build.

There are also increasing demands from government regulators around the world. Despite these challenges, manufacturers have been able to push cost down and increase production volumes to reach almost 80 million cars in 2021. Bad quality is not accepted by the global consumer market and re-tightening nuts and bolts at the service station is a thing of the past. A wide adoption of digital ways of working has been a key factor for success.

Industry leaders working together

Successful digitalization requires technology providers and users working together to find the best practical solutions. As we have talked about in this article, The Wind industry is well positioned for change. Technology is readily available, and the benefits are clear.

Atlas Copco have experience in this transformation process, and are eager to support the Wind industry with new innovation, open standards and continuous improvement together with customers and industry peers.

Summary

The impact of poor documentation, the consequential quality and service costs is apparent. Intelligent bolting tools are entering the sector not only in the factory, but very specifically now in the field during installation and service, and we believe the future of wind will be a digitalized world with significantly improved quality control, faster feed-back loops and lowering of cost across the industry.

For companies that have taken the leap there is no turning back. Running any critical operation without the insights and support of digital documentation is simply unthinkable, so why should it be different when assembly critical bolted joint connections?

To conclude, it's worth considering a very important question. What is the cost of bad joints in your operations, and for how much longer can you afford it?

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