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White paper

The impact of digitalisation in the manufacturing space for air and gas handling markets

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Operating in the backdrop of declining markets

Most air and gas handling applications today operate in the backdrop of difficult markets faced with continuously declining investments. Applications are further pressurised by tighter environmental constraints with many end user players choosing to invest less in new plants and more in prolonging and optimising the life cycle of the existing ones.

We are also witnessing the global uptake of the digitalisation trend which sees a steady move of the use of commodities towards a servitization model.

This is now starting to be very disruptive not only in organisations that are service centric (Finance, Telecommunications, etc.) but also in areas that are product intensive. As a consequence, the manufacturing sector is also seeing a push towards product strategies delivered through or by a service.

Even the more traditional manufacturing industries, which not so long ago used to operate very much a “demand and supply” business model, are now affected by the societal evolution of Industry 4.0 and the advent of the industrial Internet of Things (IoT).

The world of manufacturing rotating equipment is no exception from this evolution. Whilst the implications are disruptive in more than one way, this is also the space where the technology adoption happens at a remarkable pace. In fact, it may be argued that this adoption rate is also responsible for yet another unanticipated cultural shift in this space.

Research shows that manufacturing companies piloting new technologies to support the emerging servitization model do not spend a lot of effort in measuring financial outcomes, but rather embrace the need for such technologies as a quest for improved performance, with some pressure attributed to FOMO (Fear of Missing Out) - the dogma of the millennial generations, here referred to in the context of being left in the wake of the digitalisation wave.

The broad consensus is that the opportunities to reduce costs and digitally transform far outweigh the risks behind a rapid technology adoption, supported by IoT products previously untraditional to the manufacturing space.

Digital technology trends in manufacturing for air and gas handling applications

The digital twin has been identified as a key strategic technology trend and until recently, it seemed to be a rather elusive topic because there was no one way to define it, but more so because the cost of the computational resources required by this innovative notion were prohibitive. In essence, the digital twin involves the handling of large volumes of historical data and the advent of the cloud technology that can store an infinite volume of data.

Digital twin models are continuously evolving digital profiles comprising of the historical data superimposed on the current behaviour of the rotating equipment. The digital twin is based on cumulative, real world measurements across a wide range of operational parameters. The idea behind this process is that such measurements enable the creation of a digital performance profile of the rotating equipment that will support actions in the real world leading to design improvements and changes in the manufacturing and operation of the asset.[1]

Whilst in theory the concept is sound and it can indeed enable real value, in practice, deploying such models at full scale is still very challenging, for a number of reasons:

First, the digital profile is relying on the existence of historical data, and large amounts of it, to create an accurate performance representation of the equipment. In air and gas handling applications, the availability of historical data is a mix of heavily monitored operations with an abundance of raw data, as well high level process monitoring with basic control and instrumentation systems deployed around the equipment. In other words, you may not always have the right or sufficient data to build the digital profile.

Secondly, accessing and processing raw data in a way that is relevant for rotating equipment performance is not always possible. Creating the digital profile involves data tagging of events in the operational history of the asset.

Looking for both efficient operation and failure modes can be a daunting task, especially for machines deployed in the field for some time.

Thirdly, historical data can only be a resource for installed base and for obvious reasons. Newly commissioned equipment does not have a digital performance profile from the get-go.

In some cases, limitations such as these are deeply embedded in organisational structures and have an adverse impact on the digital transformation that can be achieved, beyond just the digital twin model concept and the solution for equipment manufacturers may be to rethink their approach to digital twins.

The new generation of digital twins

Recent research [2] shows that the future of business can be shaped differently with customer-focused KPIs and this may be indeed the approach for OEMs. KPIs such Customer Value and Customer Segmentation can drive the future of the business strategy, but should they drive the direction of their digital transformation path? Could KPIs internal to the organisation support the value analysis and what would they be?

The simplest way to identify customer value is by working back from the customers' pain points. In air and gas handling applications, end users of rotating equipment are typically focused on:

Detecting rotating equipment failure before it occurs and identifying the root cause

Understanding the impact of change in operating conditions on the equipment and process performance

Moving critical equipment maintenance strategies from reactive to full predictive

A digital twin model designed to solve physical issues faster by detecting them sooner, predict outcomes to a much higher degree of accuracy. Its ability to evaluate performance of the equipment in real-time, may help companies realise value and benefits iteratively and faster than ever before.

The value internal to a manufacturing organisation starts with having a complete digital footprint of their products from design and development through to the end of the product life cycle. This, in turn, may enable them to understand not only the product as designed but also the system that built the product and how the product is used in the field. With the creation of the digital twin, manufacturing companies may realise significant value in the areas of speed to market with a new product, improved operations, reduced defects, and emerging new business models to drive revenue [3].

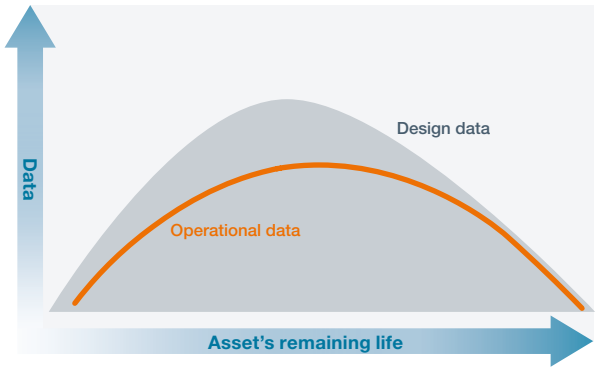
One feature that can be changed in the traditional digital twin approach to satisfy such KPIs is the source of the historical data. Whilst the concept of superimposing digital profiles on real-life application data is the true value enabler, revisiting the source of the data for the digital half may result in a game changing approach.

Traditionally, we think of historical data as operational data recorded and used to average a past behaviour.

What if the historical data is replaced by a design data set that includes the;

- Design principles of the equipment,
- Intended performance at the best efficiency point,
- CAD model with simulation values of the desired process and relevant air and gas properties?

A digital profile populated by such data will depict a "theoretical" performance map of the equipment as per its design intent. Superimposed on the real-life operational data from the sensors, such information will enable right from the get-go the mapping of the current operation in respect to the equipment best efficiency point, without processing any amount of historical data. Isolating and analysing the difference between the two data sets will enable the performance optimisation of the equipment to match the operational requirements.



For operations with pre-existing historical data, these patterns can be pre-populated and the recorded operational data may be used as a subset to assess the asset performance to date, which mapped to the design data, can be indicative of the asset's remaining life.

Driving business value with digital twins

Whilst experts predict over 20 billion connected products by 2020 [4], the exact impact this digital strategy has on driving tangible business value is still somewhat difficult to quantify.

In short term, digital twins may help equipment manufacturers with asset fleet management but beyond that, the improvements in operational efficiency and insights into the asset operation will require time and a lot of data gathering and processing and therefore, multiple years to realise any financial benefits. Hence, setting on a path of digital transformation that is focused on solely building such models should be done with the business benefits in mind, driven by the customer and organisational KPIs previously defined.

Once these objectives are clearly defined, a wider enterprise readiness assessment may be required in order to identify IoT initiatives focused on leveraging the full value of the digital twins. In this way, digital twins can offer strong potential to achieve the desired business value and support an improved decision making process altogether. The risk however, especially in manufacturing organisations that are not IoT inherent, is to develop models of unrequired complexities, quickly transforming the concept into a Big Data initiative that, in the absence of clear objectives, may be difficult to manage and result in transforming the digital journey into a data collection and storage driven process.

In air and gas handling applications, digital twins of rotating equipment can deliver more value if focused on critical performance goals, like efficient/ optimised operation and elapsed/ remaining operational life. These goals can be achieved by further enabling the digital twin with the two “A” emerging IoT technologies.

The first 'A' – Ai

Artificial intelligence (Ai) stands out as a transformational technology trend and questions about what it is and what it can do transcend all corners of our society, from manufacturing to politics, physiology, economics, law and ethics.

The definition of the Ai techniques is ever evolving and extensive research [5] in the field has mapped these techniques to industries and problem types.

Traditional analytics techniques, like tree-based ensemble learning, regression analysis, statistical interference and Monte Carlo analysis are all machine learning algorithms frequently used in air and gas handling applications and the choice of one or more to enhance the digital twins should be based on the customer and organisational KPIs previously defined as business value drivers.

The advantage thus delivered far exceeds the data collected and enables equipment behaviour learning and automation of the digital twin analytics to deliver situational analysis and better response to changing operating conditions, resulting in clear business value around:

- **Asset performance optimisation**
- **Enablement of predictive maintenance**
- **Extending the operational life of the equipment**

The more asset performance data is analysed and interpreted through digital twins, the more IoT enabled maintenance strategies will become, changing the operation of rotating equipment to data enabled actions resulting in the overall performance optimisation and the avoidance of unplanned downtime.

Driving business value with digital twins

The second 'A' – AR

AR (Augmented Reality, not to be mistaken with VR, Virtual Reality), another fast evolving trend, is a technology that superimposes the computer generated three-dimensional model on the viewer's real (not virtual) world, providing a hybrid view of the physical and digital. Though still in its infancy, AR is ready to enter the mainstream and according to one estimate, spending on AR technology will hit $60 billion in 2020 [6].

Some of the immediate benefits rely almost entirely on the "viral" factor associated to technology in terms of the highly differentiated presentation layer, which far exceeds its precursor, VR:

- VR increases engagement and interaction and provides a richer user experience
- AR is mobile and personal and, therefore, hugely accessible
- AR is a relatively inexpensive alternative to other media platforms

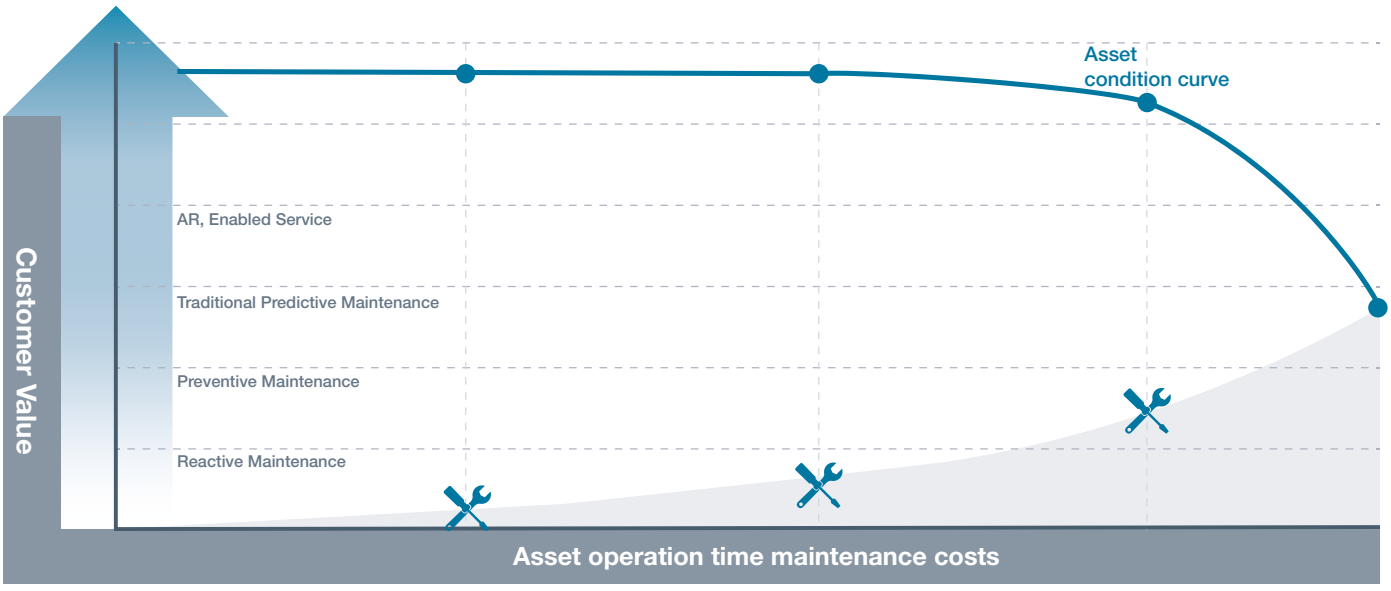
AR will affect companies in every industry, but the early adopters find it still difficult to quantify the exact business value, especially in the traditional markets that are operated by the air and gas handling applications.

For rotating equipment, AR will develop as the "skin" of the digital twins, with the ability to superimpose process and digital twin values in the most visually impactful way: overlaying on the real world application.

With AR transforming volumes of data and analytics into images or animations that are overlaid on the real world, it can deliver great customer value as a digital twin enabler. Firstly, because it allows a physical object that does not exist to be placed in the customer's physical environment and makes the product viewing experience memorable. Secondly, because it enhances the product perception, with three-dimensional thinking and visualisation in 3D rather than 2D and it facilitates the real time display of the equipment with operational and digital twin data.

In a manufacturing organisation, AR will transform the product design process. This technology provides a detailed experience of the internal features of the equipment, that would otherwise be difficult to see, thus enhancing the understanding of fundamental principles of operation and design.

Furthermore, AR has the potential to fully immerse the digital twin into the physical world, eliminating the Big in Big Data and focusing on real equipment and process performance indicators.

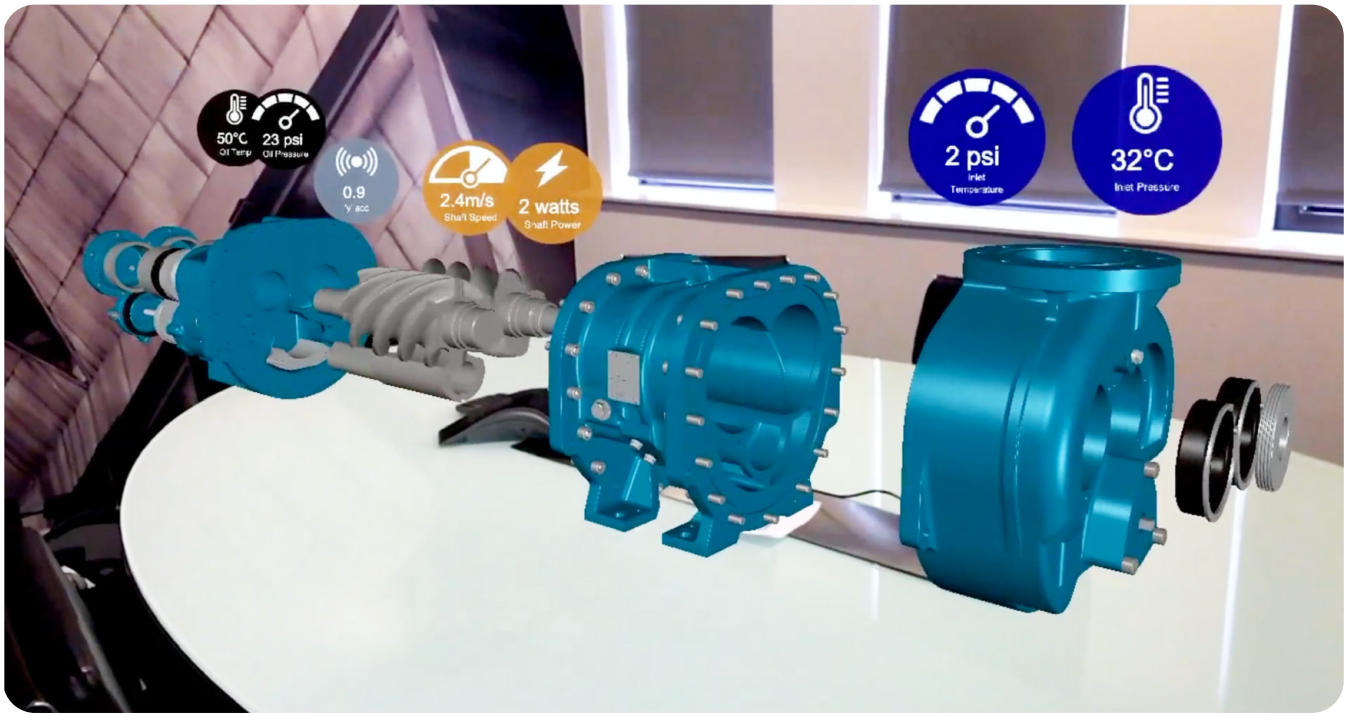


Driving business value with digital twins

AR is already seeing large deployments in the training sector by providing real-time, on-site, step-by-step visual guidance on tasks such as product assembly, component design, machine operation, etc.

The equipment servicing space is also seeing a rapid uptake of AR and with more development, we will see “hands-on” remote assistance experiences deployed, resulting in optimization of the overall process efficiency.

The not so distant future of AR will no doubt see a full immersion of the customer experience from end to end, connecting sales to design to manufacturing to installation and operation into a space where the data is displayed right in front of you.



Conclusion

We are on the edge of the fourth industrial revolution and we are witnessing a truly global uptake of the digitalisation trends, where almost everything we do in our day to day life generates a digital footprint.

The digitalisation of air and gas handling applications is pushing the use of equipment in this sector towards servitization – a very descriptive word defined as a transformation journey.

This involves equipment manufacturing organisations developing the capabilities they need to provide services and solutions that supplement their traditional product offerings. The biggest limitation of digitalisation in this space is the data, either too little or too much of it, and only a clear data strategy can yield into a successful digital transformation journey, that adds business advantage (Data Driven Advantage©).

One approach is by driving digital transformation through customer KPIs with a focus on the business value.

This approach can enhance for the customeroperations and this can be achieved with the new generation of 'smart' digital twins with prepopulated design data to reflect the equipment best efficiency point, as well deviation from intended operation conditions.

Such a data strategy eliminates the Big in Big Data and focuses on the right operational data for the rotating equipment, setting the scene for rotating equipment performance optimization.

This data strategy can be further enhanced by enabling the smart digital twins with advanced IoT technologies like the two 'A's, (AR and Ai), delivering business value according to the predefined KPIs.

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