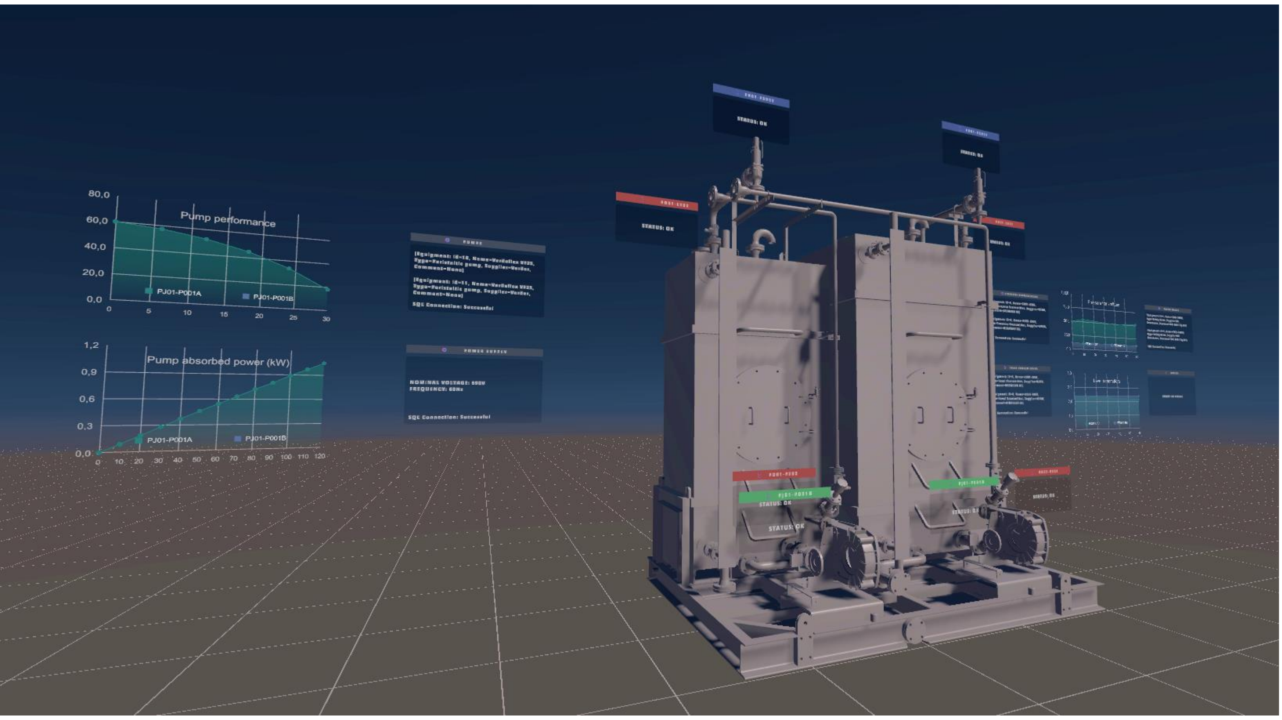
DIGITAL TWIN TECHNOLOGY AND DIGITALIZATION

ENGINEERING AND TECHNICAL ASSISTANCE



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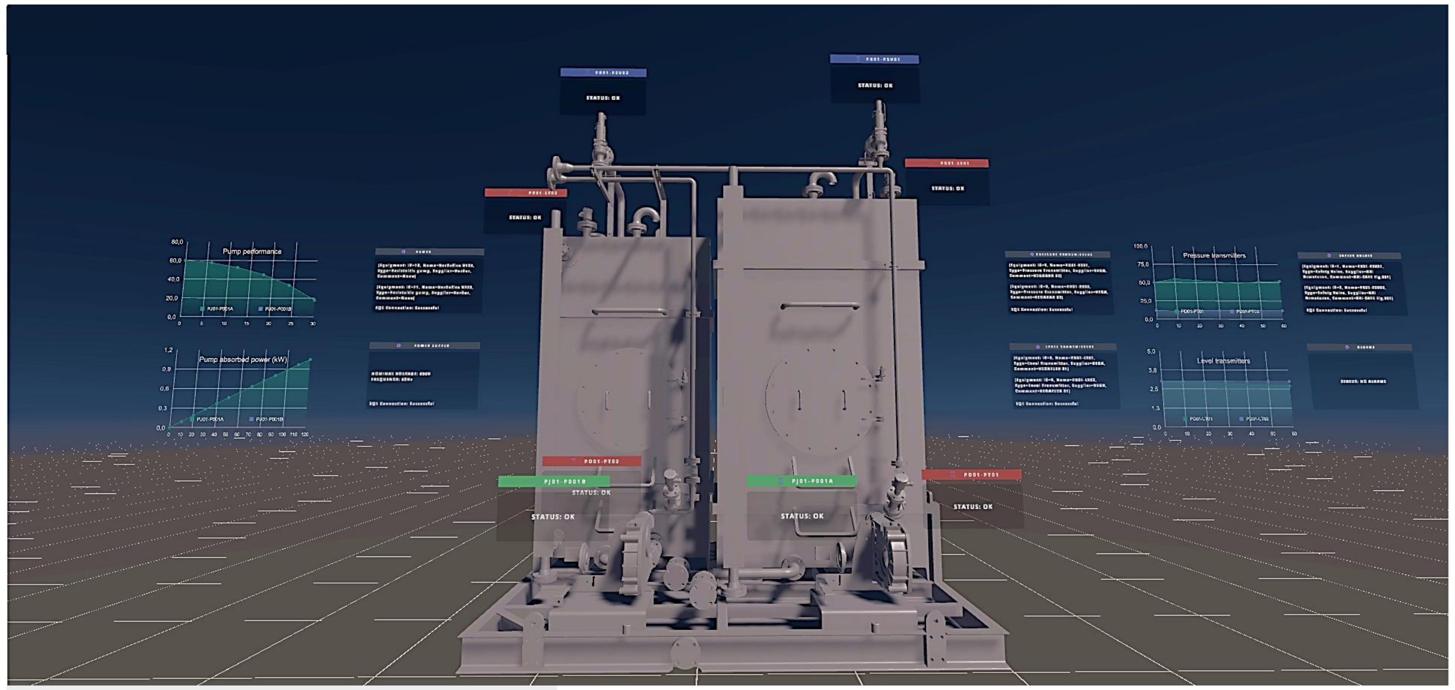

DIGITAL TWIN TECHNOLOGY
ASSET LEVEL DIGITAL TWINS

Engineering and technical assistance

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The real power of a digital twin—and why it could matter so much—is that it can provide a near-real-time comprehensive linkage between the physical and digital worlds.

An asset level digital twin parses and processes real time data streamed directly from the real world so as to create a dynamic, virtual, representation of the equipment being simulated.

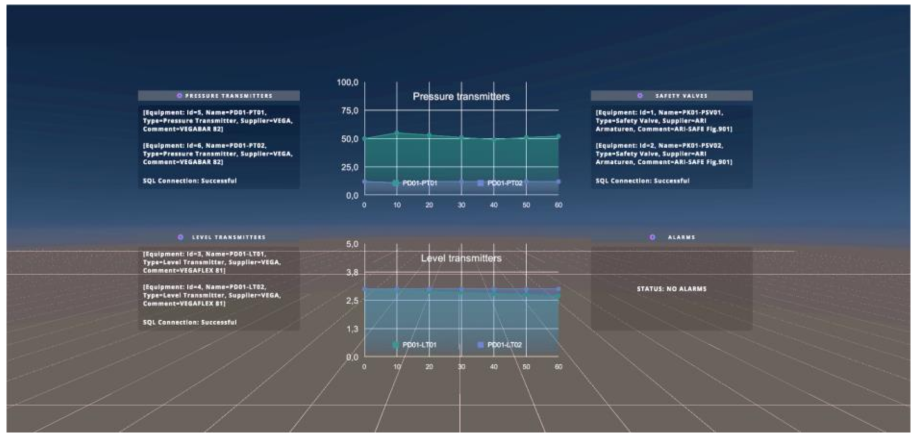
By creating a digital twin, it is possible to gather insight about potential ways to improve operations, increase efficiency or determine potential breakdown points before events happen.

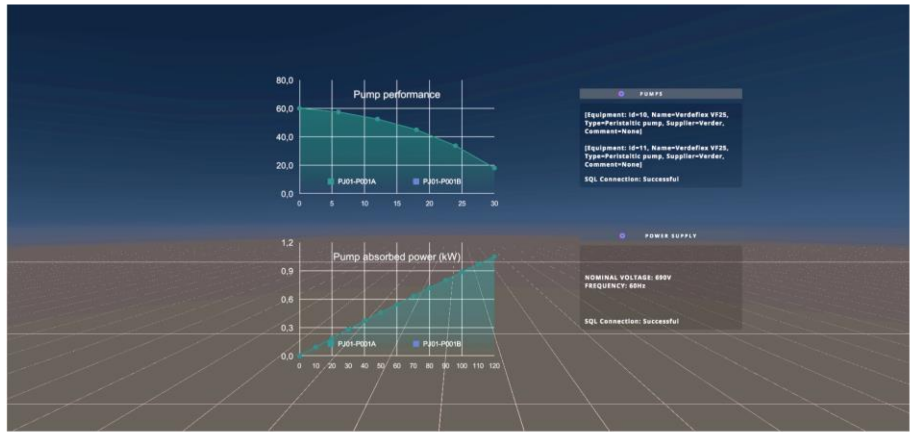
Lessons can be learnt from the digital twin which can be later applied to the real life installation, reducing process-related incidents and avoiding unplanned downtime, mitigating risk and associated costs, in consequence.

We introduce the digital twin paradigm in the following stages:

- Design: Simulation and visualization during the design phase can be used to verify and inspect the overall 3D design and make sure all parts fit together. The design review process can be undertaken remotely together with the client and/or end user to ensure that the design is deemed to be fit for purpose, in a virtual reality environment.

- System integration: 3D visualizations on a system level can verify constraints such as spatial footprint and physical connections. We can integrate the 3D model in a virtual reality environment together with a set of cloud scan data taken from the real life installation, allowing for the aforementioned verifications. Integration effort onsite and the associated downtime for the customer is reduced, as feasibility of installation can be verified beforehand at the virtual environment.





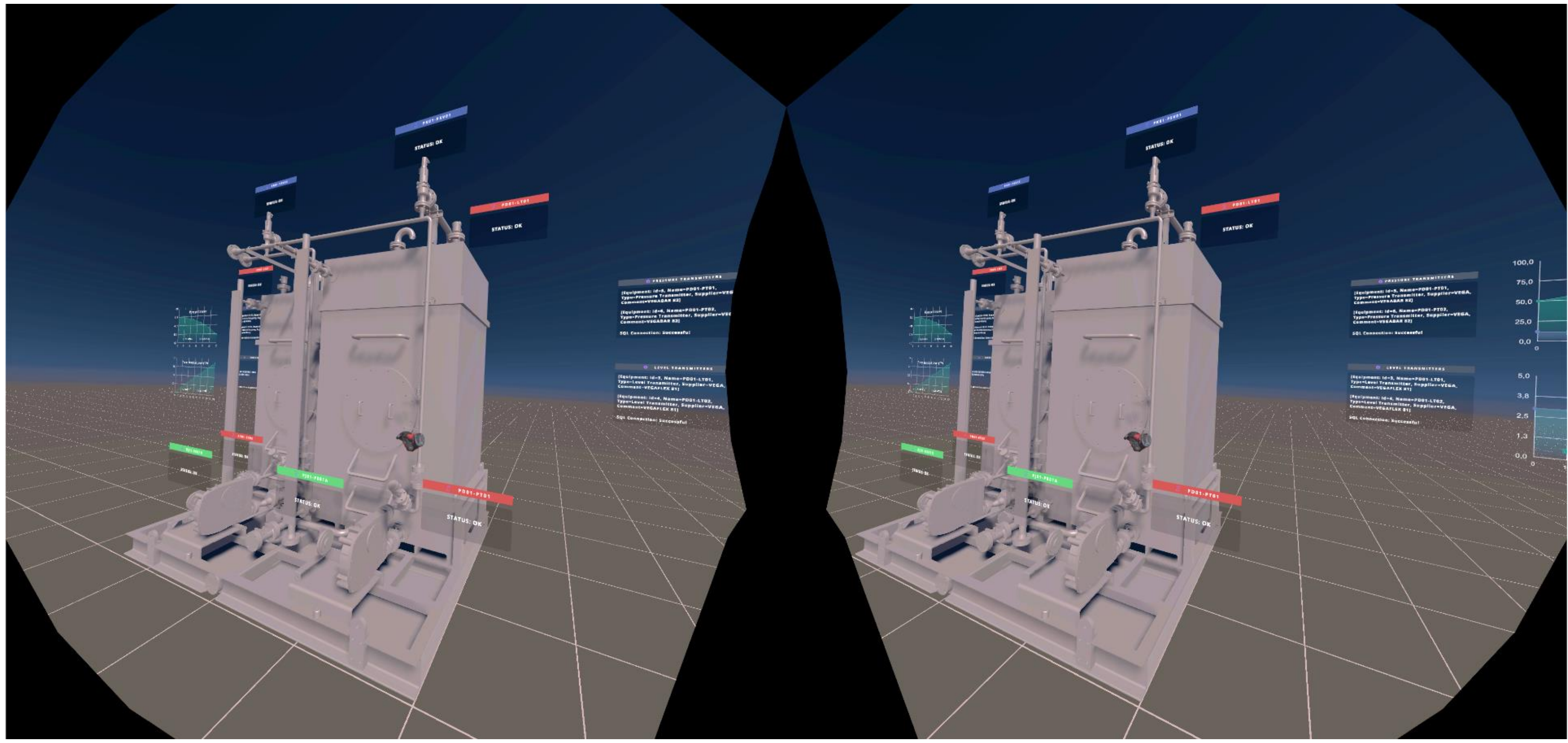


Photo top left
Detail of information windows displaying sensor information from historical data feeds.

Photo bottom left
Detail of information windows displaying power consumption and performance from historical data feeds.

Photo right
Detail of digital twin model within the virtual reality (VR) environment.

- Diagnostics: Observation of the digital twin, for example in a 3D visualization, can support troubleshooting. Augmented reality devices can provide field technicians with an overlay over the real equipment enabling the visualization of key operational parameters.

  Simulations can add non-observable data, such as key performance data of non-accessible parts.

- Prediction: Past and present operational and sensor data in combination with predictive algorithms provide insights into the condition of equipment and the likelihood of different failure modes. This helps plan rational maintenance and reduce unplanned downtime.

Some of the most significant use cases that can be tackled at the present stage of development are as follows:

- Training and capacitation: Inexperienced operators can be trained in near-real-time using a virtual reality environment, supplemented with historical sensor data feeds gathered during operation, significantly lowering expenses and reducing training times.

  Training staff can join in and participate in the virtual reality environment from a remote location, further supporting the training sessions.

- Virtual commissioning: In short, virtual commissioning allows engineers and operators to test new installations, as well as any adjustments before implementing them in the real world.

  The result is a smoother, more streamlined installation and integration, fewer cost overruns and minimal chances of downtime that could impact production.

  Service technicians can produce and review checklist and commissioning procedures against the digital twin model ahead of undertaking real commissioning on the field. Procedures can be fine tuned and skills honed, resulting in faster and more expedient commissioning

- Predictive maintenance: Once the real life installation has been commissioned, data originating from sensors can be continuously analyzed and assessed on the digital twin anytime during operation, and checked against known safe thresholds, resulting in on-screen warnings to remote operators.

  Algorithms can be put in place so as to analyze the long term consequence of operational parameters where deviations from safe settings are observed and facilitating the implementation of predictive maintenance.

  Remote diagnostics: Digital twins can be used to diagnose issues with equipment from remote locations without having to send a service team to inspect the issues.

  Where service teams need to be fielded, augmented reality devices can also be deployed, providing guidance to the service technicians from remote offices where more experienced staff and resources are located.

  Service technicians equipped with augmented reality devices are capable of accessing operational documentation, service manuals, maintenance logs, or replacement parts database, as well as live guidance from remote staff, in real time.

- Remote operation: The digital twin can be connected to its real life counterpart, allowing for remote operation. The operator is working on a simulated, real scale copy of the equipment, located within a virtual reality environment which provides a nearly seamless experience.

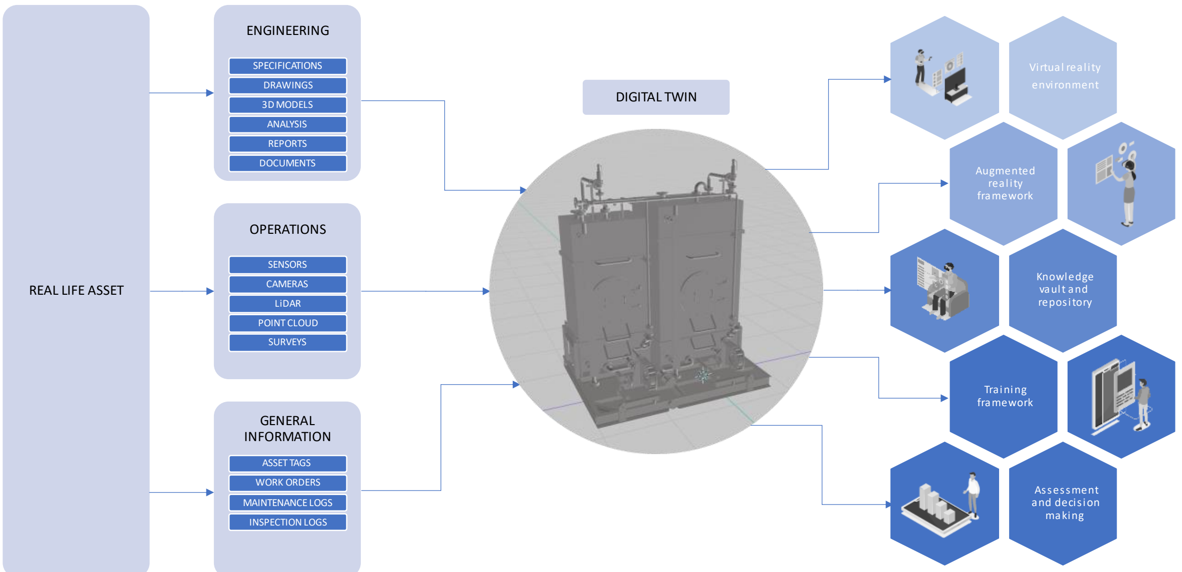
DIGITAL FLOW, STANDARDIZATION AND DIGITAL TRANSFORMATION

Engineering and technical assistance

Information concerning engineering, construction and operation of industrial facilities is created, used and modified by many different organizations or individuals throughout a facility's lifetime. Integration of data to support the life-cycle activities and processes of production facilities should be facilitated so as to ensure availability to different organizations located in different places and participating at different lifecycle phases starting from design through construction, operation and maintenance.

The digital flow is a process in which people and information are connected seamlessly, efficiently, and intuitively. Information flows where it should, and when it should, without the customary delays imposed by traditional information systems. The goal is to create a single, software-agnostic platform that will extract value from all the company's systems and disparate data sources, and assets in the field, and leverage that value into internal efficiencies for staff, as well as new capabilities for customers.

Image below
Graphical representation of a typical digital flow centered on an asset level digital twin.



Before digitization, consistency and access to critical information could be a challenge. Without efficient access to contextual and historical data, an individual inside an organization could waste valuable hours gathering specs and product documentation, through disjointed information systems and other individuals with partial access to critical pieces of information. The inefficiencies were obvious, as were the risks.

Once the digitization process described above is complete, that same individual will get access to all relevant documentation, be it project related, or relevant to operational criteria, in a seamless way and as part of their normal workflow, dramatically saving time and reducing the duplication of efforts.

The separated hard copy 2D drawings and documents used in the past can now be retained and accessed digitally. New media such as interactive 3D models, specifications, design review reports, electronic survey data, or equipment data sheets, can be used to capture knowledge in alternative ways. Since a far greater number of individual pieces of information can be collected on equipment and systems than ever before the overhead of finding relevant information is potentially increased. However, by classifying information contextually the digital twin becomes an essential solution to rapidly identify and present content in an easily consumable way.

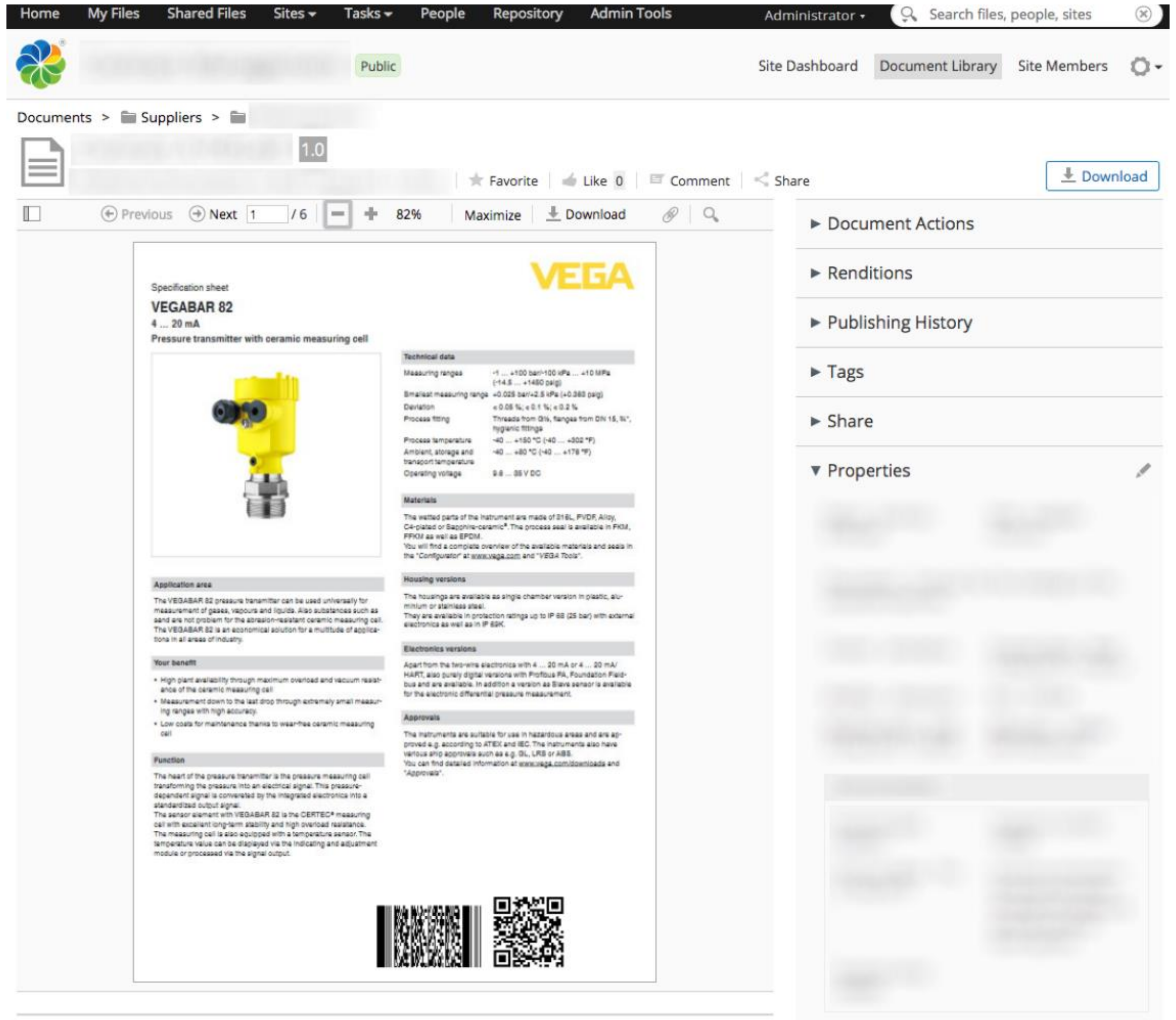
Photo right
Real life or physical asset.

The digital twin allows for easy retrieval of information from the wide array of documents and data sources covering the installation. During handover from supplier to customer or end user, these documents have been traditionally passed on as individual pieces of information disjointed and disconnected from each other. Assembling and connecting these data sources back together is a significant challenge. The digital twin technology can assist this process by publishing and collating data in a relational manner, providing automatic searching processes.

The content management system we propose is content agnostic, implying it is prepared to handle all types of documentation that has been previously digitized, archiving and correlating the data with other relevant data regardless of the source and data type, be it a production drawing, equipment datasheet, product certificate, or test record, to name but a few. Where possible, Optical Character Recognition (OCR) will be used to provide further context and content to the record.

Image below

Content management system displaying an equipment data sheet record.



Individual records can at a later stage be further tagged and commented by authorized users, and incorporated into higher level project or installation records.

The process of assembling a digital twin commences at the engineering stage by defining relationships, characteristics and specifications, representations and contexts of all assets, and captured and maintained as part of the design and fabrication process.

The engineering stage should be considered the primary source of information for a digital twin and all other documentation checked against it where possible, with regular updates to the engineering package where deviations are found in real life. A 3D representation of the digital twin, as shown earlier on in this brochure, shall be made be available providing a graphical context to all the component information in the project.

As far as the content management system is concerned, each and every component in the package or installation will have a unique identifier, and relationships between components, and between components and documentation, shall be identified, correlated, and recorded. This identifier will be a key component of the content management system, and it will be essential for the integrity of the system that consistency is maintained across the board, from the early stages of archival of the engineering package, through fabrication and, eventually, throrough the whole operational life of the asset.

This identifier follows the equipment or asset in different forms and shapes, from QR and barcodes in the content management system, to NFC (Near Field Communication) tags attached to the real life asset or components.

NFC tags are another technology widely used in different applications were positive tracking needs to be implemented in a reliable way. This technology ensures convenient and secure transfer of digital data via high-frequency radio over a short distance.

NFC tags are passive, which means they do not feature any power source; instead, they take power from the device that reads them on the principle of magnetic induction. When a device is close enough to the tag, it powers it and sends data from that tag.

These passive devices communicate with mobile devices, automating maintenance and control processes. Ruggedized devices and tags can be deployed on the field in harsh environments, even in hazardous/classified zones, and in a safe manner.

When the NFC tag is programmed with the unique identifier, it provides a connection between the real life asset and the digital twin.

A service technician, equipped with a NFC aware device, can scan different tags while on the field and poll the digital twin environment for information specifically tuned to that particular tag record, such as maintenance logs, spare parts, etc.

This information can be supplemented by an augmented reality environment designed to provide additional guidance when triggered by a specific tag detection event.

Photo right

Programming of sample non-ruggedized NFC tags and association with virtual counterparts on the digital twin environment.

Besides engineering data, access to operational data in real life applications is a reality nowadays. This wealth of information can be a valuable asset for historical reasons, in order to observe and assess the performance of an equipment during its life cycle, to evaluate potential alternatives for improvement. But it is also becoming possible to acquire real time or near real time data feeds remotely, allowing the observer to assess performance and make operational decisions based upon current conditions.

Just like engineering data can originate from a wide variety of sources, operational data can take the shape of sensor data feeds, camera feeds, or more sophisticated feeds generated by drones or LiDAR devices.

Using these sources of information, the observer can gain knowledge on almost anything through almost all their senses, and interact with the digital twin in an immersive virtual environment. Digital twin technologies, through a virtual representation of physical assets make it possible to apply predictive policies in plant management and maintenance. In comparison to traditional simulation models, a digital twin is reactive: it receives information from the sensors on the physical asset and changes when the asset is modified.

Through the analysis of physical data, sensor data and maintenance methods, the digital model can easily identify components and parts showing signs of damage, which enables data-driven analysis and incremental risk assessment strategy starting fromreporting of adverse events. Triggering predictive maintenance activities could eliminate the risk of downtime events or catastrophic failures, and related expenses.

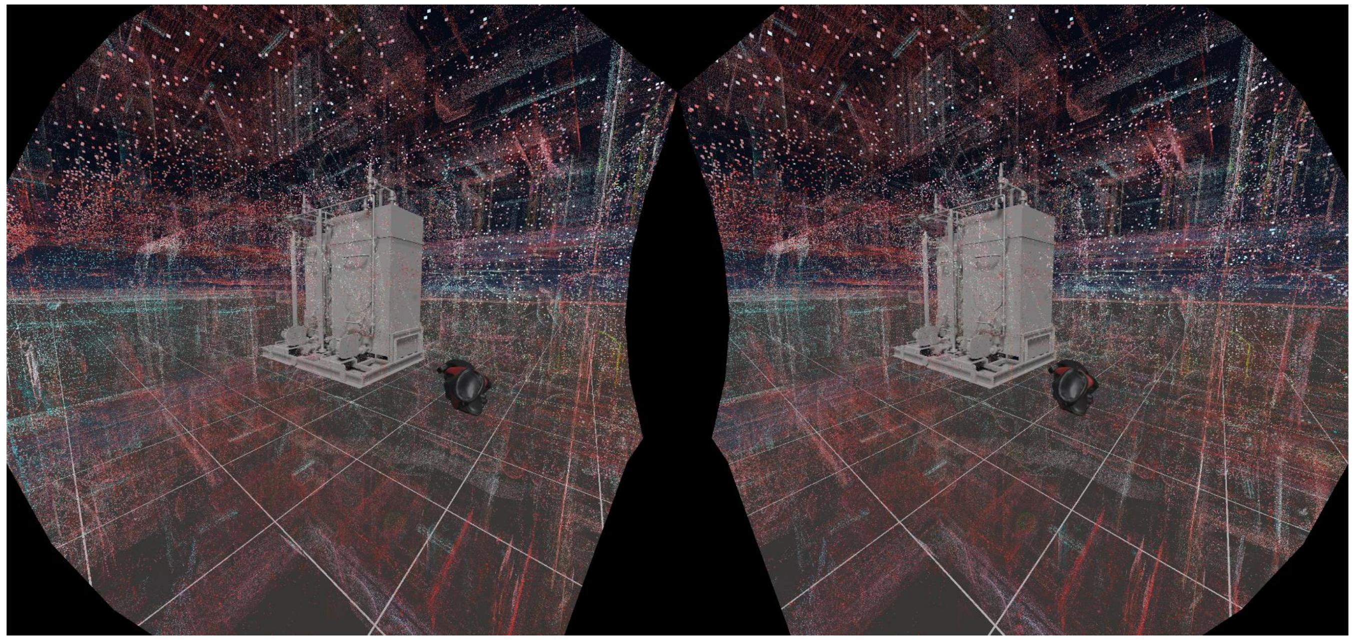
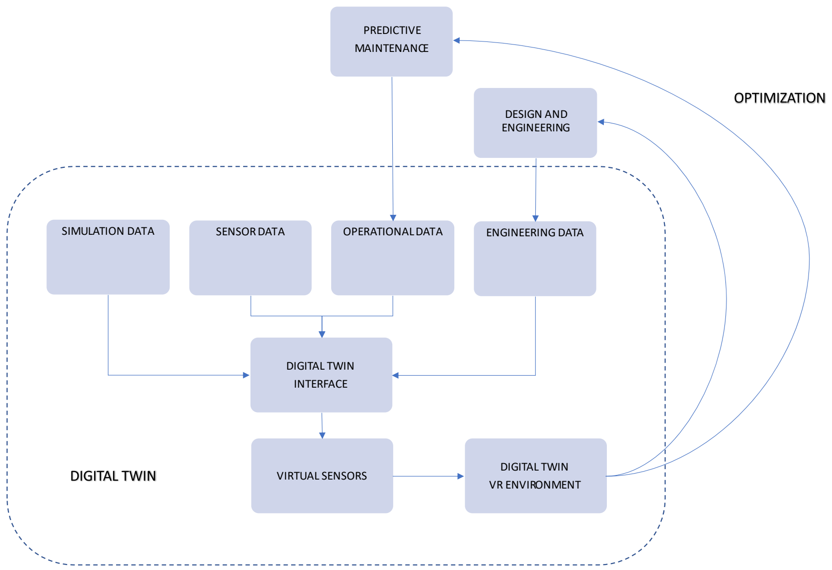


Photo above
Point cloud scan data originated from LiDAR devices merged with 3D model of the developed digital twin during a simulated design review session.

In order to fully exploit these capabilities, the design would need to incorporate certain features that would allow the digital twin to be prepared to assess and predict potential failure modes. For instance, sensors would be attached to electric motors enabling the collection of data from those motors in real time. With some configuration and data analysis paired with digital alerts, remote technicians would know a motor is starting to fail when parameters like temperature rise and/or vibration increases.

The value in knowing when something will fail before it has reached a critical breaking-down point is a holy grail for operations, because it ensures that critical equipment continues to function with no disruption to production.

Image below
Benefits provided by the digital twin paradigm in both optimization of design, predictive maintenance and operational performance.



Besides the use of specific sensors to gather live data which can be used for predictive maintenance purposes, we can also process historical data originated in operation and use machine learning algorithms to find correlations between data points and/or analyze failure patterns.

Different methods can be applied, from regression modes that predict remaining useful life to classification methods that predict failure within a given time frame. The selection of each method is contingent on the specific case and availability of historical/static data, and the accuracy of the prediction will also vary depending on different factors.

Photo right
Typical configuration of a virtual reality (VR) environment hosting a live digital twin asset, with a VR set on top, and a content management system next to an edge interface below.

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