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# How Smart Pumping & AI Can Extend Equipment Life

Digital twins, analytics and artificial intelligence provide needed insights for operations and maintenance decisions.

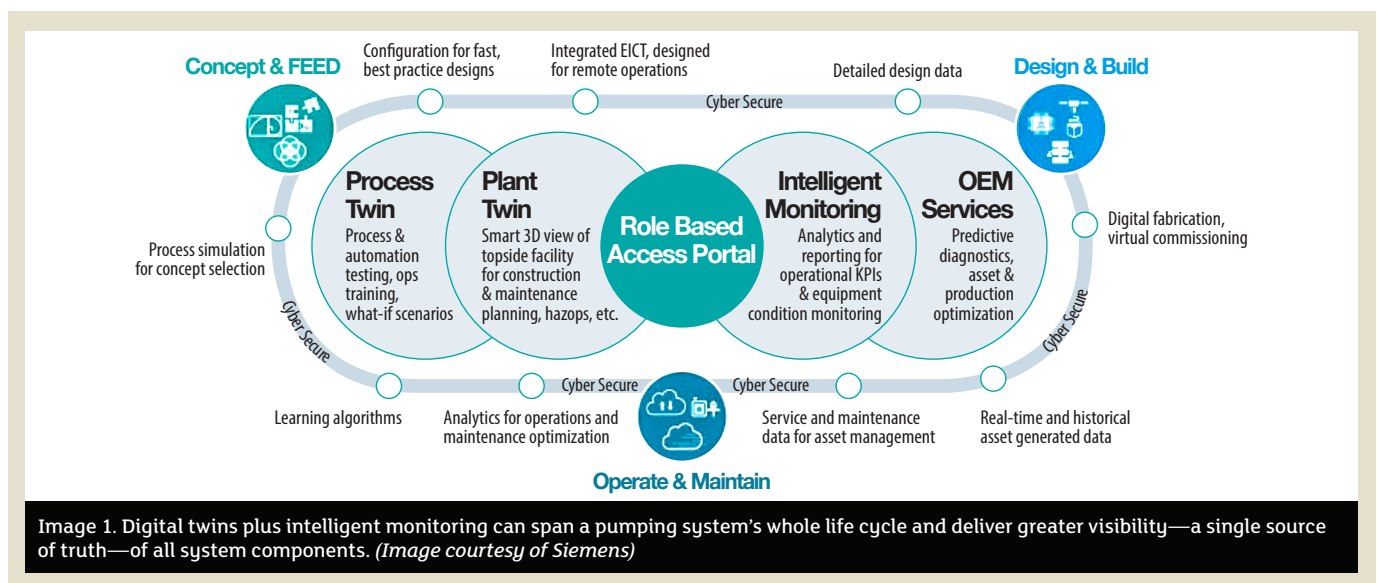
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More and more, OEMs and operators of pumps used in diverse industries such as oil and gas, water treatment, and food and beverage employ advanced digitalization technologies to optimize pumping systems operation and maintenance.

Among those technologies are digital twins—virtual 3D proxies of their physical counterparts—applied with sophisticated analytics and artificial intelligence (AI)-enabled machine learning. Together, they can enable a concept called “smart pumping” with many operational advantages and benefits.

Smart pumping, for example, can enable OEMs to enhance their offerings’ features and capabilities, especially remote condition monitoring, diagnostics and serviceability, while operators can realize savings in downtime and energy use.

The results in real time point to operational anomalies that can be investigated and mitigated or remedied before costly disruptions occur. And, with more proactive—even predictive—maintenance models, operators can extend component and system life cycles, lowering total cost of ownership (TCO) for decades of use. TCO can dwarf initial capital investments of complex pumping systems, such as those moving fluid through long-distance pipelines.



Digital twins evolved from 2D and 3D computer-aided design (CAD) and computer-aided engineering (CAE) software applications. In effect, these application outputs become inputs to even more sophisticated software running on workstations.

Digital twins can be viewed with granularity from all angles, even operated in digital form under specific conditions to study rotary and reciprocating motions.

Digital twins can also be shared from a common engineering repository across different engineering disciplines, with modifications documented and traceable to a particular team or individual. They can also be used for virtual commissioning and personnel training, even before a pumping asset gets built.

Image 1 shows how tech-enabled smart pumping can support the life cycle management of what could be an entire pumping facility, whether inside a single plant or across a distributed pipeline system spanning hundreds or thousands of miles. Engineers, operators, maintenance technicians and OEMs with the proper access privileges can examine virtually any detail of its constituent facilities—pump stations, for example—or any of their components, such as compressor trains and supporting infrastructure. The digital twin can investigate and test optimization scenarios to troubleshoot operational issues as they occur and, most importantly, mitigate or remediate them before costly disruptions.

To further explain smart pumping, it helps to understand the four key points listed in Image 1.

### **1 Process Twin**

Digital process twins can keep a pumping system's commissioning time and costs to a minimum, then continue to deliver value during its entire life cycle. Engineers can conduct dynamic process simulations over a wide range of the system's features and capabilities before its manufacture or construction, rather than making changes afterward. Simulations can include testing simple input/output (I/O) or signal of a pumping system's controls to ensure its logic and functionality works properly. They can also be used to optimize a pumping system's process and to train personnel via virtual commissioning in parallel with manufacture or construction to save weeks or months of time.

### **2 Plant Twin**

Digital plant twins can use 3D engineering data—especially as-built documentation—throughout a pump or pumping system's life to provide a virtual-reality viewer for 3D models of them.

Engineers can test the instrumentation control and safety system (ICSS) in advance of manufacture, in the case of single pumps, or with larger pumping systems, ahead of

construction, commissioning and startup. Also, engineers can use a digital plant twin to switch between 2D drawings and 3D representations via a centralized engineering data repository—a single source of truth—which can enhance cross-discipline collaboration, save time and reduce errors and miscommunications.

### **3 Intelligent Monitoring**

Intelligent monitoring of pumping systems is enabled through web-based analytics and visualization capabilities that can include:

- physics- and rule-based analytics of pump performance key performance indicators (KPIs)
- control loop and alarm system performance
- AI-driven machine learning for monitoring and optimizing the performance of pumping system components, such as compressors, turbines and drives
- daily, weekly and yearly maintenance and operational KPIs
- maintenance alerts

The visualization tools can boost real-time operational visibility and management of a pump or system, showing KPI trends—as well as alerts and faults—graphically on a dashboard that is accessible via a PC, tablet or smartphone. If there is an issue, operators (or the OEM of a pump or system) can study its engineering, maintenance and operations data to find and mitigate or remediate root causes.

### **4 OEM Services**

OEMs of pumps and pumping systems bring extensive experience not only from the design and engineering of their solutions, but also from supporting and servicing those of their other customers. So, while intelligent monitoring can offer actionable intelligence derived from condition-based analytics on these pump systems' KPIs, an OEM's in-depth and cross-industry knowledge of their pumping equipment is still invaluable.

Consider the case of complex pumping stations used in oil and gas pipelines with predictive diagnostics on the complex rotating equipment—turbines, compressors and large drives.

Remote diagnostic services (RDS) based on an OEM's engineering, support and service knowledge can be a critical complement to the pipeline operator's day-to-day operational expertise by detecting emerging performance issues before unplanned downtime or catastrophic failures. AI-enabled machine learning can compare KPI data, such as vibration, temperature, amperage and more, to baseline operating signatures to detect variations that could escape notice by human operators.

## Remote diagnostics based on engineering, support and knowledge can be a critical complement to the pipeline operator's day-to-day operational expertise by detecting emerging performance issues before unplanned downtime or catastrophic failures.

RDS can also help OEM experts advise a pumping station's engineers, control room staff or maintenance technicians on how best to address witnessed symptoms. That might involve taking immediate corrective action, operating until a planned outage or operating a pump to failure in a planned manner. OEMs can deliver decision support to pumping system operators, so end users can make better-informed, more-effective decisions faster than they otherwise could.

In the past, the use of digital twins has been limited to the design and engineering phases. Extending their use to operation and service of systems and components facilitates a shift in digitalization paradigms.

Innovations in deployments of digital twins can now include the efficient generation of new services across hierarchical levels, the reuse of 2D and 3D models from design and engineering, the fusion of simulation and data models and, ultimately, extending those performance-monitoring operational models to take advantage of new cloud-based offerings.

Cloud technology can facilitate the real-time monitoring of entire fleets of pumps and pumping systems across geographically dispersed plants and pipelines. When AI-enabled machine learning is applied to operating data, the combination can set up a more proactive and even predictive operational and risk management model.

This kind of AI-enabled machine learning can prove an advantage compared to more reactive models that often can overlook a pump or pumping system's impending failure. And this can be the case even if operators or their OEMs have installed digital diagnostic capabilities. With a more proactive and predictive operating model, maintenance can be done as-needed instead of as-scheduled, which can save labor and parts costs. Of course, it can also prevent costly production disruptions.

A food and beverage producer could have to discard work-in-progress and conduct cleaning operations, while a water treatment plant could incur regulatory fines and sanctions for noncompliant discharges.

For oil and gas pipeline operators, pumping downtime can wreak havoc on batch-throughput scheduling, causing missed customer commitments.

With the right system, if a pumping system fails during commissioning or operation, engineers can trace its root cause(s) quickly and determine the best response. This traceability improves accountability if a failure results in disruption or a catastrophe. Engineers from the system's OEM can then inspect similar systems to uncover potential failures in other systems, so preventive measures can reduce or—via repairs or replacements—lower the odds of those failures occurring.

### Conclusion

Digital twins coupled with advanced analytics and AI-enabled machine learning can help pump and pumping system OEMs and operators simplify their deployments. These digitalization technologies can also simplify operating complexities to reduce project risks while lowering TCO over a pump or pumping system's entire life cycle.

Among those advantages are real-time condition monitoring and condition-based, predictive maintenance. These can potentially boost the reliability and availability of pumping assets to ensure maximum use and minimize disruptive unplanned outages.

Then there are the benefits of improved operating visibility. This can help identify new efficiencies to enact and further enhance reliability. ■

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