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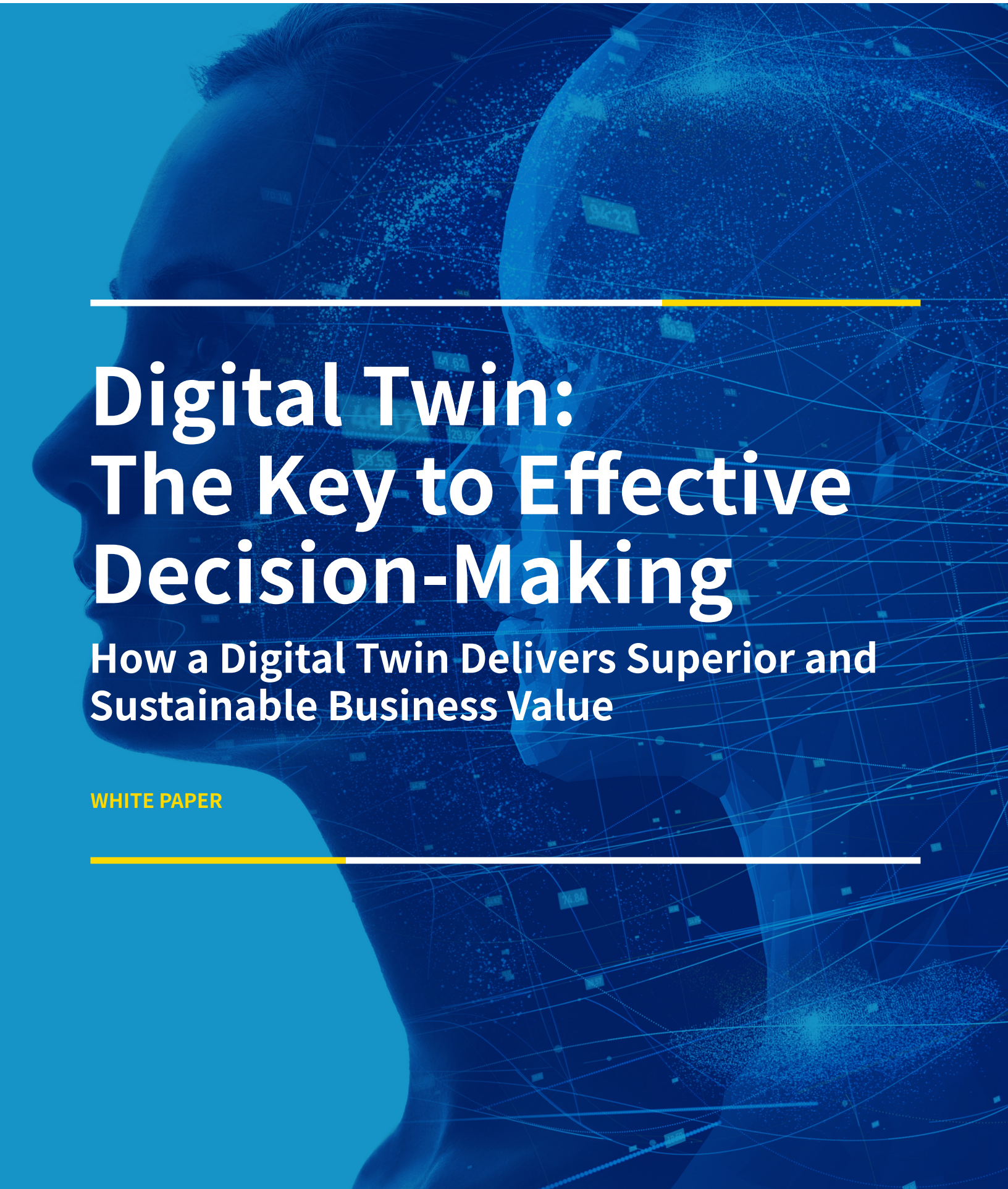

Digital Twin: The Key to Effective Decision-Making

How a Digital Twin Delivers Superior and Sustainable Business Value

WHITE PAPER

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KEY TAKEAWAYS

- ✓ Digitalization is accelerating and disrupting the decision cycle.
- ✓ Digitalization facilitates information flows throughout the organization—everyone has the information they need.
- ✓ Digitalization has enabled the transition of XaaS to outcome-as-a-service.
- ✓ Today's multiple digital twins are evolving to a single, multi-purpose digital twin concept.
- ✓ The single digital twin enables a "Digital Nirvana" that aligns asset lifecycle and value chain
- ✓ The digital nirvana insight provides superior and sustainable business value.

What is a Digital Twin? Buzzword or Value Creator?

Decision cycles across the Energy and Chemical industries are becoming increasingly disrupted by proliferation of data, new data sources and compute speeds within an increasingly volatile business environment. The digital twin is the key to effective decision-making in this new world.

Making better and faster decisions that can be executed perfectly every time is vital for delivering superior and sustainable business value. However, this is easier said than done because every individual perspective is under-pinned by a series of unique cognitive biases that drive swift action in adversity but make accurately weighing evidence, assessing probabilities, and deciding logically a challenge. Look no further than the constant discrepancy between strategic planning/ ambition and results realization - figure 1.

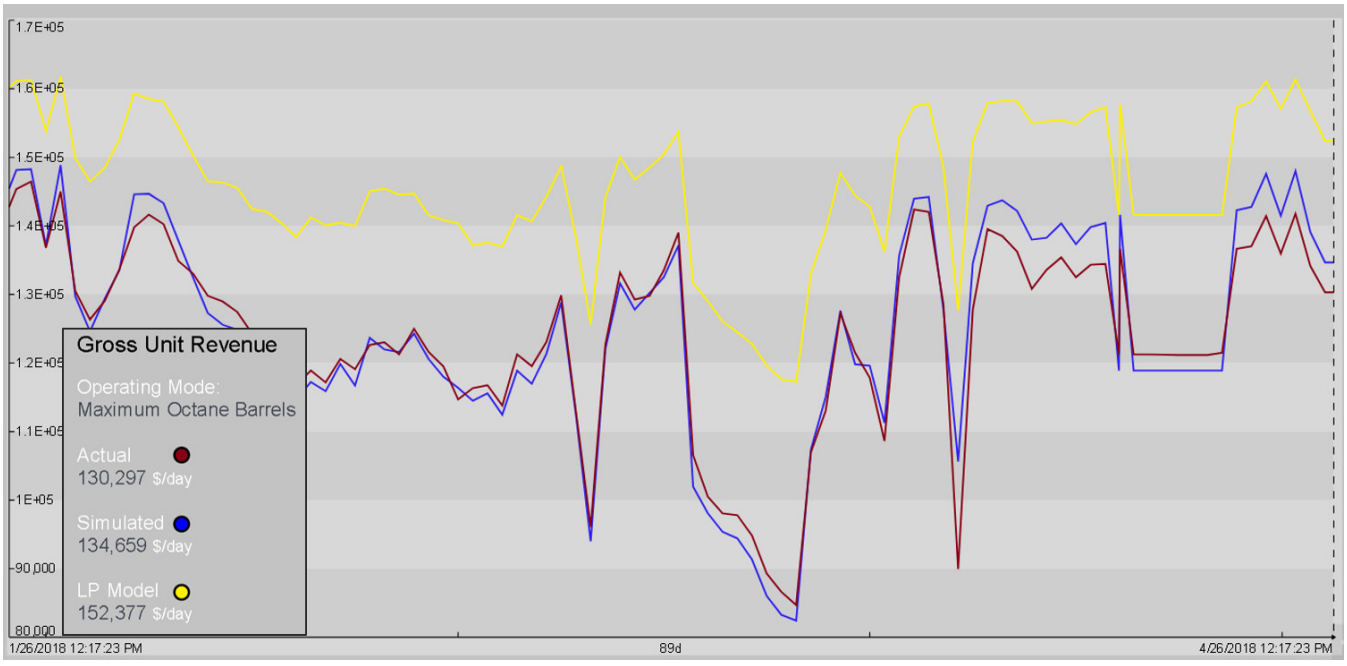


Figure 1 – Profit gaps in process plant operations – actual case study at a refinery.

A single view to the truth and analytics are therefore key to situational awareness and effective organizational decision-making. But are many players in the industry stuck on what type of analytics they need? The solution to this question should be driven by the problem that needs solving, not how much analytics can be thrown at data in the hope it will both find the problem, as well as solve it. The desired outcome should influence the type of analytics being sought and the available analytics technology that is fit-for-purpose – see figure 2.

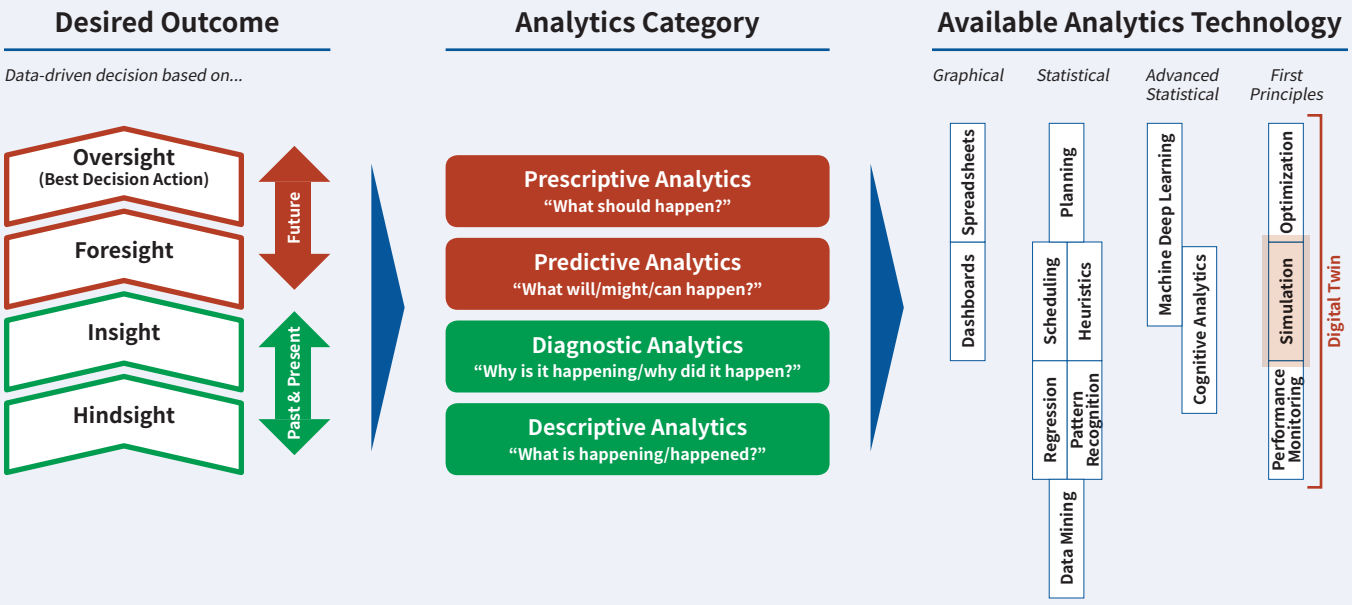


Figure 2 – What kind of analytics do you need?

Basic analytics technology can move data around and get Key Performance Indicators (KPI's) displayed to the right people at the right time to enable decision-making, and this works well in hindsight for understanding what happened. However, increasing process plant complexity requires more sophisticated ways of approaching KPIs and targets. In some cases, a rudimentary approach to KPI's setting and monitoring can even become ineffective and counter-productive. In this case, deeper analytics technology, utilizing a digital twin, is necessary to account for the multi-dimensional factors and non-linear trade-offs that make effective decision-making a challenge.

The digital twin allows "What if?" and "What's best?" scenarios to be run automatically to determine available strategies that maximize profitability. Experts can then review the recommended strategies to assess the impact of each recommended approach.

A digital twin works in the present, mirroring the actual device, system or process in simulated mode, but with full knowledge of its historical performance and accurate understanding of its future potential.

Therefore, the digital twin can exist at any level within the traditional ISA-95 architecture and can be defined as a decision support tool that enables improved safety, reliability and profitability in design or operations. It is a virtual/digital copy of a device, system or process that accurately mimics actual performance, in real-time, that is executable and can be manipulated, allowing a better future to be developed.

A digital twin is useful across the entire lifecycle of an asset. It is ideally created during the initial study to evaluate the feasibility and process model of the asset. It is then used and further developed during the design, construction and commissioning of the asset; thereby facilitating the optimum design of the asset and the training of the staff who will operate the asset. During the bulk of a plant's lifecycle, operation and maintenance activities, the digital twin can be employed for optimization and predictive maintenance.

> *"The digital twin provides the opportunity to see inside assets and processes and perceive things that are not being directly measured.*

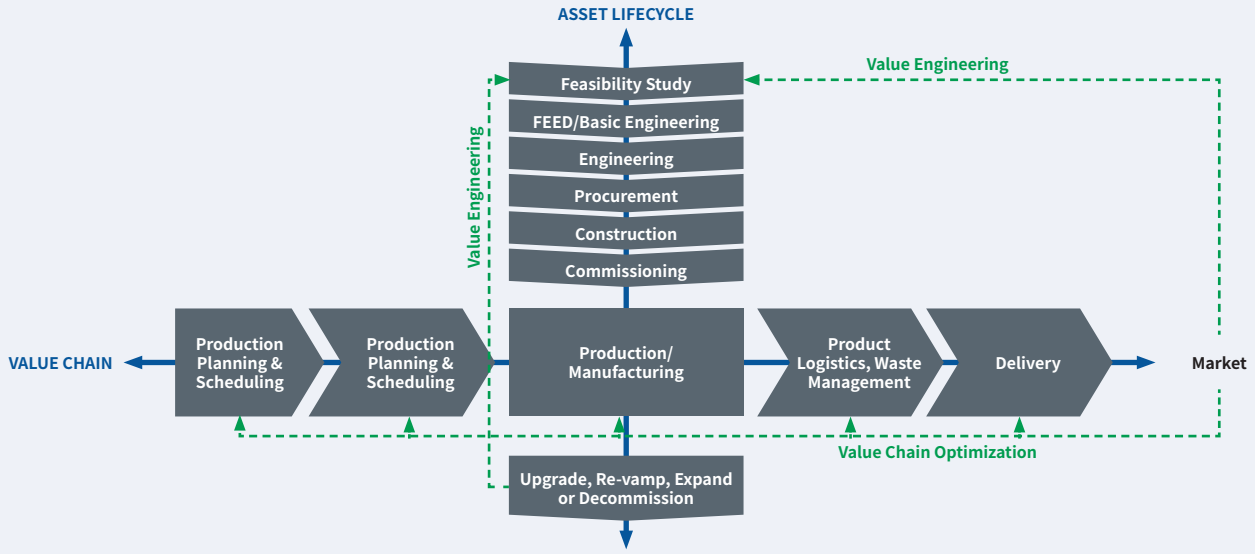
The digital twin provides the opportunity to see inside assets and processes and perceive things that are not being directly measured. It is wired up so that insights are instantly available without data and model wrangling by end users and run in a consistent way that can be understood and agreed upon. In this way the digital twin is able to drive agility and convergence in understanding and implementation across the whole business, for example from Engineering to Operations; Operations to Supply Chain; Reservoir to Facilities; Shop floor to Board room; etc..

The digital twin aims to be an accurate representation of a device, system or process over its full range of operation and its full lifecycle. Ideally the digital twin should be able to transition from design to operations with ease.

> *While individual point solution digital twins exist today, a future digital nirvana has one multi-purpose digital twin.*

In order to achieve the desired levels of accuracy, source data must be gathered in real-time, be validated, and reconciled to ensure that all physical and chemical laws are respected and electronic noise and dynamic effects are eliminated through filtering. Only through this approach can data quality issues be identified and mitigated so the digital twin can be trusted to reflect reality and relied on for quality and accuracy of its predictions.

While individual point solution digital twins exist today, a future digital nirvana has one multi-purpose digital twin. It is unrealistic to achieve a future state in one step, but more likely to be achieved by the connectivity of valuable high performing individual elements. Therefore, the mantra has to be agile – think big, start small, scale fast and drive adoption.



Today

- Multiple different digital twins covering aspects of the asset lifecycle and value chain
- Serving different purposes
- Running off siloed/limited data sources
- At fit-for-purpose compute speeds

Future Digital Nirvana

- One multi-purpose digital twin
- Which aligns asset lifecycle and value chain
- Running off ubiquitous data source(s)
- At fit-for-purpose compute speeds

Figure 3 – Evolution of the digital twin

Some examples of existing digital twins include:

- Instrument/device
- Control system
- 3D design and engineering
- Worker
- Process/optimization
- Energy/utilities
- Supply chain

Considering the above, some can understandably believe that "digital twin" is a marketing term which has been used to re-package certain technologies that have been available in the market for a long period. To some extent that might be true, but not all digital twins are made equal. Their perceived use value varies. For example, a 3D CAD model of a plant may be of less value to a process engineer than a digital copy of the plant's operating conditions and the way in which molecules behave and transform. If anything, the term has been a catalyst for driving clarity and understanding of the value that it represents.

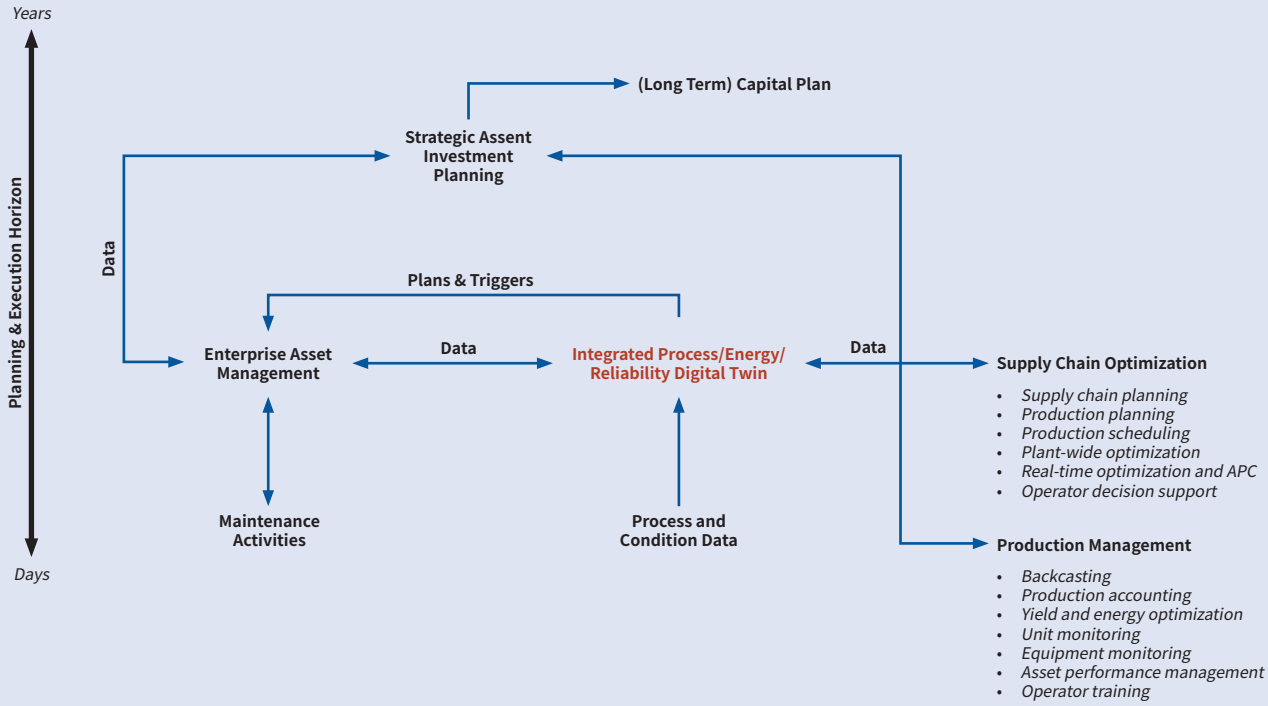


Figure 4 – Alignment of production management, supply chain optimization and strategic asset investment planning

Yokogawa and KBC have successfully achieved development of an integrated production management system digital twin that operates across the entirety of the process manufacturing supply chain and asset lifecycle – see figure 4 – to align production management and reliability, energy and supply chain optimization, and strategic asset investment planning.

From a business value perspective, digital twin technology can benefit multiple levels of the organization:

- **Enterprise Insight:** A series of business and financial Key Performance Indicators (KPI's) are updated in real-time, plan versus actual, as part of an enterprise-wide balanced scorecard for corporate situational awareness. Advanced logic is applied to real-time operations data to project current and future understanding of the business for executives.

- **Capability Assurance:** Key operator actions are captured, controlled and manipulated in real-time through monitoring and control of work processes. Minimize the learning curve for new operators, support change management and enable vastly improved scenario validation through operator training simulation and an ISA106-compliant modular procedure automation solution.

- **Advanced Production:** Multivariable predictive controls drive the plant continuously to its optimum constraints by reacting to disturbances in a closed loop.

- **Value Chain Optimization:** Drive agile and efficient alignment of supply of premium products as closely as possible to market demand with sufficient resilience or operational flexibility to readily adjust production. Exploit market opportunities through supply chain planning, scheduling and production accounting.

- **Automation and Control Integrity:** Digital representation of the live plant and its automation algorithms through the "twin" function of an Integrated Control and Safety System (ICSS) allows engineers to conduct fundamental process control tests at an engineering workstation, as well as any proposed adjustments, before they are applied on the live plant.

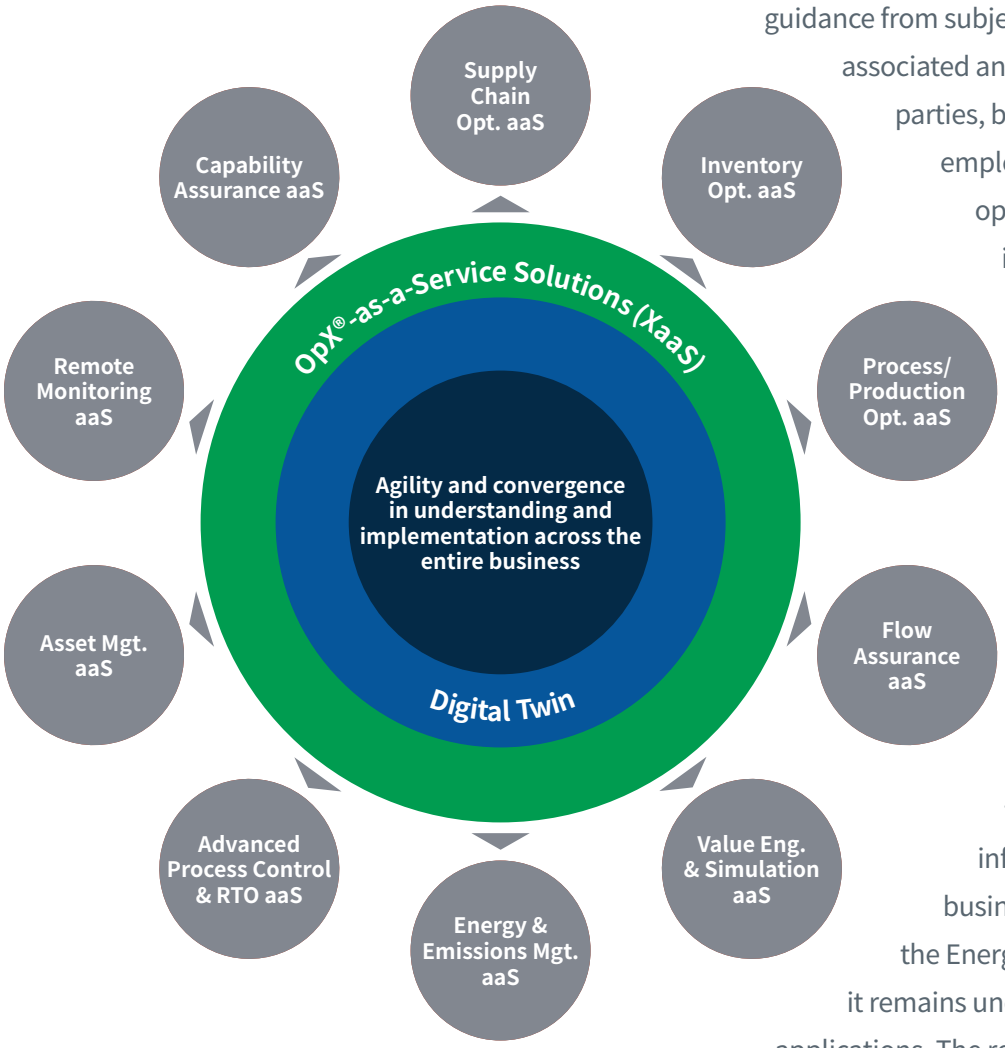
- **Instrumentation and Equipment Productivity:** Minimize the need for breakdown and preventative maintenance, reduce OPEX through advanced online monitoring and prediction of field device health, and process interface conditions that reduce unnecessary trips.
- **Advanced Chemistry:** Highly intelligent devices, such as pumps, flowmeters, transmitters, and chemical analyzers provide total insight into their ongoing performance as well as the ability to adapt to changing duty requirements throughout the measurement device lifecycle.
- **Plant Processes Optimization:** Online and offline high-fidelity models for non-linear performance monitoring, simulation, and optimization using first principle kinetics deliver optimized yield performance, flow assurance, energy efficiency improvement, enhanced reliability and operator capability assurance.

The digital twin promises to be a fantastic tool for strategy execution by:

- Ensuring field and line employees have the information they need to understand the bottom-line impact of their day-to-day choices
- Facilitating information flows across organizational boundaries
- Minimizing second-guessing of decisions

A key challenge of the digital twin is that it needs to exist within a strong governance framework. This includes well defined business processes along with clarity around the decision rights and actions for which people are responsible.

Figure 5 – Outcomes-as-a-service utilizes the digital twin



One area that needs to be considered is the necessary guidance from subject matter experts and their associated analytical insights. These can be third parties, but often these experts are in-house employees but work remotely from the operational location. Currently these insights are obtained only when there is a problem or there are structured inputs on a regular basis, such as weekly meeting, or a quarterly service review.

How do we reach a future digital nirvana with the mantra of agile? Cloud is the answer in many industries and we believe that it is a key enabler for the digital enterprise of the future. The Cloud is already the infrastructure of choice for most business applications, especially outside the Energy and Chemical sector. However, it remains unexploited for most operational applications. The reason is that most valuable operational applications rely on a continuous feed of plant data, which means they can never be isolated from the plant in a way that an HR performance management system or capital budgeting system can.

> *The Cloud is already the infrastructure of choice for most business applications, especially outside the Energy and Chemical sector.*

This is partially addressed with “Edge devices” living in the “fog” between the real world of the plant and the virtual world of the Cloud to bridge the gap, but there is still a potential pathway for a ”bad actor” to reach the plant, even through an Edge device. From an IT point of view, the Cloud offers some compelling savings vs on-premise. But unless the operational risk associated with exposing the plant to the Cloud is offset by value created by the people and applications it serves, its use will remain marginal.

The Cloud should be exploited, whenever possible, for hosting of the digital twin for the following reasons. The Cloud:

- Can engage people and technologies from outside corporate boundaries. Examples of these include: Augmentation with georeferenced 3D visualization models in remote or resource-constrained environments, the Cloud allows remote subject matter experts to join in the day-to-day troubleshooting and profit improvement activities of the plant, using the digital twin, as if they were employees present on site.
- Enables the digital twin to subscribe to external data feeds that can enrich its resolution.
- Allows analytical capabilities to be offered remotely by experts.
- Supports and nourishes agility with respect to the digital twin. It allows experimentation and rapid deployment of new solutions.
- Makes solution updates trivial and significantly reduces infrastructure costs.
- Reduces the cost of termination - if a solution does not work out as expected, a cloud solution can often be switched off with little to no on-going cost.

Overall, connectivity of the plant to the wider knowledge pool and thus completing the digital twin will provide a lot of value. Risks can be managed with governance, cybersecurity measures, and localized operational applications.

Digitalization is accelerating and disrupting the decision cycle. For the first time, a digital nirvana can be within reach for the energy, chemical, and process manufacturing industries. A digital twin initiative can rally your operations around this vision and create sustainable business value.

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