A digital twin constitutes a very rich way to look at the past, present and future of an asset. The digital twin can do so in a valuable, sustainable manner throughout the asset lifecycle. Value creation can, in fact, begin on day one of the front-end engineering design (FEED) and continue until the asset is de-commissioned.

A digital twin must be predictive in nature and constitute an advanced analytical and decision support tool. Digital twins draw on data from a variety of sources to create comprehensive situational awareness of the “here and now,” from which robust forward predictions can be made.

During project engineering, these sources might include, for example, engineering information systems, data warehouses or document management systems. As capital projects transition from engineering to operations, it is critical that models created from these sources continue to be leveraged. In operations, it is equally critical to augment them with additional sources such as hard and soft sensors. In this way, the digital twin consumes data from additional sources to tell a richer story—past, present and future—about the asset throughout its lifecycle.

The digital twin enables the transfer of “designed intelligence” from the engineering phases of a capital project into “applied intelligence” that operations can leverage.
The digital twin works in the present but with full knowledge of historical performance and future potential.

For these reasons, creation of the digital twin begins ideally during the initial study to evaluate the feasibility of the asset and validate the licensor’s work. It is then used and further developed during the design, construction and commissioning of the asset. It facilitates the optimum design of the asset and the training of the staff who will operate it. It works in the present, mirroring the actual asset in simulated mode, but with full knowledge of its historical performance and an accurate understanding of its future potential.

The digital twin concept encapsulates a broader set of dynamic but intangible interactions that occur within and around the physical asset. Those include fluid flow, heat and material balances, yield and energy inputs/outputs, thermodynamics, and human operator behaviors. These interactions are critical for asset performance management and maintaining facilities within optimum integrity operating windows for safety, reliability and profitability purposes.

Unfortunately, construction of most assets in the industry took place during the 1970s; therefore, many facilities lack the benefit of the accumulated engineering intelligence that would have begun from scratch with the FEED study and applied sequentially through operations. In this sort of case, where is the starting point? The answer, undoubtedly, is where it makes the most money. This requires an assessment of all areas to see where models already exist. Where they do, can they be operationalized with real-time data? What will the associated cost be to accomplish this, and what value will be derived in return?

The hydrocarbon processing industry makes most of its money through molecule management and manipulation of related conditions inside the pipe. These factors drive
asset management and maintenance practices. Therefore, it makes most sense to start with the digital twin that delivers deep insights into molecule transformation mechanisms and process operating conditions, while also keeping the asset running within integrity operating windows to prevent failure. The solution involves operationalizing a single, Integrated Asset Model (IAM) as an online digital twin to be used for production management, asset performance management and supply chain optimization across the following:

- **Upstream production system**, linked to the reservoir model, including wells, chokes, flowlines and all processing and power generation equipment, with common thermodynamics, fluid characterization and electrolytic chemistry throughout;

- **LNG liquefaction process and utilities systems**, including wells, chokes and pipelines through gathering systems, separation, acid gas removal and dehydration (pretreatment systems), main cryogenic heat exchanger(s) and storage facilities;

- **Oil refining and petrochemical site-wide process and utilities systems**, including crude compatibility through distillation, upgrading reactors and catalytic convertor, hydrotreating and cracking, blending facilities, olefins and aromatics;

- **Ammonia site-wide process and utilities systems**, including desulfurization, reforming, synthesis and separation with consistent thermodynamics and electrolytic chemistry throughout.

The solution could use a multitude of digital twins that operate across the traditional ISA95 Purdue Model architecture and further afield within the organization. As they are increasingly integrated and connected, the scope and scale of these “twins” will grow and their transformative effect will amplify. The more expansive and integrated the digital twin becomes, the larger the territory it encompasses. Digital twins are now emulating centralized engineering hubs, remote operations centers and integrated production centers.

We must remember that digital twins are a means to an end, not the end itself. The end has not changed. Industry must continue to strive for business outcomes in terms of operation with no safety incidents, no unplanned outages, rigorous adherence to operating plans, nimble response to changes and disturbances, a motivated and informed workforce and a culture of profitability. A digital twin, as a part of digitalization efforts and digital transformation strategies, is simply a vehicle to achieve superior results in these areas—and to achieve them in a sustainable manner.

A digital twin is simply a vehicle to achieve superior results—and to achieve them in a sustainable manner.