THE AMERICAN OIL & GAS REPORTER®
JUNE 2018
The "Better Business" Publication Serving the Exploration / Drilling / Production Industry

Digital Technologies Enable New Project Design, Management Capabilities

By Vaseem Khan

HOUSTON–Energy companies understand the importance of using digital technology to improve their operations and realize cost savings. As in exploration, drilling, completion and production workflows, digital-enabled processes also are proving invaluable in enabling integrated, end-to-end engineering of both onshore and offshore infrastructure projects.

A case in point is an advanced, cloud-based software platform that increases efficiency and productivity throughout a project's life cycle. Rather than trying to manage an engineering, procurement, construction and installation (EPCI) project by sending specifications and engineering drawings using e-mails or other legacy methods of sharing documents, the cloud-based platform makes it easy to link, share and retrieve information instantly using digital workflows within an environment tailored specifically for oil and gas project execution.

A significant component of the new platform is the ability to develop "digital twins," or virtual 3-D replicas, of physical assets such as subsea systems or platform topsides. These exact digital renderings can be manipulated in virtual space throughout a project's life cycle, starting from the initial conceptualization stage before it exists in the physical realm and long before any steel is cut.

Offshore, operators are embracing new models that seek to streamline design processes, fast-track field development workflows, and use standardized modular systems and architectures. This approach mirrors the successful fast-track strategies independents have used to bring deepwater Gulf of Mexico fields on line in a matter of months after project sanctioning, rather than years.

Onshore, meanwhile, the size and complexity of projects such as liquefied natural gas plants, ethane cracker facilities and power plants are placing new demands on engineering and design processes.

In this competitive world, the smart use of new technologies can make a big difference. Some of the most powerful innovations in offshore oil and gas are occurring in the area of project life cycle management to more effectively manage projects and improve results from the initial design concept through the end of a project's service life.

By adapting proven technologies that have been used successfully in the aerospace and manufacturing industries, and applying them to the energy sector, digital solutions can optimize project engineering and management to drive down overall project cost structures and compress cycle times while enhancing health, safety and environmental performance.

A Better Way

I have been in the industry for more than 30 years, and the way in which offshore infrastructure is designed and built has not changed significantly. Typically, all engineering and design activities are sequential. Engineers design a system, and it progresses sequentially according to a project schedule that is tracked with some type of scheduling software. After several months–or in some cases, possibly even years–into the engineering process, the project team sometimes realizes that the design will cost more than originally anticipated, requiring the initial design to be revised.

Seeking a better way to manage projects, McDermott has implemented a new, cloud-based digital solution that helps project engineering and design teams move from sequential to parallel activities ("going down multiple rabbit holes at once," as we put it). With the workflows enabled by the technology, engineers can choose components or routines so that they fully know the cost of various alternatives from the available options as they design projects.

The ability to choose the correct solution depends on how long it takes to install a designed system and how much it costs. Conducting all activities in parallel integrates engineering workflows and streamlines the design process, which greatly reduces the risk of having to revise project plans at some point.

The second feature that makes the digital solution so attractive relates to the industry's conventional practice of implementing bespoke designs for every offshore project. Whether building an export pipeline or an entire subsea development, a design typically starts from scratch every time. Although project teams may take into account past designs, those responsible for engineering new projects have not always been able to access or use that information. Today's digital solutions allow engineers to pick from an internal library of components with embedded metadata.

For example, the metadata may include past analysis, the structural steel required, and how long it will take to install. The goal is to embed the metadata into standard components, moving away from customized solutions to more standard off-the-shelf designs that have been proven effective.

What are clients looking for? Regardless of whether they are building platform topsides for a field in the North Sea or an LNG export facility in Louisiana, facility operators want to know exactly what it will cost and how long it will take. Specifically, when a concept or front-end engineering design (FEED) study is done, the operator wants assurance that at the end of the EPCI, the project will cost and take the length of time estimated at the concept stage.

The beauty of the digital technology available is that the engineering contractor can use its vast database of what it previously designed, built and installed, and all that information is available instantly.

This is practical data, not theoretical. It provides real-world information on vessel rates, how long it will take to accomplish individual tasks, etc. Putting all these data into an advanced digital platform gives the operator of offshore infrastructure certainty on the costs and timelines of their projects, which is exactly what they are looking for.

Digital workflows are key to moving project management from sequential to parallel activities, and to enabling project teams to readily draw on data from previously designed, built and installed facilities to give operators certainty on project costs and timelines, based on real-world information. The goal is to embed the metadata into standard components, moving away from customized solutions to more standard off-the-shelf designs that have proven effective in previous projects.

Life Cycle Management

Effectively leveraged on an enterprise level, the cloud-based platform enables all design processes to be fully digitized and standardized, driving down costs by eliminating legacy systems and simplifying work processes within a single, integrated engineering platform that is applicable across all global locations and at every stage of a facility's life cycle.

The technology provides an integrated project delivery approach from the point

Engineering, procuring, constructing and installing large offshore facilities is a complex and multifaceted process. Digitizing and standardizing engineering and construction activities drive down project costs by eliminating legacy systems and simplifying processes within a single integrated platform that can be leveraged from the point of inception of a project's design to its eventual decommissioning. This photo from a drone gives a view of the 2,300 metric-ton jacket and four tripods, as well as the 14,500 metric-ton topsides, for the Pemex Abkatun A2 Bay of Campeche project during fabrication.

of inception to decommissioning, and uses a true digital twin to optimize engineering, design and management.

Following the design twin created during the EPCI phase, the system enables a user to create an "operational twin," marrying the physical state with a living, up-to-date 3-D model combined with data and analysis specific to that particular facility. The operational twin is a digital twin at a facility scale, compared with the conventional approach centered on a piece of equipment.

The overall focus is on project delivery, which is the first phase in the evolution of this advanced platform. It represents a major and welcome change from the old ways of doing engineering, and allows contractors to better execute EPCI projects.

McDermott started using its new Gemini XD™ cloud-based digital platform on the FEED for subsea umbilicals, risers and flowlines (SURF) scope and subsea production system (SPS) with partner Baker Hughes, a GE company, on BP's Tortue/Ahmeyim Field development offshore West Africa. The project has the entire team collaborating fully within the platform.

Estimated to contain 15 trillion cubic feet of natural gas, the Tortue/Ahmeyim production system uses subsea infrastructure tied to a floating production, storage and offloading vessel. Once liquids are removed aboard the FPSO, the export gas is transported through a pipeline to a near-shore floating LNG terminal for liquefaction. Discovered by Kosmos Energy, BP is operator of the project with partners Kosmos Energy, Petrosen and SMHPM.

The digital platform allows the use of a wide variety of software applications to address the unique design requirements for SURF and SPS projects. An example is the ability to incorporate FutureOn Software's xSubsea field optimization and development tool (FieldAp™)–a cloud-based application for subsea project management–into the new digital platform to digitize and track the complex disparate elements from today's FEED processes, which often work with a variety of contractors, vendors and class societies.

FEED processes formerly consisted of lots of design and planning, revisions and approval procedures that often were performed manually using e-mail with spreadsheets and engineering diagrams. By combining FieldAp with Gemini XD, the goal is to make these traditionally manual processes fully digital.

From subsea field layouts, pipeline routing and other design aspects, the FieldAp software enables the conceptual and FEED design process to be performed online in the cloud environment. By bringing the field layout development together into a single, collaborative environment, the team can make design changes quickly, manage the estimated cost and schedule, and more effectively plan work. In conjunction with the new digital platform, the application functions as the single "source of truth," and is the basis for creating a digital twin of an "as-designed" or "as-built" subsea architecture.

Key Advantages

The key advantages of the new platform are the ease of transparency and better collaboration on a project. The approach uses the 3DEXPERIENCE system from Dassault Systèmes® to provide a single, easy-to-use interface for 3-D design, analysis and simulation in a collaborative, interactive environment. The customer is invited to be in the system with the engineering contractor to see the schedule, track progress and deliverables, and get all the reporting.

The ability to work collaboratively with the client in a digital fashion cuts out all the e-mails back and forth. The platform enables online collaborative markup of any documentations such as drawings, specifications and 3-D models. Members of the project team can be scattered across many parts of the globe and still access the latest versions of the documents individually or together.

Implementing a digital and collaborative environment helps expedite the project life cycle timeline and reduce costs. The goal is to be more effective and efficient during the early phases of the project, automate the FEED processes, and spend less time and effort so that customers get their desired results much quicker.

A big part of the success achieved using the platform has been to implement a strong training program for new users, including instructor-led training, training manuals, work instructions, how-to videos available online and a project life-cycle management handbook.

During the initial implementation phase, McDermott worked closely with Dassault Systèmes to make sure this first-of-its-kind system would be fully configurable, but not considered "customized." Avoiding customization while achieving full configurability means the platform can be upgraded easily, and the partnership approach

leverages Dassault's support structure.

The next projects expected to use the platform include the EPCI project execution for BP's Cassia-C compression platform offshore Trinidad and Tobago (a new, unmanned facility to provide gas compression to the existing Cassia complex), and Maersk Oil's Tyra redevelopment project in the Danish North Sea (which includes new processing and accommodation platforms for the large gas field).

Plans also are in place to expand the platform to all onshore projects so that when a new LNG facility or power plant is turned over to a customer, it is not simply receiving boxes of engineering data and drawings, but access to a fully integrated digital twin.

Virtual Twins

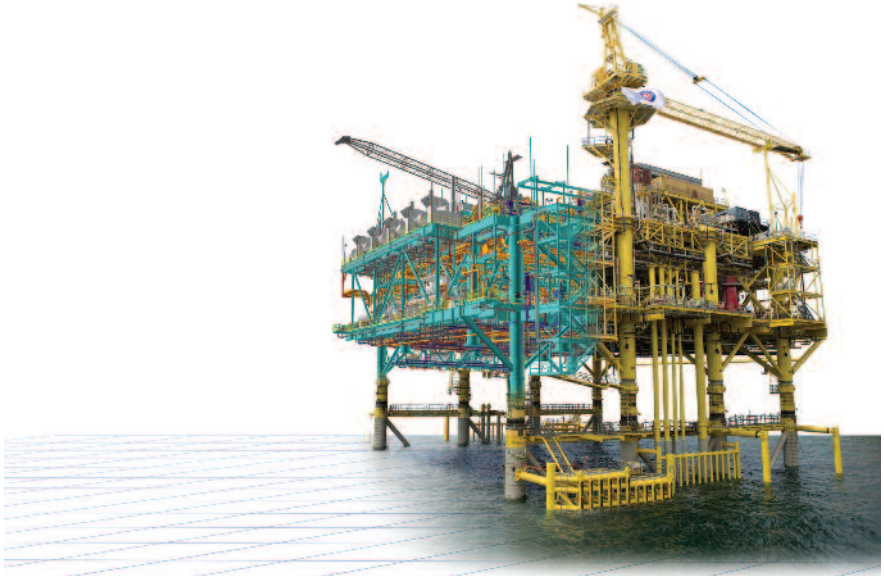
Operators of facilities can realize huge value by tying together the design twin generated through the EPCI phase, with data coming from the assets themselves to create the operational twin. On implementing the operational twin, the operator benefits from big data analytics as a component of the digital twin, which serves as the single information source for operations and maintenance.

Imagine being an offshore operator who has all the specifications, drawings and equipment operating history easily available and instantly shareable with anyone who wants them whenever a problem occurs on a platform.

Everything done today with the digital twin lays the groundwork for the operational digital twin of tomorrow to help with life-of-field services. From project inception to decommissioning, the life-of-field services digital documents permit a more open exchange of information that will improve productivity and cross-functional collaboration, and ensure on-schedule delivery of complex projects with improved safety, higher quality and greater efficiency.

The life-of-field services will focus on technical and operational data management, process optimization, predictive maintenance, operations management, and asset integrity management. A family of new applications is expected to be released over the next few years to build on the digital platform's initial capabilities. In fact, operator input is being sought actively for proof-of-concept ideas for post-hand-over, digitally enabled solutions.

As demonstrated in early offshore applications for major and national oil companies, the new digital technology offers a truly collaborative approach to providing a step change in performance and efficiency while simultaneously reducing cost and risk. The platform becomes the single source of truth for building innovative offshore projects, as well as for post-hand-over operations. Once a facility is commissioned, the operator has the option of using the platform for operational purposes such as optimization and maintenance, which provides not only an optimal capital expenditures solution, but also an optimal operating expenditures solution over a field's entire life. ❐



The digital platform becomes the single source of truth for creating a true digital twin during the engineering, procurement, construction and installation phase to optimize engineering, design and management. Following the design twin, an "operational twin" then can be developed for post-hand-over operations that marry the physical state with a living, up-to-date, 3-D model combined with all available data and analysis. The operator of a subsea field or production facility can use the operational twin to optimize asset performance over its entire life.

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Vaseem Khan is McDermott's global vice president of engineering. In this role, he is responsible for all aspects of McDermott's engineering functions, including more than 4,500 engineers spread across 16 locations worldwide. Khan has significant experience in engineering and project management in offshore and onshore projects, ranging from concept studies to large EPC projects. He holds a B.S. and an M.S. in mechanical engineering as well as a post-graduate degree in international business management.