Moving Toward Sustainable Asset Digital Twins

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Overview
Recently, several global oil and chemical leaders created a groundswell of support around the need for sustainable and open digital twins. Sustainable digital twins are needed after handover for the long operate and maintain portion of a plant’s lifecycle. Open digital twins are needed to accommodate the variety of applications and business processes to operate and maintain. The implications for this new initiative are far-reaching into the operating and business systems of energy and chemicals producers and their technology suppliers.

Digital Twins for the Entire Asset Lifecycle
Digital twins can deliver significant value through the entire asset lifecycle from design, construction through to operations and decommissioning – while optimizing and automating associated business processes. To date, the focus is on the engineering and construction (E&C) portion of the lifecycle with technology solution providers making digital twins for engineering design and building infrastructure. The complex operate and maintain portion of the lifecycle – with huge opportunities for cost savings - is underserved.

Digital twins improve collaboration; but need a significant overhaul to become “open.” Openness ensures interoperability of data and technologies to ensure cost-effective, scalable, and sustainable solutions. Sustainable Asset Digital Twins will provide a framework for connecting dataflows across silos to produce a holistic view of an asset’s information across its entire lifecycle.
Asset owners want to eliminate barriers to the integration and contextualization of disparate data sets while optimizing and automating business processes.

**Sustainable Asset Digital Twins Working Group**

The Sustainable Asset Digital Twins working group (WG) provides a framework for asset owners to achieve sustainability goals by removing inefficiencies from manufacturing operations. This will redefine many operations and maintenance work processes with more effective use of assets and systems.

The Sustainable Asset Digital Twins WG recently kicked off their inaugural meeting at the ExxonMobil headquarters with Chevron, Dow, Shell and others. The purpose of the meeting was to:

- Define guiding opportunities and preliminary framing of needs.
- Align on key industry challenges and needs and unified demand standards-based data interoperability.
- Outline a vision for a scalable, replicable, and sustainable digital twin.

The WG intends to share consistent messaging with vendors, solution providers, and standards organizations to support the industry effectively.

**Meeting of the Minds**

On January 24, 2022, Sustainable Asset Digital Twins WG met to gain an understanding of the opportunity for a more open and sustainable approach to digital twins. The meeting of asset-owner only subject matter experts (SMEs) from Chevron, Dow, ExxonMobil, Shell and others, was hosted by Exxon Mobil at their campus in Houston. The purpose of the WG was to initiate a vision, discuss common needs and agree on next steps for the scalable implementation of digital twins. A vision that can clearly articulate the needs of owner-operators and asset owners related to digital twin technologies and speak with a focused voice to the vendors providing digital twins solutions. Initially, the focus of the WG is on the sustainable, open, and interoperable use of lifecycle asset data, engineering models, visualization and reality capture and building toward a digital twin and digital thread.
The SMEs aligned on the key industry challenges and needs to address scalable, replicable, sustainable digital twin delivery, sharing consistent messaging with vendors and solution providers on that topic to support the industry more effectively. The scope of the WG will provide clear guidance on priorities and needs to facilitate digital twin technology and accelerate adoption, thus creating value by using these capabilities to lead to more efficient operating processes and in upgrades and turnarounds for the oil & gas, chemicals, and petrochemicals industries. The WG believes a focus on the delivery of digital twin technology will be necessary, including continued analysis of costs for maintaining models and what types of organizations and capabilities are needed to sustain the value, the interoperability with other business solutions, and to mitigate the apparent implementation and deployment risk. One area of guidance would include capturing, storing, delivering, and maintaining 3D visualization including seamless integration of real-time trusted engineering data, and reality capture, as part of a future open and sustainable digital twin.

Akin to similar industry initiatives, like the Open Process Automation Forum (OPAF), this WG will consider many of the OPAF principles, promote the needs for oil and gas operators and asset owners, and provide a voice for uniform messaging on critical needs and gaps. This approach is intended to assist technology suppliers to see the opportunities for participation and efficiently deliver projects in an "open" digital twin environment while leveraging or influencing new and existing data and visualization "standards" to digital twin deployment.

**The Emerging Sustainable Asset Digital Twin Strategy**

The wide range of digital twin software commercial offerings by a multitude of different vendors has created considerable confusion in the industry for digital twins. To help create clarity and align around the key opportunities for a digital twin, the WG created a Venn diagram to show relationships and commonalities between key components of digital twins.

The highest level of digital twin maturity is depicted by the center of the Venn diagram when all three components come together, and silos are integrated. This Asset Digital Twin contains all three circles - process simulation, visualization and data and the level of integration. The Asset Digital Twin
represents the physical asset and predicts outcomes through the integration of operational data and engineering simulation. The asset digital twin supports the enhanced decision making needed by industry in an environment where data is accessible and central to the digital twin. A lifecycle data model must be built with federation of data sources such that systems can be maintained cost effectively and avoiding data duplication.

Opportunities of Sustainable Asset Digital Twins
As depicted in the Venn diagram, there are several opportunities that will guide the development of the future of the asset digital twin. These opportunities address key challenges stemming from disparate data types (static, transactional, real-time, structured, and unstructured, etc.), a multitude of sources, the modalities of asset visualization, and the desire to integrate advanced simulations to achieve predictive and prescriptive capabilities. The following is a preliminary list of challenges, opportunities, and the needs.
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<tr>
<th>Challenge</th>
<th>Opportunity</th>
<th>Needs</th>
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<tbody>
<tr>
<td>There is a great diversity of disparate data sources that must be federated and unified.</td>
<td>Data will be interoperable avoiding a monolithic technology stack from a single vendor. A standards-based, common federated data model will normalize data from different sources and vendors (in place) for aggregation and contextualization via consumption platforms.</td>
<td>Need help from technology vendors in supporting data standards to allow plug-and-play. Want the data standards organizations to understand our principles and collaborate with other relevant standards organizations to avoid re-inventing and focusing on adoption using an agile approach. Asset-owners should agree on using the same vision, principles, and standards to improve consistency.</td>
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<td>Too many different modalities of 3D asset visualization (CAD, 360 photos, reality capture etc.). Numerous use cases are single use case only. Need a broader viewpoint.</td>
<td>A common set of definitions of the data sets is required. Digital twins will contain a level of intelligence in the data model.</td>
<td>Industry is aligned on the need for more integrated lidar, laser scan, and photogrammetry with engineering models however a commercial platform is required capable of delivering on broad capabilities.</td>
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<td>There are no standards for spatial coordinates used by E&amp;C, asset owners and vendors.</td>
<td>A common spatial coordinate system shall be used in the common data model for digital twins.</td>
<td>Asset owners can use any laser scan tool and “snap it in” easily without data wrangling and conversion.</td>
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<td>There is lack of clarity in the level of fidelity and fidelity of reality capture models.</td>
<td>The metadata associated with the capture must be defined for easy consumption and contextualization.</td>
<td>Reality capture data and models will plug and play in multiple activities regardless of fidelity (4K versus 720p)</td>
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<td>Maintaining relevant data, data cleansing, and deciding which data we need to have in an Asset Digital twin.</td>
<td>Support diverse data types.</td>
<td>Open data architecture.</td>
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**Preliminary Opportunities for Sustainable Asset Visualization Digital Twins**
High Value Use Cases and Pinch Points for Digital Twins

The high-value use cases identified among the working group are primarily in operations and maintenance where there are major opportunities for business process improvement to eliminate waste or reduce inefficiency by exposing and resolving pinch points and gaps. High model fidelity and update frequency are needed while also understanding the need for models to evolve over time. This exposes the need for well-integrated data with correct aggregation and context. Identification of use cases provided valuable help to drive consensus among the WG. This will also help get the technology suppliers and other stakeholders on board.

While core data and interoperability based on standards is a high priority, one interesting use case of 3D asset visualization provided a view of a “consumption platform” for increasing digital twin maturity and sustainability. This model for a digital consumption platform approach identifies and differentiates capture systems of record from storage repository, delivery, and a service window for the consumer. The capture component of the model would contain dumb dimensional data with no engineering, but includes capture tools or photogrammetry, point-cloud 3D scanning, and the metadata necessary to serve the data in a consistent and sustainable way. Spatial data, monuments and other data is inconsistent currently and only available in different formats. This concept of a content management system (CMS) approach would help industry communicate with the vendor community. In the case of the 3D visualization digital consumption, current engineering design software vendors are only consumers. In the future, system of federated data structure for capturing storing and serving / delivering will be needed.
**Use Cases**

Operations & Maintenance, Inspection, Turnaround, including automatic inspection and construction isometric drawing production

Create a hazardous area register for plot plans, electrical equipment regulations

Authenticate design specifications, model review and human factor engineering

Material handling, plan work for operations & maintenance

Quality control, for packaged equipment fit, clash detection

Isolation plans, valving, and shutoff

Inspection process, offshore savings

Construction management and coordination, including deck management, load management, and construction and completions progress reporting

Integrity management, risk-based assessment, corrosion maintenance and inspection

Subsea equipment, installation planning for vessels, remote operated vehicle, equipment installation

Operational risk management, data in context with AI, ML analysis

Spare parts management

Operations & maintenance competency training and standard operating procedure development

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### Initial List of High-Value Use-Cases

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**Conclusion**

Asset Digital twins provide a virtual representation of an asset, product, or process that mirrors the behavior of its real-world counterpart. Asset Digital twins are built for specific work processes, and often not scalable across different roles and work processes. While Asset Digital twins today certainly improve collaboration, this is not enough to transform business performance. Asset Digital twins need to be interoperable with other systems and serve as sustainable living models throughout the asset’s lifecycle. These models should provide a framework and foundation for asset owners to redefine operations and maintenance work process and remove structural cost from manufacturing or production operations.

Those who become involved in the Sustainable Asset Digital Twin WG will gain an understanding of the functions and associated business benefits that will have a high impact on operating performance. In addition to gaining
insights on adoption, participants will be able to help guide functional requirements.

ARC is hosting an industry panel session for the Sustainable Asset Digital Twins WG at the ARC Orlando Forum June 6-9, 2022. Chevron, Dow, ExxonMobil, and Shell and others will share their views on the opportunities, framing and alignment on key industry challenges and needs to address the scalable, replicable, and cost-effective digital twin delivery. ARC Advisory Group will encourage technology and solution providers, EPCs, and other stakeholders to attend.

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