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THE INDUSTRIAL METAVERSE – MYTH OR MEME?

For Microsoft, the Industrial Metaverse is transformational. Aveva ain't so sure. For Cognite it's a "buzzword that died before taking off"!

In the Winter 2022/23 issue of the Microsoft Technology Record, Rebecca Gibson interviewed **Aveva**'s global head of research, Simon Bennet. For Microsoft, the industrial metaverse (IMV) has the potential to 'solve design, operational, supply chain management and other real-world challenges'. Bennet was more circumspect, 'The much-hyped IMV represents older-than-a-decade technology that is being presented in new hardware'. The IMV is all about the digital twin, the data, 'AI-infused and first principles enhanced', and the experience (desktops, mobile devices and wearables). The IMV is a 'natural layer that organizations can deploy on top of their existing digital infrastructure'.

But will the IMV be a 'single behemoth' or is it likely to be fragmented? Bennet sidestepped the issue saying that 'over time, the metaverse will feel and be perceived as one entity in the same way we regard the internet as one thing'. Private enterprises will continue to protect their intellectual property and sources of commercial advantage inside their own IMV. Access to each metaverse will be controlled with role-based privileges and security protection in the same way that businesses protect their financial systems. Will it all be VR and headsets? The IMV will extend beyond AR/VR headsets and on to phones, tablets and desktops. But is Aveva making a play to own and run the industrial metaverse? Again, Bennet sidesteps, 'Our focus is to spark industrial innovation by connecting people with trusted information to support responsible use of the world's resources'.

For more read our report from the 2022 AVEVA World event elsewhere in this issue.

Petteri Vainikka, blogging on the **Cognite** website thinks that the last thing industry needs is another buzzword! In his sights is, you guessed, the Industrial Metaverse, a buzzword that has 'died before taking off'. 'The last thing needed is one more nonsense buzzword to fill conference stages and drive keyword bidding in vendor search engine marketing programs'. Cognite is 'delighted to see the IMV fade out before taking off, reducing the noise level, and allowing us to collectively focus on making digital twins work'. Other buzzwords that are going the same way include the 'data lake' and 'data warehouse'. Despite billions invested in cloud data warehouses and data lakes, 'most data ends there, unused by anyone for anything'.

'Dumb inaccessible data storage in the cloud is of no more business value than its predecessor: dumb inaccessible data storage on premise'.

Notwithstanding such questioning, the **Linux Foundation** has just announced the 'Open Metaverse Foundation', a 'global, vendor-neutral, and scalable metaverse built on open source software and specifications'. LF's OMF is backed by what are described as 'thought-leading' organizations and communities. However, many of these appear to emanate from the blockchain/crypto universe. LF cites the work of the Open 3D Engine as an exemplar of the future OMF. More from the OMF.

More on the evolving metaverses in Neil McNaughton's 2022 editorial.

2023 WORLD ECONOMIC FORUM DIGITAL TRACK

Data, AI and quantum to save the world! Accenture-backed "Digital Climate Network" and "Digital Solutions Explorer". Shell's 2023+ Roadmap. Worley's strategy-first approach. WEC announces Centre for Trustworthy Technology.

The 2023 World Economic Forum's get together in Davos heard from the **Accenture**-sponsored 'Digital and Climate Network' from seven chief digital officers who explained how digital transformation 'can help organizations and companies safely navigate a changing world'. The WEC believes that technology can be a 'stabilizing factor in a changing world, enhancing business resiliency'. CDOs 'should scale the use of data and artificial intelligence, while investing on emerging technologies, such as quantum computing'. The WEC/Accenture research claims that digital could deliver up to 20% of the greenhouse gas reduction needed 2050 in high emission industries. To help things along the WEC has published a Digital Solutions Explorer, a showcase of some 30 'high-impact digital solutions' along with 'getting started' guidance to enable companies to 'progress outcomes in efficiency, circularity and scope 3 transparency'. The Forum is also curating an inventory of leading lighthouse examples from partner companies that have implemented digital technologies to reduce their carbon footprint and deliver economic growth.

One enthusiastic CDO is **Shell**'s Jay Crotts who opined that 'Digitalization must play a vital role in helping to thrive through the energy transition'. Decarbonization of the energy industry is not possible without a comprehensive digital transformation. Digital technology provides mechanisms and toolsets for optimizing energy efficiency and making it possible to design and operate entirely new and low carbon footprint energy systems at scale. Shell's '2023+ roadmap*' focuses on digital technology that 'helps us reduce the footprint of our operations, offer low carbon energy to customers and design the energy system of the future'.

** We could not find any reference to this online.*

Another energy industry CDO, **Worley**'s Geeta Thakorlal added 'Digital solutions are driving outcomes that were not possible a decade ago. In the energy industry, digitalization can enable faster delivery decisions, improve asset performance and provide visibility to communities. To unlock the full potential that digital offers, we must think and act differently'. Worley advocates a 'strategy-first and integrated approach to delivering value […] on our journey to a more sustainable world'.

Comment: The WEC is a repeat offender in the digital bullshit domain with previous unsubstantiated claims that digital transformation in oil and gas demonstrated a '$1.6 to 2.5 trillion value' and that blockchain was going to 'upgrade society's operating system'. We do agree however with Worley's Thakorlal's 'strategy first' approach. Just because 'energy transition' and 'digital transformation' sound similar, they are not! Carbon accounting, be it digital or not, is a futile exercise without a change in strategy. A tough call for an oil company!

Another announcement from the WEC in Davos was the creation of a 'Centre for Trustworthy Technology'. The CTT is to encourage the 'responsible and ethical use of emerging technology technologies including artificial intelligence, blockchain, virtual reality and quantum computing'. The CTT was created in collaboration with Deloitte and the **Patrick J. McGovern Foundation** and is based in Austin, Texas. McGovern founded IDG, the International Data Group in 1967.

ON THE CREEPING COST OF THE CLOUD

Editor Neil McNaughton compares the 20th Century Telcos' evolution with the 21st Century birth of the Cloud provider. Both promised cheap bandwidth - comms for the telcos, compute for the clouds. But while comms costs are massively down, compute costs seem to be rising. And the unregulated cloud providers are much more successful at adding bells, whistles and lock-in to their services. With OSDU a case in point. But where is the end user in all of this?

About thirty years ago the big thing was not the cloud but the internet. I attended a meeting organized by what was then France Telcom as it was transmuting from a public utility to 'Orange', a private company. The meeting was to thrash-out exactly what should come under the new Orange's purview. I offered my own suggestion along the lines of, 'just give us the bandwidth and we will do the rest'. I'm not sure who 'we' were at the time. Anyhow my suggestion was very poorly received. There was no way that France Telecom was going to keep a 'utility' model in its transformation. It was going to add its own bells and whistles to the internet and it has subsequently done a pretty good job of this. As indeed it has with the provision of low cost bandwidth. A win-win in fact. Or rather a win-win-win as the regulator* has been a guiding hand in a country where fiber connectivity is now available even at the most remote locations and at very reasonable cost.

If the deal in the late 20th Century was the provision of communications bandwidth, the deal in the 21st Century has been the provision of compute bandwidth from the cloud. But the simple value proposition – of vanishingly cheap compute cycles – is much less in evidence as the more or less unregulated cloud providers add their own bells, whistles and more.

A report from Accenture 'The race to cloud: Reaching the inflection point to long sought value' fits the paradigm nicely. While the past two years have seen a 'surge in cloud commitment', with companies increasing the scope and volume of their cloud initiatives, achieving 'full cloud value' is at a 'tipping point' with some in 'cloud transformation limbo'. Only 45% report that they have 'fully achieved the expected value', in the form of 'business enablement', achieved by 'unlocking core digital capabilities and ongoing innovation needed to exploit new opportunities'.

This sounds a bit nebulous. But what of the original case for cloud computing, cost savings? Accenture reports that 'cost savings remain the most elusive of the outcomes'. Only 39% reported fully achieving their cost expectations, 'perhaps the most frustrating finding for many, as cost effectiveness was one of the early selling points for cloud'. Accenture tempers this finding with the promise of 'jam tomorrow'. The move to the cloud involves immediate costs but not instant savings. These will come from future tweaks to the business involving modernizing to a 'cloud-native mindset', using 'FinOps' and a 'Continuum Control Plane' to provide 'transparency' and manage today's 'complex IT environment'. 'As complexity increases, so too can cost if these critical elements of the value equation are missing'.

While the move to the cloud certainly involves more complexity, I'm not sure that this was very clear up front. Wasn't the idea to get rid of all that costly in-house IT and benefit from the economies of scale that the cloud providers could offer? Instead we have a labyrinthine stack of technology with a host of experts required to keep the show on the road.

So where does all this leave OSDU, the oil and gas industry's big push for cloud deployment? I emphasize oil and gas as OSDU started out firmly anchored in the subsurface and, despite subsequent scope creep, its current deliverables are mostly well-focused. That's OK. What's not so great is the way the original intent for a 'a non-competitive API and data store**' is in danger of being captured by the cloud providers themselves as in the 'OSDU Data Platform' on AWS and Microsoft Energy Data Services 'enterprise-grade, cloud-based OSDU Data Platform'***.

What is perhaps most curious about this state of affairs is that the end user seems to have been somewhat forgotten. If you are a geoscientists sitting in front of a workstation running Petrel, Geolog or DecisionSpace do you actually care about any of this?

** With regard to cloud regulation see our coverage of the ongoing 'battle' between Microsoft and the EU elsewhere in this issue.*

*** Johan Krebbers 2019 interview in Oil IT Journal.*

**** There are other offerings, from IBM, from IBM and AWS and a 'Simple OSDU instance on Google Cloud from* ***EPAM****.*

2022 ESRI EU ENERGY CONFERENCE

Forget the PUG, now its "Energy". BP - Matlab for demanning. GIS at TotalEnergies OneTech. Exprodat integrated windfarm planning. BP's "Golden Build" pipeline system. Esri Geoanalytics engine. GIS in drilling surveillance. Takatoa's quantum GIS!

It used to be the PUG, the Esri Petroleum user group. It is now 'energy'. Esri is following the lead of its major clients and shifting focus to the energy transition. Presentations at the 2022 Esri EU Energy conference covered rooftop solar modeling in Oman (Petrogas E&P) , windfarm siting and design offshore Europe (Exprodat), hydrogen and CCUS (BP) and methane tracking (Enel). In the oil and gas field, Esri technology is applied in drilling, shipping and downstream where it has the potential to displace incumbent technologies. Outside of the energy transition, some are preoccupied with the 'digital transformation', with substantial energy expended on the move to the cloud (TotalEnergies). Meanwhile Esri's already replete product line up has expanded further, adding a large choice of AI/ML platforms and tools to GIS users who now should be a match for specialists in the 'data science' department.

Stephen Hogg explained how **BP**'s GIS department is supporting the UK's energy transition, supplying front end concept delivery teams with a 'citizen developer' toolkit to integrate multiple engineering and feed contractors and ensure that projects are based on up to date offshore and onshore data. One example is a North Sea oil and gas de-manning dashboard that uses a Matlab model to forecast weekly activity, leveraging a ECMWF* weather data via a Plotly low code Python server. The system plots time charts and figures the best times to pull people from the '3M' (Morgan, Morven and Mona) offshore wind development. An animated 3D display includes bathymetry. Hydrogen and CCUS also ran in this, a spin through of BP's 'We're backing Britain' campaign.

** European Centre for Medium-Range Weather Forecasts.*

Camille Jaganathen and Veronique Miegebielle presented **TotalEnergies** GIS activity. This is conducted from Total's 'OneTech' technical unit, said to be the motor of its transformation to become a 'major player in the energy transition'. Of the 3,000 plus OneTech personnel, 45 are GIS professionals. Another 170 work across its worldwide geospatial community. A 'customer success manager' plays a key role in deployment, assisting end users and managing geospatial projects. CSM success metrics include increased product

adoption (nice for Esri!). OneTech acknowledges the help it gets from Esri's French unit with support for an ArcGIS implementation portal, and help on specific topics such as TE's Move2Cloud* program and ArcGIS Velocity roll-out.

** TotalEnergies likes to develop its solutions internally and is working on a major move to the cloud, building a shared digital platform hosted across Azure and AWS.*

Chris Jepps presented **Exprodat**'s comprehensive approach to siting a windfarm, leveraging some esoteric ArcGIS Pro functionality. Designing a wind farm involves the sea-bed environment, wind characteristics and electrical cable layout considerations. These factors are 'usually considered in isolation'. Exprodat advocates integrated planning using ArcGIS Pro to combine spatial analysis, 3D visualization and network analysis. Exprodat's ArcGIS Pro toolkit models the wake patterns for different turbine layouts using a the 'industry-standard' Jensen method. Full details of the 2021 study are available as a blog posting on the Exprodat website.

While Exprodat's use of Esri technology is very inventive, there is likely an additional step involved in windfarm design. Computational fluid dynamic calculations similar to this evaluation of a cycling peloton show how wind 'shadows' can be extremely complex and impact energy output. More on wake modeling here.

Graham Savage presented the migration of **BP**'s 'Golden Build' (GB) pipeline system of record from PODS* 5.2.3 to PODS 7, both of which leverage the Esri-flavor of PODS**. BP's PODS 7 GB has been designed and built around Esri's technology, notably with ArcGIS pipeline referencing and ArcGIS Pro. The migration and design of the new tool was performed in-house by BP's GIS team to 'allow BP to take control .. and become experts in our own data and model'. An 'agile waterfall' approach involving SparkSystems' Enterprise Architect was used. Savage concluded praising the 'beauty and simplicity' of PODS 7.

** Pipeline open data standard.*

*** Note that PODS is not exclusively Esri-focused. From the PODS website we read, 'PODS can be accessed and used by multiple vendors and software platforms. […] PODS is GIS-platform independent, meaning it can work with Esri, Intergraph, or any other GIS software.*

Scott Noulis (**Esri**) presented the 'new' ArcGIS Geoanalytics Engine* (AGE) that adds spatial analysis to a big data environment, extending Apache Spark with SQL functions and analysis tools. The Geoanalytics Engine comprises a Spark plugin and a Python library. Databricks middleware allows the AGE to run in all three clouds, Azure; AWS and Google. Noulis also presented ArcGIS Knowledge, Esri's graph technology offering. A slide of a full stack of all of the above looks rather intimidating. What is not so clear is what the AGE/Knowledge combo adds to ArcGIS' already copious out-of-the-box geoprocessing capability.

** Presented before at the 2016 Esri PUG.*

Jean-Michel Amouroux (**TotalEnergies**) showed how GIS is encroaching on yet another upstream domain: drilling and well monitoring. A WebGIS application has been developed to allow drilling events to be shared in-context between multiple stakeholders. The solution was developed for offshore Nigeria drilling operations and shares near real-time information on reservoir extent, losses and completion zones. A combination of ArcGIS referencing and event processing locates such information along the deviated well trajectory. Information is shared by both web and 'physical' maps for use by drillers, asset teams and geologists. The system was assembled in 'under two weeks'.

Finally a heads-up for a 2022 Esri Developers Conference MapGallery presentation by Roland Degelmann (Takatoa) on what happens when 'Quantum Artificial Intelligence Meets GIS'. Degelman has worked on dashboards for the 2021 German Bundestag election and the CumbreVieja eruption in La Palma, Spain. Quantum AI is claimed to generates business-relevant insights from space- and time-dependent data. Takatoa's solutions are implemented in ArcGIS and apply 'various quantum algorithms' to big geo-data. As actual quantum computers are still very much work in progress, it's not entirely clear when the its 'commercial impact' will appear. 'Although the exact timing is unknown, the resulting commercial value is likely to be enormous. It is estimated to be in the hundreds of billions of dollars'.

Visit the ESRI Events page for (some) of these presentations. The next Esri Energy Resources GIS Conference is scheduled for April 26–27 in Houston. More from Esri.

PARADIGM NOW ASPENTECH

Emerson floats new AspenTech venture with Paradigm inside. Emerson engaged in take-over battle for National Instruments.

Back in 2017 Emerson acquired Paradigm Geophysical for $510 million from a group of investors. A later 2020 deal saw the acquisition of Open Systems International, a provider of electrical grid management software for $1.6 billion. Emerson is now bundling its ex-Paradigm 'Geological Simulation Software' business and OSI which it is selling into a new AspenTech company. Along with the software units, Emerson is contributing $6.0 billion in cash in exchange for a 55% stake in the new AspenTech. Significant revenue and cost opportunities are anticipated as the OSI and GSS businesses transition to a 'token and subscription-based' business model, as deployed across AspenTech's existing portfolio, notably the AspenOne process modeling suite . Emerson is also engaged in a long running take-over battle for National Instruments with a current $53 per share offering. More on the deal from Emerson.

2023 OPEN SOURCE EXPERIENCE PARIS CONFERENCE

Craft AI explores explainable AI (XAI) open source libraries. Thales Inner Source Stack (TISS) community.

Artificial intelligence is often presented as a 'black box' providing results that defy human understanding. This need not be the case as Bastien Zimmermann (Craft AI) explained at the 2022 Open Source Experience Paris event. There are several libraries of open source software that promise 'explainable AI' (XAI), providing methods that make machine-learning derived results understandable. Zimmermann presented some of the main XAI libraries in terms of their target areas and code maturity. XAI solutions range from single developer solutions of uncertain scope to enterprise-strength environments.

Christoph Molnar, high priest of XAI, describes the approach as 'adding methods to a black box so it is understandable'. As an example, an ML model to identify dogs may come unstuck when shown a wolf. XAI would then add an 'explanation' to the training set to help the algorithm along. This is not as trivial as it might sound. AI safety is becoming an important legal field. In the EU, the AI Act and new RGPD rules mandate a 'coherent explanation' of how an AI system works.

The Shap library is behind most XAI. Shapley additive explanations is described as a 'game theoretic' approach to explain the output of a machine learning model. Shapely values indicate which input features are responsible for model output. The best XAI library is Alibi Explain. Users can create and embed counterfactual explanations in a model ('a wolf is not a dog'). For interactivity, Zimmermann recommends the Explainer Dashboard with 'quick and easy explainers for different methods'. But users need to evaluate XAI libraries in terms of code maintenance, documentation and features. 'Lots of tools fail in one domain or another'. Github metrics are often a good indicator. In the Q&A, Zimmermann allowed himself a plug for

his own company's Seldon.io MLops for explainable AI offering. The Captum model interpretability library for PyTorch also got a plug.

Watch Zimmermann's talk on YouTube.

Thomas Moreau explained how French ITC behemoth **Thales Group** has deployed an 'Inner Source' community to leverage open source software in its projects. Inner Source, the integration of open source software into professional IT projects, is a concept that was originally promoted by Tim O'Reilly* over 20 years ago and is now reported to be used at many large companies including Paypal, Siemens, Bosch, Engie and even Microsoft. Thales uses Inner Source to avoid in-house silos by building reusable code building blocks. This has involved a cultural transformation to encourage code sharing across the company, an approach that has led to the 'serendipitous finding of something good without looking for it'.

The Thales Inner Source TISS stack is built on three pillars: collaborative code development, a legal framework for deployment (with inspiration from the Eclipse Foundation) and community. TISS has governance boards and entices contributors with goodies and other incentives. Meetups and hackathons also ran. Open source components leveraged by TISS include Sonar Qube, Gitlab and components from Jfrog. Public-facing products from TISS includes the Cryptobox and Citadel (secure communications and document management) from Thales' Ercom unit. Thales also contributes to the Eclipse Project Capella, an open source solution for model-based systems engineering.

Watch Moreau's presentation (in French) on YouTube.

More from Open Source Experience.

SOFTWARE, HARDWARE SHORT TAKES

Upstream: ThermoFisher Avira/Pergeos, Ikon Science RokDoc/Curate, Beicip-Franlab Open Flow Suite Petrosys PRO, Ceetron ResInsight. Operations: SLB ProcessOps, Teledyne FLIR, Honeywell Alarm Performance Optimizer, Total Valve LiftTrack 2.0. Downstream: Ensyte Gastar, KBC Multiflash, Whip Around Wallet, Halliburton Envana.

UPSTREAM

The 2022.2 releases of **ThermoFisher**'s Amira, Avizo and PerGeos packages include enhancements to analytical workflows, AI-assisted segmentation of challenging datasets and automated processing of very large (out-of-core) datasets. PerGeos includes a new two-phase flow simulation function for visualizing the flow of two immiscible fluids inside porous materials. The mesh generation algorithm has been sped up twofold with support for multiple CAE/CFD/FEA tool file formats. More from ThermoFisher.

Ikon Science RokDoc Version 2023.1 expands machine learning functionalities and adds new visualization tools. Additions to the Deep QI function library speed up the ML workflow with automated parameter optimization, feedback and confidence metrics to provides 'a more realistic, data driven overview of the subsurface'. RokDoc 2023.1 incorporates several customer requests for improved workflows and expansion of 3D dataset viewing. Bayesian classification methods now aid in geological property categorization, establishing 'tighter integration with 3D reservoir characterization workflows'.

Ikon has also enhanced its Curate cloud-native subsurface knowledge management system to support enterprise scale collaboration and cross-discipline workflows. In the well surveillance application, a real-time chat function allows for live exchange of ideas across teams as drilling progresses. The well viewer app now features file-linked, depth referenced images of core datasets, cuttings photos and SEM imagery.

OpenFlow Suite 2022.1 from **Beicip-Franlab** is now available. The release contains multiple corrections for OpenFlow, TemisFlow, CougarFlow and PumaFlow. TemisFlow 2022 introduces the ArcTem basin simulator and new Groovy scripts for geothermal studies. TemisFlow now leverages CougarFlow's automatic calibration to well data.

Petrosys PRO V2023.1 introduces new cross section and fault statistics modules. X Sections creates a cross section from an existing Petrosys PRO map along with data from 3rd party vendors. Fault statistics adds fault plots, thematic mapping and more.

Release 2023.01 of **Ceetron**'s ResInsight reservoir modeler improves summary and ensemble plotting. The window management system has been improved and support has been added for vertical and horizontal tiling and for Roxar's ROFF file format. More from the release notes.

OPERATIONS

Schlumberger has announced ProcessOps on Delfi, a cloud-based digital facility twin that uses artificial intelligence and automation along with data and physics-based models to 'transform' facilities workflows.

Teledyne FLIR has announced a new compact thermal camera for use in hot working zones. The 'pocket-portable' FLIR Cx5 enables condition monitoring of hazardous environments. A rugged ATEX-compliant case allows users to safely monitor electrical or mechanical assets in hot working zones. More from Teledyne Flir.

Honeywell's Alarm Performance Optimizer Release 1.1.0 adds a pattern analysis and recommendation (PAR) module to the alarm performance optimizer, a 'breakthrough' analytics capability that provides recommendations for resolving nuisance alarms. The PAR module collects and analyzes historical alarm data to identify and recommend the correct alarm ON/OFF delay parameters, reducing data wrangling and providing a periodic review of recommendations that represent a 'step towards an autonomous alarm management system'. More from Honeywell.

Total Valve has announced LiftTrack 2.0, its new patented pressure safety valve lift event indicator that captures safety valve lift events. The device transmits lift events wirelessly and can also record acoustic outlet data or temperature associated with the events. Information can be viewed in the Total Valve App to see what time the lift event occurred and track how long the safety valve was open, helping mitigate the environmental release.

DOWNSTREAM

A new Gas Accounting module for **Ensyte**'s GASTAR gas management software couples tightly with client accounting systems to provide a 'seamless flow' of information from natural gas operations to accounting. The system provides auditable vendor invoice reconciliation and customer invoicing for off and on-system transactions.

Yokogawa's KBC unit has released Multiflash 7.3, the latest edition of its PVT (pressure-volume-temperature) and physical properties package. The new version leverages CAPE-OPEN's COBIA interface to provide interoperability with third party process simulators. More from COLAN.

Whip Around has launched a new document management solution for fleet managers and drivers. The Whip Around Wallet mitigates driver non-compliance and ensures that the required paperwork is available for roadside check. Whip Around Wallet is available on web and mobile. Documents are stored in the cloud

and tagged to let drivers access the documentation that they need while out on the road. Wallet also records expiration dates, renewal notifications and retention sunset reminders. More from Whip Around.

Halliburton has announced Envana, an emissions improvement engine that tracks a company's carbon footprint with 'verifiable E&P emission estimates'. Envana leverages a library of emissions sources built from Halliburton's E&P expertise, adding a 'verifiable system of record for emissions data' and a 'comprehensive visibility' of scope 1, 2 and 3 emissions'.

AVEVA WORLD 2022 SAN FRANCISCO

Schneider/Invensys, Aveva, OSIsoft consolidate. AI, digital twins and (perhaps) the industrial metaverse. Shell on the "world"s most comprehensive" digital twin and the Energy Transition Hub. Wood, "put a digital twin in your project budget". Eneos - refinery data consolidated to 3D model in Aveva Connect. ExxonMobil "RED" - data-centric engineering. Devon reduces emissions with AI, RPA and the cloud. BP"s ACE digital twin. Plains all-in on enterprise pipeline system, "OT needs to own the PI System". Accenture - oil and gas "leader of (poor) digital maturity field". Aveva"s industrial metaverse underwhelms. Microsoft Bonsai PoC "infuses" portfolio with AI.

One of the recurring issues in software is the tension between using 'best of breed' applications from different suppliers and sticking with a single developer's 'platform'. But what happens when the developers of a whole range of software tools merge. Does this make for an interoperable platform? Or will the merger/acquisition just mean rebranding? One thing is for sure, it was smart of Aveva to buy PI, grab its massive client base and extend the use of its own refinery-focused simulators.

Speaking at the 2022 **Aveva** World in San Francisco, CEO Caspar Herzberg traced the three strands of what is now Aveva. These go back over 50 years with Schneider/Invensys SimSci (1967), Aveva CAD Centre (1967) and OSIsoft PI (1980). These are now 'grouped around an industrial strategy of data sharing', providing 'end to end AI-infused engineering and operations solutions', all delivered from the cloud via Aveva Connect and Data Hub. Herzberg's flagship use cases were suitably environmentally conscious, coming from CCS, water and renewables. Herzberg stressed Aveva's 'close relationship' with Schneider Electric. This is in fact an ongoing situation. The deal was only completed in January 2023 and, as widely reported, the plan is to 'preserve Aveva's business autonomy and future R&D investments'.

Andrew McCloskey drilled down into the 'new frontiers' of the industrial software landscape, presenting **Aveva**'s toolkit as underpinning a digital twin initiative. He suggested a maturity scale for the twin from 'full DT' to FDT+ (the unified operations center) and the 'natural next extension' that is (will be?) the industrial metaverse. McCloskey illustrated the use of a laser scan backpack from Navvis for data collection and creation of the 3D point cloud model, leveraging 'infused AI'. Aveva's toolset performs the heaving lifting, extracting contextualized information from multiple sources. 'Vision AI' is said to catch what sensors and the human eye might miss. An 'early proof of concept' of the industrial metaverse was said to show the 'incremental, yet amazing value for collaborative engineering and remote operations'. The IMV is 'not about the goggles', it works on any device and is, or will be, 'highly relevant' for remote operations and collaborative engineering.

Bart-Jan Ruules presented 'the world's most comprehensive digital twin', that **Shell** is creating for its refining operations. This leverages industry standards (Ruules cited ISO 15926, ISO 14224 and Cfihos) along with Shell's own corporate standards for engineering design. All of which is being rolled into an asset data model, illustrated by a labyrinthine flow chart spanning design, build, operations, maintenance and on to decommissioning. The massive model is said to simplify the data lifecycle, supporting early (pre-Feed)

data delivery requirements and drive 'integrated end to end thinking'. Returning to the green theme, Shell has invited Aveva to participate in its Energy Transition Hub* as part of a 'deeper collaboration'.

* *'A new digital platform open to exchange emissions data, sharing best practices and exploring low-carbon solutions that work for you'.*

Rob Kennedy gave a slightly different take on **Wood**'s digital twin to the one* we reported on in our last issue. Again 'right-to-left thinking' is needed to determine the strategic capital investments required to transform both project and operating performance. This has resulted in Wood's 'best-in-class' digital twin ecosystem built with wall-to-wall Aveva components, notably with OSIsoft PI, now rebranded as 'Aveva PI'. A data integration layer is built with Aveva Asset Information Management. Kennedy recommends budgeting for the digital twin in project costs and scheduling.

* *This was built for Turkish Petroleum's Sakarya Gas Field and leveraged technology from Hexagon. In a short email exchange, Kennedy told Oil IT Journal 'While Wood has a number of digital twin solutions (such as our own Virtuoso) our main focus is on advisory and implementation services – where we remain technology independent and work with a range of suppliers and partners to deliver best fit solutions that deliver our clients' desired outcomes'.*

For a comparison of Aveva and Hexagon's AIM tools see Gartner.

Japanese refiner **Eneos** has built its digital twin using internal systems and the Aveva Connect cloud. Here, a 3D point cloud model consolidates data from Informatica, J5 (maintenance), Excel and SAP. The prototype digital twin was built and evaluated for one unit in Eneos' Kawasaki refinery. Aveva products were selected based on cost and features. The solution allows for equipment search by tag in Aveva Net Dashboard.coredownload.inline.pdf . Intelligent P&IDs are hyperlinks to documents, point cloud items and process data in PI Vision. A 'visual reporting' function allows for color-coded P&ID displays grouping equipment (e.g.) by operating temperature. Switching between PCM and AIM* allows tags and markups to be identified in the 3D model. The link to the J5 maintenance database from Hexagon allows for maintenance work planning. Work areas can be plotted on a map, again with color coding to show work types and 'keep out' areas. The prototype digital twin has been verified with various facilities management scenarios and deemed 'very effective in improving the efficiency and quality of operations'. For analytical work that deals with huge amounts of information, integration with big data/AI is required. This has been used to gain new insights into corrosion prediction from point cloud data. Other digital technologies such as OCR and robotic process automation accelerate digitization and reduce costs by adding attribute information to documents and 3D viewers.

* *Point cloud manager and asset information manager.*

Erin Jones (**ExxonMobil**) teamed with Peter Townson (**IOGP/Cfihos**) to present a practical implementation of Cfihos for data surveillance. The aim of the exercise is to populate RED, ExxonMobil's implementation of Aveva AIM and ISM. RED* promises validated data-centric engineering surveillance, improve data handover to operations, and an engineering data foundation for global asset analytics. RED seeks to expose data that may be siloed in an EPC's system. Data now passes through Aveva and on into RED for checking and cleansing. A minimum viable product was rolled out in2022. Data now goes on to maintenance as an 'O&M engineering data system of record'. RED is said to be a highly-searchable and integral data- centric element for project information and handover, contrasting with earlier document-centric project delivery.

* *More on ExxonMobil's use of Cfihos alongside RED in our last issue.*

Trey Lowe, CTO, outlined **Devon**'s data-driven production operations. Devon has thousands of sites across the US, with over 10,000 tanks. An enterprise-wide data and digital investment has seen the deployment of AI, RPA and a move to the cloud. In 2020, Devon's SWPM* hydraulic fracturing technique was granted a patent. Devon monitors over 11 million data points in PI Vision. Again, the environmental side of the business was highlighted. Devon is using its comprehensive monitoring system to reducing Scope 1 & 2 emissions and has joined the Oil & Gas Methane Partnership. A 65% reduction in methane emissions is planned for 2030. Along with the emission reduction, PI Vision has driven operational efficiencies. Image analysis turns cameras into sensors that capture data in hazardous areas, augmenting existing sensors and performing tasks such as checking pump rod rotation. PI AF and PI Vision are the foundation for advanced analytics and computer vision applications. Exception-based surveillance has accelerated time to value for advanced analytics and machine learning projects.

** Sealed (offset) wellbore pressure monitoring.*

Kenneth Guidry showed how **BP** is extending its extensive PI System infrastructure to facilitate its 'journey to net zero'. BP has almost 4 million PI tags running on 60 PI servers across its four business areas. Modeling of CO_2 emissions in refinery operations uses Aveva Unified Supply Chain to drive emission reduction. Adding the CO_2 modeling capability resulted from a strong 'co-innovation partnership' that has helped understand the options that could reduce CO_2 refinery emissions. The USC package includes flow sheets of a linear programming optimizer. Guidry also presented BP's digital twin developed for the Azeri Central East (ACE) development. Here the Aveva AIM digital twin collects plant data for viewing in PI Vision. The twin blends data from laser scans, tags data, 3D Model, documents, SAP, and Bentley APM. More on ACE here with a cool time lapse video of construction.

Prabhas Bhat and Matthew Richardson teamed to present **Plains**' experience with the Aveva portfolio. Plains software 'journey' spans Valmet, Metso, Telvent, Schneider Electric, OSISoft and Aveva – 'first as customer, now as strategic partner'. Plains has replaced a diverse, tag and Excel-based system with an 'enterprise class' solution based on PI and Aveva's Enterprise Pipeline Management System. This is now 'transforming the way we work'. A flagship development, Plains leak detection suite, was built using the PI SDK/API, working on data sent to PI from leak detection systems. This has captured 'synergy value' between PI and the EPLMS. Development was led by a operations-led PI System community of practice which has redefined the IT/OT relationship. While there is a role for traditional IT, 'OT needs to own the PI System'.

Sheri Williams explained how **Accenture** can help with Aveva-based digital twin development. Williams reported that digital maturity is poor across all industries* with many firms in 'pilot paralysis'. Williams advocates achieving greater maturity by deploying 'bionics', 'cobots', real time multilingual translation, the cloud, digital threads and twins. And, naturellement, the Aveva data hub and metaverse. A key player on the digital shop-floor is the robotics integrator, a subject matter expert on automation and robotics.

** However, unlike previous analyses of digital progress, in Accenture's current evaluation, oil and gas is actually leading a rather underperforming field!*

Aveva's Norton Green invited visitors to visit the innovation labs and 'take a walk in the Aveva Industrial Metaverse' in the form of a Youtube video. Here, a robotic avatar gesticulates at a plant model (at one point it seems to be counting on its fingers!). There is no audio so its hard to see exactly what is intended. Underwhelming!

Chris Kahrs presented a joint venture between **Microsoft** and Aveva to apply deep learning to control a distillation unit autonomously. This is presumably the 'AI-infused' aspect of the portfolio that Caspar Herzberg referred to in his keynote. The demonstrator applies Microsoft's Bonsai low code AI demonstrator

alongside Aveva DynSim to optimize operations of a digital replica of the plant in the cloud. The results appear quite convincing, but not perhaps ready to 'infuse' the whole portfolio!

Other presentations of note include **Saudi Aramco**'s development of a refinery-wide closed-loop real-time optimization, built with Aveva Process Optimization software on a PI System infrastructure. Another Aramco presentation covered a reliability and integrity management solution developed at its 4IRC center, leveraging PI data and Aveva Asset Predictive Analytics. For this 'fourth industrial revolution' development, Saudi Aramco evaluated the alternative of developing in-house applications. This was rejected due to its development and maintenance complexity. **KBR** presented its 'complete O&M digital twin' as built for the BP ACE development (see above) presented as a 3 way joint development by BP, Aveva and KBR.

View the Aveva World presentations here and visit the Aveva World minisite.

FOLKS, FACTS, ORGS

CO-LaN, AFL, Billington Process Technology, Black Bay Energy Capital, Bluefield Geoservices, Chemical Safety Board, Carbon America, Cognite, Colonial Pipeline Company, Continental Resources, CybeReady, Dataiku, Delek Logistics, Environmental Protection Agency, Eliis, ExxonMobil, Flotek Industries, IOGP, MacGregor, Object Management Group, Opportune LLP, Pason Systems, Paxon Energy and Infrastructure, Quorum Software, Resoptima, Schneider Electric, Texas Railroad Commission, Velo3D, W Energy Software, Williams, MIT, LF Energy, Object Management Group

The **CO-LaN** organization has contracted with Malcolm Woodman to manage the development of its CAPE-OPEN test suite. He is also to work on a new certification process.

Jaxon Lang is to join fiber optic manufacturer **AFL** as COO. He was previously with FiberRise.

Knut Erik Spilling has ben promoted to CEO at **Billington Process Technology**.

Matt Schovee has been promoted to MD at energy-focused private equity boutique **Black Bay Energy Capital**. Grant McClure has joined as Associate. Christine Staples and Bill Harvey have been added to the strategic advisory board.

Lev Belskiy is geotechnical project manager at **Bluefield Geoservices**. Jonathan Bell and Dariusz Nowak have joined as geotechnical technicians.

The US Senate has unanimously voted to confirm Steve Owens as Chairman of the **Chemical Safety Board**. Catherine Sandoval was also confirmed as a CSB Board Member.

CCS developer **Carbon America** has named Cruz Gamboa as CFO and Craig Spreadbury as COO. Gamboa hails from General Electric, Spreadbury from Four Corners Petroleum.

Cognite has announced four appointments: Moe Tanabian (Chief Product Officer), Paul Lightfoot (SVP User Experience), Emmanuelle Camus (President for EMEA) and Liat Berger (Chief human resources officer).

Melanie Little has been named President & CEO of **Colonial Pipeline Company**. She joins from Magellan Midstream Partners and succeeds retiree Joseph Blount.

Doug Lawler is now President and CEO of **Continental Resources**. He was previously COO.

Jonathan Stone has joined the **CybeReady** executive team as VP Sales, North America.

Ben Taylor has joined **Dataiku** as Chief AI Strategist. He hails from DataRobot, prior to its acquisition by Zeff.ai.

Rosy Zuklic has joined **Delek Logistics** as VP Investor Relations and Market Intelligence. She hails from Phillips 66.

The US **Environmental Protection Agency** has hired Jahi Wise as senior advisor to the administrator and acting director for the greenhouse gas reduction fund program. He was previously a special assistant to the President for climate policy.

Eliis has named Stuart Walley to VP Middle East and Asia Pacific at its new location in Dubai, UAE.

Larry Kellner and John Harris have been named to the **ExxonMobil** board of directors. Kellner was formerly chairman and CEO of Continental Airlines. Harris is the former CEO of Raytheon International.

Flotek Industries has named Harsha Agadi interim CEO, succeeding John Gibson who has left to pursue a professional opportunity in renewable diesel. Bond Clement has been appointed CFO. He hails from PetroQuest.

Kim McHugh (VP Wells, **Chevron**) has been appointed Chair of the International Association of Oil & Gas Producers. She replaces Fawaz Bitar (BP) who has completed a four year stint.

Seppo Heino now heads-up **MacGregor**'s Global Services Division.

Mike Bennett is now Technical Director at the **Object Management Group**. He replaces Jason Smith who returns to his consulting and research career.

Opportune LLP has announced the promotion of Trent Determann to Partner. Kevin Cannon and Teresa Kroh have been promoted to Principal.

Pason Systems has appointed Ken Mullen to its board of directors. He was previously co-founder, President and CEO of Savanna Energy Services.

Lloyd Pirtle has joined startup **Paxon Energy** and Infrastructure as SVP Business Development & Operations. He hails from TD Williamson.

Quorum Software has appointed Jan Manning as Chief Information Officer. She hails from Forescout Technologies.

Arne Skorstad is taking on the new role of VP Energy Transition at **Resoptima**, with responsibility for carbon storage, abatement and geothermal. Philippe Mieussens has been named VP Services, overseeing and coordinating the company's reservoir projects, on-site staffing and training.

Peter Herweck is to be the new CEO of **Schneider Electric** replacing Jean-Pascal Tricoire who becomes chair. Heweck was previously head of industrial automation.

The **Texas Railroad Commission** recently reported its Jan 2022 hiring of Alkesh Amodwala as its first Chief Data Officer. Amodwala was previously with General Motors.

Brad Kreger is now EVP Operations at **Velo3D**. Robin Stamp has been named Director of Solutions Engineering. Kreger hails from Thermo Fisher Scientific, Stamp from SpaceX, said to be 'one of Velo3D's biggest customers'.

W Energy Software, a provider of cloud-based accounting and ERP energy software has hired Rachel Collins as CEO, replacing Mike Crest who transitions to Executive Chair. Collins was previously with Insite360.

Williams has promoted Chad Zamarin to EVP Corporate Strategic Development.

DEATHS

Renowned geophysicist **Enders A Robinson** has died. The 'Father of Deconvolution' established the Geophysical Analysis Group at MIT and was a founding member of seismic processing specialist Digicon. Read his obituary in the Boston Globe.

LF Energy Executive Director Shuli Goodman died following a long battle with cancer. Visit his memorial repository on the LF Energy GitHub site.

The **Object Management Group** reports the passing of Victor Harrison who served on the OMG Board of Directors from 2008-2014. Harrison was SVP with the OMG from 2014 to 2018 working notably on the US National Information Exchange MetaModel (NIEM) and UAF, the Unified Architecture Framework.

SALES, PARTNERSHIPS, DEPLOYMENTS

Sales from: Ovarro/KXCit to Beijing Gas, Omnira to Apache Corp. MoU between Azuli International and AGIG. Partnerships between: Barco/GCCD, Barco/SkySoft, CGI/SAP, Emirates NOC/Comarch, Davisware/Pump and Meter/Zahl, DeepOcean/Akvaplan-Niva. Sales: Flowserve to Aramco, Honeywell to PTTEP. Partnerships: Koch and Percepto, Texas RRC and Groundwater Protection Council. Sales: Lummus to Zhangzhou Chimei Chemical, Emerson to Petronas. Partnership: Resoptima with Aker BP, Sval Energi and NORCE. Sale: Rockwell/Sensia to Petrobras. Partnerships: SLB/Cognite, Seeq/IT Vizion/Vertix/BKO Services. Sales: Technip Energies to Adnoc, Beacon Offshore to Trendsetter Engineering, Windward to US "supermajor", iRely to Corrigan Oil.

Remote telemetry specialist Ovarro and partner **KXCit** have supplied Kingfisher RTUs to support Beijing Gas Group pipeline operations in China.

Apache Corporation has deployed **Omnira Software**'s Mosaic reserves management and petroleum economics solution.

UK-based Azuli International has signed a memorandum of understanding with **Australian Gas Infrastructure Group** to collaborate on carbon capture and storage opportunities in Australia.

Barco has partnered with **GCCD** to provide the Norwegian control room market with advanced visualization and collaboration solutions. GCCD provides control room solutions, including Barco video walls, networked visualization and LundHalsey control room furniture. Barco has also teamed with SkySoft ATM to enable recording and synchronized replay of video walls and workplaces in control rooms.

SkySoft's air traffic control-derived record and replay technology will be integrated with Barco's control room solutions. The solution has application in training, incident investigation and application debugging. More from SkySoft.

CGI has strengthen its global partnership with **SAP**, adding 'RISE with SAP' to its Canadian portfolio of services. The new qualification will help CGI provide enhanced services to clients in their move to the cloud. More from CGI.

Emirates National Oil Company has given Krakow, Poland-based **Comarch** a 'partnership award' commemorating seven years of business collaboration. Comarch's 'practical IT products and services', including customer loyalty and marketing solutions, have 'played an important role in helping ENOC achieve many of its business goals'. More from Comarch.

Davisware, a provider of cloud-based software for commercial field service companies, has partnered with **Pump and Meter Service** and **Zahl-Petroleum Maintenance** Company. Davisware works with companies in the petroleum equipment services industry, accelerating their digital transformation. More from Davisware.

Ocean services provider **DeepOcean** and Norwegian Water research Institute unit **Akvaplan-Niva** are to collaborate on the use of remotely operated vehicles and unmanned glider vehicles to perform environmental studies for offshore wind and oil and gas developments. The deal envisages a combination of DeepOcean's autonomous vehicles with Akvaplan's environmental data collection services. DeepOcean will also share environmental data collected during the company's ROV operations with Akvaplan for use by the wider research community. More from Akvaplan.

Flowserve Corp. is to provide Saudi Aramco's Jafurah unconventional gas field development with a diverse portfolio of over 400 pumps, mechanical seals and sealing systems for different components. More from Flowserve.

PTTEP has chosen **Honeywell** to provide carbon capture technology for its storage project at the Arthit Gas Field in the Gulf of Thailand. Honeywell's Separex membrane will concentrate CO2 for geologic disposal in depleted reservoirs.

Koch Engineered Solutions is collaborating with **Percepto** to deploy the latter's autonomous drone technologies and AI-driven software to enable remote emissions monitoring and leak detection in a variety of industries. Percepto's 'drone-in-a-box' will now be available from KES' Koch Specialty Plant Services unit. The offering will be packaged as a turnkey solution to customers as KSPS Aerial Inspection Solutions Powered by Percepto.

The T**exas Railroad Commission**'s LoneStar state tracking and reporting system is being built on the risk-based data management system originally developed by the **Groundwater Protection Council**. All of the RRC's oil and gas division's business applications will migrate to LoneSTAR by year-end 2028. The move involves re-engineering some 12 million lines of legacy mainframe code written over the last 50 years.

Lummus Technology is to provide process technologies and 'value-driven' energy solutions to Zhangzhou Chimei Chemical Co. to digitize its petrochemical facility in Gulei, Fujian Province, China. The deal includes Lummus' O3S operator training simulator and other training and digitalization services.

Petronas has signed a memorandum of understanding with **Emerson** to 'drive digital transformation and decarbonization initiatives'. The agreement involves a collaboration on extracting highway addressable remote transducer (HART) diagnostic data from field instrument and control systems, developing effective

predictive analytics and optimizing wireless instrument performance. Applications include process control and cybersecurity along with automation solutions for decarbonization initiatives including CCUS, hydrogen and ammonia.

Resoptima is partnering with operators **Aker BP**, **Sval Energi** and Norway's **NORCE** Institute on the development of algorithms to optimize reservoir production activities with the aim of CO2 abatement. More from Resoptima.

Control and safety solutions from **Rockwell Automation** will be the 'operational heart' of Petrobras' 'P-79' FPSO. Rockwell will supply the integrated control and safety systems to the new build vessel with support from Sensia, Rockwell's joint venture with SLB.

SLB (formerly Schlumberger) has teamed with **Cognite** to deliver 'data-driven solutions at scale' to the global energy industry. The partnership sees SLB's Enterprise Data Solution for the subsurface coupled with Cognite's Data Fusion industrial 'DataOps' platform. Schlumberger is lead commercial partner in the venture and will 'exclusively provide' customers with access to the EDS. While the release does not exactly spell this out, the SLB EDS is elsewhere described as 'the first fully unified enterprise data solution for the OSDU data platform'.

At its Global Partner Symposium in Las Vegas, **Seeq** recognized its 2022 reseller and service partners of the year. In the oil and gas space these included IT Vizion (migrations of end users to Seeq), Vertix Technologies (LATAM region training and implementation services) and BKO Services (customer support at Marathon Oil, Suncor, TexGen and Shell). The event also launched the Seeq Partner Advisory Council to advise on Seeq deployment best practices and influence Seeq's product direction. More from Seeq.

Adnoc has awarded **Technip Energies** (as leader of a Samsung/Tecnimont joint venture) a 'pre-construction services agreement for the onshore facilities at its Hail & Ghasha gas development project in Abu Dhabi, UAE. The PCSA follows the successful completion of an updated front-end engineering and design contract, executed by Technip Energies.

Beacon Offshore Energy has awarded **Trendsetter Engineering** a contract to support the development of its Gulf of Mexico Shenandoah project. The deal includes a multi-year rental and servicing agreement for the provision of a 20,000 psi subsea well intervention package. Trendsetter will use Advanced Technology Valve's subsea valves for the production and export systems. More from Trendsetter.

An unnamed 'American supermajor' has deployed **Windward**'s Maritime AI software to enhance its trade compliance processes and mitigate risks in a 'turbulent' oil trading environment in a three year enterprise contract. The new client joins Shell and BP in using Windward's solution to help it comply with, inter alia, new regulations by the Office of Foreign Assets Control (OFAC) and other Western coalition members, including the price cap on Russian oil. Windward reports that 2022 saw a 300% plus per year hike in 'dark activity' connected to Russian oil, heightening the need for counterparty due diligence. Windward's platform verifies that potential business partners are not a compliance risk, flagging suspicious behavior. More from Windward.

Corrigan Oil has selected iRely's web-based ERP system for petroleum distributors and convenience stores at its Michigan-headquartered fuel, lubes, and propane distribution business. The deal includes a business process review with the iRely team, overviewing goals and improvement areas across accounting and finance processes and warehouse management.

OSDU UPDATE

OSDU at The Open Group. Plans for 2023. How "open" is the "open" subsurface data universe? M15 Release and the geospatial consumption zone. OSDU and the incumbent data stores. OSDU in retail (?!?)

OSDU AT THE OPEN GROUP

In his 2022 year end address Steve Nunn, president and CEO of **The Open Group** described OSDU as 'our most active Forum, in terms of participation'. OSDU has made 'great strides' in 2022, balancing a 'focus on open source software development of the data platform […] and creating the foundations of a certification program for commercial products and services'. OSDU work groups have been restructured to focus on standards for both legacy subsurface and emerging renewable energy data types'. Plans for 2023 include the adoption of a reference implementation for the OSDU Data Platform, which will be made freely available for end users to analyze data, application developers to test their products, academia for basic research, and verification test providers for use in verifying products for certification'.

KATALYST'S 'WELCOME TO OSDU'

If you need an update on what is currently available under the OSDU hood you might like to read Debasis Chatterjee's (**Katalyst Data Management**) 'welcome to the Forum'. Chatterjee explains how new OSDU users can access OSDU services with the Postman API platform. He recommends consulting the plethoric documentation first. According to Chatterjee, 'ideally, you would have access to a deployed OSDU data platform inside your own company*'.

** We were curious to know what access to the OSDU toolset is available for a developer that a) does not have such a platform and b) does not want to pony-up cash for an OSDU/TOG membership. How 'open' is the 'open' subsurface data universe? Chatterjee told us that,* 'Non TOG folks can indeed deploy a 'reference implementation' themselves. There are two choices, one from Google and another from IBM. These could be deployed on-premise. Even non-members can do that, except they may not be able to get suitable support*'. So OSDU is kind of open, but it does not sound quite like an open source* ***community*** *if you see what we mean.*

M15 RELEASE

M15 Release Notes we would strongly recommend interested parties to peruse the M15 'Milestone' release notes and drill down into some of the sub headings. Explanatory documentation is not an OSDU forte. As an example, we are invited 'to learn more about [the data definitions] project, read the Wiki'. The 'Wiki' in question is a blank page.

THE GEOSPATIAL CONSUMPTION ZONE

Brian Boulmay (**Esri**) does a better job of presenting the geospatial consumption zone (GCZ) with and the map service API that rolls out with the Mercury M15 release. Boulmay reports that a new 'aligned autonomy' approach was used to satisfy the different requirements of the OSDU community. The GCZ solution includes a transformer that processes the data, Apache Ignite for storage of the geospatial index, and Koop for the map service. The result is that an open source map-based API is now part of the core OSDU offering. Koop delivers geodata in multiple formats including vector-tiles, OGC WFS, Esri WFS and 'even plain GeoJSON'. The result is that 'operators no longer need complex ETL processes to publish map services and vendors have access to ready to use map services for their own OSDU-enabled applications and

services'. The GCZ approach recently received a strong endorsement from Ryan Jarvis, subsurface data strategy advisor with ExxonMobil.

OSDU AND THE INCUMBENTS

On a slightly different tack, one facet of OSDU that has always intrigued us is how existing providers of upstream data universes regard OSDU's encroachment into their own commercial domain. Why are they putting their head into the lion's mouth. Recent presentations from **Katalyst** (at PPDM) and **Petrosys/Interica** (at SPDM) appear to show OSDU as a secondary adjunct to their own data stores. Johan Krebbers's initial intent of OSDU as the corporate data store may be some time coming!

OSDU IN RETAIL?

In a rambling interview with **Energy Connect** at the recent Adipec tradeshow, Jamie Cruise (**SLB**) and Uwa Airhiavbere (**Microsoft**) extemporized on new technology, AI and data, that are paving the way for a (brave?) new world. Questioned on the importance of standards, Cruise opined that standards can be 'a bit of a minefield' as they may not be tied to local requirement or individual tools needs. But is the oil industry learning from other industries or the other way round? Airhiavbere stated that OSDU was a great example of collaboration and that 'retail and manufacturing can learn from this'.

Retail learning from OSDU? That does sound a bit far fetched!

FOSA FIBER OPTIC INNOVATIONS

Hifi Engineering's Deep Fake leak simulator builds test data for pipeline monitoring. Febus and Lytt team on well monitoring.

FOSA, the Fiber optic sensing association awarded a 2022 Innovation Award to **Hifi Engineering** for its 'Deep Fake' pipeline verification and validation methodology. Deep Fake describes Hifi's approach to testing its deep learning models for pipeline monitoring. ML-based pipeline leak detection algorithms are trained on real, in-the-field, tests of controlled leaks and other anomalies. The new approach adds to Hifi's database of field tested leaks using a 'patent pending' simulation method to generate synthetic leaks of various configurations. Leak detection systems can be tested on such synthetic data rather than on a physical product release. The system is said to successfully detect and classify leaks, enabling cost-effective system auditing that 'supports the long-term maintenance and reliability goals of pipeline operators'. Calgary-based Hifi's fiber optic sensing systems are deployed on over 3,000,000 meters of pipeline assets globally. More from Hifi Engineering.

Another FOSA prize went to France's **Febus Optics** and UK's **Lytt** for a jointly-developed well monitoring solution. The approach combines Febus' distributed fiber optic sensors with Lytt's analytics platform. More on the solution from Febus.

Hifi also merits a marketing prize for its use of the 'Deep Fake' trope. A first for industrial ML?

DONE DEALS

Automation-X MBO. Blackstone IH buys Sintemar Roteq. CGG sells US land seismics to Bon Ton. Chevron leads Svante Series E round. Cognizant to acquire Utegration. Corrosion Resistant Alloys acquires PipeSearch. Forum Energy Technologies executes sale and lease-back. Hexagon AB acquires LocLab, Projectmates, Qognify. CIC/Draeger lead Kuva Systems' Series A round. LongPath Series A led by White Deer. Profet AI Series A. Pason Systems and Intelligent Wellhead Systems. Progress acquires MarkLogic. Seadrill acquires Aquadrill. Siemens buys Vendigital. Wa'ed Ventures (Aramco) buys into Terra Drone. Vertice acquires MorphPackers assets. VistaVu acquires Quintel SAP practice.

Employees of Fort Collins, CO-based **Automation-X** have executed an employee stock ownership plan and now own 100% of the turnkey industrial automation solutions provider, founded in 2003.

Calgary-headquartered **Blackstone Industrial Holdings** is acquiring the **Roteq** division of Bilbao, Spain-based industrial services company Sintemar. Roteq provides services to the petrochemical/oil and gas sector for major clients and OEM fleets, such as Nuovo Pignone and Baker Hughes.

France's **CGG** has sold its US land seismic multi-client library to **Bon Ton Seismic** for $63 million cash.

Chevron New Energies is the lead investor in Svante's Series E fundraising round. The $318 million raised will be used to 'accelerate the manufacturing of Svante's carbon capture technology'.

Cognizant is to acquire Houston-based **Utegration**, a consulting and solutions provider specializing in SAP technology and SAP-certified products for the energy and utilities sectors.

Corrosion Resistant Alloys has acquired **PipeSearch**. The deal is said to 'drive the digital transformation of the oil country tubular goods sector'. PipeSearch's digital trading platform 'connects OCTG demand to supply needs across the globe'.

In a $32 million sale and lease-back deal, **Forum Energy Technologies** has sold four manufacturing and distribution centers in Texas and Louisiana. The properties remain 'an integral part of FET's operations'

Hexagon AB has acquired **LocLab**, a provider of '3D digital twin content'. LocLab's automated technology uses 'proven workflows and artificial intelligence' to enable the 'cost and time efficient creation' of digital twins from, inter alia, point cloud data. The LocLab technology is to integrate Hexagon's 'HxDR' cloud-based storage, visualization, and collaboration platform.

Hexagon has also acquired **Projectmates**, an 'owner-focused' enterprise construction project management software provider. Projectmates will provide asset owners with a window into Hexagon's HxGN Smart Build construction portfolio.

And again … **Hexagon** has acquired **Qognify**, a provider of physical security and enterprise incident management software. Qognify's video management solutions link business and operational workflows with surveillance data to minimize the impact of security, safety and operational incidents. The deal opens 'cross-sell' opportunities with Hexagon's Leica BLK series of reality capture sensors.

Kuva Systems has announced an $11.3 million Series A funding round, co-led by **Climate Innovation Capital** and **Draeger**, to accelerate deployment of its Gas Cloud Imaging fugitive methane monitoring technology.

LongPath Technologies has raised $22 million in Series A funding to further develop its long-range, frequency comb laser-based emissions monitoring technology. The round was led by private equity firm **White Deer**, along with **ProFrac** and **Williams**

Taiwan-based Profet AI has raised $5.6 million in a Series A funding round led by **Darwin Ventures**. Profet AI will use the monies to expand into Japan, Southeast Asia and China and to further develop its AutoML Virtual Data Scientist Platform.

Pason Systems has increased its non-controlling investment in **Intelligent Wellhead Systems**, acquiring some $7.9 million of IWS shares and agreeing on a further investment of 'up to' $25 million. The deal will support further development and sales of IWS' InVision platform for automated valve management in frac operations.

In a $355 million deal, **Progress** is to acquire Vector Capital portfolio company **MarkLogic**, vendor of a 'multi-model' NoSQL database and semantic metadata management system.

Seadrill Ltd. is to acquire **Aquadrill** in an all-stock transaction. Upon completion of the transaction Seadrill shareholders and Aquadrill unitholders will own 62% and 38%, respectively, of the outstanding common shares in the company. The transaction values Aquadrill at some $958 million.

Siemens has acquired the UK-based 'data-led' operations consultant **Vendigital**, which will become part of its Advanta professional services business. Siemens Advanta's 10,000 plus employees form a 'global network of cross-functional teams and highly skilled experts'.

Wa'ed Ventures, Saudi Aramco's VC arm has injected some $14 million into **Terra Drone Corp**. a manufacturer of drones and urban air mobility solutions. The monies will fund Terra Drone Arabia, a new subsidiary in Saudi Arabia that is to offer oil and gas inspection services.

Vertice Oil Tools has acquired 'substantially all' of the assets of **MorphPackers**, bolstering its re-completions capabilities and enabling Vertice to address the 'rapidly growing' re-frac market. Houston-based Vertice is backed by SCF Ventures, an investment vehicle within SCF Partners.

VistaVu Solutions has acquired **Quintel Management Consulting**'s SAP S/4HANA Cloud and ECC practice.

STANDARDS STUFF

IOGP JIP33 Quality Requirement Specifications. Eclipse Foundation's Sparkplug 3.0. PPDM floats AFE project, signs seismic MoU with Blockchain for Energy! Velo3D/IMI 3D print to API spec. Galileo HAS GPS operational. OGC Metaverse Work Group. OPC UA for CCS. SPE updates PRS for unconventionals. XBRL enters disclosure fray.

A new publication from the **IOGP** explains how to use the IOGP JIP33 Quality Requirement Specifications (QRS). The specification documents live in the JIP33 Specification Library for each IOGP standard and provide guidance to functions related to purchasing and manufacturing equipment for operators, EPC contractors and suppliers. The QRS introduction video explains all. *Despite the reference to EPCs, the QRS Guidance Document makes no mention of the IOGP's companion Cfihos standard.*

The **Eclipse Foundation** has released Sparkplug Version 3.0, the first version managed under the Eclipse Foundation specification process. Eclipse Sparkplug provides an 'open and freely available' specification

for how edge-of-network gateways (Sparkplug edge nodes) or native MQTT-enabled end devices and host applications communicate bi-directionally.

PPDM is floating an Authorization for Expenditure (AFE) project and is asking the community to fill out a short survey on what parts of an AFE project are of interest. PPDM is also looking for volunteers to help its data objects committee create new data objects to add to the data objects already published. PPDM has also signed an MoU with the '**Blockchain for Energy**' organization to support integration and harmonization of the work being done by both organizations. PPDM and B4E are to collaborate on 'best practices for seismic data management'!

IMI Critical and Velo3D report the successful metal additive manufacturing of oil and gas hardware, certified to the American Petroleum Institute AMSL Level 3 (API20S) standard. A Velo3D print file of an injection well choke valve was pulled from IMI Critical's PLM system and sent to six sites for 3D printing on Velo3D Sapphire machines.

Europe's Galileo high accuracy GPS service is now operational. Galileo HAS increases the accuracy of Galileo to sub-meter levels, becoming the 'first constellation worldwide' to provide a high-accuracy service globally. Galileo provides free-of-charge, high accuracy positioning corrections both from the (E6-B) satellite signal and via the internet.

The **Open Geospatial Consortium** is 'excited' to announce the formation of the OGC Geo For Metaverse Domain Working Group (MDWG), which will serve as a forum for the collective geospatial expertise of the OGC community to gather to help build and grow the open Metaverse. The group is open to OGC Members and non-members alike. The Metaverse is 'perhaps the ultimate distributed digital twin of the world'. Moreover, 'the Metaverse is not a single thing but, like the internet, is a collection of platforms and technologies: a world of objects that can be navigated and interacted with'. More in the release. The MDWG is the OGC's primary point of contact with the Metaverse Standards Forum, of which OGC is a founding and principal member.

The **OPC Foundation** has kicked-off a carbon capture and storage working group to develop OPC UA information models for various CCS-related activities including capture and compression equipment, storage, injection wells, pipelines and CO2 metering. The aim is for an interface standard for integrating CCS equipment and systems into an 'overall Industry 4.0 system architecture'. The release refers to the ongoing 'Northern Lights' CCS project. More from the OPC Foundation.

The **Society of Petroleum Engineers** has updated its Guidelines for the application of its Petroleum Resources Management System. The new Guidelines cover best practices for assessing unconventionals. There are also new chapters on petrophysics and reservoir simulation. Members can purchase the e-Book from the SPE for a modest $45.

The **XBRL International** financial standards body has pitched in to the sustainability disclosure standards battle, setting up the XBRL International digital sustainability disclosure special interest group. The DSD-SIG is to explored the idea of a shared registry of taxonomy schemas between major standard setters to harmonize standards via a generic XBRL catalog of elements that can be used 'by all the standards covering similar content'.

A SHORT HISTORY OF E-COMMERCE IN EQUINOR

In-house specialist explains how the Norwegian major's e-business has evolved over the past 20 plus years.

Writing as we do about the use or otherwise of standards, how they originate and evolve, it is sometimes hard to evaluate deployment and take-up objectively. It is also easy to view standards as 'competing', with winners and losers. In the field of oil and gas e-commerce we are fortunate in having received the following short history of e-business within Equinor from Arne Johan Larsen (Lead Analyst, SCM B2B/Supplier Integration) that shows how the real picture can be complex and how standard selection depends on much more than a choice of technology. Operating geographies, acquisitions and mergers play a large part in technology selection and standards use.

"In answer to your query about e-Invoice standards use in Equinor, first I need to explain some of the historical background and our rational for systems integration. During the establishment of Trade Ranger back in year 2000, Equinor (at that time Statoil) decided to use xCBL as the backbone integration standard. As Trade Ranger later became Hubwoo (now Proactis), Equinor continued to send and receive procure-to-pay xCBL messages in the exchange with Hubwoo in a '3 corner model', while our customers where free to use PIDX, Edifact, X12, e2b, xCBL etc. in their interaction with Hubwoo. In parallel our Accounts Payables department started to implement point-to-point e-Invoicing with some of our suppliers using xCBL or e2b message standards.

In 2015 Equinor corporate decided to replace xCBL with UBL as the backbone integration standard and started a pilot in 2016 where UBL over Peppol replaced some of the 'procure-to-pay' traffic via Hubwoo and most of the point-to-point e-Invoice set-up.

In 2019 Equinor decided to move all supplier integrations to 'UBL over a 4-corner model'. In parallel Equinor US acquired Brigham Exploration in 2012 an decided to keep the OpenInvoice solution for procure-to-pay interaction with suppliers. OpenInvoice used the PIDX standard for B2B interaction with the suppliers, while the invoice documents was converted to the 'canonical e-invoice' setup before being imported to the SAP ERP backend. When Equinor divested the assets originally acquired from the former Brigham Exploration, it was decided that Equinor left the OpenInvoice solution as well.

So to answer your original question: PIDX has officially not been part of the Equinor corporate standards, but it was indirectly used for a while with our US business. As such I can't say that UBL/Peppol replaced PIDX as e-Invoice standard. As we see it, UBL over a 4 corner model infrastructure (like Peppol and the upcoming BPC in the US) has replaced xCBL via point-to-point and 3-corner model infrastructures."

REGULATORY

New pipeline information from Canada Energy Regulator. EPA rules to eliminate gas pneumatic devices. New Mexico approves Flogistix sniffer technology. RRC: natural gas supply chain, Texas Open Data Portal, revised injection seismicity response. EU: GAIA-X cloud and "epic battle" with Microsoft. NSTA on new CCUS data regs. NSTA and Global Underwater Hub on "golden opportunity" for offshore UK.

CANADA

The Canada Energy Regulator (CER) has released new pipeline information including interactive maps, enhanced safety and environmental information and a new webpage covering pipeline flows and capacity. The latest updates profile 26 pipelines, some 92% of the line kilometers that the CER regulates. Visit the CER's interactive pipeline map.

USA

New proposed regulations from the EPA require the elimination of gas pneumatic devices across US oil and gas operations. According to the OGCI, 'over a million venting pneumatic devices will need to be replaced or supplied with compressed air over the coming years'. A recent OGCI webinar describes a potential replacement technology from Qnergy.

Comment – one advantage of pneumatic devices over more sophisticated solutions is that the former do not need electricity to operate. A possible advantage in off-grid applications or during a power outage.

The State of New Mexico has approved Flogistix's Sniffer 4Dv2 methane sniffing technology as a component of its 'Alarm' advanced leak and repair monitoring program. The Sniffer flies on a DJI Matrice 300 drone and captures geo-referenced and time-stamped gas and particle concentrations.

The **Texas Railroad Commission** has teamed with the **Public Utilities Commission** on a natural gas supply chain map. The map fulfills the Senate Bill 3 requirements and will be used by the Texas Division of Emergency Management to provide the State's emergency response.

In a separate development, the **RRC** was recently onboarded to the Texas Open Data Portal, a repository for publicly-accessible open data published by state agencies and higher education institutions. Historical oil and gas production data dating back to 1931 is available from the Portal.

Following a November 2022 5.4 magnitude earthquake in Reeves County, TX, the **RRC** is revising its seismicity reduction response plan. The plan sets curtailments on the injection volumes of produced water into disposal wells. The target for reducing daily injection volumes in deep disposal wells has been lowered from 298,000 to 162,000 bopd. In parallel the RRC's has embarked on an underground injection control program that is to use artificial intelligence to review seismicity in injection/disposal wells. The AI program is a joint venture with the Ground Water Protection Council. More on the initiative in this video.

EU

The US Cloud Act and a potential dependency of the EU on US cloud providers has sparked off a reaction in the form of EU-based clouds such as GAIA-X and the German Bundescloud. But, as users of Microsoft's OneDrive know, selecting a cloud other than Azure can be difficult. The situation, representing an 'epic battle between Microsoft and the EU' was described in a video presentation by NextCloud's Frank Karlitschek.

UK

The North Sea Transition Authority (NSTA) is seeking views from oil and gas and carbon storage industries on information and sample-related matters in CO2 appraisal and storage, to evaluate new data powers in support of energy security and the transition to net zero. The consultation concerns future NSTA requirements for CCS data retention, reporting and disclosure of carbon storage activities. More in the consultation document. The NSTA's Offshore Energy Digital Strategy Group is calling for individuals and organizations to join its 'task groups' to study data principles, cross-sector digitalization and other worthy activities.

NSTA and the Global Underwater Hub, a trade body, report that upcoming oil and gas projects represent a 'golden opportunity' for UK's offshore energy supply chain. Seven near-term projects will require 30 new wells and 194 kilometers of new pipeline. Vessel and rigs will be required for some 5,000 vessel-days and 2,500 rig-days.

NAMUR MODULE TYPE PACKAGE AND O-PAS

German standards body's Profibus-hosted MTP architecture parallels ExxonMobil's Open Process Automation work.

A position paper from the German Namur chemical industry body advocates the implementation of module type package (MTP) solutions in tomorrows distributed control systems. The paper, from Namur's DCS work group, describes the requirements for the integration of modular units into a control system and their vertical integration as 'orchestration layers'. MTP is said to be a 'key enabler' for the transition of today's systems into a world 'as described for example by the (ExxonMobil-backed) Open Process Automation Standard O-PAS'.

Namur's MTP was first presented in 2014 and predates O-PAS. MTP was originally developed in response to an earlier recommendation NE 148 for the modularization of process plants. The 'vendor-agnostic' MTP, with features such as a generic HMI description, are said to be 'of interest' to other initiatives, such as O-PAS. However the current level of MTP integration with DCS is 'insufficient'. Namur sees MTP as the orchestration layer of a future overall architecture, replacing today's DCS approach.

O-PAS and Namur's MTP appear to have been evolving over parallel for some time but both share a desire for more 'open' control systems. Namur observes that the status quo reflects something of a stand-off, as vendors and end users are both waiting for each other. While end-users would like to have MTP finalized, this may 'still takes years'. The latest Namur position paper is a call for 'additional effort' in the definition of a new system, where an 'important role' is envisaged for MTP. This would allow for integration of new systems with other plants that are automated according to 'upcoming standards' (read Namur?) across all levels of the system.

Namur has been working to 'internationalize' MTP as IEC 63280 apparently without much success. This may change with the transition of MTP into its new host organization, Profibus International. Also, a joint information model spanning O-PAS and MTP 'needs to be complemented by more pilots and field trials to avoid solutions without a real-life value'. See also the ExxonMobil paper 'OPAS Open Process Automation: A standards-based, open, secure, interoperable process control architecture where MTP is described as a 'complementary initiative' to OPAS.

CO2 TRANSPORTATION APP

OLI Systems digital chemistry for CCS. JV with Veolia targets digital transformation of refining.

OLI Systems has just launched a new CO2 Transportation App to improve CCUS* process design and asset reliability. OLI is a digital chemistry specialist working in upstream and downstream oil and gas to provide chemistry and corrosion insights, combining plant data with process engineering expertise. The new CO2 app is to address the needs of the embryonic carbon capture and storage industry which will need to transport CO2 over long distances, from industrial emitters to sequestration sites. Corrosion avoidance requires an understanding of the behavior of dense phase CO2, said to be 'complex and unpredictable'. This forces operators to make difficult choices, operating in sub-optimal conditions or risking pipeline failure. The app models impurities, such as H2S, NOx, SOx, and H2O, in dense phase CO2 transportation conditions, predicting corrosive phases or solid formations in CO2 pipelines. The app is said to 'democratize' first-principles-based predictive models through a simple user experience, helping organizations understand and optimize CO2 transport. More from OLI.

In a separate announcement, **OLI Systems** has signed a downstream joint venture with **Veolia Water Technologies & Solutions** to 'accelerate digital transformation in the oil and gas industry with water chemistry insights'. OLI is to provide its expertise in electrolyte-intensive applications in refining to Veolia's team of field engineers and experts in refining and petrochemicals. Target applications include crude distillation units, FCC, hydro processing and water stripping, leveraging OLI's 'comprehensive chemical property database and rigorous thermodynamic models'. More from Veolia.

** Carbon capture, use and sequestration.*

ROBOTIC INSPECTION ROUNDS

Namur position paper sets out requirements for autonomous mobile robots that perform safety tours, leak detection and perimeter monitoring.

Namur, the German chemical industry body has just published a position paper* on the requirements for robotic solutions for the automation of facility inspection rounds. The position paper, a product of Namur's AK 4.20 Remote and Autonomous Operations workgroup, describes the challenges and requirements for the integration of a robot-assisted inspection concept.

Inspiration for the study came from the increasing use of autonomous platforms to transport goods and equipment in plants and warehouses. Their use in the process industry is said to be an absolute novelty. However, today's robots' stabilizing and navigational capabilities make them capable of moving, running and flying, giving them potential applications outdoors.

One possible use case in the process industry is the inspection tour, where a shift worker walks the plant and verifies equipment according to a checklist. Inspection rounds provide up-to-date information on the condition of the plant and are essential to ensure plant safety and function. Robotic automation of such inspection rounds can protect employees from exposure to environmental hazards. Robotic inspection can also gather more data and potentially detect small changes in the plant at an early stage.

Use cases include container and barrier inspection, safety tours, creation of heat maps and an evergreen 3D plant model and more. Mobile robots can be also used for perimeter monitoring and emergency response. Robots need to be safe (Atex certification) and capable of use in different environments like walking on stairs. Recorded sensor data should be accessible via an open application programming interface. Processed

data should be made available to the user immediately with raw data kept available for subsequent use or further processing.

The paper ploughs on, enumerating control system, cyber security and data integrity requirements and pointing to various relevant standards that should be adhered to including KAS-51, IEC 2700X, IEC 62443, DIN EN ISO12100 and DIN EN ISO 13849. The paper concludes, rather emptily, that the 'further development of these technologies by the process industry is recommended'. 'Collaborative and autonomous mobile robots, combined with artificial intelligence methods, can open up new fields of application for the sustainable operation of chemical plants in the future'.

** The Namur report is available here (in German).*

HONEYWELL FINED FOR PETROBRAS BRIBERY

Honeywell UOP to pay over $160M to resolve foreign bribery investigations in US and Brazil.

UOP LLC, doing business as Honeywell UOP, a US-based subsidiary of Honeywell International, has agreed to pay more than $160 million to resolve parallel bribery investigations by criminal and civil authorities in the United States and Brazil stemming from bribe payments offered to a high-ranking official at Petrobras, Brazil's state-owned oil company.

Between 2010 and 2014, Honeywell UOP conspired to offer an approximately $4 million bribe to a then-high-ranking Petrobras executive in connection with Honeywell UOP's efforts to win an approximately $425 million contract from Petrobras to design and build the 'Premium' oil refinery.

In exchange for the bribe, and after obtaining business advantages including inside information and secret assistance from the Petrobras executive, Honeywell UOP won the contract and earned approximately $105.5 million in profits from the from what the US Department of Justice described as 'corruptly obtained business'.

The DoJ reports that Honeywell 'promptly engaged in extensive remedial measures' terminating and disciplining employees involved in the misconduct and strengthening its compliance program. As a result, the criminal penalty calculated under the US Sentencing Guidelines reflects a 25% reduction off the bottom of the applicable guidelines fine range. More on the Justice Department's FCPA enforcement efforts here.

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