Top 10 Trends Driving the Oil and Gas Industry in 2021

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Initiatives: Energy and Utilities Digital Transformation and Innovation

In response to COVID-19 and rising disruption from decarbonization, oil and gas companies are adopting a broader spectrum of business strategies. Oil and gas CIOs can use this research to understand key trends and keep IT capabilities in sync with evolving business operating models.

Overview

Opportunities

- The unique stresses of 2020 have elevated three business imperatives for 2021: optimizing business performance, creating new capabilities and strengthening technology foundations. The 10 trends in this report are working individually and interactively to drive progress that is reforming the oil and gas industry.

- Some oil and gas companies have slowed their digital programs. However, most are expanding them to further optimize important existing capabilities (such as automation) and create new capabilities (such as large-scale digital twin models). Some are building new business models (such as energy diversification). CIOs need to adapt IT capabilities, methods and costs to stay optimally in sync with shifting business priorities.

- IT performed very well during the pandemic. Business leaders now have much greater trust and respect for IT. CIOs need to leverage this new level of influence and strengthen IT’s role in further optimizing business performance.

Recommendations

CIOs responsible for energy and utilities digital transformation and innovation should:

- Elevate and unify business ambitions for digital by using the trends and insight from this research to inform business executives and make better recovery and renewal plans.

- Deeply embed IT leaders in digital strategy and design by leveraging the credibility that CIO’s gained during the COVID-19 response to tightly integrate IT planning with business strategy development.
What You Need to Know

The year 2020 will be recorded as one of the most unfavorably disruptive in the history of the oil and gas industry. As companies continue to stabilize their recovery and begin to move forward, the actions of oil and gas CIOs will be focused on three strategic business imperatives:

- **Optimize business performance.** According to Gartner's 2021 CIO Survey, 87% of oil and gas CIOs expect IT budgets to stay the same or grow in 2021, with an overall average increase of 2.5%. Most of the increase will reenergize digital optimization strategies that were attenuated by cash-flow constraints in 2020. That said, the situation in 2021 is more nuanced than before. Within each business domain (e.g., upstream, midstream and downstream), there is greater diversity in business strategies. Some are accelerating their digital programs and others are powering them down.

- **Create new business capabilities.** All told, 71% of oil and gas business leaders are asking their CIOs for more strategic insight and action (per Gartner’s 2021 CIO Survey). Technology and business requirements continue to converge. It is harder than ever to separate a technology investment from the impact it has on business performance. In addition, nearly all CIOs gained respect from their business peers due to their stellar performance in creating a remote work environment following COVID-19 lockdowns. Consequently, more CIOs are being invited to advise how best to use digital technologies to create new business capabilities.

- **Strengthen the technology foundation.** A total of 85% of oil and gas CIOs want to create a change-enabling technology platform and 79% want to enhance the culture of IT (per Gartner’s 2021 CIO Survey). All oil and gas companies continue to struggle with nonintegrated data and substantial unresolved technology debt (aka, obsolete technologies and solutions). Consequently, operating costs are too high and change is too slow. Most CIOs already understand the sort of technology architecture their company needs and they are committed to drive their entire computing estate (including domains currently outside IT) into modernity (see Figure 1).
Figure 1 shows the top 10 trends for 2021 and their relationship to the three business imperatives. The trends can be viewed as currents that will reshape CIO actions against each of the three imperatives. Each of these trends stands on their own, with their own value opportunities, implementation requirements and risk profiles. However, as Figure 1 illustrates, they also interact with each other and produce combinatorial impacts on each of the three strategic business imperatives. In 2021, CIOs must stay ahead of both the direct and combinatorial implications of trends (see Table 1).
Enterprise Capabilities Diverge as New Business Strategies Emerge

Description:
It is time to take a fresh look at the capabilities needed to successfully implement the business strategies of oil and gas companies. In prior years, companies focused their optimization priorities on best practices already proven by firms within their business domain (e.g., upstream, midstream and downstream). This approach is no longer sufficient as, over the last half decade, business strategies within each domain have broadened:

- Upstream companies are exploring diversified energy strategies, such as offshore wind and hydrogen.
- Midstream companies are exploring energy storage and trading strategies in addition to transportation.
- Refining companies are exploring biofuel and bioplastics production as well as deepening their presence in regional petrochemicals products.
- Marketing companies are exploring electric vehicle charging and new service-based offerings.

As individual business strategies become more nuanced and differentiated, companies are building novel enterprise capabilities to successfully implement them.
Why Trending:

It is often assumed that oil and gas companies only change their business strategies in response to external forces, such as market booms and busts. While that is partly true, over the past five years they have become aware of the waste embedded in traditional operations. Additionally, oil and gas companies have become internally motivated to discover better operating practices enabled by technologies such as the industrial Internet of Things (IoT), artificial intelligence (AI), remote and autonomous operations and others. As some companies anticipate reducing their cash operating costs 15%-25% over the next five years, internally motivated improvements in business performance made today will likely lead to tougher external cost competition in a few years.

Societal concerns over greenhouse gas emissions are rising. Tightening greenhouse gas (GHG) regulations are increasing the cost of oil and gas operations. Looming carbon taxes and other forms of government fees will likely dampen oil and gas profits. These pressures are diminishing the value of future oil and gas investment. In 2020 alone, over $145 billion of oil and gas asset writedowns occurred in the U.S. and Europe, roughly equivalent to 10% of market value. ¹

At the same time, technology advances in green energy are presenting attractive new business opportunities. Oil and gas companies are discovering that their traditional strengths give them an advantage in some green markets. For example, expertise in offshore platform design and operations has provided Equinor (and partner BP) with sufficient advantage to win the Empire and Beacon offshore wind project in the eastern U.S. ²

And the global pandemic seems to be accelerating the pace of energy transition. In a recent online poll by BP, more than 60% of respondents expected COVID-19-related disruption to accelerate the energy transition. ³

Implications:

Oil and gas companies require new enterprise-level capabilities to successfully pivot their business strategies. However, the nature and timing of new capabilities will vary among firms and must be customized for the nuances of their revised business strategies. Examples include:

- For efficiency-based strategies, the goal is the capability to fully automate operations across the firm and beyond into customer supply chain environments. Technical debt and organizational silos are making it difficult for companies to achieve this goal. However, novel approaches that build the capabilities and market at the same time — such as the Blockchain for Energy consortium in the U.S. and VAKT in Europe — provide real-world examples that these goals can indeed be achieved.

- For margin maximization strategies, the goal is the capability to build composite digital twins of major physical assets (such as upstream resource plays and entire refining systems). For most, developing such capabilities is still years away. But projects such as Abu Dhabi National Oil Company’s (ADNOC’s) Panorama collaboration center and Shell’s digital twin refinery project in Singapore demonstrate that sustained development of large-scale digital twins can reliably deliver solid business impact.
For premium-chasing strategies, the goal is the capability to understand global customers across multiple forms of energy (e.g., liquid fuels, gas, electric, hydrogen and other) and develop new products and services that capture premium margins. The passions of some customer segments (e.g., climate warriors) and the practical risk management needs of others (e.g., carbon management and mitigation across complex global supply chains) offer unprecedented opportunities for oil and gas. Companies that develop new business capabilities to create and evolve customer-centric premium products and services while continuing to improve traditional producer-centric commodity products at scale will have better business options.

Actions:

Oil and gas CIOs seeking to build essential new enterprise capabilities should:

- Create alignment for the IT requirements among the many teams developing new digital strategies by creating, sharing and continuously updating a corporate narrative that describe the result of their company's digital strategy. Use the narrative to stay focused on the strategic objective and avoid suboptimization.

- Accelerate the journey toward fully automated and autonomous operations by taking leadership for the design of a consolidated enterprise architecture built to enable automation. Establish collaborative governance (including participation by technology groups outside IT) for the design and a roadmap for its implementation.

- Facilitate business innovation by incorporating composable architecture principles in the design of the new enterprise architecture.

Accelerating Digital Innovation Is Now Table Stakes for CIOs

Description:
According to Gartner's 2021 CIO Survey, 97% of oil and gas companies have defined their digital investment programs and have a clear line of sight to the substantial business value they will generate from 2021 to 2025. The harsh financial realities experienced in early 2020 created significant management stress as companies were forced to attenuate their digital programs and defer their benefits. As discretionary cash flows improve and balance sheets strengthen in 2021, CIOs and IT leaders will be called upon to reset their digital programs and accelerate delivery of their benefits.

Why Trending:
Digital innovation is a key component of oil and gas strategies to recover from COVID-19, deliver substantial business impact by 2025 and prepare for material energy transition by 2030. Not surprisingly, the 2021 CIO Survey found that 87% of CIOs expect their digital programs to increase or stay the same in 2021. Why? Because these programs have been very rigorously developed and there is very high confidence in the large business value they will deliver. Accenture’s digital survey in early 2020 highlighted that 47% of respondents reported that the greatest risk from underinvestment in digital was loss of competitive advantage. 4
This commitment to digital innovation is a relatively new priority for oil and gas companies, rising from an insignificance in 2014 to the third-highest priority by 2019 (see 2019 CIO Agenda: Oil and Gas Industry Insights). The starting point for digital innovation was not ideal as it was overloaded with technical debt and a dearth of appropriate management practices. Despite the challenges, oil and gas companies are making strong progress. In 2019, less than one in five companies had matured to the point that they were scaling/refining their digital ambitions. But despite the turbulence and challenges, that number has risen to four in five in 2021 (see 2019 CIO Survey: CIOs Have Awoken to the Importance of AI) and (2021 CIO Survey: Drive Product Revenue by Responding to Changing Automotive CIO Priorities).

The disruptions of 2020 introduced new roadblocks that will further complicate rapid progress of digital objectives. Projects were shut down, teams disbanded, and with over 100,000 layoffs, the capabilities of oil and gas operators and their vendors were seriously degraded. It will take more than a return of funding to get digital innovation back on track.

Not all consequences of 2020 were negative. Virtually all CIOs gained respect and influence as they were able to migrate their workforces into a remote work environment unexpectedly quickly, with relatively modest levels of disruption. This has given most CIOs a greater voice in defining how digital programs will be implemented in 2021. In addition, the financial duress of 2020 paused implementation and provided extra time to evaluate, leading to more consolidation and faster progress (once reenergized).

**Implications:**
In 2021, business leaders expect CIOs and IT leaders to take on greater responsibilities for accelerating the pace of digital innovation. All told, 71% of oil and gas respondents to Gartner’s 2021 CIO survey reported that business leaders were asking IT for high-value and more strategic roles. And oil and gas CIOs are responding: 85% have assumed responsibility to create a change-enabling technical platform and 79% are working to build a stronger change leadership culture in IT (see 2021 CIO Survey: Drive Product Revenue by Responding to Changing Automotive CIO Priorities). Change leadership addresses the subjective factors of large-scale change (i.e., how people feel and what their experience is like). It is a natural complement for IT’s natural role in leading change management (i.e., training the workforce to effectively use a new system).

**Actions:**
Oil and gas CIOs tackling barriers to rapid change should:

- Strengthen the change leadership capabilities of all IT leaders by assigning personal development goals that build change competencies. Define key performance indicators and get 360-degree feedback to monitor progress.
Digital Twins Drive Transparency and Automation

Description:
Adoption of digital twins is growing rapidly across most oil and gas companies. However, the term covers a wide spectrum of technologies and use cases, and suffers from inconsistent definitions. Gartner defines a digital twin as a virtual model of a physical thing, person or process that accurately describes current operations. It may also predict future performance through simulations for a variety of scenarios for the purpose of optimizing business outcomes. Digital twins can deliver multiple forms of value that flow from the high degree of integration they create among internal systems, human activity and external business ecosystems. This integration unlocks simultaneous improvements in three different value streams: economic efficiency, operational reliability and organizational adaptability.

Why Trending:
Gartner’s 2021 CIO Survey indicates that 23% of oil and gas companies have already deployed a digital twin and that nearly 80% expect to deploy them by 2023. The growth of digital twin deployment is extensive. The scope is expanding (i.e., what is being modeled) as evidenced by ADNOC’s Panorama – a massive digital twin that models everything from the flows of individual oil wells to the of individual product cargoes coming out of refineries. At the same time, scale is increasing (i.e., the extent of physical assets/operations described by the model) as evidenced by Shell’s digital twin of the Pulau Bukom refinery in Singapore. Its objective is to improve operational efficiency, prevent downtime, reduce maintenance and maintenance costs, and allow for more effective collaboration between experts and operators.  

Digital twins are trending because of their capacity to improve the performance of business assets. The examples above highlight leading projects for highly advanced digital twin models. However, tremendous value also comes from a large number of simpler and more limited digital twins. For example, to improve maintenance practices, a digital twin model can ingest data from operational technology (OT) systems, process that data with other information and provide a simple semantic interpretation of current operating conditions. This can be done for a single piece of equipment (such as a gas compressor) or a small physical plant (such as a hydrogen plant).
Implications:

IT has a central and critical role working with the operations and business teams to drive business value from digital twin development and deployment.

As a hub of data integration, digital twins straddle the boundaries between traditional OT and IT. To successfully implement and sustain value from digital twins in their enterprises, CIOs must have a clear understanding of the nature and purpose of the digital twins being implemented in their organization. CIOs have a key role in ensuring that all stakeholders share a common understanding and language with which to frame investment and deployment decisions.

Digital twins of different types from different providers are proliferating. Increasingly, the individual pieces of equipment in new assets will come from the OEM with its own digital twins. Electronic Product Code (EPC) contractors that deliver completed assets to owner-operators are already providing as-built visualization twins as deliverables alongside the physical asset and its traditional engineering information. Vendors of modeling, simulation and visualization software are recognizing (or claiming to offer) their solutions as digital twins in many variants.

Oil and gas assets are complex physical systems. Creating a digital twin for large-scale asset visualization and optimization means undertaking a complex project of integrating smaller-scale digital twins of different types from different sources. Once built, the digital twins may persist for the life of the asset they model and must be updated as the physical asset changes. In addition, as changes are made to the systems and data sources feeding the model, appropriate updates to the model design must also be made to maintain reliability.

Coordination is required across organization siloes. Competing or conflicting understanding of the purpose of the twin, or of its type, will hamper implementation efforts and may ultimately undermine the value. CIOs can add value by ensuring that all stakeholders understand which types of twins they are dealing with and share a common and agreed understanding of the purpose of the twin they are building.

Actions:

CIOs seeking to accelerate business value from digital twins should:

- Maximize the value of digital twin investments by managing them as enterprise business assets that must meet business unit performance, financial and other metrics.
- Design modular architecture and integration approaches that reduce costs and increase reliability by enabling digital twins to be reused over time and shared among multiple business units.
- Prepare for a complex digital twins ecosystem that delivers real-world business value by engaging and rating multiple technology providers and other partners.
Comprehensive Engineering Creates Intelligent Assets

Description:
To date, digital technology initiatives for oil and gas asset optimization have tended to deploy one or two key technologies, or concentrated on selected important assets. Digital technologies, such as smart sensors and digital twins, are generally retrofitted, even to new assets, rather than being designed in from the outset.

In addition, oil and gas companies approach physical and digital asset design differently. Physical assets are comprehensively designed and constructed for a purpose and updated with care, ensuring new elements work effectively with existing elements. Digital assets, such as digital twins, AI models and IoT platforms, often evolve incrementally with more ad hoc approaches to the interactions between new and existing digital components.

As companies tackle both challenges, new assets will increasingly be designed to integrate and support digital technologies from the drawing board. Additionally, digital assets will be engineered in ways closer to physical assets, creating more coherent digital physical assets with greater capability and maintainability.

Why Trending:
To improve outcomes, such as production efficiency, uptime and yield, oil and gas companies have been supplementing traditional monitoring and control systems on existing assets with additional sensors, new (often cloud-based) data aggregation platforms, advanced analytics and AI. Cost-effective, on-site network connectivity, edge computing and the cloud are also being deployed to improve operational intelligence and optimization. Gartner's 2021 CIO Survey shows that a majority of oil and gas companies plan to invest more in key digital technologies that deliver asset performance. Significantly, around 50% or more of companies plan increased investment in analytics, AI/machine learning (ML), automation, IoT and cloud.

However, many digital initiatives focus on using a small set of selected technology types and deploying these on key assets rather than across the whole asset base. This is also true within single assets where, for example, sensors are added to provide additional data for maintenance without the data being incorporated into new operating practices.

While many OEM equipment companies, and process and automation system providers now offer connected smart equipment and IoT platforms, these technologies have been slow to work their way into newly built assets. The complexity inherent in integrating disparate modules constructed by varied subcontractors, along with slow standards development, legacy history, and safety and cost concerns drive operators to be conservative in their specifications for asset control and monitoring.

However, some companies have tackled these barriers and a number of assets commissioned in recent years have been designed incorporating digital solutions from the outset.
In parallel, companies approach the creation of digital asset designs, often as digital twins, in a far less comprehensive and holistic manner. Physical assets in oil and gas start as a comprehensively engineered system providing a defined set of capabilities. Over time, new capabilities are added through engineering modifications controlled by central engineering, considering the whole asset system as needed. In contrast, the historic practice is for digital twins to be engineered in multiple locations that must be integrated after the fact and over time. Some companies are beginning to treat digital engineering in a similar way to physical engineering. Applying this comprehensive approach to digital as well as asset design will facilitate the fusing of digital and physical technologies into a coherent system for enhancing overall asset performance.

Implications:

Many oil and gas assets have been in use for a long time. The monitoring and control systems that production installations, pipeline networks, liquefied natural gas (LNG) plants or refineries were originally built with monitoring and control systems based on supervisory control and data acquisition (SCADA) architectures. Pragmatically, many performance improvement initiatives deploying advanced analytics or AI/ML took time series data in SCADA data historians as their starting point. Digital technologies have been used to augment these architectures and fill gaps in required data, rather than replace them.

For new assets, the complexity inherent in integrating disparate modules constructed by varied subcontractors, along with slow standards development, legacy history, and safety and cost concerns drive operators to be conservative in their specifications for asset control and monitoring. However, some companies have overcome these barriers and a number of assets commissioned in recent years have been designed incorporating digital solutions from the outset.

Many companies have recognized the improved operational insights that can be generated by combining data from operational, back office and even external systems. More operators will demand that assets are engineered with these capabilities built in, exploiting more of these capabilities that vendors and contractors provide.

Actions:

Oil and gas CIOs seeking to create intelligent operations capabilities should:

- Set high-level goals for digitalization, such as the creation of intelligent assets. Build portfolios of linked digital initiatives that bring together complementary technologies in holistic approaches to build toward these goals.
- Define digital initiatives by the outcomes they achieve rather than the technologies they involve.
- Work with business leaders to identify use cases and data requirements that meet business goals applicable to the entire asset portfolio.
- To facilitate and drive technology integration, and maximize opportunities that align with broad business objectives, create a roadmap of how digital technologies and digital initiatives will interact.
with augment legacy technologies and enterprise systems across IT and OT.

Key Vendor Partnerships Define Enterprise Platforms

Description:
The concept of an enterprise platform is difficult to define in specific terms. It exists due to the need to discuss the design, management and maintenance of the collection of digital technologies that define an organization's core business capabilities. Until recently, oil and gas companies have preferred to minimize the notion of an enterprise platform, preferring instead to focus on integrating solutions for individual business units or functions (such as upstream, downstream, operations, HR, etc.).

However, the recent digital revolution has made it obvious that modern oil and gas companies need to provide unprecedented, enterprisewide access to their data. And today's top business objective for digital — which is to optimize business performance — now makes it clear that greater enterprise-level integration is needed for business efficiency, innovation, reliability and agility. Initially, large software vendors fought vigorously to become the central enterprise platform that integrated all others. However, this approach is giving way to an alternative that relies on key vendors grouped into a small number of integrated hubs, each supporting one domain of work (such as finance, industrial IoT, geoscience, etc.). In this model, the enterprise platform exists as a collaborative partnership between the enterprise and these key vendors.

Why Trending:
Gartner's 2021 CIO Survey reports that 97% of oil and gas companies now have digital strategies. Additionally, 68% of survey respondents report that their company is seeking more strategic benefit from their IT investments. And respondents cite AI/ML/analytics and the industrial IoT as the top game-changing technologies. The top objectives for digital investments include improving cost-efficiency through automation, increasing human productivity through simplified digital work environments, sharpening business outcomes by better data transparency and improving decision making through analytics and modeling. All these factors have increased expectations for creating better enterprise-level business capabilities, which in turn raises the need to rethink the strategy for an enterprise platform. A total of 85% of survey respondents cite the need for CIOs to provide a technical platform that enables the company to navigate change.

To meet this challenge, CIOs are changing their relationship with key technology vendors. The traditional approach is focused on minimizing the cost of vendor solutions by means of rigorous procurement processes aimed at meeting a rigidly defined set of technical capabilities. While that approach remains in place, CIOs are also developing more open partnership relationships with a small number of key vendors. The distinguishing characteristic of these vendors is their ability to offer an integrated suite of technologies strong enough to serve as a subplatform for one domain hub within their emerging enterprise platform. Chevron's partnership with Microsoft and Schlumberger to accelerate digital transformation is one example of partnership with industry technology and services providers.
Another large-scale example is ADNOC's 10-year partnership with Honeywell to develop its extraordinary Panorama platform for operations optimization. At smaller scale, but still highly significant, is BP's partnership with startup venture BeyondLimits, which includes investment funding. And such partnerships are no longer limited to megaplayers, as evidenced by DCP Midstream's award-winning tech venture group that is making similar investments in Silicon Valley startups Ventures.

Implications:
Strategic partners with key external vendors demand a more nuanced commercial relationship with these firms. Increasing cost competitiveness among oil and gas companies means that competitive terms are essential for large-scale technology deployments. At the same time, mutually attractive pathways must be opened to allow collaborative innovation with these vendors and equitable sharing of the benefits flowing from such collaboration. Companies seeking to expand such partnerships will need to modify their procurement practices that were originally designed to shift power to the buyer.

In addition, oil and gas companies need new internal mechanisms for governing their relationships with these key vendors. Traditionally, relationships with IT vendors, such as Microsoft, are managed by CIOs; whereas relationships with engineering vendors, such as Schlumberger, are managed by business units.

Relationships with process control vendors, such as Honeywell, are typically managed by asset operators with underdeveloped coordination across the enterprise.

In addition, most companies that make investments in tech startups still struggle to fully leverage those investments across the entire business landscape.

It is important to recognize that these partnerships are new for oil and gas companies. Managing each partnership individually can shift commercial power too far to the vendor. However, creating strong central governance over the relationships will weaken their capacity to provide specific value to business units. CIOs need to have a strong, but appropriately balanced, voice in managing these partnerships.

Actions:
Oil and gas CIOs seeking to optimize vendor partnerships for their enterprise platform should:

- Lay the groundwork for increased partnership-based R&D and innovation by modifying IT procurement practices to accommodate a broader spectrum of commercial relationships.
- Prepare for ongoing innovation of the enterprise platform by adopting a composable architecture model and training IT leaders to develop both strategic and tactical value plans for key vendors.
- Proactively engage other business leaders to develop and enhance the governance and value delivery model for managing key enterprise platform vendors.
Reliance on AI Becomes More Widespread and Less Visible

Description:
AI techniques enable an increasingly wide variety of extended computing capabilities and can enhance the business value of a wide range of software systems. AI techniques delivering value in businesses include natural language processing, computer vision, knowledge extraction and exploitation, automation, and asset and business optimization based on enhanced prediction and simulation. Many software vendors are adding AI-enabled capabilities to their solutions. In parallel, AI capabilities are being built into an ever-greater range of hardware, devices and computer processors. Paradoxically, as it becomes embedded in more and more of these systems, it will be less obvious to end users.

AI/ML are gaining acceptance quickly in the oil and gas industry. Today, they are typically operationalized mostly for specific use cases or particular processes (see AI Operationalization in Energy and Utilities). Increasing incorporation in more and more software applications to drive productivity, the spread of AI development platforms and growing trust will continue to accelerate adoption. AI is on course to become commonplace in a whole host of systems and processes in oil and gas and less visible as an independent technology.

Why Trending:
Gartner CIO surveys show the percentage of oil and gas companies that had deployed AI/ML more than doubling from 13% to 32% between 2018 and 2020. Gartner's 2021 CIO Survey confirms that AI/ML are the top technology seen as game changing for the industry. The same survey shows some 50% of companies plan to increase their investment in AI/ML in 2021. Use cases in the industry are now many and varied, including artificial lift optimization use cases, geoscience interpretation, site safety monitoring, remotely operated vehicle (ROV) autonomy, virtual assistants and process automation.

In many industries, the knowledge and experience required to extract value from AI has been developing rapidly. Vendors, service providers and system integrators are embedding AI into many software classes and generating packaged industry and use-case focused, out-of-the-box solutions. Application developers can tackle some projects with easy-to-use application platforms.

In parallel, AI capabilities are being built into microprocessors and embedded into devices and hardware. Consumers, for example, can buy smart domestic devices, such as light bulbs, shower heads, plug sockets and home heating systems, which incorporate AI. Researchers and providers recognize the weaknesses of current prevalent AI techniques and are addressing them. Increasing use of newer hybrid or composite techniques will accelerate business value.

In oil and gas, vendors are adding AI capabilities to business systems and applications in varied workflow areas, including geoscience interpretation, drilling, asset performance management and production optimization. The business value of AI to oil and gas is growing rapidly. At the same time, the cost of implementation is diminishing.
Growing trust in AI across the industry, fostered in part by people's experience with consumer use, will continue to lower barriers to acceptance — particularly where the AI is not obvious or visible in the systems being used.

Implications:
Cloud-based data integration and powerful toolsets from technology services companies, such as Microsoft and Amazon, and solutions providers like C3.ai and others, are making building and deploying AI easier. However, not all companies have yet adopted these. For some, and for more complex use cases, the need for large datasets, in-depth data science expertise and subject matter expertise mean that building accurate AI models for oil and gas can still take time, effort and skill. Leading oil and gas companies have adopted AI development platforms, but AI solutions development and deployment are the remit of specialist projects or data science teams in many companies. Many prefer to buy AI capability either packaged as features in off-the-shelf software or by partnering with specialist providers.

AI techniques continue to develop. Several trends in AI technology and approaches promise to increase AI accuracy and deployment speed and reduce data science effort. Techniques such as hybrid (or composite) AI, self-supervised learning and adaptive learning address some of the drawbacks of current operationalized AI methods.

AI that is more accurate, faster to deploy and easier to maintain will add momentum to AI adoption. More flexible and adjustable AI models will become part of almost every class of software. Added to industrial devices — with the appropriate security built in — this will enable new capabilities in asset operation and optimization. It will increase the ability of plants and assets to diagnose their own condition, manage their operation and predict their own performance. Embedded in devices or in commercial software, AI need not explicitly include humans in the decision-making loop and may not be obvious to end users.

This will mean AI capabilities spreading widely but also less visibly in oil and gas assets, enterprise tools and business workflows. Reliance on AI — knowingly and unknowingly — will increase as more and more decision support and decision making in oil and gas operations and in business involve AI input.

CIOs will see challenges in keeping track of the spread of AI in important systems. Addressing security issues and AI model governance will become critical activities. CIOs will need to ensure that valid data is used for AI development and AI outcomes are explainable where needed.

Actions:
Oil and gas CIOs seeking to embed AI into workflows should:

- Form teams of IT and business personnel to evaluate opportunities for AI and to maintain a roadmap of AI deployment in self-developed tools, vendor software and AI development platforms
- Keep on top of AI developments and evaluate and roadmap the development of AI capabilities in critical business and operations systems.
Description:
The opportunities to improve operational efficiency and optimize assets using digital technologies are now well-understood in the oil and gas industry. Many companies have been pursuing these goals for some time. More recently, companies are extending the scope of their ambitions to encompass work processes and personnel productivity. Some companies are beginning to approach work optimization in the same spirit they pursue optimization of asset performance.

Advances in collaboration tools, augmented reality, field connectivity and wearable trackers offer the potential for more continuous and real-time management, optimization of work and locational intelligence. From a confusing landscape of expanding niche solutions and self-assembled pathways, more integrated and coherent platforms for work and risk control and optimization are emerging, paving the way for consolidated real-time productivity management of connected workers.

Why Trending:
Oil and gas companies will be operating as leaner organizations in the years ahead. Through the continuing COVID-19 pandemic, business growth has been stifled by unforeseen and dramatically unfavorable market conditions. Across the industry, companies have sold assets, reduced capital and operating expenditure and shed workers. Operations and IT typically have fewer resources — human and financial — than in the recent past. Savvy oil and gas leaders have realized the opportunity to harness digital technologies in more coherent ways to control and orchestrate work, manage risk and improve productivity in difficult conditions.

Work on oil and gas assets is typically managed with closely governed but distinct processes, including job identification and scheduling, work permitting, completion signoff, worker certification, knowledge capture and others. Companies must also assess and manage risk before, during and after work. They have (with added impetus during the COVID-19 pandemic) increasingly undertaken remote support for work in progress in the field.

Remote operations are well-established in the industry; however, oil and gas companies are also increasing adoption of technologies such as augmented reality and machine vision, along with cost-effective wearable location devices and more widespread Wi-Fi and internet connectivity on sites. Some oil and gas companies have already operationalized real-time, on-site worker tracking and analysis to enhance safety and improve productivity. Some vendors of point solutions have recognized the potential of platform solutions and have begun expanding and redesigning their products, widening their workflow coverage in the process.

Implications:
In many companies, these functions rely on narrowly scoped point solutions, generic collaboration tools, spreadsheets and paper-based workflows. In an effort to improve operational transparency and
efficiency, some operators have assembled systems supporting core work management and risk functions by integrating off-the-shelf and custom solutions. However, these have tended to be custom solutions designed and deployed around specific assets. They can be complex, hard to build and difficult to maintain.

Forward-looking vendors of many tools have progressed with platform-based solutions designed to integrate better across multiple functions and capture greater workflow coverage. However, these are still limited in scope and the landscape of solutions offerings is now varied, overlapping and confusing.

Compared to asset optimization, work optimization is an underexploited opportunity to improve cost and operational efficiency for many oil and gas companies. The ability to seamlessly support and manage the full range of work-related workflows in a single platform offers the prospect of significant productivity, efficiency and safety improvement. Companies should accelerate work productivity improvement with the goal of achieving more integrated and holistic platform-inspired work management systems architecture. Operator ambition and vendor offerings are moving in this direction, but the plethora of choice and confusing vendor landscape, along with a disjointed legacy tool environment, are challenges that must be addressed to make progress.

Actions:

Oil and gas CIOs seeking to expand the use of connected field workers should:

- Identify and fix bottlenecks or gaps in current processes by leveraging already available or off-the-shelf solutions.
- Clarify and drive desired outcomes by establishing a goal of seamless and integrated connected worker support and management across all related workflows.
- Create the roadmap by building out from the systems in place that offer the greatest range of functionality today and whose vendors have a strong roadmap aligned to this goal.

Roadmaps to Avoid Carbon Management Chaos

Description:

Oil and gas companies are under intense and increasing pressure from governments, international bodies, regulatory agencies and environmental advocacy organizations — and, crucially, from their own customers — to adopt sustainable environmental practices across the value chain. Meeting these demands requires fundamental changes to energy companies’ operating models and to the technologies that support them.

Over the coming decade, individual companies will take different actions depending upon the assets they operate and the specific nature of regulations within their theater of operations. In the near-term,
however, oil and gas companies are likely to focus on a common priority: The need to reduce GHG emissions that are now universally recognized as the most important contributor to climate change. To succeed, new systems will be required to monitor, assess, manage and monetize carbon emissions.

**Why Trending:**
Growing greenhouse gas regulations present great threat and potential opportunity to the oil and gas industry. The industry has begun responding. Every year, more oil and gas companies make explicit commitments about their environmental performance. These typically come in the form of a net-zero pledge: a commitment to reach a point at which the amount of greenhouse gas the company produces equals the amount it removes from the atmosphere. An increasing number of companies have set goals of reaching net zero between 2030 and 2050, and some are making significant investments in solar and wind energy generation to that end. While the net-zero milestone is common, other levels of ambition do exist. In fact, there is a wide range in the intensity of goals for environmental performance as well as in the timelines for achieving those goals. (Several large European companies have already set goals far more ambitious than net zero.)

**Implications:**
CIOs need to provide appropriate IT infrastructure, services and talent to meet emerging carbon requirements. However, business opportunities for individual firms will change suddenly as new, game-changing energy technologies are developed and regulations evolve in their operating regions.

Companies such as BP, Equinor, Total, Shell and Repsol have already established clear, strong ambitions. While such companies anticipate attractive global expansion opportunities, others may anticipate significant hardship and must dramatically consolidate and minimize costs. CIOs need to prepare for a turbulent period of energy disruption that will dominate IT strategy for many years. This will require two fundamental changes.

First, new IT systems will be required to monitor, manage and monetize greenhouse gas emissions. There is a dearth of comprehensive solutions in this space and key IT vendors, such as ERP, analytics and process control vendors, are scrambling to lock companies into their platform. With this in mind, IT leaders need to investigate potential vendors and external partners and determine those with the most to offer. Beginning this process early should be viewed as experimental R&D that minimizes risk committing IT resources to research that may not ultimately provide value. The goal at this early stage is to acquire specific learning related to high-probability future requirements to meet the clear goal of better carbon management.

In addition, CIOs must improve IT’s ability to adopt agile strategies and planning. In oil and gas, IT planning typically follows calendar-based processes. With some variation, these processes explore future projects early each year. These projects are then consolidated in a proposed plan and budget during the middle of the year and optimized in an iterative fashion until a final budget is determined late in the year. This process will be inadequate over the next few years because it requires certainty, produces roadmaps and strategies that quickly go out-of-date and is slow to react as conditions change.
To avoid chaos as carbon management ambitions evolve, CIOs need more iterative IT strategy methodologies. These methodologies move quicker than traditional IT planning because they focus on creating a minimum viable strategy (that is, a strategy that simply identifies what the enterprise needs to do first or next). Continuous iterations of strategy are developed over time to include long-term actions as the enterprise develops a better understanding of the changes within its business context.

Actions:

Oil and gas CIOs seeking to avoid carbon management chaos should:

- Prepare to implement new systems to monitor, track, report and control GHG emissions. Start due diligence early because the market for these solutions is immature and implementations will be complicated.
- Prepare IT to undertake the amount and complexity of work required to enable higher levels of environmental maturity by proactively investigating new systems and enhancing IT’s agility.
- Increase IT’s ability to respond to sudden changes in business strategy by adopting adaptive planning methodologies.

Facing the Challenge of Attracting Fresh Talent

Description:
Both because of long-term trends and the aftermath of the disruptions of 2020, oil and gas companies face a future of increasing difficulty in recruiting and retaining top-quality talent. The increasingly negative perception of the industry in some societies and a shrinking pool of talent from which to draw will make competition for that talent more intense. To succeed, companies must reposition themselves as attractive and rewarding places to work in a changing societal and economic context.

Why Trending:
The oil and gas industry has a long history of recruiting promising talent and developing world-class skills, particularly in (though not limited to) science- and engineering-related disciplines. The engineering achievement of the industry in designing, installing and operating complex heavy assets, often in remote and hazardous locations, is immense. These achievements were made by skilled and expert human resources. Oil and gas provided the energy to power civilization through much of the 20th century and into the 21st. For much of this history, some international and national oil and gas companies have been among the largest and most influential companies in the world. As a career, the industry offered much; not least (for many) good pay and long-term prospects. Oil and gas has been a premium employer.

This has now changed radically. Two huge contractions have shaken the industry in less than six years. Oversupplied crude markets lead to a price collapse during 2014-16, which resulted in nearly 200,000 layoffs in the U.S. alone. Employment numbers began to pick up in 2019.
Then again in 2020, the unprecedented drop in demand during the COVID-19 pandemic led to sharp declines in operating cash flows, and in the U.S., eliminated 107,000 jobs between March and August.\textsuperscript{5} Not all countries have been so severely affected; however, the image of the industry as a rewarding one in which to build a career has been severely dented.

Future economic recovery that returns the sector to growth could ameliorate this, except that the public perception of the industry is increasingly negative for more profound reasons. Concern about the environment and the impact of climate change is rising in many places. Beliefs about the causes and solutions to the challenge of global warming are often passionately held by individuals. As a direct and indirect contributor of greenhouse gas, the industry is now widely seen as a major part of the problem. Unless this perception is reversed, the oil and gas industry risks becoming a pariah industry for increasingly large groups of people and in particular with the young.

Finally — and with direct implications for IT — oil and gas companies have largely been eclipsed in size and influence by, among others, the rise of the tech giants. Though not entirely un tarnished themselves, tech companies are more widely held to be the companies of the future. In recruiting high-quality digital natives, oil and gas companies face an additional challenge of an unflattering comparison with these relatively newer and future-facing organizations.

**Implications:**

The oil and gas industry will continue to need world-class talent and skills, since even under aggressive energy transition scenarios, hydrocarbons will remain a significant part of the energy mix. The “great crew change” of retiring older workers predicted for decades has so far not materialized. Additionally, the industry contraction has reduced the number of workers needed. Some may conclude that talent access won’t be a problem. But for the reasons outlined in this trend, companies settled expectations of their ability to access and keep the talent they need are likely to be increasingly misplaced. In highly developed nations at least, the age profile of oil and gas workers is increasing. For example, Oil and Gas U.K. data shows an increase in median age, year on year, in offshore workers; but even more pertinent is that less than 10% of this workforce is under 30 — down from over 18% in 2010.\textsuperscript{14}

In addition, capital expenditure across the industry has been dramatically reduced, in 2015 and in 2020. Current low investment levels could plausibly lead to supply constraint, putting upward pressure on prices and driving new investment in future. In any event, a relative upswing is likely as global economic activity normalizes when the COVID-19 pandemic eventually subsides. Much experience and expertise has left companies and will soon be inaccessible. Oil and gas companies will undoubtedly be leaner than in the past but will nevertheless continue to require world-class talent to replace lost expertise and realize projects effectively. Attracting and upskilling such talent will be no less important than in the heyday of the industry during the last century.

The profile of essential skills will also shift. Leaner companies will depend more heavily on digital technology to optimize business and operations and digital skills will become increasingly essential. The oil and gas industry has only recently needed to nurture widespread digital skills. Other industries are much more attractive for those with these skill sets. Overall, fulfilling these evolving talent requirements
is set to become even more challenging. Oil and gas companies face a future in which they must tackle societal perceptions and make themselves attractive to new workers in an employment marketplace where the industry is no longer a premium, or even desirable, employer.

**Actions:**

Oil and gas CIOs seeking to get attract and retain top talent should:

- Strive to do all they can to affect real change within their organizations by improving the sustainability and reducing the environmental impact of IT, and encouraging their enterprises to do the same.
- Highlight the real and credible contribution new talent can make to being part of the solution by supporting and facilitating IT, and the enterprise, in this endeavor.
- Reengineer IT’s operating model, in particular working methods and skills development practices that offer tangible career development based on premium digital skill sets.
- When recruiting new talent, tackle the issues head on but highlight the opportunities for innovation and development of solutions that address them.
- Accelerate the transition and improve IT’s attractiveness by widening the pool of potential talent and recruiting outside the industry in novel markets for tech-savvy IT leadership with the knowledge and drive to change IT culture.

**Multiple Disruptions Yield Hybrid Reformation of IT Operating Model**

**Description:**

Five simultaneous disruptions are driving significant changes to IT operating models in the oil and gas industry:

- The global pandemic of 2020, which reduced funding for discretionary projects and forced painful reductions in IT staffing for many.
- The sustained high priority for digital projects designed to generate business cost reductions essential to near-term cash flows and midterm competitiveness.
- The growing demand for new systems and more IT agility as greenhouse gas emissions and energy transition become new business priorities.
- The emergence of alternative methods for delivering IT services, such as secure cloud computing, composable enterprise architecture, DevOps, digital factories, integrated IT/OT at the edge and more.
- The reduction of IT staffing levels made as project levels and other cost reductions were implemented in 2020.
These disruptive forces have immersed oil and gas CIOs into a continuous struggle to forge a hybrid IT operating model. It's a system that blends new and traditional IT methodologies, develops new and traditional IT skills and meets the continuously changing mix of business priorities.

**Why Trending:**
Resuming digital transformation programs, which were slimmed down in 2020, is a top business priority as companies strive to maintain cost-competitiveness with a leaner industry. According to the 2021 Gartner CIO Survey, 87% of CIOs expect funding levels to stay the same or increase in 2021, as most companies recognize that digitally enabled capabilities, such as remote work, automated operations and AI-driven decision making, are central to the future. However, situations vary greatly across companies. In the more diverse 2021 environment, 13% expect IT funding to decrease as their company consolidates operations.

In 2021, CIOs find themselves in an awkward position. While most oil and gas CIOs do not anticipate the deep shocks of 2020 will be repeated, they do expect that business conditions will remain challenging, putting pressure on them to achieve further productivity gains within IT. At the same time, digital remains a top business priority and there is strong demand for IT services; but internal resources are thin and external high-demand skills are hard to attract. In addition, the fundamental model for providing traditional IT services is changing, generating additional work to update IT policies, controls, processes and structures.

While all oil and gas CIOs share the challenges listed above, the immediate priorities for individual CIOs vary significantly as business strategies become more diverse and nuanced across the industry. While the specific nature of changes within IT departments is unique, all CIOs are facing a sustained period of constant flux.

**Implications:**
Every oil and gas CIO now faces a long list of change requirements for the design and operations of their IT department. Gone are the days where a simple shift in IT operating model, say from service-oriented to value-oriented, was enough. Over the coming years, CIOs must provide a hybrid IT operating model that balances new and traditional capabilities against a continuously evolving set of business priorities.

Consequently, the typical 2021 “to-do list” for changes in IT is enormous:

- Complete recovery from 2020 budget and staff reductions and reorganizations
- Modernization of SCADA and Integration of IT and OT
- Migration of Petrotech to a hybrid cloud environment
Actions:

Oil and gas CIOs seeking to optimize their IT operating model should:

- Normalize IT for harsh business conditions by aggressively consolidating and automating IT service delivery while simultaneously developing the capacity for faster and more agile value delivery.
- Prepare for sustained transition by shifting core IT architecture to a composable model and developing a strong portfolio of IT talent capable of delivering both traditional and new forms of business value.
- Keep IT in sync with rapid evolutions of business demand by replacing annual planning and budgeting cycles with faster planning cycles and more agile funding mechanisms.
Evidence

1. **2020 Was One of the Worst-Ever Years for Oil Write-Downs**, Wall Street Journal.


3. BP poll. Live poll taken during the BP Statistical Review of World Energy 2020 webcast, 14 September 2020. Q: “Will COVID-19 make the pace of energy transition faster, slower, unchanged or don't know?” 66% responded faster (n = approximately 2,000).


5. **U.S. Oil and Gas Industry Lost 107,000 Jobs in the Pandemic. Most Will Take Years to Return**, Houston Chronicle.


7. Schlumberger, Chevron and Microsoft announce collaboration to accelerate digital transformation, Microsoft.

8. **ADNOC, Honeywell Embark on One of the Industry’s Largest Predictive Maintenance Projects**, World Oil.

9. **Caltech Startup, Beyond Limits Secures Investment of $20 Million From BP Ventures**, BP.

10. **2021 CIO Agenda: An Oil and Gas Perspective**


13. **Cheap Oil Has Killed Nearly 200,000 U.S. Jobs**, CNN.

14. **Workforce Insight 2020**, OGUK.

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