Engineering to Business:
Optimizing Asset Utilization
Through Process Engineering

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Asset owners who integrate the process engineering, operations and business lifecycles of their facilities can improve return-on-capital by up to 4%. Use this virtual-asset model (VAM) to optimize your business assets.

Every year, more than $300 billion is invested in building new plants, revamping existing plants, improving safety and environmental compliance, or increasing reliability in the chemical process and related industries. Concurrently, more than $250 billion are expended in asset management and maintenance. The information and knowledge generated by one discipline at a particular phase within a process-asset lifecycle is not always shared or reused in other phases throughout its lifecycle or by other disciplines. The bottom-line consequences can be staggering, and may include inefficient use of capital, poor returns-on-investment (ROI) and sub-optimal financial and plant performance, as measured by key performance indicators (KPIs).

The process industries can improve business performance by adopting a multidisciplinary, integrated workflow to ensure that engineering and operations decisions are based on sound business lifecycle knowledge. This article presents a vision for process-asset lifecycle management that combines process engineering, operations and business lifecycles into continuous projections of KPIs, such as net present value (NPV) and return-on-capital employed (ROCE).

Process-asset lifecycles
A model of the process-asset lifecycle (PAL) is portrayed in Figure 1. The physical plant is situated at the core. Closely related to this core is the process engineering lifecycle, which encompasses research and development, conceptual process design, front-end engineering design (FEED), detailed engineering design, and procurement and construction. The operations lifecycle includes operational and management issues, such as: changes in throughput and product quality; equipment availability and performance; plant shutdown and startup, equipment maintenance; and safety and environmental issues. Situated furthest from the physical asset, but closest to the business boundary, the business lifecycle deals with the highest-level strategic and financial decisions that are aimed at the overall economic performance of the business.

The individual lifecycles are interactive. For example, during the operations lifecycle, a plant may undergo a revamp for capacity or other reasons. This will initiate design and physical modifications, which involves the process engineering lifecycle. The business lifecycle interacts with both the operations and process engineering lifecycles to determine the overall economic impact of these modifications and to set targets for these changes from a business standpoint.

There have been attempts to increase the reuse of data, information, knowledge and models across some of the phases within a lifecycle, and between disciplines. This article presents a methodology for optimizing asset utilization that uses rigorous engineering modeling and simulation technology to link the business level with the physical asset. Case histories illustrate the benefits of adopting this model and the challenges that lie ahead in developing a true model-centric solution across the entire PAL.
Virtual-asset models

A vision for the process industries is one of model-centric virtual facilities with a unified and consistent, multi-period-based asset simulation deployed at the center of a host of workflow-based application and data-exchange modules (Figure 2). The process engineering, operations and business lifecycles all utilize the same virtual-asset model (VAM), which allows for a consistent understanding of the cause-and-effect relationships in the physical plant. Mapping both engineering and business parameters over time to yield historic, current and projected business performance enhances decision-making. In this manner, the effect of the physical and operational plant variables and constraints on business profitability through all phases of the plant lifecycles can be readily communicated to the various disciplines. In effect, the process engineering, operations and business lifecycles become an interconnected, engineering-to-business virtual asset.

Process engineering lifecycle vision

Practices in process engineering have steadily evolved from the use of stand-alone tools and methodologies to a more-integrated and collaborative workflow approach that combines process synthesis and conceptual design with process-simulation and detailed-design. Collaboration and integration of process engineering work results in higher engineering efficiencies with respect to a plant’s design schedule and budget, and improved energy and capital efficiency for the asset. A major challenge within the process engineering lifecycle will be to ensure that controllability, operability, availability and equipment reliability for these designs are considered as integral parts of the process-design phase.

For instance, the ROCE calculation for any plant design must incorporate influences from all aspects of the operations and business lifecycles. In a collaborative approach to this task, one should consider:

• How reliable or controllable is the highly integrated design?
• How much does a dollar saved in capital design today translate into dollars spent in future product-margin-reducing operating expenses?

A VAM of the plant, including KPIs, should be stressed during all phases, so that all disciplines can contribute to achieving true asset-design optimization.

Operations lifecycle vision

Operational improvements are increasingly based on a consistent and validated plant-performance model. Realtime optimization, model-based control, performance monitoring, equipment-condition monitoring, operator-training systems and reliability-centered maintenance can be developed from plant simulation models and associated data. The challenge is to ensure that a consistent model is used during all aspects of plant design, and that the same comprehensive performance model is integrated into the enterprise’s operations and business-lifecycle work processes. A VAM that is closely linked with, and validated against the plant performance will foster a collaborative, decision-based environment that reduces the risk in all elements of operational and business decisions.

For instance, improvements in plant operations must account for the activities and constraints of the process engineering and business lifecycles. A collaborative approach to operational improvements involves questions such as:

• How will the knowledge that is gained from model-based control and optimization be useful in process-engineering design and related NPV calculations for the next revamp?
• How far is the plant operating from its business optimum today, and just as importantly, what changes will be required for tomorrow’s business optimum?
**Business lifecycle vision**

High-level business decisions that surround a process asset are typically made with limited knowledge of the plant’s physical capabilities and constraints. Increasingly, decisions such as these are based on site-wide planning and supply chain models. These models provide a more realistic basis for business decision-making. However, the models may not embody rigorous plant-performance relationships and detailed knowledge about plant equipment capacity and constraints. Consequently, the business may expose itself to the risk of not being able to achieve performance-based contract targets or otherwise not meeting customer requirements. The NPV of the business portfolio must incorporate information from the process engineering and operations lifecycles. Examples of collaborative thinking includes the following questions:

- Will the expected enterprise-wide processing synergies be realized from the latest plant acquisition?
- What additional benefits can be obtained by revamping some of the existing plants?
- Can the ROI predicted by planning and supply chain models be achieved in actual operation?

An opportunity exists for all disciplines, including engineering, operations, planning, scheduling, maintenance, finance, sales and marketing, to interact with a VAM in order to improve the workflow and decision-making of their individual disciplines and the overall collaborative performance of the business.

**Benefits of model-centric workflows**

Integration of the design, operations and business lifecycle workflows into a VAM built on a foundation of rigorous process simulation can improve ROCE by several percentage points. Tangible improvements to ROCE are the result of:

- improved business performance, due to easily accessible and rigorous performance models
- better utilization of existing process assets
- lower maintenance and operating costs, due to more reliable plant models
- more-efficient use of soft assets and human resources
- optimum investment decisions
- managed portfolio risks (i.e., blending high-risk/high-reward and low-risk/low-reward strategies)
- reduced exposure to liability, environmental and safety issues.

Integrating the business lifecycle with the operations and design lifecycles provides a single model-centric environment to ensure the extraction of maximum value from a producing asset. The examples presented in the next section illustrate that as much as 20–30% savings in capital investment is possible through the use of better process-design tools, concurrent and collaborative engineering, and the reuse of information and knowledge across the business lifecycle. By employing elements of a model-centric, integrated lifecycle, asset owners have typically increased production by 3–5%, while decreasing utility costs by 5% via operational improvements alone. This has resulted in individual asset-utilization gains in the million-dollar range with minimal capital investment (1). A model-centric integrated lifecycle approach can substantially improve financial performance by approximately 2–4% of the total ROCE, which can transform a mediocre business to a high-performance business.

**Model-centric integration throughout the lifecycles**

Today, the process engineering, operations and business lifecycles of assets generally exist as distinct entities with moderate integration. The individual lifecycles have developed into advanced workflow methodologies that are supported by integrated applications and services. The next major leap in financial performance will involve the integration of the several lifecycles to produce a holistic virtual asset. Some of the key aspects of today’s integrated workflows are highlighted throughout the remainder of this article using examples from industry.

**Process engineering lifecycle**

The process engineering lifecycle (Figure 3) shows a typical lifecycle workflow for project design. It starts with a process concept and ends with detailed design and construction. The base-case performance is established using a combination of modeling and economic analysis tools. The initial process concept is then improved using an integrated approach that combines process synthesis and modeling technologies. The improved concept is analyzed for thoroughness and economic feasibility. The improved design is then used to develop a detailed plant design, which can be further refined and optimized through detailed equipment selection and sizing. The detailed design is then used to establish the base-case performance, which is used to analyze for economic performance. The process engineering lifecycle workflow is depicted in Figure 3.

![Figure 3. Lifecycle of project design for an engineering process.](figure3.png)
safety and controllability using the same model as developed during the early conceptual-design stage, with dynamic modeling to define the basic control strategy for the plant. The resulting process concept is then ready for transitioning into process design, so that equipment design, process flow diagrams (PFD) and equipment data sheets can be finalized.

At this stage, many engineers need to work together concurrently on the project. This collaborative approach would be best handled in an environment that uses a single process engineering database with workflow management capabilities.

The following scenarios show how to integrate process engineering lifecycle workflows and reuse data, information and models.

1. Integrated conceptual design and business economics.

This example illustrates the integration of process simulation, synthesis and economics analysis. Typically, the driving force is lower capital expenditures, better design and an optimum trade-off between capital and capacity. The subject is an ethylene revamp project at an integrated petrochemical complex in the U.S. (2) The complex produces ethylene in two adjacent plants by cracking ethane, propane and liquid feedstock. An economical expansion of the facility was sought by using an integrated approach that took into account the capital economics, feedstock mix, energy minimization and cross-plant dynamics. By using integrated process design, the company constructed a cost vs. capacity graph for the two crackers (Figure 4). The graphical results made it possible to optimize where the next incremental capacity should be placed in order to minimize the overall capital investment needed. Figure 4 also illustrates that an 11% capacity increase can be achieved with $12 million saving in the capital investment using the integrated approach. This benefit translates into 4% extra plant capacity for the identical capital investment. The integrated approach also generates a range of options that provide a clear understanding of “step increases” needed in the capital investments.

A similar integrated approach applied at YNCC, a large ethylene producer at Yosu in the Republic of Korea, reduced capital investments for a revamp project by 40%, increased capacity by 4%, and afforded significant energy savings (3). Furthermore, the U.S. Dept. of Energy (Washington, DC) indicates that an integrated design approach combining process simulation, synthesis and novel equipment concepts can reduce overall costs of production in existing ethylene plants by 15% compared to world-class ethylene plant designs today (4).

2. Integrated steady state and dynamic analysis.

One of the major advances in modeling technology in recent years has been the seamless integration of steady-state process simulation (SSPS) and dynamic simulation (DPS) — so much so, that many tender documents now require the supply of DPS as a matter of course. DPS models provide insight into how the process responds during upsets and changes to control-system objectives. A user armed with this tool can predict the outcome of a process design or operating-parameter changes without setting foot in the plant. Process engineers may even simulate dangerous or non-profitable operating conditions in order to gain unique insights and further improve plant profitability.

One example of the use of integrated steady-state and dynamic analysis, detailed in Ref. 5, involves the verification of the process control system for a monoethylene glycol (MEG) regeneration system before commissioning. Installation was to be on Norway’s Statoil Åsgard B platform, which processes petroleum from the North Sea’s Midgard field. (Figure 5). MEG is injected at the wellheads for hydrate mitigation in the Midgard subsea gas and condensate-production pipeline. On the platform, the MEG is recovered, regenerated and subsequently reinjected upstream into the Midgard pipeline system. The MEG reclamation involves a conventional process of inlet separation, heating and liquid-phase separation, followed by additional heating and degassing. The MEG is then processed via two novel process steps: vacuum-flash separation for water removal, and crystallization for particulate and ion decontamination. The remaining water is removed in the final distillation stage, leaving a lean MEG product ready for reinjection.

This system constitutes the world’s largest continuously operating MEG recovery and regeneration unit to be installed on a semi-submersible platform. The successful application of DPS for this offshore oil-and-gas installation was achieved before commissioning of the novel unit, and with only an incremental increase in cost.
above SSPS. Figure 6 compares the simulation results with the actual performance. Further use of DPS contributed to the complete verification of the process-control system and a shortened commissioning time.

3. Integrated process design.

Processes that support concurrent project workflows for process and detailed design are increasingly being executed in a collaborative environment. In parallel, mechanisms for the capture and reuse of knowledge have been used to help improve the quality and effectiveness of the design process. Integrated FEED brings together process design, equipment and preliminary control-system design and economic analysis in a single, concurrent engineering environment. The major benefits have been engineering efficiency and collaboration across engineering disciplines, resulting in better designs and less rework.

An example of this integration has been achieved at Mitsubishi Chemical’s Mizushima, Japan, Engineering Research Centre (6), which documents a 42% decrease in project man-hours as a result of the adoption of integrated process-design techniques during the design lifecycle.

The integrated FEED vision is similar at Fluor Corp. (Greenville, SC) (7). An example of how this company is benefitting from collaborative engineering is based on a nine-month engineering project for a gas-processing plant. A new integrated FEED system allowed nearly 50 engineers stationed in six offices in the U.S. and Europe to work concurrently while sharing the same process data and knowledge. Immediate benefits from the integrated FEED system included a marked improvement in quality from inputting data just one time and the ability to easily access employees’ expertise in every Fluor office.
The implementation of an integrated front-end design system has provided Fluor’s 2,000 engineers with the capability to perform collaborative engineering in realtime through:

- work sharing *(i.e.,* concurrent users from different offices working on the same model in realtime)*
- client portal access *(i.e.,* allowing customers to log into the system to see realtime updates to projects and approve work)
- a “round-the-clock” project execution *(i.e.,* handing off work at the end of the day to an office in another time zone so that there is almost continuous 24-h project execution).

**Operations lifecycle**

Today’s operations lifecycle consists of a number of established and developing technologies. The main applications to date, listed in order of increasing complexity, are: data reconciliation; performance monitoring; production accounting; operator training; advanced process control (APC); closed-loop realtime optimization; condition-based and reliability-centered maintenance and facility availability.

The open architecture of the process-simulation environments, with equation-based and sequential modular calculation approaches and the relative ease of interconnection with DCS systems and data historians gives the model-centric approach an unrivalled position as the virtual plant model for online and offline process optimization. By incorporating data reconciliation and parameter-estimation methods as fundamental steps in the overall optimization process, the solution ensures that the model reflects the plant state at any point in time on a historical, current or predictive basis. The result is that process models developed during the process engineering lifecycle can be reused in many situations for online plant monitoring during the operations lifecycle.

The challenge within the operations lifecycle is to extend the VAM to predictive maintenance (see sidebar, p. 106). The model should predict the reliability and availability of the asset, as a function of the operating parameters and process conditions, and link this information with the process engineering and business lifecycles. Ultimately, the operations lifecycle should provide an instant “profit meter” of the facilities’ behavior, constructing NPV calculations from the interaction with the business lifecycle.

The following examples showcase operation-lifecycle integration opportunities that are currently being exploited:

1. **Extending the benefits of process control.**

APC and realtime optimization (RTO) are increasingly being considered as standard applications. The technology has matured for many petrochemical and refining processes *(8)*. Benefits of incorporating APC and RTO into the asset lifecycle are derived from enabling the process asset to run reliably closer to its true constraints, resulting in increased throughput, less downtime and a significant reduction in off-spec product. Typical payback on projects is approximately three months. The Kuwait National Petroleum Co. has realized a $14 million annual benefit from implementing integrated APC at its Mina Abdullah Arabian Gulf refinery *(9)*. Similarly, the implementation of integrated APC and RTO at Huntsman’s Wilton, U.K., ethylene cracker has resulted in a 5% increase in the plant output *(10)*.

2. **Integrated energy management.**

Many opportunities exist for applying a model-centric VAM to the design, operation and management of process utility systems (Figure 7). With the advent of deregulation
Optimizing a Chemical Plant’s Physical Assets

Process optimization has been widely practiced in the chemical industry as a means of cutting costs. However, the ability to optimize a plant’s physical assets, coupled with optimizing the associated processes, is a relatively new approach. By addressing four key reliability processes — maintenance strategy, work identification, work control and work execution — chemical industry senior management and operations personnel can optimize a plant’s physical assets for greater equipment productivity, efficiency and cost savings (see figure). Information management systems (IMS), which include automated diagnostics and decision support systems (DSS), push the information to plant personnel (e.g., operators, maintenance personnel and plant management).

Maintenance strategy — The maintenance strategy process identifies the right tasks to be performed at the right time on the right equipment and includes a proper mix of reactive/corrective, preventive, predictive and proactive tasks.

In one industrial application, a combination of diagnostic testing, root-cause failure analysis and proactive measures applied to a recovery solvent system is saving a Northeast U.S. chemical plant $80,000 per year.

At the core of the maintenance strategy lies reliability-centered maintenance (RCM). This is a discipline that helps plant management align maintenance tasks with business objectives, and can turn a plant’s reliability processes into a living program for continuous improvement. RCM often uses a DSS to update system behavior and conduct equipment analyses. The DSS obtains the data on the health of physical plant assets from an online computerized monitoring system, incorporates design criteria and historical operating changes, and sends a message to the problem-solving personnel in a usable format so corrective action can be taken.

Work identification — Work-identification tasks may include one or a combination of time-based, condition-based and operator-driven reliability activities. These tasks complement functional performance tests and corrective maintenance activities, and, when integrated into an automated maintenance decision-support system, can improve personnel productivity.

For instance, the mechanical seal is part of the pump most prone to failure. If seal failure could lead to environmental or safety problems, monitor the temperature of the high-pressure side of the seal face. If the pump has an external seal-flush system, monitor the discharge pressure of the barrier fluid. If the pressure wanders outside the normally acceptable range, it indicates a problem with the seal. A physical inspection of the unit is necessary to determine if any problems exist.

Condition-based activities include the use of predictive technologies (e.g., those used to characterize and predict equipment vibration, noise and oil condition) such as trending, cross-correlation and plot-overlay analyses. They also include the trending of various process variable data, such as temperatures and pressures. The implementation of predictive technologies requires personnel who are trained on data-gathering and analysis and an established process by which maintenance decisions are based on equipment conditions.

Operator-driven reliability, which assigns asset-management responsibility to the person closest to the process, is a chemical plant’s first line of defense. It mandates that operators feel empowered to perform basic maintenance tasks and adhere to a carefully planned inspection schedule. Using one’s senses to monitor the sounds, sights, smells and feel of equipment may not be high-tech, but a human’s natural monitoring capabilities constitute an effective set of tools for detecting equipment malfunctions.

The integration of information obtained from these work-identification tasks allows for effective decision-making — i.e., the generation of work requests in a computerized maintenance management system (CMMS) when exceptions occur.

Work control — Plant management can turn to the CMMS to manage and control the restoration and improvement activities that are necessary to optimize physical plant assets. A DSS can reliably predict unexpected events, such as part failure or machine trip, so that a course of action can be defined. Staging and planning of work-control activities are necessary to avoid delays in the delivery of equipment parts or the availability of human resources. Typically, a rolling schedule of six weeks or more will optimize resources and enable a plant to achieve performance objectives.

Work execution — This process requires properly trained personnel to initiate work orders, carry out each maintenance task, and communicate project status and machine condition from the field to plant management. Effective work execution involves post-maintenance testing (PMT) — i.e., the functional testing of equipment before it is returned to service — PMT can be as simple as stroking a valve or as complex as conducting an extensive pump-performance test. Work execution is vital to the continued optimization of the plant’s maintenance process because it is the human factor by which history, experience and knowledge are fed back to the plant’s reliability program. DSS facilitates the program and ensure that the learning is shared across the organization. A CMMS is also essential for the documentation of a plant and its machinery, so that it can be transferred from one generation of engineers to the next. In this way, costly mistakes can be avoided.

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and the growing popularity of both distributed generation and cogeneration, the use of well-integrated energy-management techniques provides a consistent basis for operational improvements, load balancing and contract optimization throughout a company’s portfolio of utility assets. The benefit of adopting this approach and the subsequent integration with process engineering and business lifecycles can be on the order of 2–5% of the total energy bill, and also has a positive impact on the environment.

One such example is DSM (Geleen, The Netherlands), a highly integrated chemicals, specialty chemicals and biotechnology firm. DSM adopted a model-centric approach to optimize its heat and power utility systems, and reported a savings of $2–3 million in energy costs during the first year of operation (11) due to contract optimization alone (i.e., no capital investment was required to realize these savings). Subsequently, DSM has been using the model-centric approach for day-to-day operational improvements and long-term utility planning.

**Business lifecycle**

At the highest level in the business lifecycle sits enterprise resource planning (ERP). With its resources-based approach (i.e., financial capital, human capital and fixed assets), it is inherently internally focused. ERP looks for efficiency gains through inventory reduction, workplace automation and similar cost-saving strategies achieved by imposing standardized business practices.

ERP technology was beneficial for its early users, but when a whole industry adopts the same best practice, there is no longer a sustainable competitive advantage to be obtained from the technological investment. Consider the refining industry. Despite employing relatively high levels of sophisticated ERP solutions, it is still a low-margin operation, and refiners have a tough time competing with other industries for investment capital.

The following examples illustrate business lifecycle integration.

1. **Integrating the VAM into supply chain management (SCM) and the enterprise.**

   In order to realize additional benefits from the investment made in the ERP systems, users in the process industries have been implementing SCM solutions, which focus on the business value chain and customer-producer-supplier relationship management. SCM unlocks the value that ERP misses by embracing the corporate capabilities and competencies contained within its hard and soft assets. Instead of pushing product out to market, SCM strives to pull product through the value chain, minimizing slack that can be caused by excess inventories and allowing for customer-oriented mass customization.

   Using a VAM to bridge engineering and business allows for the true physical and economic constraints, corporate objectives and proper KPIs to move through the plant’s process engineering and operations lifecycles to the boardroom, thereby unlocking the value of SCM and ERP (Figure 8). An improvement in ROCE of up to 4% has been reported by companies that have implemented integrated solutions that bring together decisions related to operations-oriented-production accounting with higher-level business decisions, such as feedstock selection, production planning and SCM.

   Equistar Chemicals (Houston, TX) is one company that has benefited from the integration of manufacturing optimization software with its ERP suite (12). The implementation at its Matagorda plant saved the company $20 million in two years.

   At Hercules Inc.’s (Wilmington, DE) Aqualon division, a link between SCM and production increased the company’s sales, improved customer service (due to a higher percentage of correct shipments) and lowered inventory by approximately 18%, all in the first year of operation (13).
2. Integrating economic analysis.

In the process engineering lifecycle, the importance of a well-defined basis for economic analysis (i.e., a basis that is consistent with business assumptions that anchor the corporate strategy and planning models) cannot be overstated. Today, it is possible to conduct a complete decision analysis that incorporates various economic aspects of the business lifecycle in order to provide the rigor needed for proper evaluation of the large number of process design options and feasibility paths. This economic analysis can be done at minimum cost, concurrently with the process engineering phases of the project.

An example of a company benefiting from the implementation of an integrated economic analysis is GE Plastics (Pittsville, MA). The firm trimmed more than 25% off the capital investment required for a $500 million project by combining process simulation, pinch analysis and integrated economic analysis (14).

3. Asset-wide optimization to the business boundary.

Within the operations lifecycle, SSPS models have typically been used for operations-centric offline performance models, what-if studies and throughput maximization. By designing the open models with simple front-ends and employing workflow and lifecycle-specific interfaces, one can incorporate input from multiple lifecycles into the economics of asset optimization. Whether the task at hand is predicting the impact of catalyst deactivation, reliability-centered maintenance or capturing spot-economic opportunities from business development, modeling the asset to the business boundary will lead to optimum global-asset utilization.

Although 100% asset-wide optimization to the business boundary may be an elusive target, it is possible to get close. This is shown in the next example, describing a model-centric approach in the business lifecycle of the BP Harding Daily Optimizer (15).

The BP (London, U.K.) North Sea Harding asset consists of three types of fluid contained in 15 wells. The production from the reservoirs is a heavy, viscous crude oil with a high acid number. The platform conducts a difficult oil/water separation with numerous separator and heat-exchanger unit operations. The crude is exported with a production of around 85,000–105,000 bbl/d and the associated gas is reinjected into the production system.

BP’s Daily Optimizer is a software system designed for the Harding asset that was integrated in-house and assembled using a combination of in-house and commercially available software. It predicts the offline operating conditions and available safety margins of the entire asset, from wellhead to tanker. The effect of plant upsets, the point of train shutdown, and the incipient point of full-asset shutdown can all be tracked (Figure 9).

The system ties into a back-end program that receives and reconciles rigorous petroleum production and process parameter information from the digital control system (DCS) and various data historians. Rigorous, thermodynamically consistent asset-wide simulation and in-house optimization technology make use of the reconciled input. All this sits beneath a custom-designed Excel spreadsheet front-end (Figure 10).

The system displays the best selection of well production schedules and process facility parameters to the operations staff, thereby maximizing the profit, when given the asset constraints and the economic inputs to the model. Cross-disciplinary knowledge that is shared during the construction and deployment of the VAM leads to a better understanding of the interaction between the petroleum wells and the facilities on the Harding Platform. The benefit to BP was an average gross incremental oil production of 4,300 bbl/d, with very low production costs.

The future of virtual asset modeling

Managing the process asset lifecycles of tomorrow is not merely survival of the fittest and the fastest — a Darwinian ability to adapt is also a necessity. Better-informed decision-making is required to counter new competitive threats and adapt to the rapidly changing business environments of globalization, deregulation, and environmental, social and political issues. By transcending the process engineering, operations and business lifecycles, model-
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