Creating a Competitive Advantage Through Integrated Upstream Asset Management

by Livia K. Wiley

Executive summary

The oil and gas industry is expanding at a stellar pace. The potential profits are great, but so is the risk. This paper shows how a fully integrated, real-time performance-based set of software tools that use a common interface to model an asset holistically throughout its entire lifecycle — from design to operations to optimization and planning — can improve profitability by increasing production and oil recovery, reducing costs, and mitigating risk.

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Introduction

The upstream oil and gas industry is bursting at the seams. Companies are investing large amounts of capital, pursuing new advances in extraction technology, and automating existing operations. There is certain risk but smart companies know that today's investment will lead to huge payoffs in the future. But the number one challenge remains how to improve production output and oil recovery factors given the current environment and impending risk. Is there a way to meet this challenge when first considering an asset for development before commissioning a facility?

Whether the asset is onshore or offshore, a new or an existing reserve, in a mature market or an emerging one, companies are in the business of making money. But the landscape is continually changing (**Figure 1**) and so are the economics. The discovery and extraction of unconventional oil — mainly shale deposits and oil sands — has flipped convention on its head. For example, ten years ago the United States imported 60% of its oil; today, it is only 22%, the lowest since 1970. The U.S. Energy Information Administration has predicted that 2015 U.S. crude oil production will hit its highest level since 1970.[1]

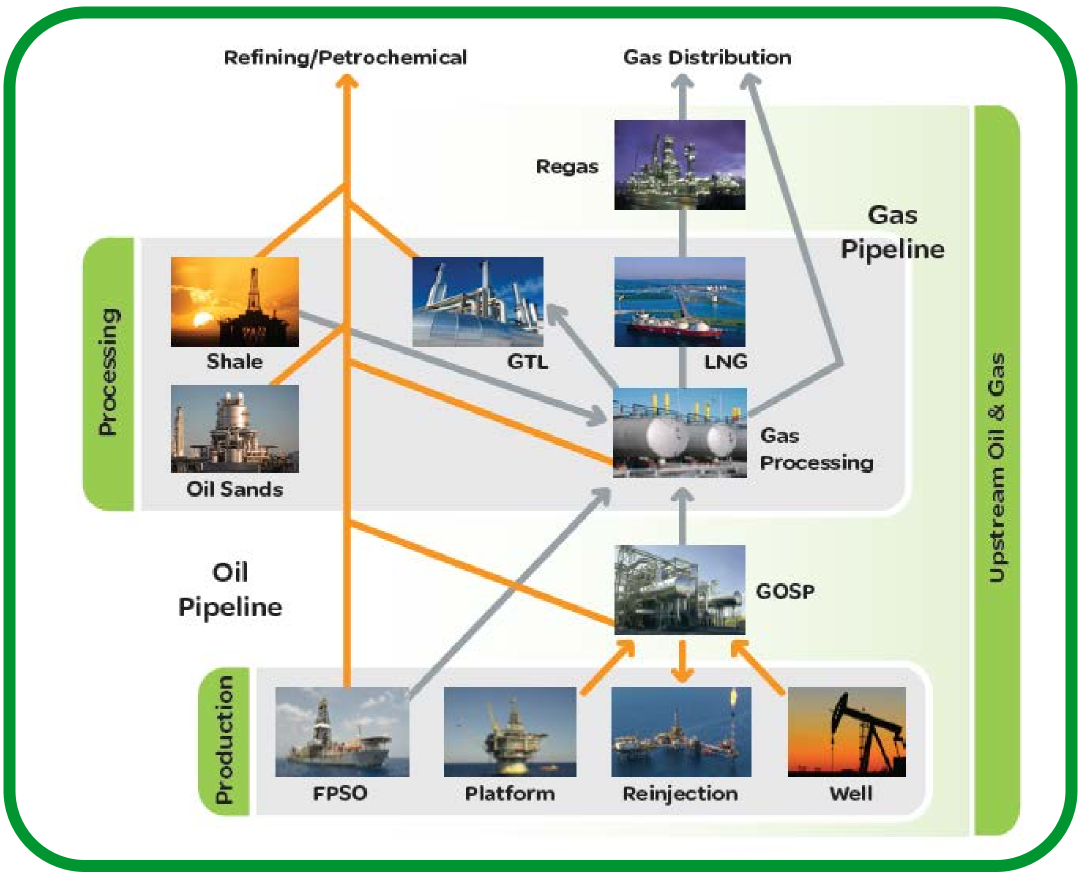

Figure 1
The landscape of upstream oil & gas industry is continually changing

It is expected that the oil and gas industry will grow consistently, with capital expenditures outpacing revenue over the next five years. Demand for gas will grow above average, at a rate of about 1.7% per year over the next 20 years. Demand for oil will remain lower during the next five years, but will surge 25–56% over the next 20 years. Economic expansion will be supported by significant investments in shale gas in the United States, oil sands in Canada, and deep sea exploration in Europe.[2]

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[1] U.S. Energy Information Administration

[2] U.S. Energy Information Administration

The increasing wealth in emerging markets, especially China and India, will shift the supply and demand for energy and dramatically change how the industry progresses. Both geopolitical and socio-economic tendencies will influence how and when these markets develop.

According to the EIA, "The United States and Canada are expected to account for most of the world's projected growth in production of oil and other liquid fuel through 2015 while China and less developed countries will drive most of the growth in consumption".

From a technological perspective, companies intend to increase their efforts in automation and remote operations management, putting funding toward real-time management in gas pipelines, pump optimization in liquid pipelines, and expansion of downhole production.

For each new mega-project, the asset development manager must prove that the overall project risk is low enough when compared with the high rate of return, years from now. This can be much harder to do today because tougher operating environments and increased risk in extracting unconventional oil and gas has pushed capital spending above revenue. What is economical today may not be tomorrow.

Challenges & business drivers

As the industry continues to pursue more unconventional sources of oil and gas and recover more from conventional reserves, better, smarter technology is being developed to improve production output and oil recovery, both in greenfield assets and brownfield operations. The potential profits are undeniable, but there are some definite challenges too. These include:

- Tougher operating environments
- Increased economic, geopolitical, and ecological/environmental risk
- Hurdles to regulatory compliance, including the governing of emissions, crude, water, soil, etc.
- An aging and changing workforce
- Global corporate-wide production planning

Technology, however, is only part of the story. To drive growth, maximize profit, and minimize risk, upstream asset development must be considered holistically.

Viewing upstream asset development holistically

Whether the asset is onshore or offshore, conventional or unconventional, oil or gas, considering asset development and utilization holistically can provide many advantages, the largest being economic.

This view first considers the asset or asset set as a single entity (**Figure 2**) — any combination of reservoirs, wells, platforms, pipelines, processing plants — with all the modeling, resources, performance metrics, costs, and schedules for which an operator is responsible. Then, using the unified model from each asset, one can manage and optimize assets 1 – N from the corporate level (outer ring) to provide greater field planning, operations decision support, and asset utilization and optimization, all in real time.

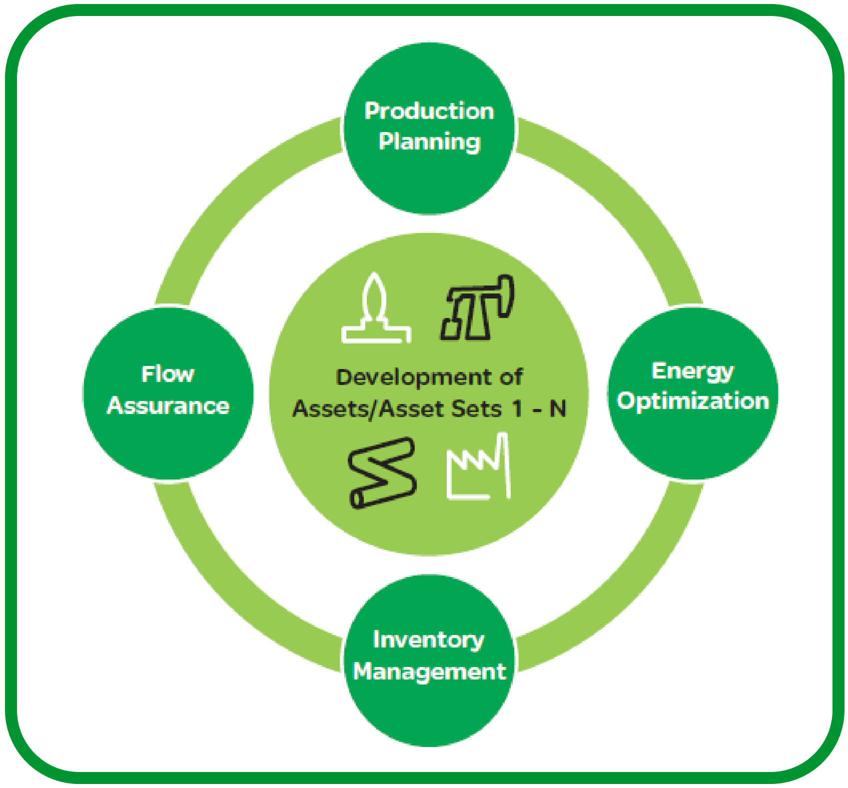


Figure 2
Holistic view of upstream asset development

This holistic view of assets, from reservoirs through to the processing facilities, allows operators to plan, manage, and optimize oil and gas production. An end-to-end solution is the only way to reduce costs, maximize profit, and minimize risk.

Figure 3 expands the "Development of Assets/Asset Sets 1 – N" above to show the three key areas of investment when developing an individual asset:

- Engineering management
- Asset management
- Operations management

The success of each area is tied to specific key performance indicators (KPIs) with the purpose of designing, operating, and optimizing a safe and profitable facility.

- The bottom third of the model shows the progression of engineering activities for evaluating the feasibility, economics, and scheduling of a prospective asset.
- The left third of the model shows the progression of asset management from reactive to preventive all the way to predictive maintenance.
- The right side of the model shows the operational progression from basic control to advanced control all the way to process optimization.

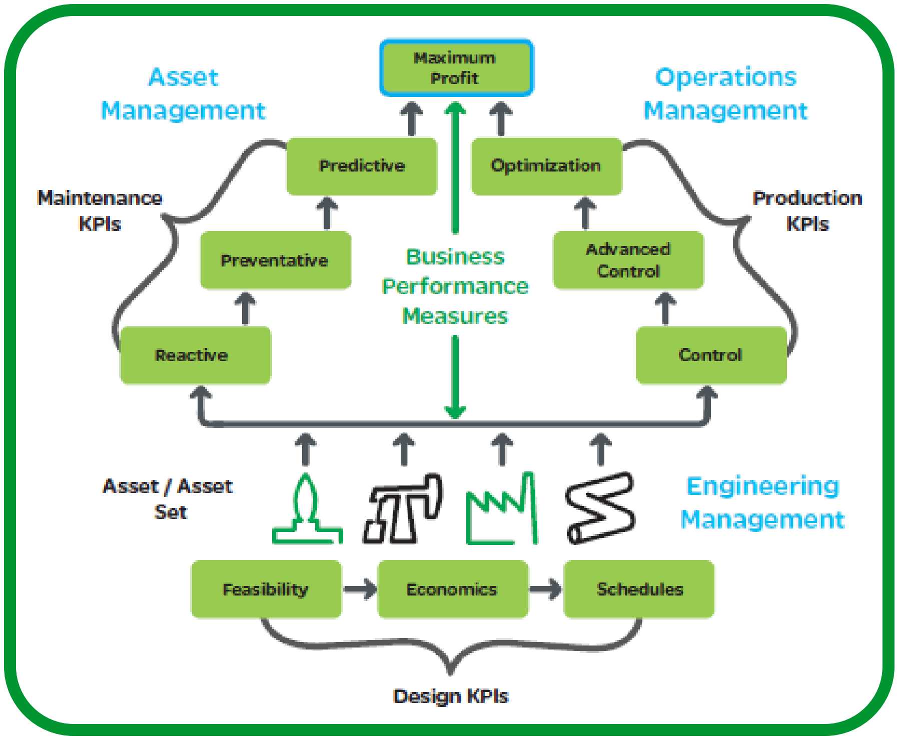


Figure 3
Key performance indicators (KPIs) for upstream asset development

With each step, the performance and profitability of the operation improves and the supporting teams are able to make better, collaborative, and more timely decisions. The convergence of these two perspectives provides the maximum combined performance of a facility, as measured through real-time economic and operational metrics.

Translating those steps into executable actions, **Figure 4** maps the individual functions or programs an operator would implement to meet expected KPIs.

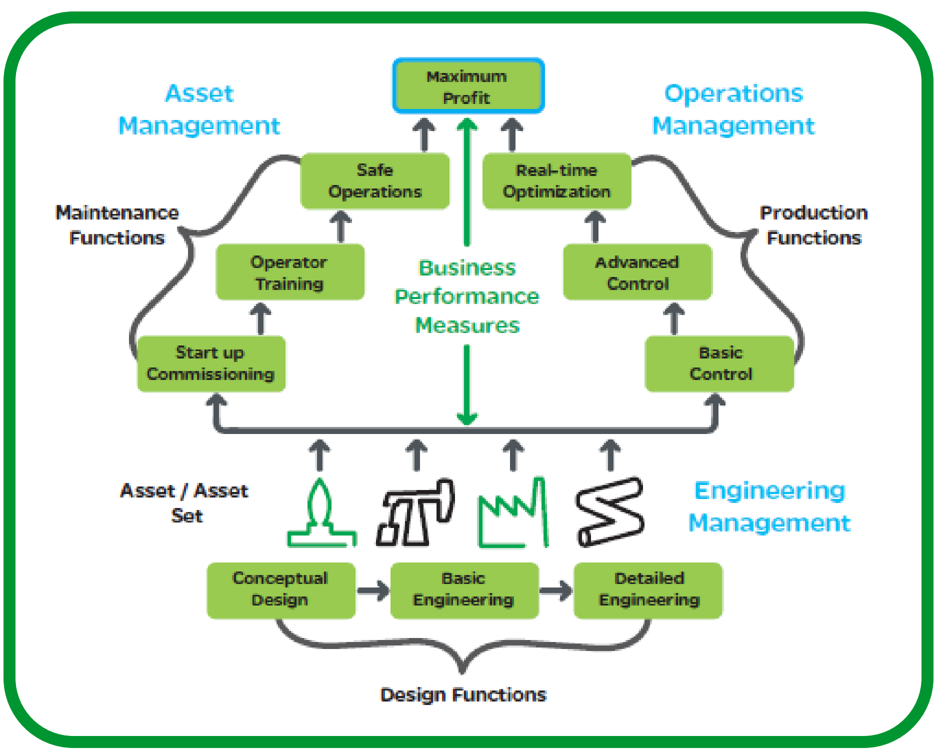
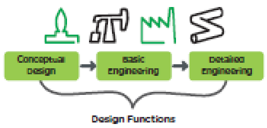


Figure 4
Individual functions or programs for upstream asset development

Programs, functions, and metrics, however, are only half the consideration. The only way to balance return on invested capital with operations excellence is to use a single set of integrated software tools across the entire asset — from reservoirs to wells to surface facilities to process plants — and throughout its entire lifecycle, starting with the engineering design through operations and into optimization and planning.

Engineering management



The engineering management of an asset is typically executed via the front end engineering design (FEED) or front-end loading (FEL) process. FEED/FEL is a useful engineering design approach for thoroughly planning, estimating, and controlling project schedules and expenses to meet the specified technical requirements before a project is even considered for construction.

For a new asset, the FEED/FEL process is often used to decide the viability of a project. Design functions and KPIs are set up in such a way that the project may be stopped during any of the three engineering phases (conceptual design, basic engineering, detailed engineering). For example, if the project is technically feasible but is too costly, it may be put on hold until the economic environment improves. Or further development may be halted because although the project is technically and economically feasible, the timing and/or resourcing are insufficient. Both scenarios are common occurrences in the oil and gas industry as market, economic, and political conditions change continually.

"A global leader in project management, engineering, and construction for the energy industry saved more than $25 million on a single flare project in a new facility by using dynamic simulation software."[3]

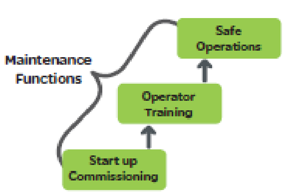
Process simulators can be extremely effective in determining the viability of an asset by executing the conceptual design, basic engineering, and detailed engineering phases. It begins with the accurate modeling of the fluid and its inherent properties. As there are large differences in conventional oil, heavy oil, tight oil, and shale oil, an accurate characterization is the basis for modeling upon which simulations are built. These simulations allow for the evaluation of production networks, alternate plant configurations, and operating conditions. A process engineer can easily run sensitivity analyses, planning studies, operational execution runs, and on-demand decision support with the highest level of confidence and rigor.

Some benefits of executing integrated engineering management include:

- Optimized field-wide production
- Expected performance capacity of a facility
- Reduced design time
- Lower capital and operating costs
- Increased engineering productivity

Taking the same static process model, selected in conceptual design and perfected in basic engineering, into a dynamic environment then allows for process design validation, safety and control systems testing, and optimization of capital expenditure by avoiding costly overdesign.

Asset management



One of the key tasks of asset management for oil and gas production is to ensure plant safety while maintaining high economic efficiency. In a typical production field, operations personnel must deal with several thousands of operating limits and operating parameters, which make it impossible to effectively monitor them and take timely actions. The result: critical operating situations can be missed that can lead to serious safety accidents and loss of productivity.

[3] All customer reference quotes and quantified savings, payback periods, and ROI drawn from Schneider Electric surveys

Some benefits of executing integrated asset management include:

- Lower capital expenditures, operating expenditures, and market risk
- Refined process designs and superior control system software designs
- Higher plant performance efficiency and increased process uptime
- Better operator effectiveness and agility through faster, equivalent on-the-job training
- Shorter plant commissioning schedules
- Better regulatory compliance documentation

"A world-leading LNG carrier reported to Schneider Electric that it saved over $1 million on a distributed control system (DCS) project by using dynamic process simulator to check out controls."

Startup commissioning

The pre-testing of control logic in a dynamic simulation environment can reduce commissioning time by several days, and sometimes even weeks. Virtual stimulation software can augment the dynamic model to design, test, and perform system checkout prior to startup. Because all functions are executed within a dynamic environment, it has the capability to bulk configure tie-back models to aid in training.

Operator training

Companies struggle today to operate more complex plants with fewer people responsible for even more tasks. With limited expereicne, both control room and field operators require extensive distributed control system (DCS) and process training. Under this premise, companies must be able to easily test control applications and complex control strategies, reduce startup time, and establish long-term training strategies.

"Nexen attributes cost savings of 50% at its Long Lake facility to focusing on essential features to simulate in its well-defined OTS scope."

Operator training simulators (OTS) are now used for greenfield and brownfield plants across all process industries. Regardless of the application, operators need to know how to operate the DCS and the plant. Today's control room operators run mission-critical processes across multi-billion dollar businesses where missteps can be very costly in terms of safety, availability, and profitability.

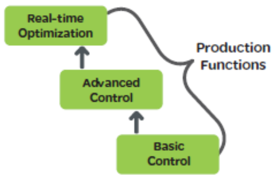
3D immersive technology that integrates directly into a robust dynamic simulation can be used to design the process, validate the control system, and familiarize the operators with the DCS interface. Investment in OTS can be further leveraged by adequately training control panel and field operators to cooperate and coordinate working together. Schneider Electric research has shown that 3D virtual reality training can reduce the time-to-value and costs of on-the-job training by 30–40%, reduce the time of startup when recovering from a planned/unplanned shutdown, or from warm/cold conditions, by 15–20%, and contribute to maintenance budget savings of 1–3%.

Safe operations

"BP estimated two production days saved each year from improved recovery from upsets and 1% improvement in costs through better control of the plant."

Operational integrity has a significant impact on a facility's bottom line. The associated costs of lost production and HS&E (health, safety, and environment) incidents can easily justify any expenditure that improves safety, reliability, and performance. A solution in this space must produce measurable improvements and benefits, including increased facility utilization, improved equipment reliability, and less downtime. The objective is to reduce maintenance costs while improving safety and environmental compliance, thus creating a safer, more reliable operation of facility assets.

Operations management



A brilliant strategy may get things started but sustainable competitive advantage isn't possible without flawless execution. Unfortunately, most companies struggle with implementing their strategies. To navigate the business through uncertain conditions and steer it toward future growth, operations management must focus on synchronizing that strategy and execution in real time.

Some benefits of executing integrated operations management include:

- Improved reliability, safety, and throughput
- Higher asset utilization and process yields
- Lower operating costs
- Lower emissions, energy consumption, and waste

Basic control

Basic controls are designed and built with the process itself, to facilitate basic operation, control, and automation requirements. The virtual simulation of DCS or PLC (programmable logic controller) systems, which is built on algorithms and communication infrastructure of industry control processors, can provide an ideal environment for designing superior real-time control software, providing high-quality operator training, and accurately analyzing and troubleshooting control system response and performance. This saves time and resources.

Advanced control

"Advanced process control (APC) software payback periods vary by industry, but typically range from 3–6 months."

In today's economic environment, capital budgets and overhead are constantly being cut. Companies are faced with rising manufacturing costs, global competition, and soaring energy costs. Basic process controls are insufficient. To meet these challenges, companies are forced to optimize manufacturing operations and make performance improvements that will positively affect their bottom line.

Whether implementing a new system or fine-tuning an existing one, the need for greater visibility of legacy processes and control strategies to engineering logic is obvious. Advanced process control (APC) software allows the process to operate much closer to the operating limits by reducing variations in the process. APC software that uses model-based predictive control to improve process profitability and control can often reduce variability by a standard of deviation of two or greater. This improves process profitability by increasing throughput (by as much as 5%, according to Schneider Electric surveys), enhancing process yields (from 2–10%) and reducing energy consumption (by 3–10%).

Real-time optimization

"Process optimization and modeling software produces typical savings of 3–5% of a plant's total value, with a payback period of one year or less."

Today's primary opportunity to create business value at the plant level is to maximize production value while reducing the variable costs of the operation, which are predominantly energy and material costs. As plant operations focus on these objectives, safety and environmental impact continue to be critical constraints.

Process optimization is where operations meet economics in real time and is used to sharpen both facility performance and profits. Online modeling and optimization capabilities enable managers to react quickly and precisely to changes in market pressures, energy costs, and equipment performance. Real-time optimization and control software enables companies to achieve improved reliability and safety, higher asset utilization, lower operating costs, and lower emissions.

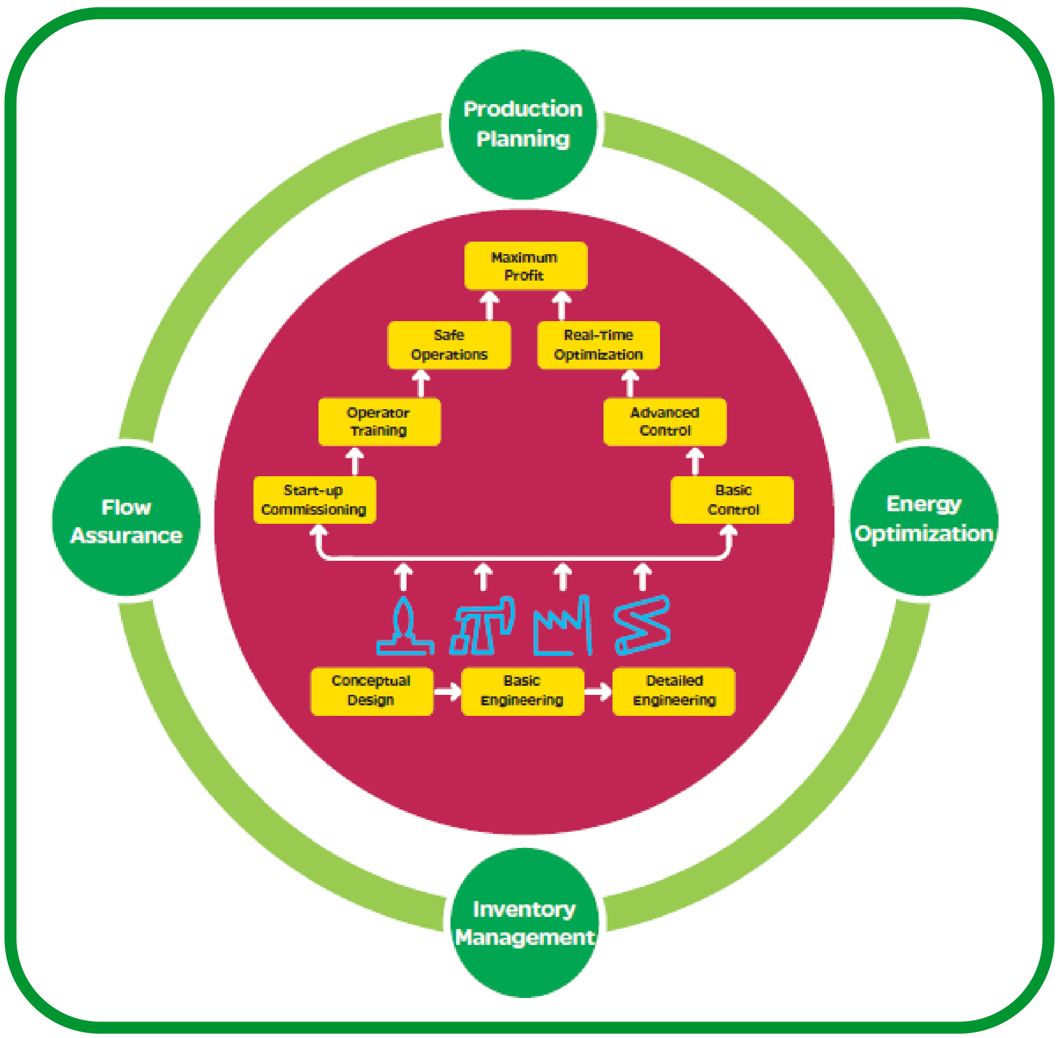
Corporate-wide asset optimization

The technology and experience available today can help industrial operations better drive profitability from all industrial assets. Success in this area requires that companies view and address problems, objectives, and metrics from the corporate level, treating each asset as interdependent upon the others. This helps identify underperforming assets or areas, and the impact of performance inefficiencies in order to:

- Improve asset availability and utilization
- Lower operating expenses and increase profits
- Prevent unplanned downtime
- Optimize maintenance strategies, resources, and costs
- Maximize the operational life of your assets

Figure 5 shows the four strategic planning areas with the greatest return on investment when considering the optimization of multiple assets. Taking these steps to enable the execution of corporate-wide initiatives is essential to remain competitive.

Figure 5
Corporate-wide asset utilization & optimization



Production planning

"Schneider Electric found that 100% of process optimization and modeling software users surveyed feel that it improves the profitability of their process."

Production planning means meeting oil or gas production requirements in the short term and getting the most out of existing assets and preserving the ultimate recovery of the field over the long term. The models of the processing facilities and wells/networks are used together with constraints from the reservoir planning as inputs to the planning.

On the asset/facility level, short-term planning helps anticipate problems and performance issues, and warn about current issues. Integrating production planning and maintenance can help ensure schedules are met reliably and in a timely manner. However, given the large footprint and changing landscape of bringing new unconventional sources of oil and gas online, executing production planning for an individual asset can be difficult and costly. There is a greater advantage when production planning is done at a higher level, taking into account multiple assets operating interdependently. It can take into account current and expected production, as well as operations downstream from the upstream asset.

The objective of this application is to provide a solution for simulation and optimization for surface networks incorporating practically every piece of equipment, from wellhead to the processing plant. The application simulates the total production system behavior and concurrently optimizes the production, honoring the user-defined economic model — typically resulting in substantial production increases and/or reductions in operating costs.

Energy optimization

"Improvements from real-time energy control and optimization deliver reductions in energy costs of 3–8%."

Industrial companies may have executed energy management programs designed to reduce the consumption of energy by the operation in the past, but consumption is only part of the challenge. Reducing energy consumption during peak pricing periods and operating energy-intensive operations during low pricing periods may have a broader impact on the bottom line. Besides overall consumption reductions in real time, the true objective of energy optimization is to drive and control production value, feedstock costs, safety, and environmental stewardship.

To accomplish this, a model-based real-time measurement of energy accounting and KPIs is required at each consumption, production, transfer, import, or export point in the plant. This allows for real-time updates of critical production, feedstock, safety, and environmental variables that are directly or indirectly impacted by energy and provides a balanced approach to energy cost management across a production operation. This transparency also empowers critical plant personnel to deliver a reduction in energy costs through their everyday tasks.

Inventory management

"Off-sites inventory management recaptures ROI in less than 6–12 months."

Consistent and accurate inventory information is important for optimal planning, scheduling, and material loss management. This can be accomplished with off-sites inventory management and blend optimization solutions in conjunction with smart instrumentation to optimize tank farm and terminal operations. Increased automation and information management reduces quality giveaway, avoids reprocessing, and improves accounting accuracy. Reduced product cost and faster time to cash are the result, while also increasing customer satisfaction.

Flow assurance

Flow assurance ensures proper expected flow in pipes to prevent production interruptions or asset damage. Proper flow needs to be ensured from the reservoir through the point of sale. Network modeling and transient multiphase simulation are typically required as part of flow assurance efforts. The real-time transient modeling of gas and liquids pipelines allows for the optimization of pipeline operations for greater efficiency, effectiveness, and an improved bottom line through analysis and optimization of the cost of transporting product.

Value of a single software solution

Programs, functions, and metrics are only half the consideration in developing an asset. Measurable value lies in using a single set of integrated software tools across the entire asset and throughout its entire lifecycle. This single user interface for development, execution, and optimization provides unmatched economic value.

Modeling a single asset

Pipeline network models are typically designed and optimized in conjunction with reservoir modeling capabilities, which provides a single rigorous model for designing, rating, and simulating the surface facility or plant while preserving the integrity of the subsurface details. Added value is achieved from combining this model with feedstock evaluation and data management, as well as planning and scheduling software to monitor crude quality or compare stream data for blending to pipeline, tank/terminal, and refinery specifications. Incorporate cost estimation and detailed equipment design into the same model to easily balance design with economics early on in the evaluation process.

The value of a single integrated model proceeds from there. Engineering use the dynamic simulation to validate the process designs and test safety and control schemes. They will then pass these models off to Maintenance, who use the dynamic simulation as the basis to conduct startup commissioning and operator training, and safely operate the facility. A common base of tightly integrated products ensures a moderate learning curve, transferable skills, and reduced commission and start-up times.

The same dynamic model can be passed off to Production to advance control system design and troubleshooting, hooking in the plant's control systems. Real-time optimization, together with advanced process control software, can then be used to determine the optimal operating parameters for a process to deliver the targeted operational results while subject to feed, safety, environmental, and other constraints. This combined optimization solution can monitor performance, control operations, and obtain peak performance to deliver the maximum benefit in large and complex process plants where the scale and complexity requires formal solutions.

Performing corporate-wide asset optimization

The same software tools used to design, operate, and optimize an individual asset can be used for the asset-wide optimization of production, energy, inventory, and flow. This common base eliminates the need for rebuilding models, re-entering data, and additional training. A real-time optimization tool is the underlying powerhouse for driving these initiatives and is often used across the entire enterprise for real-time optimization applications, plant data reconciliation applications, and asset monitoring.

For production planning, a composite solution is based on the real-time measurement framework where the network model is embedded within, and the crude library is accessed directly from, the process model. The coupling of real-time optimization with blending functionality provides the flexibility to evaluate blends for any pipeline, tank, and refinery specification while optimizing the integrated asset model.

For energy optimization, model-based real-time measurement of energy accounting and key performance indicators at each consumption, production, transfer, import, or export point in the plant is key. This allows for real-time updates of critical production, feedstock, safety, and environmental variables that are directly or indirectly impacted by energy and provide a balanced approach to energy cost management across a production operation.

For inventory management, software that can accurately and reliably access inventory and movement information, automate movement, and perform multi-blend optimization is imperative. The integration between inventory management and real-time optimization allows actual crude blend assay and other properties to be passed directly between the two portals. Inventory blend data now becomes the input for enhancing the accuracy of the optimization model, and optimization data is passed back to inventory management software. Increased automation and information management reduces quality giveaway, avoids reprocessing, and improves accounting accuracy. Results from this cohesive solution include reduced product cost and faster time to cash, while increasing customer satisfaction at the same time.

For flow assurance, the power of coupling a network assurance model (which accurately models multiphase flow in single pipes or in complex networks) with real-time optimization software (which optimizes conditions given real-time data and its optimization capabilities) provides a strategic advantage for planning the flow of all fluids used and transported in the extraction of oil and gas.

As is evident, real-time optimization software provides numerous performance-enhancing solutions with the ability to view what is happening at any specific plant now and make appropriate and timely business decisions. This single integrated solution is critical for optimal operation and allows customers to remain competitive in changing economic times.

Conclusion

The vibrant oil and gas industry is expanding at a stellar pace. As the industry continues to pursue more unconventional sources of oil and gas and recover more from conventional reserves, better, smarter technology is being developed to improve production output and oil recovery. But technology is only part of the story. To drive growth, maximize profit, and minimize risk, upstream asset development must be considered holistically.

Whether the asset is onshore or offshore, conventional or unconventional, oil or gas, considering asset development and utilization holistically can provide many advantages, the largest being financial. That means viewing reservoirs, wells, platforms, pipelines, and processing plants as a single entity with all the modeling, resources, performance metrics, costs, and schedules for which an operator is responsible

A single set of integrated software tools across the entire asset — from reservoirs to wells to surface facilities to process plants — has been shown to improve profitability by increasing production and oil recovery, reducing costs, and mitigating risk. A fully integrated model provides a common interface for field planning, operations decision support, and real-time asset management. The same continuous model of assets are leveraged throughout their entire lifecycle, starting with the engineering design through operations and into optimization and planning.

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