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THE BENEFITS OF REFINING OPERATIONS MANAGEMENT – PART 2

Enabling Step-change in Performance with Refining Operations Management

WHITE PAPER

October 2018

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Executive Summary

AVEVA Refining Operations Management™ (formerly known as the Integrated Refinery Information System or "IRIS") has been implemented since 1996. Refining Operations Management focuses on enhancing the work processes rather than simply being a technology-centric vision. The objective is a sustained change in behaviors, which is key to achieving and sustaining the step-change.

Audience

This document is intended for business leaders in the Refining industry who are seeking to drive a step-change in performance improvements across their end-to-end value chains by leveraging an integrated digital operations strategy.

Summary

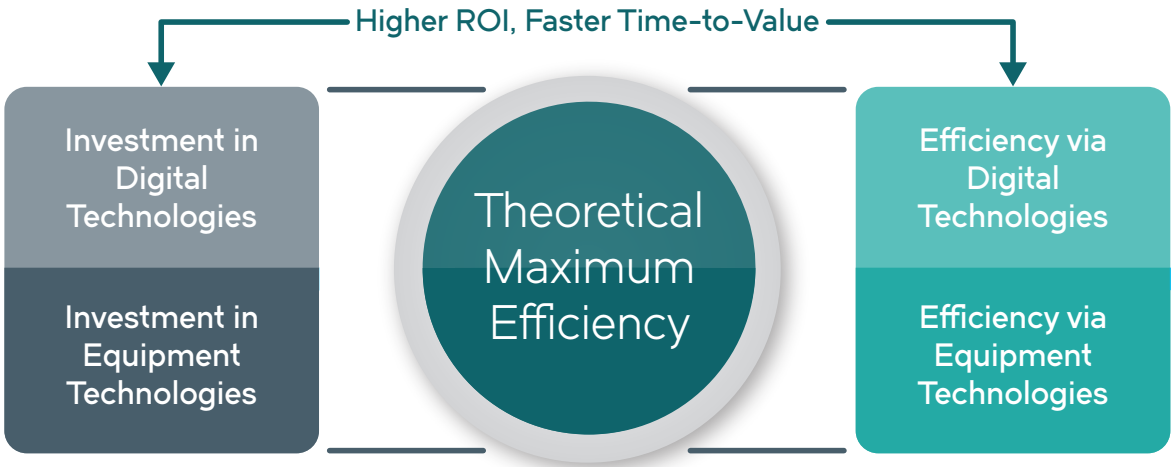
This document is the second in a series of three whitepapers on Refining Operations Management (formerly known as the Integrated Refinery Information System or "IRIS"). The focus of this paper is on the benefits of deploying Refining Operations Management to the business and its stakeholders as summarised below:

- **Refining Operations Management is about the Smart Plant:** The "smart" label often connotes a technology-centric vision of sensors and big data analytics. In contrast, we present a more holistic definition where the work is the center (instead of the technology) and the different work practices shapes the required technology.
- **Refining Operations Management do's and don'ts from project experience:** In this section, we condense 20 years of experience in implementing Refining Operations Management projects of various scopes into a few nuggets of wisdom for maximising transformation success.
- **Refining Operations Management benefits – client examples:** This section briefly summarises 5 client examples of Refining Operations Management projects along with their corresponding impact on operations.
- **Refining Operations Management benefits – functions impacted:** Refining Operations Management presents the opportunity to improve both functional and cross functional processes, and this section presents examples of benefits realised by the various functional departments.
- **Refining Operations Management improvement methods:** Finally, we walk the reader through 12 proven improvement methods that have been used to extract the captive value within refining operations.

Introduction

Refining Operations Management is a strategy enabler. As such, its ability to help achieve and sustain significant performance improvement depends upon the improvement opportunities and the strategy. It is recognised that implementing and evolving Refining Operations Management is very different from installing new process equipment or catalysts; Refining Operations Management delivers improvements in unique ways, and requires a different approach to achieving the next level of performance improvement.

Refining Operations Management is an information technology-enabled approach to maximise the value from refining assets. As illustrated below, while investment in software is a fraction of the total investment in a refinery, its impact on efficiency is disproportionately higher because it gives us the information to optimise that asset by balancing the various operating goals of safety, productivity, and profitability.



So what's the best way to maximise this type of performance impr`ovement? The traditional approach is an application-based approach, with many "value leaks," of which some are obvious, and some are hidden. AVEVA uses the phrase "value leaks" to include missed opportunities to increase business value and missed opportunities to prevent reduction in business value. This white paper describes several examples of these. In contrast, the Refining Operations Management approach is an integrated approach that eliminates operations disconnects, distortion, and delays, to consistently and safely operate closer to the maximum performance capability.

Traditional:
An Application-based Approach

Refining Operations Management:
An Integrated Approach

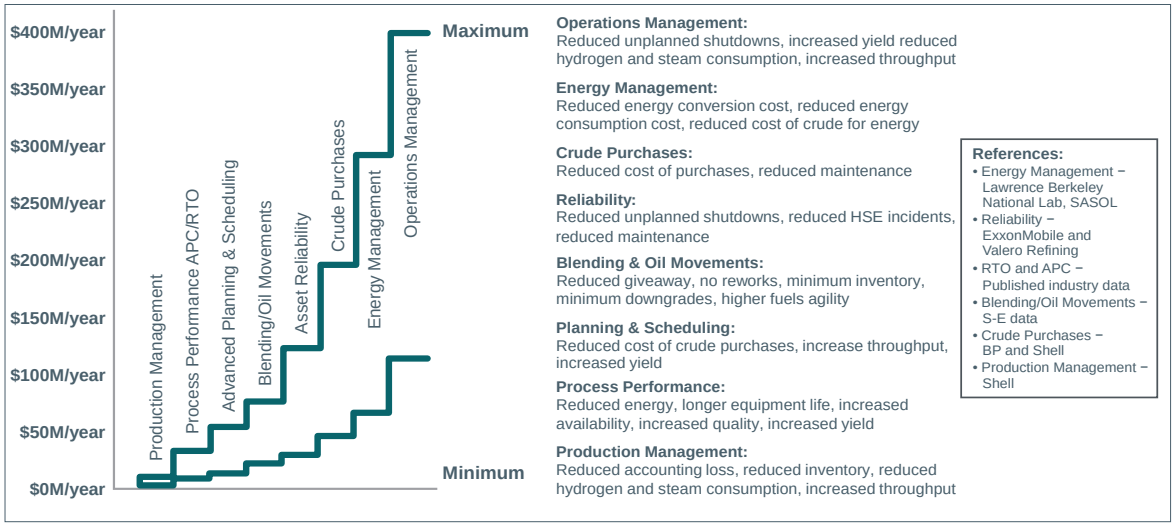
Many world-scale refineries already have a set of applications and some presentation tools, such as reports, desktop-accessible data, and some partially automated procedures. The following diagram summarises a journey of gradually adding software technology to improve business performance:

In the above diagram, many refineries have made progress on a journey which has gradually increased the adoptions of software tools. Tools by themselves have limitations; the next level of business performance requires integration of people, processes and technology, and techniques to sustain operations excellence. These are indicated in the top 2 layers of the above diagram. Refining Operations Management implements these top 2 layers – the objective isn't to add more technology for its own sake, but to transform the integration so that business processes are digitised and interact with people in effective ways.

Why Refining Operations Management is about the Smart Plant

Our view of the "Smart Plant"

As described in the white paper "Enabling a Step-Change in Performance for Refining Operations," a 400,000 bpd refinery can achieve and sustain a revenue increase of at least 1%, which is worth more than USD 67 Million per year, energy efficiency of at least 4%, which is worth more than USD 20 Million per year, and further cost reductions of at least 1%, which is worth more than USD 60 Million per year. These savings are based on early 2015 crude oil and product prices.

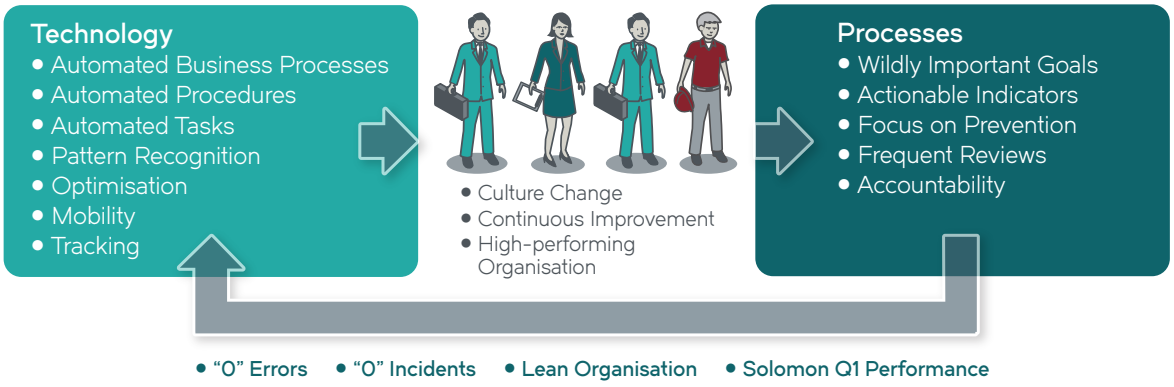


To achieve and sustain this level of performance, the refinery needs to operate differently. This type of operation is often called the Smart Plant. The refinery isn't "smart" because it has more sensors, more data or more computers; it is "smart" because it operates in a "smart" manner, which means that undesired events are prevented more frequently and desired opportunities are "exploited" or taken full advantage of more often.

There are several definitions of Smart Plant; for this white paper, we propose using the following definition:

- A Smart Plant has a transformation to "smart" work
- That is enabled by technology
- That is governed by business processes
- To sustain a strategy

In this definition, the work is the center instead of the technology, and the different work shapes the required technology. The following diagram highlights some of the key interactions between the workers, the smart work and the enabling technology.



There are 4 key aspects of the above diagram:

1. The way that people work has changed. This is the most challenging to achieve, where performance, including failure is more visible, and responsibilities are measured more precisely.
2. The workers are governed by a set of business processes, which help them and their management to achieve, sustain and then improve the targets.
3. The technology is shaped to support the new ways of working, with an emphasis on enhanced decision-making and actions instead of enhanced reporting.
4. The goals are aspirations but these are consistent with best practices of quality management, which include elimination of "waste" – wasted work, wasted quality, wasted opportunities etc.

End-State Vision

The end-state vision of a Smart Plant is less about supercharging the refinery IT Dept and more about a sustained change in behaviors. Characteristics of these changes in behaviors include:

- Solomon Associates first quartile performance in several categories when compared to other refineries in the region.
- A "lean" organisation. This often means having approximately the same staff for field workers, but fewer experts and managers for the same operation, or the same staff for a greatly expanded operation.
- A new "smart" working culture, with teamwork, workers trust each other more (no secrets, activities among departments are harmonised), and everyone is focused on common business objectives.
- Increased automation for prevention, although "automation" doesn't imply control systems.
- Arrangement of information for timely and accurate actions, called Situation Awareness, which doesn't imply control systems.
- An effective operations center.
- A virtual Smart Plant that is used for sustaining culture change, training and continuous improvement.

Departments Impacted

The Smart Plant often has an impact on up to 10 departments or functional teams:

- Refinery Supply
- Planning
- Scheduling
- Operations (operators)
- Operations (optimisation)
- Production Support
- Production Accounting
- Reliability
- Maintenance
- Environmental Health & Safety

Challenges

Each refinery is different, but often we observe common challenges. Teams often have difficulty in knowing early enough about desired and undesired situations. Teams also have difficulty in responding to situations, including prevention, in a sufficiently consistent manner. Workers don't always act on good information — as a result, much of the information is ignored for good reasons.

Along with the above challenges, the greatest challenges can be culture, even if it is with only one team or department within the refinery. Although more visible reporting has been implemented in most refineries for more than 15 years, there are often workers, including middle managers, who try hard not to share "bad" news, and sharing is the only way that the larger teams can work together to achieve and sustain the expected business improvement.

Using Refining Operations Management is very different than installing a new piece of equipment or catalyst. By definition, the equipment and catalysts are passive and less visible. Refining Operations Management is necessarily very active (often prescriptive), and quite visible.

Refining Operations Management Project Experience

Refining Operations Management has been implemented in various scopes since 1995. Although the technology continues to evolve, we have learned the following "wisdom" concerning achieving business success with Refining Operations Management:

Do's: Patterns for replicating success

The following 4 patterns for success have been consistently observed over the past 20 years:

- Refining Operations Management projects were designed as work transformation projects
- Refining Operations Management projects were implemented as holistic integrations of people, business processes, strategy and technology
- Senior management actively sponsored the "new way of doing work"
- The Stephen Covey "high performing organisation" is present, based on the Covey "4 disciplines of execution," which are addressed further below in this white paper

Don'ts: Patterns to be avoided

Unfortunately, the following 5 patterns for failure have been occasionally but consistently observed over the past 20 years as well:

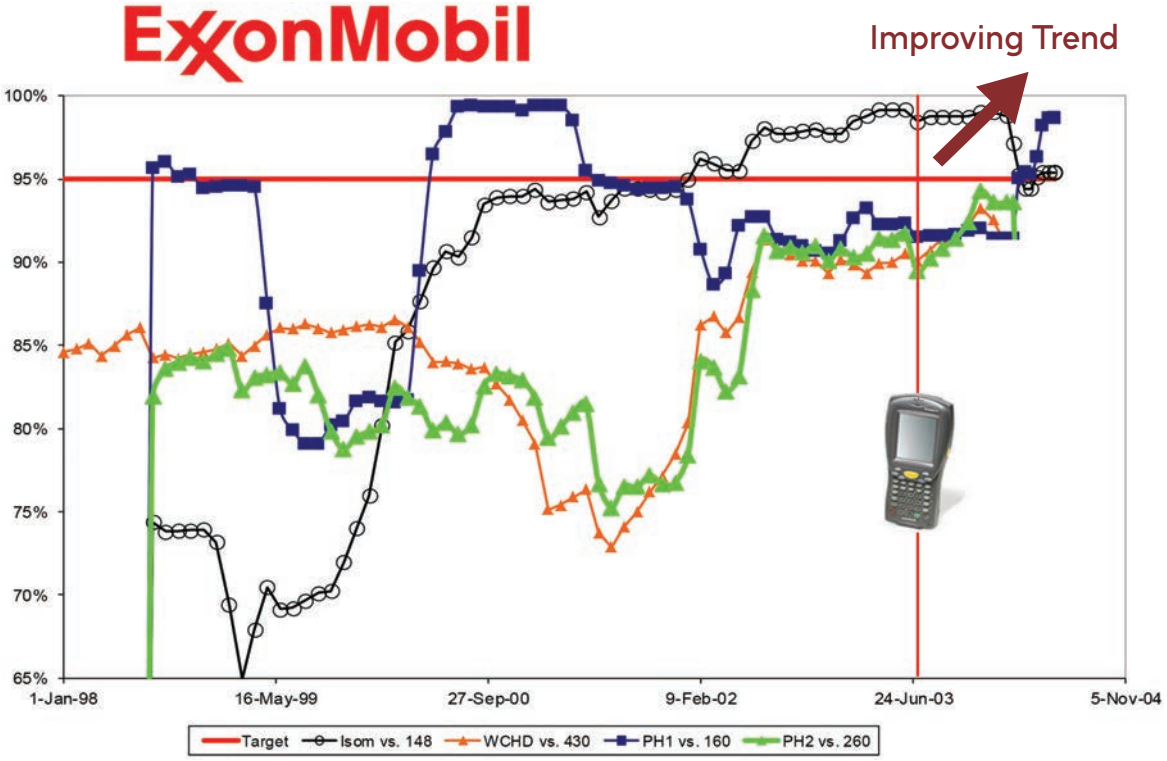
- Refining Operations Management projects were designed as technology projects
- Refining Operations Management projects were implemented as technology roadmaps
- There was insufficient organisation change management
- There was insufficient integration of people, business processes, strategy and technology
- There was innovation fatigue — the required changes in work and technology were implemented in too many small steps

Benefits: Client Examples

ExxonMobil

ExxonMobil has publicly acknowledged two components of their Refining Operations Management projects with associated benefits. These include:

- Increased availability through workflow automation. This is an example of "smart" work that increases overall availability beyond 95%



- Increased utilisation through integrated unit optimisation. This is part of a unified on-line modeling approach, which allows several departments to share a single version of the truth.
- ExxonMobil uses AVEVA as their corporate standard for:
  - Process Optimisation
  - Equipment and Process Health Monitoring
  - Hydrogen Management
  - Operator Training
- AVEVA's partnership with ExxonMobil Research and Engineering, incorporating proprietary reactor modeling technology into the ROMeo platform.
- AVEVA's real-time optimisation solution is a key contributor to benefits exceeding $700 Million per year to ExxonMobil.

AVEVA's real-time optimisation solution is a key contributor to benefits exceeding $700 Million per year to ExxonMobil.

Introduction

Valero

Valero has publicly acknowledged one component of their Refining Operations Management projects with associated benefits. This is increased availability through field workflow automation. The chart below shows rapid and sustained reduction in maintenance costs, as part of an Operator-Driven Reliability (ODR) program:

Shell Canada

Shell has publicly acknowledged two components of their Refining Operations Management projects with associated benefits.

- Measurement Management

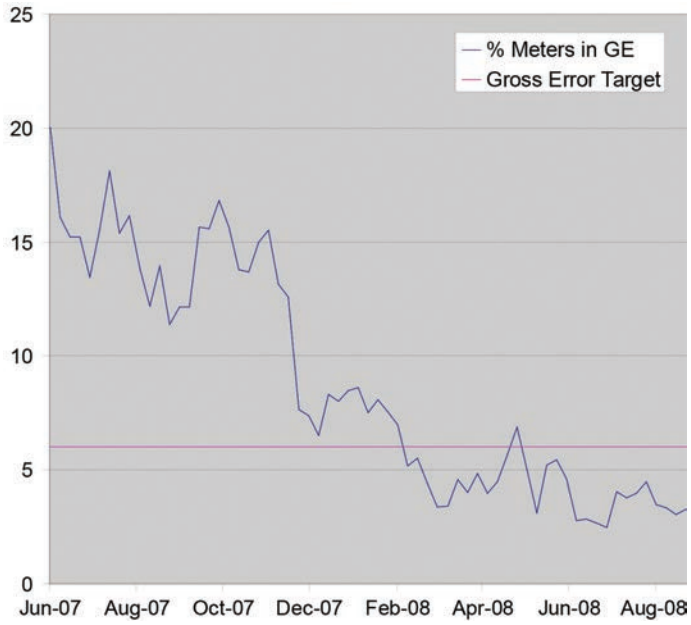
Shell has implemented performance measures for technical support personnel and on-line data reconciliation with material balancing. The result has been significantly reduced measurement errors, and significantly higher trust and use of their Refining Operations Management solution. In Canada, the Shell group of refineries have sustained Solomon Associates 1st quartile performance, which Shell asserts is due in part to this solution.

The trend chart on the right was from the pilot, which was the start of a successful journey across the entire refinery group.

- Integrated Unit Optimisation

Shell has been an early adopter of unit optimisation, and their key to expanding and sustaining the use of this technology was to use AVEVA technology which Shell claims very low cost to support as a ratio to benefits achieved. This measure is key to proving sustainability of the technology.

- 1997: Joint development relationship for ROMeo with Shell
- 2006: Shell Canada collaborates to create Material Balance Module for meter accuracy monitoring
- 2008: Corporate agreement for off-sites movement monitoring and inventory management
- Currently rolling out ROMeo to all Shell sites globally

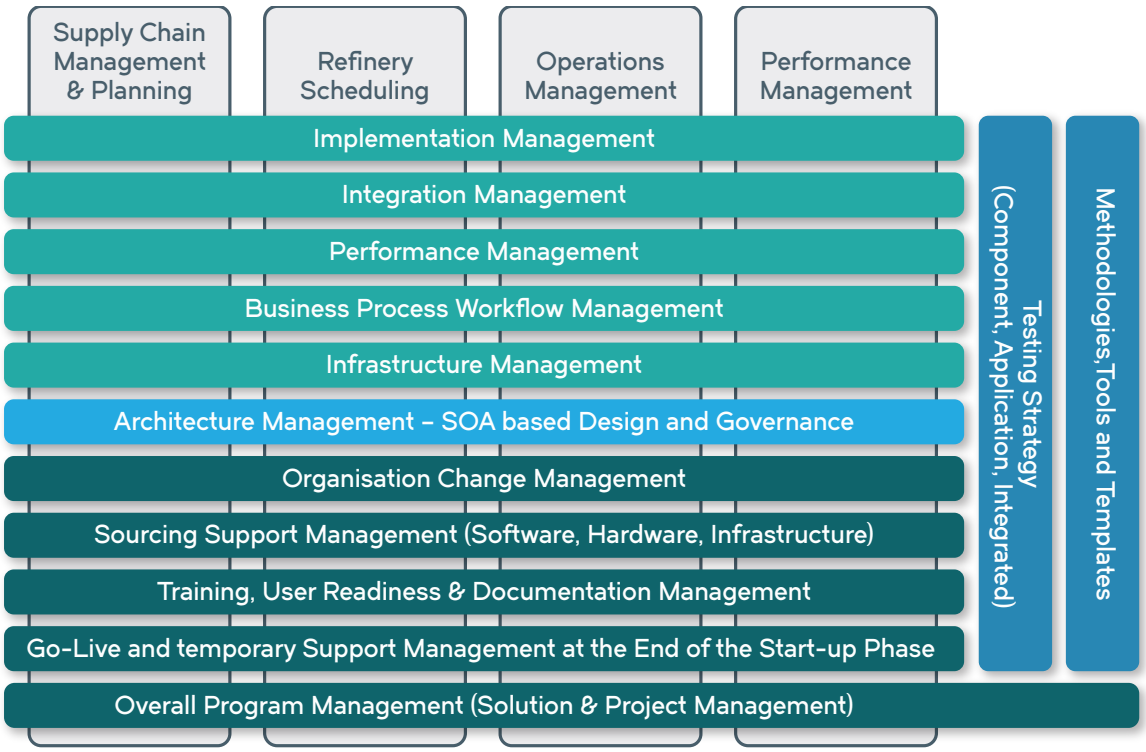


" Shell spends about $25 in support costs to achieve $1,000 in benefits from optimisation."
–Bert Onstott,
Shell Global Solutions

The information above shows the beginning of a journey which has evolved for 18 years to increase the adoption of integrated unit optimisation for all of their refineries.

SATORP

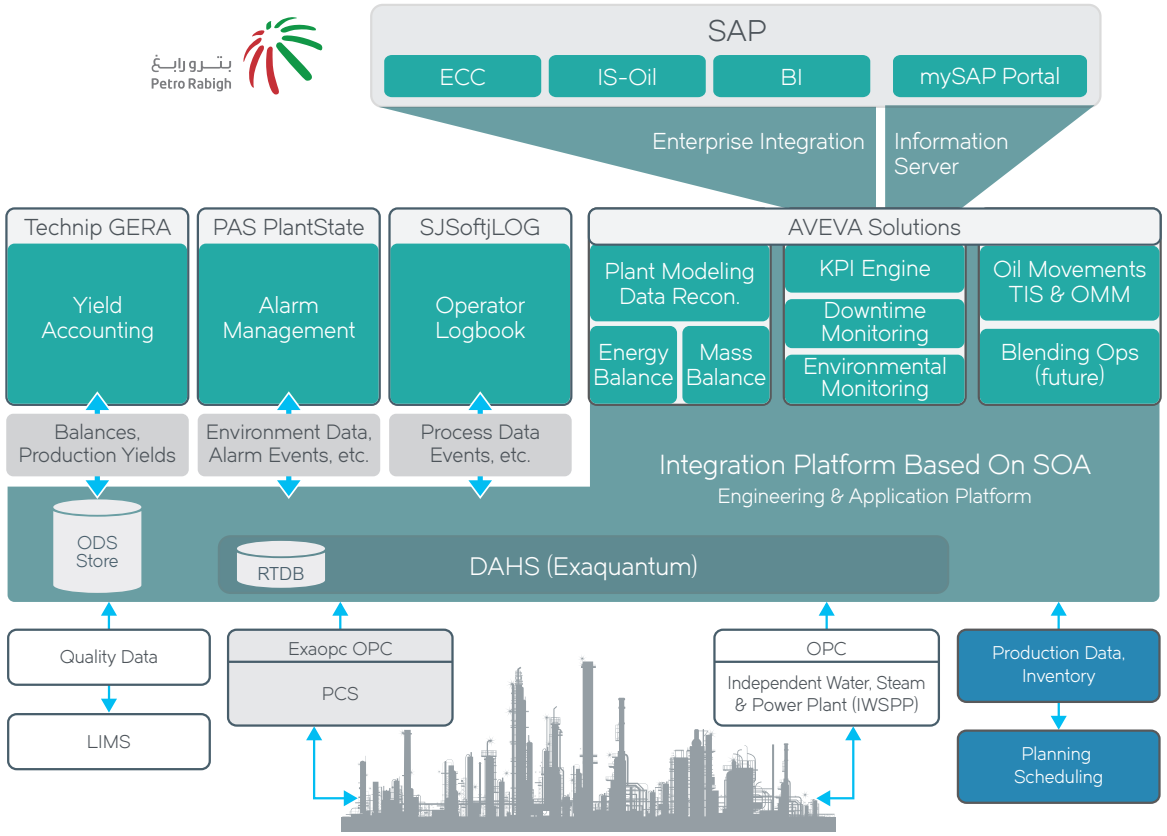
SATORP is a joint venture between Total and Saudi ARAMCO. SATORP has implemented a business — process driven Refining Operations Management solution which includes business processes from pricing to shipping logistics, and from inventory valuation down to HSE. This solution has been in use for 1 year, and SATORP has not yet released the economic benefits..



The above diagram shows how 10 project activities, including organisational change management, were implemented across a set of 15 applications for the full scope of digitised business processes.

Petro Rabigh

Petro Rabigh is a joint venture between Sumitomo Chemicals and Saudi ARAMCO, and one of the key partnership reporting measures is frequent material balances throughout the complex. This reporting mechanism uses a digitised business process to handle measurement errors, missing measurements and imbalances and all levels of the organisation use this. This is an example of a sustained solution.

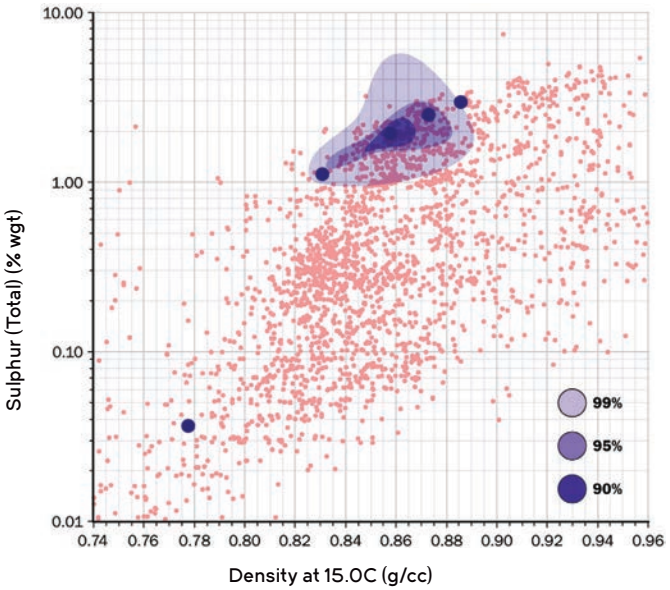


The above diagram shows the scope of the Refining Operations Management solution, which also addresses HSE, operations management, off-sites management and operations support.

Benefits: Functional Areas

Planning and Scheduling

AVEVA uses the phrase "value leaks" to include missed opportunities to increase business value and missed opportunities to prevent reduction in business value. While some refinery groups have best-in-class planning activity when measured by accurate and up-to-date crude assays, the planning department is limited by the amount of information integration and digitised business processes which provide the "right" information about refinery schedules and performance. Refining Operations Management allows planners and schedulers to work with complete and trustworthy information, and test planning and scheduling scenarios against the refinery configuration which incorporates maintenance activity and changes in equipment performance. It is important to note that crude quality varies significantly even for single-source supply, such as shown in this scatter graph.



For refineries which process multiple crude oil qualities, the following benefits can be achieved and sustained for a 400,000 bpd refinery at early 2015 crude oil prices:

Estimate typical value impact of cargo quality variations ≈ $0.50/bbl = $69 Million/year.

Estimate $0.15/Bbl increased revenue or decreased crude cost = $20.8 Million/year.

- Estimate 4 hours off-spec product per crude switch
- Estimate crude switch frequency is every 3 days = 116 crude switches/year
- Estimate 464 hours of off-spec product and yield loss = 7 Million Bbl/year
- Assume $0.10/Bbl loss = $0.7 Million loss from crude receipt scheduling
- Assume $1.5 Million/year demurrage costs
- Estimate 30% reduction in demurrage = $0.9 Million/year

Total $91 Million/year for a 400,000 bpd refinery using early 2015 crude prices.

Actual benefits will vary based on the frequency of crude switching, feedstock blending, and the integration of operations activities.

Blending and Oil Movements

A common challenge is achieving gasoline/petrol high octane and low sulfur properties at minimum cost. Two symptoms of operations difficulties are reblending in product tanks and quality give away. Smart blending "repairs" almost all blends during the first blend run, using the minimum cost of components. Smart blending integrates quality analyses from the refinery units with the quality analyses of the blend runs, and optimises frequently during the blend run (instead of using only one set of targets for the entire blend run). Refining Operations Management integrates these and digitises the business processes when scheduling must assist and assess the impact of modifying the schedule to avoid reblending the current run.

- Estimate 55% capacity for gasoline/petrol products
- Estimate 5 blends per day at 44,000 Bbl/blend run
- Estimate 7.6 million Bbl/year reblended due to 10% reblends
- Estimate $0.80/bbl reblending cost (utilities, demurrage, loss of inventory) = $6 Million/year
- Estimate $0.60 per octane barrel giveaway
- Estimate 0.3 RON quality giveaway
- Estimate 10% blends are overblended = $12.4 Million/year

Total $18.4 Million/year for a 400,000 bpd refinery using early 2015 crude prices.

Operations Management

One of the most significant performance improvement is energy efficiency which comes from stabilisation through better coordination and improvements in steam, hydrogen and fuel gas management. There are at least 5 energy management studies for petroleum refineries that were conducted by government and industry organisations which consistently demonstrate that Refining Operations Management solutions can achieve and sustain the following improvements:

- Improved heat recovery within and across process units of 4 to 9%
- Utilities(primarily steam) conversion efficiency and demand/supply balancing of 2 to 3%
- Hydrogen and fuel gas management which maximise hydrogen and LPG recovery for 1 to 2%
- Estimate $17.3 to 32 Million/year for a 400,000 bpd refinery using early 2015 crude prices

Production Management

As noted by some of the reference customers described earlier in this paper, measurement loss is an important area for improvement, not only for its own benefit, but to improve the contribution of the other performance improvement methods. Lack of accurate weight / volume balance around process units, as well as receipts and shipments (i.e. flaring, spills, emissions, custody transfer, and other physical losses, especially if uncontrolled) easily account for 1% of the total weight input. A more significant weight balance could save at least 20% of these losses. Estimate based on crude oil value.

- Estimate 1% measurement loss in mass/volume balance
- Assume that measurement loss can be improved to 0.8%
- Measurement recovers 176 Million pounds / 591,000 Bbl/year

Total $15.3 Million/year for a 400,000 bpd refinery using early 2015 crude prices.

Asset Reliability

Our experience has shown that it is achievable to significantly improve overall operations availability, by improving asset reliability.

- Estimate 1% improvement in overall availability (larger improvements are feasible)
- Estimate $53.7 Million/year increased revenue
- Estimate overall maintenance cost reduction of 3-5%
- Estimate maintenance cost benefits of at least $13.9 Million/year

Total $67.6 million/year for a 400,000 bpd refinery using early 2015 crude prices.

Improvement Methods

Improvement No. 1. Covey's 4 Disciplines of Execution

There are several methods for improving organisational performance, but one of the most practical is Dr. Stephen Covey's **The 4 Disciplines of Execution**. All methods to improve organisational performance must address organisational change management, because these methods always include sharing of performance, both good and bad.

This method focuses on 4 changes:

1. Focus on the "wildly important goals," which may vary throughout the year. This is because all attempts to convert the most important goals into goals for teams and individual contributors introduce some distortion in how their goals affect the most important ones.
2. Act on the leading measures, which drives a continual assessment of which measures are "actionable," which is often the basic ability to adjust performance early enough to prevent undesired performance and take the most advantage opportunities to improve performance.
3. Keep a "compelling" scoreboard, which drives a transformation in the frequency and selection of performance measures for each team and contributor.
4. Create a cadence of accountability, which includes a business process which helps middle managers to consistently negotiate the next set of targets and assess performance across shifts.

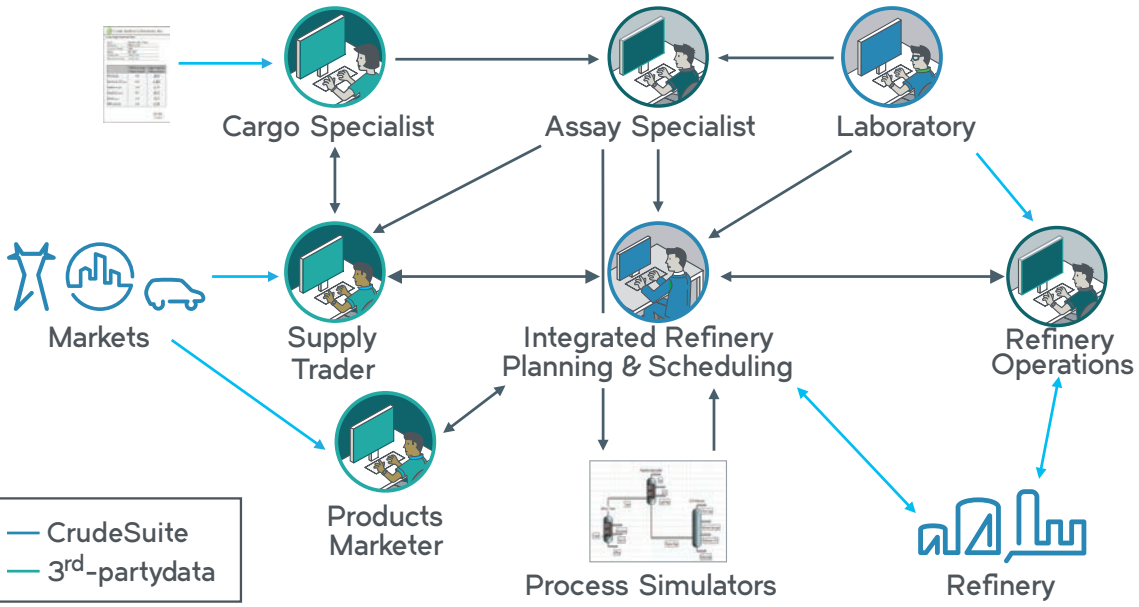
AVEVA has patented approaches 1991, and helped refineries, petrochemical plants and other heavy process operations achieve and sustain these 4 disciplines of execution.

Improvement No. 2. Cross-Functional Teamwork

Establishing clear roles and responsibilities is always important for safety, quality and general productivity, but teamwork is essential to reduce "value leaks," especially due to delayed and distorted information that should be shared and transformed between teams. The business process to assess the refinery's capability to process a candidate crude for a product slate is a prominent example, and there are others for energy management etc.

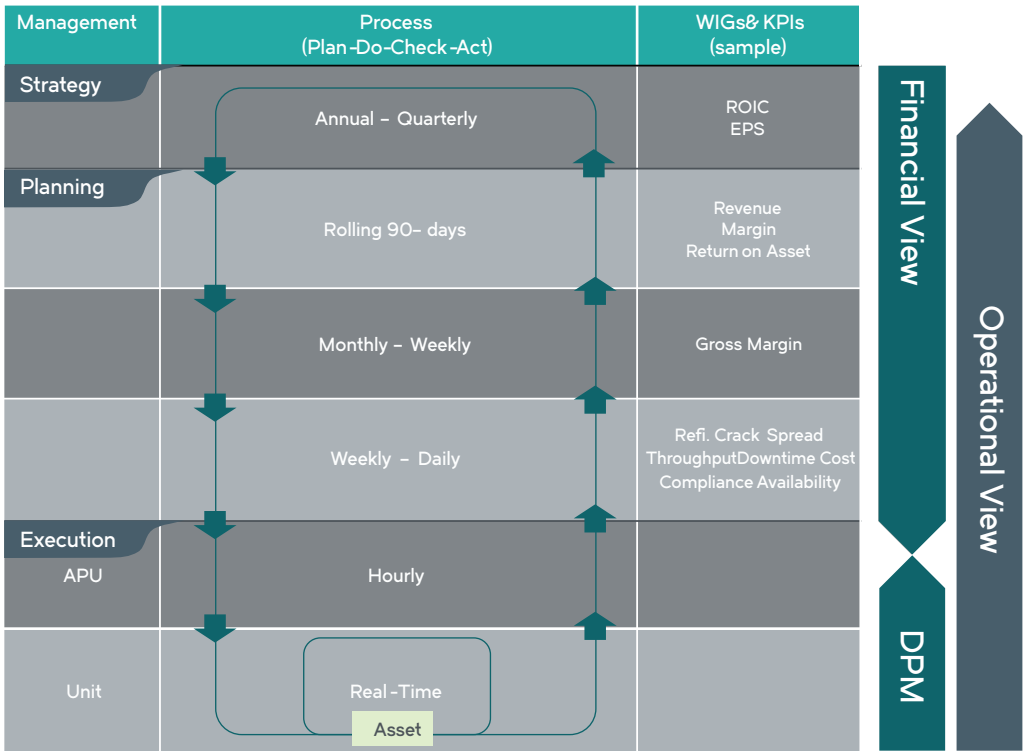
	Siloed	Coordinated	Integrated	Optimised
Description	Functionally optimised approach; no business integration	Some functional collaboration, but limited business alignment except for major events & decisions	Enterprise focused approach to value chain, but business & value chain strategies not fully aligned	Unified business & value chain strategies, driving enterprise optimal decision making
Benefits	Operational plan focused	Supply & demand matched to meet commercial obligations	Increased profitability & improved decision making	Maximised economic value for enterprise
Capability Requirements	Deep functional knowledge, but does not require documentation	Formal, structured approach; point-solution technology toolset	Process tailored to business needs; technology tools built to support processes	Tool & processes are fully integrated to support risk-value tradeoff & value chain optimality

The above table is derived from the analyst firm ARC which has observed the characteristics of improved collaboration across departments and teams.



Improvement No. 3. Real-time Performance Management

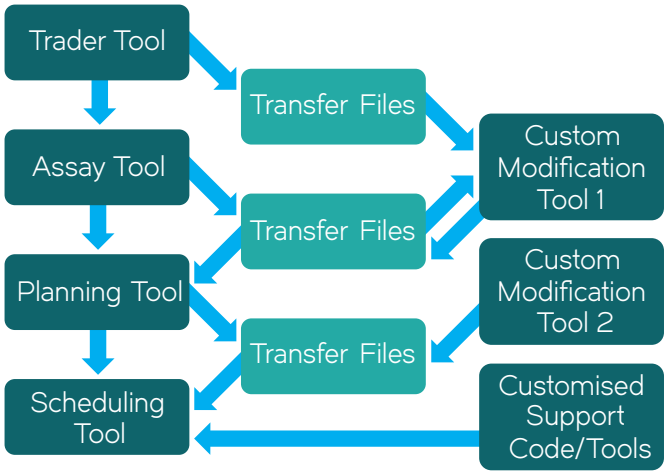
Although designing performance measures with appropriate frequency and ability to act upon them early enough is critical, governing these and balancing the selection across organisation levels is also critical. Most targets are designed only from the business goals, and our experience of 24 years has shown that operations goals are also necessary. The following diagram shows an example of interaction across 4 levels of the organisation to respond in "real time" (appropriate for the operations activity) to intervene on undesired performance. This is very different from reviewing data every 30 days.

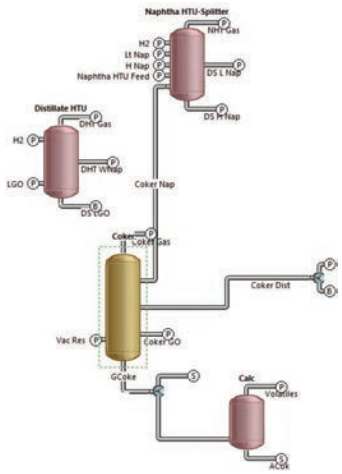


Improvement No. 4. Smart Planning and Scheduling

"Smart" planning and scheduling digitises the forward business process of evaluating crude and product slates in future operations and maintenance scenarios, and it digitises the feedback business process of understanding operations activities for maintenance and oil movements.

The key transformation is automating the assessment and analysis of proposed and actual planning and scheduling decisions. The key to "smart" planning and scheduling is to unify the planning and scheduling process and empower the planners and schedulers with "smart systems" that contain years of refinery process knowledge and business process logic build into their tools. This near real time "one version of the truth" enables the planners and schedulers to collaborate effectively and focus on more important optimisation decisions than some of the daily time consuming tasks performed today.



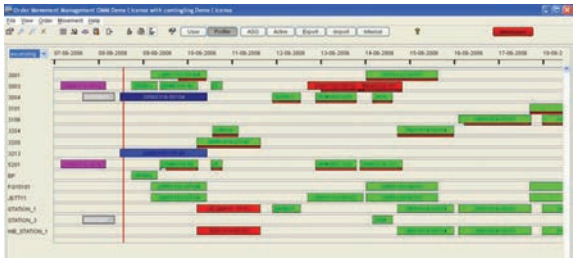


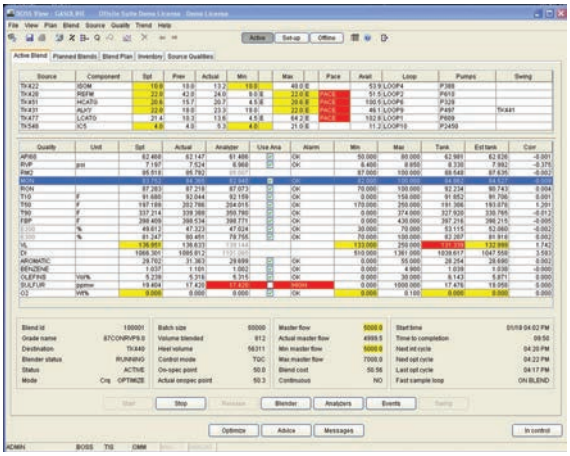
The above left-hand diagram is a summary of typical "integrated" planning and scheduling; the above right-hand diagram is an example of "unified" planning and scheduling, where a scheduler can clearly see the operations configuration if a process unit will be available or not, and the impact on processing a selected crude for the scheduled products. The scheduler can perform this check quickly without requiring process engineers to perform an analysis — manually — several days later. An example like this addresses the "value leaks" that are mentioned in this white paper.

Improvement No. 5. Smart Blending and Oil Movements

Smart Blending continuously optimises, which helps to prevent almost all re-blends (repairs blends during each run) and makes "hot" blending (direct feeds from the process units) feasible.

Smart Oil Movements reliably tracks and guides movements even when valves are opened or closed during the movement (splits or joins 2 movements).





The left-hand image above shows a screen display for "smart" oil movements, which reliably tracks movements even when a valve is opened or closed during the movement. The right-hand image on the previous page shows a screen display for "smart" blending, which is optimising every cycle, and clearly displays limitations and constraints during the blend run. The smart blending has been reliably used for "hot" blending directly from process units, for blending directly into pipelines, and for blending with other product tanks to maximise throughput.

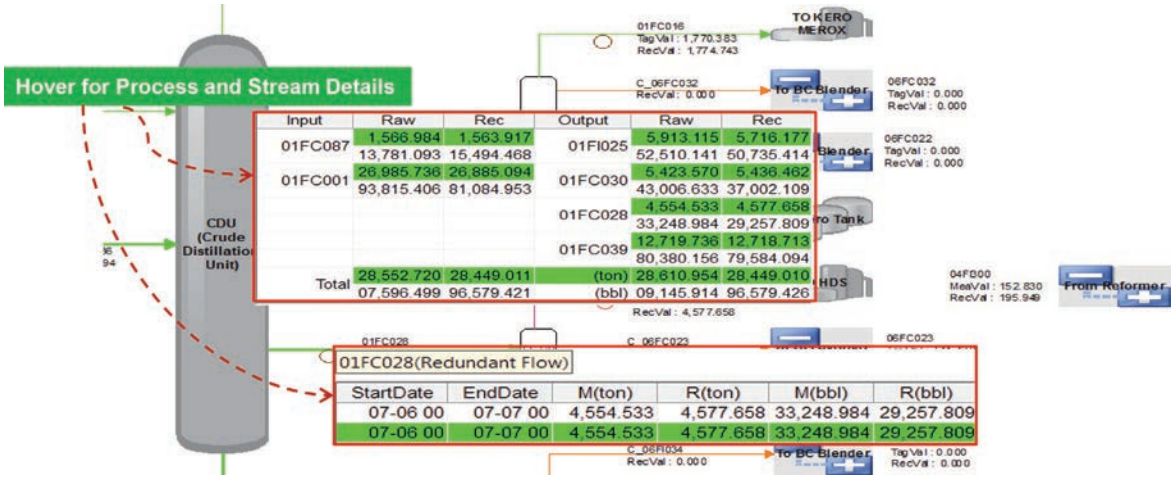
Improvement No. 6. Smart Production Management

Site-wide near real-time integrated yield accounting and production management is a key enabler to maximising trust in Refining Operations Management and maximising yield. Key leading practices regarding production management with regards to quality control include the following:

Production Management

Issues	Landing Practice Characteristics
Accounting	Accurately tracks material use - Reduce inventory levels
	Identifies custody transfer measurement issues
	Provides for the identification, explanation and elimination of losses - real and apparent
Operational	Improves yields and recoveries
	Calculate and predict production without inclusion of gross errors and with self-consistent validated information
	Identify faulty measurements that would otherwise constrain plant performance
	Provide more effective instrument maintenance
	Increase operator information
	Provide operation with balance data to aid operational decision making

The above right-hand screen image shows an effective application which clearly indicates by color any process streams which have imbalances, and this image also shows how hovering over process equipment also reveals actionable information about material balances.

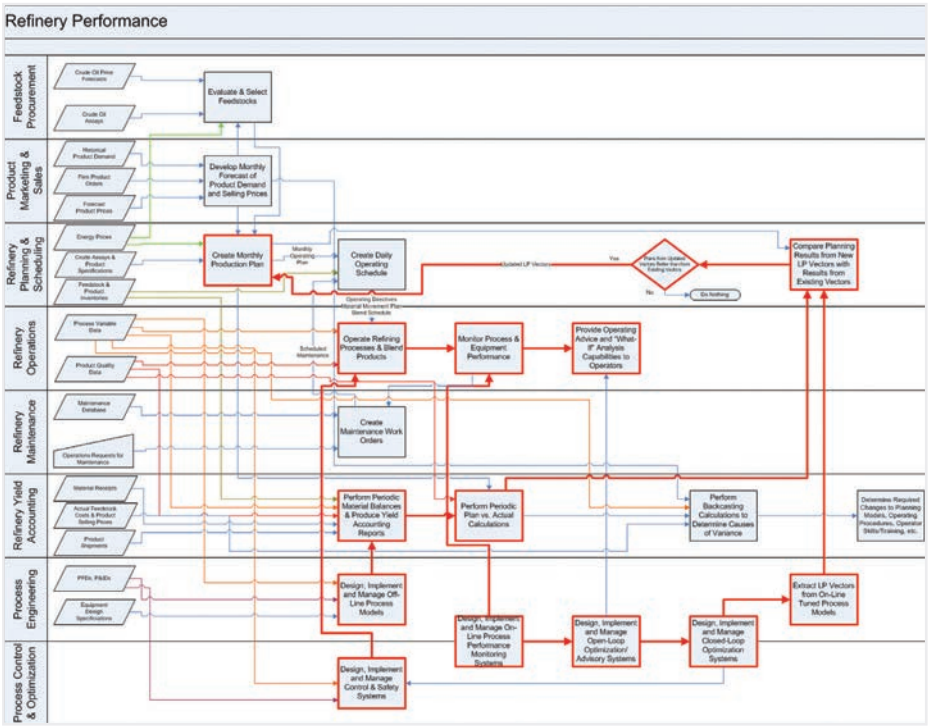


Improvement No. 7. Smart Work Processes

"Smart" work processes are more than simply digitised or partially automated — they are arranged for consistency and good governance. The activities to achieve these include:

- Review all operations and technical support work processes
- Automate and standardise as much as possible
- Enhance the work processes for prevention instead of "reacting better"
- Automate the tracking for knowledge capture and improvement

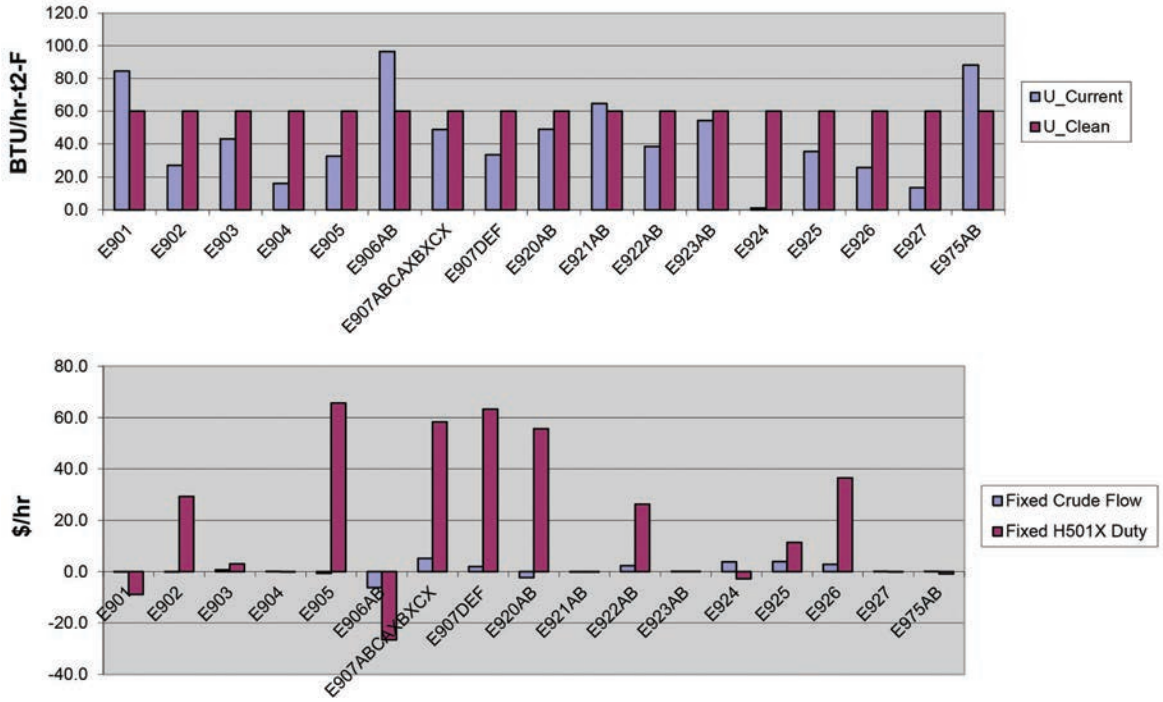
The following is an example of a "smart" work process for end-to-end planning and scheduling:



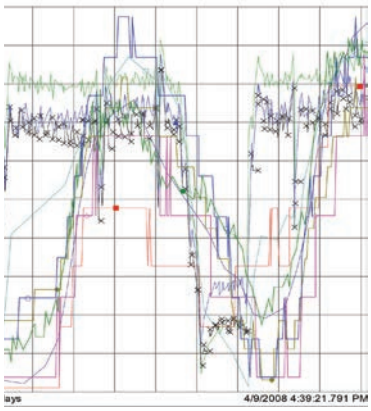
Improvement No. 8. Smart Asset Reliability

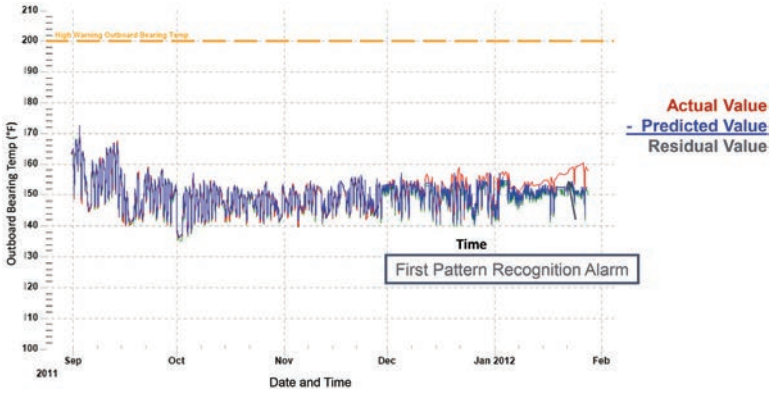
Key to improved availability is higher process unit reliability. Smart Asset Reliability focuses on Smart work processes, technologies, and people. It digitises a business process to continually seek out and remedy sources of unavailability, and it uses an infrastructure for implementing continuous improvement in people, work processes, and technology. But this is only an enabler; it must be an enabler for a culture of high availability operation, which requires trust, teamwork, and some work transformation.

Increased clarity as to the costs and causes of events which reduce availability is key to prioritising and implementing corrective actions that will result in sustainable improvements in reliability and availability. Best-in-Class companies use the data they collect more effectively, and turn that data into actionable intelligence.



The above report shows a profit analysis and efficiency benchmarking of 17 heat exchangers. This is a good example of proactive information- all of the heat exchangers are serviceable, but limiting the duty of a crude unit fired heater reveals the sensitivity to economic performance of at least one of these heat exchangers. This is much more than predicting imminent failures or corrosion analysis.

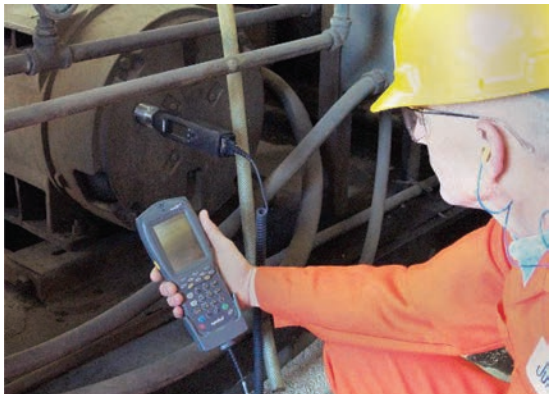




Predictions of imminent failures are valuable and necessary, and "smart" technology automatically predicts the likely imminent failures. The above left-hand image shows the typical historical trend group which does not clearly show an emerging failure condition; the same data is shown in the right-hand image, where the smart pattern recogniser accurately identifies the emerging condition and make the visualisation clear, with associated notifications and alerts.

Improvement No. 9. Automated and Governed Field Work

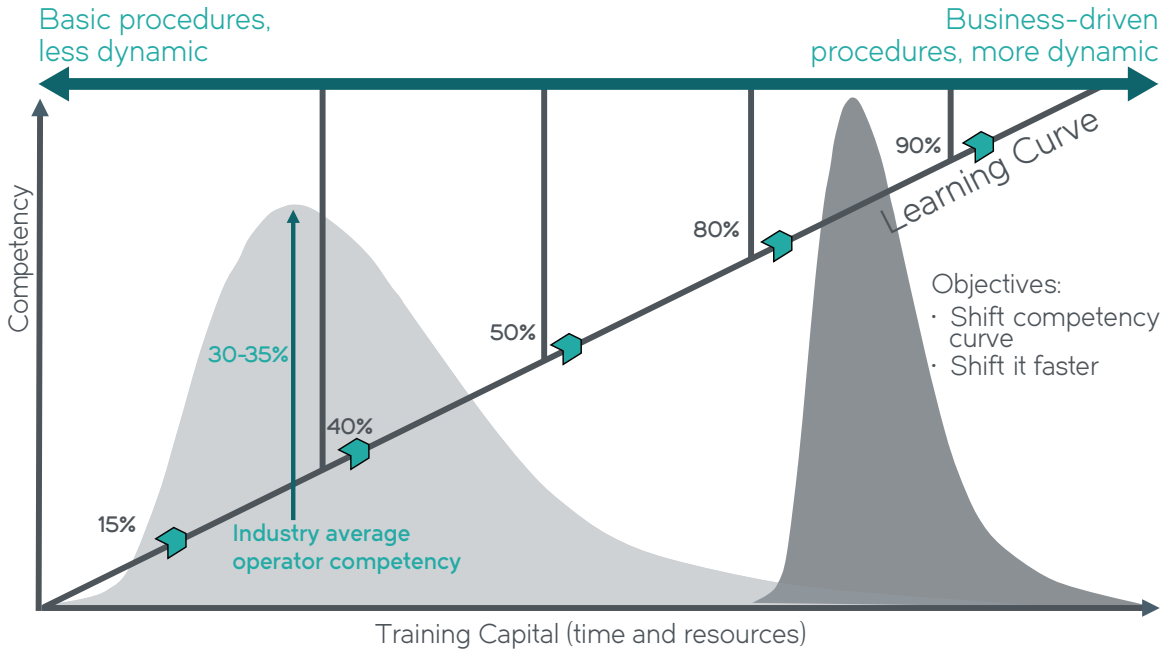
"Smart" field work digitises procedures and these are highly automated. The field workers act as "agents" for others in the central control room and the remote operations center, because they can take a few steps to inspect or monitor equipment conditions while they are performing their rounds. Tasks are adapted in real time, and each field worker adapts travel to support remote teams — both on-site and across the world.



The above images show a progression from paper-based field work, through live digitised business processes with automated data capture, to "augmented reality" where the remote workers share the video with the field worker, and voice communications optimise the teamwork among the field worker and the remote experts.

Improvement No. 10. Extend and Transform Operator Training

Most world-scale refineries have and use operator training simulators. However, most training simulators are implemented only for basic operations. Although this is always top priority, it is insufficient to limit this training scope, especially when operators stay in their jobs for much shorter durations, and when operators must contribute to "smart" operations.



The above diagram positions 5 training topics against where most refinery training programs focus, and "smart" training which trains operators on a much broader scope and has accelerated the certification of "error free" operators by as much as 6 times – from years to months. The training focus is traditionally on the left side of the diagram, which is more static and limited to procedures. The best practice training focus is toward the right side of the diagram, which is dynamic and includes operating to targets such as quality, efficiency and contribution to profit (or reduced cost). Operators who are trained with an emphasis on the dynamic behavior and targets tend to learn the procedures must faster.

Improvement No. 11. Plant-wide Modeling and Optimisation

Most world-scale refineries have implemented some unit real-time optimisation solutions. "Smart" operation extends this, as shown by some of the reference customers described earlier in this paper. The extension methods include:

- Integrating the steady-state models with the real-time optimisation
- Applying closed-loop real-time optimisation and almost all units with integration to the steady-state models
- Applying on-line real-time forecasting

As the refinery evolves its configuration and as process units shift in performance and constraints, the off-line simulations used for plant models and the on-line performance monitoring and unit optimisation are synchronised. This produces "one version of the truth," which makes performance analysis and technical support more trustworthy and effective.

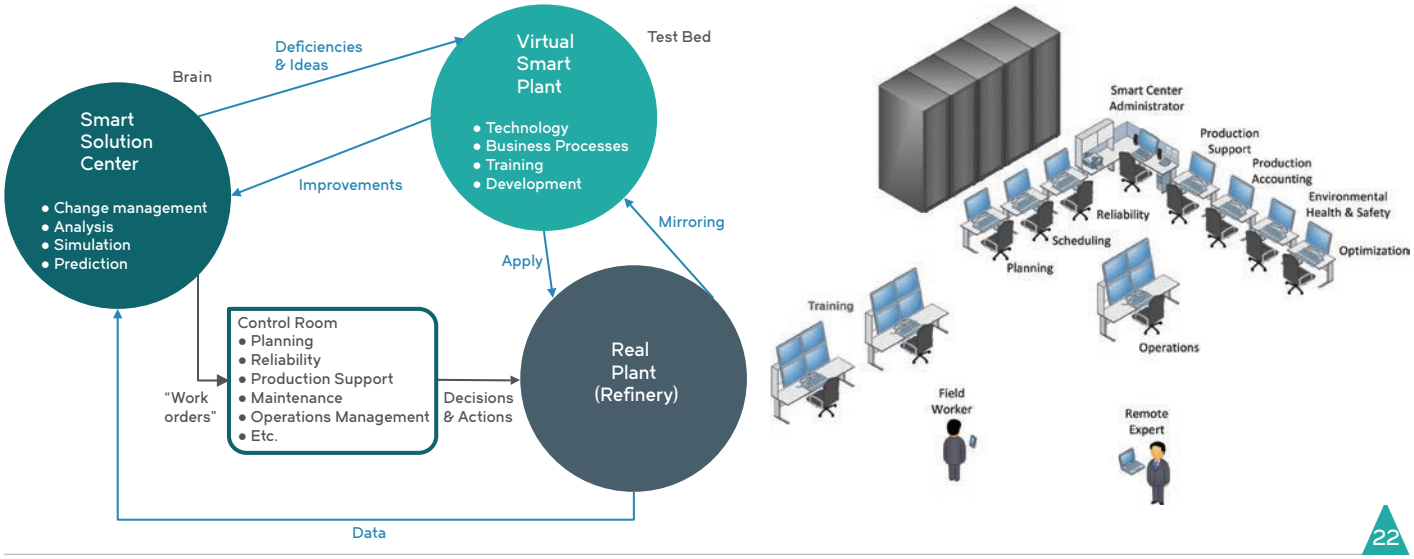
Improvement No. 12. "One" Refining Operations Management/Smart Plant and Virtual Refining Operations Management

Enthusiasm and competitiveness among department heads and their staff, along with separate budgets, can lead to a set of isolated "Refining Operations Management" projects and multiple attempt to produce a unified Smart Plant. Given that teamwork is required to achieve the most significant performance improvement, our 20 years' of experience strongly recommends that Refining Operations Management projects are designed as a single solution for all of the affected departments, rather than several isolated architectures.

Since Refining Operations Management is an enabler for a unified Smart Plant, we also recommend that refineries implement Refining Operations Management as a single program driven by transformed work processes and measures, implemented in one area at a time, with combinations of people, work process and technology transformations. Another recommendation is to implement a virtual Refining Operations Management, which is used for the following functions:

- Training and culture change management
- Technology evaluation and improvement
- Business process evaluation and improvement
- Economic assessment of improvements

The virtual Refining Operations Management installation is a full Refining Operations Management architecture, which uses a combination of simulated and real data. It also has a library of Refining Operations Management configurations and versions. The following are sketches of the main data flows and the equipment and users for virtual Refining Operations Management:



The previous diagram shows the main data flows between the physical refinery, the main Refining Operations Management system in an Operations Center, and the virtual Refining Operations Management system. The notifications and instructions from Refining Operations Management aren't formal work orders, but they are a set of information, instructions and notifications which are used by professionals, technicians and field workers.

Summary

The business benefits of Refining Operations Management are compelling and achieve performance improvements which cannot be achieved by installing new equipment or catalyst by themselves, with a much smaller capital investment and much faster returns.

As described in this paper, our 20 years of Refining Operations Management project experience has strengthened the recommendation to implement Refining Operations Management as a single project that is focused on the appropriate digitisation of business processes, and that is used as part of performance management such as the Covey 4 disciplines of execution. Although the project must be implemented in steps, it is risky to focus on technology "islands" or on single departments; business processes, teamwork and elimination of "value leaks" can only be sustained when departments and teams work together with shared business processes and targets.

This document outlines just a few of the many benefits of an Refining Operations Management implementation. As shown, the significant business benefits will improve refinery margins with $200 Million/year for a 400,000 bpd refinery ($1.50/bbl) using early 2015 prices, and result in lasting performance improvements. To successfully undertake an Refining Operations Management implementation is a much smaller capital investment than adding equipment to the refinery. However, it does require a much larger management buy in and overall employee commitment. Now is the time to take full advantage of the technology, tools, industry knowledge and experience that are available within Refining Operations Management and maximise refinery performance.

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