On the way towards Value Chain Optimization through Production Accounting and Scheduling Integration

Monroe Trainer Facility

Enrique Salomone, Supply Chain Scheduling Product Management, KBC
Federico Neira, Production Accounting Product Management, KBC
Roque Costanza, Technology Services Consultant, Technical Lead, KBC
Lucas Nieto, Technology Services Engineer, KBC
Matias Bertone, Technology Services Engineer, KBC

Abstract

The inherent complexity of refineries and associated terminals, the difficulty of modelling process units, the logistics, the optimization of crude and product blending, the combination of paper and physical accounting requirements, the natural different models' granularities for serving different purposes, among others, make refineries production scheduling and accounting extremely challenging processes.

The issues are even harder when the main tools that support the scheduling and accounting processes (several dozens of linked spreadsheets in more cases than one could suppose), are often poorly integrated and have limited automation and optimization capability.

Recent developments in technology support the digital transformation of the hydrocarbon value chain by enabling new business models, better optimization, more agility and better execution of plans.

Key technologies enabling this transformation include cloud, big data, AI, among others. These technologies can be combined with the traditional solutions to form a digital twin of the value chain including digital twins of the associated assets.[1]

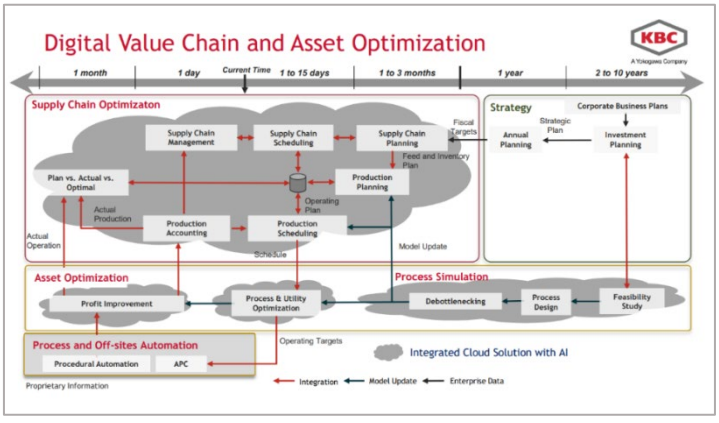


Figure 1 - Digital Value Chain and Asset Optimization

1 Simon Rogers, Strategy and Business Excellence | Digital Transformation | Value Chain and Asset Optimization | Sustainability, https://www.linkedin.com/pulse/next-generation-value-chain-optimization-simon-rogers/

Digital transformation of the value chain enables new ways of working with supply chain partners and new ways of managing and optimizing supply chain and asset operations. This transformation allows real-time optimization of the entire supply chain. The companies that take this opportunity for transformation most quickly will have a strategic competitive advantage over their competitors resulting in significantly higher returns to stakeholders.

In this article the benefits of a combined implementation of KBC's Visual MESA Production Accounting and Supply Chain Scheduling systems at Monroe Trainer facility, Philadelphia, are presented while describing some of the most challenging aspects of the system implementation. The application of combined accounting and scheduling solution was performed in two stages, first training and familiarizing the users with a highly detailed accounting model as per dictated by Monroe's accounting business needs, and later configuring the logistics and refinery scheduling model. Both systems were conceived with the required specific granularity, fulfilling the highly demanding customer needs, while exchanging information, minimizing the data entry required to keep themselves updated, and significantly improving the quality of the obtained results.

Introduction

Scheduling and production accounting are key business processes. While planning is fundamental for optimal operation of the plant and resources allocation[2], being able to properly track the inventories and material movements allows to calculate yields and percentage of objectives reached. Misalignments in expected results and actual outcome could make reality and simulations drift apart if not corrected swiftly. When the mass balance is done properly, and even better when reconciled values are available, the scheduling system has an excellent baseline to work with.
Consequently, with good quality data, better performance can be obtained throughout the refinery[3].

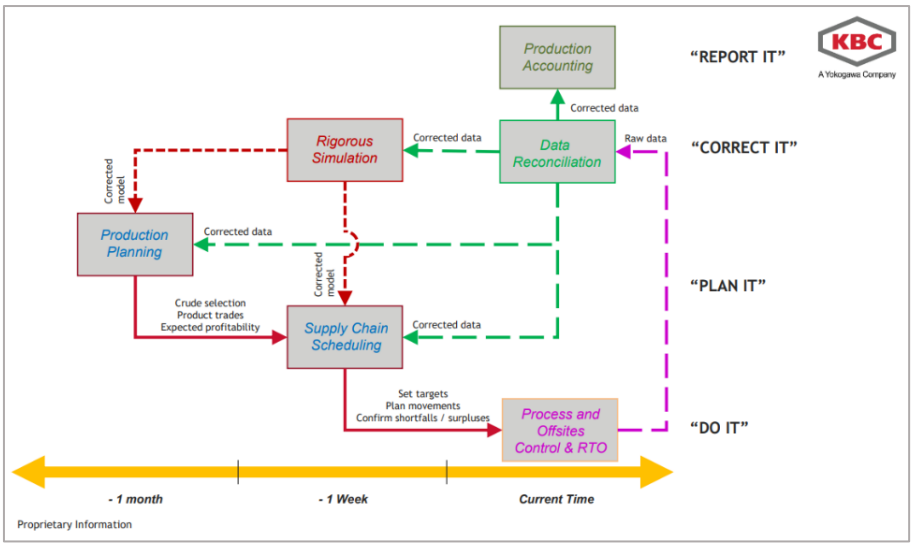


Figure 2 - Hydrocarbon Management integrated workflow

[2] Shah, Nikisha K. and Li, Zukui and Ierapetritou, Marianthi G., Petroleum Refining Operations: Key Issues, Advances, and Opportunities, Industrial & Engineering Chemistry Research, 50 (3) 1161-1170

[3] Christos T. Maravelias and Charles Sung, Integration of production planning and scheduling: Overview, challenges and opportunities, Computers & Chemical Engineering, Volume 33, Issue 12, 2009, Pages 1919-1930

In turn, the scheduling system can provide the operators and accountants with the forecast for the state of the site, making data input easier and more amicable[4].

Whenever there are troublesome outputs from the scheduling systems, such as unrealistic scenarios, they are typically caused by an incorrect baseline. Most of the errors found doing the mass balance procedure have to do with input errors[5]. An integrated workflow between the two systems can reduce data related issues to the minimum expression, while decreasing the amount of work required for data entry[6].

Implementation case

Monroe Energy is comprised of a 185,000-barrel-per-day oil refinery and its associated docks and pipeline assets, located along the banks of the Delaware River, just outside Philadelphia. Focused on shifting its product slate to maximize the production of jet fuel, Trainer refinery obtains crude from numerous sources and distributes product through an extensive pipelines network and also via ships and barges to Delta Airlines and other strategic partners. It is a medium-complexity refinery -which also produces gasoline, diesel, and home heating oil- tight to a massive high-complexity products reception and distribution network[7]. It has a total tankage capacity of nearly 5 million barrels, including but not limited to Trainer Refinery, Chelsea Terminal, Woodbury Terminal, G Street Terminal and the interconnecting line fills. The scattered nature of the layout of terminals and plants arises the need to have multiple users in different locations working collaboratively, entering information simultaneously[8].

Supply Chain Scheduling provides mechanisms to allow multiple Users/Schedulers to work over the same schedule case or scenario giving the user the ability to check-out a scenario to define the schedules of a given area of interest, and not preventing other users to concurrently view data or to work in the definition of schedules of another area at the same time.

Both Visual MESA Production Accounting and Visual MESA Supply Chain Scheduling architectures have a centralized server, which runs the system platforms while operators can access via web or graphical client from any security approved site. This presents an advantageous solution to the multiple-users and locations situation. The implementation allows to have centralized, unified and auditable databases, easily accessible via http or graphical client, with flexible configurable user's execution permissions.

[4] Agrawal, A., and K. Balasubramanian. "Consider adopting next-generation refinery scheduling: an opportunity exists to redefine the way planning is done, involving the key groups more in a strategic supply-chain management role." Hydrocarbon Processing, Sept. 2006, p. 65+.

[5] http://www.energysys.com/wp-content/uploads/2014/02/Challenges-in-HA-Survey-Results.pdf

[6] https://www.hydrocarbonprocessing.com/sponsored-content/honeywell/2017/march/integration-the-next-frontier-in-supply-chain-production-management

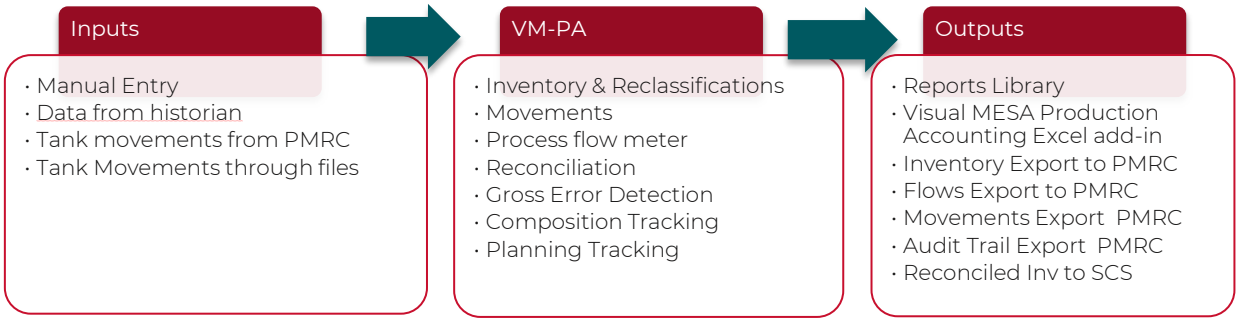
[7] https://www.hydrocarbonprocessing.com/blog/2012/05/column-delta-refines-a-fallacy

[8] https://www.monroe-energy.com/

Production Accounting

Visual MESA Production Accounting is a software intended to record material inventories and movements through the entire cycle of the materials once they entered the battery limits of the refinery as raw materials up until they leave the facilities as finished products. The software can capture the information from external systems, e.g. Historians, databases, laboratory or in-house systems, calculate corrections, net values, and everything required to solve the site-wide mass balance and reconciled values. It utilizes statistical analysis to point out possible errors in early stages and can produce reconciled values from a successive error identification and simultaneous compensation algorithm, which is able to isolate the most probable sources of post-reconciliation errors. Visual MESA Production Accounting is also able to produce a set of reports that complies with the industry standards and export any data to external systems. Other capabilities of the software include composition calculation, planning tracking, pipeline batches tracking, tasks automation, evaporation losses calculation, etc.[9]

Monroe Energy at Trainer facility utilizes extensively Visual MESA Production Accounting (VM-PA) to keep thorough records of material movements and inventories throughout multiple locations. This has allowed Monroe Energy to obtain a series of advantages: replace the prior spreadsheet-based production accounting processes; acquire detailed knowledge of tanks operations and movements, calculate process units yields, improve data quality and operating procedures, detect gross errors in early stages (e.g. data entry errors, instrument failure, missing movements), solve the mass balance of the site through reconciliation, manage and sustain a focused instrument maintenance program through the systematic analysis of plant custody transfer and measurement errors, maintain consistent and verifiable data for the ERP system, operations planning and production accounting reports.



Supply Chain Scheduling

Visual MESA Supply Chain Scheduling is a scheduling decision-support application that provides future events visibility through detailed simulation models to support the management of operations, enabling plant personnel to perform a consistent, plant-wide, detailed schedule of operations, keeping an updated projection of inventories and qualities

[9] https://www.kbc.global/software/production-and-yield-accounting/

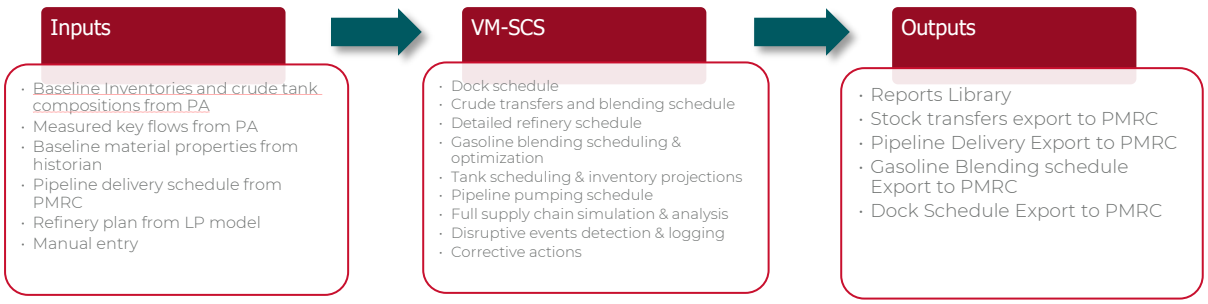
for feedstock, intermediate and finished products[10].

Monroe supply chain scheduling model includes all relevant equipment and their connectivity: Docks (including feedstock supply and products offtake by ships), Production (Refinery units), Gasoline Blending, Receipts by Pipeline and Railcars, and Shipments by Pipeline, Railcars and Trucks.

The simulation of the complete scheduled operations automatically propagates their effects all along the supply chain, allowing the easy identification of possible imbalances between interdependent operations. This provides efficient monitoring of disruptive events by automatically alerting on critical situations such as out-of-range levels and properties or material degradation by blending, permitting schedulers to react with quick and precise corrective actions.

End-to-end model simulation also provides the possibility to generate an optimum gasoline blending schedule for short to mid-term periods, considering projected rates, inventories and qualities of blend stock production, forecasted demand of different gasoline grades, and projection of inventories. This way, optimal recipes and blend volumes are obtained for all products, minimizing the total cost of the campaign, matching between the supply and demand forecasts, storage capacity, product specifications, recipe constraints, and blending capacity.

Finally, the supply chain scheduling refinery model includes a modular integration with the PETRO planning model, reflecting the refinery process flowsheet with close similarity. The scheduler can set the operational parameters for each process unit, and rundown options for each mixer and splitter, allowing to properly predict the refinery behavior during the simulation[11].



Integration benefits

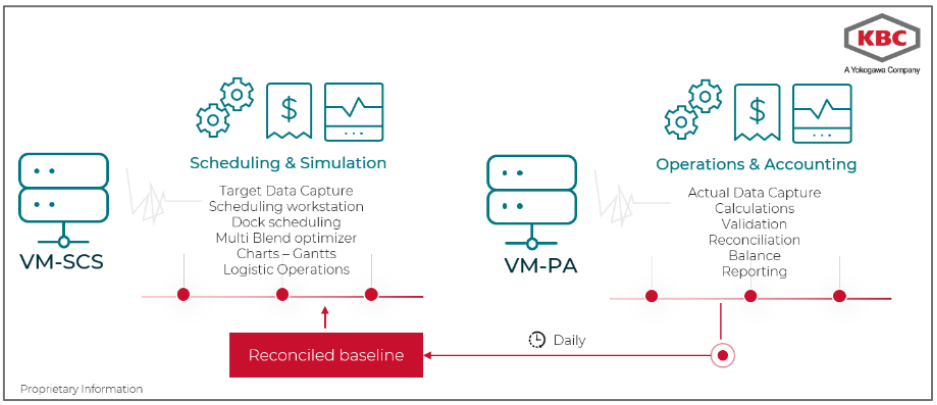
At Monroe Energy refinery, Visual MESA Supply Chain Scheduling (VM-SCS) can update its baseline inventories collecting the reconciled data exposed by Visual MESA Production Accounting, for any working scenario. Reconciled values and calculated compositions can be pulled on-demand, so the scheduling plan can be produced with the most recent

[10] https://www.kbc.global/software/supply-chain-software/

[11] Al-Husain, Raed & ASSAVAPOKEE, TIRAVAT & KHUMAWALA, BASHEER. (2006). Supply Chain Management in the Petroleum Industry: Challenges and Opportunities. International Journal of Global Logistics & Supply Chain Management. Vol. 1. 90 - 97.

information whenever it's required, whether because the mass balance was recently closed, or the process targets have changed.

The import in supply chain scheduling of the reconciled inventory for all tanks along with the composition of crude tanks from production accounting, added to the detailed scheduling crude reception, transfer and blending model, allows operators to simulate crude distillation and refinery operations with updated and precise data, improving refinery planning results with, creating detailed reports of the production rates and qualities down to the gasoline blending.

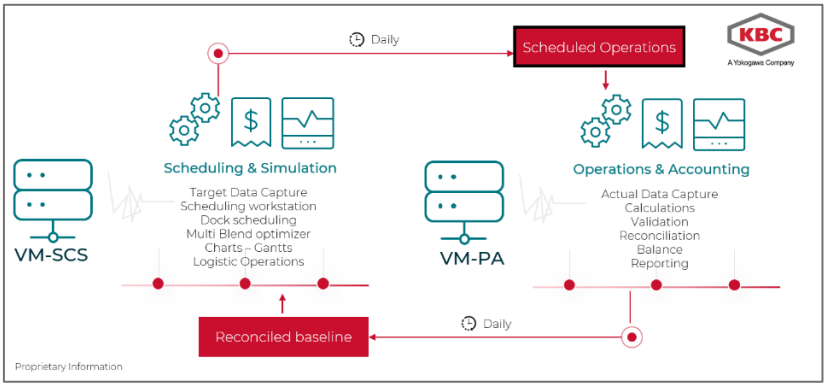


The integrated workflow between Visual MESA Supply Chain Scheduling and Visual MESA Production Accounting allows to have an optimal and continuously updated pathway for the operation of the plant and terminals, avoiding the delays and possible errors that can derive from manual input. The fact that production accounting is the centralized database for all the site movements, can guarantee that supply chain scheduling is working with the most updated information, which also represents the official mass balance of the company.

Conclusions and Future Work

Besides the individual benefits obtained from the production accounting and scheduling systems, the decision of Monroe Energy of integrating them resulted in significant advantages, both in the workload reduction of data entry and the improvement in the quality of the results obtained.

As a future work, further integration between the two systems is under analysis. It is intended that scheduled operations could be automatically populated in Visual MESA Production Accounting.



The scheduled movements information can significantly decrease the amount of data that operators have to enter, changing the role from creating the movement with all the details to simply updating them from scheduled to actual operating details. The biggest challenge of this task is to be able to translate the scheduled data into individual movements, given that the level of detail of production accounting and scheduling system models have a level of granularity dictated by the specific requirements of each business process which are different in nature. For model translations purposes, a mapping layer is mandatory. For this task, an ontology-based semantic approach could provide a solution for most cases, but this area is still under research.