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Improve reliability and reduce maintenance with advanced analytics

A common misconception in large-scale process manufacturing is that minimizing downtime by increasing reliability is the key to increasing profitability. This mindset fails to address the fact that some downtime can improve capacity, increase production and minimize maintenance expenses. The most effective way to maximize production is by striking a balance between reducing costly unplanned downtime and taking proactive, calculated downtimes to restore or increase throughput capacity. Planned downtime also provides an opportunity for proactive maintenance, which is much less costly than reacting to failures after they occur.

Unplanned downtime is primarily due to equipment failure, and reducing it requires understanding the leading causes. It involves identifying historical losses, analyzing root causes and categorizing them in a way that can be easily summarized and consumed by relevant stakeholders.

This production-loss accounting activity is a taxing drain on valuable process engineering resources, consuming hours to days of their time for each reporting period. Reducing the time to insight for this analysis frees up engineering resources to make effective use of the data to reduce unplanned downtime and corresponding reactive maintenance through the design and implementation of process improvements.

Calculated, opportunistic downtime is a paradigm shift from the mentality of keeping a process unit running at all costs. These types of calculations require an optimization problem to be solved for identifying the minimum time to order fulfillment. Traditional solutions to this problem typically rely excessively on assumptions and are highly complex. A simpler, more transparent solution is required to achieve buy-in of this new operating strategy at all organizational levels.

Frontline subject matter experts (SMEs) can address both problems with advanced analytics solutions.

Traditional approaches encounter insurmountable limitations. As the field of data analytics advances, users are identifying and solving more computationally complex problems, revealing a host of insufficiencies in their traditional spreadsheet-based calculation tools. Leading limitations include data connectivity and access, computational performance, collaboration, versioning, visualization and reporting functionalities.

YTD losses by reason code – by month

Production loss reason code	January 2019	February 2019	March 2019	April 2019	May 2019	June 2019
External factor, klb	862.78 klb	268.5 klb	413.09 klb	3698.6 klb	224.63 klb	532.95 klb
Feed constrained, klb	264.6 klb	533.9 klb	233.77 klb	1329.6 klb	0 klb	789.74 klb
Heating constrained, klb	2110.6 klb	3213.8 klb	1924.3 klb	403.02 klb	0 klb	1576.6 klb
High reactor DP, klb	507.72 klb	3152.1 klb	1471.8 klb	1088.7 klb	528.39 klb	191.47 klb
Human error, klb	0 klb	551.54 klb	0 klb	0 klb	275.54 klb	441.22 klb
Instrument reliability, klb	1142.6 klb	1465.3 klb	1157 klb	165.51 klb	578.21 klb	304.18 klb
Packaging constrained, klb	663.42 klb	0 klb	271.79 klb	400.47 klb	364.1 klb	0 klb
Refrigeration constrained, klb	0 klb	0 klb	84.214 klb	452.44 klb	3462.7 klb	5341.8 klb
Rotating equipment reliability, klb	779.37 klb	133.89 klb	976.7 klb	1947.2 klb	798.47 klb	333.53 klb

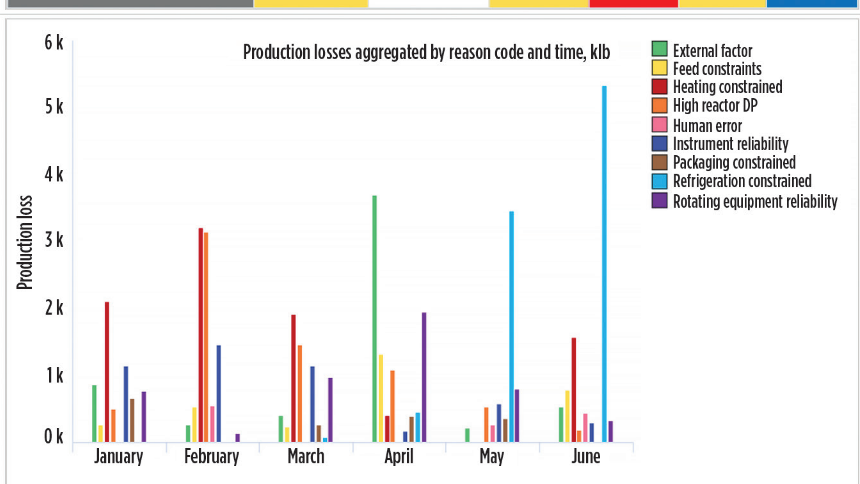

FIG. 1. Diagram from a production loss analysis dashboard for a petrochemical production unit.

When establishing the root cause of a shutdown or a slowdown, it can be helpful to overlay process data with contextual information, such as operator logbook notes or maintenance work orders. Establishing a live connection to these types of data sources is challenging because, without it, engineers must extract data from multiple databases and build separate queries for each.

Spreadsheets encounter performance limitations when dealing with highly complex calculations or high data volumes. The latter of these becomes a serious problem when performing historical data aggregations, as the volume of data compounds with time. Spreadsheets reach row and column limits, and they become increasingly difficult to manipulate as file size increases.

Limited higher-order modeling functionalities require implementation of Visual Basic scripts or data dumps into other advanced programming tools. Both options present additional challenges regarding knowledge transfer and software tool maintenance.

Multi-user collaboration has become increasingly important as workforces adapt to a remote environment. Online tools allowing simultaneous input from multiple users are replacing offline versions. Spreadsheets and traditional desktop-based statistical modeling software present version management and other issues, creating a barrier to collaboration.

For presentation or sharing, spreadsheet-generated data visualizations are often embedded in slide decks or other reporting tools. These visualizations can be tedious to construct due to chart axes limits, as displaying more than two parameters together requires manual scaling, which is often specific to a single iteration of the visualization. All this effort ultimately results in reports full of static images that require reconstruction any time a report is created for a new time range.

Advanced analytics solutions to overcome limitations. Browser-based advanced analytics software applications have filled the gaps left by spreadsheet-based calculations and reporting tools. Data connectivity and refreshing, along with computational load, interactive visuals, and live updating summary dashboards and reports are now well within reach.

Advanced analytics applications provide out-of-the box connectors to process data historians and SQL-based contextual databases—making process, maintenance, shift log and other data available to SMEs from a single application. Refreshed data is indexed on demand in a live updating environment, while maintaining the integrity of the data source.

Cloud or on-premises, server-based computing is leveraged, empowering SMEs to do calculations beyond the capabilities of their respective singular machines. These browser-based applications save information after every click, thus alleviating the threat of catastrophic crashes of large spreadsheets hours after the most recent save (an all-too-common occurrence when dealing with large volumes of data and complex calculations).

The combination of a versatile visualization pane and a robust calculation engine enables intermediate visual feedback and rapid iteration of analyses. Visualizing all the steps in a workflow enables users to identify potential issues sooner, troubleshoot more efficiently and minimize recycle time.

A "set it and forget it" dashboarding and reporting tool with a live connection to the data embedded in the visualizations saves engineers significant time that was previously spent updating and formatting reports. Auto updating or scheduled date range configuration ensures that high-horsepower calculations are run at optimal times, with reports made available for other users at a time of their choosing.

Use cases demonstrate data-driven operating strategies in practice. The author's company's digital technologies have been deployed across various industries to enable customers to maximize long-term production, optimize maintenance spend and improve reliability—as shown in the following examples:

1. **Identification, categorization, summary and reporting of production losses**
   Challenge: Process manufacturers need to track and categorize performance losses to identify

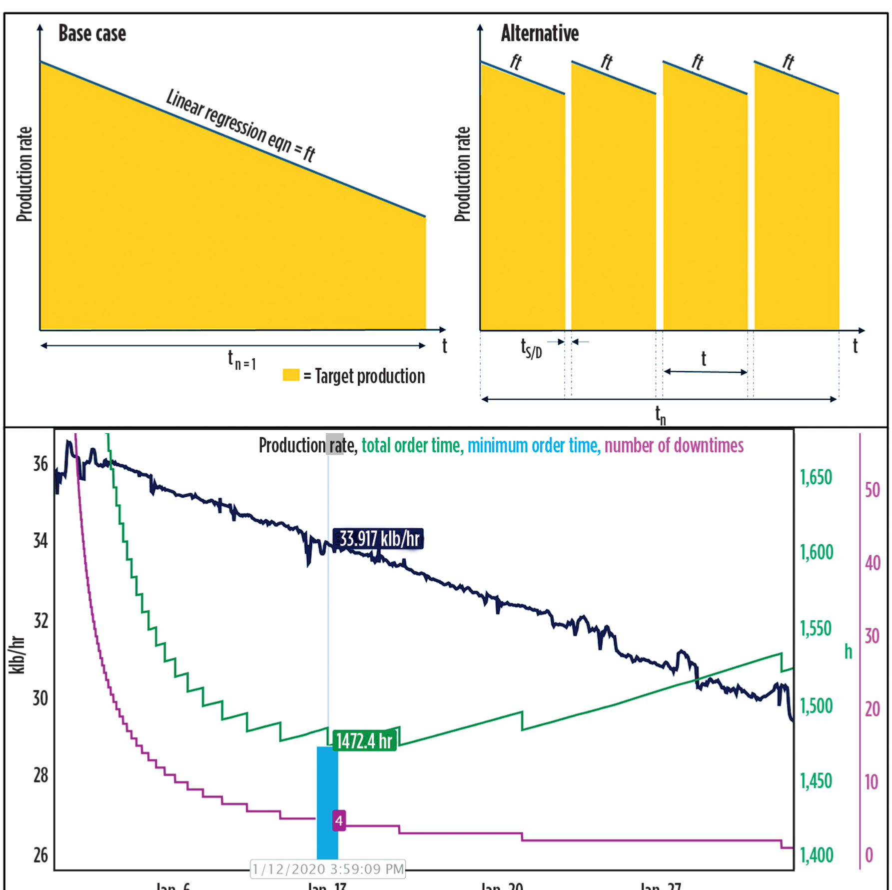

FIG. 2. Sketch depicting the optimization problem solved (top) and the graphical solution to the problem (bottom).

bad actors, justify improvement projects, and perform historical and global benchmarking. Production loss accounting for process manufacturing is a tedious activity that can cost days of work for process engineers. It requires identifying losses, performing root cause investigations, and documenting the events leading up to the loss. To make this information available to all interested personnel, it needs to be easily aggregated into reports that convey overall equipment effectiveness and identify unreliable equipment. Effective use of this data can inform decision making on capital project spending to remove process bottlenecks and upgrade unreliable equipment, with the end goal of minimizing downtime, maximizing production rates and optimizing maintenance. This categorization is hard to do retroactively, and most accurate performance loss coding is done either programmatically or by frontline personnel at the time of, or shortly after, a performance loss event.

Solution: Digital tools[a] are used to identify performance losses by comparing an operation to ideal situations and creating conditions when the operation is constrained compared to target. Losses are categorized using specific conditions, where events can be placed in the correct categorical buckets, either manually or logically, based on configured thresholds. Summary visualizations are created in the application to represent the losses both graphically and tabularly. These summary visualizations are compiled into an organizer[b], where configurable live or scheduled date ranges are used to create automatically generated periodic reports, complete with collaboration and sharing capabilities (**FIG. 1**).

Result: Automatically generated monthly reports can save 1 d/mos–5 d/mos of valuable process engineering time. This is time that engineers can get back to work on improvement projects and other value-added activities. Easily exportable historical loss data enables engineers to spend more time adding value to improvement projects and less time developing cost justifications.

2. **Production run length optimization**

Challenge: Many process manufacturing units hit process throughput constraints over the course of a run, resulting in the degradation of production rates over time. These constraints are often reversible, but at the cost of shutting down to clean/maintain equipment. Sometimes, the decision to shut down and clean equipment—regaining the throughput rate upon startup—enables a unit to meet its production goals sooner. This type of planned downtime also reduces maintenance spend, as opposed to spending time reacting to equipment failure. Meeting targets sooner translates into more production and increased profits over the long term. Developing solutions to these types of optimization problems typically requires complex calculus, along with advanced modeling packages and programming experience.

Solution: A calculation engine[c] was used to calculate the number of shutdowns that would minimize the total time required to produce a given order size. After determining the optimal number of shutdown/run cycles, engineers were able to determine the run length between shutdowns and to create a golden profile of these run cycles. The forecasted profile was then used to compare against the actual production rate to understand where the projected end-of-run date stood compared to the best-case order fulfillment date (**FIG. 2**).

Result: A sold-out production unit had been looking at ways to increase capacity to meet demand. By implementing this proactive downtime strategy, they were able to meet supply chain targets on average 11% sooner over the course of the year. This allowed them to creep production volumes for multiple products by a proportional amount, thus growing sales and market share.

Takeaway. Reporting, complex calculations, modeling and other tasks required for analysis of time series process data have traditionally been performed using spreadsheets. As data volumes grow, along with pressures to increase personnel productivity, new solutions are needed to deal with these and other issues.

Advanced analytics applications that are specifically designed to deal with time-series process data provide a solution for large data volumes. As these use cases demonstrate, utilizing the right tool for the job saves hours or days of process engineer time, freeing these valuable individuals to work on higher-value activities that will optimize production, increase reliability and optimize maintenance. HP

NOTES

[a] Seeq Workbench
[b] Seeq Organizer Topic
[c] Seeq Formula

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