

DRIVING INCREASED PERFORMANCE

Ryan Thompson, Emerson, USA, explains how even the most experienced terminal schedulers can increase peak operational efficiency with the help of digital twin-based scheduling and optimisation software.



In the increasingly competitive liquid storage business, high customer satisfaction is paramount. A seemingly small delay can have multiple cascading impacts, as terminals frequently run very tight schedules to satisfy the needs of their customers. Therefore, terminal operators poised to deliver outstanding service are well-positioned to increase market share while retaining their existing customer base.

Traditionally, good service simply meant a deep bench of expert personnel who could effectively manage the tank farm with its spider webs of pipe, complex vessel schedules, and vehicle loading. Today, however, these highly skilled employees are becoming hard to find, and even harder to retain, as many of the most experienced operators are retiring. New personnel, while potentially easier to find, do not have the expansive knowledge or skill set that comes from years of experience at a specific facility.

Furthermore, even experienced human schedulers tend to be conservative in their use and operational deployment of the terminal's physical assets. Tried-and-true asset line ups are preferred, which means that the full operational capacity of the

existing assets may remain unexplored. The ability to squeeze in one or two additional tankers a month, for example, would represent a significant increase in revenue and profit margin, but this would require running closer to constraints.

Without a paradigm shift, basic terminal operation in the future will become increasingly difficult, and possibly non-competitive against more efficiently run terminals.

Closing the inevitable skill gap while simultaneously improving customer satisfaction will require the employment of advanced technology. One of the most impactful new pieces of terminal-centric technology is digital twin-based terminal scheduling and optimisation software. Implementing scheduling software moves specialised data and esoteric scheduling processes onto a standardised and easy to use platform.

Moving product is complex

Unsurprisingly, the more complex a terminal, the more difficult it becomes to schedule the product movements, define movement interdependencies, and plan related operational activities efficiently and accurately. Operators are trying to satisfy the competing requests of multiple customers to ensure that they receive the level of service dictated by their contracts, without unexpected delays, all while avoiding unintentional transmix or contaminations.

Consider the complexity of a large multi-modal terminal facility: many dozens of tanks, scores of products, complex spaghetti webs of interconnected pipes, vessels of varying sizes whose arrival is highly dependent on weather, connections to major international pipelines, fleets of trucks moving through the terminal daily, railcar loading and storage, and inter-tank transfers. Creating a schedule for such an intricate orchestration is no simple task.

Additionally, routing a movement through the terminal's complex of pipe headers is just the beginning, because the product portions already in those pipes must also be displaced or flushed in many cases. Each one of these displacements becomes a scheduling concern in its own right.

Even after a schedule is set, circumstances can change the plan, sometimes leading to all-hands-on-deck scrambles, resulting in losses in efficiency at best, and mistakes or safety incidents at worst. Even the best prepared operators can fall victim to changes that are out of their hands. For example, operators often attempt to expedite operations by prefilling lines going to a certain jetty. But when a ship is late, operations can become complicated very quickly.

Beyond the spreadsheet

Necessity is the mother of invention, and some incredibly complex scheduling spreadsheets have been created to support this statement. Typically, scheduling spreadsheets were built by a small group of experienced users, or, in some cases, even a single expert engineer. Many terminals pin their entire operations on spreadsheets to track and schedule product movements in granular detail.

While these spreadsheets are often powerful, the inherent risk lies in the ability to maintain and adjust them when a terminal no longer has a deep bench of



expert personnel to support such bespoke solutions. If nobody else on staff understands the macros and the programming of that complex spreadsheet, the terminals quickly find themselves in a bind. Moreover, even the best, most well-supported spreadsheets are subject to human error. Improper data entry, unverified changes, and security gaps also pose a serious risk to the long-term viability of these well-intended solutions. Finally, spreadsheets are simply not designed for this type of task, and are hard to create, maintain and change as a result.

One step at a time

To avoid these and other problems, forward-thinking terminals are employing standardised fit-for-purpose terminal scheduling software. The leading solutions rely on simulation based on a digital twin – an exceptionally detailed replica of the facility, with digital representations of the critical physical elements needed to create an actionable schedule, including all the tanks, lines, valves, pumps, interconnections, manifolds, jetties, gantries, and more (Figure 1).

Prior to any new simulation, a few precursor activities are required:

- The period of the simulation must be set. Due to the fluid nature of terminal operations, most simulations are

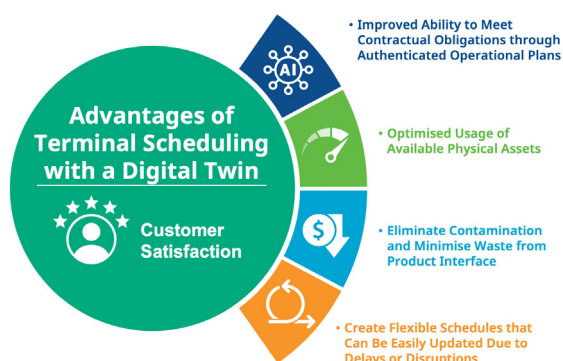


Figure 1. Digital twins provide terminal operators with the necessary insight to deliver outstanding service, leading to more satisfied customers and increased market share.

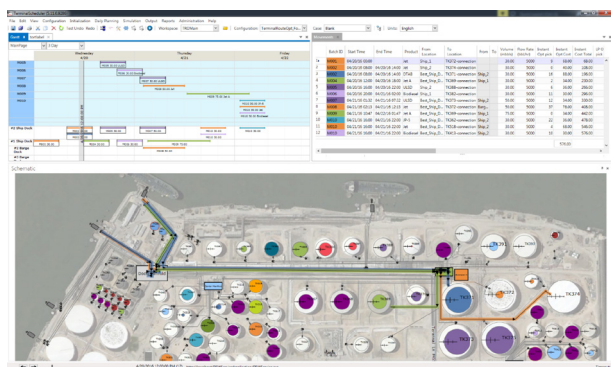


Figure 2. A digital twin of the terminal enables operators to quickly determine optimal path routing, allowing for increased product movement and scheduling efficiencies.

run for a period of two to three days, but the length of time can vary from terminal to terminal.

- All relevant movement requests (orders or nominations for product entering, leaving or moving within the terminal, etc.) must be captured in the scheduling tool.
- The digital twin starting point needs to match the physical reality, i.e., tank levels, line fill status, equipment status, etc.

Once precursor activities are complete, the simulation can begin. The first stage is a general inventory check to ensure that the terminal will either have enough pumpable volume to go out, or will have enough ullage to bring product in. For smaller terminals with simple path routing, this may be all that is required to schedule the terminal adequately.

In more complex operations, the simulation should employ a customer-driven weighting system to determine the optimal path for movements from origins to destinations. Given that a typical terminal's profit is heavily based on throughput, path routing cannot be left to chance. Weight-driven optimised routing automates the process of deciding which routes products must not take, as some may be out of service, a pump on one route might not be big enough to provide the right flow rate, or some other constraint may be in place.

What seems like a small difference becomes a critical variable when that flow rate could mean filling a holding vessel in two days rather than three. Scheduling software tracks and incorporates all of these variables so that humans do not need to perform this complex task. This type of software application will avoid line conflicts, pipeline/tank contamination, and other scheduling complications (Figure 2).

Once complete, the simulation will either successfully pass, or produce errors. With the right software, all product movements (tank, pipeline, marine and truck/rail) can be displayed in graphical, tabular, and Gantt-style views. Using these and other tools, a passing simulation can then be approved, with the software creating a schedule and supporting line-ups.

The schedule can be sent to internal and external (connecting carrier) parties, and the line-ups can be used by operators to carry out the product movements. With the appropriate level of automation within the terminal, scheduling software can send line-ups directly to the automation systems for digital execution.

At the end of the scheduled period, or sooner if off schedule, the plan and actual movements must be reconciled in the scheduling software before a new schedule can be created.

Plan, pivot, replan

Operators using terminal scheduling software create a schedule, including all product movement activities, for the desired length of time. The software then runs the simulation to see whether the plan is feasible. If a problem is predicted in the physical world, such as an overfilled tank, the software will return an error, letting the user know what would happen and why. Armed with that knowledge, the schedule can be easily adjusted and run through the simulation again, without the risk of real-world safety or efficiency impacts. Once the

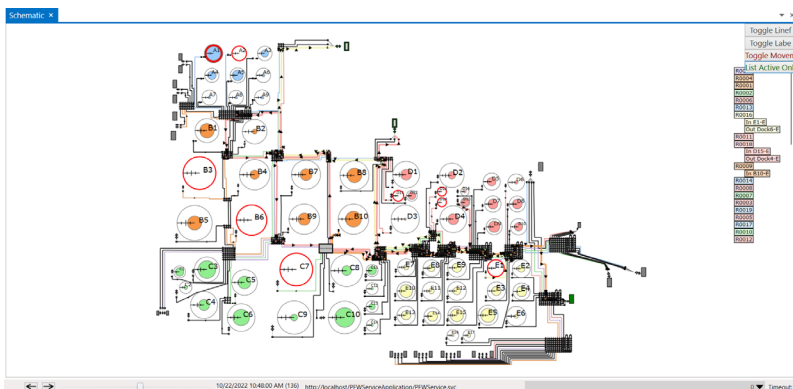


Figure 3. Advanced automation improves tracking of tank and tank pool volume levels, enabling operators to easily identify available product for scheduling.

simulation runs without error, the schedule can be published to interested parties, including external parties such as connecting pipeline operators (Figure 3).

However, whilst having a perfect plan is the ideal scenario, what happens when a ship reports that it will be coming in eight hours early or late? It does not matter how good a model looks or how detailed the schedule is if it cannot easily accommodate minor or major changes. With scheduling software, an operator can easily modify the ship movement and re-run the simulation to identify new conflicts, see how any changes will cascade down the line, and identify which elements – such as truck and rail loads – may need to be rescheduled. Schedule upsets will still need to be remedied, but scheduling software makes it far faster and easier to get the terminal back on track.

Flexibility in handling real-world situations also benefits the planning stage. Terminal schedulers can use the power of digital twin technology to test an infinite number of scheduling ‘what-ifs’ against their operations strategies. What if a supplying refinery ramps up production? What if a tank or line segment needs to go out of operation for service? With a few adjustments, the simulation can report back the outcome of the change in a matter of minutes. The options to tweak and optimise the schedule are truly endless.

Technology empowers personnel

In today’s competitive landscape, companies are running leaner, and terminals are no exception. The challenges of reduced staff are compounded by a general decline in overall experience due to the retirement of more experienced workers. Terminal scheduling software can help ease the burden on these small teams while simultaneously closing the knowledge gap, making it easier for less experienced operators to perform their work, and with more confidence.

Traditionally, setting a terminal schedule could easily take hundreds of clicks in a spreadsheet or other software program, each one essential to getting the process right. Data entry throughout the process leaves room for errors, as critical information is manually transcribed from multiple source systems.

Today’s terminal scheduling software solutions automate most of the process. Operators can typically complete a schedule in far fewer clicks, cutting time out of the scheduling

process. Additionally, scheduling software can connect directly to external systems such as enterprise resource planning packages and order-to-cash software. Data from these systems can be automatically pushed down to the scheduling software, simplifying the process of defining and creating movements, while eliminating the risk of human error in data entry from source systems.

The personnel benefits of automated scheduling go well beyond simple time savings. Partial automation and support of the asset line up validation lends a higher level of certainty to that process. The software can also provide close to real-time capabilities to monitor and verify that the schedule is being executed as planned.

Time saved leads to opportunities to work on other high-value tasks, such as reviewing data trends for additional efficiency gains.

Build a foundation for the future

Adopting terminal scheduling software will provide immediate benefits to the day-to-day operations of the facility, and it is also a critical step in securing future success.

Traditional scheduling methods only provide the terminal’s owners with general knowledge and inexact certainty as to what was in each pipe, and what the exact state of the terminal is at any particular time. In contrast, a digital twin can exactly identify the state and content of all assets and volumes in the terminal.

Companies in every industry are realising the massive value of their data, and are looking to a more connected and data-centric future where granular field-level data is aggregated to make key business decisions – both for individual facilities and for the enterprise. Analytics can be applied to this data, with the insights used to find trends in deltas between the terminal’s schedule and actual results.

For example, a diverging trend may only be seen on one segment of pipe within the terminal. It could be that a valve is not opening completely, causing a reduction in actual vs expected flow rate. Quickly identifying and resolving such issues is critical for a fully optimised terminal operation.

Top performers focus on customer satisfaction

Today’s sophisticated terminal customers expect more than a functioning terminal; they want an efficient terminal that provides insights that help them to manage and optimise their own businesses. Terminal scheduling software can provide these capabilities through the easy and automated transfer of data, forecasting at different levels – such as inventory and individual tank levels – and notifications of delays as early as possible, whether due to product movement disruptions or equipment downtime. Operators are finding that scheduling software not only helps them operate more efficiently and effectively, but also gives their personnel more time to focus on facility safety, gain competitive advantage through customer service, and achieve top performance among their competitors. **T&T**