WHITE PAPER

Specialty Chemicals: Unlock Agility and Improve Customer Satisfaction Through Enhanced Production Scheduling

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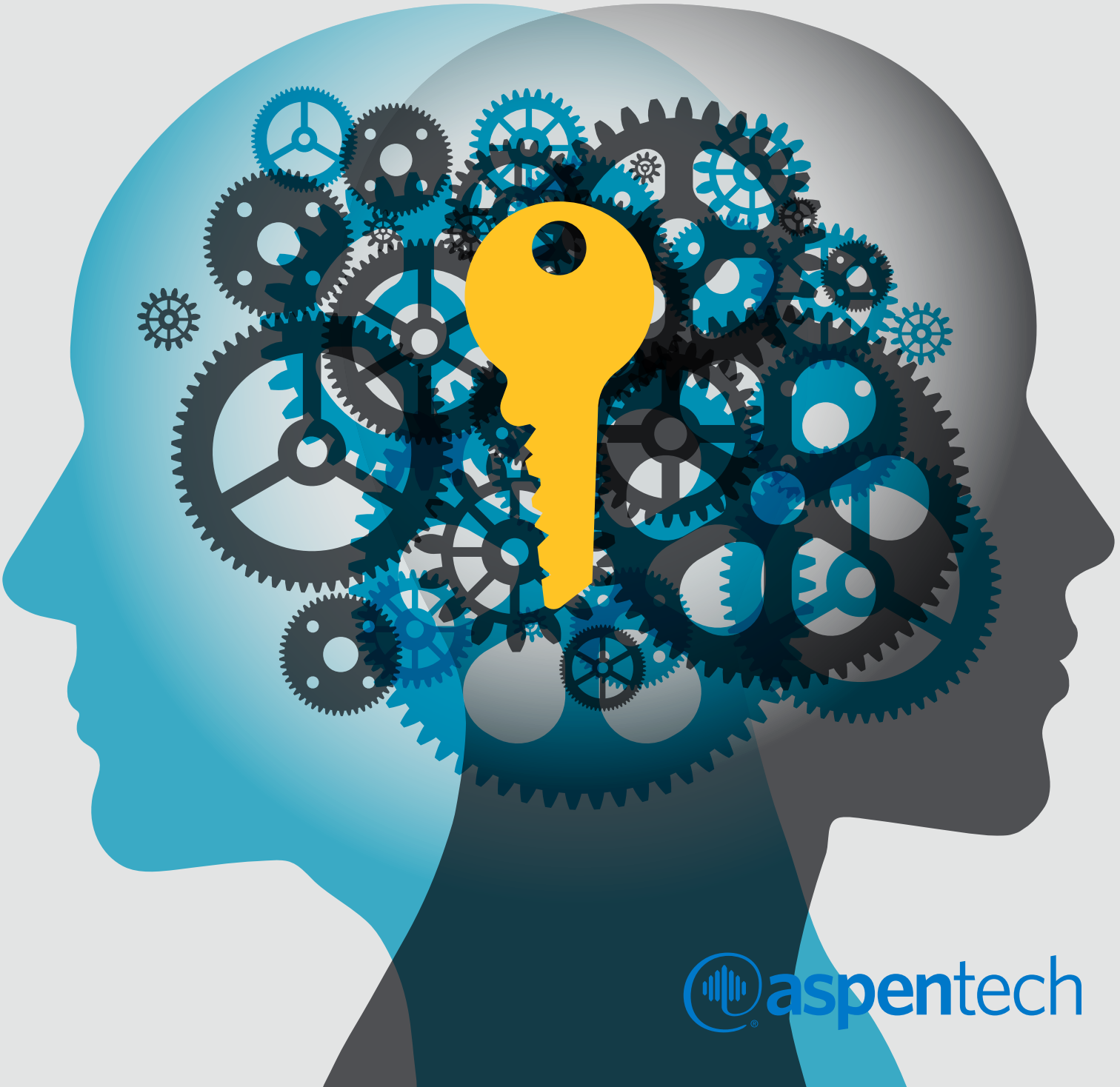

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Introduction

The specialty chemicals business landscape is in a process of transformation. Virtually all multi-national, diversified chemical companies are expanding their emphasis on specialty chemicals. At the same time, a rising wave of merger and acquisition activity is fundamentally restructuring business portfolios and creating focused players. Competition is intensifying, resulting in both margin degradation and faster product commoditization while customers are further exacerbating the situation by demanding "faster, better and cheaper" products.

The push for differentiation has never been more urgent in specialty chemicals, and producers are moving closer to their customers to improve both satisfaction and loyalty. The key reasoning in moving closer to customers is that it will be easier and faster to be more responsive to their needs, such as achieving predictable order fulfillment, providing tailored service offerings or addressing last-minute demand changes. Simply put, customers want the right product at the right place at the right time, despite inevitable changes in demand.

Agility is at a premium for specialty chemicals producers in this customer-intimate business model. Being able to leverage the flexibility that exists in their manufacturing and supply chain operations is not only critical to customer responsiveness, but is actually a significant competitive differentiator. The concepts of agility and flexibility aren't new in this industry, so why do so many specialty chemicals producers struggle to achieve them, even with a flexible infrastructure in place? The answer may lie in the crucial gap between their sales and operations planning (S&OP) process and their manufacturing operations. This gap can be addressed by improving production scheduling practices.

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Production Scheduling is the Cornerstone of Agility

Production scheduling is one of the most important supply chain business processes in any company. It is effectively the interface between the commercial S&OP functions and manufacturing operations. Daily decisions made in this vital function influence both customer satisfaction and operational efficiency. Production scheduling determines what products to make, where and when to make them and how much to produce. These decisions ultimately impact customer order fulfillment and bottom-line profitability. As specialty chemicals producers strive to increase agility, they need to look towards substantially improving their production scheduling process because this is the only way to truly take advantage of agility inside the plant.

Complexity Must Be Addressed

Complexity is a fact of life in specialty chemicals, and it has been on the rise in recent years as producers have expanded product and customer portfolios and leveraged more complicated manufacturing processes. Complexity is also a barrier to agility, as it requires a myriad of degrees of freedom and constraints to be simultaneously evaluated when making production scheduling decisions. For production scheduling to actually enable agility, it must fully comprehend the growing complexity of specialty chemicals operations. Attempting to arbitrarily "simplify" or "water down" the inherently complex business processes of specialty chemicals producers can result in misinformed or ill-advised decisions, while failure to address complexity leads to being at the mercy of today's volatile markets. The secret to taking advantage of the multiple degrees of freedom inside the plant lies within the production scheduling process - can it accurately represent and model key sources of complexity within the supply chain?

Key sources of complexity in specialty chemicals operations include the following:

- Multiple products and grades produced per plant
- Multi-stage production operations with an emphasis on batch processes
- Multiple pathways to manufacture products across different plants and production lines
- Interchangeable and/or shared equipment and resources between production lines
- Sequence-dependent setups and changeover considerations
- Customer-specific products and service offerings
- Customer or market-specific certification requirements
- Frequent changes to the product portfolio, including new product launches

These are only a subset of the sources of complexity that specialty chemicals producers must factor into their production scheduling process in order to make optimized decisions that promote agility. Optimized decision-making comes from being able to simulate and evaluate a wide range of production scenarios in a reasonable amount of time to arrive at the best scenario for any situation. However, many specialty chemicals producers aren't able to do this because they resort to simplifying key sources of complexity to the point that they're making decisions using scenarios that are inaccurate and distorted. Specialty chemicals producers must also balance the tradeoffs of agility with manufacturing costs and asset utilization to determine the most profitable "formula" for agility.

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Real World Dynamics Must Be Comprehended

A highly dynamic environment is a fact of life for specialty chemicals producers, but even more so when it comes to customer demand and manufacturing operations. Customer demand can change frequently and abruptly in terms of volume, product mix and customer location. Unexpected orders can also appear on short notice, whether driven by customer events or by competitors not being able to meet all of their customers' demands. Factors such as unanticipated logistical challenges can impair order lead times, and promotional offers can be far more successful than originally planned resulting in product shortages. The potential dynamics in customer demand are many and varied.

For specialty chemicals manufacturing operations, the potential dynamics are also many and varied. Equipment breakdowns and unplanned outages may reduce available production capacity and bottlenecks may arise that could slow down the plant or limit product mix flexibility. Quality issues may impair a portion of available product inventory while demonstrated or planned production capacity may be exceeded due to outstanding operations performance, even if not performed sustainably. Also, unanticipated site inventory constraints may cap production rates or narrow the product mix. These dynamics around customer demand and manufacturing operations represent today's market conditions and have to be taken into account by specialty chemicals producers.

The production scheduling process is crucial to both mitigate these inherent dynamics and enable agility in specialty chemicals. Not only must production scheduling factor in complexity as described in the previous section, but it must also comprehend "real world" dynamics. Production scheduling must be both adaptable and efficient, enabling the evaluation of a wide range of production scenarios in a reasonable amount of time. It must also support rapid re-scheduling in response to inevitable dynamics, whether inside the plant or within the customer base. Finally, reducing manual activities and increasing automated decision support is the only way that agility and customer responsiveness can be significantly improved.

Agile Scheduling Requires Frequent Decision-Making

Frequent decision-making is at the heart of agile scheduling. Decisions must be made on a daily basis and multiple times per day as warranted by the dynamics in customer demand and manufacturing operations. Decisions aren't truly isolated – in fact, they tend to be highly interrelated. Production scheduling decisions are complicated due to the fact that they span multiple time horizons, impact common plant equipment and resources and involve multiple products and customers. The figure below illustrates common scheduling decisions that are frequently required in specialty chemicals companies.

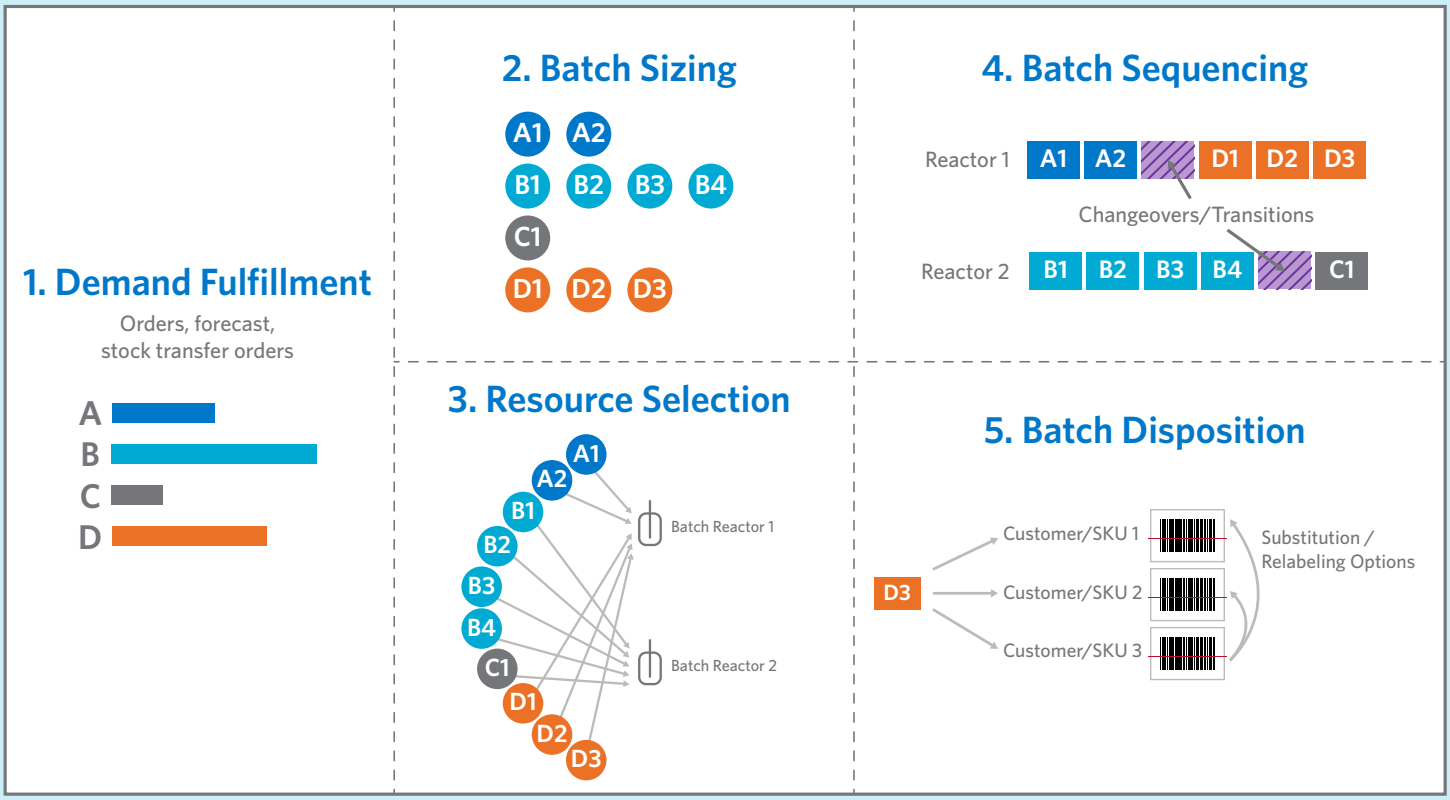


Figure 1: Complexity of common scheduling decisions.

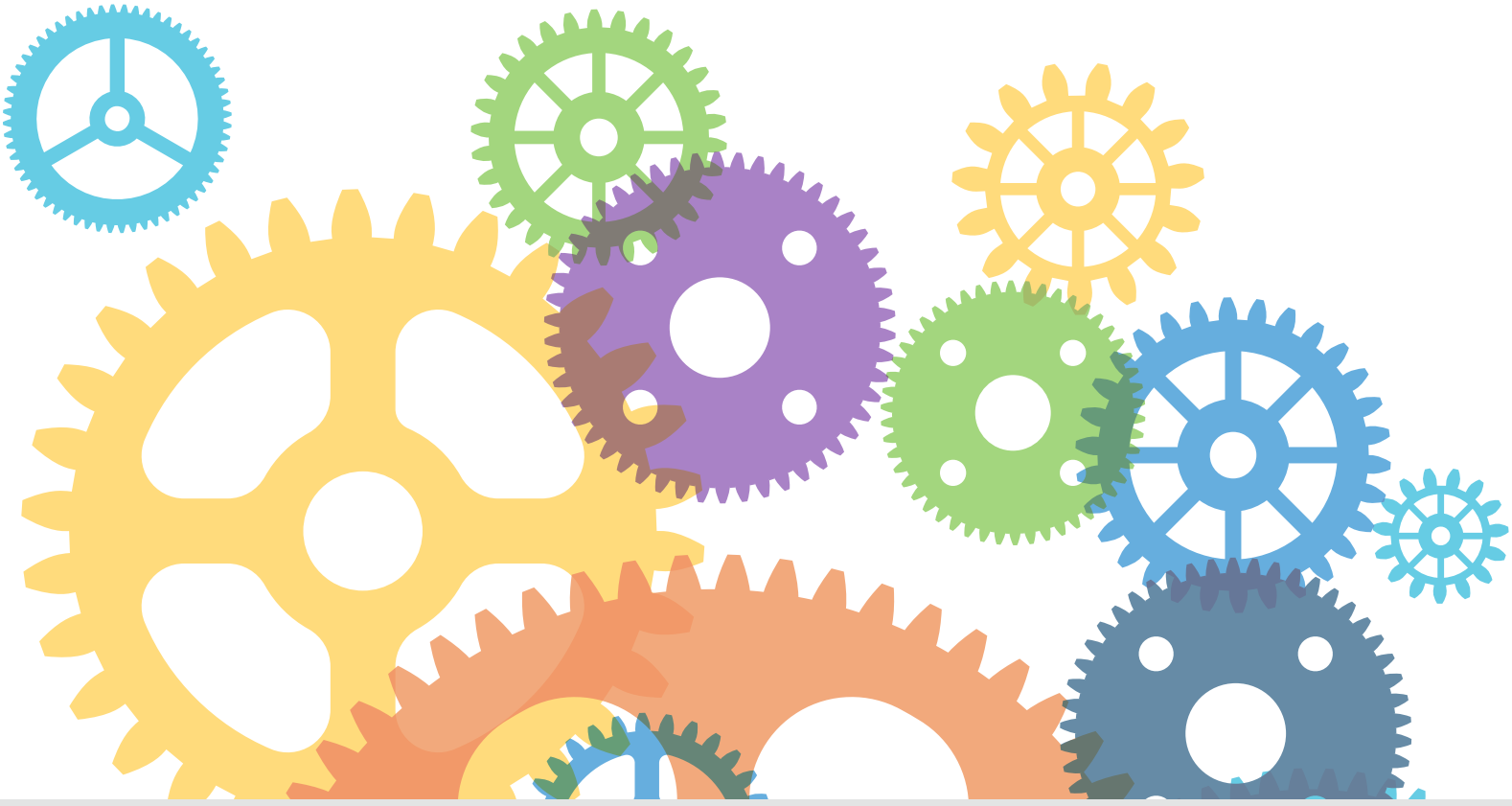
1. **Demand fulfillment decisions:** The primary challenge is figuring out how to run the plants at high asset utilization while maximizing demand fulfillment metrics and minimizing costs. When all demand can't be filled, how do you decide which customers to prioritize?

2. **Batch sizing decisions:** Typically, there are company policies or rules to decide the quantities of products A, B, C, etc. to make when trying to cope with complexity. For example, a company might always make 30 days of supply when making product A. While these rules make it easier to create the schedule, the company might be losing money if there isn't enough demand for product A, or losing capacity due to sub-optimal decisions.

3. **Resource selection decisions:** The rules at this stage might dictate that product A is always made on batch reactor 1, and product B is always made on batch reactor 2. However, depending on the situation, it might be better to make half a batch of product A in a different reactor to avoid excess inventory and still meet customer demand.

4. **Batch sequencing decisions:** If a company decided in the resource planning stage that product A is made on batch reactor 1, then the company is constrained by this decision because there might be better alternatives than making product A on reactor 1. What if it's less expensive to make product A on batch reactor 2 because of reduced changeover costs? Changeover time becomes more important at higher asset utilization levels. It then becomes a tradeoff between meeting high on-time order fulfillment rates (no late orders) and reducing costs. Are companies taking advantage of the full flexibility of their plants?

5. **Batch disposition decisions:** A key decision is how to post-process and partition a batch into final products. One batch might be able to create dozens of different final products. Finalizing a batch includes packaging and labeling, but could also include blending or drying.



Rule-Based Decision-Making

A method to approach decision-making in situations with complex and interrelated decisions is to break down the problem and develop a system of administrative rules or guidelines for plants. This is often referred to as "rule-based decision-making". The advantage of rule-based systems is that they can be easily communicated and followed when making decisions in the well-defined situations for which they were intended. In Figure 1 above, there are examples of company policies for product A. One example is that product A is always made on reactor 1, and 30 days' worth of supply must always be made. While these rules make it easier to create the schedule, the company might be losing money or capacity due to sub-optimal decisions that are made. The primary disadvantage of rule-based systems is that the underlying scheduling rules at specialty chemicals producers are frequently gross oversimplifications that do not closely approximate the actual complexity of the manufacturing operation, product portfolio or customer base. Furthermore, these rules frequently only cover a subset of all possible scenarios, providing little guidance, if not bad guidance, in particular situations. The net result is that the accuracy of decisions can be far from ideal, resulting in underutilization of manufacturing capacity, inefficient operations and lower customer order fulfillment.

Another major disadvantage of rule-based systems is that they are often deployed via customized spreadsheet tools that generally lack the ability to evaluate a wide spectrum of potential scenarios. They also tend to be non-automated, requiring users to devote extensive effort and time for data gathering and "trial and error" scenario analysis. These shortfalls make it nearly impossible to evaluate a broad range of complex scenarios in a reasonable time period. Finally, rule-based spreadsheet tools suffer from a major drawback of all custom-developed business tools - they function best when the individual that developed them is still around. Once that person leaves, so does all the underlying expertise needed to successfully run that spreadsheet.

Some company rules are gross oversimplifications by those that don't fully understand the complexity inside the plant.

Agile scheduling requires both speed and accuracy in decision-making. Rule-based decision methods generally fail to deliver either one, particularly in highly dynamic environments where situations frequently fall outside the bounds of what rule-based systems were designed to address.

Optimization-Based Decision-Making

An alternative means of decision-making leverages optimization methods to simultaneously evaluate all of the interrelated scheduling decisions to arrive at the best decision in terms of supply chain performance and profitability. This is often referred to as "optimization-based decision-making", and is gaining traction amongst leading specialty chemicals producers.

Optimization-based systems are based on realistic models of production operations that capture both complexity and flexibility across a full range of production scenarios. These systems can typically model the product mix across multiple production lines while evaluating options to swap products between those production lines to improve performance. These systems can also evaluate the impact of adjusting interchangeable equipment and resources between production lines to achieve better outcomes. Beyond the plant, they can model the segmentation of the customer base to support prioritized decisions when all demand can't be met. These scheduling models serve as the foundation of optimization-based systems, and they are intended to capture the actual complexity of production operations, product portfolios and customer segmentation.

Sitting on top of the scheduling models are the optimization methods that are the namesake of these systems. Optimization methods are based on sophisticated mathematical algorithms that rigorously evaluate all available permutations of production scenarios to arrive at the most profitable decision for any situation. These optimization methods are highly automated to support quick evaluation of the full range of potential options, whether as part of the regular daily scheduling process, or in response to an unexpected event or opportunity.

Optimization-based methods deliver both the speed and accuracy that is required to enable agile scheduling. They support the fast and frequent decision-making that is essential in the highly dynamic environment of specialty chemicals. Beyond that, optimization-based methods promote the discovery of new and improved ways of meeting customer demand and running manufacturing operations that may lie outside of the experience and rule systems of a company. Now, schedulers can eliminate the phrase "I don't know" from their vocabulary when deciding on what the most optimal decision is among a group of scenarios.

Implications for a Scheduling Decision Support Tool

As specialty chemicals producers strive to increase agility, they need to look towards substantially improving their production scheduling process to truly take advantage of agility inside the plant. When done effectively, customer satisfaction and operational efficiency are improved because specialty chemicals producers are able to handle the increasing complexity and real-world dynamics of this industry to make better decisions. The selection of a scheduling decision support tool is vital in being able to achieve agility through production scheduling. The single most important criteria when evaluating a decision support tool should be its ability to enable agile scheduling through fast and accurate decision-making.

Optimization-based scheduling systems offer clear advantages to rule-based scheduling systems. They can evaluate a much broader range of production scenarios with more accuracy and speed, and they support decisions based on economic optimization, not the opinion of an individual or an outdated business rule. Their models comprehend the actual complexity of specialty chemicals operations, and their automation enables faster response times to today's volatile markets. Finally, standardizing on an optimization-based scheduling system and its associated methodologies enable long-term business continuity because specialty chemicals producers are no longer reliant on multiple spreadsheets and the personnel needed to run them. The bottom line is this: optimization-based scheduling systems enable agile scheduling, whereas rule-based scheduling systems do not.

For example, Owens Corning, a company that develops products and systems that save energy and improve comfort in commercial and residential buildings, replaced their legacy, spreadsheet-based scheduling system with an automated, model-based scheduling solution to determine the best course of action when dealing with large changes in supply and demand.

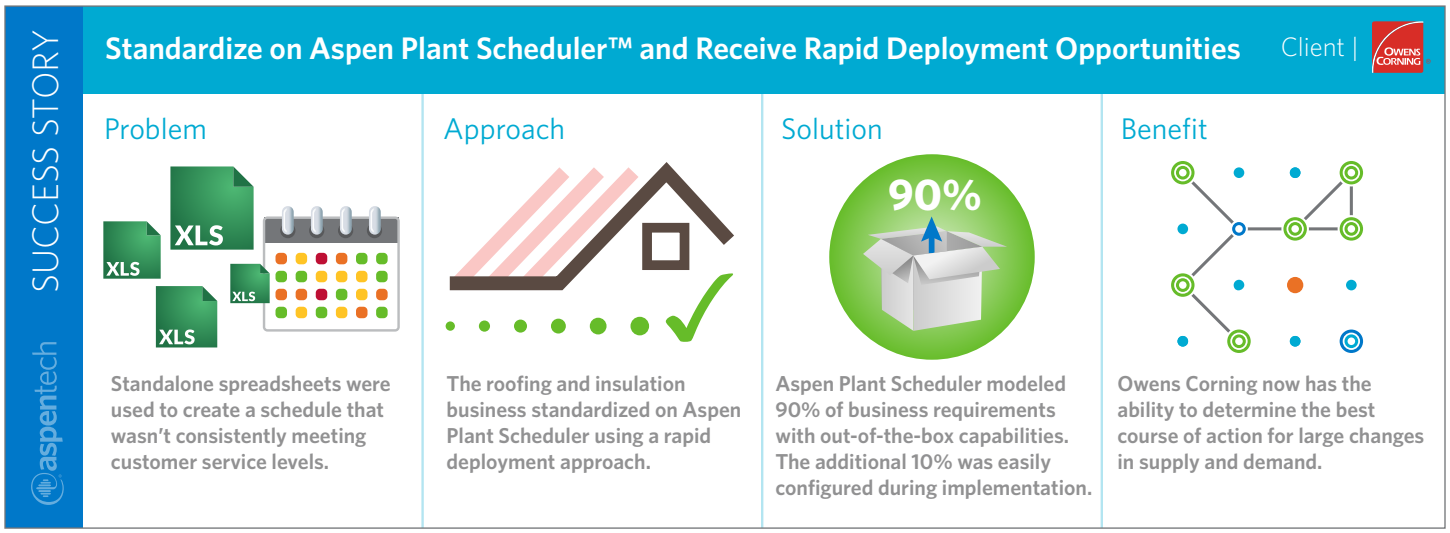


Figure 2: AspenTech has a full suite of solutions to address the complexity found in the specialty chemicals industry.

Agility Equals Profitability

Agility is at a premium for specialty chemicals producers as they move towards more customer-intimate business models. Being able to leverage the flexibility that exists in their manufacturing and supply chain operations is becoming critical for both customer responsiveness and operational efficiency. Increased agility can be a form of competitive differentiation that can improve customer satisfaction, market share and profitability. As production scheduling is often the cornerstone of agility, it should be strongly considered as part of any improvement program that intends to increase agility in specialty chemicals.

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