UNLOCKING CAPACITY:

System Optimization Strategies for Smarter Ingredient Handling

A guide to identifying bottlenecks and scaling without expansion

AZO.

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INTRODUCTION:

The Hidden Power of Optimization

Every bulk ingredient handling system in a manufacturing facility has limitations. Some are known, many hidden. If you were asked to increase production without adding new lines, could you do it? For many facilities, the answer lies not in expansion, but in optimization.

System optimization refers to the process of rethinking how your existing equipment, layout, workflow, and process controls are used and managed. It helps you do more with what you already have, rather than start from scratch. In this white paper, we'll explore how small changes in layout, logic, and workflow can lead to measurable improvements in throughput, downtime, safety, and overall efficiency.

Let's start with a few basics. Optimizing a system might mean separating ingredient bins that share transfer lines and cause queuing. It might mean adjusting blower settings to improve airflow or updating filter maintenance routines to reduce clogs. Optimization can also involve shifting batch sequencing to reduce allergen cleanouts or rethinking floor space to improve operator access. Sometimes, it means upgrading a component. Often, it's simply better coordination of the ones already in place.

Just like automation doesn't eliminate the need for people, optimization doesn't eliminate the need for engineering insight. Quite the opposite. Optimization works best when it's collaborative. Operators, maintenance teams, engineers, and leadership all play a role in identifying inefficiencies and uncovering opportunities. In fact, some of the most impactful changes come from those who work with the system every day.

System optimization also ties closely to regulatory requirements. With the introduction of NFPA 660, many facilities are required to reevaluate their ingredient handling systems for dust hazards and explosion risks. Optimization in this case might include ductwork redesign, equipment upgrades, or process changes, all of which can improve safety while boosting performance.

The goal of this guide is to provide a practical overview of what system optimization entails. We'll define key terms, outline common pitfalls, and share real-world examples from manufacturers who increased output, improved reliability, and lowered cost without complete system overhauls.

If your system feels maxed out but performance still lags, this paper may help you uncover hidden potential. Sometimes the capacity is already there — it just needs to be unlocked.

Signs It Might Be Time To Optimize

Many inefficiencies in ingredient handling systems go unnoticed not because they aren't real, but because teams get used to them. Workarounds become standard practice and small losses in time, material, and labor add up quietly over months and years. But even when no one's actively complaining, the signs of optimization opportunities are often there — if you know what to look for. Let's start with a few of the more common indicators.

1. **Downtime caused by ingredient delays or scale congestion.**
   If a system is designed so that multiple ingredients share the same transfer line, they may end up waiting for one another. This queuing effect often slows down batch cycles and reduces mixer utilization.

2. **Repeated cleaning cycles due to allergen changeovers.**
   When allergen-containing and allergen-free recipes run on the same line, deep cleaning between batches is mandatory. But if changeovers are frequent or poorly sequenced, cleaning becomes a major time sink. Optimize by adjusting production schedules to run allergen-free products early in a campaign to reduce downtime and improve control.

3. **Operator workarounds that increase labor or injury risk.**
   If operators are using ladders to reach filters, manually dumping 50 lb bags into bins, or running equipment manually because automation is unreliable, those are clear signs of system friction. Switching to **super sack unloaders** can reduce strain on operators and speed up batch prep without increasing labor cost.

4. **Recurring maintenance to prevent equipment wear.**
   Component failure isn't always random. Bearings that fail annually or screeners that plug mid-batch signal a mismatch between system design and production demands. Switching from reactive to planned maintenance can improve uptime and extend equipment life.

Individually, these symptoms might seem manageable. But together, they indicate a system that's working harder than it should. Optimization helps prevent these issues from becoming entrenched in the first place. A few adjustments may reveal more hidden capacity than expected.

CASE STUDY

Designing Around the Mixer: Keeping the Right Bottleneck

The problem: In batch processing, there's always a bottleneck. The key is making sure it's in the right place. For one food manufacturer AZO partnered with, that meant designing the system so the mixer was the only constraint. Everything before and after was engineered to keep the mixer running continuously.

The solution: If scale receivers were ever the hold-up, it signaled a problem. Rather than adding bulk storage, the team added diverter valves and alternate pipe paths to reroute ingredients to different scales. This gave them more flexibility without more footprint.

Originally, each mixer had three scales. As recipes became more complex, a fourth scale was added. That extra capacity enabled more efficient batching and kept pace with changing formulations.

The takeaway: By designing around the mixer and adding strategic flexibility, the plant maintained high throughput without adding production lines, demonstrating that optimization is often less about expansion and more about control.

Hidden Costs of ‘Normal’ Inefficiencies

In manufacturing environments, persistent inefficiencies often become invisible. But these “normal” inefficiencies come with a price and, over time, that price adds up. The biggest risk isn’t the inefficiency itself — it’s actually accepting it as normal. Optimization helps teams reevaluate old habits, uncover overlooked costs, and make smarter decisions that improve both performance and profitability.

Common Hidden Costs

Energy Waste

Not all inefficiencies show up in downtime or maintenance logs. Some are buried in everyday operating costs, like power consumption. Even when production slows, air compressors and vacuum blowers continue to run at full load. As one manufacturing engineer put it, “The lights are still on, whether we’re transferring product fast or not.”

Labor Inefficiency

Manual bag dumping, climbing ladders, or performing repetitive tasks adds time and strain for operators.

Product Loss

Escaped dust or poor flow control often leads to wasted ingredients. At first, a little bit of product loss doesn’t seem like an issue, but as raw material prices rise, what was once considered negligible becomes costly.

Compliance Risk

Inconsistent cleaning or allergen management can result in recalls or failed audits.

CASE STUDY

Uncovering Hidden Capacity: The Blower Filter Fix

The problem: After a weekend vacuum blower cleanout, an operator at one facility discovered that their entire system was moving much faster than it had been. They realized that product leakage into the blower inlet filter reduced airflow and slowed transfer rates, something that had gone unaddressed because it wasn’t visible.

The solution: It wasn’t long before the filters got plugged up again, so the facility implemented a routine cleaning schedule to regain valuable vacuum capacity.

The takeaway: Not all slowdowns are mechanical. Sometimes, it’s about recognizing what’s been normalized and getting curious about why it’s happening.

Getting Started With System Optimization

System optimization refers to the holistic engineering and refinement of ingredient handling systems to improve safety, efficiency, and material flow within processing environments. It's more than getting new equipment — it's making the most of the equipment and layout you already have, which includes hardware, software, and how you manage those assets.

A comprehensive system optimization strategy should take into account the following:

Improving Material Flow and Compatibility

Material behavior is the critical factor in ingredient handling. Flowability, density, moisture content, particle size, friability, and electrostatic properties all affect how an ingredient behaves inside a pneumatic conveying system. When systems are designed without taking these variables into account, issues like clogging, ingredient segregation, excessive dust generation, and inconsistent dosing can quickly undermine production.

In other words, system optimization can only truly begin when you understand the ingredients you're handling. Address these challenges through a multi-step evaluation process so you know where and how to optimize your system. At AZO, we do the following:

Material characterization and lab testing: AZO routinely performs flowability and bulk density analysis in-house or in partnership with customers to ensure accurate equipment selection.

Conveyance method: For example, fragile materials may require dense phase conveying to prevent degradation, whereas light, dusty powders may need vacuum systems with controlled airflow to minimize airborne dust.

Customize hoppers: Free flowing materials will flood hopper outlets and feeders, while poor flowing materials will plug and cause bridging and ratholing. In these cases, AZO recommends design modifications with bin discharge aids like live bottom bin activators and material vibrators.

Smart sequencing: Ingredient scheduling can impact flow. Allergens and dense powders can be scheduled in a specific sequence to optimize cleanout and prevent blockages. Coarse or abrasive materials, such as sugar or salt, are often brought in last to scour convey lines and ensure no other materials are left behind.

Ultimately, flow optimization is not about forcing ingredients through standard equipment, but rather designing the right environment for each material to move efficiently and consistently.

Evaluating Equipment

Most gains can be made by intelligently modifying or reconfiguring existing equipment. AZO's approach to equipment evaluation considers mechanical reliability, compliance risk, cleaning and maintenance access, and integration potential. Retrofit recommendations tailored to your plant's unique needs can help you achieve more reliable performance from the assets you already own.

Key areas of evaluation should include:

Bin and Scale Layout

Reorganizing bin assignments can reduce ingredient queuing and improve scaling throughput dramatically. For example, imagine 10 ingredient bins that make up 30% of your formula. If those bins are split into groups of three, three and four, they will share the same transfer lines to the scale receiver.

Preventive Maintenance Routines

AZO customers have seen success by shifting from reactive to planned maintenance. For example, replacing rotary sifter bearings every nine months instead of 12 prevented unplanned downtime and improved system reliability in one facility. In addition, this manufacturer created kits in the maintenance shop for quicker changes on the floor. This optimization reduced downtime by approximately 1% during production.

Cleaning Procedure Improvements

Equipment with AZO's sanitary design features — such as rounded corners, tool-less disassembly, and dust-tight seals — streamlines allergen cleanout and reduces downtime.

Legacy Component Assessments

While older systems may still function, they often lack the efficiency or safety performance of newer designs. These small degradations in inefficiency can stack, leading to larger problems. A site visit can reveal how small retrofits, like replacing filter configurations, can extend life and create larger gains over time.

Enhancing Safety and Compliance

Sometimes optimization isn't a choice, but rather influenced by compliance mandates. Regulatory standards like the **newly consolidated NFPA 660** require plants to reevaluate their handling systems, especially in the context of combustible dust hazards. Where NFPA 652 and NFPA 61 once stood alone, NFPA 660 now provides a comprehensive framework for conducting Dust Hazard Analyses (DHA), designing explosion venting and isolation, and managing ignition sources across mixing, blending, and conveying equipment.

Optimization in this context may include:

- **Meeting enhanced ignition source management requirements** in spray dryer systems, mixers, and blenders
- **Using intrinsically safe devices** to comply with Class 2 Division II Electrical Classification requirements
- **Enhancing explosion protection** in small-volume air-material separators
- **Investing in explosion venting alternatives** for bins, silos, and tunnels

Reducing Energy and Space Use

Physical footprint and energy consumption are tightly linked. Systems designed with unnecessarily long conveyance paths, oversized equipment, or inefficient layouts contribute to elevated utility costs, ergonomic strain, and workflow bottlenecks.
Optimization strategies should focus on:

Right-sizing Equipment

Motors, blowers, and receivers should be matched to application needs, not oversized "just in case." Overspecifying equipment may seem like a safe bet, but it often leads to wasted horsepower, higher energy use, and poor control at low flow rates.

Shorter, Efficient Conveyance Routes

Every bend, branch, and extra foot of piping adds resistance. By re-routing lines or consolidating transfer points, teams can reduce both energy consumption and material hang-up. In one plant design, reconfiguring vessel placement allowed super sacks to drop directly into the process vessels, which eliminated the need for multiple intermediate transfers and reduced the total number of components required.

Elevating Ergonomics

Manually dumping ingredient bags slows throughput and introduces repetitive strain risks. Replacing manual handling with super sacks, hoists, or platforming allows operators to work more efficiently with less strain. Plus, bulk ordering can lead to additional cost savings.

Consolidating Equipment Functions

Multi-functional devices — such as combination scales and feeders or integrated receivers and screens — can replace multiple pieces of equipment while improving flow and reducing points of failure. Fewer components means fewer cleanouts, fewer leak points, and less floor space needed.

Integrating Process Control

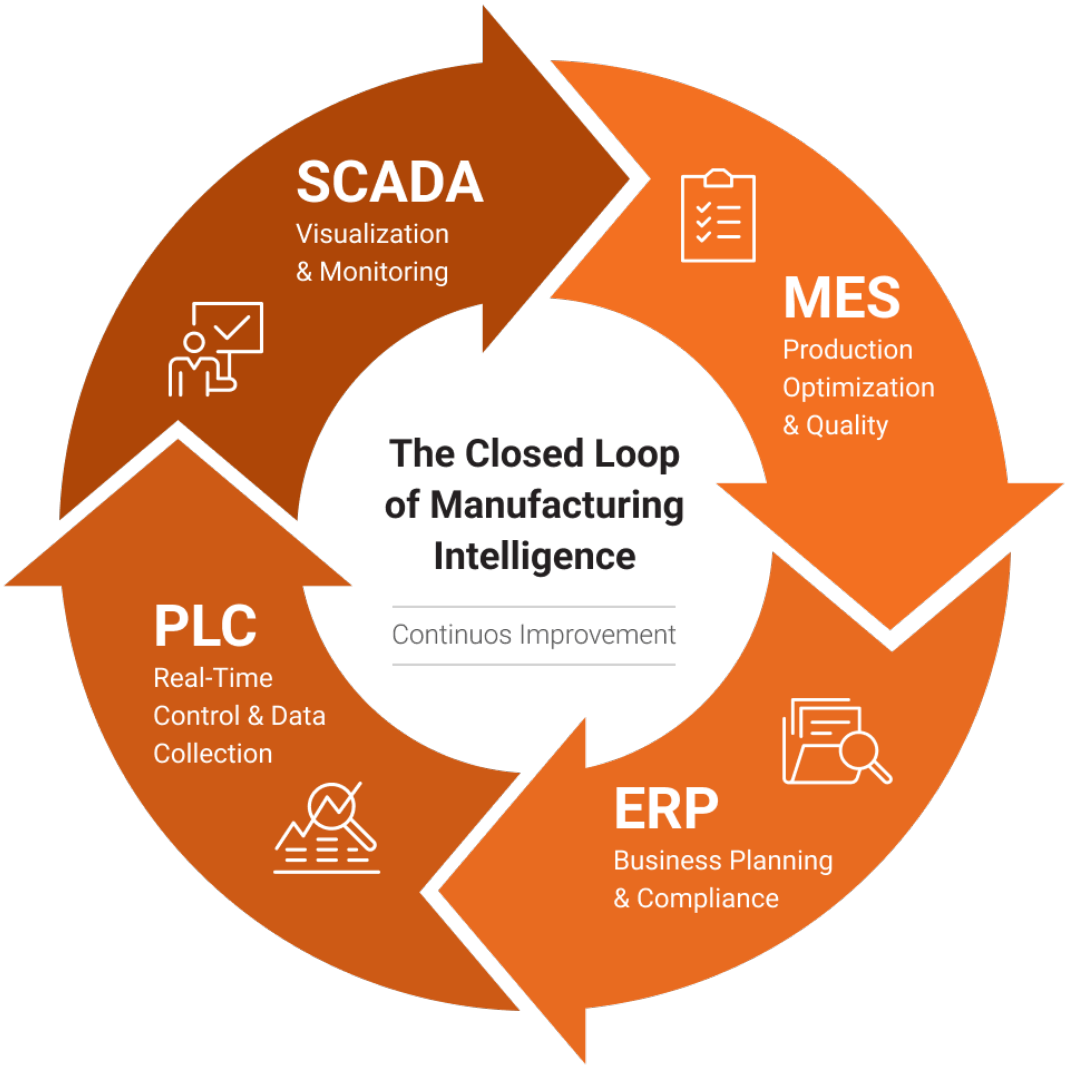
Process optimization and automation must work hand-in-hand. Integrating process control means aligning upstream handling systems, like storage, dosing, and conveying, with downstream operations such as mixing and packaging. Well-integrated systems should support this kind of coordination by including:

Precise dosing and weighing controls tied to recipe management software: This ensures consistent formulation across multiple SKUs, reducing variation and manual adjustment. Gravimetric and loss-in-weight systems provide the accuracy required for critical ingredients, while allowing real-time correction based on live feedback.

Automated sequencing and batch validation: Batch management software can validate recipe steps, verify ingredient availability, and trigger alarms or prompts when manual intervention is required. This reduces operator workload and minimizes the risk of missed steps or incorrect order of operations.

Real-time system diagnostics: Operators should be able to see the current status of all critical components — flow rates, scale levels, blower operation, valve positions — at a glance. When the system communicates clearly, it allows the operator to respond faster and with better context when something deviates from normal.

Connectivity with existing systems: Data doesn't belong in silos. Integrating control systems with plant-wide platforms allows for better scheduling, traceability, and quality reporting. It also allows production data to inform purchasing, maintenance, and operational decisions.



Designing for Future-Ready Flexibility

Ingredient sourcing, regulatory labeling, and consumer trends are in constant flux. System optimization isn't just focused on solving today's problem. It helps you design a framework that evolves with your operation's needs, whether that's adjusting to cleaner labels, scaling up production, or reducing downtime for changeovers. Customers who build flexibility into their systems at the outset avoid costly retrofits later. Our clients say that if they could build a facility from scratch, here's what they'd do differently:

- Separate allergen lines from non-allergen lines.
- Automate material handling from delivery to the line.
- Invest in higher-tech packaging that moves products faster.
- Instead of multi-handling, use big bags to drop ingredients into vessels.
- Leave more room for additional ingredient storage, especially outdoor bin storage.
- Increase floor space during initial build so you can accommodate for expansion later.

Building a Culture and Mindset for Optimization

Successful optimization programs are built on cross-functional collaboration, clear communication, and measurable value. Teams that embrace this approach make steady, sustained improvements year after year. Let's look at what that mindset may include.

Empower Operators To Spot Bottlenecks

Using existing equipment, one food manufacturer bought analytics software that functions like an AI tool to monitor real-time performance and make on-the-fly changes. AZO helped train the plant's operators on how to monitor the exact timing of all the plant's equipment. This allowed operators to see how to move ingredients so they could shorten batch time. "The single biggest factor for us in optimizing was giving the operator the ability to see where the bottlenecks were," an engineering manager said. "Once we did that, our efficiency went through the roof."

Encourage Cross-Functional Collaboration

Optimization efforts work best when engineering, maintenance, operations, quality assurance/quality control, and leadership are aligned. Each group brings a valuable perspective. Operators see bottlenecks firsthand, engineers understand system dependencies, and leadership keeps sight of strategic goals.

For example, one facility's operators pushed back because when the system ran faster, then they would have to work harder and faster, too. To address operator workload concerns, a new hire became a "floater," an extra team member who could step in where needed. This reduced stress during runs and helped gain buy-in for the optimization changes.

Communicate Benefits

Operators don't always care about ROI. They care about how changes affect their work. When presented with an optimization plan, one team made the case by explaining how the changes would require less physical effort for operators — not more. That clarity made a difference in getting all workers on board with changes.

Show ROI

Leadership support depends on a clear value proposition. One plant engineering team approached optimization by presenting multiple cost-saving projects each year to the C-suite, each with a target payback of under two years. They also highlighted how changes could support worker safety and future production trends, which added weight to their case and helped win approval.

Focus on Incremental Wins

The best optimization plans start small: Choose one to two high-impact projects at a time. These early wins build momentum and help teams learn what works. Over time, small improvements compound. One facility that AZO partnered with on system optimization completed 20–25 optimization projects over 20 years. The result? This manufacturer doubled plant output without adding a single new line.

Prioritizing Optimization Projects

Remember, optimization isn't solely about one big win, but compounding long-term gains. We've seen our clients do impressive numbers when they dedicate their time to system optimization. Results like:

- Production output doubled over 20 years with no new lines
- Preventive maintenance reduced downtime to <1%
- Seconds shaved off batches added up to hours per week

The most effective strategies for optimization include:

- Implementing the biggest impact projects first
- Staging 1-2 projects per year to see the distinct results from each
- Stacking 4-5 capital project ideas per year for future approval
- Planning around equipment lead times
- Focusing on ROI, safety, and regulatory compliance

ROI Expectations

Project Size	ROI Timeframe
Small	4-6 months
Medium	1-3 years
Large	5+ years

For support with defining return on investment, check out our resource: **Start Building Your Business Case for ROI**

AZO: Your Partner in Continuous Optimization

The most successful manufacturers embrace optimization as a partnership, not a project. That means working closely with vendors, staying curious about performance, and continuously identifying new opportunities to improve.

We partnered with one facility that doubled its throughput — from 140 million to 280 million pounds — without a full redesign. We did it together by completing 20-25 targeted optimization projects over 20 years. None of these changes radically altered the original layout. Instead, each one shaved off a few minutes, and then seconds, from batch time. And at that scale of production, every second mattered.

What made the difference was consistency. Every year, our teams collectively reviewed bottlenecks, identified two or three areas to explore, and tracked additional opportunities in a running file for future upgrades. This ongoing mindset allowed them to build a compelling case for capital improvements over time with ROI data to support each investment.

That kind of progress only happens when both sides approach the relationship as partners. Frequent site visits, operator feedback, and shared visibility into system performance create the conditions for smarter decision-making. Sometimes, what seems like a minor constraint turns out to be a major opportunity — especially when an outside expert can spot something that's been normalized on the plant floor.

At AZO, we support customers through ongoing system refinement with services like:

- Annual bottleneck and throughput reviews
- Operator training and changeover best practices
- Material behavior testing and handling recommendations
- System audits for NFPA compliance and dust mitigation
- ROI modeling to support capital planning and justification

Whether you're managing a legacy facility or building from scratch, we meet you where you are and help take your system where it needs to go. Optimization is about more than speed: **It's building a system that gets better every year.**

CONCLUSION:

Unlock What You Already Own

Many manufacturers assume the only way to increase output is to expand capacity. But the truth is most ingredient handling systems aren't running at their full potential — they're limited by small inefficiencies and workarounds that add up over time.

System optimization helps you reclaim that potential. Look closer at the details — bin sequencing, blower performance, ergonomic layout, and cleanout procedures — and ask how each one could perform better. Then, make sure you align engineering, operations, and leadership around smarter, safer, and more flexible ways to run the plant.

Throughout this guide, we've shown how optimization can:

- Improve safety and compliance
- Reduce downtime through better batching and material flow
- Lower utility costs with right-sized equipment and simplified routing
- Increase operator engagement through better ergonomics
- Deliver measurable ROI without the disruption of new lines

Optimization isn't a project; it's a practice. One that compounds its value over time and positions your facility for whatever comes next: new ingredients, new SKUs, or new regulations.

> **You don't need a new system. You need a new strategy.** Let's unlock the performance already built into your system.
>
> Start Optimizing Today