

Practitioner's Section

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Accelerating Industrial Innovation under Time Pressure: Platform-Based Lessons from Specialty Chemicals

Innovation in the specialty chemicals industry is increasingly constrained by shortened product life cycles, rising regulatory complexity, and strong dependencies on critical functional components. When essential inputs become unavailable, companies must rapidly develop substitutes while maintaining performance, scalability, compliance, and economic viability. This article presents an anonymized industrial case study showing how additive and formulation development under severe time pressure can be accelerated through parallelized development structures and modular platform strategies. Focusing on process architecture and managerial decision-making rather than technical specifics, the contribution derives practical insights for innovation managers in process-oriented industries. Project risk is shown to be strongly influenced by early parallel R&D resource allocation rather than by capital investment decisions alone, highlighting the importance of development process architecture under severe time pressure.

Keywords: Innovation Management, Stage-Gate[®] Process, Parallel Development, Platform-based Development, Chemical Industry

1. Introduction

Innovation is a critical driver of competitiveness in the specialty chemicals industry, where differentiation is often achieved through highly specific functional additives and tailored process solutions. At the same time, innovation activities are increasingly constrained by shortened product life cycles, rising regulatory complexity, and growing global competition. As a result, chemical companies are required not only to innovate effectively but also to bring new solutions to market within increasingly narrow time windows.

A particular challenge arises when established products or processes depend on critical components that become unavailable due to external factors such as supply chain disruptions, regulatory changes, or strategic shifts by upstream suppliers. In such situations, companies are forced to substitute essential components while ensuring equivalent or improved performance, industrial

scalability, regulatory compliance, and economic viability. Failure to do so may result in significant revenue losses and erosion of market position.

Classical linear gated development models, such as Stage-Gate[®] type processes, are widely used in the chemical industry to structure innovation activities and manage technical and commercial risks. While these models provide transparency and control, they often rely on sequential execution of development phases. This sequential logic can become a limiting factor when multiple interdependent development streams such as substance development, process scale-up, sourcing, regulatory approval, and market preparation must progress simultaneously under high time pressure.

This article presents an anonymized industrial case study from the specialty chemicals industry that illustrates how innovation can be accelerated when

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classical sequential development models are replaced or complemented by parallelized development structures. The case focuses on the substitution of a critical functional additive in an established industrial application, where time-to-market constraints necessitated a departure from traditional development logic.

The objective of this article is threefold. First, it analyzes the limitations of linear gated development models in highly time-critical innovation scenarios. Second, it demonstrates how principles of Simultaneous Engineering and modular platform strategies can be applied in an industrial chemical context to enable parallelization of development activities. Third, it derives practical lessons learned and managerial implications for innovation managers facing similar challenges in process-oriented industries.

By abstracting technical and economic details and focusing on organizational design and decision-making logic, this contribution aims to provide transferable insights for practitioners and researchers interested in accelerating innovation under conditions of uncertainty and time pressure.

Importantly, the case is not a one-to-one replacement of a single molecule. The legacy additive was embedded in multiple formulations and process variants, which required a modular substitution strategy and the development of two new proprietary additives. In this context, innovation is reflected less in isolated molecular novelty than in the successful alignment of (i) conceptual novelty, (ii) industrial applicability, and (iii) market viability. Both additives are protected by intellectual property rights and were implemented at industrial scale, demonstrating that the case exceeds a purely technical substitution and represents an industrial innovation under severe time constraints.

2. Main Part

2.1 Development Challenge and Industrial Context

2.1.1 Business-Critical Substitution under Time Pressure

The case presented in this article originates from a situation in which a multinational specialty chemicals company faced the imminent unavailability of a critical functional additive used across multiple established

formulations and industrial processes. The additive represented a key performance component, and its substitution was mandatory to ensure continued market participation and business continuity. In addition to the limited remaining availability of the legacy raw material, the situation was further exacerbated by a pronounced dependency on a single external supplier, which significantly increased supply chain risk and reduced strategic flexibility. The challenge was therefore not driven by exploratory innovation or market expansion, but by the necessity to redesign an existing solution architecture under severe time constraints.

Due to the broad range of applications in which the legacy additive was embedded, the substitution problem could not be addressed through a simple one-to-one molecular replacement. Instead, the development ultimately required two new proprietary additives to cover the functional requirements of the existing formulation and process landscape. Consequently, the innovation task comprised two tightly coupled development streams: (i) the synthesis, scale-up, and industrial production of new additives, and (ii) their integration into existing formulations and applications, requiring reformulation and validation at system level.

The remaining availability of the legacy raw material defined a fixed and non-negotiable development window of approximately three years. This constraint fundamentally shaped the innovation strategy, as it effectively ruled out extended sequential exploration or radical chemical novelty. To meet the time-to-market requirements, the project relied on a modular substitution logic based on established additive classes and shared synthesis intermediates. Several intermediates had already been developed and industrialized for related products, while only a limited number of additional precursors required further development.

This modular architecture enabled reuse of existing manufacturing routes, analytical and quality control methods, and qualified toll manufacturing capabilities. Beyond accelerating development, the approach reduced regulatory uncertainty and positively affected cost structures, which is particularly relevant in specialty chemical contexts characterized by low substance volumes and stringent registration requirements. Although performance improvement was not the primary objective, the resulting additives exhibited improved stability and robustness in application, further supporting their industrial and commercial viability.

2.1.2 Boundary Conditions and Constraints

The development challenge was shaped by a set of non-negotiable boundary conditions that significantly constrained the range of feasible innovation strategies. First, the fixed time window imposed by the limited remaining availability of the legacy raw material eliminated the option of extended sequential exploration. Delays or late-stage failures would have directly translated into business interruption rather than postponed market entry.

Second, the substitution affected an existing and commercially active process landscape. Unlike exploratory innovation projects, the case required compatibility with established formulations, production infrastructure, customer qualification routines, and regulatory frameworks. As a result, the project could not rely on trial-and-error experimentation or radical departures from known chemical classes without incurring disproportionate technical and regulatory risks.

Third, the specialty chemical context introduced additional constraints related to substance volumes, cost sensitivity, and regulatory compliance across multiple regions. As the additive was used globally, registration requirements extended beyond REACH to include additional national and regional regulatory regimes with differing timelines, data requirements, and approval procedures. Late structural changes would have multiplied regulatory effort and uncertainty across jurisdictions, thereby strongly favoring reuse of known intermediates, established toxicological profiles, and proven substance classes.

Combined, these boundary conditions favored an innovation strategy based on modular recombination of existing technological assets rather than radical novelty. Platform-based additive classes, shared synthesis intermediates, and established analytical and manufacturing capabilities provided a sufficiently robust solution space to enable early parallelization while maintaining acceptable risk exposure. Under these constraints, the primary innovation challenge shifted from molecular discovery to the orchestration and synchronization of tightly coupled development activities.

2.2 Limitations of Linear Stage-Gate® Development

2.2.1 Role and Strengths of Linear Stage-Gate® Models

Classical linear gated development models, such as Stage-Gate® type processes, are widely used in the chemical industry to structure innovation activities and manage technical and commercial risks. By dividing development projects into sequential phases separated by formal decision gates, these models provide transparency, clear accountability, and structured decision-making, and have become a dominant framework for managing innovation projects (Cooper, 1990; Cooper, 2008; Smolnick and Bergmann, 2020). In the chemical industry, such gated development processes are widely applied to balance technical risk, regulatory requirements, and resource allocation across development stages (Cooper, 1990; Cooper, 2008; Leker et al., 2018).

In the present case, the linear gated model initially provided a useful orientation, especially for framing the overall project scope and defining high-level milestones. As a governance framework, it offered a common language for cross-functional coordination and supported alignment between technical development and management oversight.

However, as the project requirements became clearer, several structural limitations of the sequential development logic emerged. These limitations were not inherent flaws of the gated approach itself, but rather the result of a mismatch between the process architecture and the specific constraints of a highly time-critical substitution scenario. The classical Stage-Gate® logic assumes that uncertainty can be reduced stepwise and that downstream activities can be postponed until upstream phases have been completed. Under severe time pressure and strong interdependence between development streams, this assumption proved increasingly restrictive.

2.2.2 Mismatch Between Sequential Processes and Time-Critical Substitution Projects

In the present case, several structural limitations of the sequential development logic became apparent as project requirements crystallized. These limitations were not inherent flaws of the gated approach itself but resulted from a mismatch between the process

architecture and the constraints of a highly time-critical substitution scenario.

A key challenge arose from the strong interdependence between multiple development streams. The project required simultaneous advancement of substance development, process scale-up, sourcing of raw materials and intermediates, regulatory preparation, and market-facing activities. In a strictly sequential model, downstream functions such as procurement, regulatory compliance, and production would only be formally engaged after completion of earlier development phases. Under severe time pressure, this sequencing would have postponed critical activities and concentrated technical, regulatory, and supply chain risks into late project stages.

Furthermore, the linear gated model implicitly assumes a relatively stable problem definition during early phases, with uncertainty gradually reduced before subsequent activities commence. In the present case, however, uncertainty was distributed unevenly across the project timeline. While early-stage technical screening could be performed rapidly based on prior knowledge and platform elements, uncertainties related to industrial

scalability, cost structures, supply chain robustness, and global regulatory requirements could not be resolved without early involvement of downstream functions. The sequential logic therefore created artificial waiting times that did not reflect the actual information needs of the project.

This misalignment is particularly critical in chemical development contexts, where cost-relevant parameters are often fixed early in the innovation process. Prior work on cost management in R&D-intensive industries has highlighted that late discovery of unfavorable cost structures significantly constrains corrective action (Murjahn, 2004). Under severe time pressure, postponing cost, sourcing, and regulatory assessments until late development stages increases the likelihood that economically or operationally infeasible solutions are identified only when remaining time and degrees of freedom are already exhausted.

As a result, effective risk management in such projects requires early synchronization of technical, economic, and regulatory considerations rather than late-stage control. This observation motivated the transition toward a parallelized development approach, which is

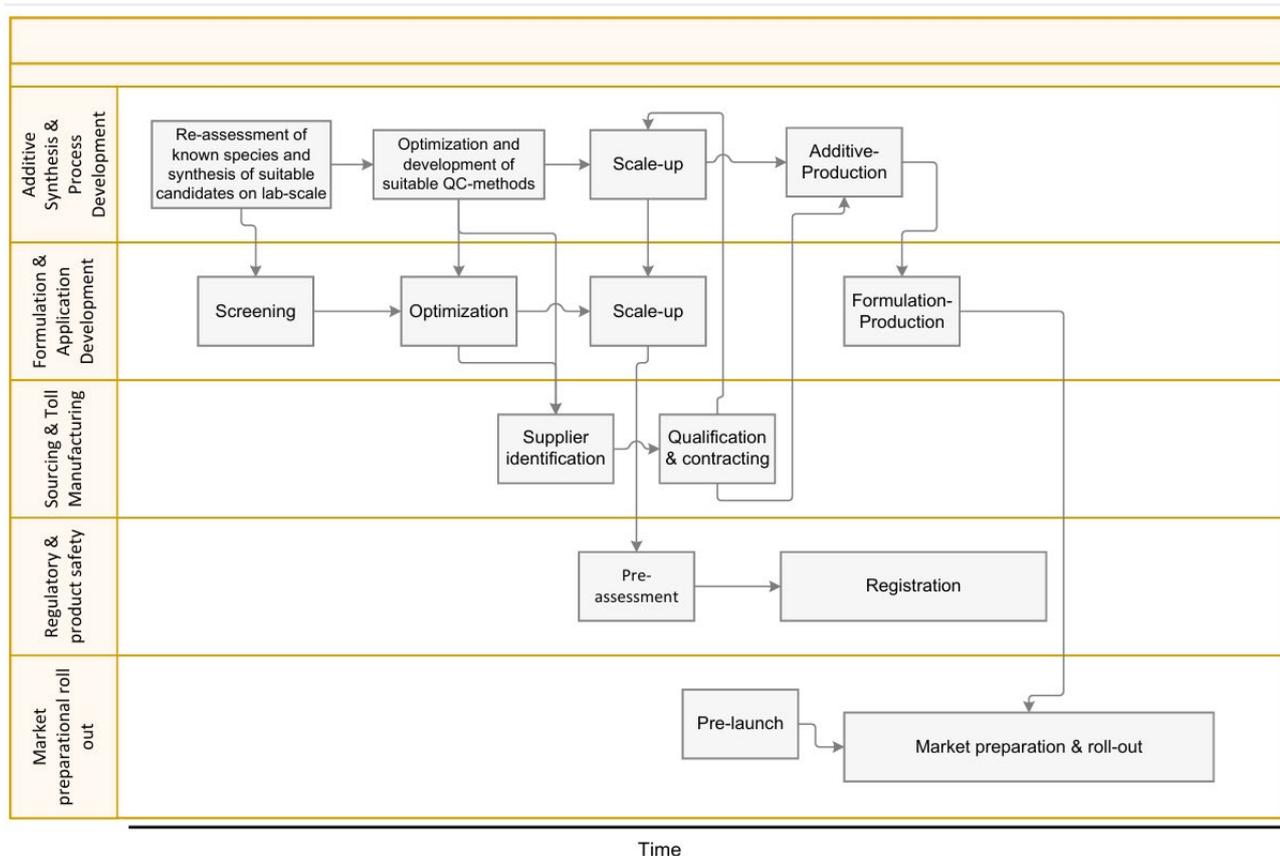


Figure 1. Simplified and anonymized development timeline illustrating parallelized innovation activities

discussed in the following section.

2.3 Parallelized Development and Platform-Based Strategies

2.3.1 Transition to Parallelized Development

In response to the limitations of a strictly sequential development logic, the project organization was deliberately reconfigured toward a parallelized development approach inspired by principles of Simultaneous Engineering. Prior research has shown that overlapping development activities and early cross-functional integration can significantly accelerate innovation processes in time-critical environments (Eisenhardt and Tabrizi, 1995; Bender and Gericke, 2016). The objective of this transition was not to abandon structured governance altogether, but to decouple critical activities from a rigid phase sequence and enable controlled concurrency across organizational functions.

The transition was initiated once a sufficiently robust solution space had been established through early technical screening. Existing knowledge of additive classes, synthesis routes, and application behavior allowed the project team to narrow down viable solution candidates at an early stage. This early convergence enabled downstream activities to be launched based on provisional but reliable information, rather than waiting for full technical validation as implied by a classical Stage-Gate[®] logic (Cooper, 1990; Cooper, 2008).

To illustrate the underlying logic of the parallelized development approach, Figure 1 provides a simplified and anonymized development timeline highlighting the deliberate overlap of key activities. Rather than following a strictly sequential progression, additive synthesis and process development, formulation and application development, sourcing and toll manufacturing, regulatory preparation, and market-related activities were advanced concurrently. This overlap reduced idle time and allowed interdependencies between development streams to be addressed early, thereby preventing late-stage bottlenecks under severe time pressure.

The conceptual differences between a classical sequential Stage-Gate[®] process and a parallelized development approach are summarized in Table 1, highlighting shifts in process logic, risk exposure, and early-stage resource commitment under conditions

of severe time pressure. As illustrated in Table 1, parallelization redistributes risk toward earlier project phases and increases upfront R&D resource commitment, while reducing the likelihood that critical technical, regulatory, or sourcing constraints are identified only at a point where remaining time and degrees of freedom are already exhausted.

The feasibility of this early parallelization was further supported by established analytical and quality control routines. As key synthesis intermediates and additive platforms had already been characterized in prior development activities, analytical methods and quality specifications were largely available from the outset. This reduced uncertainty and enabled early decision-making without disproportionately increasing technical or regulatory risk.

2.3.2 Role of Modular Platform Strategies

In addition to organizational parallelization, the acceleration of the development process was strongly enabled using a modular platform strategy. Platform-based development approaches aim to reuse existing technological building blocks across multiple innovation projects to reduce uncertainty, increase learning efficiency, and enable faster downstream decision-making (Meyer and Lehnerd, 1997; Gebhart et al., 2016). In the present case, the platform strategy did not represent a long-term product family initiative, but a pragmatic response to severe time pressure and regulatory constraints.

Rather than developing a single replacement compound, the substitution challenge required the development of two new proprietary additives to cover the functional requirements of multiple existing formulations and process variants. Both additives were deliberately designed using a modular synthesis architecture with shared intermediates. Several of these intermediates had already been developed and industrialized for related products, while only a limited number of additional precursors required further development and scale-up. This modularity significantly reduced technical uncertainty and enabled parallel progress across synthesis, formulation, sourcing, and regulatory activities.

From an innovation management perspective, the platform-based approach facilitated early convergence on a robust solution space. Familiarity with synthesis routes, analytical characterization, quality control

Table 1. Conceptual comparison of Stage-Gate® and simultaneous engineering approaches in additive and formulation development

<i>Dimension</i>	<i>Stage-Gate® process (sequential)</i>	<i>Simultaneous Engineering (parallel)</i>
Process logic	Sequential phases separated by formal decision gates	Overlapping and parallelized development activities
Functional involvement	Gradual, function-by-function activation	Early simultaneous involvement of multiple functions
Dominant early-stage cost driver	Individual experiments and focused tests	Number of functions involved and parallel activities
Primary source of risk	Late technical failure within individual disciplines	Early mis-selection of development direction
Character of cost exposure	Gradually increasing over project phases	Early bundled allocation of R&D resources
R&D budget exposure	Limited in early phases due to selective progression	Elevated due to early parallel resource commitment
Cost of wrong direction	Relatively contained	Significantly amplified by parallel resource commitment.
Flexibility of project termination	High	Reduced
Learning and iteration logic	Sequential and focused	Parallel, but less reversible
Role of CAPEX in early stages	Typically, marginal	Typically, marginal
Relevance of OPEX considerations	Addressed at later stages	Implicitly shaped earlier but still limited.
Typical application focus	Explorative search and option generation	Targeted optimization of defined concepts
Suitable for additive and formulation development	Resource-efficient selection under uncertainty	Faster integration at the expense of higher R&D risk.

methods, and qualified toll manufacturing partners allowed downstream functions to engage early based on provisional but reliable substance definitions. This was a critical enabler for parallelization, as it reduced the risk that late-stage feasibility constraints would emerge after substantial time and resources had already been committed.

Beyond speed advantages, the modular platform strategy contributed to risk mitigation and economic viability across multiple dimensions. Reuse of shared synthesis intermediates reduced development effort, supported cost efficiency in low-volume specialty chemical contexts, and simplified global regulatory activities by leveraging existing toxicological and registration knowledge. In addition, the availability of established analytical and quality control routines further stabilized development execution and reduced coordination effort

across organizational interfaces.

From an operational and quality perspective, both newly developed additives were protected by comprehensive intellectual property rights, underscoring their strategic relevance and long-term applicability. Compared to the legacy additive, the new compounds exhibited higher chemical stability and improved reproducibility of the synthesis and scale-up processes. This, in turn, facilitated more robust analytical characterization and quality control, contributing to enhanced process stability and reduced variability in industrial production. These properties further supported reliable global deployment and reduced operational risk across the value chain. In the context of specialty chemicals, functional additives are typically embedded in complex formulation and process systems, where stability, reproducibility, and robust analytical characterization are critical

prerequisites for reliable industrial application (Fink, 2017). Beyond improved chemical stability and enhanced reproducibility, the two newly developed additives also generated structural advantages along the value chain and within the supply network. Their modular synthesis architecture enabled, in principle, in-house production and thus increased internal value creation. At the same time, the availability of alternative qualified toll manufacturers facilitated a flexible allocation or relocation of production capacity without fundamental changes to the process architecture.

In contrast, the legacy additive had been manufactured exclusively by a single external supplier on a dedicated production line, resulting in a pronounced sole-source dependency. In addition, significant quality fluctuations were repeatedly observed, which required continuous formulation adjustments to ensure consistent product performance. Such variability was not encountered with the newly developed additives, further contributing to operational robustness and supply chain resilience.

Taken together, the platform strategy functioned as a structural enabler rather than an isolated methodological choice. By stabilizing early assumptions and reducing uncertainty across technical, regulatory, and economic dimensions, it allowed the project team to deliberately accept higher early R&D resource commitment in exchange for protecting time-to-market and business continuity under fixed external constraints.

2.3.3 Parallelization versus Front Loading

Both parallelized development and front-loading approaches aim to improve innovation performance under uncertainty by shifting activities toward earlier project phases. Front loading has been discussed in the context of engineering design and innovation management as a strategy to increase the amount of information generated early in the development process, thereby enabling earlier optimization and more informed downstream decisions (Bender and Gericke, 2016). This approach assumes that uncertainty can be sufficiently reduced through early analysis, experimentation, and knowledge generation.

In contrast, the platform-based parallel development approach applied in this case focused less on early convergence and optimization, and more on preserving decision optionality. Rather than committing prematurely to a single solution, multiple development activities were advanced concurrently on the basis of

provisional but sufficiently stable assumptions. This logic allowed technical, economic, and regulatory uncertainties to be explored in parallel, without forcing early irreversible decisions.

This distinction is particularly relevant in innovation contexts characterized by high irreversibility of downstream decisions, such as industrial chemical development with global regulatory requirements and fixed time windows. In such settings, late-stage changes to substance structures, synthesis routes, or sourcing strategies typically entail disproportionate cost and regulatory effort (Loch et al., 2006). Parallelization therefore served not as a means of early optimization, but as a risk management mechanism to prevent critical feasibility constraints from emerging only after remaining time and degrees of freedom had already been exhausted.

From a management perspective, the degree of parallelization represents a deliberate decision variable that directly affects early R&D resource commitment and risk exposure. While front loading seeks to reduce uncertainty through early information generation, parallelization redistributes uncertainty across organizational functions and project phases. In the present case, this trade-off was consciously accepted in order to protect time-to-market and business continuity under fixed external constraints.

2.4 Risk Management and Organizational Implications

2.4.1 Managing Risk through Reversible and Irreversible Decisions

The transition toward a parallelized development approach fundamentally altered the project's risk profile. While sequential development processes aim to defer uncertainty to later stages, parallelized development redistributes uncertainty across the project timeline and requires earlier managerial engagement with incomplete information. As a result, risk management shifted from late-stage control toward proactive orchestration of assumptions, dependencies, and decision points.

A central element of this risk management approach was the explicit differentiation between reversible and irreversible decisions. Managing innovation under high uncertainty requires careful attention to the degree of irreversibility associated with early commitments

(Loch et al., 2006). In the present case, activities with low irreversibility—such as exploratory formulation work, preliminary sourcing assessments, and regulatory pre-evaluations—were deliberately advanced early to preserve schedule flexibility. In contrast, decisions associated with high sunk costs or long-term commitments, including final process investments or binding supplier contracts, were postponed until sufficient technical and regulatory confidence had been achieved.

This differentiated treatment of decision types enabled the project team to accept higher early R&D resource allocation without disproportionately increasing overall project risk. By consciously delaying irreversible commitments while advancing reversible activities, the organization maintained strategic flexibility despite severe time pressure.

2.4.2 Coordination, Governance, and Communication

Parallel execution of interdependent development activities significantly increased coordination and communication requirements. Multiple organizational functions operated simultaneously on partially provisional assumptions, increasing the risk of misalignment and information asymmetry. To manage this complexity, explicit coordination and governance mechanisms were required.

Rather than relying exclusively on formal gate decisions, the project organization emphasized frequent cross-functional synchronization. Regular alignment meetings ensured transparency regarding progress, assumptions, risks, and interdependencies across synthesis development, formulation, sourcing, regulatory preparation, and market-facing activities. Importantly, the objective was not to eliminate uncertainty, but to make it explicit, shared, and manageable at an early stage.

From a managerial perspective, this required a shift from gatekeeping toward active orchestration. Decision-making focuses less on pass/fail judgments at predefined milestones and more on continuously reassessing assumptions and updating priorities as new information emerged. This adaptive governance approach proved essential for maintaining coherence and momentum in a parallelized development environment.

At the managerial level, several transferable implications

emerge from the case.

First, development process architecture should be treated as a situational design choice rather than a standardized template. In time-critical substitution scenarios with high interdependence between development streams, parallelization may provide superior risk control compared to strictly sequential approaches.

Second, early parallelization requires explicit decision rules regarding reversibility and resource commitment. Without such rules, parallel execution risks degenerating into uncontrolled resource consumption. Platform-based strategies and established organizational knowledge play a critical role in stabilizing early assumptions and enabling informed concurrency.

Finally, accelerated innovation under time pressure is less a function of individual technical breakthroughs than of organizational design and managerial decision-making. The case demonstrates that maintaining strategic flexibility, aligning cross-functional activities early, and consciously managing irreversibility can significantly improve innovation outcomes when time-to-market constraints are externally imposed.

2.5 Results and Lessons Learned from Practice

2.5.1 Development Speed and Economic Effects

The implementation of a parallelized development approach in combination with a modular platform strategy resulted in measurable improvements in development speed and coordination efficiency. Compared to comparable innovation projects following a strictly sequential development logic, the overall development timeline was reduced by approximately 20–25%. This reduction was primarily driven by the early overlap of synthesis development, formulation work, sourcing activities, and regulatory preparation, which significantly reduced idle time between development phases.

From an economic perspective, early parallelization shifted cost exposure toward earlier project stages, primarily through increased upfront R&D resource allocation. However, this increase was offset by reduced late-stage rework, earlier identification of infeasible solution paths, and improved transparency regarding cost drivers. In particular, early visibility into sourcing options, regulatory implications, and scale-up feasibility

enabled informed trade-offs between performance optimization, economic viability, and time-to-market. This observation is consistent with prior findings on early fixation of cost-relevant parameters in chemical development, which emphasize the limited corrective potential once unfavorable cost structures are discovered at later project stages (Murjahn, 2004). Especially in the context of specialty chemicals characterized by low substance volumes, the reuse of shared synthesis intermediates and established analytical routines contributed to cost efficiency and reduced overall development risk. While the approach required higher early coordination effort, it prevented the accumulation of technical and regulatory risks at late project stages, where corrective actions would have been significantly more costly or infeasible.

2.5.2 Managerial Lessons Learned

Several transferable lessons emerge from the case. First, development process architecture should be treated as a situational design choice rather than a standardized template. Under severe time pressure and high interdependence between development streams, strictly sequential processes may amplify rather than mitigate risk.

Second, early parallelization requires disciplined management of assumptions, decision reversibility, and resource allocation. Parallel execution is not inherently superior to sequential development but becomes effective when supported by platform-based strategies, established organizational knowledge, and explicit coordination mechanisms.

The case further illustrates that supply chain structure should be treated as an integral design parameter of the innovation process rather than as a downstream operational concern. Strong dependencies on single suppliers or dedicated production assets significantly amplify project risk under time pressure, as they reduce strategic degrees of freedom and increase the consequences of late-stage failure.

Platform-based development and early parallel engagement with sourcing and manufacturing functions can mitigate such risks by preserving make-or-buy optionality and enabling flexible allocation of production responsibilities. From a managerial perspective, reducing sole-source dependencies is therefore not merely a procurement objective, but a strategic lever for increasing innovation robustness and

organizational resilience in time-critical development projects.

Third, the case highlights that accelerated innovation under time pressure is less driven by individual technical breakthroughs than by organizational design and managerial decision-making. The ability to recombine existing technological, regulatory, and organizational assets in a modular way proved to be a critical enabler for maintaining strategic flexibility while meeting externally imposed time constraints.

Finally, the findings underline the importance of distinguishing between analytical generalization and statistical generalization in practice-based research. While the insights derived from this single case are shaped by its specific industrial context, the underlying mechanisms—early parallelization, modular platform use, and explicit management of irreversibility—are transferable to other process-oriented industries facing similar time-critical innovation challenges.

3. Conclusion

Innovation in the specialty chemicals industry is increasingly shaped by external constraints such as shortened product life cycles, global regulatory requirements, and fragile supply chains. In this context, innovation challenges often arise not from the pursuit of radical novelty, but from the necessity to redesign existing solution architectures under severe time pressure. This article analyzed such a boundary case using an anonymized industrial case study and focused on development process architecture rather than technical detail.

The case demonstrates that classical sequential Stage-Gate® models, while effective in many innovation contexts, may reach their limits when multiple tightly coupled development streams must progress simultaneously within a fixed and non-negotiable time window. Under such conditions, development process architecture and early cross-functional synchronization become critical managerial levers—not only to accelerate time-to-market, but also to reduce structural vulnerabilities arising from supply chain dependencies. Thus, platform-based parallel development provides a viable alternative by enabling early synchronization of synthesis development, formulation work, sourcing, regulatory preparation, and market-related activities. Rather than eliminating uncertainty, this approach

redistributes and manages it proactively across the project timeline.

Importantly, the innovation character of the case does not primarily reside in isolated molecular novelty, but in the successful alignment of three core dimensions of industrial innovation: conceptual novelty, practical applicability, and market viability. The development of two new proprietary additives based on a modular platform architecture fulfilled all three dimensions. The underlying idea was technically novel and protected by intellectual property rights, the additives were industrially producible and robustly characterizable, and their application in existing formulations and processes was successfully implemented at commercial scale. In this sense, the case illustrates a Schumpeterian understanding of innovation as the realization of new combinations rather than mere invention.

The findings indicate that innovation success and project risk are less a function of individual technical breakthroughs than of early managerial decisions regarding parallel R&D resource allocation, process architecture, and the orchestration of interdependent development activities.

As with all practice-based analyses, the insights derived from this single case are shaped by its specific organizational, regulatory, and market context and should be interpreted accordingly. Nevertheless, the underlying mechanisms identified—a modular platform use, controlled parallelization, and proactive risk orchestration—are transferable to other process-oriented industries facing time-critical innovation challenges. When applied selectively and in alignment with contextual constraints, platform-based parallel development can complement established Stage-Gate® processes and contribute to more resilient and successful innovation outcomes. Hence, development process architecture should be treated as a strategic management variable rather than as a purely procedural choice.

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