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Accelerating innovation with higher returns

—In a recent survey of chemical companies, 80% report they are not satisfied with their time-to-market and only 60% are satisfied with their return on R&D investment.

Innovation and the introduction of new products continues to be the primary driver powering sustainable growth in the chemical industry. Innovation intensity (the ratio of a firm's new product development expense to total revenue) has long been a well-accepted indicator for the future growth of a company. However, a far more powerful gauge to a company's future operating performance and market valuation is how well the investment dollars are put to use, rather than simply how much is invested. The impact investment dollars have on the business should be considered along two vectors; Effectiveness and Efficiency. Effectiveness or 'Lift' evaluates the impact a development has in the market in terms of financial return either as revenue, profit, market share, or a combination of these. Efficiency or 'Throughput' evaluates the amount of innovation delivered per given time interval. These two elements combine to provide insight into a company's return on R&D investment and a company's future success. As we look across the chemicals industry, there is significant variation in how well companies utilize their investment dollars. *(Fig. 1)*

A recent survey conducted in partnership with Chemical Week found that only 60% of chemical companies are satisfied with the financial returns they realize from their R&D investments while only 20% of companies are satisfied with their time-to-market. This means that nearly half of the companies are not satisfied with the effectiveness or Lift of their development efforts, and 80% of companies are not satisfied with the efficiency of their innovation processes in terms of Throughput or time-to-market.

The chart above (Fig. 1) underscores that better practices drive higher returns. What does this mean for organizations wanting to improve their operating performance, future market valuation, or stock returns? The

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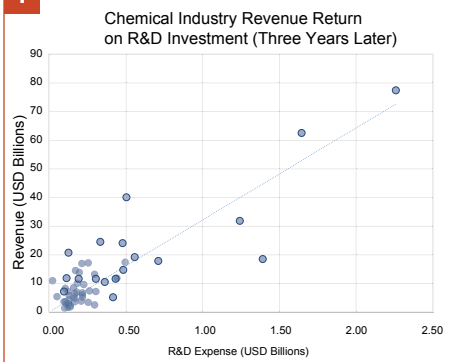

greatest determinant of an organization's innovation delivery success over time is rooted in the practices they utilize to develop their products and services. The predominant new product development methodology utilized by companies in the survey is a traditional system based on a 'stage and gate' model (66%), followed by

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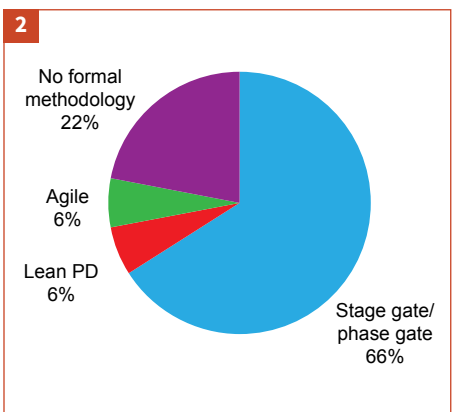
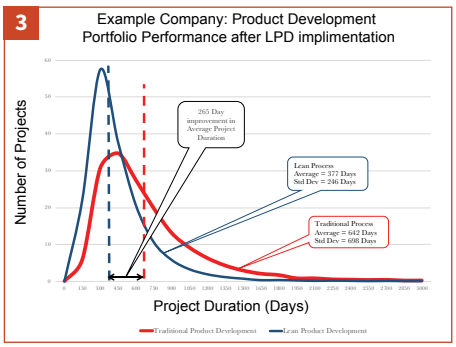


23% of respondents having no formal methodology in place. Only 6% of companies use a system based on either an Agile, or Lean development methodology. *(Fig. 2)* **This indicates a tremendous improvement opportunity for those organizations electing to transform their development system.**

Software development has improved significantly using forms of the Agile model, but for organizations involved in complex, highly integrated development solutions, or conducting development with significant learning, a Lean Product Development approach is shown to be much more effective. **Organizations that successfully transition from traditional development to Lean Development systems realize nearly twice the innovation in half the time.** *(Example company results depicted in Fig. 3)*

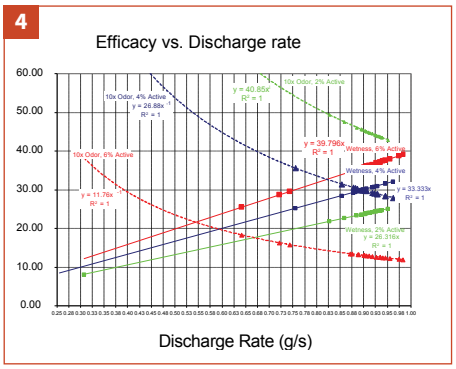
In the traditional approach employed by most chemical companies today, the work conducted by a researcher in a chemical R&D lab involves sifting through data and reports to develop a formulation for a customer's new application. The time to develop a product is largely driven by the need to formulate and test various alternatives limited by the capacity of a physical laboratory and generally only produces incremental improvements. Even as chemical companies begin transitioning to computer-based evaluations and AI support, the approach continues to be one of formulate & evaluate. One of the elements that makes the transition to Lean Development methods so powerful for chemical companies is the focus on learning and making knowledge and knowledge-gaps visible, stimulating more innovative solutions through proactive learning rather than reactive learning, and brought to market in less time. The example in (Fig 4) depicts visible knowledge created by a chemical company mapping the effective solution space available in the creation of chemical formulations for a customer's product. The transition to this type of knowledge depiction rather than reports and data sheets enabled this company to essentially eliminate routine testing, cutting their development time by greater than half.

It is important to recognize that the transitioning to Lean Product Development is very different from the waste



elimination approach associated with Lean in operations. To optimize innovation, the focus needs to be on value creation. In our experience, we find that senior leaders generally know their manufacturing capacity or service rate capability. However, when it comes to innovation, we find a disconnect. Senior leaders rarely know the development throughput rate necessary to deliver the value the business needs long-term. As such, we find that successful Lean product development initiatives first align and closely connect an improvement effort to business results in terms of value flow. Just as in operations, the development throughput must match the business need. When the lift (the business impact in terms of revenue and profit) and the delivery rate (time-to-market) improvements are understood and connected to the business needs, the business strategy, objectives, and plans can confidently be delivered.

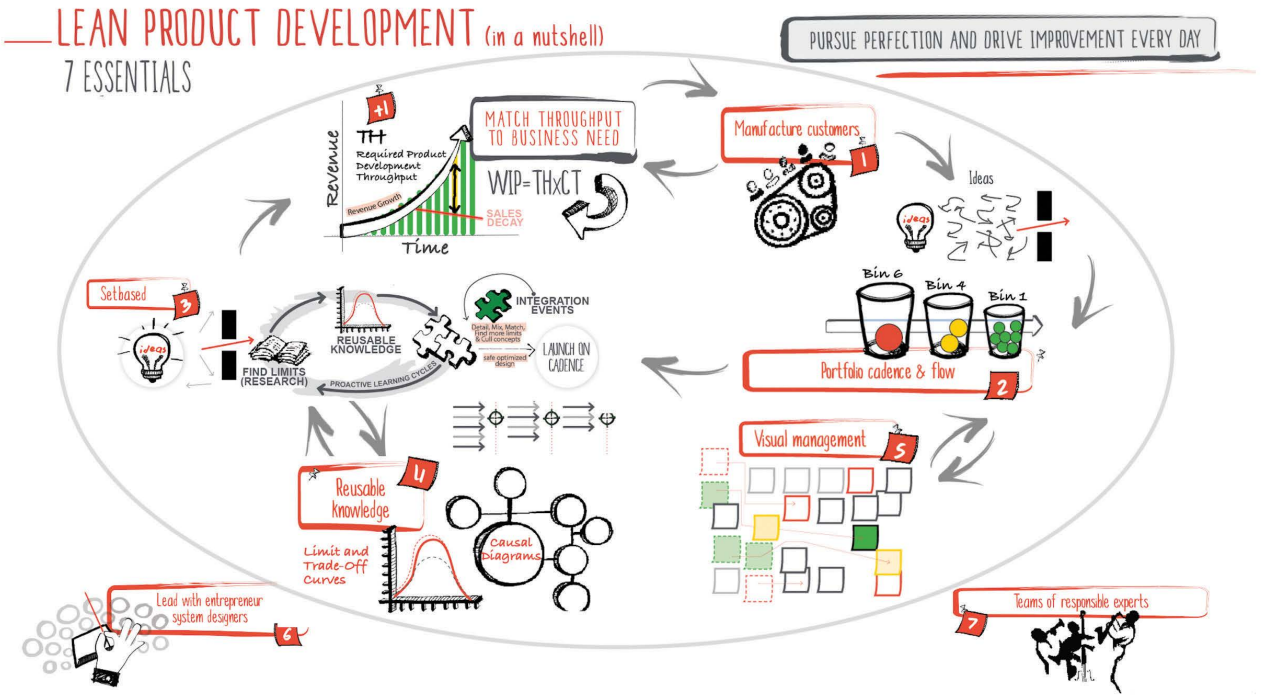
Experience has shown the most effective method to instituting Lean Product Development is through a principle-based approach with clearly defined objectives that can be managed across business



segments as well as aligned across the enterprise as a whole. As such, in addition to connecting the change initiative to the business objectives, seven key principles are defined below to accelerating the pace of innovation. The movement towards this ecosystem should be approached strategically. Although these seven principles are not all encompassing, companies that focus on these seven principles go a long way in improving their time-to-market and innovation process and establish the framework to develop further.

The diagrams below depict an integrated high-level approach that describes key principles and highlights the iterative nature of a modern innovation system which greatly improves time-to-market, throughput, and value flow. This process works with both early stage, long time horizon projects rooted in early stage research and development (internal or external) as well as rapid application development efforts focused on rapidly addressing customer needs. Once implemented, this process drives improvement along both the Effectiveness vector as well as the Efficiency vector driving greater return on R&D investment delivered to the market in less time.

—Dantar Oosterwal, Chuck Deise, Andreas Dörken, Argo Consulting and Tim Mueller, Ph.D, DuPont



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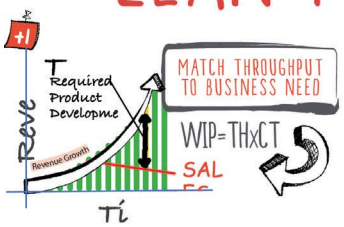
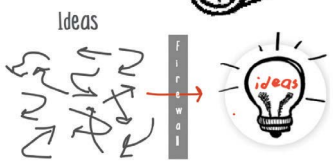
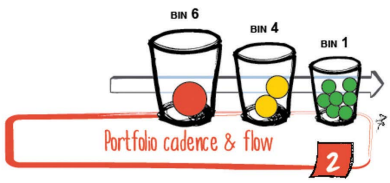
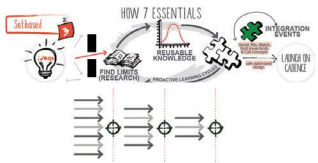
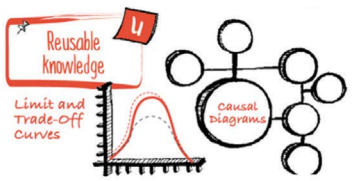
LEAN PRODUCT DEVELOPMENT (in a nutshell)

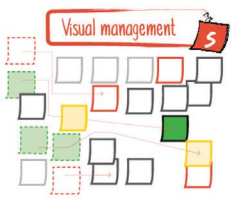












Successful Lean Product development efforts are connected to business results. Just as in manufacturing, the development throughput must match the business need: The lift (the business impact in terms of revenue and profit) by type of project must be understood. With an understanding of project lift, the delivery rate in terms of the number and type of projects can be aligned with what the business requires and connected to the business strategy, objectives, and plans. This must be identified in quantifiable terms, measured, and managed. Objectives, goals, actions, progress to the business plan, and the improvement effort must be tracked.

Manufacture customers: An intimate understanding of customers' needs, desires, and preferences is necessary to guide product development plans and the introduction of new products that create demand. Companies must build a deep intimate, hands-on, active understanding of real customers, not simply rely on indirect market studies.

Bins, cadence, pull, and flow: Ideas "swirl" in front of a firewall that paces and only allows the best ideas to become development projects. Upon passing through the firewall, those projects are structured into categories called "bins," which standardize similar types of projects in terms of resources, scope, and schedule. This concept is the foundation of a repeatable innovation process that leads to the consistent and continual release of new products at a rate and by type necessary to support the business and drive profitable sales growth.

Set-based concurrent development: Contrary to linear, point-based phase and gate development processes, a set-based approach establishes multiple design parameters and explores many attributes simultaneously, focusing on closing knowledge gaps more effectively in the development process. Rhythmic "integration events" are the decision-making mechanisms that aligns and drives the development portfolio.

Reusable/visible knowledge: Compiling information into reusable/visible knowledge (e.g., limit curves, trade-off curves, casual diagrams) allows organizations to see their knowledge gaps and proactively address them. They create an effective means for teams to repeatedly leverage existing knowledge, more efficiently explore design limits, and more rapidly create the best solutions for a specific design space.

Visual management: Product development is fraught with hidden work and unknown issues. Visual management provides the mechanism to see the work and see the issues, leveraging predefined help chains to ensure effective progress.

Entrepreneurial system designer (ESD or Chief Engineer): A single entity (not necessarily a single person) — the Chief Engineer — is responsible for the success of a product, from making the business case through design and to production. While wielding little to no authority over any business function with which he or she interacts, the ESD, nonetheless, unites the organization around creating value for the customer. The ESD embodies a passion to develop products through intimate knowledge of customer needs, deep technical capabilities, and a drive to deliver business results.

Teams of responsible experts: Individuals with personal mastery in their area of expertise collaborate on a shared vision with defined objectives, creating and sharing knowledge. The team's cross-functional dialogue results in a level of collective thinking not attainable by individuals alone. Team members embrace "dynamic subordination" as their form of leadership. Dynamic subordination allows for fluid leadership that is determined by current conditions and needs rather than titles or positions.

WE ARE NOT JUST ANOTHER CONSULTING FIRM. WE ARE ARGO.

Argo's proven team of industry experts is unique and understand how to transform your organization to **achieve breakthrough performance in both Product Development and Operations** that stands the test of time.

Our team is results-driven, drawing from experience in the chemical process and petrochemical industries cross-pollinated with expertise in other fields. We bring years of first-hand experience improving productivity and agility in heavily regulated asset intensive industries.

Our clients have realized up to 50% reduction in time to market in Innovation and Product Development, and have leveraged our Best Run Chemical Operations Playbook to accelerate value and drive Excellence in Manufacturing, Maintenance & Reliability and other areas of plant operations.

Argo is an operations improvement consulting firm that breaks through the traditional barriers of the consultant-client relationship. We are hands-on consultants who deliver real results and no excuses. We are different because we focus on your performance, not a PowerPoint.

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Real Results. No Excuses.

We'd value a conversation. Please contact us at +1 312 292 6148 (US) or +49 172 325 7449 (Europe), or visit us at argoconsulting.com/chemical