

Product Development Processes Three Vectors Of Improvement

Improving product development processes along three key vectors leads to greatly improved business performance.

Maurice F. Holmes and R.B.Campbell Jr.

OVERVIEW: Product Development Processes have achieved a state of some maturity in recent years, but have focused primarily on structuring technical activities from the initiation of development to launch. We advocate major advances on three fronts; first, implementing an end-to-end process from the front end through field operations, second, integrating business considerations much better into the end-to-end process, and third, incorporating a performance improvement closed loop into the process. We call the resulting process a Product Development Business Process. Three initial applications are summarized.

Current State

During the late 80s and the decade of the 90s, major efforts were undertaken across American industry to develop and implement Product Development Processes (1,2), variously called phase gate or stage gate processes. For purposes of this paper, a process is a *structured set of activities organized to deliver value to the end customer of the process*. From discussions at IRI meetings, we estimate that some 3/4 or more of IRI companies have implemented new PDPs.

The two driving forces behind these process improvements were to improve business effectiveness, i.e. to achieve higher revenue growth and profitability per unit investment and to improve QCD efficiency, i.e. to develop higher quality products with fewer resources in less time.

PDPs differ in detail, but their two salient features are the organization of a process into a number of phases, typically four to six, with check points or gates between the phases. The check points serve to synchronize all on-going activities and function as go/no-go decision points. At checkpoints the work accomplished during the last phase is reviewed and assessed. Problem areas are addressed and plans for resolution are established. To ensure success in the remaining phases, the requisite enablers, resources, competences, and plans must be in place.

The perspective of this paper is that the only sustainable source of product advantage is a superior product development process (1). Accordingly, in highly competitive industries, a company's differential rate of improvement to its current state is a key competitive factor. If some 3/4 of your competitors have a capable PDP, having one in your company likely implies competitive parity. In itself it is unlikely to provide sustained competitive advantage.

In a survey in October 2002 at the MIT Center for Innovation in Product Development Conference, 83 people from a variety of industries rated their organizational capability in 140 elements of product development. The level of capability typically ranged only between 3 and 4.5 on a 7 point scale with 1 as not capable and 7 as extremely capable (4), indicating a great need for better implementation and execution of existing processes.

This paper addresses not better implementation, but fundamental enhancements to the development process. Our area of focus was high technology companies with a major manufacturing component. We sought processes and methodologies applicable to a wide size of companies, since development groups within large companies are set up frequently to model small scale operations. We asked what major changes were required in an environment of intense world-wide competition, of rapid technological and market change, and of serious challenges to RD&E investment levels. We identified three areas for fundamental improvement: process scope, process functionalization, and process optimization.

Relative to scope, the PDP typically runs parallel to and separate from the strategic front end and field operational processes. These activities frequently proceed with little connection or influence upon each other. Disconnection into three relatively autonomous activities inevitably leads to major decision delays, scope changes, and rework at the transitions from definition into full scale development (initiation) and from development to field operations (launch). An underlying problem is that this disconnection tends to cause sub-optimization of the full offering.

Relative to functionalization, the classic PDP deals primarily with technical matters and is functionally separated from business performance by layers of requirements and specifications. The working assumption is that if the specs are met, business success will ensue. By contrast, we advocate that business success must be the highest level objective of the entire process. Specifically, business gaps be used to drive functional optimization as well as functional participation in the process.

Relative to process optimization, the key point is that process improvement must be organic to the process itself. Processes need to be continually improved and refreshed as technology advances and competence improves. The improvement must be driven by business performance through the use of a closed loop mechanism (5).

Product Development Business Process

The *product development business process*, or PDBP, is designed to overcome the limitations of current PDPs. It has three differentiating characteristics:

1. End-to-end scope: It integrates a strategic front end and a field support back end with the product development core.
2. Integral business process: It is driven and governed by a corporate or business unit decision team that integrates business priorities throughout the end-to-end process.

3. Closed loop performance improvement: It is energized by a performance improvement closed loop that transforms business improvement requirements into business improvement initiatives. These initiatives or corrective actions close performance gaps and improve the performance of the entire system.

Figure 1 is a (simplified) block diagram of the current state. Figure 2a depicts the transition to an end-to-end process, Figure 2b the transition to a business process, and Figure 2c the transition to a closed loop optimizing process. In practice, improvements along these three vectors should be carried out concurrently because of their reinforcing nature, resulting in the final state of an *optimizing PDBP*.

The PDBP is designed to enable corporations to maximize their return on their investment in the commercialization of new products and services while at the same time continuing to optimize the business performance of its existing product lines. Figure 3 is a more detailed depiction of the PDBP for purposes of the following discussion. The essential requirements for a PDBP are:

- Respond directly to the corporate vision and strategic planning activities.
- Create high demand portfolios by addressing the way products and services attack the market segments in which a business entity is chartered.
- Guide the development of these products through methods that assure full participation of the entire value chain.
- Support the marketing, distribution, manufacturing, and service activities required to successfully launch into world wide field operating units.
- Support the demand creation, cost containment, and customer satisfaction activities needed to realize the full business potential of the product or service after launch.
- Incorporate a method for systematically solving business performance issues and for guiding the continuous improvement of the process itself.
- Be managed end-to-end by a single decision authority.

The loop is closed around the process by comparing the desired results to the actual outputs, and using the gaps to drive improvement initiatives. This forms a *metrics driven feedback* system. It is important to note that the metrics are used primarily as the team's feedback signals, not as reports to higher management. The end-to-end focus of the process and the ability to close the loop on business results are distinctive and powerful process attributes. In themselves they enable an improved business focus because from the earliest stages of development, attention is paid to the desired end result – performance in the field. Furthermore, through the assignment of responsibility for execution of the PDBP to a single Management Decision Authority, a corporation or business unit can assure that a responsible entity exists for the transformation of corporate strategies and resources into business performance.

We now describe in more detail the four major operational pieces of the PDBP: strategic front end, product delivery pipeline, field operations, and closed-loop performance improvement. From a BU perspective, all four pieces are occurring and are being

managed simultaneously on different programs. To avoid discontinuity, we emphasize that authority, responsibility, and motivational structures must exist across these four pieces. Refer to Figure 3.

Strategic Front End

In the strategic front end, the business entity or unit establishes its business, product, technology, and value chain strategies and their link with the corporate vision and strategic planning processes. Typically these are based on the BU charter which defines the market segments to be attacked. The business unit develops the market attack plan by realizing these strategies as a prioritized portfolio of products and services, supported by the architecture and the technology sets required for successful implementation. The inclusion of the entire value chain at this stage in the process is a critical element of the process. New and exciting product strategies often require new and exciting approaches in marketing, manufacturing, distribution, and sales or service for successful implementation. The strategic front end is the place where these approaches are defined and managed as a set of business enablers. The following set of questions¹ constitutes a systematic way to address the challenge of the front end.

- What business are we in?
- What markets do we/ can we serve?
- In what segments can we effectively participate?
- How large is the business opportunity?
- What are our expectations for the competitive environment?
- What are our key value propositions?
- What will we establish as major vectors of differentiation?
- What are the platforms to address the targeted customer and markets?
- What architectures and technology sets will enable these platforms?
- What will we offer as product families and services?
- How will we organize the value chain strategies and enablers?
- What are the resources required to deliver against the product and strategic plans?
- What is our expected integrated business outcome?

The above questions must be addressed in an integrated way to achieve a *robust* strategic plan. An example of an appropriate integration methodology is McGrath's Market Platform Plan, which ties together the market segmentation and the platform architecture (3). The strategic plan should constitute a complete map for achieving success in the targeted market, accordingly it can be referred to as a Market Attack Plan (MAP). The plan is resourced for all elements, e.g. technology sets, products, services, and value chain enablers, that are strategically aligned with market segments, key business goals, and corporate priorities. The business goals, expected outcomes, and funding plans are documented in a corporate Plan of Record.

¹ Recall that one of the best management tools is a good set of questions.

With the end-to-end business perspective pervading the strategic front end, companies achieve a more effective balance among new products and services, products currently under development, and products and services already in the field. By funding the product team and the total value chain as a whole, companies assure better alignment of resources and priorities of the entire company with the portfolio decisions made in the strategic front end. Cross-functional contracting, where the decision authority funds support and value chain groups directly via a “contract,” instead of negotiating for support from the group’s budget, is a very effective methodology to ensure end-to-end alignment.

The Product Delivery Pipeline

The product delivery pipeline refers to the more typical Product Delivery Process employed by many companies today. It is the place where the strategies and products approved by the strategic front end and captured by the Plan of Record are implemented. It has a set of phases with associated criteria where decisions are taken relative to product viability and judgments made relative to product maturity. As well, there must be a portfolio management function to manage the flow of multiple products and services across all functions in the organization and throughout the entire value chain. This function is greatly facilitated by the end-to-end perspective. Much has been written about how to install and manage a product delivery processes. Companies that have done so have reported major improvements in time-to-market and of the quality of their products. From our experience we have found that the most successful PDPs contain the following elements:

- Quantitative checkpoint criteria for each phase that were defined and approved before the start of the program.
- A well defined management decision process capable of making decisions in hours and not months.
- The practice of inclusion of all required functions throughout the entire process.
- A method for measuring, improving and tracking the maturation of the new technology utilized by the product.
- Means for continuously monitoring and upgrading the skill base of the people doing the work on the program.
- A method for continuously linking the needs of the market and the customer with design and process optimization decisions.

We find it helpful to manage development flow by a set of *readiness criteria*. Readiness is achieved when a program team and the functional managers assert that the functional organization responsible for a specific readiness condition has met the predetermined criteria associated with that condition. Readiness is a measure of the functional organization’s ability to effectively support the next phases. Readiness conditions are managed at checkpoints along with other predetermined checkpoint criteria. A minimum set of readiness criteria is:

- Requirements readiness

- Technology readiness
- Design readiness
- Manufacturing readiness
- Field readiness
- Value chain readiness

Measuring products against a predetermined set of quantitative maturation criteria and measuring functional support organizations against a predetermined set of readiness criteria are best practices for managing product development through the pipeline. Readiness criteria in essence look ahead. The key question is not, “Did you meet the requirements as specified by this phase gate,” but, “Are you ready to proceed with confidence in the next phase(s)?” Having an end-to-end capability and common management decision processes across all parts of the Product Development Business Process facilitates better alignment between the front end and the delivery pipeline. Having a closed loop process improves the ability to take corrective action across the entire value chain to support the resolution of issues that arise in the pipeline.

Field Operations

Field operations refers to the marketing, sales, service, and manufacturing operations and to the customer support activities that occur during and after the introduction of the product. Here companies have the opportunity to achieve the full business potential of their products and services. It is often desirable to assemble cross functional resources to address customer satisfaction issues and to focus on demand expansion enablers. It is also important to assure that the value chain innovations identified in the earlier segments of the process are delivered with high quality and appropriate timing. Typical enablers are new systems, process changes, marketing programs, service tools and methods, sales and customer training, etc. These are defined in the strategic front end as crucial to business achievement, but are often forgotten or neglected during the press of product development and consequently are not available in the field when needed.

Proactive approaches to continuous quality improvement and cost down activities can substantially improve business performance while simultaneously improving the customer experience with the product. The end-to-end nature of the PDBP provides a basis for defining and initiating field improvement activities as well as for funding and prioritizing these programs relative to the other activities being implemented throughout the entire PDBP. Continuity of management and process from end-to-end provides consistent forums for such prioritization and aids in assuring that field knowledge is injected into strategic front end planning and decision making.

Closing The Loop

Process for process sake can form a deadly trap for a company’s improvement activities. Companies that have installed conventional product development processes have sometimes reached productivity plateaus after successfully plucking the low hanging

fruit. Over time the process can stagnate to an inspection and tracking mechanism, with process managers perceived as traffic cops.

The closed-loop nature of the PDBP overcomes this stagnation by providing an integral mechanism for business performance improvement. The primary objective of a business process must be to continuously improve the top and bottom lines of the business. Accordingly a process must be dynamically proactive in its ability to respond to business strategies and goals that are themselves dynamic. Closing the loop on the PDBP gives companies the process velocity required to address rapid change. By having the same management decision team that presides over the closed loop, the decision team can address issues or attack opportunities from end-to-end. Business performance is defined by a set of quantifiable metrics that relate directly to the financial condition of the company. Since the vast majority of the future business potential of the company arises from competent execution of the PDBP, the company should expect a highly productive PDBP to produce major improvements in business performance.

To close the loop, the decision team defines business goals required to meet the business expectations of the company. These goals are quantified and become shared objectives of all organizations represented on the team. Typical metrics at this level relate to new product revenue ratio, customer satisfaction, time to profit (or revenue), and achievement of product or platform business cases. The metrics at this level can be combined with more specific and detailed metrics to form a *tiered balanced scorecard*. The difference between the goals and the outputs are the gaps. These drive the closed loop. As in any feedback process, high signal-to-noise ratio is important, implying that metrics definition and implementation are critical success factors.

The decision team appoints a working group to analyze and to define corrective gap closing actions through traditional root cause analysis and quality improvement activities. Once planned and funded, these actions are formalized into business improvement initiatives that are implemented in one or more areas of the PDBP. Gap closure can often require the development of a new tool or methodology to support effective implementation of initiatives. These new enablers become an integral part of the process itself. Initiatives are tracked throughout the end-to-end process and can be financially traded-off against the other programs in the process. Tracking and support continues until the gap is closed.

In summary, the closed loop gives the company an effective mechanism for attacking business issues throughout the process and by doing so establishing the pressure for continuously improving the process itself.

Governance

The PDBP is guided by a senior management decision team. This team presides over the process from end-to-end. They manage the flow of strategic directives, products, value chain enablers and business improvement initiatives throughout the process. Through cross functional representation, priorities and trade-offs can be applied against sets of

activity to allow critical projects to acquire the resources across the company that optimize the probability for business success. The decision team, through its responsibility for business goals, strategic planning, resource optimization, initiative tracking, and administrative support, proactively energizes the process while assuring its focus on continuous business performance improvement. Working together, the four parts of the PDBP with decision team oversight form a powerful process for effective commercialization of products and services. An efficient and effective platform for business performance improvement is established.

Case Histories

Three case histories are summarized. Although each case emphasizes different aspects of improvement, in each case substantial progress was made along all three vectors of improvement.

Case History 1. Large Company Implementation

A multi-billion dollar company in the digital storage industry was positioned strategically to participate in markets that were growing substantially, but was unable to capture that growth with existing product lines. In its attempts to direct new product development resources toward those markets of opportunity, they found that their existing RD&E spending was already higher than they could justify based on existing or expected revenues. Further investment might therefore exacerbate an already unacceptable financial position. Competitive and internal business analysis indicated that large improvements in RD&E productivity were possible resulting in product development and associated cost base reductions approaching 3% of yearly revenue, or almost one-third the RD&E budget.

The company had a conventional phased product development process in place which facilitated time to market, but the limited scope of the process made it difficult to capture opportunity both up and down stream of the core process. This scope limitation also contributed to the lack of sufficient alignment between market strategy and product strategy. It also created an artificial barrier toward capturing the cost and quality opportunities in existing product lines that in turn might be used to support its strategic imperatives.

The company management installed, in their largest business unit, a pilot initiative based on an end-to-end Product Development Business Process. It was their belief that a broader, more integrated approach would allow a more optimal application of existing resource to address this critical issue. After appointing a senior management decision team from operational management at the business unit level, they added a strategic front end and a field operations piece to their process and provided for a closed loop function supported by a quarterly inspection process. The decision team proceeded to establish business goals that were quantified based on a large set of potential productivity initiatives. A productivity team was appointed to measure the gap represented by these goals when contrasted to the current state or process capability of the company. The team

completed the root cause analysis and defined options for correction. The decision team had decided that the savings from these options could be managed as a reinvestment pool by the decision team. The pool would in turn fund future productivity options or be allocated for other business purposes.

From the options four major productivity initiatives were chosen, planned and funded; market attack planning (front end), RD&E prioritization, cost of sales and service reduction, and cross-functional contracting.

The integrated *market attack planning* (MAP) method, used for in the strategic front end, redefined and prioritized the critical market segments and the strategic plan for participation in these markets. By adopting a clear strategy in the RD&E prioritization process, and ranking products against it, products in the pipeline and in the field were more effectively aligned with the market and business strategies. The new product pipeline was found to be clogged with products that were important but not crucial to business success. Unclogging of this pipeline yielded significant RD&E savings. Strike teams were formed to address unit manufacturing costs, product complexity and cost of quality issues. An integrated focus on reducing cost of sales, product cost plus all related costs such as warranty, inventory, reliability, drove all teams. The fourth initiative was the implementation of a cross functional contracting mechanism. This rapidly revealed functional misalignments, with consequent excess spend, in support activities.

In summary, the PDBP offered a common forum for integrating a broader approach to productivity than was previously possible. The four initiatives were managed by the decision team as an integrated set of activities. The first year accomplishments are summarized in Table 1. Note the major improvements at the business level.

Table 1. First Year Accomplishments from new PDBP

Element	Accomplishment
Process	New PDBP operationally capable
Focus	Higher degree of market focus achieved in development
Alignment	Better aligned and more productive support functions
Prioritization	Improved prioritization process implemented
RD&E Efficiency	20% improvement in RD&E efficiency (Output per unit investment)
Cost Base	15% cost base improvement

Case History 2: Sustained Improvement

At another multi-billion dollar industrial company, studies of time-to-market performance concluded that a one-third gap in schedule performance existed relative to their competition. A number of improvement activities had been carried out over the years, but the gap stayed constant because rate of internal improvement just equaled the rate of external improvement.

Based on very thorough benchmarking, a major improvement program was defined and implemented. The central realization was that to close performance gaps, the rate of performance improvement had to exceed the rate of competitive benchmark improvement. A set of four year improvement trajectories, based on a three-tiered metrics scorecard, was established. While aggressive in total, annual objectives were set so that determined improvement actions would allow managers and teams to succeed and achieve the trajectories.

An end-to-end PDBP was defined, deployed, and steadily refined in the light of experience. This process was supported by a set of six major initiatives. For instance, a new front end was designed, with the dual objective of greatly improved strategic execution and rapid transition into development. The metric “RD&E Effectiveness Index” was introduced as the basic framework relating time, effort, and business results. An example of a “barrier-busting” metric was time-to-(product) volume, a metric owned by the launch team with the joint support of the development team and the field teams.

The set of technical initiatives was complemented by a set of activities addressing involvement, commitment, communication, and incentives. Everyone from the CEO to new hires was covered. By far the most important driver of motivation was the directive by the CEO that the benefits from all improvement activities would be re-invested. This was done simply by holding the R&D investment constant as a percentage of revenue. Now the feedback loop became a “virtuous” loop. The technical community was not working to make one of out every three engineers unemployed; they were working to speed their new technology to market.

The key results are summarized in Table 2. The reduction in slip rate led to a much more controllable over-all process. This was accompanied by a major improvement in cycle time. The combination of these together with other productivity improvements led to a dramatic 3x improvement in product launches for the same RD&E investment (N.B. normalized for complexity).

Table 2 Four Year Accomplishments from new PBDB

Metric	Four year improvements
Slip rate	Reduced by a factor of 2/3
Cycle time	Improved by a factor of 1/3
Launch rate (normalized)	Improved by a factor of 3 per unit RD&E expense

Case History 3: Small Company Deployment

A small start-up company with less than 100 employees had been frustrated by its inability to commercialize a breakthrough new technology in the healthcare industry. The technology provided a major advantage in both cost and quality, it was well protected as intellectual property, and the company was well capitalized. The company had introduced several products that as well as being late to market did not effectively engage the customers or the market to capture the business potential of the technology. The CEO and

several board members noted a lack of structure and discipline and supported the installation of a Product Development Business Process. This process was highly customized to the company with three phases: front end, core process, field operations. The front end of the process was highly integrated with the company's strategic process and yearly plan while the last phase was highly integrated with field operational activities. A small corporate decision team consisting of the CEO and direct reports presided over the entire process end-to-end.

As is often the case with small start-ups, the primary issue is growth. The magnitude of product related problems was indeed a significant barrier to growth. The closed loop nature of the product development business process provided a forum for focusing the company on this critical issue. The revenue growth gap was quantified and recovery targets were set. A team was assembled from all functions of the company to address the gap. The team used the *market attack planning* method (MAP) to better align business, market, technology, and product strategies. Drawing heavily on outside resources, the team concluded that the current product set did not address the sweet spot of the market and were therefore designed against an inappropriate set of customer needs.

A new market segmentation was defined that better addressed the growth needs of the business. The RD&E organization completed a platform plan that demonstrated that the technology could scale to effectively attack the new segment with products and services that would sustain over time a clear competitive advantage. The sales and service group identified new channel approaches that would effectively reach the customers in this new higher end market. The development team created an integrated program plan that required a substantial redirection of resources and an innovative integration of internal and external resources. By managing the execution of the plan throughout the entire process, end-to-end, the decision team was able to maintain consistency of priority and focus on the growth issue over time.

The net impact of these changes was dramatic. Although the financial details of this privately owned company are proprietary, the company, with the launch of a new and highly successful product line, is now a preferred supplier to the largest retailers in the industry. Their growth after the new product release was five times their old growth rate and more in line with company expectations. The smallness of the company in this case made it relatively easy to integrate and prioritize resources across functions. The learning from this project is now being used to scale the process as the company grows.

Although the details of the process for this company are quite different from that of the multibillion dollar companies in the earlier cases, the basic principles of the improvement: end-to-end, business process integration, and closed loop, are the same. In fact the scalability of the PDBP was a pleasant surprise.

In all examples, an end-to-end product development business process with closed loop feedback around quantifiable business performance issues was shown to be an effective method for commercializing technology and for managing business performance

improvements. Placing such a system under the guidance of a single decision authority enabled cross functional approaches to sustained improvement.

Conclusion

The productivity (effectiveness and efficiency) of product development processes relative to competition is a sustainable source of advantage. We advocate progressing concurrently along three vectors of improvement:

1. Implementing an end-to-end development process, from front end through field operations.
2. More effectively integrating business objectives and priorities into the end-to-end process.
3. Establishing an integral closed loop for sustaining business performance improvement.

Effective implementation along these vectors will move your product development capability to new levels of productivity; rapid implementation will provide competitive advantage.

References

1. McGrath, Michael E., *Setting the PACE in Product Development*, Butterworth-Heinemann, 1996
2. Cooper, R.G. and S.J. Edgett, *Winning at New Products: Accelerating the Process from Idea to Launch*, Perseus Books, 2001
3. McGrath, Michael E., *Product Strategy for High Technology Companies*, Butterworth-Heinemann, 2001
4. Seering, Warren P., "Product Development Capability Assessment", Lean Aerospace Initiative, MIT
5. Patterson, Marvin L., *Accelerating Innovation*, Van Nostrand Reinhold, 1993, Chapter 2

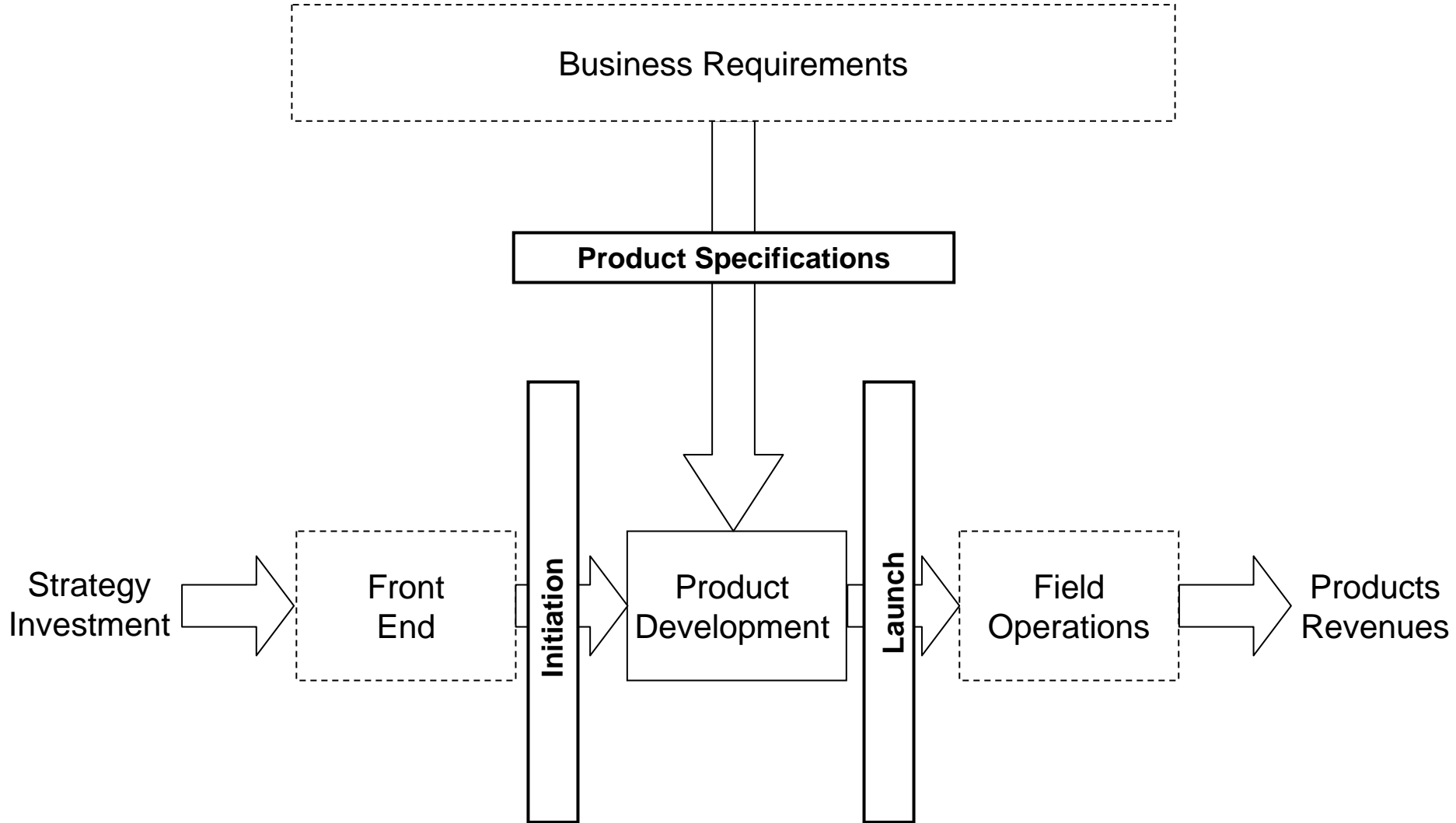


Figure 1.—The current state of product development processes is depicted. Barriers and major transitions are shown.

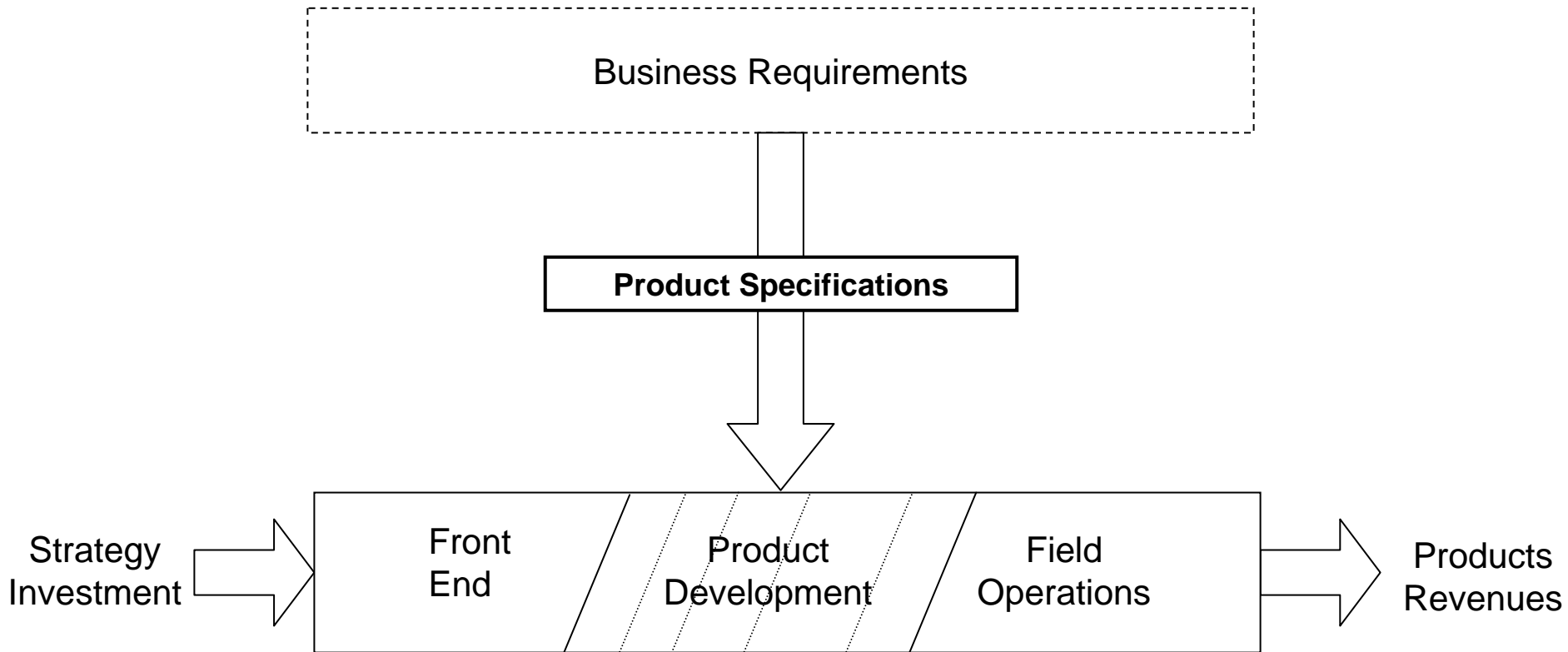


Figure 2a.—The transition to an end-to-end process is depicted. In particular the barriers of initiation and launch are addressed by implementing a more continuous process.

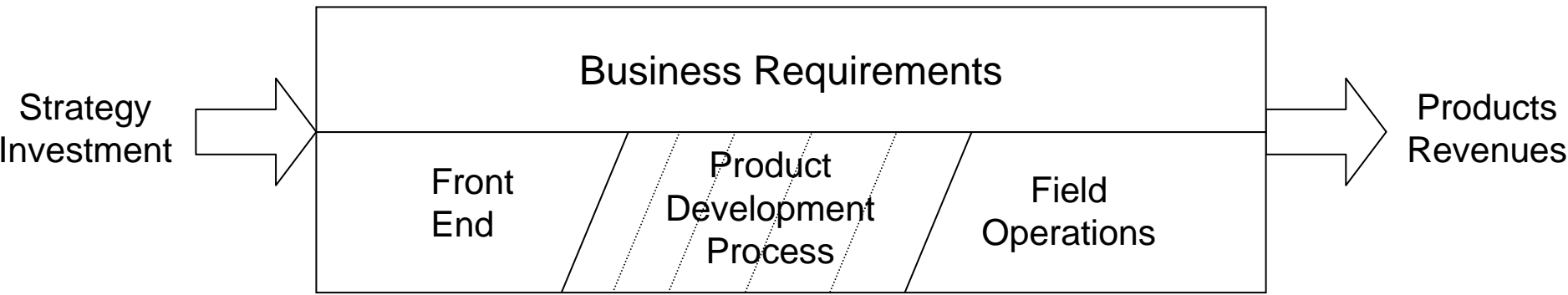


Figure 2b.—The transition to an end-to-end product development business process(PDBP) is depicted. In particular business requirements are illustrated as much better integrated into the process.

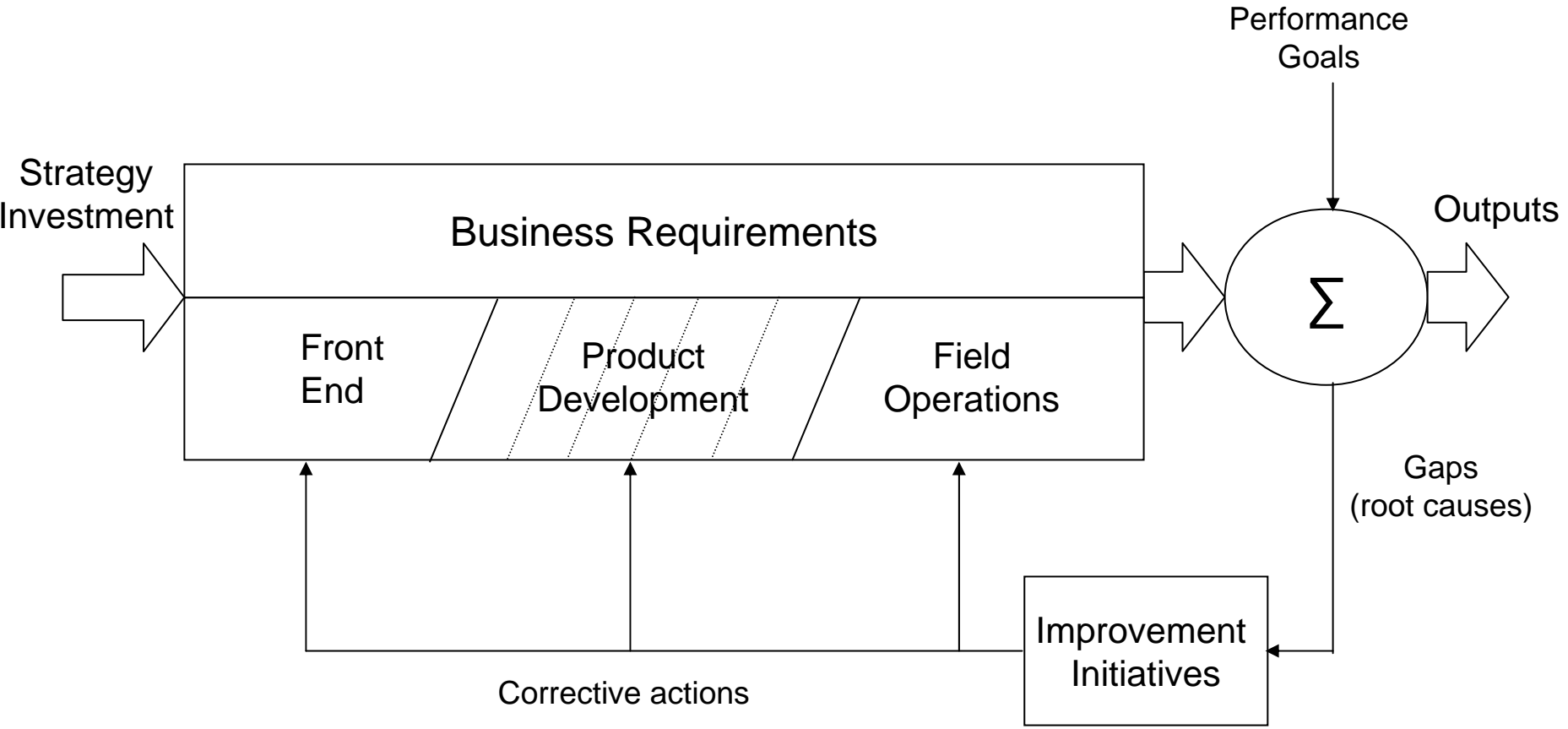


Figure 2c.—The third step to an optimizing PDBP is directed. A loop is closed around the process, driven by the gaps between performance and requirements, to drive longer term improvements.

Figure 3.—The Product Development Business is illustrated in more detail. Key supporting methods are shown, as well as the metrics balanced scorecard which organizes the feedback.

