Where Are All the Breakthrough New Products?

Using Portfolio Management to Boost Innovation

Ensuring that high-risk projects receive their fair share of the resources requires a different approach to portfolio management and different analytical tools.

Robert G. Cooper

OVERVIEW: There is a real shortage of breakthrough initiatives in businesses' development portfolios. A major challenge in developing these high-risk projects is portfolio management—how executives make R&D investment decisions. Financial approaches, such as net present value and the productivity index, are traditionally recommended to lend rigor to go/kill decisions. An overreliance on financial tools favors incremental projects whose financial forecasts are reliable, however, producing an abundance of small, low-hanging–fruit projects and a failure to allocate resources to strategic projects. Different toolsets must be used to assess high-risk breakthrough initiatives, including strategic buckets, expected commercial value, and spiral development processes. All of these must be supported by a climate and culture that provide the appetite to take on risky projects.

KEYWORDS: Breakthrough innovation, Portfolio management, Options, Strategic buckets, Expected commercial value

Most businesses' development portfolios have far too many projects, and often the wrong ones, according to a major APQC study (Cooper 2012a; Cooper 2005). A comparison of the breakdown of development portfolios in the 1990s versus the 2000s reveals a huge increase in product development projects that are really renovations—incremental improvements—and a decrease in true innovations (Figure 1). The fact is over the last 15 years, portfolios have drifted from moderately balanced to extremely unbalanced, with far too many small projects and few major or breakthrough initiatives. There is a real shortage of the type of breakthrough initiatives that drove many of these same companies to greatness in the last century. A good part of the problem is the climate and culture within these organizations, namely a preoccupation with short-term financial results, reflected in the way senior people are incentivized and a general risk aversion. But a major part of the challenge also lies with portfolio management—how executives make their R&D investment decisions.

The last 20 years have seen the rise of a number of financial approaches intended to lend more rigor to go/kill decisions, including net present value (NPV), the productivity index, payback period, and economic value–added (EVA) methods. These are fine for evaluating traditional, "known" projects. However, an overreliance on these approaches will tend to favor incremental projects whose financial forecasts are reasonably reliable; further, applying such methods to bolder initiatives will tend to kill all but the sure bets. These popular methods thus produce an abundance of small, low-hanging–fruit projects that will have little impact on the business. Bottom line: If the goal is a higher proportion of bigger, bolder initiatives in the development portfolio, then stop relying on traditional financial approaches to help make portfolio choices!

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Project Type	1990s	2000s	% Change
New to world, new to market – innovations	20.4%	11.5%	43.7% decrease
New product lines to the company	38.8%	27.1%	30.1% decrease
Additions to existing product line in company	20.4%	24.7%	20.8% increase
Improvements & modifications to existing company products	20.4%	36.7%	80.1% increase
Total	100.0%	100.0%	

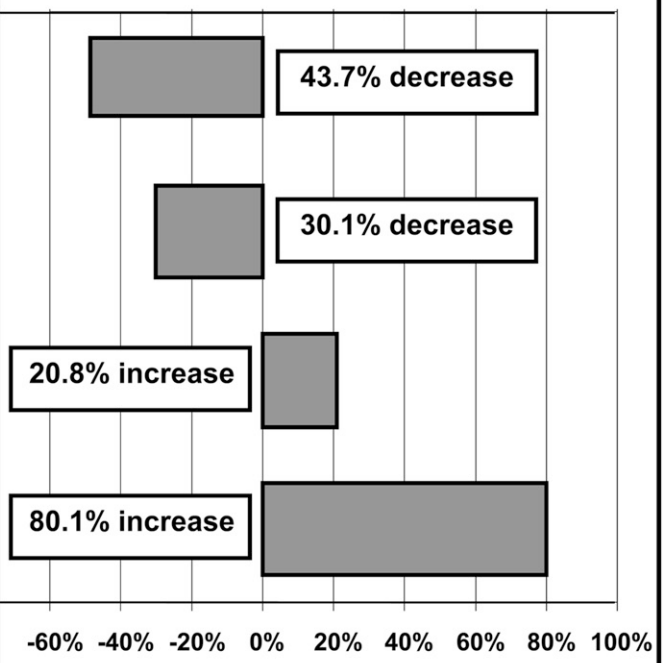

FIGURE 1. Percent of projects by type in the typical development portfolio, then and now

A related cause for the dearth of breakthrough projects is the failure to set aside strategic resources to fuel these major initiatives. As one executive declared in a workshop on strategic portfolio management, "We have a long list of smaller projects that we have to do. By the time we're through these, there's simply nothing left over for the longer term, bigger projects." Resources are scarce in most firms, and there is an unending list of small "renovation" projects requiring attention. After the portfolio allocation exercise, resources are already overcommitted, leaving few or no resources available for the breakthroughs—and so they get put on hold.

Portfolio Solutions

Solutions to these portfolio challenges do exist, and a number of firms have begun implementing such solutions. The recognition that there is indeed a problem—that there are too many minor projects in the portfolio consuming virtually all the resources and a real dearth of major, long-term and high-impact initiatives—must come first. A solid portfolio review is a good place to begin; a current-state assessment of the breakdown of projects, where the resources are going, and where the results (sales and profits) are being generated, can provide insight (Figure 2). With this data in hand, the management team can set a goal to shift the portfolio to a higher proportion of bigger, bolder development initiatives.

Simply setting the goal is not enough, however; these goals must be supported by resource allocations. Resources are often not available for larger projects simply because they are totally consumed by too many small projects. One solution is an organizational one, namely to fence off people who work 100 percent on major developments or breakthroughs. Indeed, a major APQC study revealed that 51.7 percent of top performers in innovation have a dedicated innovation group (Cooper 2012a).

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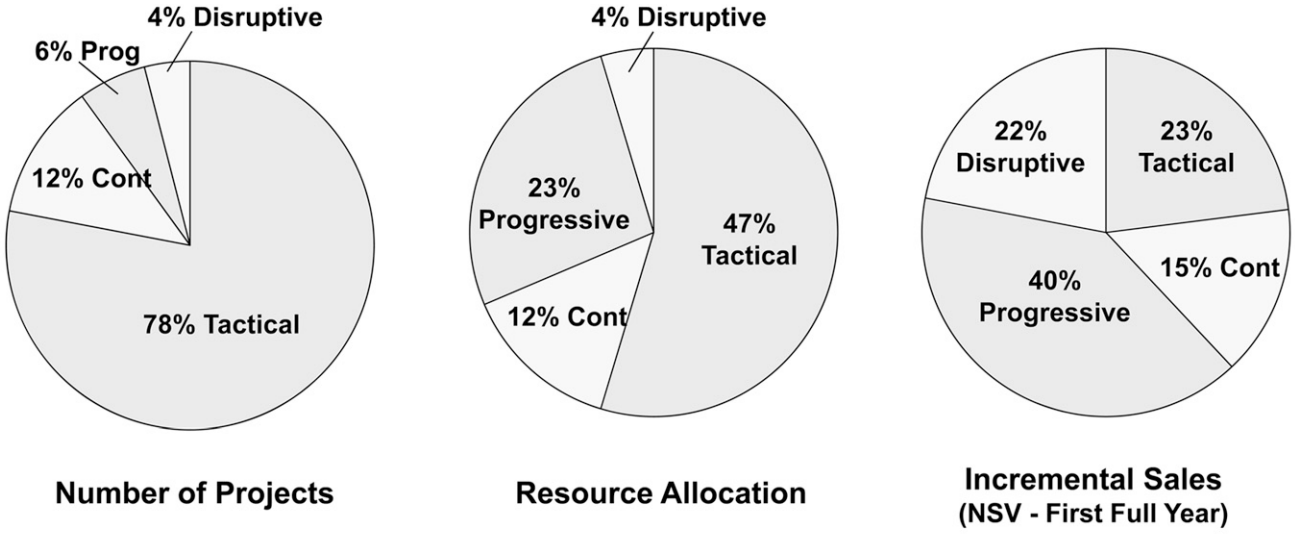
A second solution is a portfolio approach known as "strategic buckets." Here, management makes a strategic decision to set aside resources for different types of projects, including breakthroughs. This approach is based on the simple premise that strategy becomes real when you start spending money on it—so make the spending decisions! Here's how it works: Various categories or "buckets" of projects are defined, from maintenance projects, such as cost reductions and product



DISRUPTIVE	PROGRESSIVE	CONTINUOUS	TACTICAL
Unmet consumer need. New technology.	Addresses consumer need better than competition. Significant technology development.	Range extension or upgrade. Technology available, some development required.	Graphics change, bonus bags, deletions, seasonal.

FIGURE 2. A sample current-state assessment showing an overabundance of tactical projects

updates, through to breakthrough innovations (Figure 3). Next, the business's leadership team makes deliberate decisions about what proportion of R&D resources goes to each bucket, setting aside resource buckets for major initiatives versus incremental projects versus sales force requests, and so on. The distribution of resources is dictated by the business's strategy. Active and proposed development projects are next categorized by bucket and rank-ordered within each bucket until there are no more resources in that bucket. Each bucket has its own ranking criteria. Over time, the method ensures that resources are reserved for innovative projects; it shapes the development portfolio so that it mirrors the strategic priorities of the business; and it protects resources for higher risk, innovative projects, because they are not required to compete with more predictable, smaller ones for resources.

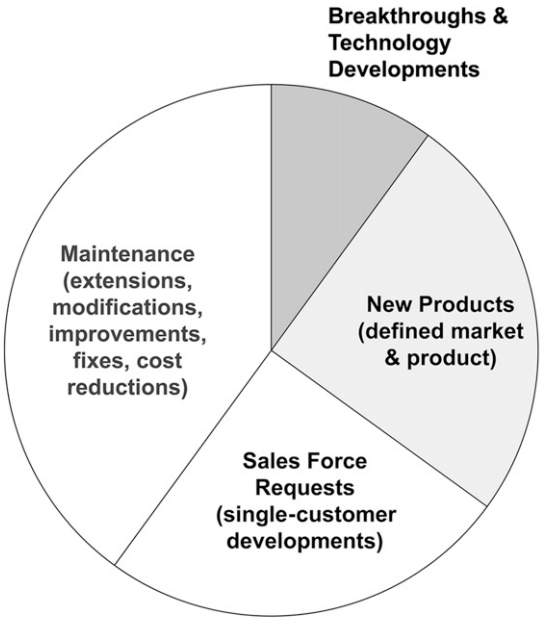
What if there are not enough "good" potential projects in any one bucket to use up the allocated resources—for example, not enough breakthrough projects? The short-term solution is strategic allocations, cutting back resources for that one bucket that has no immediate need for resources. The longer-term, and more appropriate, response is to acknowledge that the strategic resource allocations—the bucket allocations—are correct but that more effort must be made to find "good" projects for the deficient bucket. Thus, a more aggressive ideation and search program should be initiated.

BASF's Crop Protection Division implemented strategic buckets to overcome the problem of "too many little projects and not enough high-value ones," as the firm's CTO told me. Five types of projects were defined for the business unit:

- Research projects (fundamental science)
- Truly new products (innovation projects)
- Defensive projects (projects designed to protect market share)
- Offensive projects (projects designed to increase market share)
- Global projects (products targeted at world markets, as opposed to regional/domestic projects)

The last three categories are life-cycle management projects, sustaining innovations undertaken to maintain and expand sales of a product after its introduction to market, through all the stages of its product life cycle. At BASF the business unit management team makes strategic decisions in advance about where resources go. In this way, the right balance of projects is maintained, including a higher proportion of innovative developments. Because allocation decisions are made by the team, it is more difficult for individual managers to "game the system" or distort allocations to match their own priorities.

Dimensions other than project types can be used to guide allocation. For example, resource splits can also be made by market sector, geography, technology type, and product category or product line. But if the goal is more breakthrough new products, then a strategic buckets exercise with one bucket being breakthrough initiatives is key.



Strategy dictates distribution of resources to buckets. Projects are categorized by bucket and ranked. Bucket resources are allocated to projects in order of ranking until the bucket is empty.

FIGURE 3. Example of R&D resource allocation into defined buckets

How does one determine the appropriate distribution of resources across project types? No magic answer exists here, anymore than there is a single optimal split among stocks, bonds, and bank deposits in an individual's personal investment portfolio. But the decision must be made. Failure to make a strategic decision here will result in a split based on a series of ad hoc tactical decisions made as the need arises. As the CTO of a major U.S. conglomerate declared, noting that his firm was one of the first to opt for the strategic buckets method, "The default option is always wrong!"

In deciding the optimal split for your company, start with the current breakdown of resources, as determined by your current-state assessment. Merely knowing the current resource split—something that is not always visible in many businesses—will suggest what the split should be, for example, that certain categories should have increased resource allocations and others should be decreased. The direction is perhaps as important as the absolute spending amount. As the CTO of Emerson Electric said, "Our business unit executives are pretty bright—if they see these splits, they should have a good idea of what the spending split ought to be!"

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Emerson Eclectic has also implemented strategic buckets; there, the practice is "a core concept of Emerson's portfolio management process."

Scoring Models for Early Go/Kill Decisions

Another solution, somewhat more tactical, is to use a scoring model method of project evaluation for early-stage portfolio reviews or gates. Smart companies, such as Procter & Gamble, ITT Industries, W. L. Gore, 3M, and BASF, have developed scorecards for gatekeepers to use in rating and ranking projects at gate meetings. The goal is to protect more venturesome projects in the early days—to get them partway through the "valley of death"—until the project team has something tangible to show management and customers.

A second goal of these methods is to reduce the overreliance on financial models in the case of breakthrough initiatives, where so little is known with certainty, especially in the early stages. Scorecards place more emphasis on nonfinancial factors, the theory being that certain projects have a winning profile, and that profiling projects via a scorecard provides a much better predictor of eventual success than do financial projections. Research evidence also suggests this is true; in a study by Cooper and Edgett (2006), scorecards were rated by managers to be more effective and more efficient than financial tools for early-stage project selection.

Scorecards are carefully crafted to assess each project on a list of factors that are known predictors of success for innovative development projects. Research-based scoring criteria for evaluating major initiatives include:

- Does the project align with the business and innovation strategy? And is it strategically important to do?
- Is there competitive advantage—for example, a unique superior product with a compelling value proposition for the customer? Will the product deliver real benefits to the user?
- How attractive is the market, in terms of market size and potential, growth, margins earned, and the competitive situation?
- Will this project leverage core competencies in marketing, technology, and manufacturing?
- Is the project technically feasible, taking into account the size of the technical gap, technical complexity, and technical uncertainty?
- What's the potential for reward? Is the project worth the risk?

Projects are rated on these factors, typically on 0–10 or 1–5 scales, by the gatekeepers at the gate meeting, and scores are immediately displayed for discussion. Both the scoring process and the discussion around scores assist managers in making the go/kill decisions at early gates; project scores are also used to help prioritize projects at quarterly portfolio reviews.

Options Approach to the Investment Decision

Some managers don't understand that, at the early stages of a venturesome project, they are not making an all-or-nothing go/kill decision. Rather, they are making a relatively small

investment to undertake a preliminary investigation—providing the resources to test the waters. Thus, the initial investment decisions do not need the rigor of later-stage decisions. Think of the idea-to-launch process as buying a series of options on the project, rather than buying the whole project outright. Buying options is one way to mitigate risk. That's why many firms use a gated approach that breaks the project into stages, with each stage being more costly than the previous one (Cooper 2011). Gates precede each stage; at each successive gate, the data are more reliable, but the investment is also greater. This gating, or options, approach helps to manage the risk of breakthrough development projects.

At ITT Industries, managers were demanding rigorous analyses even at very early gates in their stage-and-gate process. Project teams arrived at gate meetings with full NPV and payback calculations, constructed with far more apparent rigor than was required for such an early decision. But major projects, which often involved more innovative concepts, technologies, and markets, were plagued by uncertain data, making these financial analyses suspect. As a result, these projects suffered at the early gates; management lacked the confidence to move forward.

Two points are relevant here: First, even though the project might be a potentially large one, the first stages are not expensive. Realizing that such an approach was killing all but the sure bets, ITT's management team dictated that the first few gates should be relatively gentle, with qualitative rather than financial criteria. As one frustrated executive told me, "We're not betting the farm here—we're making a relatively small decision to spend a little money, have a look-see, after which we'll make another decision to continue." Second, even though project teams had been presenting NPVs and detailed financial analyses very early on, the sophistication of the analysis far exceeded the quality of the data; the data upon which the NPVs were based were largely speculative and often wrong—certainly not reliable enough to drive a valid decision.

At some point in the investment process, certainly before moving into the expensive development stage, financial analysis must be used as part of the business case. One of the problems with traditional NPV and related financial techniques is that they are standard capital budgeting techniques. That is, they assume an all-or-nothing decision: Should we build the new factory or not? Only the expected cash flows are considered, and the flexibility to alter strategy or direction in view of new circumstances or information is ignored.

But product development is not an all-or-nothing decision; as noted above, it should be a series of options decisions—invest in a preliminary investigation; check the results; and either kill the project or, if the results are positive, move ahead to a more detailed phase. The assumptions in an NPV calculation are inconsistent with this step-wise approach. A more realistic financial model in the context of product development is expected commercial value (ECV), which looks at risks and probabilities, but most important, takes the investment a step at a time via a decision tree approach (see "The Expected Commercial Value Method," p. ***XXX***). Real options analysis is another method that deals with step-wise investment decisions under uncertainty; Monte Carlo simulations handle investment decisions with multiple probabilistic outcomes.[1] (See Cooper 2011, 242–245.)

As an example, consider a risky major project with a potential payoff of $50 million (based on the present value of a stream of future earnings). The all-in development and commercialization costs are $7 million, for an apparent NPV of $43 million. The project can be broken up into four phases, each with its own probability of success. The overall probability of success is 0.147 (arrived at by multiplying the chain of probabilities together), which is unacceptable. Suddenly, the NPV is not so attractive: the probability-adjusted NPV is only $350,000, barely more than zero on a $7 million investment. Kill the project!

Using the ECV approach, however, one sees that the project is actually worth $5.2 million at its beginning, when the only decision is to spend a mere $300,000, and the project's value jumps to $19.4 million by the time the $3 million go-to-development decision must be made. The ECV presents a much more realistic view of the situation and will portray risky and larger projects in a fairer and thus more favorable light.

Get Confirmation of the Data . . . Fast

Dealing with the high technical and market uncertainties inherent in these larger, bolder, and riskier projects presents a major challenge to some senior management teams. The traditional development process requires that all the homework be done up-front, and that answers to most of the key questions, including the product definition, are found in the business case *before* development begins. But reliable data and "all the answers" are usually not available for a major, high-uncertainty innovation in the early stages. For some management teams, this presents too high a risk, and they simply back out of the project.

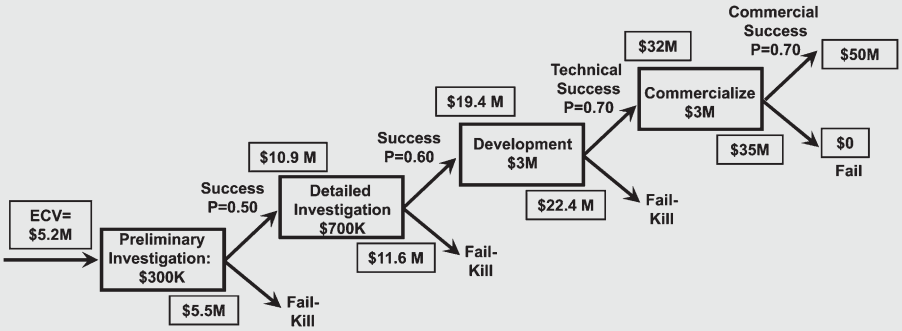
What some companies have done is to modify their traditional gating system and make it much more agile, adaptive, and entrepreneurial in order to handle bolder, riskier breakthrough projects (Cooper 2011). Smart companies have built a series of build-test-feedback-revise iterations into their development process to deal with uncertain market

Smart companies have built a series of build-test-feedback-revise iterations into their development process to deal with uncertain market requirements and technical solutions.

[1] Real options analysis (ROA) methods are mathematically complex and may not be for everyone. Monte Carlo simulation generally does not treat the investment in a step-wise fashion, but it does consider multiple possible final outcomes.

The Expected Commercial Value Method

The expected commercial value (ECV) of a project is determined through a decision-tree approach that accommodates a step-wise investment model. This structure approximates the decision process in a risky venture, such as a breakthrough innovation project. This flexibility allows ECV to treat risky investments more fairly—and generally more favorably—than such yes-no methods as NPV.



The decision-tree structure estimates value at each stage of the project's development. In the four-stage decision process above, starting on the left, $300,000 is invested in a preliminary investigation with 50-50 odds of success. If the investigation does not yield desired results, the project is killed and no further investment is made. If the result of the preliminary investigation is positive, $700,000 is invested in a detailed investigation with a 60 percent chance of success. The process continues through the next two stages, with both investment and odds of success increasing at each stage, for a total investment—if the project proceeds to commercialization—of $7 million. The "payoff" if successful is the present value of future earnings after launch, namely $50 million. Working back from the ECV of $35 million at the beginning of commercialization ($50M x .7), the ECV at the beginning of the project is a respectable $5.2 million.

By contrast, with an overall probability of success of .147, the probability-adjusted NPV is just $350,000—too low to justify the risk and investment (probability-adjusted NPV = .147 x 43M – 7M x .853 = $350K). The probability-adjusted NPV thus paints a very negative picture, while the ECV, the more correct approach, is much more positive.

requirements and technical solutions. These spirals or iterations begin early with a virtual prototype that is shown to customers for feedback. These spirals continue into development, moving from "protocept" rapid prototype (something more than a concept but less than an early prototype) to working model and so on (Figure 4).

HP has utilized a traditional and linear phase-review process for years, mostly for traditional product development. But the firm has recently implemented two variations that make use of spiraling iterations (MacCormack et al. 2012). One version, called their "agile" process, is for products aimed at rapidly growing but changing markets. The process rapidly evolves the product's design to meet changing customer needs and technical choices. This evolutionary gating process features frequent design-build-test iterations, much like the spiral development pattern described above. The goal is to probe via multiple prototypes to understand the value proposition for different customers and to gain insights into the technical solution.

A second version is designed for new products for embryonic markets—a new market or new technology. This process is a lightweight stage-and-gate system with fluid product design objectives that permit experimentation. It features rapid exchange of information with potential customers to identify the customer's value proposition. The goal is to quickly and cheaply confirm the product's design and market acceptance.

Spiral development is based on the premise that "customers don't know what they want until they see it." The overriding imperative is to get something in front of the customer, early and often. This was one of Steve Jobs's principles, and it helped make Apple products so appealing and successful (Isaacson 2011). With an iterative, spiraled process, not only is the design confirmed but valuable data on purchase intent and likely market acceptance are obtained, data that are vital to a reliable financial analysis.

Surviving the Valley of Death

The "valley of death" is the period between when an idea is born and when the concept is approved as a funded development project. Many great ideas start out with huge enthusiasm, but time passes, and the facts become known, and suddenly, the project does not look quite so great after all. Over time, all projects get warts! So the initial enthusiasm wanes, and too often the project is dropped before it even gets into development—another victim of the valley of death.

The message is this: Don't overscreen and don't kill too early! Progressive firms recognize that the best concepts are often the most fragile ones—the easiest to kill. Protecting early-stage projects is thus vital to ensure that the breakthrough project gets through the valley of death.

There are several ways to provide the protection projects need at the earliest stages. One approach is to provide a

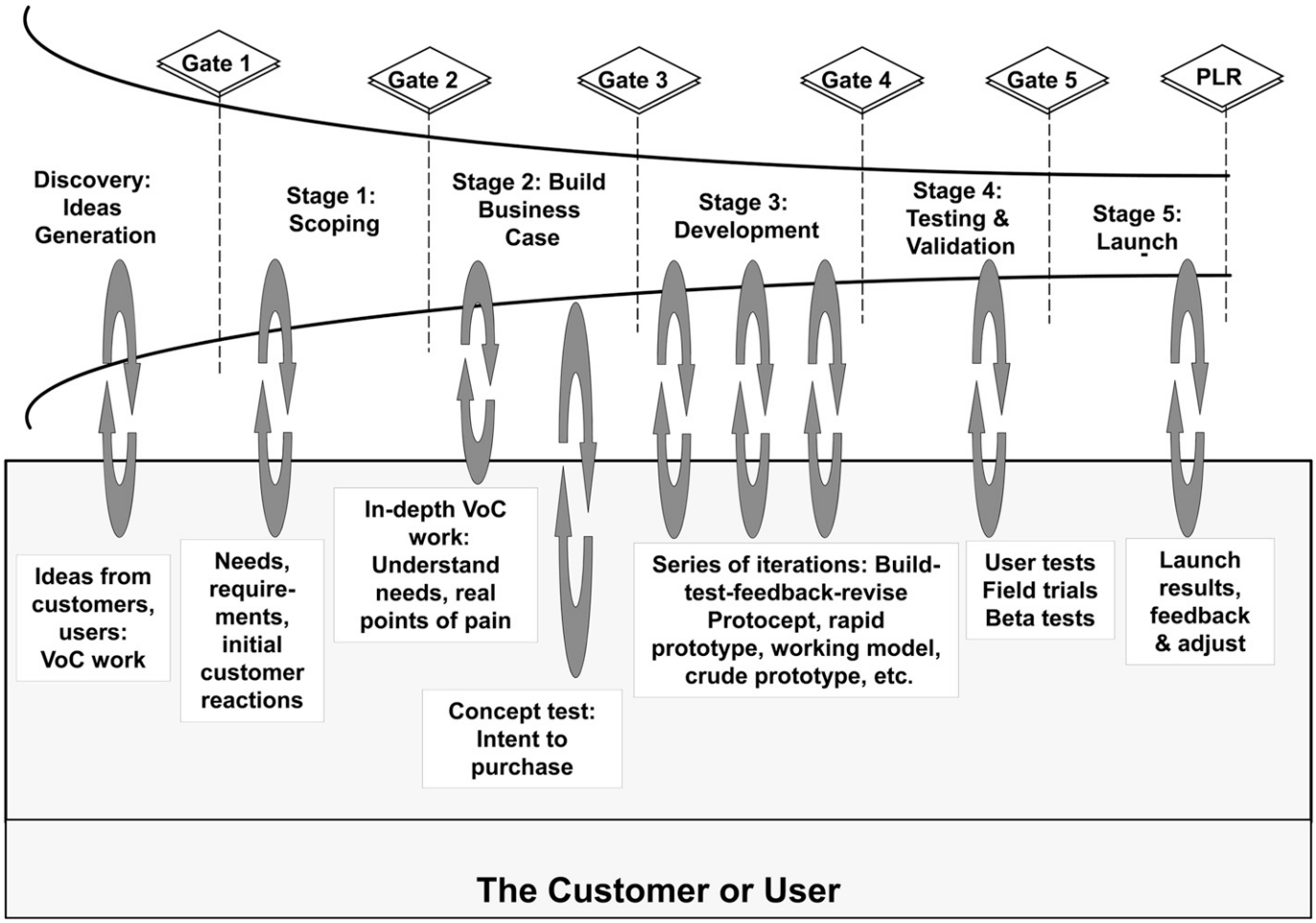


FIGURE 4. Spiral development process with iterative feedback cycles

lengthy phase, for example six months, in which the project team can operate without go/kill evaluations, after which the team must deliver something that can be demonstrated to stakeholders (customers and management). This method is patterned after the time-boxed sprints that occur in agile development, a process used primarily in software development, except here the sprints are six months, not six weeks. After six months, management can invest in another six-month time-boxed sprint, cancel the project, or move it into their traditional product development process.

A major electronics firm in Austria, considered to be that country's most innovative company, has adopted this sprinting approach for its physical product development. Similarly, 3M's "projects on the side" system protects embryonic projects from an overly rigorous business analysis done too early. This is a well-known method in which scientists are allowed to spend 15 percent of their time working on the projects of their dreams without formal approvals. After some months or even years, the scientist (often a team of scientists) may have something to show management and customers and also some data to present. Then, the project is ready to enter 3M's traditional stage-and-gate system.

Technology development projects also challenge traditional stage-and-gate systems. While product developments result in a specific product ready for the market, technology or technology platform developments create a technical capability from which multiple new products can be developed—for example, a new catalyst technology in the chemical business that can enable a new family of polymers. Forcing such a project through a traditional gating system will often damage it. Thus many firms, such as 3M, BASF, and Exxon Chemical, have installed modified systems to handle technology development projects. These systems rely on strategic go/kill criteria and require far less financial data to justify a decision to proceed. (For an outline of such processes, see Ajamian and Koen 2002; Cohen, Kamienski, and Espino 1998; and Cooper 2006.)

The overall message is that one process does not fit all projects. Companies must tailor their processes to the type of project; that is, they need to use different development processes for different types of projects. A traditional development process is ill suited for projects that are not traditional, such as most breakthrough initiatives. The process selected must accommodate the particular challenges of these kinds of projects. For example, both of the modified HP processes allow projects to proceed at the beginning without much of the information required by the company's traditional phase-review process; the iterations or spirals provide the information on the fly.

The Right Climate and Culture, the Right Metrics

Implement all of the portfolio management techniques outlined here, or adopt new idea-to-launch methodologies that promote innovation, but at the end of the day, it all boils down to climate and culture. Is your business prepared to make tough choices and invest in risky major projects? Indeed, having the right climate and culture for innovation, an appetite to invest in innovative and more risky projects, and the right leadership from the top is the number one factor that distinguishes top innovation companies, according to extensive studies of innovation results (Cooper 2012b).

Culture and climate is a much broader topic than portfolio management, but it is also integral to successful portfolio management. Those businesses that create a positive climate for innovation, support innovation at every opportunity, reward and recognize innovators and successful development teams, and welcome and reward ideas from all employees, do much better at product innovation (Cooper 2012b). Similarly, having the right senior leadership to drive and support the innovation effort with words as well as through actions is vital to success.

Metrics are intended to measure success, but frequently they shape the innovation climate in counterproductive ways. "Change the metrics!" was the plea from a 3M senior person at a workshop on bold innovation held at a recent innovation conference. He was bemoaning that fact that 3M, and so many firms that followed 3M's lead, is married to its new product vitality index (NPVI) as the key performance metric. By focusing on "percentage of sales by new products launched in the last five years" as the critical measure of success, the company may actually be discouraging true innovation. Such a metric promotes a lot of small product developments—renovations, not innovations—and creates much unnecessary churn in the product line, encouraging business units to replace older products with new ones just to make the numbers. The consensus of senior people attending was that while percentage of sales from new products is a useful metric, other metrics should also be considered, such as percentage of sales from significant new products or true innovations.

Grundfos, considered by many to be Denmark's most innovative company, offers an example of how culture can drive innovation. The company produces innovations consistently, even though it's in a mature industry (pumps). Grundfos strongly promotes new-product development at every opportunity—in its annual report, which devotes more pages to product innovation than to finances; in the showcase of new products that occupies its headquarters front lobby; with the campaign of posters emphasizing innovation hung throughout the premises; and in the open-concept office that allows teams of employees to coalesce. The company motto, "Be. Think. Innovate," is everywhere, even on company vehicles.

Emerson Electric also foregrounds innovation with a "wall of fame" in their St. Louis headquarters building that honors project teams and innovation leaders in a highly visible way. Similarly, it publishes *Innovations Magazine*, which showcases Emerson innovations and innovators. And visitors to Hilti's R&D building at their Lichtenstein headquarters are overwhelmed by a massive display of new products in the front lobby; this is clearly a company obsessed with innovation.

3M's "projects on the side" program also works to build a culture of innovation, one that consistently produces breakthroughs. Insiders report that most of 3M's breakthroughs over the last decades have come via this route. Google has a similar policy: "The bright Googlers get 20 percent time in which they're free to pursue projects of their choice. Some immensely popular projects from the Googleplex like Orkut, Google News, Google Suggest and even AdSense were conceptualized and developed by Google engineers during their '20% Time'" (Agarwal 2007). This works for smaller firms too; the digital agency Rockfish in Rogers, Arkansas, openly encourages its employees to create entrepreneurial projects on the side (Stillman 2012). The effort regularly returns profitable, creative ideas to the company, enabling it to more effectively respond to client needs.

Breakthrough Innovation—Final Thoughts

There are no simple solutions in the quest for bold new products. But the search is vital to the growth and prosperity of your company, so do persevere. Portfolio management offers some solutions:

- Employ strategic buckets to set aside resources for big, risky projects.
- Use scoring models for early gate decisions rather than relying on financial models, which often lead to the wrong decisions at these stages.
- Adopt a step-wise approach to investment decisions to mitigate risk, and use the right financial models (options models), such as ECV.
- Seek fast confirmation of data via spiral or iterative development to provide robust data for early-stage financial calculations and to get the product design right.
- Utilize novel idea-to-launch processes to get risky projects through the valley of death.

The full solution lies beyond portfolio management, however. Fostering the right climate and culture and using the right performance metrics to promote bolder investments is one direction companies must take. And developing a product innovation strategy for your business is yet another important endeavor; a strategy that identifies the right strategic arenas for your business will ultimately be your engine of growth.

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