Stage-Gate Systems: A New Tool for Managing New Products

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New products can help your company much more quickly and efficiently with a bit of planning before development starts.

America is in a product war, and the management of innovation is the strategic weapon. The battles take place on many fields: from electronic chips to tractors, cameras to machine tools, scientific instruments to automobiles.

Our ability to get better at the innovation process—to drive new products from idea to market faster and with fewer mistakes—is the key to winning this war. Sadly, many firms miss the mark: Only one product development project in four becomes a winner, and almost 50 percent of the resources American firms devote to innovation are spent on products that are commercial failures.

Stage-gate systems form one solution to what ails many firms' new product programs. Facing increased pressure to reduce the cycle time yet improve their new product "hit rate," corporations are increasingly looking to stage-gate models as effective tools to manage, direct, and control their product-innovation efforts.

What are stage-gate systems? A stage-gate system is both a conceptual and an operational model for moving a new product from idea to launch. It is a blueprint for managing the new product process to improve effectiveness and efficiency. Although conceptually quite simple, as we shall see later, the intricacies, design, and operationalization of stage-gate approaches are considerably more complex.

THE NEED FOR BETTER NEW PRODUCT MANAGEMENT

Facing increased competition from home and abroad, maturing markets, and the heightened pace of technological change, corporations look to new products and new businesses for sustained growth and competitive advantage.

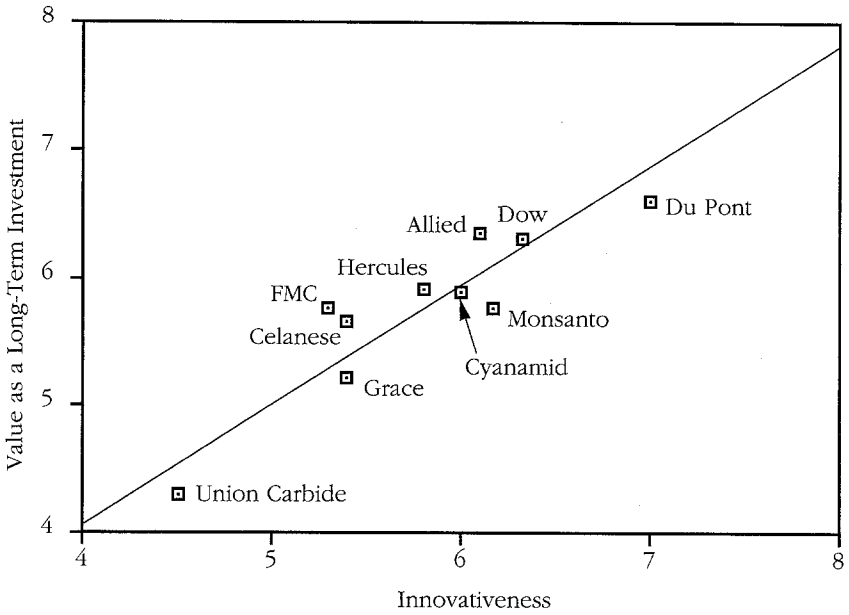
The desire to develop and launch new products is obvious. The manager's bookshelf is replete with new books on managing innovation, launching new products, and managing technology. A study by the Conference Board (Hopkins 1980) revealed that, by an eight-to-one ratio, CEOs believed that their firms would be much more dependent on new products in the years ahead. A Coopers & Lybrand survey (1985) reported that most companies are counting heavily on new product development for growth and profitability.

There is good reason for this heightened interest in product innovation. An annual *Fortune* survey rates top American corporations on a number of criteria, including "value as a long-term investment." Using data supplied by *Fortune*, we studied various predictors of investment value. The results were provocative: The single strongest predictor of investment value is "degree of innovativeness of the company." A typical industry relationship—how innovativeness impacts on investment value—is shown for the chemical industry in **Figure 1**.

The need for effective product innovation is there; are the results? Products continue to fail at an alarmingly high rate. In one study (Hopkins 1980), 63 percent of managers felt that their new product success rate was "disappointing" or "unacceptably low." The Coopers & Lybrand survey

revealed that there is widespread disillusionment with many of the new products that firms develop (notably extensions and incremental improvements) and that firms have had too much of a "tech push" rather than "market pull" orientation in their new product efforts. The inability of many firms to use their internal resources effectively for new product growth may be one reason for the recent merger mania, itself almost an admission of the failure of their internal growth programs.

Figure 1
How Innovativeness Affects Value as an Investment: Chemical Industry



Source: Fortune *and Erdos & Morgan, Inc.*

THE SOLUTION

The strategic solution is that management must get better at conceiving, developing, and launching new products—not just extensions and incremental improvements, but new products that give the firm a sustainable competitive advantage. This translates into better management of the innovation process. Stage-gate systems are seen as one answer, as the following examples show.

With a rather dismal new products and models record for the last decade, General Motors is now trying to beat the Japanese at their own game. GM is currently implementing a Four Phase system for product design and introduction—a methodology that promises to drastically cut the idea-to-launch time of a new car model. This copyrighted Four Phase system is nothing more than GM's version of a stage-gate system.

3M traditionally has had an enviable new product track record. An innovative corporate culture and climate are often cited as 3M's secret weapons. But 3M has also had in place various stage-gate systems for managing the innovation process. Thus creativity and discipline are blended to yield a successful new product program.

One major packaged goods firm, always noted for its forward-thinking management methods, is currently facing tougher times in its new products efforts. A senior committee has tried to find out why. One fact was that back in 1964, the company had implemented a gating system at a time when most people thought that product innovation couldn't be managed. The system worked well for 15 years, but fell from favor in the late 1970s. One recommendation of the committee: "Let's get back to basics and redesign and re-implement the stage-gate process."

Northern Telecom, a telecommunications equipment manufacturer who has successfully penetrated the international market in recent years, implemented their four-stage gating system for new products in the 1980s. The stage-gate model cost approximately $1 million to design and implement, but the results have been impressive: shorter times to launch; fewer mistakes; less recycling and rework in the process; and a more successful development effort.

A major electrical/electronics corporation recently undertook a study of the innovation process within its roughly 50 operating divisions. The results were conclusive: Only a handful of the divisions had implemented stage-gate systems, but those few were achieving a much higher level of new product performance than those divisions that lacked a formal game plan.

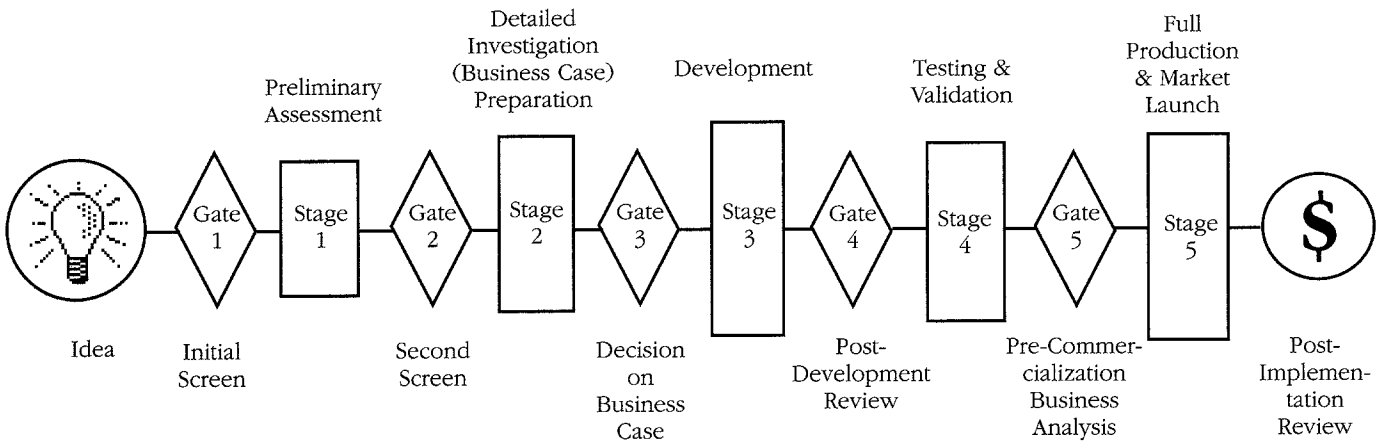
THE CONCEPT OF A STAGE-GATE SYSTEM

Individual companies may refer to their systems by different names, and on paper they appear to be unique to that company. In practice, however, there is a surprising parallelism between different stage-gate approaches.

Stage-gate systems recognize that product innovation is a process. And like other processes, innovation can be managed. Stage-gate systems simply apply process-management methodologies to this innovation process.

A good analogy is the production process to manufacture a physical product. The way to improve the quality of output from the process, of course, is to focus on the process itself—to remove variances in the process. A process is sub-

Figure 2
An Overview of a Stage-Gate System



divided into a number of stages or work stations. Between each work station or stage, there is a quality control checkpoint or gate. A set of deliverables is specified for each gate, as is a set of quality criteria that the product must pass before moving to the next work station. The stages are where the work is done; the gates ensure that the quality is sufficient.

Stage-gate systems use similar methods to manage the innovation process. They divide the innovation process into a predetermined set of stages, themselves composed of a group of prescribed, related, and often parallel activities. For example, the "Validation" stage might entail a list of mandatory or optional activities such as in-house prototype tests, field tests with customers, pilot or trial production, and test marketing.

Usually stage-gate systems involve from four to seven stages and gates, depending on the company or division. A typical system is shown in **Figure 2**. Each stage is usually more expensive than the preceding one. Concurrently, information becomes better and better, so risk is managed.

The entrance to each stage is a gate; these gates control the process, much like quality control checkpoints control the production process. Each gate is characterized by a set of deliverables or inputs, a set of exit criteria, and an output. The inputs are the deliverables that the project leader must bring to the gate. The criteria are the items upon which the project will be judged, the hurdles that the project must pass at that gate to have the gate opened to the next stage. The outputs are the decisions at the gate, typically a Go/Kill/Hold/Recycle decision, and the approval of an action plan for the next stage.

Each project leader is required to provide the specified deliverables and meet the stated criteria at a given gate. For example, at Gate 3 in Figure 2, the inputs might include: results of the user "needs and wants" market study; the competitive analysis; the detailed technical appraisal; and the financial assessment. The inputs and the criteria change from gate to gate; Gate 1's inputs and criteria are quite different from Gate 4's.

Gates are manned by senior managers who act as "gatekeepers." This gatekeeping group is typically multidisciplinary and multifunctional, and its members are senior enough to have the authority to approve the resources needed by the project. Its role includes:

- Review of the quality of the inputs or deliverables;
- Assessment of the quality of the project from an economic and business standpoint, resulting in a Go/Kill/Hold/Recycle decision; and
- Approval of the action plan for the next stage (in the event of a Go decision) and allocation of the necessary resources.

The project leader drives the project from stage to stage, gate to gate. He or she is well aware of what inputs are required to "pass" the next gate and organizes the team to meet the input requirements of the upcoming gate.

The implementation of stage-gate systems requires certain organizational changes within some firms. For example, a project team approach to organizing new product projects is fundamental to stage-gate approaches. No longer can projects be handed from department to department within the firm; a team and leader must carry the project in all stages.

A second organizational change for some

firms is the involvement of senior management as gatekeepers. Successful product innovation requires significant resources and demands the commitment of top management. Gates manned by senior people are not only essential to gateways systems; they build in top management involvement and commitment.

WHERE'S THE EVIDENCE?

A number of firms have adopted such a formal model. But does such a process approach, although intuitively appealing, have any impact on performance? One study (Booz, Allen & Hamilton 1982) found that it does: firms that adopted a formal new product process did better, and those firms with the process in place for the longest time fared the best.

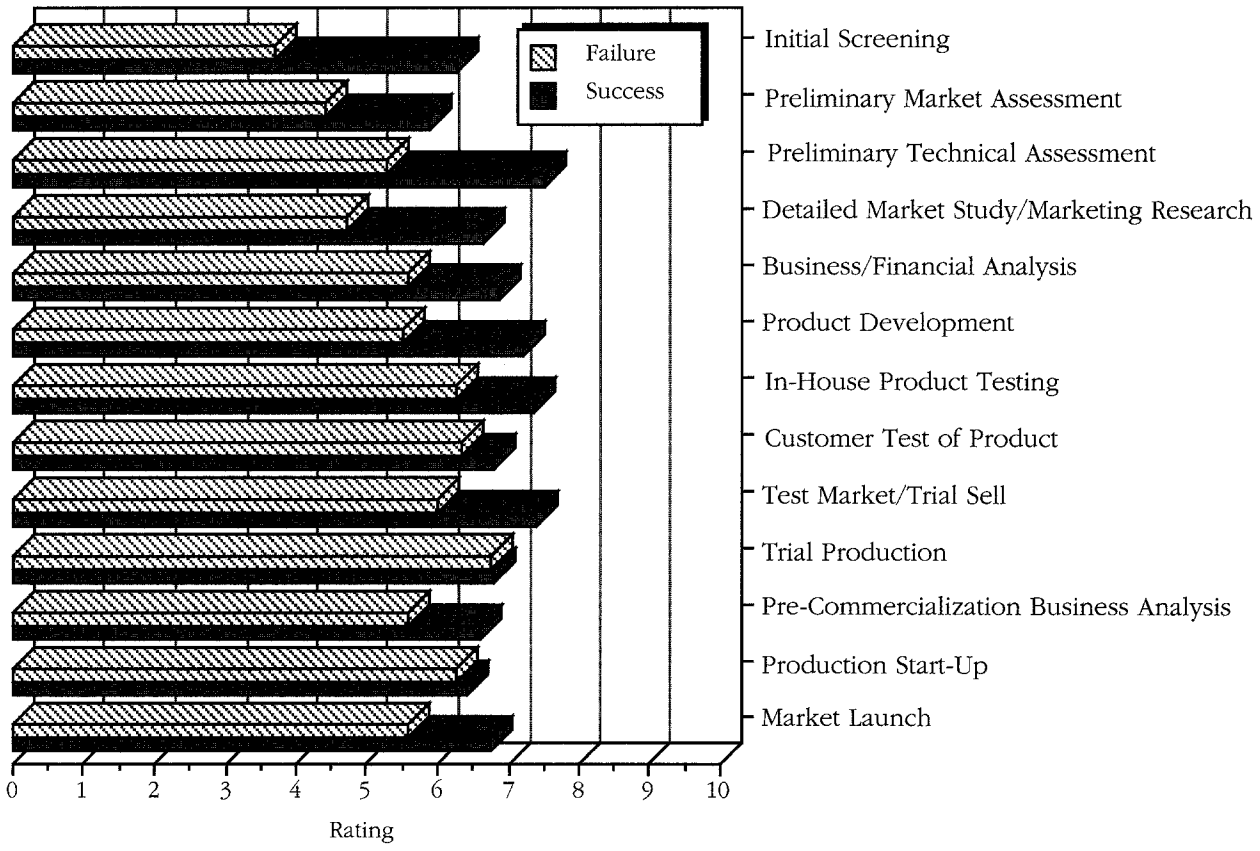
A Quality Focus

The issue of a successful new product process—one that is complete and is executed in a quality fashion—must be a fundamental concern of management. But a research study of 203 new product projects (Cooper and Kleinschmidt 1986) suggests that quality processes are lacking in most firms' new product programs. New product processes were found to be incomplete and to suffer from sloppy or under-resourced execution.

In three-quarters of these 203 projects, there was no detailed market study or marketing research undertaken at all. Yet a lack of market assessment has been consistently cited for years as the number-one reason for new product failure. Fully 77 percent of these projects featured no test market or trial sell; 34 percent omitted product testing with the customer; and 32 percent of these new product projects did not even have a formal product launch.

Thirteen commonly prescribed activities were studied in these 203 projects, ranging from "initial screening" to "prototype/sample tests" and "formal launch." Only four projects out of the 203 featured all 13 activities—that is, could be considered a complete or "textbook" approach. The other 98 percent were abbreviated processes, often omitting crucial steps. Further, the study found that the completeness of the process was significantly related to project success: the more steps or activities one left out, the higher the likelihood of failure.

Figure 3
Quality of Execution of Activities—Success versus Failure



A similar picture emerges when one looks at quality of execution of each of these 13 activities (see **Figure 3**). Successful products were strongly linked to quality of execution. Where activities were proficiently undertaken, there was a higher likelihood of new product success. Those most poorly executed, and those cited in greatest need of improvement, were initial screening, the detailed market study, and preliminary market assessment. The most pivotal activities, those in which the differences between successes and failures were the greatest, were the early activities in the new product process. The seeds of success or failure are sown in the first few steps of the process: the predevelopment or "homework" stages.

"The most pivotal activities, those in which the differences between successes and failures were the greatest, were the early activities in the new product process."

What this and other studies reveal is convincing. First, most products fail because of errors of omission and commission in the new product process: a lack of market assessment; product defects; inadequate launch efforts; poor screening and project evaluation, and so on. Second, current performance of product innovation is far from ideal: there are too many missing steps and short-cuts, and questionable quality of execution. Third, quality of execution separates winners from losers: How well the activities are carried out, and indeed whether they are carried out at all, is strongly correlated with project outcomes. And finally, the weakest and most pivotal activities are the predevelopment and market-oriented ones.

Stage-gate systems, although simple conceptually, have a profound impact on the innovation process. Stage-gate models provide the quality focus that is often missing in firms' new product programs. By building in quality control checkpoints in the form of gates, stage-gate systems ensure that project leaders and teams meet high standards of execution. As the project leader approaches a gate, he or she knows what inputs are required and that these deliverables will be carefully scrutinized by the gatekeepers. The pressure is very much on the project leader to build quality into his or her project.

Gates ensure that no critical activities have been omitted: an action plan is agreed upon at each gate, and the deliverables for the next gate are clearly specified. The result is no critical errors of omission, no gaps in the process, and a "complete" process.

Attention and resources are devoted to activities and stages that are often deficient in the innovation process. Stage-gate systems typically emphasize a market orientation and marketing inputs, and they devote far more attention to the front-end or "homework" stages that precede the product development phase.

A Stronger Market Orientation

A lack of a market orientation and inadequate market assessment are consistently cited as major reasons for new product failure, particularly in industrial-product and high-technology firms. Moreover, the market-oriented activities tend to be the weakest in the new product process, yet they are strongly linked to success.

Many managements profess a market orientation, but the evidence is otherwise in the case of new products. In one study of new product case histories (Cooper and Kleinschmidt 1988), only 16 percent of the total effort expended on new product projects went to market-oriented activities. The breakdown for the average project in man-days spent was:

- Technical and production activities, 78 percent;
- Market-oriented activities (including launch), 16 percent;
- Evaluative/financial activities, 6 percent.

If launch activities are removed, the amount devoted to efforts such as market assessment, detailed market studies, customer tests, and trial sell/test markets becomes pitifully small.

The provocative finding is that those firms that did proportionately more market-related activities reaped the benefits. Overall, successful new products had considerably more time, money, and energy devoted to market-oriented activities than did failures. In successful projects, three times as many man-days and twice as much money were devoted to preliminary market assessment than was the case for failures. Twice as much market research (measured in both man-days and dollars spent) was conducted in successful products as in failures. But in both cases, the amounts were still small. Successful products had more than twice as much money spent on customer tests of the product as did failures. And six times as much money and twice as many man-days were spent on the launch of successful products as for failures.

None of these marketing costs was significant relative to the total project costs, with the exception of launch. So doubling the marketing effort did not materially affect the total project costs but clearly yielded a marked impact on project outcomes. Stage-gate systems provide for a much stronger market orientation in the new product process. Those market-related activities, so often

omitted or weakly handled in most new product projects, are built into the process by design, not as an afterthought. The stages of the process typically include a number of market-related activities, such as user needs and wants research; concept tests; competitive analysis; development of a detailed marketing plan; product tests with customers; trial sell; and formal launch. The project leader must ensure that these critical steps are executed: unless they are, his or her project does not pass the next gate.

Better Homework

We all learned in fifth grade how distasteful homework is. (Many of us haven't forgotten.) But homework is critical to a successful development program. Sadly, too many new product projects suffer from a lack of homework. Only 7.1 percent of the total expenditures on the typical project was spent on homework (or predevelopment) activities—activities undertaken to qualify and define the project prior to a major development program. By contrast, development and product testing received 39 percent of expenditures, and commercialization 54 percent. In man-days spent, only 16.4 percent of the total project effort went to predevelopment efforts. Development and product testing received 61 percent and commercialization 22.5 percent. Of all the activities in the new product process, predevelopment activities were the ones most weakly executed and in greatest need of improvement.

The most important steps of the new product process—those that usually separate winners from losers—lie in the stages that precede the product development phase. Figure 3, which captures the quality of execution in typical projects, reveals that how well these homework stages are undertaken is strongly linked to product success. Further, successful projects spend over twice as much money and 1.75 times as many man-days on predevelopment steps as failures. Finally, a Booz, Allen & Hamilton study (1982) found that Japanese firms and successful U.S. firms devote considerably more time to the homework stages before entering development than does the average U.S. firm.

The predevelopment activities are important because they qualify and define the project. They answer key questions such as:

- Is the project an economically attractive one? Will the product sell at sufficient volumes and margins to justify the investment in development and commercialization?
- Who exactly is the target customer? And how should the product be positioned?
- What exactly should the product be to make it a winner? What features and attributes should be built into the product to give it a differential product advantage?
- Can the product be developed, and at the right costs? What is the likely technical solution?

Stage-gate systems provide a focus on homework. The typical game plan has one or two stages devoted to predevelopment investigation, as shown in Figure 2. If this homework is not done or is done poorly, the project fails to enter the expensive development phase.

"More homework means longer development times" is a frequently voiced complaint. This is a valid concern, but experience has shown that this homework pays for itself in reduced development time and improved success rates. First, without homework, there is a much higher likelihood of new product failure. So the choice is between a slightly longer project or increased odds of failure.

Second, many projects are poorly defined when they enter the development phase. This is often the result of weak predevelopment activities: the target user is not well understood, user needs and wants are vaguely defined, and required product features and attributes are fuzzy. R&D people and design engineers are not mind readers. With a poorly defined project, they waste considerable time seeking definition, often recycling back several times to "get the product right." Better project definition, the result of sound homework, actually speeds up the development process.

"More homework up front encourages changes to occur earlier in the process rather than later, when they are more costly."

Third, rarely does a product concept remain the same from beginning to end. The original idea that triggered the project is seldom the same as what goes to market. Given this inevitable product design evolution, the time to make the majority of these design changes is not when the product is moving out of development and into production. More homework up front encourages changes to occur earlier in the process rather than later, when they are more costly. The result is a considerable savings in time and money at the back end of the project and a more efficient new product process.

Parallel Processing

Parallel processing is an important feature of stage-gate systems. It means that activities are parallel rather than sequential. At each stage of the gateways system, many activities take place concurrently and involve different functions of the firm.

Why parallel processing? New product managers face a dilemma: On one hand, they are being urged by corporate management to shorten the elapsed time from idea to launch. On the other hand, the manager is urged to improve the effectiveness of product development: cut down the failure rate; do it right. The desire to "do it right" suggests a longer process. So the new product manager is caught between conflicting demands of time efficiency and project effectiveness. Parallel processing compresses the development cycle without sacrificing quality.

The sequential analogy is that of a relay race: One runner, perhaps the product manager, runs with the baton for a while, passing it to the next runner, likely R&D. He takes over the project and runs with the baton, passing it on to production, who throws it over the wall to marketing, who, if not busy on more pressing matters, carries the baton across the finish line and into the marketplace. Phrases such as "handoff," "passing the project on," "dropping the ball," and "throwing it over the wall" are common in the too many firms that have adopted this approach. Besides all the miscues, the process takes far too long.

In parallel processing, many activities are undertaken concurrently rather than in series. The situation is more like a rugby football game than a relay race. A team (not a single runner) appears on the field. A scrum or huddle ensues, after which the ball emerges. Players run down the field in parallel, passing the ball laterally. After 25 yards or so, the players converge for another scrum or gate, and another stage of activities takes place. The play is far more intense than a relay, more work gets done in a given elapsed time period, and many players are involved at any one point in time.

Parallel processing, an integral facet of stage-gate systems, means that more activities occur in an elapsed period of time, which results in time compression. The process is obviously more complex than the series approach, requires more careful management, and hence points to the need for a thoughtful game plan. A second benefit of parallel processing is multidisciplinary inputs (the team passing the ball). Parallel processing means multifunctional, multidisciplinary inputs—different activities in different parts of the firm being undertaken concurrently, but all converging at the next scrum or gate.

"Established criteria ensure that all projects are evaluated consistently and fairly, and that gut decisions and hidden criteria take a back seat to specified criteria and thoughtful decisions."

Better Project Evaluations

New product resources are too valuable and scarce to misallocate. Sound project evaluations, where Go/Kill and prioritization decisions are made, are critical to the proper allocation of development resources. But in too many firms, project evaluations are weak, deficient, or even nonexistent. In one study (Cooper and Kleinschmidt 1986), initial screening was one of the most poorly handled activities of the entire new product process. Further, 37 percent of projects did not receive a business/financial analysis prior to the R&D phase, and 65 percent of projects did not include a pre-commercialization business analysis.

Typically, at the idea stage, projects were initiated on the basis of relatively little information and no formal criteria. When under way, projects became express trains: once the project got a head of steam, very little could stop it. Subsequent evaluations tended to be viewed as obstacles to be overcome, and rarely was a project killed once it made it to the product development phase. The train slowed down at the stations, but little stood in the way of its ultimate destination (market launch).

Most projects are unfit for commercialization. Booz, Allen & Hamilton (1982) reported that for every seven projects at the idea stage, only one becomes a commercial success. Effective project evaluation is critical to successful new product programs. Good evaluations prevent "losers" from proceeding too far, with the resulting misallocation of scarce resources. And good evaluations focus the resources on potential winners.

Stage-gate systems are designed to overcome these deficiencies in project evaluation. First, project evaluations and bailout points are built into the process via preset gates. A project cannot pass into the next phase or stage until the evaluation is done and the gate is opened. For example, in Figure 2, the decision to "move into a full-scale development project" cannot be taken until the Gate 3 criteria have been met. Some firms impose a maximum dollar or time limit per stage, which if exceeded signals another gate review.

Second, gates are characterized by a list of preestablished criteria. In the early gates, these criteria tend to be largely qualitative and deal with "must meet" and "should meet" issues. At later gates, a stronger financial orientation is introduced, where expected financial return becomes the focus. Established criteria ensure that all projects are evaluated consistently and fairly, and that gut decisions and hidden criteria take a

back seat to specified criteria and thoughtful decisions. Established criteria also force a discussion of important issues, ensuring that none are overlooked in the evaluation procedure.

Finally, gates provide for top management involvement. Typically the gatekeepers include the senior managers in the business unit. Since they have the authority to make spending decisions, the project leader can seek an immediate Go/Kill/Hold decision. More importantly, he or she can obtain immediate approval of the needed resources. Gatekeepers also have more and broader experience than most project leaders and bring useful insights to the project. One key role of gatekeepers, for example, is to help the project leader chart the project's path. Finally, by manning the gates and taking a direct hand in project evaluation from Gate 1 onward, senior managers "buy into" projects.

A Visible Road Map

Stage-gate systems provide a road map for the project leader and team. The project team members, often from different functions and locations within the firm, now have a clearer idea of where the project stands, where it is going, and what needs to be done next. "At least they're reading from the same page of the same book," commented a senior Exxon Chemical executive about his marketing and technical people as they implemented a stage-gate system.

Stage-gate approaches lay out the suggested activities for each stage of the process. None of these activities is mandatory—each project is unique—but now the project leader has a good sense of what activities seem reasonable to consider for the next stage of the project. For example, some of the actions that are suggested in the gateways model for Stage 2 in Figure 2, the detailed investigation, include:

- Undertaking a market study to identify user needs and wants, their "must have" and "would like to have" features in the product;
- Undertaking a detailed technical appraisal to determine the probable technical solution, the likelihood of completion, the costs and times to develop, and the potential killer variables;
- Initiating an investigation through the legal department to determine the copyright/patent/legal status of the project and how any roadblocks/problems will be solved.

These suggested activities are laid out in considerably more detail in companies' individual game plans.

Gates also provide a set of objectives for the project leader. The prespecified deliverables or inputs to each gate become the objectives for the next time period. For example, the required inputs to Gate 2 in Figure 2 might include:

- Market analysis: size; growth; segmentation; trends;
- Competitive analysis: players; market shares; strategies;
- Customer reaction: reaction to concept; price sensitivities;
- Development appraisal: feasibility; route; times and costs;
- Production appraisal: feasibility; route; times and costs;
- Legal: initial assessment from legal;
- Financial: payback period.

With a clearly defined set of objectives, the leader and team are more likely to reach the desired destination: a well-thought-out, carefully executed new product.

"Stage-gate systems provide an overview of the entire new product process for senior managers giving structure and a vocabulary for better management and control."

Finally, the outputs of each gate help to define the project and guide the project leader. One role of the gatekeepers is to review and approve the action plan at each gate. Here, senior managers provide suggestions and guidance to the project leader and help move the project forward.

Senior managers also benefit from the visible road map that gateways systems provide. Executives are often concerned about questions such as, "What's the status of Project X?" or "How many projects are coming into the launch phase in the next quarter?" Stage-gate systems provide an overview of the entire new product process for senior managers giving structure and a vocabulary for better management and control.

One Du Pont division that recently implemented a stage-gate model developed a computer tracking system for new product projects, based on the gates and stages of the model. Now an executive can review on a terminal where Project X stands, or which projects are approaching Gate 2 this month. Eventually, the system will include a complete history on each project, so instant information is available on any development project—including, for example, how the project was rated on various criteria at each of the previous gate reviews.

A TYPICAL STAGE-GATE SYSTEM

The system shown in Figure 2 is fairly generic, based on one used in a typical manufacturing firm. But it serves as a

sample or skeleton from which to develop a custom-tailored model. (Very similar stage-gate approaches have been implemented in a wide variety of industries, including chemicals, financial services, and consumer nondurables). The various stages and gates are described below.

Idea

The new product process is initiated by a new product idea, which is submitted to Gate 1, Initial Screen.

Gate 1: Initial Screen

Initial screening is the first decision to commit resources to the project: the project is born at this point. If the decision is Go, the project moves into the Preliminary Assessment stage. Thus Gate 1 signals a preliminary but tentative commitment to the project: a flickering green light.

Gate 1 is a "gentle" screen, and amounts to subjecting the project to a handful of key "must meet" and "should meet" criteria. These criteria deal with strategic alignment, project feasibility, magnitude of the opportunity, differential advantage, synergy with the firm's core business and resources, and market attractiveness. Financial criteria are not part of this first screen. A checklist for the "must meet" criteria and a scoring model (weighted rating scales) for the "should meet" criteria are used to help focus the discussion and rank projects in this early screen.

Stage 1: Preliminary Assessment

This first and inexpensive stage has the objective of determining the project's technical and marketplace merits. A preliminary market assessment is one facet of Stage 1 and involves a variety of relatively inexpensive activities: a library search, contacts with key users, focus groups, and even a quick concept test with a handful of potential users. The purpose is to determine market size, market potential, and likely market acceptance.

Concurrently, a preliminary technical assessment is carried out, involving a quick and preliminary in-house appraisal of the proposed product. The purpose is to assess development and manufacturing feasibility, and possible costs and times to execute.

Stage 1 thus provides for the gathering of both market and technical information—at low cost and in a short time, so the project can be reevaluated more thoroughly at Gate 2.

Gate 2: Second Screen

This gate is essentially a repeat of Gate 1: The project is reevaluated, but in the light of the new information obtained in Stage 1. If the decision is Go at this point, the project moves into a heavier spending stage.

At Gate 2, the project is again subjected to the original set of "must meet" and "should meet" criteria used at Gate 1. Here, additional "should meet" criteria are considered, dealing with sales force and customer reaction to the proposed product, the result of new data from Stage 1. Again, a checklist and a scoring model facilitate this gate decision. The financial return is assessed at Gate 2, but only by a quick and simple financial calculation (for example, the payback period).

Stage 2: Definition

This is the final stage prior to product development. It is the stage that must verify the attractiveness of the project prior to heavy spending. And it is the stage where the project must be clearly defined.

Here, market research studies are undertaken to determine the customer's needs, wants and preferences—that is, to help define the "winning" new product. Competitive analysis is also a part of this stage. Another market activity is concept testing, where the likely customer acceptance of the new product is determined.

At Stage 2, a detailed technical appraisal must focus on the "do-ability" of the project. That is, customer needs and "wish lists" must be translated into technically and economically feasible solutions. This might even involve some preliminary design or laboratory work, but it should not be construed as a full-fledged development project. An operations appraisal can be a part of Stage 2, where issues of manufacturability, costs to manufacture, and investment required are investigated. If appropriate, detailed legal/patent/copyright work is undertaken.

Finally, a detailed financial analysis is conducted as an input to Gate 3. This financial analysis typically involves a discounted cash flow approach, complete with sensitivity analysis.

Gate 3: Decision on Business Case

This is the final gate prior to the Development Stage, the last point at which the project can be killed before entering heavy spending. Once past Gate 3, financial commitments are substantial. In effect, Gate 3 means "go to a heavy spend."

The project is once again subjected to the set of "must meet" and "should meet" criteria used at Gate 2. Next, the qualitative side of this evaluation involves a review of each of the activities in Stage 2, checking that the activities were undertaken, the quality of execution was sound, and the results were positive. Finally, because a

heavy spending commitment is the result of a Go decision at Gate 3, the results of the financial analysis are an important part of this screen.

A second part of Gate 3 concerns definition of the project. At Gate 3, agreement must be reached on a number of key items before the project proceeds into the Development Stage. These items include target market definition; definition of the product concept, specification of a product positioning strategy, and delineation of the product benefits to be delivered; and agreement on essential and desired product features, attributes, and specifications.

Plans that chart the path forward—the development plan and the preliminary operations and marketing plans—are reviewed and approved at this gate.

Stage 3: Development

Stage 3 involves the development of the product and (concurrently) of detailed test, marketing, and operations plans. An updated financial analysis is prepared, and legal/patent/copyright issues are resolved.

Gate 4: Post-Development Review

The Post-Development Review is a check on the progress and the continued attractiveness of the product and project. Development work is reviewed and checked, ensuring that the work has been completed in a quality fashion. This gate revisits the economic question via a revised financial analysis based on new and more accurate data. The test or validation plans for the next stage are approved for immediate implementation, and the detailed marketing and operations plans are reviewed for probable future execution.

Stage 4: Validation

This stage tests the entire viability of the project: the product itself; the production process; customer acceptance; and the economics of the project. A number of activities are undertaken at Stage 4:

- In-house product tests: to check on product quality and product performance;
- User or field trials of the product: to verify that the product functions under actual use conditions, and also to gauge potential customers' reaction to the product;
- Trial or pilot production: to test and debug the production process, and to determine more precise production costs and rates;
- Pretest market, test market, or trial sell: to gauge customer reaction, measure the effectiveness of the launch plan, and determine expected market share and revenues;
- Revised financial analysis: to check on the continued economic viability of the project, based on new and more accurate revenue and cost data.

Gate 5: Pre-Commercialization Decision

This final gate opens the door to full commercialization. It is the final point at which the project can still be killed. This gate focuses on the quality of the activities at the Validation Stage and their results. Financial projections play a key role in the decision to move ahead. Finally, the operations and marketing plans are reviewed and approved for implementation in Stage 5.

Stage 5: Commercialization

This final stage involves implementation of both the marketing launch plan and the operations plan.

Post-Implementation Review

At some point following commercialization, the new product project must be terminated. The team is disbanded, and the product becomes a "regular product" in the firm's line. This is also the point where the project and product's performance is reviewed. The latest data on revenues, costs, expenditures, profits, and timing are compared to projections to gauge performance. Finally a post-audit—a critical assessment of the project's strengths and weaknesses, what we can learn from this project, and how we can do the next one better—is carried out. This review marks the end of the project.

Not all projects pass through every stage of the model. Usually there are at least two or three categories of projects—ranging from sales developments (small projects in response to a single customer request) to major projects involving heavy expenditures. Standard definitions of project types are developed and based on project scope and investment required. Appropriate routes are determined for each type of project. The routing for any project at the idea stage is decided in the first gate, Initial Screen. Projects that are "closer to home," hence less risky, are necessarily treated in a less rigorous fashion than "step out" projects, major projects with high risk.

The basic benefits of the stage-gate process are evident. The model puts discipline into a process that, in too many firms, is ad hoc and seriously deficient. The process is visible and relatively simple: what is required at each stage and gate is understood by all. The process provides a road map to facilitate the project, and it better defines the project leader's

objectives and tasks. Also, the process builds in evaluation stages to better rank projects and focus resources.

Parallel processing is a facet of stage-gate models, ensuring timely completion of projects. Moreover, stage-gate systems build in key activities and focus attention on often-deficient areas such as the predevelopment and market-oriented tasks. And finally, there is a quality focus to the process: a complete process with quality of execution.

Product innovation will always be a high-risk endeavor. The stage-gate system is merely a discipline that builds the success ingredients into the innovation process by design rather than by chance. The results are better decisions, more focus, fewer failures, and faster developments. ❐

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