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How Do You Win the Capital Allocation Game?

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To remain competitive, a company needs to align its capital budgeting system with its overall strategy.

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Which is better for your firm? Invest prodigious amounts of capital or scale back on capital investment? Reduce employment to raise the dollar amount of assets at work per employee or elevate employment to meet the demands created by new investments? Questions like these confront all senior managers as they formulate strategic plans and allocate capital. The questions become more compelling as investors demand that corporations consistently deliver shareholder value regardless of their long-term strategy for deploying human and financial capital.

An important factor that distinguishes the winners from the losers in creating share-holder value is the *quality* of investment decisions, which, in turn, depends on the soundness of a firm's capital budgeting system. Unfortunately, the history of corporate America is littered with examples of poor investment decisions, ranging from investing too little in positive NPV (net present value) projects and too much in negative NPV projects to investment myopia.[1] Such distortions can distract companies from what they do best, causing them to sink millions of dollars in the wrong products and ideas. For instance, Coca-Cola invested in pastas and wines, products for which its rates of return were not only well below those of its core soft-drinks business, but also below its cost of

Capital budgeting cannot be the exclusive domain of financial analysts and accountants.

capital. Such errors deplete shareholder value and lead to corporate control contests that result in CEO replacements and hostile takeovers.

Despite the obvious consequences of misallocating capital and human resources, why do companies continue to blunder? We believe it is because they have flawed capital budgeting systems, which they apparently fail to recognize. Some firms sense the weaknesses in their capital budgeting analyses but view them as individual problems rather than *systemic* deficiencies. They misdirect efforts to redress

mistakes and produce greater frustration. As a result, corporate strategy and capital allocation become misaligned and remain so despite disappointing financial performance. Senior management then gets the blame for failing to provide the appropriate leadership and strategic guidance.

Our goal is to present a framework that senior managers can use to allocate capital. The framework explicitly recognizes that capital budgeting cannot be the exclusive domain of financial analysts and accountants but is a multifunctional task that must be integrated with a firm's overall *strategy*. Our capital budgeting framework has six key features, each indispensable *(see Figure 1):*

• It is *dynamic*, not static. It explicitly recognizes that the quality of information can be improved over time. Thus capital budgeting should be a sequential,

Figure 1
What Is the Impact of Features Missing from the Capital Budgeting System?

Dynamic	Strategy	Options	Cross-Functional	Compensation	Training	=	
Dynamic	Strategy	Options	Cross-Functional	Compensation	Training	=	Success
	Strategy	Options	Cross-Functional	Compensation	Training	=	Biases investment choice against even value-enhancing projects with considerable uncertain information, e.g., new products
Dynamic		Options	Cross-Functional	Compensation	Training	=	Misestimation of cash flows and misallocation of resources
Dynamic	Strategy		Cross-Functional	Compensation	Training	=	Biases investment choice against even value-enhancing projects with high risk
Dynamic	Strategy	Options		Compensation	Training	=	Degrades quality of information inputs in capital budgeting
Dynamic	Strategy	Options	Cross-Functional		Training	=	Leads to gaming behavior and selection of negative NPV projects that maximize compensation
Dynamic	Strategy	Options	Cross-Functional	Compensation		=	Poor execution, including analytical errors, bad assumptions, and nonuniform analyses

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multiple decision process that integrates the information needed to obtain cash flow estimates into the financial analysis of the cash flows.

- It is integral to the company's *strategy*. Thus, while its conceptual underpinnings remain the same across companies (e.g., using NPV analysis), its details can vary greatly because it is tailored to the needs of a firm's strategy.
- It recognizes the *options* inherent in value-enhancing capital budgeting. Most capital investments present a company with a sequence of options, which, when explicitly analyzed in capital budgeting, lead to a fundamentally different view of *risk*.[2]
- It takes a *cross-functional* approach. The quality of estimates of expected cash flows and the uncertainty in cash flows are critical. Since the underlying information for these estimates comes from many functions within the company, those providing information must see themselves as strategic partners in the process, i.e., they must fully understand the consequences of their input.
- It views the company's *compensation system* as a centerpiece of capital budgeting. Unless the way in which managers and employees are rewarded is aligned with how capital is allocated, there will always be a possibility for poor decisions.
- It stresses the importance of *performance-based training*.[3] The people using capital budgeting must understand it, buy into it, and implement it *consistently* across the entire company. Cross-functional training designed to enhance the performance of those involved is essential.

Common Drawbacks of Capital Budgeting Systems

Although there are countless ways in which capital budgeting systems can be flawed, in our experience, the most common drawbacks fall into one of nine categories.

1. Misalignment between Strategy and Capital Budgeting

Most companies have a well-articulated vision statement or corporate goal, followed by a description of the strategy for attaining that goal. The design of the capital budgeting system, however, is often not integrated into the strategy. For example, a company's corporate strategy may be to grow aggressively through new product introductions, yet its capital budgeting practice may attach great importance to

potential revenue losses when new products cannibalize old.

2. Lack of Dynamic Structure

A good capital budgeting system must involve not only an analysis of capital allocation requests when the project is executed, but also an analysis of all the capital needed to generate information (e.g., market research, prototype development, testing, and so on) prior to investing in the project. Moreover, the analyses of two capital requirements should be integrated within a dynamic system that takes into account the options inherent in most capital budgeting opportunities. Many firms lack such a well-developed system. We illustrate two (of the potentially many) kinds of problems this creates, using hypothetical companies, *Sundial Electronics* and *Excellent Manufacturing (see the sidebars)*.

The example of Sundial Electronics highlights the problems associated with the common practice of "front loading" cash outlays for a new project. One problem, in particular, is the propensity to incur some engineering and tooling expenses early, when they should be incurred *after* project launch. When a company finally evaluates a project just before its execution, it considers these initial outlays "sunk costs" that are irrelevant to the decision to accept the project. In this way, more capital is committed to the project than is accounted for in the capital budgeting analysis. A dynamic capital budgeting system serves the purpose of justifying *all* capital outlays when they are, in fact, still relevant.

The case of Excellent Manufacturing demonstrates that the anticipation of *future* investment options can alter the value of *present* investment options. The option to acquire information about project costs increases the value of the option to acquire information about market demand. Thus these options are interrelated.[4] In the example, if Excellent decides to launch production at full capacity at the outset, then it should spend only a moderate amount on market research. But a greater expenditure on market research is optimal if Excellent recognizes that it can better exploit the option to acquire information about production costs by *sequentially* committing to expanded production and thereby linking the decision to continue or abandon the project to what it learns about costs. Many companies don't have dynamic capital budgeting systems that consider market research and product development outlays as

What a company should use to determine compensation are flow measures that it can compute periodically.

investments in options and don't *integrate* determining the amount to spend on these activities to their overall capital budgeting systems.

3. No Connection between Compensation and Financial Measures

Many companies use the NPV criterion to select a project but compensate managers based on product earnings or rates of return.[5] This misaligns their interests with those of shareholders *(see the sidebar on Multiproduct Corp.).*

One reason for misalignment between compensation and capital allocation systems is that the NPV cannot be readily used to determine compensation because it is a stock measure. Moreover, NPV is a summary measure based on projected cash flows and not realized performance. What a company should use to determine compensation are flow measures that it can compute periodically, say, every quarter or every year, as they are realized. Some companies use flow measures such as earnings and cash flow; unfortu-

nately, they can shift managers' behavior away from shareholders' interests. A flow measure such as EVA (economic value added) can be helpful, because it theoretically produces the same recommendations as the NPV.[6]

4. Deficiencies in Analytical Techniques

Many companies use flawed analytical techniques in their capital budgeting. The most common deficiencies are:

Poor Base-Case Identification. For any capital budgeting analysis, a company needs to know the base case that defines the status quo NPV, i.e., what happens if the company keeps things the way they currently are. The company then computes the NPV from the proposed alternative and asks which alternative dominates. The worse the base case looks, the better any alternative appears; this sometimes tempts financial analysts to make the base case look terrible so their "pet" project seems irresistible.

Competition and Cannibalization Issues. A company should estimate the likelihood of competition using game theory and probabilistic scenarios and determine a probability distribution for the competitive entry, along with its impact on project cash flows.[7] The company should then integrate this information into its capital budgeting. Cannibalization estimates

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Sundial Electronics

Sundial Electronics has two different approval processes, one for expense budgets and another for capital budgets. It recently approved the development of a new electronics product to be used as a component in TVs. The company estimated the capital required to purchase land, build a plant, and acquire equipment and working capital at $50 million. It tentatively approved this $50 million as part of the capital budgeting process, pending the outcome of market research and other studies before the product launch decision. It set aside another $5 million for conducting market research with TV manufacturers, dealers, and end users to get information for refining product design and for the tooling, equipment, and labor needed to develop prototypes. The company approved the $5 million as part of its expense budget. At the time the product launch was approved, Sundial estimated the present value (PV) of cash

flows from the project at $60 million and the net present value (NPV) at $60 - $50 - $5 = $5 million, considering all outlays. (For simplicity, we are ignoring the differences in the timings of these cash outflows.)

During the market research and prototype development phase, the manager responsible for developing and launching the product discovered that customers' quality expectations were higher than the company had initially thought. Consequently, the company needed to do additional market research and more costly prototype development. Instead of $5 million, it would need $7 million. Although this amount was higher than expected, it would sell the product at a higher price as well, and it revised the PV of cash flows to $61 million. Moreover, the manager argued that the company had already invested six months of its time and millions of dollars in the product, so continuing was the best approach.

The expense budget committee approved the $2 million increase. Two months later, it received a request for another $5 million, based on cost overruns, that it approved as well. Eventually, when it was time to decide whether to invest the $50 million, the capital budget committee got a request that gave the project NPV as $11 million, based on a PV of cash flows of $61 million and an investment of $50 million; the company viewed (correctly) the $12 million approved by the expense budget committee and spent earlier as a sunk cost from the standpoint of whether or not to invest in the project.

It is interesting to speculate about the extent to which the manager of the new product may have intentionally understated the market research and prototype development expenses or shifted postproduct launch outlays to the preproduct launch phase in anticipation of the outlays being treated as sunk when the company had to approve the capital appropriations request.

Excellent Manufacturing

Excellent Manufacturing Company is considering a new product introduction that calls for an investment of $8 million. The company faces uncertainty about future revenues and costs. Expected future revenues will be $2 million per year if product demand is high, $1.25 million per year if demand is medium, and $0.5 million per year if demand is low. Each of the three demand scenarios is equally likely, i.e., the probability is one-third that demand will be high, one-third that it will be medium, and one-third that it will be low. There are two possible cost scenarios that depend on, say, material prices and maintenance costs: with probability of one-half, the cost will be $0.3 million per year (low), and with probability one-half, it will be $0.8 million per year (high).

Low costs could be realized if, say, material costs are low and machine breakdowns are infrequent, while costs could be higher if material prices increase and the machinery needs frequent maintenance.

All costs and revenues are perpetual and after tax, and the cost of capital is 10 percent. (The discount rate used for the costs could be lower since cost estimates may be subject to less risk than revenue estimates.)

Excellent Manufacturing has to decide whether to spend money on market research to find out the level of demand. If it spends nothing, it will not know which demand scenario to anticipate and will view its expected revenue as the average of the three scenarios or {1/3 × $2 million + 1/3 × $1.25 million + 1/3 × $0.5 million} = $1.25 million per year. If it spends $1 million on market research, it will be able to distinguish between low and high demand, but the imprecise information will not enable it to distinguish medium demand from the other two. It is equally likely that Excellent could mistake medium demand for low or high demand. If the company spends an additional $200,000 on market research ($1.2 million total), it will be able to pinpoint demand precisely. (Assume these investments in

market research are after-tax.) What should Excellent Manufacturing do?

First suppose that the company decides to invest nothing in market research. It assesses an average expected revenue of $1.25 million per year and an average expected cost of 1/2 × $0.3 million + 1/2 × $0.8 million = $0.55 million per year. The present value of these perpetual cash flows is thus [$1.25 - $0.55]/0.1 = $7 million. Since the required investment is $8 million, the NPV is -$1 million; Excellent Manufacturing will therefore decide *not* to invest.

What if Excellent spends $1 million on market research? In the low-demand situation, it will not invest, because the NPV is negative regardless of whether the demand is true low or medium. If, after research, the company sees that demand is high, it could be true high or medium. If it is true high demand, the NPV is {[$2 - $0.55]/0.1} - $8 = $6.5 million. If it is true

Sidebar continued on next page…

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do not involve game theory but do require probabilistic estimates that are woven into the capital budgeting. Moreover, the NPV-relevant impact of cannibalization is predicated on the assumptions about the competitive entry, an important interrelationship that companies often erroneously ignore. The example of *Innovative Product Co.* shows the importance of recognizing the interdependence between the competitive entry and cannibalization assumptions *(see the sidebar)*.

Inadequate Treatment of Risk. There are two main types of risk in capital budgeting: (1) the business and financial risk in cash flows that is reflected in the cost of capital (discount rate), and (2) the risk in estimating expected cash flows. We can think of the first risk as arising from the distribution of cash flows around a known statistical mean. For example, in the context of the capital asset pricing model (CAPM), such a distribution implies a particular relationship with the return on the market portfolio, which, in turn, helps determine the cost of capital. The second risk arises from the analyst's lack of knowledge of the statistical mean of the cash flow distribution, or uncertain information. Failure to assess *both* risks in capital budgeting may produce a misleading picture

of the project's riskiness. Ignoring the second risk often leads firms to work with point estimates of financial measures like IRR (internal rate of return), NPV, and yearly EVAs. Occasionally, companies develop low-, medium-, and high-risk scenarios to characterize possible future project outcomes. These overly simplistic characterizations are often inadequate for well-informed decision making. Many companies are, however, increasing the sophistication of their risk assessment. For example, Merck has developed a sophisticated capital budgeting system that deals with both types of risk.[8] Whirlpool has also recently moved away from discrete characterizations of risk to ranges of outcomes and probability distributions, something that we recommend.[9]

Nonuniform Assumptions. Many multidivisional companies contend with unwanted variety in the assumptions that their financial analysts use in capital budgeting. Assumptions about residual values, rates of growth in cash flows, inflation rates, cycle times, the amounts of capital required, and so on may not be uniform.[10] With different assumptions in different capital allocation requests, senior managers are compelled to compare apples and oranges in ranking projects for capital allocation.

…continued
Excellent Manufacturing

medium, the NPV is {[$1.25 - $0.55]/0.1} - $8 = -$1 million. Before spending $1 million on market research, the company assesses the probability of true high demand as one-third and the probability of true medium demand with high demand as one-sixth. Thus, given that the company will not invest in the low-demand situation, the overall NPV is 1/3 × $6.5 + 1/6 × (-$1) = $2 million, and the NPV is $1 million, after deducting the money spent on market research.

If Excellent spends $1.2 million on market research, it can estimate demand precisely and thus avoid investing in both low- and medium-demand situations. Its NPV will be 1/3 × $6.5 - $1.2 = $0.967 million, which is less than the $1 million NPV from spending $1 million on market research. Excellent Manufacturing therefore prefers to spend $1 million on market research; the additional cost of obtaining information about medium demand is not worthwhile in light of the benefit. Thus the value of investing in information to learn about market demand is $1 million — the difference between the expected NPV from investing $1 million in market research and the NPV(= 0) from not investing in the project.

Excellent views outlays on R&D, market research, and so on as the prices of *options*. Investing $1 million in market research enables Excellent to avoid investing when the research reveals the demand to be low. It would erroneously reject the new product if it ignored the option nature of its market research outlay.

The *interaction* of various options is another aspect of dynamic capital budgeting. Suppose that investing $4 million, half the required amount, would enable Excellent to learn about cost. It could find out whether machine breakdowns were frequent with small test-production runs and also determine the amount of materials needed. If, after learning about cost, it decides that it does not want to invest, it can liquidate its investment at $3.5 million; it would lose $500,000 and avoid further investment.

Suppose Excellent ignores the option of investing in market research. It has already calculated the expected NPV of investing in the project if it also ignores the option to find the cost. This is -$1 million. What is the expected NPV if the company exercises the option to find the cost? Since it hasn't invested in market research, the *expected* revenue is $1.25 million per year. If it invests $4 million initially and learns that the cost is low, then the NPV = {[$1.25 - $0.3]/0.1} - $8 = $1.5 million and it will invest in the project. If it invests $4 million and learns that the cost is high, then the NPV of investing in the project is {[$1.25 - $0.8]/0.1} - $8 = -$3.5 million, which is less than the NPV of *not* investing in the project and liquidating the $4 million, which is -$0.5 million. Thus the *expected* NPV (prior to investing in learning about cost) with the option to find the cost equals 1/2 × $1.5 + 1/2 × -$0.5 = $0.5 million, which is also the value of the option to learn about cost. Having computed the value of each option separately, Excellent now examines their value together to show that value-additivity does *not* hold in this setting.

Now suppose that Excellent spends $1 million on market research and learns that demand is high. It knows that demand is $2 million per year with probability two-thirds and $1.25 million per year with probability one-third. That is, expected demand is $1.75 million per year. Even if the cost is high, the NPV is {[$1.75 -$0.8]/0.1} - $8 = $1.5 million. Thus the

company will invest the full $8 million in anticipation of high demand. If it perceives low demand, it will not invest. Consequently, the NPV of spending $1 million on market research and then investing is the same as before — $1 million, which is also the value of the two options (to learn about market demand and to learn about cost) added together when each option is treated separately. This value is *not* $1 million (value of learning about market demand) + $0.5 million (value of learning about cost); that is double-counting.

What if the company spends $1.2 million? In the medium-demand situation, if the company invests $4 million and the cost is low, the NPV is [{1.25 - $0.3}/0.1] - $8 = $1.5 million, so Excellent will invest the entire $8 million. But if the cost of materials is high, the NPV is [{1.25 - $0.8}/0.1] - $8 = -$3.5 million, so it is better for Excellent to cut its losses by liquidating the initial $4 million investment and losing only $500,000. Thus the overall NPV in the medium-demand situation is 0.5 × $1.5 million + 0.5 [-$0.5 million] = $0.5 million.

To summarize, if Excellent spends $1.2 million on market research, the NPV is $6.5 million if the product is in high demand, $0.5 million if in medium demand, and 0 if low demand. The overall expected NPV is 1/3 × $6.5 + 1/3 × $0.5 + 1/3 × 0 - $1.2 = $2.33 - $1.2 = $1.13 million. Thus Excellent Manufacturing prefers to spend $1.2 million on market research, rather than $1 million (NPV = $1 million). It would have set the wrong market research budget had it ignored the sequential investment option embedded in its $8 million capital investment. Moreover, value-additivity does not hold here. When the two options are independent, their total value is $1 million, but when their interdependency is correctly recognized, their total value is $1.13 million.

5. Finance Function Not a Strategic Partner

Financial analysts doing capital budgeting are sometimes seen more as traffic cops than strategic partners. They often enter the capital budgeting process near the end merely to rubber-stamp a conclusion that a marketing or manufacturing executive reached earlier. In other companies, financial analysts may be involved early on, but if the numbers they come up with are not "satisfactory," they get the capital budgeting proposal back with the admonition, "Get the IRR up to 25 percent or else we can't approve this request." This invites massaging of the numbers. Capital budgeting then becomes an exercise in finding the values that produce the desired answer, and, consequently, the quality of the information for capital budgeting is seriously compromised.[11]

Multiproduct Corp.

Multiproduct Corp. must choose one of three projects. It can invest $50 million to improve an existing product, $110 million to introduce an extension of an existing product line, or $240 million to introduce a completely new product. Improving the existing product would generate incremental net operating profits after-tax (NOPAT) of $50 million in one year and $40 million in two years, after which the company terminates the project. Introducing the product-line extension would generate incremental NOPATs (adjusting for possible cannibalization of the sales of existing products) of $45 million the first year, $70 million the second year, and $70 million the third year, and then the project is ended. The new product would generate incremental NOPATs (after adjusting for cannibalization) of $55 million the first year, $75 million the second year, $80 million the third year, and again the project is terminated.

Which project would a manager select if his or her compensation is tied to the rate of return of the project, to product earnings (NOPAT), or to EVA? Assume that the capital cost is 10 percent and that capital levels are maintained at their original levels throughout the life of each project. That is, new capital investment in any year equals depreciation. Moreover, assume that the capital is sold at its book value in the last year of each project's life. As a consequence, free cash flow will be equal to NOPAT in each year except for the last year when the capital is recovered.

The product earnings (NOPATs), free cash flows, IRRs and NPVs are:

Project	NOPAT in Millions	Free Cash Flows in Millions	IRR	NPV in Millions
Improving existing product	$50, $40	$50, $90	93%	$69.83
Product-line extension	$45, $70, $70	$45, $70, $180	53%	$124
New product	$55, $75, $80	$55, $75, $320	28%	$112.4

Clearly, the product-line extension project is the best choice for Multiproduct's shareholders. However, a compensation or capital allocation scheme based on IRR would lead the manager to propose improving the existing product. If the company compensates the manager based on product earnings, he or she will prefer to introduce the new product. But, if the company uses EVA to compensate managers, Multiproduct will choose the correct project where (EVA = NOPAT - (capital employed at beginning of period × cost of capital):

Project	EVA in millions	NPV=PV of EVAs in millions
Improving existing product	$45, $35	$69.83
Product-line extension	$34, $59, $59	$124
New product	$31, $51, $56	$112.4

Innovative Product Co.

Innovative Product Co. is thinking of introducing a new product that requires an investment of $6 million and is expected to produce a perpetual after-tax cash flow of $1 million per year. However, the company also expects that the new product will cannibalize its existing product line to the extent of $500,000 in after-tax cash flows per year perpetually. There is also a 0.8 probability that a competitor will enter with a new product. If this happens, Innovative Product's existing product line will suffer an after-tax cash flow decline of $600,000 per year regardless of whether it introduces its new product or not, and the new product will suffer an after-tax cash flow decline of $100,000 per year. Should Innovative Product introduce the new product? Its weighted average cost of capital is 10 percent.

First suppose that Innovative takes into account the cannibalization impact of the new product introduction but ignores the competitive entry. Then, the NPV of introducing the new product is:

$$\frac{\$1}{0.10} - \frac{\$0.5}{0.10} - \$6 = -\$1 \text{ million},$$

and Innovative would forgo the new product.

Now suppose that Innovative also accounts for the impact of competition. Then, the NPV of introducing the new product is:

$$\frac{\$1 - \$0.1}{0.10} - \$6 = \$3 \text{ million},$$

where the company has not charged the new product for cannibalizing the existing product line because the competitor's new product has an impact on the existing product. If the competitor does not enter, the NPV of the new product is -$1 million (calculated earlier). Thus the expected NPV of the new product is:

$$(0.8 \times \$3) - (0.2 \times \$1) = \$2.2 \text{ million}.$$

This means that considering cannibalization and competitive entry simultaneously changes the decision.

6. Lack of Integration

In many firms, capital budgeting and expense budgeting are distinct processes. For example, the companies that do capital budgeting make assumptions about future cash flows that are dependent on certain advertising and sales promotion outlays. However, these outlays are typically covered by the expense budget. Even in companies in which the determination of the expense requests is tied at the outset to the capital requests, the people approving the two requests do not necessarily try to ensure consistency between the two budgets. And, even when consistency is achieved at the outset, a meltdown occurs later when pressure to produce short-term financial results causes cutbacks in expense budgets, resulting in two negative consequences. First, the cash flows promised in earlier-

approved capital requests fail to materialize because of reductions in key expenses. Second, the poorer-than-promised financial results lead to skepticism about promises in future capital requests and threaten to choke off capital to future positive NPV projects.[12]

7. Confusing Financial Measures

Many capital budgeting systems suffer from a multiplicity of financial measures, some of which produce conflicting recommendations in project ranking. For example, companies often calculate the NPVs, IRRs, and payback periods for the projects they analyze. In recognition of the obvious conflicts between the rankings produced by the different measures, companies sometimes develop a "point rating" system in which they assign each financial measure a relative weight and then rank projects based on their overall scores. The weighting scheme in such systems is arbitrary and often leads to decisions that do not maximize values.

8. Poorly Trained Financial Analysts

Even the most sophisticated capital budgeting system will fail if those executing it are not trained to use the available tools. Many companies have great enthusiasm for new ideas and techniques (e.g., EVA) but none for employee training. When resources are constrained, often the easiest expenditure to cut is training. This is an expense-budget problem, since training outlays are typically (incorrectly, in our opinion) treated as expenses rather than investments. However, without the necessary investment in upgrading those involved in capital budgeting, expecting good capital allocation is akin to expecting to win a battle by sending in people unfamiliar with guns.

9. Inadequate Post-Audits

Post-auditing the capital budgeting process is the examination of previous investments, comparing them to projections contained in the capital request, and documenting the causes of the observed deviations. When this process works well, it is an invaluable learning device, facilitating continuous improvement. It also prompts a review of the base-case assumptions, thereby stimulating a reassessment of the competition. However, many companies misun-

derstand the post-audit process and either don't use it or misuse it. The process ends up being a policing device, creating suspicion and mistrust.

Framework for Dynamic Capital Budgeting

The framework for capital budgeting that we propose has the familiar objective of maximizing shareholder wealth. To meet this objective, we designed a system with three simultaneous steps:

• Map out the *strategy* of the firm. The capital budgeting system is a plan to execute the strategy.
• Develop an *evaluation system* for project proposals. The goal of evaluation is to separate winners from losers; the effectiveness with which a chosen project helps execute the strategy is the measure of success.
• Develop a *culture* within the firm that is consistent with the strategy and the evaluation system.

Strategy and Capital Budgeting

A company must first identify a status quo strategy and its performance to maximize shareholder value. It must ask what kinds of investments have enabled the strategy to be successful. The company can then understand the effective parts of the strategy and the amount of risk within which it must operate.

The strategy also helps define a fundamental trade-off in capital budgeting between *cycle time* and *risk*. The more time and resources that a firm is willing to commit to collecting information about project cash flows, the more it can learn about the cash flows and the lower the informational risk. But it achieves this risk reduction at the expense of a longer cycle time (*see Figure 2*, in which ABCD represents the cycle time–risk-efficiency frontier for a new and risky product initiative). It is impossible for a company to lie below the frontier, given existing human capital, organization structure, and technology. For any point off the frontier, say, point E, there is another point on the frontier that the firm would prefer. For example, point B represents a shorter cycle time with the same level of risk as point E, and point C represents a lower level of risk with the same cycle time as E. Depending on the cycle time–risk trade-off that the firm desires, it would prefer either point B or C to point E.

A company should view the frontier as a given, at least as a starting point. Where along the frontier it

wants to be is a matter of strategic choice. A firm that is more tolerant of informational risk may prefer to be at point B, whereas one that is less tolerant of informational risk may prefer C. If these two firms have the same risk-efficiency frontier, then the firm that chooses B will be more error-prone in identifying customer tastes, estimating market demand, and so on, but when it is right, it will have a competitive first-mover advantage over the firm that prefers point C. This is an important aspect of time-based competition. A firm with shorter cycle times has a competitive edge, but it is also assuming more risk because the quality of the information on which its capital budgeting is based is not as good as that of a firm willing to tolerate longer cycle times. For example, some claim that Japanese companies prefer shorter cycle times (and greater risk) than U.S. companies when introducing new products.[13] Of course, a firm need not consider the frontier as a given, but could try to push the frontier down to, say, A'D'. This usually requires a fundamental reengineering, which, if achieved, can be a powerful competitive advantage.

Firms that perceive different frontiers may also make different decisions about product introductions. Suppose two firms both view R as the acceptable level of risk. The firm on the risk-efficiency frontier ABCD would see its cycle time as T_2, whereas the one on the frontier A'D' would view it as T_1. The
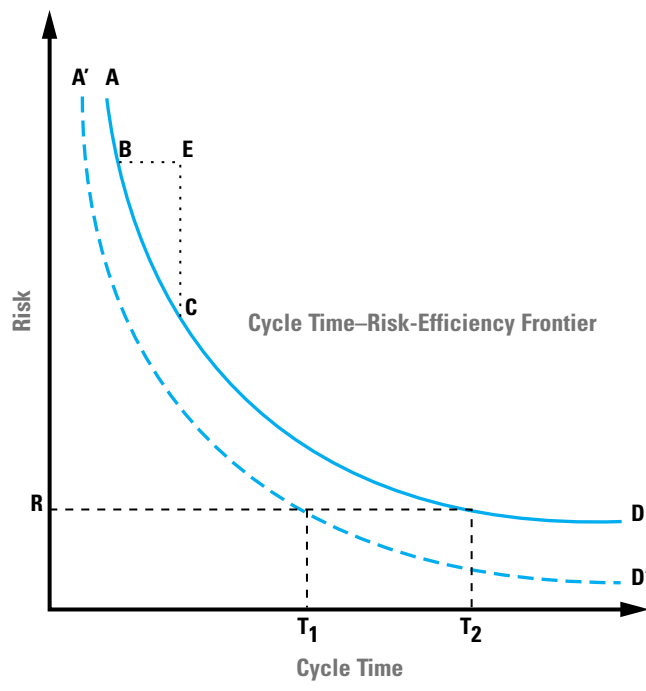
firm with the shorter cycle time would spend less money before product launch and bring the product to market faster; thus it would assess a higher NPV from this product than its slower competitor. The NPV might be positive for the faster firm and negative for the slower firm, so that one firm would reject the product and the other would introduce it. An example of this is the flat screen that Westinghouse patented but never commercially produced. The Japanese powerhouse Sharp bought the early patents and successfully marketed the product not only for computer monitors but also for flat-screen, high-resolution TVs.[14]

Whatever the risk-efficiency frontier, the company's strategy determines the point along that frontier where the company wants to be. The company should communicate the implications of this strategic choice to the people responsible for capital budgeting. Just as importantly, those who screen capital requests and allocate capital should ensure that the criteria they use are consistent with the company's strategic choice. Breakdowns occur when a company's strategy is decoupled from its project-ranking criteria.

For example, the strategy may be to grow aggressively through global expansion in developing markets, yet a key capital budgeting criterion may be to discriminate against projects with payback periods longer than three years. Alternatively, the strategy may be to introduce a new product every year, yet the demands on the quality of market research data used to support assumptions about sales volume may be so great that it is impossible to achieve the cycle time–risk trade-off consistent with the strategy. It's no wonder that some innovative customer-focused companies like Compaq, Motorola, and Steelcase are shortening cycle times for new product introductions by *reducing* their dependence on market research data.[15]
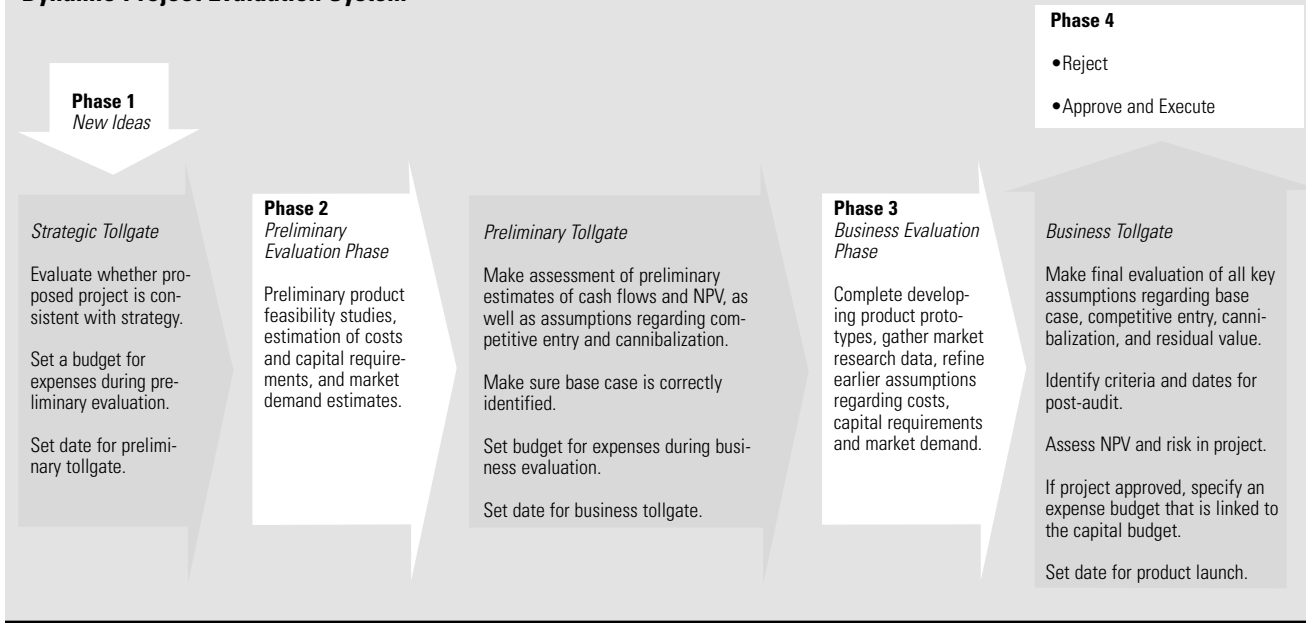
Evaluation System

The system for evaluating projects and preparing capital allocation requests must be consistent with the strategy and reflect the role of financial analysts as strategic partners. It must be a dynamic system with well-defined checkpoints for examining the consistency of projects with strategy *(see Figure 3)*. Many companies have adopted (or are adopting) such multiphase evaluation processes for major capital investments, for example, Merck, Shell, United Technologies, Boeing, and Whirlpool.

Figure 2
Trade-Off between Cycle Time and Risk

Cycle Time–Risk-Efficiency Frontier

Risk

Cycle Time

Figure 3
Dynamic Project Evaluation System

Phase 1
New Ideas

Phase 4
- Reject
- Approve and Execute

Strategic Tollgate

Evaluate whether proposed project is consistent with strategy.

Set a budget for expenses during preliminary evaluation.

Set date for preliminary tollgate.

Phase 2
Preliminary Evaluation Phase

Preliminary product feasibility studies, estimation of costs and capital requirements, and market demand estimates.

Preliminary Tollgate

Make assessment of preliminary estimates of cash flows and NPV, as well as assumptions regarding competitive entry and cannibalization.

Make sure base case is correctly identified.

Set budget for expenses during business evaluation.

Set date for business tollgate.

Phase 3
Business Evaluation Phase

Complete developing product prototypes, gather market research data, refine earlier assumptions regarding costs, capital requirements and market demand.

Business Tollgate

Make final evaluation of all key assumptions regarding base case, competitive entry, cannibalization, and residual value.

Identify criteria and dates for post-audit.

Assess NPV and risk in project.

If project approved, specify an expense budget that is linked to the capital budget.

Set date for product launch.

The system has four phases and three tollgates. For approval, a project must pass through all three tollgates, with a review at each gate. In the first phase, the company generates new ideas. This is a multifunctional process; many firms have formally charged advanced product-concept groups with this task. The company screens ideas at the strategic tollgate for consistency with its strategy. Thus the company should present ideas as proposals that outline consistency with the strategy and enhancement of shareholder value. Moreover, the company must determine a budget for expenses that it will incur during preliminary evaluation and set a date for the next review. This ensures consistency of the cycle time between the strategic and preliminary tollgates and the strategy.

During preliminary evaluation, the company should shape the idea into practical reality and obtain preliminary estimates of costs and capital requirements. It should formulate explicit assumptions regarding product demand. Also, it should clearly identify the base case and crystallize assumptions about the competition and cannibalization. This should lead to preliminary estimates of cash flows and NPV and the need for additional information. This, in turn, will help determine the expense budget and the duration of the next phase, business evaluation.

The expense budget for the business evaluation phase includes the amounts allocated for information acquisition and product development. The company should

see the amount allocated for acquiring information as the cost of purchasing an option. Thus the analysis of how much to invest in information acquisition during this phase could exploit the insights of option pricing theory. In particular, the greater the informational risk in the project, the more the company should be willing to invest in information acquisition, since options on riskier securities are more valuable.

If the company decides against committing further resources to the project at the preliminary tollgate, it should terminate the project. If the company decides to go through business evaluation, then the expense budget committed to this phase and its duration should be consistent with the cycle time–risk trade-off implied by the firm's strategy.

The company should do the bulk of its information gathering during business evaluation. It should complete product specifications, develop and test prototypes, conduct market research, and refine all the earlier assumptions regarding costs and capital requirements. The purpose of this phase is to implement the information-acquisition strategy developed during the preliminary phase and approved at the preliminary tollgate. Information gathering during business evaluation is a multifunctional task. The financial analyst, working as a strategic partner with others from manufacturing, technology, and marketing, should elicit information to accurately estimate future cash flows but also assess risk. If the information from manufac-

turing, technology, and marketing managers is in the form of point estimates, for example, how can the financial analyst obtain ranges and probabilities of possible future outcomes? Thus the method for eliciting information is critically important. Moreover, the analyst must be trained to judge the quality of the information, so he or she can quantify informational uncertainty in assessing project risk.

A benefit of a dynamic capital budgeting system is the opportunity for learning.

During business evaluation, the financial analyst should also revisit the assumptions made earlier about the base case, since base-case cash flow estimates may change over time. The analysts should refine probabilistic estimates of competitive entry and its impact on cash flows and evaluate the overall joint impact of cannibalization and competition. The analyst should determine the variables to review in the first post-audit and its scheduled date.

The capital allocation request should stipulate the expense levels in each year of the project's life that will support the cash flow assumptions. There should be a link between the capital invested in a given year and the expense budget for that year to ensure that the two remain temporally and strategically aligned.

The analyst should prepare a brief summary of the key value drivers and financial performance measures for the project. The performance measures could include the project's NPV and the EVA for each year of the project's life. Moreover, the risk analysis could include probability distributions of the NPV and each year's EVA.

Ranking Projects. A company can use probability distributions of project financials to rank projects if it is rationing capital. Some companies use an NPV distribution–strategy grid analysis to rank projects *(see Figure 4)*. The grid shows the range of NPVs for each of a company's proposed projects within each major strategy grid. Each vertical line represents the range of NPVs for that project. The company can choose projects based on each project's contribution to the overall risk of the project portfolio (the range of possible NPVs for the project is useful) and allocate the amount of capital to each strategy based on the company's overall strategy. Thus, in the grid, if all four

strategies are equally important, senior managers should ask why there are only two projects proposed in strategy III. Perhaps the people proposing projects under this strategy are playing it too safe. Moreover, since each strategy, other than III, contains projects with NPVs that *could* be negative, how many the company funds depends on the overall portfolio risk that it wants to take. This kind of analysis is integral to capital budgeting.

A benefit of a dynamic capital budgeting system is the opportunity for learning. The financial analysis of future projects is aided by feedback from previous projects. As one project proceeds through the capital budgeting process, a firm can ask:
1. How reliable was the information generated by earlier market research?
2. Did the quality of this information justify its cost?
3. What fraction of the total cycle time was consumed by market research and what fraction by product development?

One way to assess the value of risk reduction *ex post* is to calculate the project's NPV, say, at the business tollgate, including the previous expenditures or the costs that the company now considers sunk. Although a company should never use a project's NPV, including sunk costs, to accept or reject a project at the business tollgate, it can use it for accountability and learning. In particular, the company can monitor and curb analysts' propensity to front-load project outlays so as to treat them as sunk costs at the business tollgate (as in the Sundial Electronics example). Moreover, if the NPV with sunk costs is negative and the NPV without sunk costs is positive, the company

Figure 4
Grid for Determining Project Rankings
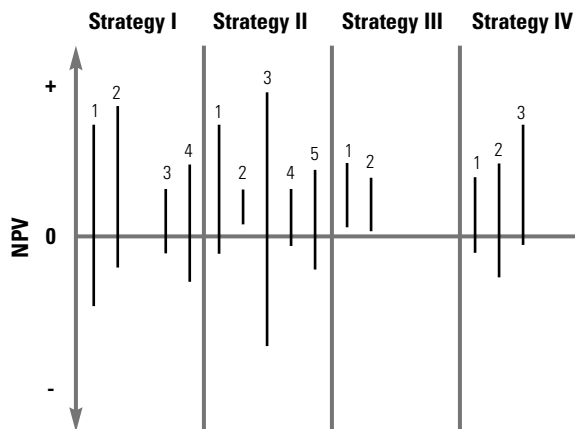
would accept the project but conclude that the risk-reduction and product development outlays were excessive. Such information would be valuable for future projects.

Culture

Although companies often ignore these three cultural aspects, they are crucial to the success of capital budgeting in implementing the chosen strategy:

Commitment. A company's culture should be consistent with both the chosen strategy and the proposed evaluation system. In some companies, employees perceive no long-term commitment to strategy. Various aspects of the strategy are viewed as "programs of the month," which impedes implementation.

Training. Essential to effective capital budgeting is employee training. Financial analysts and people from other functional areas should learn the system's conceptual underpinnings and details, so that they understand its pivotal role in implementing strategy. The company should design the training to improve the performance of those involved in capital budgeting. Moreover, training should be a strategic instrument for eliciting information from financial analysts and line managers that could help refine the evaluation process. In particular, it should provide an opportunity to find the organizational impediments to executing strategy. In this regard, training can be a direct instrument for organizational change. The company should capitalize and amortize training outlays rather than view them as expenses.

Compensation. Compensation is central to aligning the incentives of people involved in capital budgeting with shareholders' incentives. Thus it is imperative to develop a compensation system in which bonuses are tied to performance measures that correlate highly with shareholder wealth. Many companies, such as Coca-Cola, AT&T, CSX, and Briggs & Stratton, have recently adopted compensation systems based on EVA. In a capital budgeting context, this system is equivalent to basing them on NPV, because EVA is the flow equivalent of the stock measure NPV. Thus, by tying compensation to EVA, management provides wage incentives that are aligned with maximizing NPV.

However, not all companies that tie compensation to EVA recognize that the desired behavioral change requires more than just asking financial analysts to calculate EVA in addition to other financial measures. Quite often, a fundamental overhaul of the entire capital budgeting system is required, as Whirlpool, Eli Lilly, and R.R. Donnelley have recognized.

Putting It All to Work

Capital allocation, as one key to developing competitive advantage, should be carefully aligned with a company's strategy. Companies can no longer compete only along product dimensions. Rather, they compete with all firms in the global community. A company with an effective capital budgeting system invests capital more effectively, finds it easier to raise additional capital, invests in R&D and product innovation, and grows. Developing such a system requires careful integration of corporate strategy, a dynamic project evaluation system, and corporate culture.

References

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■ 1. See W. Fruhan, "Pyrrhic Victories in Fights for Market Share," *Havard Business Review*, volume 50, September-October 1972, pp. 100-107; and A.V. Thakor, "Investment 'Myopia' and the Internal Organization of Capital Allocation Decisions," *Journal of Law, Economics and Organization*, volume 6, Spring 1990, pp. 129-154.
■ 2. See L. Trigeorgis, *Real Options* (Cambridge, Massachusetts: MIT Press, 1996); and A.K. Dixit and R.S. Pindyck, "The Options Approach to Capital Investment," *Harvard Business Review*, volume 73, May-June 1995, pp. 105-118.
■ 3. See, for example: R.F. Mager, *What Every Manager Should Know about Training* (Belmont, California: Lake Publishing, 1992).
■ 4. For interesting research on this issue, see: L. Trigeorgis, "The Nature of Option Interactions and the Valuation of Investment with Multiple Real Options," *Journal of Financial and Quantitative Analysis*, volume 28, number 1, 1993, pp. 1-20.
■ 5. In firms with large amounts of debt following leveraged buyouts, it is typical to tie compensation to cash flows because a key objective is to generate cash flows to pay off the debt.
■ 6. EVA is defined as [return on net assets - weighted average cost of capital] $\times$ net assets. Thus the present value of all future EVAs for a project equals its NPV.
■ 7. See A.M. Brandenburg and B.J. Nalebuff, "The Right Game: Use Game Theory to Shape Strategy," *Harvard Business Review*, volume 73, July-August 1995, pp. 57-73; and F.W. Barnett, "Making Game Theory Work in Practice," *Wall Street Journal*, 13 February 1995.
■ 8. N.A. Nichols, "Scientific Management at Merck: An Interview with CFO Judy Lewent," *Harvard Business Review*, volume 72, January-February 1994, pp. 88-99.
■ 9. One way to evaluate both types of risks is with Monte Carlo simulation. Analysts can forecast input ranges (or probability distributions) for a project's key value drivers (e.g., units sold, price, costs, and so on) instead of assigning a single expected value. These values determine the project's yearly free cash flows (FCFs), which are then discounted at the cost of capital to arrive at the project's NPV. A simulation then draws from these input distributions, resulting in a distribution of yearly FCFs and NPVs. The analyst now has the expected NPV and the likelihood that the NPV is positive, given the underlying assumptions. All else equal, the firm should accept all projects with positive expected NPVs. However, in light of capital constraints, corporate strategy, and project

interactions, the distribution of NPVs may be very important in making key decisions.

Simulation analysis is also useful for calculating the expected yearly FCFs when there are interdependencies across different variables or options latent in the project. For example, price and unit demand may be negatively correlated or there may be an abandonment option. Often, the analytical solution to these relationships is difficult to obtain, thereby making the simulation analysis useful in calculating the numerical solution to these problems.

■ 10. In one company, we observed analysts in one region who consistently assumed that the assets invested in new products had no residual value after ten years, whereas analysts in another region would assume that the residual value was the present value of a perpetual stream of the net operating profits after tax in the tenth year. Both regions competed for the same capital pool. Guess which region received larger capital allocations?

■ 11. This issue was raised by:
P. Barwise, P.R. Marsh, and R. Wensley, "Must Finance and Strategy Clash?," *Harvard Business Review*, volume 67, September-October 1989, pp. 85-90.

■ 12. For a discussion of other consequences of draconian expense cutting, see:
B. Wysocki, Jr., "Some Companies Cut Cost Too Far, Suffer 'Corporate Anorexia,'" *Wall Street Journal*, 5 July 1995.

■ 13. Another benefit of consistently having short cycle times is that the firm becomes quite adept at responding quickly to change, which may result in a lowered operating risk for the project, thereby offsetting some of the information risk. There may also be learning benefits (learning by doing) associated with short cycle times.

■ 14. It is important to note that while a firm's strategy will dictate where the firm should be in terms of cycle time and risk for different types of projects, the option valuation method for risk reduction will enable the firm to focus its capital allocation on projects that are consistent with that strategy.

■ 15. See, for example:
J. Martin, "Ignore Your Customer," *Fortune*, 1 May 1995, pp. 121-126.

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