Strategic Analysis of Application Framework Investments

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Introduction

The brief history of application frameworks has been focused primarily on technical issues. That is changing today, as more and more organizations are recognizing the potential of application framework investments to improve their strategic position in the markets they serve. But to realize this potential, an approach firmly grounded in the disciplines of business strategy is needed. *Value Based Reuse Investment* (VBRI) integrates principles drawn from Value Based Management (McTaggart, Kontes, & Mankins 1994)--which has been adopted by many of today's most successful companies--with concepts drawn from recent thinking on capturing information technology business value. The VBRI approach was developed for investments in reusable software in general, but is especially well-suited to investments in application frameworks, due to their role in the acquisition of *organizational reuse capability*.

An essential premise of VBRI is that the principal source of value of investment in organizational reuse capability is in the *strategic options* it generates. Through the introduction of principles drawn from the field of option pricing theory, these strategic options are linked to an established discipline of economic value. This explicit linkage between strategy and economic value supports an approach to strategic planning whereby management is actively involved in the continuous formulation, evaluation, and implementation of strategic options.

Software Reuse Economics and Organizational Reuse Capability

The Software Engineering Institute introduced the notion of organizational software development *capability* with its popular Capability Maturity Model (Paulk, Curtis, & Chrissis 1991). It has proven to be a useful approach to the analysis of how and when organizations transform technical capabilities into strategic capabilities. Several variants of the Capability Maturity Model have been proposed in the area of software reuse. For example, Bassett (1996) describes a model with five Reuse Maturity Levels (*ad hoc*, *latent*, *project*, *systemic*, and *cultural*). Another important model, the Reuse Capability Model developed at the Software Productivity Consortium (Davis 1993), foresees four levels:

Opportunistic. Reuse is practiced at the level of the individual project. Project staff bear primary responsibility for reuse-oriented activities. Reusable assets are acquired according to the technical needs of the project development teams.

Integrated. Project staff and management work together to define organization-wide reuse processes and assets that may be used over multiple projects. Assets are acquired according to anticipated technical needs of the development teams.

Leveraged. A product-line reuse strategy is defined that takes into account sets of related products. Metrics are used to measure costs and benefits. Reusable assets are acquired according to current requirements of customers in the product markets.

Anticipating. Management creates new business opportunities by exploiting the organization's reuse capabilities. Future, anticipated market needs drive the acquisition of reusable assets. New

technologies are seen as strategic drivers. The reuse infrastructure is flexible enough to adapt rapidly to market evolution.

The traditional kinds of reuse supported by heterogeneous component repositories are reflected in the opportunistic level of the Reuse Capability Model, whereas organizational policies such as reuse *best practice* initiatives are reflected in the integrated level. A large body of work has been carried out to develop metrics (Poulin 1997) and economic models (Lim 1996) to measure the cost reduction and various quality and productivity factors that are relevant to this type of reuse. These metrics and models are characterized generally by their project-level, even component-level focus, and can be applied directly by project staff during project execution. Little work in strategic planning exists for these levels of the Reuse Capability Model, largely because it is not really necessary--reuse at these levels is usually aimed at the improvement of existing projects and processes.

Although application frameworks exhibit some characteristics of the lower levels of the Reuse Capability Model, they exhibit even more characteristics of the upper levels. Fayad and Schmidt (1997) observe that frameworks *leverage* domain knowledge to support the development of families of related applications, or *product lines*. For example, Bäumer, Gryczan, Knoll, Lilienthal, Riehle, and Züllighoven (1997) describe the framework-based development of a family of applications in the banking domain. Up until now there have been few metrics and economic models for the analysis of product line approaches, but several projects are currently underway to fill that gap. For example, both the Software Engineering Institute (Software Engineering Institute 1998) and the European Software Institute (European Software Institute 1998) have launched significant product line initiatives.

More and more, however, application frameworks are seen to support the activities of the highest, anticipating level of the Reuse Capability Model. Codenie, De Hondt, Steyaert, and Vercammen (1997) describe how framework technology plays a *strategic* role in their business of creating software for television stations. They cite the adaptive nature of frameworks as a factor that enables flexible response to new and rapidly changing market opportunities, resulting in a competitive advantage. Citing considerable experience with frameworks not only at the technical level but also at the *managerial* level (a key characteristic of the anticipating level of the Reuse Capability Model), they emphasize that their primary focus is market-oriented rather than technology-oriented. They go on to note, however, that " ... the details of using a framework as a strategic weapon in attacking a vertical market are largely neglected in the literature." It is here that VBRI seeks to fill the gap.

The capital investment process always consists of two basic kinds of activities: *strategic planning* (the identification of lines of business to pursue) and *capital budgeting* (the financial analysis, allocation of resources, and monitoring of performance in projects in the chosen lines of business). In a sense, they are two ways of looking at the same problem--whereas strategic planning is top-down, capital budgeting is bottom-up. Indeed, Brealey and Myers (1996) characterize strategic planning as *capital budgeting on a grand scale*. The activities of the lower levels of the Reuse Capability Model share the bottom-up characteristics of capital budgeting; those of the higher levels exhibit the top-down characteristics of strategic planning. Ideally, the two views will complement each other, providing an integrated view of the capital investment process, where the link between strategy and economic value is made explicit. The rest of the chapter is devoted to a discussion of the VBRI approach to strategic planning and financial analysis.

Strategy: A Value Based Investment Framework

Strategy elevates us to the level of the business, and strategic decisions far overshadow capital budgeting decisions in their potential for value creation or destruction. In fact, a business strategy by its nature does not concern single projects, but a *bundle of projects*. For example, a strategy involving application framework technology will give rise to a number of individual projects, which may include technology investment, research and development, personnel training and deployment, and marketing activities. A manager developing such a strategy cannot even begin to foresee what all these projects *are*, much less calculate their individual economic values. This is, in its

essence, what makes strategic planning so difficult--and what makes excessive standalone analysis of individual projects a futile exercise. But even if we concede that it is impossible to foresee all of the parameters, factors, and conditions that will affect the value of a strategy, we *can* arrive at an understanding of what creates business value and let this understanding inform our strategic planning process. The first step is the adoption of a single, coherent overall governing objective: the *maximization of economic value over time*.

Although this governing objective may seem self-evident, by no means do companies always pursue it in their actions. Application frameworks have been constructed for many different kinds of product markets, and therefore are particularly susceptible to misuse in the indiscriminate pursuit of *product market* objectives--such as market share and customer satisfaction. Product market objectives, even when fully achieved, may or may not contribute to the maximization of value over time. A company that achieves a dominant share of its market will in fact destroy value if it does not earn over and above its cost of capital--on the contrary, *reduction* of market share (through appropriate focusing) would be the appropriate strategy in that case. Similarly, pursuit of enhanced customer satisfaction has been a successful strategy in many cases--but this strategy does not always *automatically* contribute to economic value maximization. Likewise, in today's fast-moving software industry, it is tempting to stress reduction of time to market on all product introductions--yet it is only one of many, possibly conflicting considerations (as will be seen in the section on financial analysis).

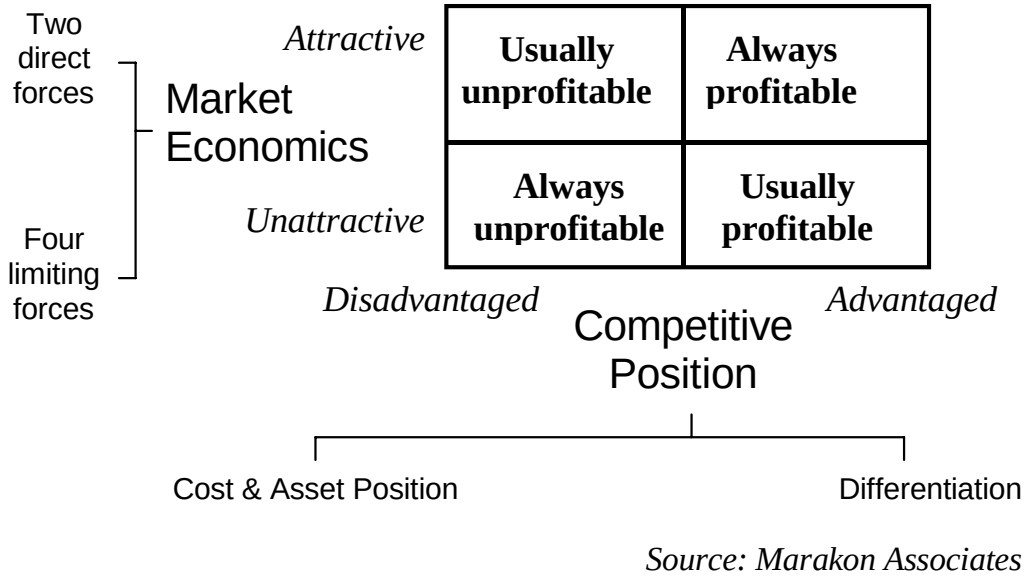

Figure 1: The MECP investment framework

In order to insure that only those strategies are pursued that really have the potential make a positive contribution to economic value, an investment framework is needed within which to reason about value creation. In VBRI we make use of the *Market Economics/Competitive Position* (MECP) framework (McTaggart et al. 1994), illustrated in Figure 1. This framework supports a fundamental assertion: the primary determinants of economic value are the profitability of the markets in which a company participates, and its competitive position within those markets. In consequence, the *only* criterion that determines the potential of a particular strategy to create value is whether it enables the firm to participate in economically attractive markets and/or improve its competitive position within those markets. Companies with a strong competitive position in attractive markets will nearly always create value, whereas those with a weak competitive position in unattractive markets will nearly always destroy value. In the other cases, the situation with respect to value creation is unclear, and the challenge to management is to try to change the company's position within the framework.

In VBRI, therefore, strategic planning becomes a process of developing strategic options and evaluating them against the MECP framework: this process gives a company a valuable focus for strategy development.

Competitive Position

The forces of competition are such that it is difficult to create and sustain economic value in any markets, particularly those with unattractive economics. But experience has shown that the competitive position of a company has the potential to dominate over market economics in its potential for value creation. This is partly true because a company that can establish a powerful and sustained competitive advantage can often influence directly the economics of the markets in which it participates.

However, a misunderstanding of the drivers of value creation often lead to strategies that ultimately have no effect at all on the competitive position of a company. The MECP framework tells us that there are two (and *only* two) fundamental possibilities for achieving competitive advantage:

- Product offering advantage
- Relative economic cost position advantage

A product offering advantage arises from successful *differentiation*, whereby an economic cost position advantage results from lower production costs. Strategic options have value only to the extent that over time they contribute to competitive advantage in one of these two ways, ultimately translating into higher margins and/or higher market share.

Economic Cost Position

Cost reduction capability through software reuse has been appreciated for many years, and little needs to be added to the discussion. Application frameworks provide even more cost reduction capabilities:

Reduced production cycle time. In competitive situations where reduced cycle time is critical, the many advantages of applications frameworks have been documented in great detail and need not be elaborated further.

Lower production costs, higher productivity. Application frameworks are being designed to enable platform independence and increased modularity, allowing framework based developers to lower their production costs by picking and choosing among the most cost-efficient alternatives available. In addition, labor costs may be lowered through the improved developer productivity that has been associated with framework-based development. Reduced maintenance costs have also been associated with application frameworks.

Product and process innovation. Application frameworks give rise to the promise that innovation can be encouraged not only in the design *process*, but in the very design of the *products* and services themselves. Previously used development processes (e.g. the waterfall model) will be replaced with innovative new processes that can lower overall development costs significantly. In addition, this different perspective on software development and structure may encourage imaginative new product and service designs.

Process complexity reduction. Even in cases where the basic underlying development process remains essentially unchanged, its complexity could be reduced considerably through leveraging of application framework facilities that handle complex technical and business subprocesses (e.g. application distribution, financial accounting procedures, etc.).

Differentiation

Although the economics of a cost position strategy are straightforward, well-understood, and in successful use in many organizations, the economics of differentiation are much less well understood. Yet one of the primary competitive advantages foreseen for application frameworks is the possibility of differentiation of framework-based products or services, particularly through customization. Thus it is well to understand clearly the economics of differentiation. A differentiation (or *offering*) advantage is obtained when customers perceive a product to be superior to its

competitors in terms of quality, satisfaction, or performance. Being merely *different*, however, is not the same as being *differentiated*. In our experiences, managers tend to overestimate the uniqueness of their offerings. In the value based approach, we use a precise, measurable definition: Differentiation only occurs when the *customer's* perception of superiority is sufficient that it is *possible for the offering to be priced at a premium* relative to competitive offerings. At this point, management has a strategic option which may be exploited in one of two ways:

- raise prices as much as possible without losing market share
- hold prices even and exploit the differentiation advantage to gain market share

Thus it becomes possible to observe the extent to which differentiation has really occurred, by measuring explicitly either (a) the size of the price premium or (b) the increase in market share, or (c) a combination of both. These explicit value measures can deliver information about the level of differentiation that diverges significantly from what management believes is really happening. As an example, a few years ago Marakon Associates worked with a business unit in which the manager was a firm believer in differentiation as a competitive strategy, and was confident that he had achieved technical superiority in all of his product lines. Yet by the differentiation measures described above--price relative to competitors, and market share--he had managed to achieve a superior combination of price and market share with only two of five product lines (McTaggart et al. 1994). Thus, in spite of the clear *difference* in his product lines to the competition, he had not achieved *differentiation* according to a value based definition. On the contrary, research with the customers showed that in most of his product lines, he was actually at a significant differentiation disadvantage--the users had become sufficiently comfortable and skilled with the previous versions of his products that they were not willing to pay the premium to upgrade to his new versions--a phenomenon often seen in the software industry.

Similarly, the differentiation advantages obtained through framework technology can turn out to be a mirage if not planned and measured in an objective, disciplined manner. Consider, for example, framework technology for the construction of graphical user interfaces. They allow a software developer to construct an infinite number of different graphical interfaces, perhaps even customized for each individual end user. But will these *different* user interfaces result in *differentiation* of the underlying product, or will differentiation depend on some other characteristic, such as the core functionality delivered by the product?

Developing a Competitive Strategy

There is no single answer to the question of whether it is preferable to pursue an economic cost position or a differentiation strategy. In a commodity market, where competition is primarily price-based, a cost advantage can be essential to success. But in highly differentiated markets, where there is little price competition, a cost advantage may not contribute greatly to building consistent profitability over time. This highlights again the basic lesson of the governing objective of value maximization: any single product market objective may or may not contribute to value creation, depending on the circumstances in which the company finds itself.

The investment of resources in framework development or acquisition should be directed to the characteristics that support the chosen competitive strategy--otherwise they are wasted, since they will not make a contribution to economic value creation. But management should be aware that there are choices to be made in this respect. Demeyer, Meijler, Nierstrasz, and Steyaert (1997) write at length about the two conflicting technical characteristics of application frameworks that relate directly to this issue: *reusability* and *tailorability*. The reusability of frameworks in related applications contributes most directly to a cost reduction strategy. In contrast, the tailorability of frameworks makes a stronger contribution to a differentiation strategy. Since reusability and tailorability can be conflicting goals in an application framework management may need to make choices about the relative priorities of each, in light of its overall business strategy. Consider, for example, the decision of whether to build or buy application frameworks, discussed by Fayad and Schmidt (1997) together with their three-level classification scheme of *system infrastructure*, *middleware*, and *enterprise*

application frameworks. The first two kinds of frameworks are especially intended to support the cost-efficient production of software. A company in a line of business where price competition dominates may find it worthwhile to make major investments in these types of framework, including a decision to build rather than buy, in order to bring this kind of strategic competence in-house. As an example, imagine a company whose line of business consists solely of providing reliable data archival services to customers at the lowest prices possible. Infrastructure and middleware technology can help it take advantage of the best mix of platforms and distribution strategies to keep prices low while expanding market share. In contrast, imagine a company whose main line of business is to provide highly differentiated, customized services in a vertical market (such as telecommunications services) at premium prices. Here a highly tailorable enterprise application framework provides critical support. Middleware and infrastructure frameworks will have little strategic importance in this case and may be bought from third-party vendors as necessary for technical support.

Market Economics

Although in traditional markets competitive strategy is generally more critical than market economics, that is not necessarily true in the markets in which application framework technology is deployed. The information revolution is facilitating the emergence of new markets (and market niches) with vast possibilities for value creation for those who are able to take advantage of them. Application frameworks can support the creation of market opportunities at the highest level of the Reuse Capability Model. The *market economics* component of the MECP framework is concerned with *participation strategy*: the entry into profitable markets and exit from unprofitable markets--whereby markets and market segments may be defined in a number of meaningful ways (such as by country or end user). As Figure X.1 shows, there are two direct forces and four limiting forces that affect the attractiveness of a market and tend to place a ceiling on the prices that can be obtained. The two direct forces are the *intensity of direct competition* and *customer pressures*. Some information technology markets are characterized by fiercely intense direct competition, such as the market for relational databases. Even more important can be the power of sophisticated customers to limit profitability. In Internet markets, customer pressures have succeeded in lowering prices to zero (literally) in many cases. In other markets, such as the Enterprise Resource Planning market, customers are used to paying high premiums for services.

The four limiting forces on market profitability are:

Intensity of indirect competition. When substitutes for a company's product or service exist, it has the effect of placing a ceiling on the prices charged, to avoid switching to the substitute. The Internet is creating substitutes for the traditional distribution of many kinds of media, from books to music. In this light, it is not difficult to see the strategic utility of flexible multimedia application frameworks for tracking technology advances (Posnak, Lavender, & Vin 1997).

Threat of competitor entry. Markets with low barriers to entry have a ceiling on their profitability, because prices generally have to be kept low in order to protect market share and make it economically unfeasible for competitors to enter. Recent maneuvers in the World Wide Web browser market provide ample illustration of this situation. Application framework technology vendors would seem to be exempt from this kind of threat, but with the appearance of free middleware products, the commercial vendors will have some difficult pricing decisions to make.

Supplier pressures. Although this force would not seem to be relevant to the current discussion, consider that the development of application framework technology solutions generally requires highly skilled, expensive labor resources, which can drive up the cost of production dramatically and limit the firm's capacity to operate profitably. Hopefully, this downward pressure of labor costs on profitability will be mitigated by an increase in productivity as experience is gained with framework technology.

Regulatory pressures. Some markets, such as aerospace, defense, and the environmental industry, are subject to heavy regulations that limit profitability. Up until now, this has also been true

in many segments of European industry (e.g. telecommunications), although with the wave of privatization occurring in recent years this situation may change.

Since value creation is highly concentrated, the potential can exist for an enterprise to increase its value several times over in a relatively short time by entering profitable markets, and by exiting unprofitable markets that produce large economic losses. McTaggart et al. (1994) note that there are three basic guidelines to follow when considering market entry:

First, the market itself should be economically profitable and likely to remain so. Some markets, such as defense electronics, have declined significantly in profitability in recent years. Others, such as multimedia and certain segments of the Internet services market, have yet to show evidence that the average participant can consistently turn a profit. In addition, a high degree of uncertainty is often associated with market profitability forecasts in the high technology arena; in the section on financial analysis we will discuss how to incorporate considerations of this type of uncertainty.

Second, there should be sufficient confidence in the company's ability to sustain a competitive advantage in the targeted market. This may involve leveraging framework technology to increase customer satisfaction through better, more rapid response to their particular needs, as discussed by Codenie et. al. (1997). Or it may involve a cost reduction strategy through acquisition of middleware frameworks.

Third, the barriers to market entry should not seem insurmountable. In mature markets with entrenched competition, entry can be nearly impossible--few would seriously consider entering the personal computer operating system market today. However, many new information technology markets (such as electronic commerce), with essentially no entrenched competition and no sophisticated customer base, offer great opportunities.

Developing a Participation Strategy

The essential question in a market participation strategy is: What capabilities and strategy can enable the company to enter attractive markets? Experience has shown that one of the most powerful entry strategies is to enter simultaneously in several closely-related segments. Framework technology can support a strong offering in several related segments of a newly entered market through exploitation of commonalities in a product line strategy. For example, Bäumer et al. (1997) describe an analysis of several related segments in the banking domain, resulting in a layered framework architecture to support the combined offering. In the case of electronic commerce, an enterprise may identify several related segments, such as retailing, credit card transaction processing, telemarketing, secure cybercash transactions, publicity and advertising. After a competitor analysis, the company's own offering is encapsulated in a suitable framework (or combination of several frameworks) in order to create and sustain a strong competitive advantage on entry. The economics of market entry will be examined in the section on financial analysis, along with another important strategic consideration in market entry: the *timing* of entry. On the one hand, if there are not yet strong competitors in the targeted market, it may be advantageous to make an early, preemptive entry with a strong offering. On the other hand, management often sees the considerable commitment of financial, organizational, and human resources implied by application framework technology as effectively *irreversible*, and understandably hesitates to make the commitment in an uncertain market environment. The choice of how to exploit the timing option can have significant effects on the value created by market entry.

Although the capture of new market opportunities is an important factor in a market participation strategy, an equally important factor in value creation is the *reduction* of participation in unprofitable markets, which should be considered as soon as a company's competitive position deteriorates to the point where economic losses are continually sustained. One type of exit strategy relevant to framework technology is the rationalization of unprofitable product lines. Many software service companies attempt to serve a variety of markets with often redundant capabilities. A framework-based approach to the creation of a meaningful strategy at the leveraged level of the Reuse Capability Model can lead to a streamlined product offering in those markets where the company can truly create a substantial competitive advantage. Domain analysis can help reveal which kind of product line can be sustained in a cost-effective way by the company.

A *combined* entry and exit strategy can be particularly attractive in today's rapidly evolving information technology environment. McTaggart et al. (1994) describe how Hewlett-Packard successfully pursued an entry/exit strategy in the electronic calculator market in the 1980s. Aiming only for the high-end segment of the market, they would introduce an innovative new offering at premium prices, reaping significant cash flows, until the mass-market competition began to catch up in functionality. The company would not attempt to lower prices and meet the competition head-on, but instead would plow revenues back into research and development. When revenues from the current product offering began to dry up, they would exit that segment, re-position themselves, and re-enter at a higher level with a new, even more innovative offering.

Framework technology is ideal for the support of this kind of combined entry/exit strategy. Codenie et al. (1997) observe that "... a framework's objective is to consolidate the domain knowledge during earlier projects so that it can be reused in future projects to realize a product goal." A company can exit an unprofitable market segment supported by its framework technology, plow its revenue into framework enhancement, and re-enter a new segment with a stronger competitive position. Bassett (1996) observes that in this way, organizations can "anticipate changing market conditions ... they occupy market niches that have short half-lives; they quickly tailor products and services for their customers to a level of sophistication that their competitors cannot match."

The role of framework technology in consolidating knowledge is central to the *conservation of business value* when exiting a market segment, so that it can be reused when entering a new market segment. (We will come back to this issue in the section on financial analysis.) Thus, the continuous enhancement of application frameworks to incorporate and conserve business value can become a key element of a company's market participation strategy. As Codenie et al. (1997) aptly note, " ... as the business evolves, so must the framework."

An Expanded View of Risk Management

Before leaving the section on strategy, a discussion is warranted on the role of risk management in strategic planning. The software development community has traditionally defined risk in pessimistic terms: risk is something to be avoided, reduced, conquered, mitigated. This view of risk results from the myopic perspective associated with the lower levels of the Reuse Capability Model. At these levels, the technical risk associated with specific projects is the principal concern. In contrast, the upper levels of the Reuse Capability Model elevate us to the level of business strategy. Yet even at these levels, strategic thinking often tends to view only low-risk, stable environments as good candidates for framework technology, justifying the large up-front investments required (Codenie et al. 1997). But this view is mistaken, because it still only considers technical risk. In addition to project-level technical risk, there is *market* risk, which brings valuable opportunities with it as well as uncertainties.

In today's fast changing, volatile software market, risk and opportunity go hand-in-hand, and the strategic investments characterized by many framework investments cannot afford to view risk in pessimistic terms. As Brealey and Myers (1996) say, the purpose of risk management should not be to reduce risk, but to *add value*. Risk management should properly to identify those risks that are worthwhile taking and those that are not--as Lister (1997) says, "...only stupid risks are bad." Indeed, markets that exhibit high risk and volatility often present the most valuable opportunities. A willingness to undertake well-chosen risks can prove a great source of value for the enterprise. In the next section, we will see how taking on increased market risk can actually *increase* rather than reduce the value of an investment.

At the lower levels of the Reuse Capability Model, we often speak of "management support" for reuse-related activities. This expression accurately reflects the fact that at these levels, responsibility rests mainly in the hands of the technical project personnel. It also conveys an idea of business as usual, whereby management intervention is neither needed nor desired--the business-level strategic decisions have already been made. In contrast, the primary responsibility for risk management at the upper levels of the Reuse Capability Model migrates from the technical project personnel firmly into the hands of management. At these levels, the mere *support* of management is not sufficient--the active *involvement* of management is necessary for the creation of strategic options,

and then the evaluation not only of the risks associated with these options, but also of the value-adding market opportunities they present to the enterprise. The analysis of application framework investments cannot occur in a narrow project-level context of efficiency improvements, but rather in the broader context of strategic investment, where technical risk, market risk, and business opportunities are analyzed in an integrated fashion. In this section, we have presented the strategic elements of Value Based Reuse Investment. In the next section we discuss how these elements are integrated with the financial indicators of value creation.

Finance: Linking Strategy to Value

In the previous section we discussed many kinds of strategic options that may be formulated during the strategic planning process, ranging from operational cost reduction to combined market entry/exit scenarios. But formulation of strategic options is only the half the story. McTaggart et al. (1994) observe that "strategic planning must be rigorous and objective. This means, among other things, that it will require managers to generate high-potential strategic options for comparison on the basis of their value creation potential for the company. It also means that good strategic planning cannot be done without numbers." This observation brings us back to the central tenet of VBRI: strategic planning can only be meaningful when linked to the economic consequences of the strategies that are elaborated in the planning process.

Disciplined economic evaluation of information technology investments has never been an easy proposition (Clemons 1991). An entire school of economists is currently engaged in a lively and vigorous debate about the best metrics and methods for capturing the full business value of investments in information technology. Simmons (1996) discusses a number of different approaches. But there remains widespread agreement among those thinking seriously about the issue--and in the most successful companies--that even new approaches must start from the foundations upon which all modern thinking about economic value rests.

Discounted Cash Flow and Operational Value

In describing the so-called *firm-foundation* theory of investment valuation, Malkiel (1996) discusses the concept of the *intrinsic value* of an investment. He credits John B. Williams with working out the basic theory of intrinsic value and its definition: the discounted value of all future cash flows resulting from the investment. The idea of intrinsic value corresponds to the more formal concept of *present value*: the value today of cash flows in the future. The technique of Discounted Cash Flow (DCF) is widely used for the calculation of Present Value, and is still the best way to capture sources of operational value in framework-based projects at the lower levels of the Reuse Capability Model--in particular, with respect to strategies for improving economic cost position in well established lines of business.

If we assume that cash flows are net flows, in the sense that they represent the difference between costs and benefits in each period, then the Net Present Value (NPV) of an investment can be expressed as follows:

$$\text{NPV} = C_0 + C_1/(1+r) + C_2/(1+r)^2 + \ldots + C_n/(1+r)^n$$

Here C_i is defined as the net cash flow in period i and r is the *discount rate*. If the investment is risk-free then r is simply the risk free rate of return such as that guaranteed by Treasury bills. If the investment carries associated risk (such as a stock, or a real-world project) then r is generally higher, reflecting the higher uncertainty of returns. If a proposed investment has a Net Present Value greater than zero, then it is considered worth undertaking. A very entertaining introduction to Discounted Cash Flow concepts, particularly the relationship between discount rates and risk, can be found in Malkiel (1996).

To illustrate the technique, consider a simplified generic scenario for the deployment of framework technology in a well-established line of business, illustrated in Table 1. We postulate three successive time periods of equal duration (e.g. one year): an initial period of framework development, followed by a second period of application development, and a third period of operations and

maintenance. Amounts are expressed in thousands of dollars. Negative amounts represent cash outflows; positive amounts represent cash inflows. Forecasts may be based upon estimates obtained from the application of the best available reuse metrics and cost models (Frakes & Terry 1996).

Cash Flows	Framework Development	Application Development	Operations
Revenues	100	350	600
Programming labor	-600	-100	-25
Maintenance	-100	-50	-25
Net cash flows	-600	200	550

Table 1: Discounted Cash Flow Evaluation of Generic Framework Scenario

If we assume a discount rate of 15 percent, then for this scenario the Net Present Value is -10, which would discourage the up-front investment. The relative sizes of the numbers reflect the observations of many authors about the economic characteristics of framework projects: an early period of heavy investment and scarce cash inflows followed by later periods of cost savings and higher revenues. For example, in describing the large up-front costs associated with framework development, Doscher and Hodges (1997) note that "the initial cost of specification and implementation is further increased by costly framework skills, added education, validation and conformance testing."

This also illustrates why it can be so difficult to make the business case for application frameworks. The up-front costs and lead time before revenues begin to flow weigh heavily on a traditional discounted cash flow calculation. The distribution of labor and revenues in more traditional development projects generally produces more revenue earlier. Even the promise of future high revenues coupled with low maintenance costs is often not good enough. Many application framework projects have never been launched because the up-front costs simply could not be justified.

At the lower levels of the Reuse Capability Model, the decision not to invest under this generic scenario may well *be* the correct one. After all, in a well-established line of business with a well-defined operational scenario, the forecast of costs versus benefits and their comparison through a Discounted Cash Flow calculation represents the best available measure of the economic worthiness of the investment. For a specific project, if this measure tells us that the costs of introducing framework technology are not outweighed by the foreseeable benefits over the life span of project operations, then the investment is unjustified.

However, this measure does not always tell the full story. The Discounted Cash Flow approach to cost/benefit analysis of framework investments is predicated on a scenario of *business as usual*, with a foreseeable future and a stable operating strategy. It cannot be denied that frameworks can contribute to improvement of this kind of business scenario--in particular, through improvement of economic cost position and product offering. We have discussed in the section on strategy how each of these kinds of improvement can be measured, and they create value within the MECP framework by improving the company's competitive position. Yet the upper levels of the Reuse Capability Model introduce other considerations, that are related to the market economics component of the MECP framework. These considerations are predicated on new business models, where new markets are opened up by the introduction of new ideas and technology, and active management reacts in response to rapidly changing market conditions with the value adding exploitation of strategic organizational reuse capabilities. Is it impossible to estimate the value of these benefits, so often considered to be intangible?

Real Options and Strategic Value

We consider dangerous the way of thinking that insists that the strategic value of information technology must remain intangible and therefore incalculable. It is a step towards vagueness in concept, and away from realistic, grounded financial estimates. We believe, along with many others, that the central notions associated with intrinsic value can be conserved so that the discipline brought by valuation can be preserved. The field of *option pricing theory* has proven to be a potent link

between the analysis of traditional sources of value and the more intangible sources of value seen in information technology investments. It is no accident that this theory of economic value has a direct bearing on the concept of *strategic options* on which VBRI is predicated. Applied within the context of the MECP framework, it can help solidify the link between strategy and economic value at all levels of the Reuse Capability Model.

Financial options have been traded on general and specialized stock exchanges for decades. They are special forms of *derivative* securities--that is, their value depends on the value of an underlying asset. A *call option* gives the owner the right, but not the obligation, to buy an asset on a specified future expiration date, at a specified *strike* or *exercise* price. Similarly, a *put option* gives the owner the right (but not the obligation) to sell an asset for a specified price on an expiration date in the future. A so-called *European* option can be exercised only on the expiration date, whereas an *American* option can be exercised at any time before the expiration date. The flexibility afforded by options has made them a popular instrument for investors on both ends of the spectrum: for aggressive investors exploiting the leverage of options for speculation; and for conservative investors using options for hedging against possible future downturns. As we will see, there are useful parallels in framework-based investment strategies.

Option pricing theory seeks to understand the fair prices that investors should pay when they buy options, taking into account the relative parameters such as time to expiration, difference between current price and strike price, etc. Black and Scholes (1973) developed a formula for the exact pricing of options that is regularly used in daily trading. The mathematics associated with the formula are beyond the scope of this discussion--we are more interested in the implications of the theory for the strategic planning and decision-making process. Fortunately, it is possible to make immediate use of the formula without dwelling unnecessarily on technical details. Many spreadsheet packages and special calculators exist to make the use of the formula a simple matter. Let us assume the availability of a spreadsheet function of the following form for calculating the value of a European call option.

CALL(V, E, T, RF, STDDEV)

The parameters involved this function highlight the factors affecting the value of an option.

- V, the current market price (value) of the stock;
- E, the exercise price of the call option;
- T, the number of days to expiration of the option;
- RF, the prevailing risk-free interest rate (for example, the Treasury Bill rate);
- STDDEV, the instantaneous standard deviation of the stock's returns.

The pricing of put options is essentially the mirror image, and involves exactly the same parameters.

Discounted Cash Flow was developed for the valuation of financial instruments such as stocks and bonds, and then was mapped onto the real world of capital budgeting for projects, as we have seen in the previous section. In a similar vein, the real world has borrowed again from the financial world in applying option pricing theory to the valuation of strategic options in capital investment projects. Over the past two decades, applications have been found in sectors as diverse as petroleum exploration and the insurance industry. Consider some real options that can be found in information technology investments:

Option to expand. Also known as a *growth option*, it concerns the creation of future product market opportunities through up-front, pioneering investment. An example would be the development of an application framework preparatory to entering the electronic banking services market.

Option to abandon. In a sense the opposite of a growth option, it concerns the ability to abandon a current investment scenario without losing part or all of the value of the investment. An example would be developing an accounting system around a commercial database which can be reused for

another projects if the project is abandoned (instead of developing it around a custom solution that would lose its value under abandonment).

Option to defer. This is the ability to defer an investment while waiting for better information. An example would be a decision not to buy a new version of a software product while waiting for a possibly superior version the following year.

Option to switch inputs or outputs. This option concerns the possibility to change either the process (inputs) or products (outputs) of a system. An example would be a component-based software process, or customizable user interface building systems.

The introduction of option pricing theory allows us to account for two important characteristics of investments at the upper levels of the Reuse Capability Model:

- the notion of *active management*. We discussed in the section on strategy that in strategic framework technology investment, management plays a key role in value creation by intervening to alter the course of a business strategy as events unfold. This notion is not present at the lower levels, where a project unfolds according to a known, foreseeable scenario, nor is it reflected anywhere in the DCF model of investment.

- explicit acknowledgment (and exploitation) of uncertain market conditions. We have discussed at length the futility of strategic planning and risk management without considering the business risks and opportunities associated with the market. Discounted Cash Flow analysis only considers market factors in an indirect, relatively one-dimensional fashion (in the discount rate).

This approach makes an important contribution to the managerial decision-making process by enforcing discipline in reasoning about the value of the strategic options made possible by application framework investments. Instead of departing from the solid foundation of value based thinking and making vague statements about intangible benefits, we adopt the principle of trying to obtain an estimate of the intrinsic value of a strategic option in an *augmentation of* rather than *departure from* value based thinking. By avoiding generalities, and instead reasoning in a concrete fashion, the decision-maker is forced to focus his analysis and make grounded, realistic estimates. It is an important step toward the *integration* of the strategic planning and capital budgeting processes that we discussed earlier.

New Market Entry—The Growth Option

Let us now return to one of the most important strategic activities at the anticipating level of the Reuse Capability Model: the exploitation of organizational reuse capability to enter new markets with attractive market economics. New market entry is an example of a company's market *participation strategy*, and an important component of the MECP framework. As an example, let us now consider an emerging market which has been cited often in the context of application framework technology: electronic commerce. In a typical scenario for attacking this market, a company might consider a preliminary strategic investment, consisting of developing an application framework that contains the core business logic for many kinds financial transactions and services. Company management feels that the electronic commerce market could boom, but there is still a high degree of uncertainty about whether this boom will actually occur. (For example, the market around Teletext never really developed as expected.) Management faces a difficult decision. The competition isn't sleeping--if the investment is not made now, it will not be possible at a later date to gain a foothold in the electronic commerce market if and when it does explode.

More concretely, suppose that in 1998 the company has the opportunity to carry out a pioneering three-year research and development project for electronic banking services for a large bank. The project itself generates some revenues, and it could be carried out within budget if the software were custom-built. But management is considering additional investment to build a full-blown framework within the project, because this should put the company in a strategic position to enter the larger market later. Framework-based application development with high quality business

components may be the only way to sustain a substantial competitive advantage in the expected highly competitive environment. How can management reason about the economic value of the essentially strategic option that framework technology investment would create to enter this new market? The first step is to separate clearly the pioneering framework development stage from the subsequent stage of full entry into the market:

Stage 1: Pioneering investment. In the year 1998, the company commits resources up-front to a project which includes research and development of application framework technology for electronic banking services. (Normally this will consist not only of research and development, but also consolidation of domain knowledge and experience.) The required investment is 600 thousand dollars. The present value in 1998 of all projected cash flows from the pioneering project over its lifetime, discounted at 20 percent, is estimated to be 550 thousand dollars.

Stage 2: Market entry. Management believes that the decision about market entry must take place in 2001, when the company plans to commit resources to full entry into the electronic banking services market. The required investment will be 1500K dollars--well over double the investment for the pioneering stage. The present value in 2001 (the year of market entry) of all future cash flows from operations in the market is projected (at a 20 percent discount rate) to be 1400K dollars.

Unfortunately, a straightforward cost/benefit analysis of each of the ventures makes them both look like losers:

NPV(pioneering investment project including framework construction) = 550 - 600 = (-50)

NPV(electronic banking services venture) = 1400 - 1500 = (-100)

Yet clearly this analysis does not capture the strategic intention of the framework-building project: to create the opportunity to participate in a possibly burgeoning electronic banking services market. Viewed this way, the initial project can be seen as creating a growth option--an option to make a larger follow-on investment if the market develops favorably. This view also makes it possible to introduce market uncertainty directly as a parameter in the decision-making process. This is done by estimating the *volatility*, or standard deviation of annual returns of the electronic banking services venture. In practice, this might be done by considering the volatility of returns of ventures or stocks in similar market segments, or by forecasting several different market evolution scenarios, estimating the cash flows for each scenario, and calculating the volatility across the cash flows for the individual scenarios (Damodaran 1996). Let us suppose in this case that the uncertainty surrounding the future of the electronic banking services venture is such that a standard deviation of annual returns of 30% must be assumed. Suppose also that the prevailing risk-free (e.g. Treasury bill) annual interest rate is 10%. We can determine the Present Value in 1998 of the expected cash flows of the electronic banking services venture by discounting back three years at 20%.

PV(electronic banking services venture in 1998) = $1400/(1.2)^3 = 810$

We now interpret the initial framework construction project as a European call option on the expected returns of the electronic banking services project (810 in the year 1998) for an exercise price of 1500 (the required investment) in three years. We would use our hypothetical spreadsheet function to calculate the Black-Scholes value of the call option as follows:

CALL(V=810, E=1500, T=3*365, RF=10%, STDDEV=30%) = 81

Thus, the *expanded* Net Present Value of the initial framework building pioneering venture is not only its traditional NPV (the discounted value of net returns over its lifetime), but also the value of the growth option to enter the electronic banking services market.

NPV(pioneering venture) = DCF value + growth option = (-50) + 81 = 31

This is a *positive* outcome, when the full intention of the pioneering venture is taken into account, and triggers the up-front commitment of resources to the pioneering investment--even in the face of a negative NPV forecast. This seemingly counterintuitive result can be understood by recalling the nature of the pioneering framework technology investment as a strategic *option*. It gives

management the option, *but not the obligation*, to make the larger follow-on investment in the electronic commerce venture if market conditions evolve as hoped. If the market does not evolve favorably, then management can change the investment scenario and cut its losses by choosing not to make the follow-on investment. This is why we speak of *active* management intervention with respect to strategic investment scenarios. Note also how we were able to incorporate strategic considerations while still remaining firmly within the discipline of determination of intrinsic value. The DCF component accounts for value creation at the lower levels of the Reuse Capability Model; whereas the growth option component accounts for value creation at the upper levels.

In order to highlight the insights that this approach can give us into the strategic decision-making process, let us carry out a *sensitivity analysis*. Sensitivity analysis helps to deepen our understanding of the effects of variations in key parameters. In Discounted Cash Flow analysis, it is the estimated cash flows that are the primary parameters of the calculated value. In an options-oriented analysis, however, the palette of parameters that can be varied and studied is richer.

Scenario	V	E	T(months)	RF	STDDEV	CALL
1	***810***	1500	36	10%	30%	***80***
2	***1000***	1500	36	10%	30%	***165***
3	***1100***	1500	36	10%	30%	***221***
4	***1200***	1500	36	10%	30%	***284***
5	***1300***	1500	36	10%	30%	***352***

Table 2: Sensitivity of Growth Option Value to Gross Project Value

Table 2 illustrates the effects of variation in the gross value of the electronic banking services project on the value of the growth option. As the gross project value rises from the base case (810 in Scenario 1) all the way up to a maximum of 1300, the value of the growth option increases dramatically, as high as 352. This reflects the intuition that the bigger the prize, the more valuable the option that keeps the possibility open to obtain the prize.

Scenario	V	E	T(months)	RF	STDDEV	CALL
1	810	1500	36	10%	***5%***	***0***
2	810	1500	36	10%	***20%***	***32***
3	810	1500	36	10%	***40%***	***135***
4	810	1500	36	10%	***70%***	***300***
5	810	1500	36	10%	***100%***	***446***

Table 3: Sensitivity of Growth Option to Market Volatility

Table 3 illustrates the sensitivity of the growth option to volatility in the returns of the electronic banking services project. Here we see a dramatic illustration of the principle discussed in the section on risk management: higher market risk actually *increases* the value of an opportunity. In order to understand this seemingly counter-intuitive insight, we appeal once again to the principle of active management: management has the ability to exploit favorable market developments, while minimizing the negative effects of unfavorable developments. In a market evolution scenario with little variation (five percent in Scenario 1) there is little chance that the Net Present Value of the electronic banking services venture will deviate from the dismal figure that was forecast by the Discounted Cash Flow analysis. Thus, the option to undertake this surely losing venture is completely worthless. But in a booming market evolution scenario where the value of the electronic banking services venture could rise as much as one hundred percent above the forecast NPV (Scenario 5), the market positioning afforded by the pioneering venture is worth a great deal--over half the forecast value of the electronic banking services venture itself. This offers an important insight for managers: the new, highly volatile markets of today's information technology industry present an enormous potential for value creation.

Scenario	V	E	T(months)	RF	STDDEV	CALL
1	810	1500	***12***	10%	30%	***5***
2	810	1500	***24***	10%	30%	***36***
3	810	1500	***36***	10%	30%	***80***
4	810	1500	***48***	10%	30%	***129***
5	810	1500	***60***	10%	30%	***179***

Table 4: Sensitivity of Growth Option to Time Horizon

Table 4 illustrates the sensitivity of the growth option to variations in the time horizon between the pioneering venture and the electronic banking services venture. The base case is illustrated in Scenario 3. As the duration of the time horizon contracts to only one year in Scenario 1, the value of the growth option reduces to effectively zero. Intuitively, this happens because there is little time for favorable market evolution in such a short time horizon--which brings us back once again to the original (dismal) DCF forecast. As the time horizon increases up to five years in Scenario 5, so does the value of the growth option that is being kept open to take advantage of favorable market developments. But note that the value of the option is considerably more sensitive to the volatility of market returns than to the time horizon.

Conserving Business Value—The Option to Abandon

The growth option of the previous section represented a case of market *entry*. However, we saw in the section on strategy that a company's market participation strategy also includes market *exit* considerations. The governing objective of economic value maximization is also served by abandoning unprofitable, value-destroying lines of business. In today's constantly changing information technology environment, the danger of a market segment becoming suddenly unprofitable is especially high, due to technology advances, competitor entry, and customer pressures. But the cost of abandoning a market segment can be high, and it is reasonable for companies to look for ways to protect their considerable investments if the decision to abandon should be taken. In particular, the conservation of the value of existing business assets becomes important if the company is pursuing the kind of combined entry and exit participation strategy discussed earlier. At the same time that technology advances and business practices render entire market segments obsolete, they create entire new market segments. A company that is able exit, re-position itself, and re-enter at new levels of sophistication is in the possession of a considerable competitive advantage.

Suppose that a company is pursuing a line of business in the computer-aided educational services market. The slow, steady, and profitable growth of the market segment has permitted the company to establish itself at a satisfactory level of economic profitability over the past several years, with a well-known service product line (including CD-ROM based instructional packages) and competent, experienced personnel. But management has noted the rapid advance of multimedia technology over the past few years and its probable impact on the market in which the company participates. In particular, the rise of the Internet has brought not only technological advances with it but also an increase in competition and a larger expected variety of competing services, including new services (e.g. Web-based training) that did not exist previously. Increased direct and indirect competition is to be expected, through new entry and through substitute products and services.

Management is now planning its next generation of services and technological support. If the business continues as usual, it is certainly the best policy to continue with the same technological support infrastructure. However, management has identified another strategic option: to make additional investment and consolidate the knowledge obtained over the years into application framework technology that would allow it to adapt and defend its services in case of unforeseen (but feared) market developments. This additional investment may take place in the form of multimedia infrastructure frameworks such as that described by Posnak, et al. (1997), which would help the company insure its base technology against becoming obsolete through substitute technology. It may also include higher-level frameworks similar to that described by Goldberg, Abell and Leibs (1997) that would consolidate the logic of its curriculum offerings in a more formal, flexible manner and

provide some insurance against radical changes in the nature of computer-assisted educational services. In both cases, the extra investment is significant in terms of technology, training, and realignment of business processes, and management would like to know the value of the strategic option that would be created by this investment. Essentially, it must compare the economics of two scenarios:

Expanded NPV(Scenario 1) = NPV of business without framework technology

Expanded NPV(Scenario 2) = NPV of business with framework technology + option to abandon

Management already understands that the NPV of the business with the extra framework technology investment is lower than the NPV of the business without framework technology if the current scenario continues as before, but it also understands that the extra insurance against a deterioration in its current business conditions has value. Cast in terms of option pricing theory, the growth option of the previous section was an example of a *call option*--it pays off in case of an upturn in market conditions. The option to abandon is an example of a *put option*--it pays off when the value of the underlying investment sinks below a certain level, providing insurance against a market downturn.

Suppose that management estimates that the gross value today of its educational services business is 100 thousand dollars. It considers that the uncertainty of market evolution is such that the standard deviation associated with this estimate is 60 percent. The prevailing risk-free interest rate is assumed to be 3 percent. Management decides that it will operate for eighteen months and make the decision whether to abandon the current business strategy at that point, depending on how the market has evolved. This corresponds to the characteristics of a European option. (Although it would possibly more realistic to think in terms of an American option, which would permit the company to abandon the business strategy at any time, there are technical complexities in the evaluation of American options that would needlessly detract from our examination of the decision-making process here.) Finally, after consulting with the technical staff, management estimates that in case of abandonment of the current strategy, around 85 percent of the value of its investment in the business would be conserved if it was based upon framework technology--to a great extent because it would drastically reduce the effort required to re-group and redirect its strategy. Our spreadsheet function would evaluate this option as follows:

PUT(V=100, E=85, T=1.5*365, RF=3%, STDDEV=60%) = 18

An estimated value of 18 thousand dollars gives management a more tangible basis on which to reason about the amount of strategic value added by the extra investment in framework technology. As before, sensitivity analysis can help management improve its grasp of the key parameters affecting its strategic scenarios. Intuitively, it would seem that the value of the abandonment option created by framework technology investment should depend on the amount of business value the technology is able to encapsulate and conserve. As Table 5 illustrates, this intuition is correct.

Scenario	V	E	T(months)	RF	STDDEV	PUT
1	100	***100***	18	3%	60%	***25.9***
2	100	***95***	18	3%	60%	***23.0***
3	100	***90***	18	3%	60%	***20.2***
4	100	***85***	18	3%	60%	***17.6***
5	100	***80***	18	3%	60%	***15.1***

Table 5: Sensitivity of Abandonment Option to Abandonment Value

As the value conserved in abandonment rises from the base case shown in Scenario 4, the value of the option also rises, until in the rather idealistic case of Scenario 1, where all of the value of the business is conserved, the value of the option to abandon amounts to over 25 percent of the value of the business itself.

Scenario	V	E	T(months)	RF	STDDEV	PUT
1	100	80	18	3%	***10%***	***0.1***
2	100	80	18	3%	***25%***	***2.8***
3	100	80	18	3%	***50%***	***11.4***
4	100	80	18	3%	***75%***	***20.7***
5	100	80	18	3%	***100%***	***29.6***

Table 6: Sensitivity of Abandonment Option Value to Volatility of Returns

As in the case of the growth option, however, it is the uncertainty associated with market evolution that gives the option its real value. Table 6 illustrates a set of scenarios where only 80 percent of the value of the business is conserved by the framework technology investment in conditions of market exit. In the stable market conditions of Scenario 1, reflected in a standard deviation of only 10 percent of returns, the extra investment in framework technology is wasted. But as market conditions become increasingly volatile, the value of the abandonment option rises rapidly, up to nearly thirty percent of the value of the business in the extreme case illustrated in Scenario 5. Not only does this illustrate the powerful influence of market volatility, it also reminds us of the key role of management in intervening *actively* to mitigate the effects of a market downturn on the business.

Managing Market Timing—The Option to Defer

In our discussion of growth options we saw that economic uncertainty can motivate early investment in framework development in order to create an option for large follow-on product market investments. Such early investments are important when the decision has been make to attempt entry into a market; the option requires time to build (certainly the case in framework development); and the expected market evolution is such that subsequent entry would be too expensive or too late when the time for the follow-on investment arrives.

Purchasers of application frameworks often have a different perspective. Their problem isn't necessarily *whether* to invest, but *when* to invest. For example, along with the high uncertainty associated with the market, there might also be uncertainty associated with the rate of maturation of framework technology. A company investing in a software development project for multimedia services in today's volatile economic and technical climate in that market sector may worry that in a year's time:

- the multimedia market has developed differently than expected;
- multimedia framework technology has become available in the meantime that would have provided a much better technical solution than the *ad hoc* solution that had to be adopted only a year before.

Even mature framework technology can lead to a similar dilemma. The purchase of application framework technology is often seen as an effectively *irreversible* investment because of the large financial, technical, and organizational commitment it involves. (Purchasers of Enterprise Resource Planning frameworks often complain that they become unwilling partners for life with the framework supplier, tied to his technology, training, and business processes.)

Astute managers sense instinctively that sometimes it is better to wait for better information than to undertake even a good investment immediately--for by doing so, they may enhance the value of the investment even further. Yet they are also aware of the opposing pressures of time to market, usually manifested in terms of lost revenues due to delayed market entry or the effects of competition. In simple terms, the risk of investing too soon must be balanced against the risk of waiting too long. In a strategic analysis of this situation, it is useful to think of the manager's latitude in the timing of his investments as an *option to defer investment*. Let us consider now how to value this type of strategic option and render it useful to the manager in his decision-making process.

Consider an independent software vendor that would like to participate in the market for outsourcing of enterprise management software services (such as inventory and sales management). Entry into this market will involve becoming a business partner of one of the vendors of enterprise applications frameworks for these kinds of services. The investment will be significant, involving technology purchase, as well as training of personnel as certified applications development partners. The total investment required is 125 thousand dollars. The market economics look attractive, and the gross value of the prospective business has been estimated to be 130 thousand dollars. It is estimated that after it is launched, the business will produce an annual cash flow equal to 15% of the gross value of the project. Since the business under this scenario has a positive Net Present Value of 5 thousand dollars, there seems to be no reason not to invest immediately and begin producing revenues.

But there is a problem. The market is still shaking out and management is not sure whether the enterprise application framework vendor it is considering as a business partner will emerge as the most popular vendor. If it does, then revenues are likely to soar; but if it does not, then the value of the business will diminish greatly. Once management has teamed up with its business partner, it will have taken an effectively irreversible step, and therefore it is considering waiting a year to see how the market evolves before placing its bets. But that will mean giving up the revenues that immediate investment would produce. How can it reason about the relative values of each strategic option?

As noted, the essential dilemma faced by management involves balancing the increased value of waiting to invest (because of active management's ability to exploit increased exposure to market uncertainty) against the drain of lost cash flows due to delayed investment. The holder of an option on a stock that pays *dividends* faces a similar dilemma. The holder of a stock is entitled to receive the dividends on the stock from the moment he acquires the stock. But the owner of an option is not entitled to receive dividends until the option is actually exercised. Thus, although we have seen in the section on growth options that the value of an option normally increases with its time to expiration, a dampening effect on its value arises from the lost dividend payouts.

Since we are more interested here in gaining insight into the decision-making process than in the details of option valuation, we make use of an extended Black-Scholes formula together with some simplifying assumptions. Although modeling the timing decision as an American option that could be exercised at any time up to its expiration date would be more realistic (as in the case of the abandonment option), we will finesse the implementation problems associated with the evaluation of this type of option by modeling a *pseudo-American* option (Damodaran 1997) with a series of European options that can be exercised at a series of discrete dates (e.g. at three-month intervals). Furthermore, we will assume that the prospective investment produces cash flows at a continuous rate at some percentage of its gross value, analogous to a *continuous dividend yield* on a stock. These assumptions will limit the precision of our analysis, but still convey a sense of the how the value of the option is affected by the key parameters.

In our example, the 125 thousand dollar investment can be viewed as the exercise price of an option on the gross value of the business. If exercised immediately, the option is simply worth the value of the business minus the exercise price--its Net Present Value. Its value after one year can be estimated by making further assumptions about the evolution of the gross value of the business. For example, suppose that management accounts for the uncertainty in the evolution of the market by estimating a standard deviation of annual returns on the prospective business of 20 percent. Assuming the current risk-free interest rate to be 5 percent, we make use of an extended Black-Scholes formula for the evaluation of *European call options with continuous dividend yield*, by adding the DIV parameter to represent the estimated annual cash flows as a percentage of the gross value of the business.

CALL(V=130, E=125, T=365, RF=5%, STDDEV=20%, DIV=15%) = 6.1

Thus, the NPV of the business if launched after one year would be increased by over 6 thousand dollars, despite the missed revenues from the first year's operations. In other words: it is better to wait.

Scenario	V	E	T(months)	RF	STDEV	DIV	CALL
1	130	125	***4***	5%	20%	15%	***6.0***
2	130	125	***9***	5%	20%	15%	***6.2***
3	130	125	***12***	5%	20%	15%	***6.1***
4	130	125	***18***	5%	20%	15%	***5.7***
5	130	125	***24***	5%	20%	15%	***5.2***

Table 7: Sensitivity of Option to Defer to Time Interval

Table 7 conveys a feeling for the value of the option to defer as the time to defer increases. Our base case (Scenario 3) of one year is not in fact the optimal length of time to wait. The value of the option increases from 6.0 at four months to a peak of 6.2 at nine months, before the missed revenues begin to drag down the value of the option as the time interval increases.

Scenario	V	E	T(months)	RF	STDEV	DIV	CALL
1	130	125	12	5%	20%	***5%***	***12.2***
2	130	125	12	5%	20%	***10%***	***8.8***
3	130	125	12	5%	20%	***15%***	***6.1***
4	130	125	12	5%	20%	***20%***	***4.1***
5	130	125	12	5%	20%	***25%***	***2.6***

Table 8: Sensitivity of Option to Defer to Rate of Cash Flow Generation

As Table 8 illustrates, the magnitude of the cash flows that are missed by waiting to invest has a significant effect. If the business only produces cash flows at an annual rate of 5 percent of its gross value (Scenario 1), then these lost cash flows do little to offset the value added by waiting out market developments. But when the lost revenues amount to as much as 25 percent of the gross value of the business (Scenario 5) then even the value added by exploiting market volatility is effectively wiped out, and there is little incentive to wait.

Scenario	V	E	T(months)	RF	STDEV	DIV	CALL
1	130	125	12	5%	***10%***	15%	***1.9***
2	130	125	12	5%	***20%***	15%	***6.1***
3	130	125	12	5%	***30%***	15%	***10.5***
4	130	125	12	5%	***40%***	15%	***15.0***
5	130	125	12	5%	***50%***	15%	***19.4***

Table 9: Sensitivity of Option to Defer to Volatility in Returns

Once again, however, Table 9 illustrates the dramatic effects of market volatility on the value of an option. In a stable scenario with essentially no forecast deviation from the estimated NPV (Scenario 1), there is no reason to wait--nothing is likely to change, and the revenues will be lost. But as market uncertainty rises, the value of the option to wait rises rapidly, up to a significant percentage of the project's value at a standard deviation of 50 percent (Scenario 5). This provides yet another confirmation of the importance of viewing risk management as a way of adding value not only by *reducing* risk when appropriate, but by *taking on* risk when appropriate.

The Value of Flexibility—The Option to Switch Use

Consider the hypothetical example of a company that pursues business interests providing information technology solutions in the financial management and human resource management sectors. One business strategy may be to create custom solutions for each of these different market sectors. Another may be to base one's solution upon a shareable application framework that makes it possible to switch among business sectors as demand fluctuates. How can the value of the flexibility afforded by the framework-oriented solution be estimated?

This is an example of an *option to switch use*. The option to switch use underlies the rationale for *flexible manufacturing systems*, a paradigm that has been used by Bassett (1996) and others to describe framework-based software construction capability, as well as component-based software engineering capability. The discrete valuation techniques that are generally used to analyze this type of option (Cox, Ross, and Rubinstein 1979) are out of the scope of this treatment, but we expect to see more work in this area in the future.

Conclusions and Related Work

We have presented a value based view of investment in which the objective of economic value maximization governs the strategic planning process. But in strategy development, as in software development, there are no silver bullets. Value based strategic planning is one of the most difficult challenges faced by management, because no individual product market strategy is ever universally valid. As McTaggart et al. (1994) observe,

> *Value based strategic planning upholds no particular orthodoxy of business strategy. For instance, if more market share, more customer service, more quality, or reengineering the manufacturing process to increase efficiency will create more value for the business, it is a good thing. If the effort does not create higher value, further investment in share, service, quality, or efficiency is unjustified. There is no a priori view on whether markets should be served globally or locally, large scale is better than small scale, a full product line is better than a focused product line, vertical integration is better than outsourcing, cost or differentiation should be the basis of competitive advantage, growth should be sacrificed for higher Return on Equity, or vice versa. The right answers to these questions will depend on a detailed understanding of the financial and strategic determinants of value for the business, and the options afforded by the strategic value drivers for a particular business.*

VBRI thus views reuse investment planning as a continuous process of formulating strategic options and evaluating them with respect to their potential for value creation, either by improving the organization's competitive position or its market economics, or both. The MECP framework adopted by VBRI is presented in detail by McTaggart et al. (1994). Many of the principles embodied in this strategic framework have their origins in the work of Porter (1985). Bassett (1996) also discusses at length the nature of strategic organizational reuse capabilities deriving from investments in framework technology.

Present value concepts in the valuation of capital investment projects are explained in many texts, both informally (Malkiel 1996) and formally (Brealey & Myers 1996). Due to the importance of market considerations in large investments in organizational reuse capability, VBRI introduces concepts from the field commonly known as competitive strategy under uncertainty (Porter 1985). Dixit and Pindyck (1994) provide a particularly extensive presentation of the notion of irreversible investment under uncertainty that we have highlighted with regard to application framework technology investments, and relate it to the notion of options. There are many good texts available on the mathematical elements of option pricing theory (Hull 1993). The perspective on organizational information technology capabilities as real options is represented by several initiatives, such as the work at the Boston University School of Management (Kulatilaka, Balasubramanian, & Storck 1996). We caution that in emphasizing the contribution of an options perspective to value based strategic planning we have glossed over many important conceptual and practical issues in the application of option pricing theory to capital investment projects. Trigeorgis (1996) gives a thorough treatment of these issues.

Future work includes consideration of other techniques for strategic planning under uncertainty, such as scenario planning (van der Heijden 1996), and the incorporation of VBRI principles into the lifecycle process of developing strategic organizational reuse capabilities. Several authors recommend that application framework development should take place within an iterative, spiral lifecycle model, where risk management serves to mitigate technical risk from one iteration to another (Fayad & Schmidt 1997). We have proposed that market risk considerations be incorporated into the risk management process in order that active management intervention may add value by

redirecting strategy according to changing business conditions, possibly taking on *more* market risk when appropriate. Sullivan, Chalasani, and Jha (1997) have taken an options perspective on the spiral model of software development, suggesting that each stage of development may be viewed as an option on the activities of the next stage. They go on to propose an options perspective on the software design process itself, suggesting that it provides a more rigorous way of reasoning about a variety of well-accepted but informal design heuristics.

We have discussed the four levels of organizational capability that are identified in the Reuse Capability Model. Many organizations have already realized significant benefits from reuse investment at the lower levels of the model. Application framework technology investment promises even more significant benefits; but the potential of application framework technology for value creation can only be realized if it is exploited at *all* levels of the Reuse Capability Model. That is the goal of Value Based Reuse Investment.

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