Finally, when the two alternative development options were evaluated and presented against the perceived underlying strategic value of the site with these opportunities, management debate focused on market uncertainty in both sectors and the cost and timing of the switch. A real options analysis provided a quantitative and analytical backdrop for those discussions. The option to keep the ability to switch open until such a time when it was concluded optimal to pursue a residential development and, therefore, the contingent claim will then be exercised.

CASE 9: NAVAL SPECIAL WARFARE GROUP ONE'S MISSION SUPPORT CENTER CASE

This case study was developed by Sarah Nelson, Tom Housel, and Johnathan Mun. Nelson is the CEO of Intellectual Capital Ventures, LLC, a boutique consulting and valuation firm in Chicago, Illinois. Housel is a professor of information sciences at the Naval Postgraduate School in Monterey, California. Both Housel and Mun are strategic partners of the author's firm, Real Options Valuation, Inc., and the results of this project were presented to the Office of Force Transformation, Department of Defense. Proprietary and sensitive information have been removed but the essence of the real options application remains.

We developed the following case study for the Office of Force Transformation, Department of Defense (DoD), to demonstrate the power of applying real options analysis, populated with new raw data gathered using Knowledge Value-Added (KVA), to battlespace strategic planning initiatives. The quantitative analyses provided by pairing KVA and real options analysis enabled the DoD to better understand its return on investment in people and information technology for a technology-heavy mission support center. It also enabled the DoD to gain clarity regarding the many benefits of real options analysis for future planning purposes.

The Naval Special Warfare Group One (NSWG-1) of the United States Navy established and utilized a Mission Support Center (MSC) to assist in conducting mission planning and execution during Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF). The MSC was a reach-back component, located in San Diego, California, that used information technologies to enhance the collaboration between forward and rear units and provided shared situational awareness for war planners and war fighters.

The MSC was designated NSWTG-REAR and was able to generate high-priority requests for information (RFI) that the intelligence community answered. Three new IT tools were also used as an integral part of MSC operations:

- A3, a relational database developed to provide tailored intelligence products.
- WEBBE, a multipoint instant messaging tool with voice-over capabilities.
- Access to Global Broadcast Service (GBS), a satellite downlink that provided for fast transfers of large data files.

Table 11.36 summarizes the people, processes, and technologies that made up the MSC for OIF.

The Mission Planning Cycle supported by the MSC included a number of core processes such as Mission Feasibility Assessment, Warning Order, Fragmentary Order, Concept of Operations, and Execution Order.

We selected the Mission Feasibility Assessment (MFA) cycle for our analysis and made the following assumption: The Mission Feasibility Assessment Cycle was the only segment of the Mission Planning Process in which the MSC-Rear participated and the remainder of the Mission Planning Process occurred forward in the field. This assumption allowed us to equate the total costs and proxy revenues for the MFA cycle with the costs and proxy revenues for the MSC as a whole for use in developing net cash flows for discounted cash flow and real options analyses.

The MFA cycle consisted of ten subprocesses: Receipt of Mission, Mission Feasibility Analysis, Assess SOF Operational Criteria, Develop Courses of Action, Analyze Courses of Action, Compare Courses of Action, Recommend Course of Action, Commander's and Forward Staff's Planning Guidance,

TABLE 11.36 People, Processes, and Technology for OIF MSC

Force Elements	MSC for OIF
Information Sources	Collaborated intelligence/info sources sensors, HUMINT
Value-Added Services	Federated network, Blue Force Tracking, A3, Global Broadcast System, WEBBE, JWICS, SIPRNET for strategic and tactical missions
Command and Control	MSC was permanent and colocated; staffed 24 hours a day, 7 days per week
Effectors	Force composition was 110 staff forward in theater; 75 staff rear at MSC. Supported 600 SOF forces and 7,805 METOC requests
Operating Environment	Desert

HUMINT = human (source) intelligence; JWICS = Joint Worldwide Intelligence Communications System; METOC = a privately owned U.K. company; SIPRNET = Secret Internet Protocol Router Network; SOF = soldier of fortune.

Issue Warning Order, and Issue Feasibility Assessment to JTF/Requested Element. In addition, we included IT infrastructure support in the analysis.

Statement of the Real Options Case Problem

According to a detailed study (June 2004) by Booz Allen Hamilton that assessed the effectiveness of the MSC, the MSC enhanced command and control, increased mission unit effectiveness, altered initial conditions, significantly increased combat power by increasing the number of combat missions that could be simultaneously conducted worldwide, and decisively impacted events in the global war on terror.

For this reason, the U.S. DoD has decided that it needs several more MSCs to assist Joint Forces Special Operations in their warfighting missions. However, the DoD does not know the most effective force mix to use to staff the MSCs and whether the supporting IT should be built, bought, or outsourced. The uncertainties related to acquiring the right MSC analysts and IT, and budgetary constraints were significant.

Instead of simply making a decision on whether implementing the MSCs is prudent and executing it without regard for an ongoing implementation strategy, the DoD has chosen to create a sequential compound option for quantification and review. This stage-gating approach will allow the DoD to halt strategy execution at any given decision node, should that strategy no longer be desirable to pursue.

Three Strategies for Analysis

Three strategies have been selected for analysis. All three have the same initial assumptions:

- The requirements of projected combat potential indicate that Joint Forces will need to enlarge the current MSC to full capacity during Year 1, using current IT.
- Within the next three years, the DoD will also need an additional five MSCs containing 25 analysts each to support five Combatant Command teams of five (i.e., five analysts will be assigned to one Combatant Command team).
- The MSCs will begin to serve all Joint Forces special operations groups, rather than just NSWG-1.

The other critical assumption is that the Mission Feasibility Assessment Cycle is the only segment of the Mission Planning Process in which the MSC will participate. The remainder of the Mission Planning Process will occur strictly in the field. This assumption allows us to equate the total costs and proxy revenues for the MFA cycle with the costs and proxy revenues for the entire MSC. Simplified descriptions of the three strategies are presented next.

Strategy A The increasingly complex technologies and training required to develop, staff, and operate an MSC in support of widely dispersed, ever-changing, asymmetric warfighting scenarios are probably best obtained from the already intensive, mission-specific R&D and long-term training and expertise offered by in-house DoD initiatives. Although Command does not want to utilize warriors from the tip of the spear as MSC analysts, the Reserves have an excellent pool of talent that could be retrained and used in this capacity. In addition, these Reserves would have actual military training and experience and would not need the extensive preparation required for civilian analysts.

The DoD wants to rehab existing military facilities to house the MSCs and will use the current MSC as a prototype for the initial rehab of a physical plant. In addition, the DoD will lease the IT infrastructure and hardware necessary to operate the MSCs and develop customized software over a six-month period, using contract labor under the direction of DoD experts.

Strategy B The increasingly complex technologies and training required to develop, staff, and operate an MSC in support of widely dispersed, ever-changing, asymmetric warfighting scenarios represents a challenge. Command feels that, given the unique nature of Special Forces Operations, the best pool of talent to use in MSC staffing is regular military, preferably with exposure to Special Forces Operations. Neither Reservists nor civilians fit this profile. Command also feels that there is not enough time to develop software in-house or by outsourcing can meet the urgent needs in the field today. So Command has made the decision to purchase off-the-shelf software, utilize intensive training on the software for seasoned military analysts, and adjust as needed at the end of Year 1.

The DoD wants to rehab existing military facilities to house the MSCs and will use the current MSC as a prototype for the initial rehab of a physical plant. In addition, the DoD will lease the IT infrastructure and hardware necessary to operate the MSCs and will enter into a joint venture with the vendor supplying the software in which the vendor will supply the initial software and upgrades at a healthy discount from private sector prices.

Strategy C The increasingly complex technologies and training required to develop, staff, and operate an MSC in support of widely dispersed, ever-changing, asymmetric warfighting scenarios is probably best obtained from the private sector. Here the profit motive, extensive R&D, and technology entrepreneurship will provide a much fuller menu of choices at a lower cost than those offered by DoD R&D initiatives.

The DoD wants to rehab existing military facilities to house the MSCs and will use the current MSC as a prototype for the initial rehab of a physical plant. In addition, the DoD wants to purchase and own the IT infrastructure and hardware necessary to operate the MSCs, but does not want to buy or build the software in-house. A software developer will provide customized software and upgrades for all MSC functions, hire and manage all analysts, and also hire the original five military analysts at equivalent private sector rates to use them as trainers as well as analysts. The vendor will retrain and redeploy the analysts assigned to the MSCs for other DoD functions, should the DoD seek to cancel the contract after Year 1. The strategic tree for this analysis is found in Figure 11.63.

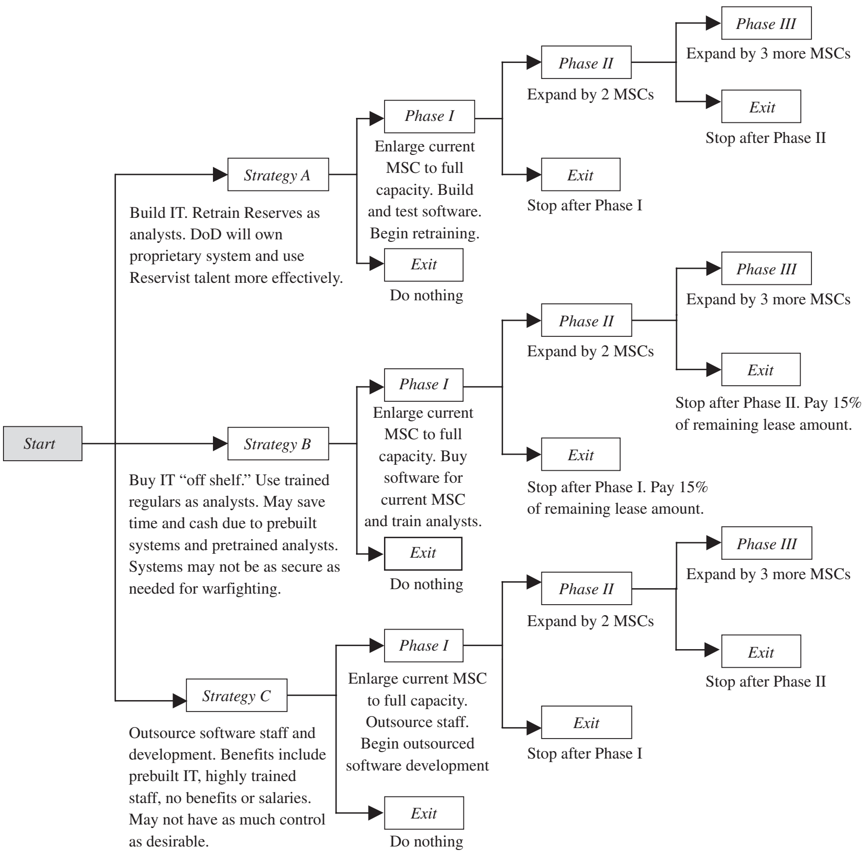

FIGURE 11.63 MSC Strategy Tree

Unique Data Needs

As the future MSC concept will be developed and owned by the DoD, a not-for-profit organization, the analysis requires the use of unique data sets for revenue. Traditionally, for government forecasting, budgeted revenues are equivalent to budgeted cost. This makes it impossible to develop a genuine return on investment (ROI) or to change strategic focus from cost savings to value creation. In addition in this setting, the for-profit capital markets provide no reasonable proxies or comparable data by which to develop the discount rate to be used in Discounted Cash Flow (DCF) analysis or other inputs to the real options analysis model.

To solve these problems, we took two steps: (1) We developed proxy revenues, and (2) we used KVA to assign these proxy revenues to the MFA cycle subprocesses in order to develop a discount rate and real options analysis model inputs.

Developing Proxy Revenues

In the MFA cycle, processes are executed by humans, assisted by information technology. In a very real sense, humans drive the "revenues" (i.e., cash inflows) of the MSC because, without their agency, the MSC would cease to function and it would receive no budget dollars. For this reason, we have chosen to use the private sector "market values" of these human agents as proxy revenues for the MSC. These proxy revenues are a conservative reflection of market expectations for the leverage of human capital in producing revenue (value) for the organization.

Such market values are equivalent to private sector salaries for human agents with similar experience, skill sets, and responsibilities. We developed our proxy revenues by increasing budgeted annual military salaries by a "market premium." This market premium is the percent by which private sector salaries would exceed military salaries for the same levels of experience and responsibility.

KVA and Its Use

KVA is the seminal work of Dr. Tom Housel (Naval Postgraduate School), the coauthor of this case, and Dr. Valery Kanevsky (Agilent Labs). Developed from the complexity theoretic concept of the fundamental unit of change (i.e., a unit of complexity), KVA *provides a means to count the amount of organizational knowledge, in equivalent units, that is required to produce the outputs of the organization*.

The following four assumptions allow KVA to equate units of change (complexity) with units of organizational knowledge and then count them:

1. Humans and technology in organizations take inputs and change them into outputs through core processes.
2. All outputs can be described in terms of the amount of change (i.e., complexity) required to produce them.
3. All outputs can also be described in terms of the time required by an "average" learner to learn how to produce them. Learning time can be considered a surrogate for the amount of organizational knowledge required to produce the outputs. KVA describes these common units of learning time (i.e., units of output) by using the term *knowledge units* (K_μ).
4. A K_μ is proportionate to a unit of complexity, which is proportionate to a unit of change.

By describing all process outputs in common units (i.e., the K_μ required to produce them), it is possible to assign revenue, as well as cost, to those units inside the organizational boundary at any given point in time. This makes it possible to compare all outputs in terms of revenue per unit as well as cost per unit. In addition, once we have assigned both revenue and cost streams to suborganizational outputs, we can apply standard accounting and financial performance and profitability metrics to them. This methodology applies to not-for-profit as well as for-profit organizations.

KVA and Real Options Analysis for the MSC Sequential Compound Option

The question that remains after building and analyzing the strategy tree is: Which strategy is optimal? The KVA methodology provides the raw inputs (return on knowledge investments as well as assignment of both costs and proxies for revenue). Real options analysis uses these inputs to determine the optimal strategy to execute.

Apply Base Case NPV Analysis and Use Results in Monte Carlo Simulation

First, we modeled the results from the KVA approach into a set of discounted cash flows for the three strategies, resulting in expected net present values (NPVs, i.e., benefits less cost, on a present-dollar value basis), without flexibility, for each. For base case NPV analysis, DCFs were run for each year and then summed to arrive at a total NPV for the three years for each strategy. This base case approach assumes that all future net cash flows are known with certainty and therefore there is zero volatility around input values.

However, the future net cash flows related to the MSC project strategies do involve uncertainty. For example, salary levels may fluctuate over the course of the project. Since we pegged proxy revenues to budgeted salaries, proxy revenue fluctuation will be correlated to the volatility of salaries. In addition, the rate of inflation, modeled in the base case as 4.5 percent, may fluctuate (i.e., exhibit volatility), as may the risk-free rate used to discount future net cash flows. These kinds of input volatilities suggest that we should develop a probabilistic range of NPV values for our analysis, rather than on a single-point estimate of value.

These probabilistic value distributions are generated by using Monte Carlo simulation. All the volatile (i.e., fluctuating) inputs into the model are simultaneously run through 1,000 trials, allowing them to all change at the same time. The results are 1,000 NPV values collated into probabilistic distributions.

For example, Strategy A's NPV is distributed such that its expected NPV is $24.37 million. However, due to the probabilities related to input volatility, the 90 percent statistical confidence range places this NPV at between $23.60 million and $25.13 million.

Table 11.37 shows the expected NPVs and statistical confidence ranges of the three strategies. As we review these results, they indicate that, using the base-case NPV approach, Strategy B is the optimal decision to pursue.

However, NPV analysis only provides a static description of a single decision pathway for each strategy, utilizing a single probability distribution to represent each strategy's input fluctuations. It does not take into account the discrete volatilities and uncertainties related to *staged* MSC implementations or the option to exit and abandon the program if a future stage proves to be unsuccessful. NPV analysis looks at the strategy as a straight path that must be traversed regardless of the learning and changes that occur at a later date. It ignores the inherent flexibility to abandon or expand to the next phase.

So we used real options analysis to look at the complete strategic value of each pathway, accounting for not only the underlying base case input volatilities and uncertainties but also the strategic flexibility embedded in each stage of the pathway.

Develop Volatility Parameter and Calculate Option Results with Simulation

One of the more difficult input parameters to estimate in a real options analysis is volatility. The base-case NPV probability distributions do not tell

TABLE 11.37 Expected NPVs and Statistical Confidence Ranges

	Expected NPV	90% Statistical Confidence Range
Strategy A	$24.37M	$23.60M to $25.13M
Strategy B	26.63M	26.24M to 27.02M
Strategy C	24.75M	24.02M to 25.51M

us what volatility parameters we should apply to inputs into a *staged* MSC implementation. Ordinarily, to get these we could go out to the markets and make estimates based on our informed professional judgment or use historical data to help us build our estimates. However, the DoD has no market comparable data that could reasonably be used for this purpose.

KVA produces an internally generated historical ratio, return on knowledge investment (ROKI), which can be used in a Monte Carlo simulation to generate a volatility parameter. This volatility parameter is a statistical value representing the distilled, integrated effects of all the volatilities and uncertainties inherent in the forecasted values for each MSC strategy stage.

Several methods are available to calculate volatility. We used the Logarithmic Present Value Approach with Monte Carlo simulation, as it was the most robust method and provided a higher degree of results precision. When implied ROKI volatilities were simulated using the Logarithmic Present Value Approach, they produced the volatility parameters shown in Table 11.38. These parameters implied that there were high levels of fluctuation by staged ROKIs around base-case returns, suggesting high degrees of risk inherent in all strategies.

Using these volatility parameters as well as the other inputs associated with each stage of each strategy, we ran real options analysis using binomial lattices and simulation.

Each real options analysis provided us with two new valuations to consider along with the base case NPVs: the total strategic value and the value of the options built into the staged models. Table 11.39 summarizes these values for our three strategies. [Columns (A) + (B) = (C)]

Once the real options analysis was completed for all strategies, we were able to compare total strategic values with base case NPVs under varying levels of volatility, to identify the optimal strategy to execute. Table 11.40 presents the results of this statistical comparison.

An interesting result emerges. When volatilities are low, Strategy B is optimal. However, when the volatility is high, the total strategic value (NPV plus real options value) indicates that Strategy C is optimal. Because the analy-

TABLE 11.38 Volatility Parameters Related to Strategy ROKIs

	Volatility Parameter for ROKI (%)
Strategy A	92
Strategy B	86
Strategy C	92

TABLE 11.39 Base-Case, Option, and Total Strategic Values

	A Base-Case NPVs	B Option Values	C Total Strategic Values
Strategy A	$24.37M	$9.42M	$33.79M
Strategy B	26.63M	8.37M	35.00M
Strategy C	24.75M	14.17M	38.92M

sis of each strategy involved a relatively high volatility for ROKIs (92 percent, 86 percent, and 92 percent), the optimal strategy is C.

Hence, when accounting for the strategic flexibility of the MSC implementations, Strategy C should be undertaken. In fact, Figure 11.64 indicates that 99.90 percent of the time, Strategy C has a higher strategic value than Strategy B.

Problem-Solving Contributions of KVA to Real Options Analysis

At the most aggregated level, real options analysis occurs in four phases over time:

- Phase One—Establish the structure for the problem.
- Phase Two—Plan and frame the options (i.e., lay out the options).
- Phase Three—Implement (exercise) the options over time.
- Phase Four—Track options results and adjust decision paths.

KVA can make significant contributions in Phase One by providing a higher quality of fundamental data inputs to the problem structure. Currently real options analysts use project-level, or even company-level, data for real options analysis. There are currently no specific suborganizational data that can be used. KVA can analyze the effects of core processes on a project and provide fresh raw data based on estimated suborganizational revenues and costs. This suborganizational level data also allows analysts to identify and understand the interdependencies among processes within the project and between the project and the company.

In addition, KVA can make significant contributions in Phase Four. As KVA data is gathered, it can be used to build near real-time option performance assessments. Currently, there has been no direct way for management to measure option performance on an ongoing basis once an option decision path has been selected.

TABLE 11.40 Reversion of Optimal Strategy under Different Volatilities

	Volatilties (%)														
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Total Strategic Value	B	B	B	B	C	C	C	C	C	C	C	C	C	C	C
Base-Case NPV	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B

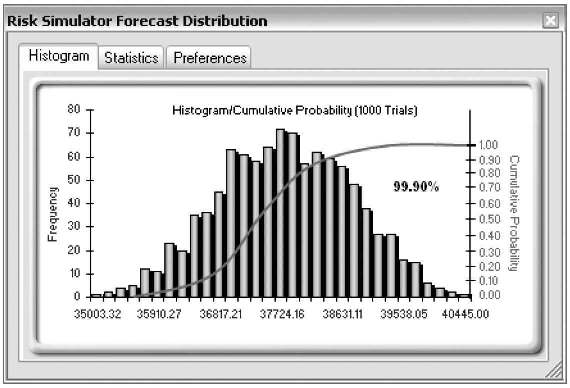

FIGURE 11.64 Strategy C's Statistical Probability of Exceeding Strategy B's Value

Problem-Solving Contributions of Real Options Analysis to KVA

As we stated earlier, KVA uses historical data. KVA has needed the theoretical and practical means by which it could also be used prospectively. Real options analysis provides the rigorous quantitatively based structure in which

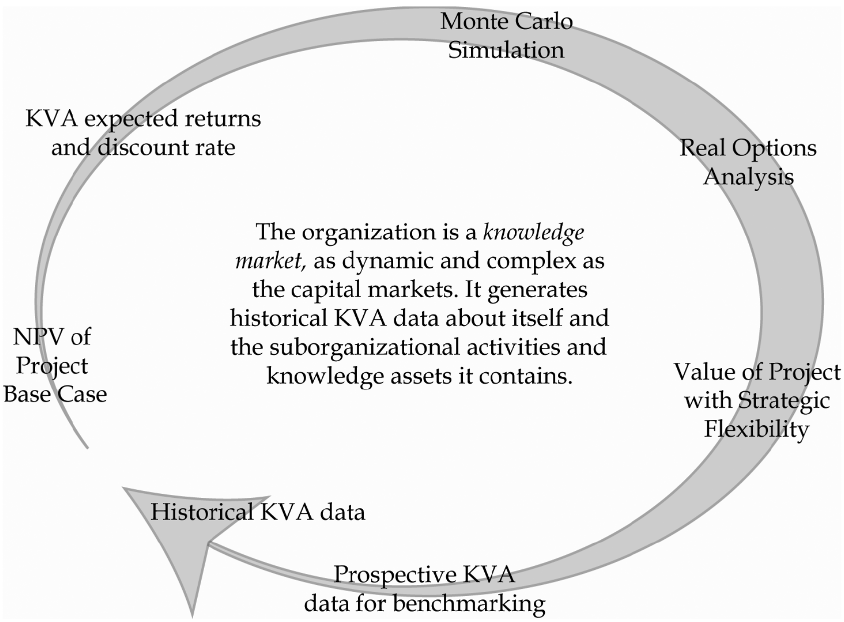

FIGURE 11.65 KVA and Real Options Analysis Cycle

to use KVA data and build effective prospective analyses of suborganizational activities and knowledge assets.

Figure 11.65 offers a diagram of the contributions of KVA and real options analysis to each other. It is intended to demonstrate why they should be applied together as a total solution to strategic planning initiative problems.

KVA provides the required data and real options provide the methodology to analyze the data for aking the right decisions.