Teaching Case
InterCon Travel Health: Case B

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ABSTRACT

InterCon provides services to health insurers of foreign tourists who travel to the United States and Canada. Management wants to implement a new information system that will deal with several operational problems, but it is having difficulty securing the capital resources to fund the system's development. After an initial failure, the chief information officer tries a second time with a modified approach referred to as real options valuation. Real options valuation methods are well suited when valuing assets that present discretion or flexibility in how asset implementation is structured in terms of amount or timing. The efficacy of real options valuation to information systems development projects is explored as the company's management applies the valuation method to the proposed information system.

Keywords: Information Systems Management, Real Options, Monte Carlo Simulation, Information Technology Planning, Capital Budgeting, Systems Development

1. INTRODUCTION[1]

CIO Richard Nettleson was surprised to learn the outcome of the claim automation system valuation—the project had been passed over because its 5-year NPV was estimated in the range of $2.1-2.5 million.[2] Moreover, the Monte Carlo simulation showed that the project had about a one in four chance of attaining a 5-year NPV of at least $3 million, InterCon's de facto cutoff for funding. These were not good odds. Nevertheless, he believed that the claim automation application was essential for creating effective and efficient business processes, which would become even more critical as the company grew. He felt strongly that this project should receive funding, and that somehow the NPV analysis was missing some of the value of the project.

Nettleson had at least two alternatives. He could argue before the project evaluation committee that the project was critical to future growth, and that it should go forward despite the unfavorable valuation. The committee had been generally unenthusiastic about and unsupportive of such efforts in the past. Moreover, as a committee member, he had recently voted against funding a different project that was advocated on similar grounds. He could potentially lose credibility were he perceived as applying a double-standard.

Another alternative would be to reframe the claim automation project proposal using real options analysis to value the inherent flexibility provided by either successively staging or stopping different parts of the system over time, depending on how the actual circumstances turn out. Nettleson knew that the prior NPV analysis did not consider such flexibility, and he felt that it must have some value. Having recently read about and heard from others about the use of real options in IT capital investment valuation, he was interested in knowing the valuation level that would result from considering the real options inherent in the claim automation project. He was also interested in better understanding how and why real option valuation models are generally considered more complex than DCF models.[3]

In order to proceed, Nettleson realized that he had to do three things. First, he needed to understand option pricing methodologies in general and how these methodologies might be applied to real assets such as an IT development project. After considerable reading and several consultations with his neighbor Michael, who was a finance professor at a nearby university, he wrote a brief primer to formulate and clarify his understanding. Second, he had to re-conceptualize the IT development project in terms of successive stages, so that any stage can be thought of as creating conditions that can inform management whether or not they should proceed to the next stage. Rethinking the IT development project in this way would be useful to show the inherent flexibility behind staging implementation, and to make the connections between staging IT implementation and real option valuation more salient. Finally, Nettleson had to show specific details about how real option valuation could be applied to the specific IT development project in question.

2. A PRIMER ON OPTIONS PRICING [4]

At its base, real options analysis uses techniques and concepts that are similar to those used to price finance options, such as those used to value call and put options on stocks, commodities, or financial instruments. As a result, a short review of financial options may be helpful.[5]

Financial options give a buyer[6] the option, but not the obligation, to buy (call) or sell (put) an underlying instrument such as a stock or commodity at a specified price on a specified date.[7] The specified price is called the strike price, and the specified date is called the expiration date. Between the time that a call (put) option is purchased and the expiration date, the buyer is betting—read hoping—that the current price will rise above (fall below) the strike price to a level that presents a gain situation over and above the cost of the option itself, which is called the premium. If a loss situation presents at expiration date, then the buyer simply does not exercise the option. For this benefit, the buyer of the option must pay the premium to the seller. This option therefore provides for potential gain or profit on the upside without incurring any loss exposure or risk on the downside except for the premium paid for the option.

Valuing a financial option on an underlying instrument or asset can be modeled in different ways. The choice of a model should be principally driven by the objective to match the valuation model's assumptions to the underlying asset's characteristics. While any match is imperfect, there are varying degrees to which a chosen model's assumptions fit with the asset's characteristics. Thus, a model should be chosen with the objective of optimizing the fit.[8]

A common model for valuing options on financial instruments, the Black-Scholes model, includes the following parameters and formulations[9]:

◊ X – Strike (exercise) price
◊ r_f – Risk-free discount rate
◊ V_o – All expected future cash flows discounted by r
◊ t – Option's time to expiration
◊ σ (sigma) – Volatility of V
◊ C – Price of the option

$$C = V_0 N(d_1) - Xe^{-r_f t} N(d_2)$$

where N(d) denotes the cumulative probability of the normal distribution up to the point d, and

$$d_1 = \frac{\ln(V_0 / X) + (r_f + \sigma^2 / 2)t}{\sigma\sqrt{t}}$$

and

$$d_2 = d_1 - \sigma\sqrt{t}$$.[10]

The price of any underlying instrument will vary over time as it is subjected to various market forces. During the time period between purchase and exercise of the option, greater levels of price volatility renders a greater likelihood that the price will exceed the strike price by greater amounts. This increases the likelihood of a gain situation—increases the upside potential. While there is greater likelihood that the price will fall below the strike price as well—and therefore a greater likelihood of a loss situation—the buyer is protected from the downside risk because there is no obligation to exercise the option. As a result, the buyer of the option will have the possibility of unlimited gain on the upside, but the loss to the buyer is limited to zero plus the premium on the downside. Thus, as the underlying instrument's price volatility increases, the value of a call option on that underlying instrument increases as well, as more volatility might cause more gain, but the losses are limited. This counterintuitive effect results from the fact that a rational buyer will exercise the option only when a gain situation presents, and will forego the option in the event of a loss situation.

After concluding the primer, Nettleson remained fascinated by the pricing of financial options, but was curious as to how this real option framework may be applied to IT development projects. After some further review, he noted that the future investment cost can be considered the strike price (X). Upon doing that, Nettleson realized that the cost of the project should then be subtracted from the value or price of the option (C) to see if the project is worth doing, which is similar to the NPV analysis.

However, Nettleson wondered if this formula that was created for financial options should be used to value real options. He learned that there is some debate about the applicability of option pricing formulas such as Black-Scholes to real options, because these formulas carry the assumption that the underlying asset is easily tradable so that a replicating portfolio may be made and then bought or sold readily. Nettleson read that this tradability assumption is clearly violated for many real assets, particularly for projects that have specific cash flows for a particular firm, as these projects generally cannot be traded.[11] Clearly this pertained to the IT development project under consideration—there was no conceivable way that InterCon could trade the project once development was underway. Moreover, Nettleson learned that the tradability assumption applied in several derivations of real option valuation models including Black-Scholes (Black and Scholes, 1973;Merton, 1973), and even binomial tree models. Nonetheless, after further review, Nettleson discovered that financial option valuation methodologies are still widely used to value real options despite the tradability assumption violation.

3. RECONCEPTUALIZING IT DEVELOPMENT PROJECTS

Whether customized or off-the-shelf, IT applications are typically designed in modular fashion. Applications' modular design allows for several advantages, including the ability to follow a staged implementation strategy. Under a staged implementation, management may introduce an application's modules or parts in successive stages or phases.[12] This strategy staggers development and implementation of modules, and will allow for concentrated effort on one or few modules. This strategy also typically reduces the development time for those modules that are implemented first, consequently some benefits are realized earlier. In summary, another way to think about introducing different parts or modules of an IT system is in terms of staging or phasing in their implementation. So an initial investment in one or few modules provides the conditions for subsequent investment in additional modules at a later time.[13]

After the initial modules are created and implemented, conditions can be re-evaluated by management before the additional modules begin. Should the situation have changed since the initial decision on the initial models, or should it turn out that the initial estimates are later proven to be wrong so that it is clear that the entire project will not work, management has the flexibility to either re-sequence module staging or the discretion to abandon the additional modules altogether. Thus, by leveraging the module nature of applications, management gains some flexibility or discretion over how or whether to proceed partway through the application´s implementation cycle.

4. APPLYING REAL OPTIONS VALUATION TO IT DEVELOPMENT PROJECTS

Nettleson recalled that the original project proposal identified two modules for initial implementation—online claim entry and automated claim processing modules. He also recalled that other important modules were identified during the original valuation effort, but these were not included as part of the first stage of implementation. It was initially thought that these other modules would be added later by implementing them in a successive stage. Moreover, based on his experience, he felt that implementation of these other important modules would likely provide additional benefits and, ultimately, add pay-off or value to the claim automation system. While he was comforted by his previous experience that these other modules are generally beneficial, Nettleson felt that it is always worthwhile to evaluate ALL potential projects to make sure that the financial situation in this particular case supports his general intuition.

Nettleson realized that by implementing the two modules in an initial stage, the firm will have the opportunity, but not the obligation, to implement other important modules in subsequent stages. Based on his experience, Nettleson identified some important modules for second-stage implementation including medical term explanation, language translation and module integration. Largely due to his general intuition that application integration usually leads to substantive benefits, he decided to first study the value of the flexibility created by adding module integration to the proposal. If he needed additional justification, then he could assess any increase in value from the flexibility created by including other modules as well.

4.1 Module Integration

The online claim entry and automated claim processing modules that were previously proposed and analyzed in ITH-A will only partially automate the claim adjudication process. The systems analysts envision that the online claim entry module will be used to both enter claim data and subsequently view them. This module will also exert control over data entry procedures, such as requiring certain data upon initial claim submission. This is intended to alleviate a common problem of missing data, which sometimes prevent the staff from settling the claim on time. The module can also be designed to help increase the overall accuracy and completeness of the information.

After the data are entered online by a medical provider, they will enter a queue for adjudication. The adjudication procedure involves claim administrators in manual effort to determine the settlement amount, which takes both time and mental energy. The settlement amount is based on the facts of the underlying claim and InterCon's internal decision rules, and is typically less than the claim amount. Claim amount, medical procedure, treatment date, deductible, maximum out-of-pocket and co-insurance factors are some of the relevant facts that must be considered when adjudicating a claim, as well as rules invoking the relevant health care policy's eligibility criteria and rules invoking the patient's current annual out-of-pocket expenditures. As a result of these complexities, claim adjudication is a complex process.

The complexity of the adjudication procedures also varies by claim type. The procedure is generally most complex for class A claims and least complex for class C claims, with class B claims lying somewhere in the middle. Complexity also varies according to the patient's home country. In some countries, national health care policy dictates full coverage for many medical procedures. Such full coverage policies actually simplify things as the settlement amount is the claim amount, since many of the facts and rules are no longer considered during adjudication.

InterCon's analysts envision that the automated claim processing module will present the claim data to the staff member in a comprehensive format.[14] This format includes convenient display of complete and accurate medical provider and host country representative contact information, which is currently stored in and referenced from separate hard-copy files. Even with this module, determining the settlement amount will remain largely a manual effort, and more manual input will be required. Once calculated by a staff member, the settlement amount will need to be entered along with an adjudication date, which will flag the claim as complete. If everything works correctly, the system will subsequently print a check for the medical provider, bill the foreign insurer, and generate the necessary accounting transaction information for InterCon's accounting staff automatically. Ninety days after completion, any claim will be automatically removed from the queue and archived.

Module integration will entail automating the adjudication procedure by modeling the decision rules of the adjudication procedure. Assuming that the data are complete and accurate, and that the decision rules are reliable, the settlement amount will be automatically determined by the system. This automated procedure will replace the manual procedure that currently involves claim administrators in an effort to determine the settlement amount. This will relieve the claim administrators from both time and mental energy, and significantly speed up and improve the accuracy of the claims adjudication process. When it works, the entire adjudication procedure will be automated from start to finish. Based on his experience, Nettleson felt that this module in particular will provide many benefits, and may even provide some eventually transformative effects such as significantly expanding claim processing capacity or improving agility with respect to incorporating adjudication rule changes.

Nettleson was excited about the possibilities! He renamed the project to Comprehensive Claim Automation (CCA), and he decided to stage implementation of the CCA modules according to joint effect of technical, organizational and political considerations. Thus, online claim entry and automated claim processing would be included in the first stage, and module integration would be included in the second stage. By introducing the modules in successive stages, some degree of flexibility is introduced with respect to the amount and timing of system capabilities, as well as managerial discretion as to whether or not to proceed depending on the circumstances and the success or failure of the initial implementation. This flexibility and discretion might be best captured by real option analysis, Nettleson felt.

5. THE PROJECT'S DETAILS

5.1 Benefits

During the initial valuation, the benefit group organized the expected benefits into three areas—claims processing cost reduction, lost claim income reduction, and service quality enhancement. The group assumed that service quality enhancement would attract more insurers and providers in the long run and therefore would generate more processing fees. Nettleson now asked them to reconsider the larger but more flexible CCA project. As they began to explore additional benefits that would result from the CCA, they quickly realized that any additional benefit would fall into the same three areas.

Following data collection procedures similar to those for the initial valuation, the benefit group determined that the average benefit levels were \$1,200,000, \$800,000 and \$200,000 for claims processing cost reduction, lost claim income reduction, and service quality enhancement respectively. All benefit annual growth rates were estimated at 3%. Finally, in cases where a module or feature was replacing manual effort and its introduction was transparent to the users—or at least very nearly so, then little to no lag in benefits should occur. The benefit team believed that this was likely to occur for module integration. Thus, they anticipated no lag. This placed the timing of benefit introduction at year 3 and continuing in perpetuity at the estimated growth rate.

5.2 Costs

Nettleson also asked the separate cost group to reconsider the larger CCA project. The projects costs were broken down into three areas: development, operations and maintenance. Development costs generally related to the up-front or one-time investment related to designing, building, testing and implementing the CCA modules. Operations and maintenance were generally related to the continual or on-going expenses that are incurred from using the CCA modules.

The costs group solicited estimates from informed and expert individuals as before. In addition, they decided to estimate very conservatively by doubling the obtained cost estimates. The conservative approach yielded figures that were very close to the cost estimates associated with the online claim entry and automated claim processing modules. In the end, the costs group settled on \$3,500,000 development costs to be incurred in year 2. Operations and maintenance costs were estimated at levels identical to those for the initial modules—\$110,000 with 5% annual growth rate for operations and \$150,000 with 10% annual growth rate for maintenance.

As before, Nettleson reminded the benefit and cost groups to take great care in calculating estimates of the expected benefit and cost levels. He stressed that, regardless of the power or sophistication of the analytical framework and methods, starting with biased estimates will yield biased results and conclusions. Nettleson reminded them that the typical "garbage in, garbage out" scenario still holds true regardless of the level of sophistication of the technique, and, in fact, the problem may be exacerbated with highly sophisticated techniques that tend to be more sensitive to assumptions.

6. A GREEN LIGHT THIS TIME?

Nettleson was anxious to know what decision outcome would result for the CCA as the project was conceptualized from a real options perspective. He knew that the benefits and costs groups would not tolerate continually revisiting this investment decision, so he hoped that the real options valuation model would result in a favorable outcome for the investment decision this time.

7. DISCUSSION QUESTIONS

1. What are the specific costs and benefits that are associated with module integration?

2. How does the real options valuation model yield a different result from that of NPV?
3. Should the company fund the project based on the funding criteria and information presented in the case?
4. How significant is the impact of different assumptions on the inputs in the option pricing model for the final decision?.[15]

8. ENDNOTES

Most data that are referenced in the case may be found in the worksheet models.

[1] As noted in InterCon Travel Health A, although the NPV rule suggests taking any project with a positive NPV, due to capital constraints InterCon has *de facto* adopted a rule that a project must have an NPV of larger than $3 million in order to receive funding.

[2] For a description of financial modeling, including both NPV and real options, see http://www.financialmodelingguide.com/analytical-tools/real-options/.

[3] The reader may find these web resources helpful for understanding options in general: http://en.wikipedia.org/wiki/Call_option and http://en.wikipedia.org/wiki/Put_option. For an excellent quick online primer on real options, see Campbell Harvey (editor of *The Journal of Finance*)'s website: http://faculty.fuqua.duke.edu /~charvey/Teaching/BA456_2002/Identifying_real_options.htm. Another real options source is http://www.puc-rio.br/marco.ind /tutorial.html.

[4] Many financial textbooks have a discussion of options. For a basic understanding, see Chapter 10 (Derivative Security Markets) in Saunders and Cornett (2007). The excellent appendix that describes the Black-Scholes Option Pricing Model can be found at http://highered.mcgraw-hill.com/sites/dl/free/0073041696 /315960/App_sau4170x_app10.pdf. Another source is Chapter 21 (Option Valuation) in Bodie, Kane, and Marcus (2008).

[5] Any financial option involves two parties—a buyer and a seller. We discuss only the buyer's perspective here, because this perspective is most relevant to applying real options theory and models to the IT asset valuation problem at hand.

[6] European options may be exercised on the maturity date only, while American options may be exercised at any time up to and including the maturity date. This difference is irrelevant to our IT asset valuation problem.

[7] Additional difficulties arise when applying option valuation to real assets, as in real options. Several articles address issues related to the fit between real option models' assumptions and IT asset's characteristics. See for instance Tallon et al. (2002), Taudes, Feurstein and Mild (2000) and Benaroch and Kauffman (1999).

[9] The Black-Scholes option pricing model was first developed in Black and Scholes (1973) and added to by Merton (1973), for which Scholes and Merton won the Nobel Prize in Economics in 1997. (Fischer Black had since passed away.). While it focused on the valuation of a financial option, Black and Scholes (1973) also discuss using this methodology on real assets as the underlying instrument. Specifically, they suggest that the equity of a firm be considered a call option on the assets of a firm, with the debt being the strike price. See also Merton (1973).

[10] The value of N(d) can be computed in Excel by using the =NORMSDIST(d) function. (See teaching note.)

[11] See page 21 of Damodaran (1999) at http://pages.stern.nyu.edu /~adamodar/pdfiles/papers/realopt.pdf. Also see Fernandez (2002), available at http://www.iese.edu/research/pdfs/DI-0455-E.pdf, which directly discusses Damodaran and the problem with real options and not having a replicating portfolio.

[12] An incremental implementation strategy can be contrasted to a full implementation strategy, sometimes called a "big bang" approach. Under a full implementation strategy, a set of modules that make up the entire application are implemented together. No module is used until all modules are used. Incremental and full implementation strategies represent end points on a continuum of possible implementation strategies. In other words, in practice the question is one of degree—the chosen implementation strategy more closely represents either an incremental or full implementation depending on how module implementation is sequenced.

[13] See Taudes (1998) for a more general treatment of how real options theory may apply to software development and implementation projects.

[14] The term "automated claim processing module" is somewhat of a misnomer as only partial automation is attained,

[15] See the following articles for examples of real options theory application to real assets, which may be separated into contexts that involve IT and non-IT assets. Studies related to valuing real IT assets include Benaroch and Kauffman (2000), who use a real options model to value a market entry decision into POS services. Additionally, Taudes, Feurstein and Mild (2000) value a package application software platform. Studies related to valuing non-IT assets include Bowman and Moskowitz (2001), who value a strategic business relationship with another firm. Lander and Pettengill (2007) value a new product development effort.

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