Delaying Investments: The Value of Waiting

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ABSTRACT

In Architectural, Engineering and Construction disciplines, it is accustomed to define every aspect of a project well before it starts. Typically a scheduling, estimating and budgeting process is the starting point. Once defined, it is expected that the project manager or builder reproduce those decisions to meet budget and prevent any profit loss. Hence in today's culture, moving definitions and decisions to a later time can be seen as procrastination and dangerous. However, with the Real Options Approach (ROA) - similar to the options theory of the stock market- decisions can be moved to a later time when more information is known or available, adding more flexibility to the project. It may sound like a contradiction for the current managerial culture where decisions are made early during budgeting, but the flexibility of moving decisions to a later time when more information is available, in fact add value to the projects.

Keywords: Real Options, Construction Management, Project Valuation**.**

1. INTRODUCTION

Early in the seventies, two graduate students, Fisher Black and Myron S. Scholes (1973), developed a famous formula for European call options, which is used in complex strategies to hedge unwanted risks that can not be avoided in any other way. Later, Robert C. Merton added another piece to the formulated equation and since then it is used extensively in the stock market.

In 1973, the Chicago Board of Trade, a large futures exchange, created the Chicago Board Options Exchange (CBOE). The CBOE is an organized options exchange place that trades highly standardized options contracts. It opened on April 26, 1973 to trade calls, and four years later, in 1977 it began trading puts. Today thousands of traders and investors use Black, Scholes and Merton formula to value stock options in markets throughout the world; especially after Merton generalized the formula.

Today, options play an important role in security markets. Any person can call a broker and trade an option in seconds. In the beginning, the exchange was only for stocks, but now everyone can trade a variety of underlying goods, such as bonds, foreign currencies and futures contracts; and more recently, it has been extended to decision making process in real projects.

In December of 1997, Scholes and Merton received a Nobel Prize in Economic Sciences for a method to determine the value of derivatives - specifically for the formula they developed in the early seventies. Black was not at the ceremony since he died three years before, none the less the Royal Swedish Academy of Sciences included his name in the recognition. At the awards ceremony Scholes and Merton mentioned that options can be applied into real projects. It was their comment that officially gave life to the Real Options Applications, hence, opening a new means to project management.

Using the options framework in 1996, some consultant firms and scholars like Trigeorgis (1996) -a professor at the University of Cyprus- have in fact found that options are a new way of thinking in calculating financial decisions. But it was only after Merton and Scholes were awarded the Nobel Prize in 1997 that the academic world woke up and started an options revolution in real projects.

For instance, in an article that appeared in The Magazine for Senior Financial Executives in May of 1997, entitled "To Wait or Not to Wait," written by Linda Corman (1997), it said, when referring to this ROA methodology: "Takers are few" regarding how academic experts have treated capital investments such as financial options for more than a decade. "People feel like it's a good idea, but no one knows how to make this happen," says Martha Amram, Vice-President of Analysis Group Economics in San Francisco. She is one of a number of academics who became a consultant trying to cultivate a more receptive environment in decision-making for business projects.

The topic of ROA was a very quiet matter until the Royal Swedish Academy of Sciences recognized the work of Black, Merton and Scholes. Even most of Merton's and Scholes' students that knew about how options could apply to real projects, did not expand on the subject. It was the Nobel Price that served as the pivotal point in deepening and popularizing ROA research. In the article "To Wait or Not to Wait", Martha Amram said, "It's just a question of how long it will take MBA programs to diffuse the knowledge." Further, in February of 1999 Amram and Nalin Kulatilaka (1999) published a book through the Harvard Business Schools Press, called Real Options.

Some Master in Business Administration (MBA) programs are doing a nice work in disseminating the knowledge of ROA and it is much easier today to find publications and books from people applying it to Mining and Oil exploration, Manufacturing, Product Outsourcing, Pharmaceutical Developments, Nanotechnology and Resource Allocation. However, the progress in Engineering, Design and Construction, has been very slow. Some engineers and managers find the Real Options Theory difficult since each problem has to be tailored individually. They create their own barriers because they feel they do not have the time go the extra mile to tailor the projects, or they do not have the basic concept of the process. Rather they prefer to lead in a traditional way - applying big discount rates. This is just another reason the spread of ROA knowledge finds resistance to its progress.

In general, Real Options are unfamiliar for engineers and many of them see the real option approach as a mysterious matter. That is why it is important to teach engineers and modify the corporate culture to incorporate options as the new way of thinking; in managing strategic initiatives and investments on real projects.

2. WHAT IS AN OPTION?

In the stock market, a Call Option (C) is the right to buy something and pay a price for it (E) within or before a specific date (T). If the option is exercised before maturity, it is called an American option; if it is exercised at maturity, a European option. The buyer has the right to buy (or not to buy) a specific asset for a specified amount of money any time before a specific date, called the expiration date. An example of an American option, the buyer has the right to buy a building for \$1 million on or anytime before January 30 of the year 2011. Options are a unique type of financial contract because they give the buyer the right, but not the obligation, to do something. The buyer uses the option only if it is a smart thing to do; otherwise, the option can be thrown away. The buyer will make the decision to buy the asset if it is worth more than the exercise price (\$1 Million) at the moment of the decision. In option nomenclature, it can be written:

$$C = \begin{cases} 0 & \text{if } S_T \leq E \\ S_T\text{-}E & \text{if } S_T > E \end{cases} \tag{1}$$

The value of the option (C) is zero if the value of the asset is equal or less than the exercise price (E) and the owner of the option does not exercise his right. If the value of the asset (S_T) is greater than the exercise price (E) the owner will exercise the option, and its value is the difference between the value of the assets and the exercise price (S_T-E). In real options the call option (C) is the difference between the market value of the project minus the expected cost if the options are exercised at maturity.

In real projects, an option is an opportunity to delay a decision to a latter time when more information arrives. If the option is worthy, the owner of the option will undertake the option, and the actions associated with that option. If the option is not worthy, no decision is made and no action is taking. If the building the buyer pretends to buy using the call option worth for example $1.2 Million on January 30, 2011, it is smart for the buyer to buy a building that is worth $1.2 Million for $1 Million. In this case, the value of the option is $200,000 dollars that is the difference between the value of the asset ($1.2 Million and the exercise price of $ 1 Million. In the opposite situation if on January 30 2011 the value of the building is 0.8 Million, the buyer do not exercise the options and walk away from the contract without exercising it. The whole theory of the real options rests in this simple concept. At this point it can say that an option is an opportunity to make decisions and the decision is made only if it is smart to do.

In everyday life options and alternatives are synonymous. When thinking of vacation, there are many choices or alternatives to choose from and deciding where to go, one is deciding between alternatives. When holding an option, a person defers the selection between the alternatives to a later date. When a person holds a decision to select between alternatives until a specific date, all alternatives become options or possibilities for future decisions. It means, there is a distinction between alternatives and holding options to decide in a future time. One can hold the alternatives until time pass and the person gets more information. At this moment alternatives become options. In other words when one adds time to an alternative, it becomes an option and he or she will select between alternatives at the expiration date of the option.

When time is attached to alternatives in real projects, alternatives become options and a decision between alternatives can be made before the expiration date, in which case, the option is called "American Option" or at the expiration date, in which case, the option is called "European Option".

When option ideas are used in business rather than financial markets, they are called real options. Construction projects are full of options. Economic results depend upon the actions taken when decisions have to be made. Options add flexibility to engineering, design and construction projects.

3. CASE STUDY: THE OPTION TO DEVELOP

Let us consider an example: John Morley and Associates wants to build an apartment building with some money that the company has in stocks and CDs. The company is looking for investments that last long term. They already have land that is presently worth $100,000. The total amount of money the company estimates to invest in this project including the land is a total of $1 Million dollars. The design phase cost is $65,000 and the construction phase is $835,000. Let us assume that the value of the project could go up 30% (u=1.3) or down 23%. Additionally, they assume the risk-free rate is 5% (r_f). Note that for simplicity in the problem, al values will be expressed in thousands.

Mr. Morley the CEO of the company thinks that once the apartments are rented, they will get two different types of dividend cash flows: the first, k=20% is a fair normal competitive return on the $1 Million dollars the company is investing (some people called this percentage, the cost of capital). The second cash flow comes from the rents after expenses which he estimates to be a $100,000 for the first year. Due to anticipated competition, the second cash flow will shrinks by g=8.5% through the years. Even with that decrease due to a possible competitor, the expected return is much better than the return available for risk-free investments.

Uncertainty about the value of the project, competition pressures and the owner's wish to know weather the company can delay the development over the next three years, makes this problem an excellent candidate to be analyzed with a Real Options Approach (ROA).

There are different approaches to determine the present value of the building: First, the cost approach for this case is known to be $1 Million. Second, the sales comparison approach in this case could be a little difficult since comparison needs to be done apartment by apartment with similar apartment's sales in the last few months. The third approach is the income approach. This method is wide used by investors since it gives greater weight to the income received during the life of the building.

As mentioned before, this case has two economic returns or dividends; the first-one corresponds to the return on the investment that can be seen as an infinite constant annuity (*kI/k)*, where *I* is the initial investment and *k* is the rate of return on the investment. It is supposed the project produces an economic return forever (Ross, Westerfield and Jaffe, 1996). The second return relates to the rents, and it is assumed it goes forever, also mortgage companies make similar calculations when determining the value of an asset and it can be calculated with the formula of a Present Value for a growing (shrinking) perpetuity (Rent/(k-g)), where g is the growing rate, and when g decrease over the time, it is negative. To solve this problem, the present value of the building has to be calculated based on its income through the years. The Present Value as a function of its dividends at the year zero is:

$$PV_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + \ldots + \frac{D_N}{(1+k)^N}$$

Where the dividends *D* has to parts: The return on the investment (*I*k)* and the rent. In each case dividends are discounted at the market rate or cost of the capital *k.*

$$PV_0 = \frac{kI + 100(1-.2)}{(1+k)^1} + \frac{kI + 100(1-.2)^2}{(1+k)^2} + \ldots + \frac{kI + 100(1-.2)^N}{(1+k)^N}$$

$$PV_0 = \sum_{t=1}^{N} \frac{kI}{(1+k)^t} + \sum_{t=1}^{N} \frac{kI + 100(1-.2)^t}{(1+k)^t} \qquad (2)$$

The equation (2) represents the Dividends of the project, where the first part is an infinite constant annuity (return of the investment) and the second is an infinity growing (in this case shrinking) annuity (Rents), that can be simplify as follow:

$$PV_0 = \frac{kI}{k} + \frac{\mathrm{Re}\,nt}{k-(-g)} \qquad (3)$$

$$PV_0 = 1{,}000 + \frac{1000 * .10}{.20 + .085} = \$1{,}351$$

A project today based in its income, worth \$ 1,351. The Net Present Value of the project will be obtained by subtracting the initial investment from the PV₀.

$$NPV_0 = PV_0 - I = \$1{,}351 - \$1{,}000 = \$351 \qquad (4)$$

The Present value of the project at year one will be as follows:

$$PV_1 = PV_0 * (1+k) - D_1 = PV_0 * (1+k) - ((I * k) + (\mathrm{Re}\,nt)) \qquad (5)$$

The first part of this equation is the value of the project before dividends at year one and the second term correspond to the return on the investment and the rent.

$$PV_1 = PV_0(1+k) - D_1 = PV_0(1+k) - (k * I + \mathrm{Re}\,nt)$$

$$PV_1 = \$1{,}351(1+.20) - (.20 * \$1{,}000 + \$1{,}000 * .10)$$

$$PV_1 = \$1{,}621 - (\$200 + \$100) = \$1{,}621.20 - \$300 = \$1{,}321$$

The dividends the project is producing to the company are proportional to the present value of the project cumulative dividends.

$$PV_2 = PV_1 * (1+k) - D_2 = PV_1 * (1+k) - ((I * k) + (\mathrm{Re}\,nt_1))$$
$$PV_2 = PV_1 * (1+k) - ((I * k) + (I * .10 - I * g))$$
$$PV_2 = 1321 * (1+.20) - ((1000 * .20) + (1000 * .10 - I * .085))$$
$$PV_2 = 1{,}585 - (200 + 100 - 8.5) = 1{,}585 - 292 = 1{,}294$$

By repeating this process, the expected value of the project is obtained and it is shown on Fig. 1.

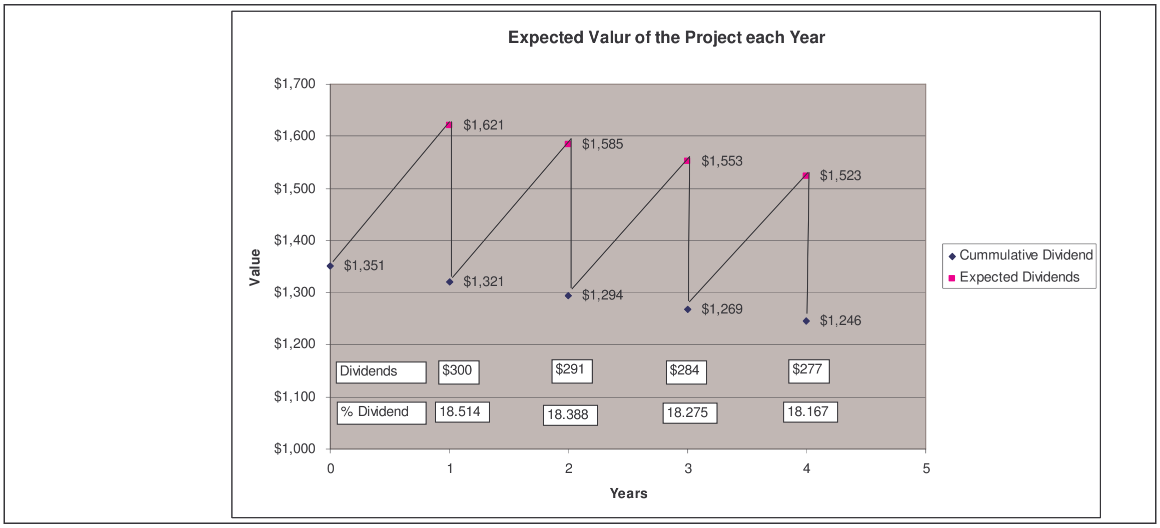

Figure 1: Expected Value of the Project in Thousands

Now base on its income through the years, the building today that worth 1,351 thousand dollars, it is important to know the evolution of its value due to the uncertainties of the market. Mr. Morley the CEO of the company believes the market can go up by 30% or down by 23%. The ups and downs were defined for the binomial tree by Cox, Ross, and Rubinstein (1979) $d=1/u = 0.769$.

Using the PV of the project and the ups and downs, the tree shown in Fig. 2 can be build showing the evolution of the building value in the following three years. After considering all combinations, at year three, its value could range from \$2,968 thousand dollars (u^3Po) to only \$615 thousand dollars (d^3Po).

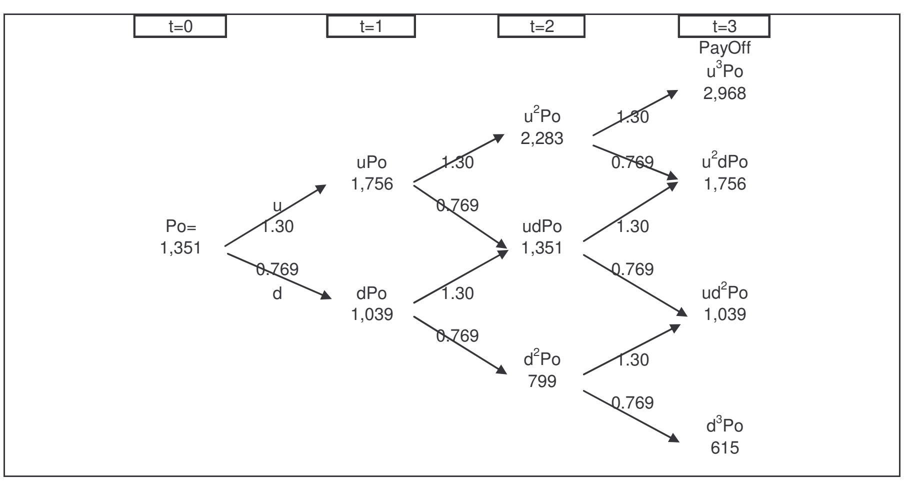

Fig. 2. Expected Value of the building on the next three years

Now, it is meaningful for us to find the probability of having a project today with these payoffs. Calculating its probability is important because there is a relation between the current price of the project and the expected payoffs at the end-of-period. Figure 3 illustrates this for a one-year period. The present value of $1,351 thousand dollars is equal to the average of the expected cash flow at period one, discounted by the risk-free rate, which means that *Po* can be expressed, as shown on Equation 6, as a function of *Pu* and *Pd* according to their risk-neutral probabilities (*u*s and *ds* are for the ups and downs).

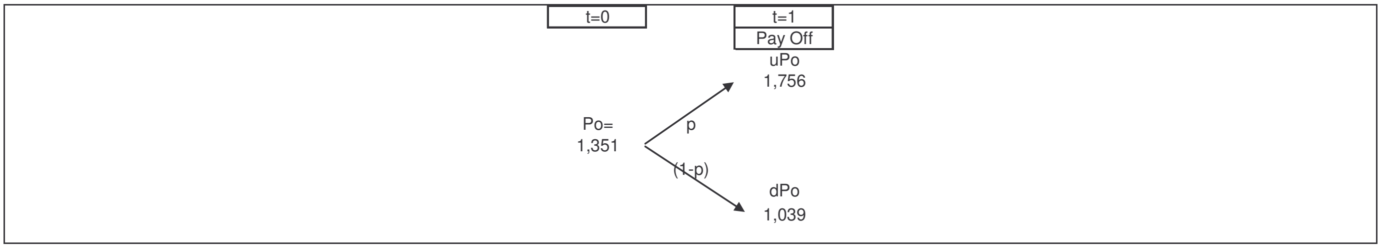

Fig. 3. Risk Neutral Probabilities

$$Po = p \cdot \frac{Pu}{(1+r_f)^t} + (1-p) \cdot \frac{Pd}{(1+r_f)^t} \tag{6}$$

Solving for *p* from the above equation and using t=1, it is founded that

$$p = \frac{(1+r_f)^1 \cdot Po - Pd}{Pu - Pd} = \frac{(1+r_f) \cdot Po - u \cdot Po}{u \cdot Po - d \cdot Po} = \frac{(1+r_f) - u}{u - d} = .53 \quad \text{, and } (1\text{-}p) = 1\text{-}.53 = .47$$

Under the risk-adjusted discount, the probabilities *p* and (1-*p*) are called the objective probabilities for the up state and down state volatilities respectively. If these probabilities are used as well as the risk-free rate, the same tree node values as those shown in Fig.2 are founded, but this time the tree is solved in backwards. It means starting from year 3 and moving to year 1. The resulting tree is shown on Figure 4.

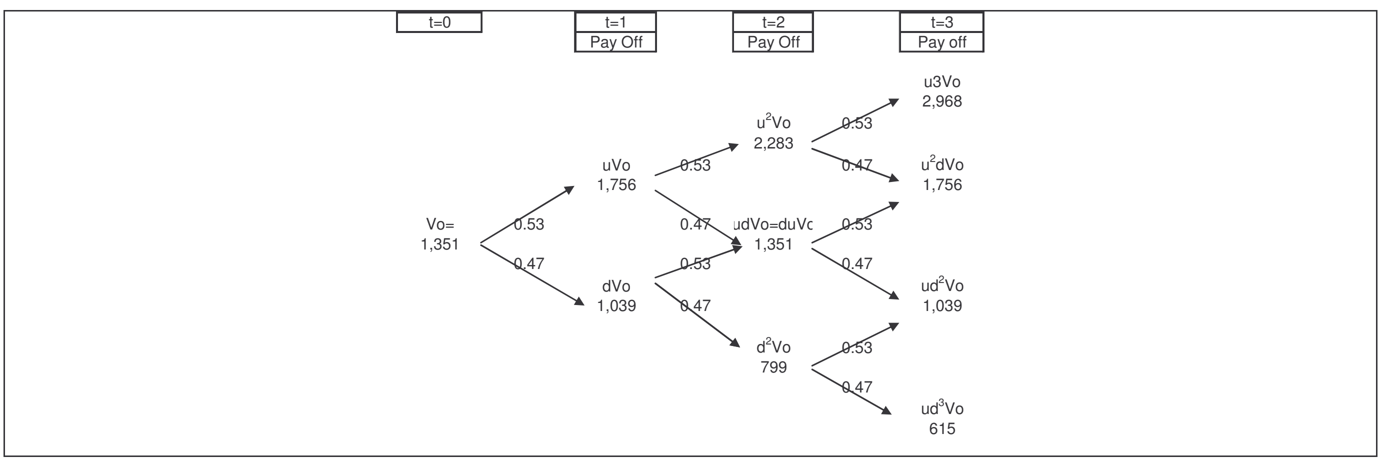

Fig. 4. Risky Asset with Risk Neutral Probabilities

Note that calculations here are done backwards, for example, at the upper node of the tree at the year 2, is based on the pay offs of year three as follow:

$$P_2 = \frac{P_u * p + P_d * (1-p)}{(1+r_f)^1} = \frac{\$2,968*0.53 + \$1,756*0.47}{(1+0.05)^1} = \$2,283 \quad (7)$$

Calculations continue in backwards until you arrive to the year zero with a value of $1,351 thousand dollars.

There are two options in this problem and the second is alive only when the first-one is exercised. It means you start the construction only after you have the design. The first option is to decide when to do the design and the second is the option to delay the construction maximum until year 3 for this specific case. An option is an opportunity to make a decision. The owner of the option has the right but not the obligation to exercise or not to exercise it at the expiration date. The owner exercises the option only if it is the smart thing to do. If the option is not exercised, it becomes valueless. For compound options or continued options, you always consider the second option first and then the first-one because calculations are done in backwards. Then, it is necessary to consider the construction- phase first. An amount of $835 thousand dollars is derived from the option to build at the latest three years from now. Fig.5 illustrates the option valuation as well as the decisions that would be appropriate (decision to wait, not to wait, to exercise the option, or not to exercise it).

Now the call option value is determined by using Equation 1. The exercise price is $835 Thousand dollars, and the value of the project is the one at year 3, which, as it was discussed previously, can be one of four different payoff values at year 3 (Fig. 4 payoffs at year 3). For the results of the new calculations, see Fig 5, sequential Compound Options, where the second options are first analyzed and the first option to design the building is analyzed after, since calculations need to be done in backwards.

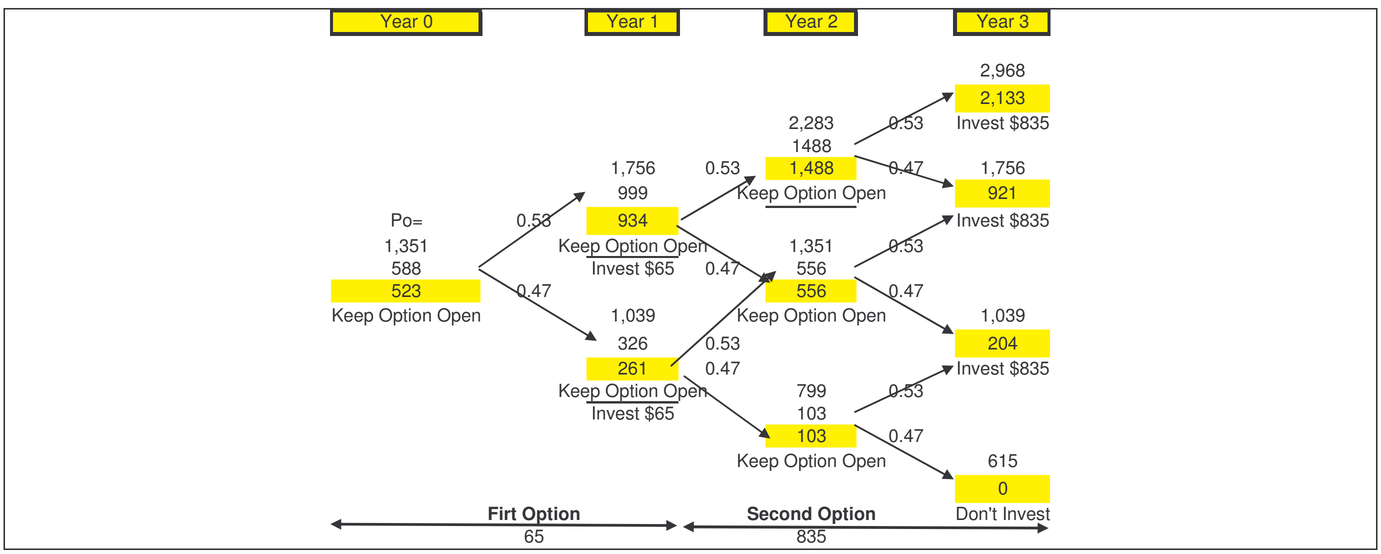

Fig. 5. Sequential Compound Option.

To analyze the options, each node of the binary decision tree has to be solved in reverse; the existing option at each node is analyzed in order to decide whether to defer the investment, to invest or not to invest. At each node of the year 3, the value of the option is given by:

MAX
- Present value of the project (Figs.4) minus the construction investment of $835 thousand dollars. If this value is negative, the value of the option will equal zero, and the owner of the project will choose not to invest.
- If this difference is greater than zero, the owner of the project will choose "Exercise" the option and invest. As was mentioned before, in this case, the value of the option will be the difference between the pay off and the construction investment.

For example C= Max ($2,968 - $835,0). In this case C = $2,133. The owner will decide to invest in the construction, because having a building that worth $2,968 thousand dollars, it supports a debt for its construction of $ 835 thousand dollars.

At the lower node in the same year 3, the owner will choose not to invest, since the building only worth $615 thousand dollars and do not support a debt of 835 thousand dollars. In this case the value of the option is zero.

Only the cases that ended with zero, correspond to the states where the option should not have been exercised i.e. "Do not invest." Now, the tree needs to be worked backwards using the probabilities found above and using the risk-free rate.

The option to delay the project one more year (from year 2 to year 3) comes from the addition of the upper and lower values of the options of the following year 3, affected by the calculated probability and the free rate of return. If this value is higher than the option to invest, the smart alternative for the owner will be to defer the investment for another period. If its value is zero, no option exists.

For example, at the upper node of year 2, the following values are found (Fig. 6).

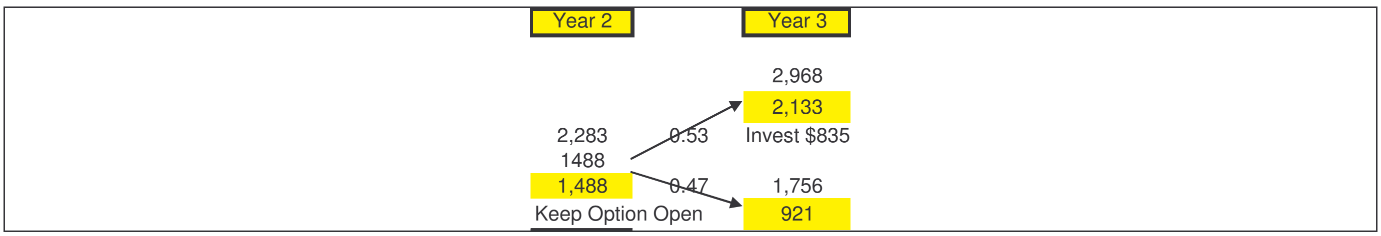

Fig. 6. Option Valuation Upper Node Year 2

MAX

- Value of the option = present value of the project $2,283 minus $835 = $1,448
- Value of the option = the value, given the flexibility to delay the project one more year; this value comes from the addition of the upper and lower values of the options affected by the calculated probability, and of course dividing by ($1+r_f$), which is the factor required when moving the value of the money from year three to year two (r_f is used according to the rules of the Real Options approach). $1,488 = ($2,133*.53+$921*.47)/($1+r_f$). See equation (7).

  If any value is negative, the value of the option becomes 0 or no option exists here. In both cases positive numbers are found and because the mission is to maximize the decisions, the owner of the project, select $1,488 that in this case comes from the option to defer the investment another year. The conclusion here will be to keep the option open.

Observe that in all the nodes of the year 2, the decision comes from the option to delay the investment one more year. Continuing moving backwards the next calculations will be at year 1.

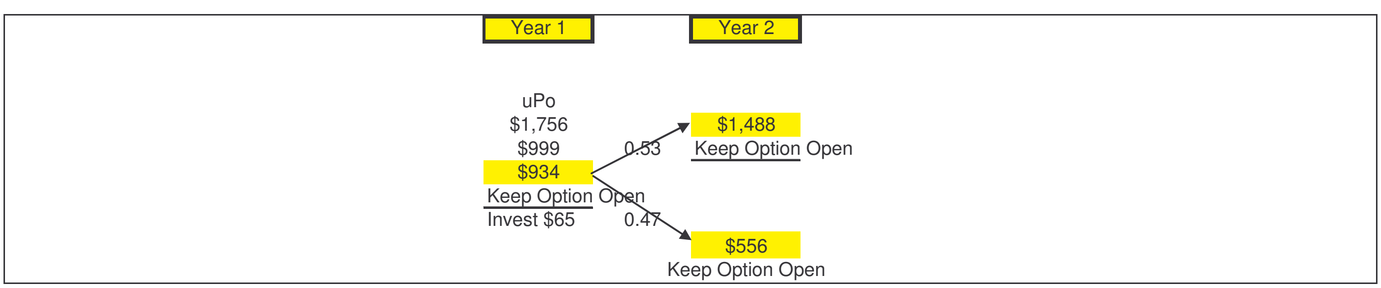

Fig. 7. Option Valuation at Upper Node Year 1

Let us then consider the first node of the figure 7, above. The call option value would be:

MAX

- Value of the option = present value of the project \$1,756 minus \$835 minus \$65 = \$856
- Value of the option = the value, given the flexibility to delay the project one more year; this value comes from the addition of the upper and lower values of the options affected by the calculated probability, and of course dividing by ($1+r_f$), which is the factor required when moving the value of the money from year two to year one. \$934 = (\$1,488*.53+\$556*.47)/($1+r_f$) minus \$65 = \$999-\$65 = \$934

  In both cases the results are positive numbers and because the maximization of the decisions, the owner of the project, select \$934 that in this case comes from the option with the flexibility to defer the investment another year. The conclusion here will be to keep the option open and the owner can invest \$65 in the drawings or can keep the option for another year to be ready for construction at the third year.

Continuing backwards, at year zero, would have an expected value derived from the first and second stages of the first year. (Try to imagine that the arrows used in the figure have been reversed on Fig 5). So the call option value for this case will be: (Fig, 5)

$$\frac{p \cdot \$934 + (1-p) \cdot \$261}{(1+r_f)^1} = \$588$$

A positive option value at year 0 indicates that the project with can support a construction cost of \$835 at any time until year 3 and a design cost of \$65 at year 2. Because the maximization of the decisions, it is needed to ask if having a project today with a present value of \$1,351, it can support a construction cost of \$835 and a design cost of \$65. The answer is \$451=\$1351-\$835-\$65. When comparing \$451 and \$588, the last-one is higher. Then \$588 is selected with the attached decision of keeping the option open. The reason why it has been talking about debt, it is because compound options can be seen as subordinated debts, and changes in time in the value of a call can be expressed as a function of changes in the value of the project (Genske 1979).

The solutions of all nodes are shown in Fig. 5 with the value of the option on a colored cell. To make the options comparable with the initial calculation of a Net present value, the value of the land (\$100) is discounted from the result of the tree; \$488 = \$588 - \$100. Observe that the value of the project with the option to defer is \$488 thousand dollars instead of the net present value of \$351 thousand dollars calculated from equation (4). The difference of \$137 thousand dollars corresponds to the "added value" from the flexibility of waiting to see of how events unfold and taking the decision when more information was available.

4. CONCLUSION: REAL OPTIONS CAN BE APPLIED IN ENGINEERING, DESIGN AND CONSTRUCTION MANAGEMENT

The problem is that in engineering and construction, managers are accustomed to decide everything in advance, most of the time because of the need of an estimate to become the budgetary schedule of the project. Thus, it is believed that a good manager is one who finishes the project on time and on budget. This group of "good managers" also besides getting the project on time and on budget, do not care about the increase in profits they can bring to the company.

A "good manager", in the normal way of running calculations, risk is absorbed by high rates of discount when cash flow is converted to present value. Additionally, a simple explanation for the difference between the predicted profit and the actual cost of the project is due the increase to the value of the land, to "good luck", or to no presence of risk – but never to management skills.

To become a "great manager", the employment of the Real Options Approach in engineering and construction projects, adds monetary value and choices to the project aside from meeting time and budget.

In conclusion, with the Real Options Approach, monitoring the progress becomes very important, and decisions made through the development add value to the project. At the time to make a decision with real options, if the evaluation shows that the decision adds value to the project, the decision is made and managers may decide to scale up or to initiate a new one. On the contrary, if the manager sees unfavorable results, the project may scale down, defer, temporarily suspend, or even abandon the project. In short, the value of the project will be affected by exercising the options embedded in the project – these actions are known as real options and management skills.

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