A Real Options Analysis of Olympic Village Development: How Design Flexibility Adds Value

by

Robert J. Martinson

B.S.E., Chemical Engineering, 1998

University of Michigan

Submitted to the Center for Real Estate in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

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Signature of Author____
Center for Real Estate
July 24, 2009

Certified by ____
David Geltner
Professor of Real Estate Finance, Department of Urban Studies and Planning
Thesis Supervisor

Accepted by ____
Brian A. Ciochetti
Chairman, Interdepartmental Degree Program in
Real Estate Development

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ABSTRACT

This thesis applies past research on real options – a right, but not an obligation to take some action on a real asset in the future – to a very specific type of real estate development related to Olympic Village development. The Olympics have been previously criticized for the excessive cost of preparation for the 16 or 17 day event. Chicago, if selected to host the 2016 Summer Games, could be faced with many of the same challenges of past cities.

The purpose of this thesis is not to provide the final answer to whether a developer should implement design flexibility into a project like the Chicago Olympic Village, but rather provide a tool for which to analyze the project and areas of uncertainty. Real Options Analysis (ROA) is presented as a set of specific steps that correlate with more commonly used methods of real estate valuation.

In order to determine the optimal sources for flexibility, qualitative research identifies challenges and uncertainties of Olympic Village development. This data is reviewed, analyzed and used to illustrate potential sources of flexibility for further analysis. ROA introduces the use of Monte Carlo simulation to better forecast the range of expected outputs and then integrates flexibility at various decision points of the project. The results of this model should allow decision makers for a project to choose the most desired path based on the goals and requirements of the project.

It is observed, based on the assumptions used for this analysis, that flexibility "in" and "on" the project does create additional value, however this additional value is partially offset by the cost of the flexibility, if applicable. The results also illustrate the benefits of mitigating the downside risk of a project with the use of a real option. The process could provide alternate results with the use of other assumptions.

The analysis of the hypothetical case study also investigates the relationship of two individual real options applied to a project simultaneously. It is determined, through results analysis, that the effect of a real option "on" and a real option "in" are virtually cumulative in achieving additional value for each type of option.

Thesis Supervisor: David Geltner
Title: Professor of Real Estate Finance

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1.0 Introduction and Methodology

A real option as defined by Copeland and Antikarov (2003) is "the right, but not the obligation, to take an action (e.g., deferring, expanding, contracting, or abandoning) at a predetermined cost called the exercise price, for a predetermined period of time – the life of the option". This thesis ventures to apply past research on real options to a very specific type of real estate development related to Olympic site preparation. Olympic venue requirements are very specific and differ from those of the private market. As will be discussed further in the paper, the International Olympic Committee (IOC) presents a full package of guidelines for Olympic Village design that are optimal for Olympic athlete use, but often not as desired by private users of the facility following the Games. For example, the IOC requests that all athletes eat in communal dining facilities, therefore not requiring, nor accepting, kitchens or cooking facilities within the athlete suites. These differences create significant challenges of transforming these facilities to their legacy uses. However, by applying the concepts of flexibility "in" the design, or also referred to as "design flexibility", into the planning of these Olympic venues, real options can be created that could help mitigate risk of transformation and subsequent potential downside of the development while taking advantage of the upside (potentially more profitable) aspects of the project. All of this could even result in a higher overall expected value of the project.

1.1 Purpose and Context of Study

Preparation for the Olympic Games has cost billions of dollars in past years: Beijing - $43b, Athens - $8.6b, Sydney – $AUD 6.6b, Atlanta - $1.7b (Demick, 2009; ATHOC, 2004; SOCOG, 2001; ACOG, 1997). Now, London and Vancouver find themselves struggling to complete infrastructure and venue improvement and development as costs rise high above budgeted amounts while the financial markets crash all around the world (Donville, 2009, Pletz, 2009). Chicago, as a final bidder for the 2106 Summer Olympic Games, could find itself in the challenging position of figuring out how it will deliver the Olympics to the expectations of the IOC and the rest of the world while also creating a vibrant, economically advantageous environment for this world class event and its legacy. The issue of financing the Games and specifically venue development is a very important and a particularly timely topic. The topics presented in this study should also be interesting as the proposed Chicago 2016 Olympic Village is very early in the conceptual design phase when the application of flexibility "in" design could be especially useful. While the idea of hosting the Olympic Games has its supporters and non-supporters, if Chicago is selected to host the 2016 event, it will have an effect on virtually everyone in the City and potentially the State of Illinois.

Olympic venue development is unique in that it is subject to a set of requirements and uncertainties that are similar yet differ somewhat from those of other real estate development projects. As a result Olympic venues and the legacy they present have often been targets of severe criticism. As the Olympic Games duration is extremely short, only 16 or 17 days (IOC, 2009), compared to the many years it takes to plan for the events, many venues have resulted in underutilized, or even vacant projects such as those of the 1976 Montreal Games (Guay, 1996). This can either result from poor planning, changes in market conditions, or a combination of both. If, however, proper planning is conducted during the design phase and flexibility is designed into the project, a "real option" is created which allows the owner to take advantage of market conditions at a future time, at a decreased cost to switch asset type (i.e. condominium to apartment) (Silver and de Weck, 2007). In fact, the option minimizes the potential downside of the project and should result in an increase in overall project value. Real options can also provide the investor the opportunity to expand and seize the upside benefits by taking advantage of the value they created through the initial delivery of the project. Chicago, if selected, may be able to learn from the lessons of cities like Montreal to consider uncertainty in the early conceptual design phases and together with flexibility avoid disappointment of such events and venues.

By combining the fields of finance with architecture and design, design flexibility can be analyzed using simulation methods to predict the expected investor return and in turn quantify the additional created value. Creation of value should be relevant to virtually all developers, whether public or private, but as most funding for the Olympic venue development in the United States comes from private developers and local tax financing, this issue is very relevant (Chicago 2016, 2009). Also, this additional value should be able to be realized to limit risk of the projects following the Games.

Olympic related real estate development is also unique in that the developer's typical opportunity, or option, to stall, slow or abandon a project due to market conditions, financing constraints or other variables is removed. As IOC President Avery Brundage said in time of tragedy at the Munich games, or as others have used his words during other unfavorable conditions, "The Games must go on!" (IOC, 2009), and that means that the Olympic Village development, or any Olympic venue, still needs to be delivered despite conditions outside of the developer's control. This unique requirement provides yet another challenge to any developer in assessing the risk associated with Olympic venue development.

1.2 Objectives of Study

The purpose of this thesis is to analyze current Olympic bid proposals and plans from the Chicago 2016 Bid to see whether design flexibility in Olympic venues and sites can be used to create additional value. This thesis not only reviews the past literature on real options, but also how design flexibility is viewed by current developers and planners involved with the Chicago 2016 plans as well as those involved with past Olympic Village development. The thesis investigates how additional value, if any, created by the real option is quantified. This process or method is also known as Real Options Analysis ("ROA") and can be quantified through evaluation methods such as Monte Carlo Simulation[1]. The net value of flexibility is then the value created minus the cost of the flexibility.

As Olympic venues have very specific requirements that need to be delivered for the games and often do not have long term use in its original form, an adaptive reuse, or switching the project use, type of real option provides a great opportunity to maximize value of the asset in an efficient manner. From an investor's perspective, premiums should exist for a building that can accommodate many uses. This should be especially valuable for a building that is known to change uses shortly after its originally intended use is delivered. There is, however, a cost to providing, or purchasing, the option. This then needs to be compared to the added value to determine if it is advantageous to include the flexibility in design. While the opportunity to exercise the option is far into the development process, the choice to include design flexibility, or purchase the option, needs to be addressed very early on in the design phase of a project. With careful planning, however, this assessment can be made and the opportunity to realize additional value through flexibility can be achieved.

This thesis reviews ROA literature, along with the advantages and disadvantages of the various analysis methods associated with ROA, and then applies ROA to the proposed Chicago Olympic Village development case study. As part of this research and analysis, the main questions this thesis will answer are:

- Can flexibility "in" design of Olympic Village development improve the overall expected value of these projects?

[1] Monte Carlo simulation references Monte Carlo Casino in Monaco but is a method for constructing stochastic or probabilistic financial models where many iterations of an analysis are processed with random sampling of various inputs.

- How is flexibility "in" the design viewed by private and public real estate professionals for Olympic preparation? Are real estate professionals using real options analysis to evaluate the added value of flexibility?
- What value, if any, is created by applying "real options analysis" to a current proposal for or completed project of an Olympic venue or site?
- What are worthwhile kinds of flexibility that designers can insert and/or design in the project early on to help improve expected economic value? What is that value? Is it worth the cost? How do we identify these sources of flexibility?
- What makes Olympic Development different from other Real Estate Development?
- How is the realization of added value applicable to other "short term" use venues or sites?

1.3 Literature Review Summary

The main topics that are reviewed for this study are those related to the research in Real Options, the retrospective analysis of past Olympic Games and the completed real estate development as was required to host the Games. Chapter 2 provides a broad overview of Real Options and Chapter 3 focuses on past Olympic Villages and other Olympic Venues as well as an overview of the proposed Chicago 2016 Olympic Village project.

There are many past theses, articles and publications that discuss real options and methods for analyzing them. There are also many articles and papers discussing Olympic development and even a past thesis that addresses design flexibility for Olympic Stadium development (Jakimovska, 2007). An in depth literature review was conducted to find relationships between these two topics however very little literature combines these two areas of past research. Past literature on each topic does, however, provide the necessary background information to set up this study to fully understand what "real options analysis" is and how it can be a beneficial tool for evaluating Olympic related projects. And while non-technical literature such as letters, reports, newspapers are not generally used as sources of data in quantitative studies, they do play an essential role in grounded theory studies (Strauss and Corbin, 1990). It is still important to cross-check the validity of these non-technical sources against other sources of data such as interviews and observation.

Existing literature already provides information on the various categories of real options as well as specifies the difference between real options "in" and "on" a particular project. This distinction is important to identify as various types of real options are discussed for the Olympic projects. Although, most of these options are real options "in" the project as they are allowing change of use and adaptive re-use, as opposed to the option to build or not build the initial structure.

A few past papers provide a framework for applying the quantitative ROA methods to the projects (Barman and Nash, 2007; Babajide et al, 2008). These studies, among other academic research and publications, provide a strong framework on the mechanisms of real options. Popular media also provides significant background information regarding the particular Olympic projects, the players involved in those projects, as well as assessments from the public realm on how the projects were received by the community.

1.4 Literature Gap Identification

Through a comprehensive literature review, it is confirmed that the basis of the study of applying real options analysis to Olympic development is new. It should be noted that even though these two topics (Olympic Development and Real Options Analysis) are not new, they have not been combined in a formal study. It is also possible that while past Olympic host cities may have inherently used the ideas of flexibility, these cities may not have attempted to quantify the value of the flexibility. Therefore, this research is very investigative in nature and between the new context of the study and the real time nature of the Chicago 2016 selection process, some qualitative data is disguised, modified, or noted as anonymous at the interviewee's request. This initial literature review also provides the working knowledge to intelligently and effectively question the interviewees as part of the data requirement phase.

1.5 Research Hypothesis

It is anticipated that developers interested in the Chicago Olympic Village and those involved in past Village development have thought about, or even already used, design flexibility for their projects. However, it is most likely they did not use ROA as this type of analysis is not yet widespread in normal real estate practice. Design flexibility, when applied to large-scale, important projects, like an Olympic Village development, is expected to add value to the project even when analyzed as net of the cost of the option. The introduction of real options is also expected to decrease the downside risk of the project.

1.6 Overview of Methodology

The methodology for this study is representative of a common qualitative and quantitative approach consisting of two main parts: first using a proven method in social sciences to interview people and analyze qualitative data, and second using a financial approach that is transparent in an engineering/design context and provides a distribution of results for decision-making about design.

The research for this project began with a thorough literature review of real options and Olympic development and is followed up by the first main step of qualitative data gathering method, by interviewing key individuals involved with the Chicago 2016 Bid Committee and those previously involved with the Salt Lake City Games. These interviews were targeted at project managers and other key planning decision makers for the Olympic Villages of each of those events. Side conversations regarding other Olympic venues, such as the Olympic Stadium, were also evaluated to identify common challenges among various types of Olympic venue development.

Since the idea of design flexibility starts early in the planning phase, architects were also interviewed to determine how they viewed and valued this flexibility. Finally, the City of Chicago had recently solicited 11 responses from private development firms that are interested in developing the proposed Olympic Village, if Chicago is, in fact, chosen to host the 2016 Games. Part of the data gathering method was to interview a few of the responding developers to see what they feel the challenges of Olympic Development are, how they are viewing design flexibility for a project of this nature and possibly how they could apply ROA to their development analysis.

To prepare for the quantitative second main step, during the interviewing process, one of the goals was to obtain project specific data for a proposed or past Olympic Village project. Another goal was to identify sources of uncertainty in the project and specifically discuss flexibility "in" design of the project. The third objective was to determine the current use of real options analysis in the industry and specifically for the interviewee's relevant project.

The remaining data required was quantitative in nature. One main objective was to gather development costs, financing data, operating costs and proposed tax liabilities among other project specific information and use this data to analyze the proposed or past development projects to identify the potential value creation using real options. Considering the timing of this project and the fact that it is in the middle of an active developer bid process for the rights to develop the site, much of the detailed quantitative data for the proposed project is not available. Unfortunately, past project data is also difficult to obtain. Instead, assumptions are based on developer rules of thumb, general market knowledge and public information regarding the project to create a framework and template for how ROA could be used by developers in the future for this type of project. As a result, much of this data was created in order to complete a conceptual analysis of the proposed Chicago 2016 Olympic Village project.

A framework for analysis, however, is developed in this thesis and can be used to better quantify the areas of uncertainty in the project. More specific figures can be used in this framework once – and if – the data becomes available. Like other real estate development processes, this analytical process is iterative and can continue to be used as development and revenue data becomes more specific and the design and planning process move further along. As observed in recent research on DSM (Design Structure Matrix) application to the real estate development process where 91 various development tasks are grouped together in six stages based on information required to move on to the next stage, the proposed Chicago 2016 Olympic Village project is very early on in the development cycle and in fact, only in the first "stage" of the process (Bulloch and Sullivan, 2009). As the development process continues so will the refining of data and subsequent financial analysis of the project.

1.7 Interviewee Selection and Interview Questions

To answer the question of how ROA is viewed and how design flexibility is currently used, interviews with industry professionals were conducted. These interviews were with individuals taking an active role in the Chicago 2016 Bid and specifically involved in the planning and budgeting for the Olympic Village and the Olympic Stadium. Chicago has already received information from interested developers, in response to a City issued request for qualification (RFQ), from eleven private companies for the development of the Olympic Village. Interviews were requested from many of these responding firms to determine how they may be viewing design flexibility and how ROA could benefit their proposal. Of the eleven responding developers, six were identified and two were formally interviewed. Additional comments were also received from a third responding firm.

All of the actual interview questions can be found in the Interview Guide in Exhibit A. While the interview guide is used to lead the interviewee, they are written to be slightly more open ended to provide opportunity for discussion of the topic and "free response" as the interviewee sees fit. The goal of the open-ended was to stimulate a series of more specific and related questions and further discussion on the topic (Strauss and Corbin, 1990).

1.7.1 Procedure

The process for obtaining data followed the two step methodology as previously discussed. The first was to qualitatively learn about issues that are specific to Olympic venue development and even more specifically the proposed Chicago Olympic Village. During this discussion, the interviewee has the opportunity to identify area of uncertainty in this type of project. The information received was then used to encourage discussion with the interviewee on potential opportunities for design flexibility in the project.

1.7.2 Qualitative Data Analysis

The qualitative analysis uses a procedure called "coding" as discussed in Strauss and Corbin (1990). This type of analysis should not only allow the researcher to develop themes in the acquired data, but also:

- build theory instead of only testing theory
- help the researcher limit biases and assumptions that can be present during the study
- provide the needed tools to create an integrated theory that mimics reality as best possible

Through the use of "open coding", information obtained through literature review, interviews and observation is labeled and then categorized. By categorizing information, it allows for similar properties and concepts to be applied to various members of the category, and therefore generalized observations and conclusions can made for the category as a whole. The use of the "coding" system is also a beneficial framework of analyzing and identifying "important" opportunities for design flexibility in this type of project.

2.0 Real Options Overview

Real options theory stems from the ideas of financial options, however the options are used to evaluate physical assets instead of financial assets. As a simple example, land can be considered one of the most basic forms of a real option. By leaving land undeveloped, it naturally creates an option to develop it at a later date when a higher profit can be realized. But the question still exists of when in the optimal time to exercise the option and develop the land. ROA should also provide a solution for this optimal timing (Mun, 2006).

ROA, however, is not suited for all projects. The project needs to face a level of uncertainty and in fact, the greater the uncertainty, the more valuable the option actually is. As almost all projects face at least some uncertainty, it is also critical that project decisions can be modified when presented with new information. Project decision makers should also have the ability to make midcourse alterations to a plan when uncertainty becomes resolved and can subsequently exercise an option at the appropriate time. If these requirements are not the case, then real options are deemed worthless in the same way any option would be worthless if left to expire without execution.

The Net Present Value (NPV) rule[2], which is commonly used to make decisions regarding large investments, is flawed because it is based on expected future cash flows and fails to account for the value of flexibility. In reality, management will typically have the ability and the option to modify their investment decision based on changing market conditions. The NPV rule does not account for this; it assumes 100% commitment at time zero in all projected decisions, which is unrealistic. For example a project could be abandoned after the design phase, expanded if it provided better than expected returns, or phased if market demand decreases. So why would managers disregard the option value of flexibility? While there may be reasons for this lack of consideration, there are many more reasons why ROA should become a more embraced method of evaluating a project in the coming years (Copeland and Antikarov, 2003).

Using a more traditional Discounted Cash Flow (DCF) method, instead of a Real Options approach to analyzing a project, will show that DCF will actually observe higher risk in the form of a higher

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[2] NPV rule is to accept investments that have positive net present value (or the present value of an investment minus the initial investment)

standard deviation (σ), but a lower overall return. Figure 2.1 illustrates the comparison of these two approaches:

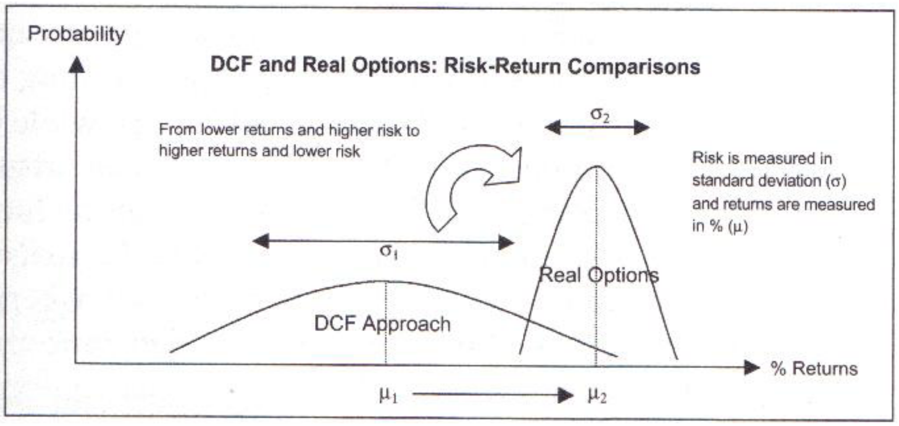


Figure 2.1 – Comparison of DCF and Real Options Analysis Approaches (Mun, 2006)

By applying real options, the downside is mitigated and therefore the risk is reduced. Real options should also provide a higher overall expected return.

Based on this reasoning, real options should be reviewed by developers or investors in response to uncertainty in a project. The fact that any expected performance could change, despite the cause of the change, implies uncertainty (Geltner et al, 2007). Accordingly, this further analysis could be useful as uncertainty about a project's return results in additional risk.

2.1 Real Options versus Financial Options

While real options theory stems from financial options, there are key differences in the two concepts.

Table 2.1 - Comparison between Financial Options and Real Options adapted from Mun (2006)

FINANCIAL OPTIONS	REAL OPTIONS
• Short maturity, usually in months	• Longer maturity, usually in years
• Underlying variable driving its value is equity price or prices of a financial asset	• Underlying variables are fee cash flows, which in turn are driven by competition, demand, management
• Cannot control option value by manipulating stock prices	• Can increase strategic option value by management decisions and flexibility
• Values are usually small	• Major million and billion dollar decisions
• Competitive or market effects are irrelevant to its value and pricing	• Competition and market drive the value of a strategic option
• Have been around and traded for more than three decades	• A recent development in corporate finance within the last decade
• Usually solved using closed-form partial differential equations an simulation/variance reduction techniques for exotic options	• Usually solved using closed-form equations and binomial lattice with simulation of the underlying variables, not on the options analysis
• Marketable and traded security with comparables and pricing info	• Not traded and proprietary in nature, with no market comparables
• Management assumptions and actions have no bearing on valuation	• Management assumptions and actions drive the value of a real option

There are, however, cases where real options are similar to financial options. In both types of options a premium, or cost, exists for the option which effectively indicates the option's maximum loss. The basic types of financial options can also be compared to the various types of real options. Examples are as follows:

- A long call option => An expansion option
- A long put option => An abandonment option

2.2 Real Options "in" versus "on" Projects

While real options "on" projects are typically motivated by the desire for investment professionals to accurately value opportunities, real options "in" projects are mostly concerned with the "go" or "no go" decision of whether to purchase a real option, how to implement the flexibility to create that option and finally when to exercise that option. All of these parts of a real option "in" a project lead to a valuation of a project including the option.

The table below illustrates some of the key drivers for each of these types of real options:

Table 2.2 – Comparison between real options "on" and "in" projects adapted from Wang and de Neufville (2005)

Real options "on" projects	**Real options "in" projects**
Value opportunities	Design flexibility
Valuation important	Decision important (go or no go)
Relatively easy to define	Difficult to define
Interdependency/Path-dependency less an issue	Interdependency/Path-dependency an important issue

Real options "on" projects are also conceptually more closely related to financial options and are typically exercised based purely on the value created by the option in the project, regardless of technology or design in the project (Guma, 2008). Real options "in" projects integrate technology and design to provide opportunities to acquire and exercise options at a future date. A simple, yet powerful, example of a real option "in" a project is observed in the Targus River Bridge project in Portugal where the bridge was originally built to accommodate four lanes of vehicular traffic, however the structure was over-built to accommodate future rail and automotive traffic (Gesner and Jardin, 1998). When additional capacity was required, the option was exercised to fulfill that need. Another exemplar of this type of option is present in the HCSC tower in Chicago where vertical expandability was designed into the base structure. Again, this option was exercised when additional space was needed and the building was expanded from twenty-nine to fifty-four floors (Pearson and Wittels, 2008).

2.3 Types of Real Options

From previous research, seven categories of real options have been identified (Trigeorgis, 1996):

1. Option to defer
    - wait a period of time before resuming operation
2. Time-to-build option (staged investment)
    - can also be viewed as a type of option to phase
    - typical in normal real estate development where only sections of a large project are built and delivered at one time
3. Option to alter operating scale
    - expand or contract a project that has already commenced or shut down and restart at a later date

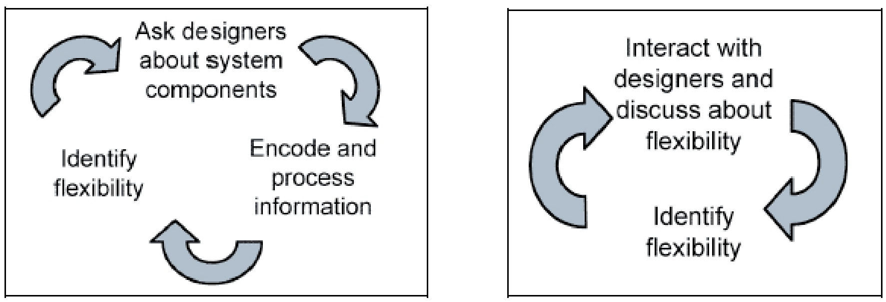
4. Option to abandon
   - abandon project and sell the remaining pieces for salvage value
5. Option to switch
   - choice to change the way a product is being built (process flexibility) as well as changing what product is being built (product flexibility) and delivered to market (all depending on market conditions)
   - ex. Oil refinery can be designed to use alternative forms of energy (e.g. fuel oil, as or electricity) to convert crude oil into a variety of outputs (e.g., gasoline, lubricants or polyester)
6. Growth options
   - future opportunities to grow or expand a project, i.e. un- or under- developed land that is part of a larger project
7. Multiple interacting options
   - the previous six categories do not need to stand alone, but can interact with each other to create more complex forms of options "in" project

Each of these types of real options is reviewed in projects when attempting to identify design flexibility. Not all types will always be applicable to all projects, so each must be considered individually and in their more complex, integrated form. Of these categories developed by Trigeorgis, the option to defer, abandon and growth options are categorized at real options "on" a project, while the time-to-build option, option to alter operating scale and option to switch, along with interacting, complex options are considered real options "in" a project. As discussed previously, technology and design is therefore a more critical component of the options "in" a project.

2.4 Identifying Design Flexibility

"Give me a set of requirements today, a timeline and a budget and I will design and deliver the best possible product/system/project for you by tomorrow." (de Weck, 2007) While this may be the mindset of a typical engineer for a large project, it relates very well to that of a real estate developer as well. The typical process for real estate development involves reviewing current market conditions and attempting to forecast conditions upon delivery of the project. However, changes in market conditions can be detrimental to the overall returns of a project. At that point, the ability for a development to repurpose a project at a minimum cost can determine how they had viewed design flexibility during the initial planning and design stages of the project and then the ability to implement or act upon the "real option" they created through design flexibility.

Design flexibility can be identified through direct or indirect approaches. It is believed, however, that architects and developers already think about design flexibility intuitively when planning for permanent long term structures (Barman and Nash, 2007). This seemed to be the case with those involved with Olympic Village and Olympic Stadium development as well (Dickson, 2009; Loewenberg, 2009; Harder, 2009). As a result, the direct approach for identifying opportunities and sources of design flexibility is assumed to be an appropriate approach for these types of projects.



Indirect Approach Direct Approach

Figure 2.2 – Indirect and Direct Approaches to Identify Sources of Flexibility (Cardin and de Neufville, 2009)

2.4.1 Indirect Approach

Indirect approaches for identifying sources of flexibility in real estate projects generally question the architects and other designers of a project to determine "design variables" and "how they are connected", but less directed at specifically identifying opportunities for flexible solutions in the project (Cardin and de Neufville, 2009). These variables and their relationships are "encoded" in a process known as DSM (Design Structure Matrix) and optimized through various algorithms to determine an efficient flow of tasks, along with opportunities for real options "in" the project (Cardin and de Neufville, 2009; Bulloch and Sullivan, 2009).

2.4.2 Direct Approach

The direct approach of identifying sources of flexibility on the other hand is conducted by discussing a large scale project with the developers, architects and planners to identify areas of uncertainty which can then be used to identify opportunities for flexibility implementation (Cardin and de Neufville, 2009). It is found that many of these design professionals are already thinking of flexible solutions "in" the project, but have not necessarily identified these opportunities as real options. In order for this direct approach to be successful, it is critical to engage designers early in the design process to identify and implement flexible opportunities, as well as ensuring that the design professionals have the ability and authority to influence design and make final decisions accordingly.

2.5 Methods of Real Options Valuation

There are essentially two different approaches to valuing real options. As the underlying theory of real options is in the financial knowledge of options, typical financial approaches to valuing options, including Option Valuation Theory, can be applied. Per previous research, however, developers are typically unlikely to use such a valuation process due to lack of knowledge of the process and complexity involved with pricing such an option that only has a limited number of possibilities (Barman and Nash, 2007). Instead, developers would prefer to use the tools they are currently familiar with such as Argus or Excel to further value the uncertainties and associated real options for a proposed development. By combining methods from the engineering community, valuation techniques such as Monte Carlo simulation can assist in quantifying the value of the option in a real estate application. This method also provides a more simplified method that real estate professionals can utilize effectively.

In Figure 2.4 below, a comparison of the various types of analyses can be viewed:

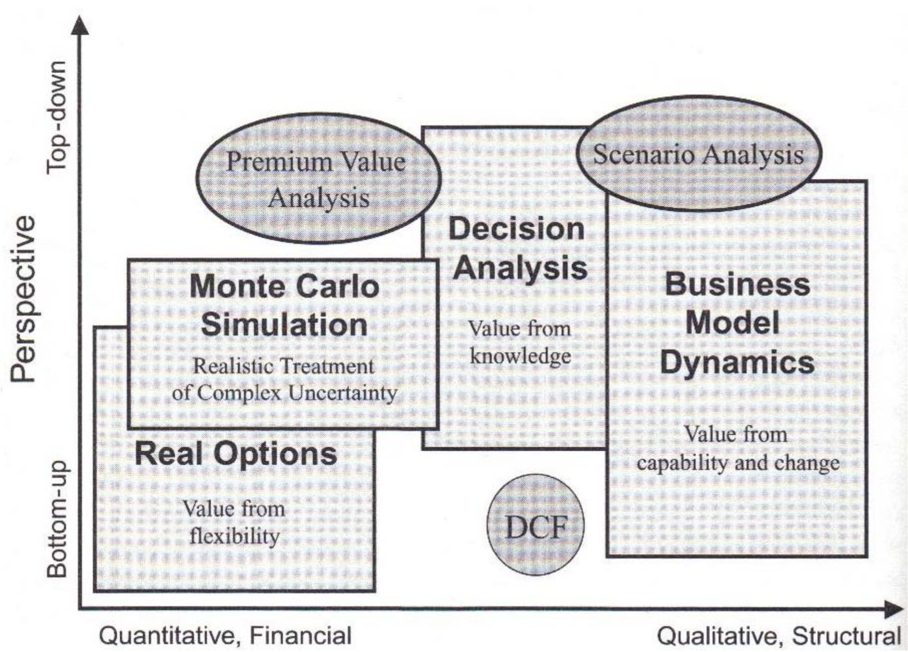


Figure 2.3 – Visual comparison of analysis types adapted from Mun (2006).

2.5.1 Financial Approach

The following financial approaches are presented for comparative reasons, however have their limitations for applicable and realistic use by everyday real estate professionals. This is based on interview responses for this study as well as the information obtained in previous research where these financial approaches are unlikely to be used by developers (Pearson and Whittels, 2008; Barman and Nash, 2007). The engineering approach, as presented in a later section, provides a method that may be more familiar to those real estate professionals looking to value real options.

2.5.1.1 Black Scholes Model

Developed by Black and Scholes in 1973, this model provides a solution to value the price of a call option but it includes many limitations for its use in real options analysis. Examples of these limiting assumptions include (Copeland and Antikarov, 2003):

- the option may only be exercised at maturity
- there is only once source of uncertainty
- the option is contingent on a single underlying risky asset
- the underlying asset pays no dividends
- the current market price is known
- the variance of return on the underlying asset is constant through time
- the exercise price is known and constant

As most real options examples are complex and would require one or more of these assumptions to be voided, the Black-Scholes equation would no longer hold. Also, due to the lack of familiarity of this method, it is unlikely to be used in everyday valuation of real estate projects.

2.5.1.2 Binomial Option Pricing Model

As another financial approach to valuing real options, the binomial option pricing model is based on building a binomial decision tree of potential future values (Copeland and Antikarov, 2003). In this method, probability theory is used to determine an expected "upside" and "downside" outcome at each decision point, or period. A binomial lattice is generated to then determine expected probability of particular outcomes for a project. A very basic example of this type of model can be observed below:

Table 2.3 – Example of Binomial Option Pricing Model (Geltner et al, 2007)

($ Millions)	Today	Next Year	
Probability	100%	30%	70%
Value of Developed Property	$100.00	$78.62	$113.21
Development Cost (Excluding Land Cost)	$88.24	$90.00	$90.00
NPV of Exercise	$11.76	-$11.38	$23.21
(Action)		(Don't Build)	(Build)
Future Values		0	$23.21
Expected Value of Built Property	$100.00	$102.83	
(Probability x Outcome)	(1.0 x 11.76)	(0.3 x 78.62) + (0.7 x 23.21)	
Expected Value of Option	$11.76	$16.25	
(Probability x Outcome)	(1.0 x 11.76)	(0.3 x 0) + (0.7 x 23.21)	
PV (Today) of Alternatives @ 20% Discount Rate	$11.76	$13.54 = (16.25/1.20)	
Land Value Today = MAX(11.76, 13.54) = $13.54			
Option Premium = $13.54 - $11.76 = $1.78			

As observed in Table 2.3, at the end of one year, there is a potential upside or downside scenario. Only the upside scenario, however, would be exercised, thereby mitigating the effect of the downside scenario. Once the option is purchased, the purchaser can not lose money on the option, except for the sunk cost of the option itself.

2.5.2 Engineering Approach

Monte Carlo simulation, as an example of an Engineering Approach to valuing options, is a tool for financial analysts to evaluate models based stochastic or probabilistic inputs as opposed to traditional static or deterministic approaches. While this approach has been very common in industries such as the physical sciences, engineering and even insurance, it has only recently been applied to real estate analysis and specifically that of real options analysis. Commercial software packages and add-ons such as Crystal Ball and At Risk provide solutions for performing Monte Carlo simulation, however through the use of some basic Excel modeling skills, this simulation can also be integrated or adapted into virtually any typical Excel model for real estate analysis and valuation.

Traditional methods of valuation suffer from "the flaw of averages" where the expected, or most probable, average of an input is used in a valuation model, disregarding the possibility that there could be a large range of probable inputs that make up that average (Scholtes, 2007). An example of this phenomenon is as follows:

> *Using an example of a river with an average depth of 30 inches, the question presented is whether one can cross the river safely on foot? The answer is no, but this is not because the average 30 inch estimation of expected*

depth is incorrect, but rather that the average fails to exclude any potential holes in the bottom of the river that may exceed 6 feet and therefore unable to be traversed (Adapted from Scholtes, 2007).

This same issue is often seen in real estate analysis when inputs are based on averages of expected values. By using Monte Carlo simulation, a range of values are used an inputs to the model and a range of probabilistic results are obtained.

3.0 Olympic Villages and Other Olympic Venues

The Olympic Games, originally created in approximately 776 B.C., can be traced back to the ancient plains of Olympia, Greece, where they continued for nearly 12 centuries until Emperor Theodosius banned "pagan cults". At these ancient games, "imposing temples, votive buildings, elaborate shrines and ancient sporting facilities" were combined to create the venue and community for the Olympic Games (IOC, 2009). It was not until 1896 though that the Olympic movement was again created and the first modern Olympic Games were held in Athens, Greece (IOC, 2009).

First conceived for the 1902 Paris Games and since modified, the Olympic Charter now reads:

> *"With the objective of bringing together all competitors, team officials and other team personnel in one place, the OCOG shall provide an Olympic Village for a period determined by the IOC Executive Board." – Olympic Charter (IOC, 2007)*

With this being clearly stated as not just a goal, but as a requirement of hosting an Olympic Games, the Olympic Village is a critical component of delivering a successful event. The Olympic Charter also goes as far to express the desires of what the Olympics will bring to all those involved:

> *"Olympism is a philosophy of life, exalting and combining in a balanced whole the qualities of body, will and mind. Blending sport with culture and education, Olympism seeks to create a way of life based on the joy found in effort, the educational value of good example and respect for universal fundamental ethical principles." – Olympic Charter (IOC, 2007)*

These same principles must be integrated and evident in every aspect of the Games, including the venues for which the Games are housed.

Due to the Olympic Movement and its motive to make the Games a "world" event, it makes it almost impossible for the Games to be held in the same city more than once. Only three cities have held the games twice (Paris, London and Los Angeles), and even then the events were held a minimum 24 years apart in each city (Millet, 1997). With that being said, it is very difficult to build the Olympic infrastructure and particularly the Olympic Village to be used for purely an Olympic use.

Many past Olympic host cities have built great venues that instill the values of the Games, but years later some of these venues sit vacant, abandoned and in disarray, or with hefty financial tabs that are the public's responsibility, because there was little use for them following the events. Examples of these are:

- 1976 Montreal venues

  Significant debt for Olympic venues was not paid off until 2006. Additionally, various facilities are abandoned due to lack of interest or other use. The Velodome was converted to a Biodome which is a center dedicated to ecology and environment and a very questionable occupant of a large sports venue. (Guay, 1996)

- 2008 Beijing Stadium

  "The National Stadium, known as the Bird's Nest, has only one event scheduled for 2009: a performance of the opera "Turandot" on Aug. 8, the one-year anniversary of the Olympic opening ceremony. China's leading soccer club backed out of a deal to play there, saying it would be an embarrassment to use a 91,000-seat stadium for games that ordinarily attract only 10,000 spectators. The venue, which costs $9 million a year to maintain, is expected to be turned into a shopping mall after several years, it owners announced last month." – (Demick, 2009)

- 2000 Sydney Stadium and Olympic Park
- 2004 Athens Stadium

Other cities on the other hand have been able to create great value out of some of their venues. In Atlanta, the main Olympic Stadium was designed and developed with the full intention of converting it to become the new Atlanta Braves stadium. With some forward thinking and up front design, flexibility was created in the structure to allow for this conversion from an Olympic use to a post-Games use to occur in an efficient manner.

3.1 Examples of Past Olympic Villages

The first modern Olympic Village was constructed for the Los Angeles Games in 1932 in the Baldwin Hills neighborhood of Los Angeles, California. This Village consisted of several hundred buildings including not only residential areas for athletes, but other amenities such as a bank, amphitheatre, hospital, and post office. This Village was not expected to survive past the Olympics and was dismantled just after the Games (Xth Olympiad Committee, 1933).

Olympic Villages have since been delivered in many different forms from utilizing virtually all existing facilities in Los Angeles for the 1984 Games to creating alliances with established institutions in Atlanta and Salt Lake City (ACOG, 1997; SLOC, 2002) and building entirely new neighborhoods in a "new urbanism" effort to revitalize an area of the host city (Barcelona, 1992 and Sydney, 2000). Lake Placid, 1980 even went to the extreme of using a newly built medium security prison as part of its Olympic Village in an effort to provide a safe and secure facility for the athletes. In finding comparative cities and sites for the proposed Chicago 2016 Village, it is important to understand the differences between the National Olympic Committee's (NOC) policies in the United States versus those in other countries. Unlike most other host cities, there are no national subsidies for the project. Chicago instead will rely virtually entirely on private financing through a private developer (Chicago 2016, 2009). Therefore, Salt Lake City and Atlanta were reviewed to see if there were any "lessons learned" that could be applied to the Chicago site. As discussed below, it was realized that the Salt Lake City and Atlanta Villages were very different from the proposed Chicago Village mostly due to the fact that their legacy use was already established prior to the Games. For this reason, Barcelona was briefly researched as another example of the "new urbanism" model that Chicago may attempt to recreate or follow.

3.1.1 Salt Lake City Olympic Village

The Salt Lake City Olympic Village overview is based on interviews with John McNary, Director Campus Design and Construction, University of Utah and Jane Cady Wright, President and CEO, Hanbury Evans Wright Vlattas + Company and Lead Designer on the Salt Lake City Olympic Village.

Salt Lake City established its Olympic Village on approximately 64 acres within the confines of the University of Utah campus by utilizing existing dormitory and institutional buildings while also developing new buildings that would serve as new student housing facilities following the Olympics. Existing buildings included approximately 22 historic properties that were rehabilitated and integrated into the master plan for the Village. Legacy use for all the buildings included student dormitories along with a community center, dining halls, and common use facilities.

There are many reasons why this Village was an extreme success but it is mostly due to the fact that the legacy use of the Olympic facilities were well known during the design and planning stages. In fact, even though the idea of developing the new buildings was initiated with the premise that they would serve the Olympics, the design process looked at the new facilities in exactly the opposite form. Instead, the buildings were designed specifically for the University of Utah's use and then the plan was adapted to see how the Olympic use and requirements would fit that design and plan. This process ensured the University of Utah would be left with venues that were well designed and efficiently met their needs.

While the Salt Lake Village was not required to have the same type of flexibility as may be required of other Olympic venues, there were still some requirements for the Olympics that were not needed for U of Utah. One example was the "disco", a bar or nightclub, that was created for the Village in old warehouse space. This "disco" was broken down and the warehouse was returned to its original use post Games.

One of the largest advantages this site had to achieve success was the ability to operate all venues for a full year prior to delivering it to the Olympic Committee. This led to a challenging problem of locating temporary housing for all of the students during the Olympics, but by finishing the project one year before the Games allowed the users to work out the "kinks" before the athletes arrived.

3.1.2 Atlanta Olympic Village

Atlanta was another example of an Olympic Village that was built with an institutional partner in Georgia Tech University and Georgia State University and was located on the campus of the Georgia Institute of Technology. This site was selected for a variety of reasons including the university's ability to provide "many suitable facilities for the Games, especially in the areas of housing, dining, recreation and training" (ACOG, 1997) This included the use of approximately 200 permanent facilities on the campus and approximately 270 acres of Georgia Tech's campus.

It was the goal of the Atlanta Committee for the Olympic Games to provide a completely secure and self-contained community that offered a full range of amenities for the residents. Members of the ACOG even visited the Barcelona Olympic Games in 1992 to observe the Village and help identify both the physical and operational requirements for the Atlanta Olympic Village (ACOG, 1997) A few new facilities were required and built to accommodate the Olympic Village including one 8-story building and one 13-story building constructed on the southeast corner of the campus. These facilities were used and managed by Georgia State University after the Olympic Games.

Overall delivery of the Olympic Village was a joint effort between Georgia Tech and ACOG:

> *"In order to develop the permanent facility infrastructure required by the Olympic Village and to make long-term improvements to the Georgia Tech campus, the Board of Regents undertook construction of new housing projects, numerous housing renovation projects, and the Georgia Tech plaza, an attractive, new, open area that was the main gathering place in the international zone." (ACOG, 1997)*

> *"Probably the most demanding challenge facing ACOG in connection with the Atlanta Olympic Village involved building approximately $17 million worth of temporary and portable structures in 16 days to transform the Georgia Tech campus into a completely secure and functional Olympic Village." (ACOG, 1997)*

After the Games, Georgia Tech was offered to purchase the temporary facilities for their sole use going forward.

3.1.3 Barcelona Olympic Village

Barcelona used the motivation of "new urbanism" to create a new mixed use village that would stand as a vibrant community long after the Olympic Games concluded. As part of this vision, they created the Parc de Mar area which served as the Olympic Village during the 1992 Summer Games.

> *"Apart from the facilities in the Montjuïc Olympic Ring and the Vall d'Hebron, the Barcelona Candidature had made plans for urban development in what was to be another large Olympic area for the Barcelona of 1992: the Parc de Mar, in Poblenou, where the Olympic Village for the athletes and team officials who would be coming to the Games was to be built. Initially the sheer size of this development aroused doubts and reticence and it was suggested that alternatives should be sought to cover the Olympic accommodation. In the end, however, it was decided to forge ahead with the studies and the planning of Parc de Mar, which would open up the city to almost five kilometres of coastline." – (COOB'92, 1992)*

A Special Development Plan for the Barcelona Seafront was approved by the City Council in which it contained "a number of central, interlinked proposals for one of the most important steps in the creation of the Barcelona of the future." These proposals included "the construction of a new area which would serve as the Olympic Village and would then be destined for residential use after the Games, the opening up of the city to the sea, and the reorganization of the road system. (COOB'92, 1992)"

> *"Even more impressive was the legacy of the Olympic Games of the XXV Olympiad in Barcelona in 1992. The city was literally transformed; its front on the sea was opened up and accentuated…" (Synadinos, 2002).*

The newly developed area of the Parc de Mar turned out to be a tremendous success for the City of Barcelona, even with overcoming many challenges with the recovery of the Barcelona coastline for the project. In the end, the Parc de Mar was able to provide a new area for the city that was highly desirable to Barcelona residents (COOB'92, 1992).

3.2 Examples of other Olympic Venues

3.2.1 Atlanta Olympic Stadium

The Atlanta Olympic Stadium is an excellent example where thoughtful planning of a new Olympic venue proved to be a very successful project. This stadium was designed and built to accommodate the needs of the Olympic athletes and the Olympic Organizing Committee, but by building in flexibility, the stadium was easily and efficiently transformed into the new Atlanta Braves home baseball stadium following the Games. As presented in a recent study on flexibility in stadium design, the Atlanta Olympic Stadium was originally constructed to hold 80,000 spectators, but was reconfigured and downsized from an athletic stadium to a baseball stadium to hold 50,000 spectators (Jakimovska, 2007). This conversion allowed the Atlanta Committee for the Olympic Games to elude the situation of having another overpriced Olympic white elephant on their hands, and instead provided a facility that has since been used by over 30 million people since the Games (Sandomir, 2005).

3.3 Proposed Chicago 2016 Olympic Village Plan

The information in this section has mostly been obtained from the Chicago 2016 Bid Book, unless otherwise noted, which was distributed to the IOC and general public on or around February 12, 2009.

Chicago 2016's goal for the proposed Olympic Village is to transform an underutilized hospital campus of approximately 52 hectares[3], or 128 acres, on Chicago's near South side to a new "urban, compact" neighborhood for the 2016 Games and beyond. This proposed village would provide a "unique experience in the middle of the City" for the 16,000 athletes and team officials during the Games as well as an entirely new community for many years following. As part of the Bid process, the village has been conceptually designed to consist of 21 residential buildings or approximately 12 stories each, totaling approximately 3 million square feet along with a lakefront park and private beach for Village residents. The Village is designed to integrate into the existing city fabric while providing a "congenial, pedestrian friendly setting" designed around a Main Street and the Olympic Village Plaza that links all of the most important functions.

[3] one hectare = approximately 2.47 acres

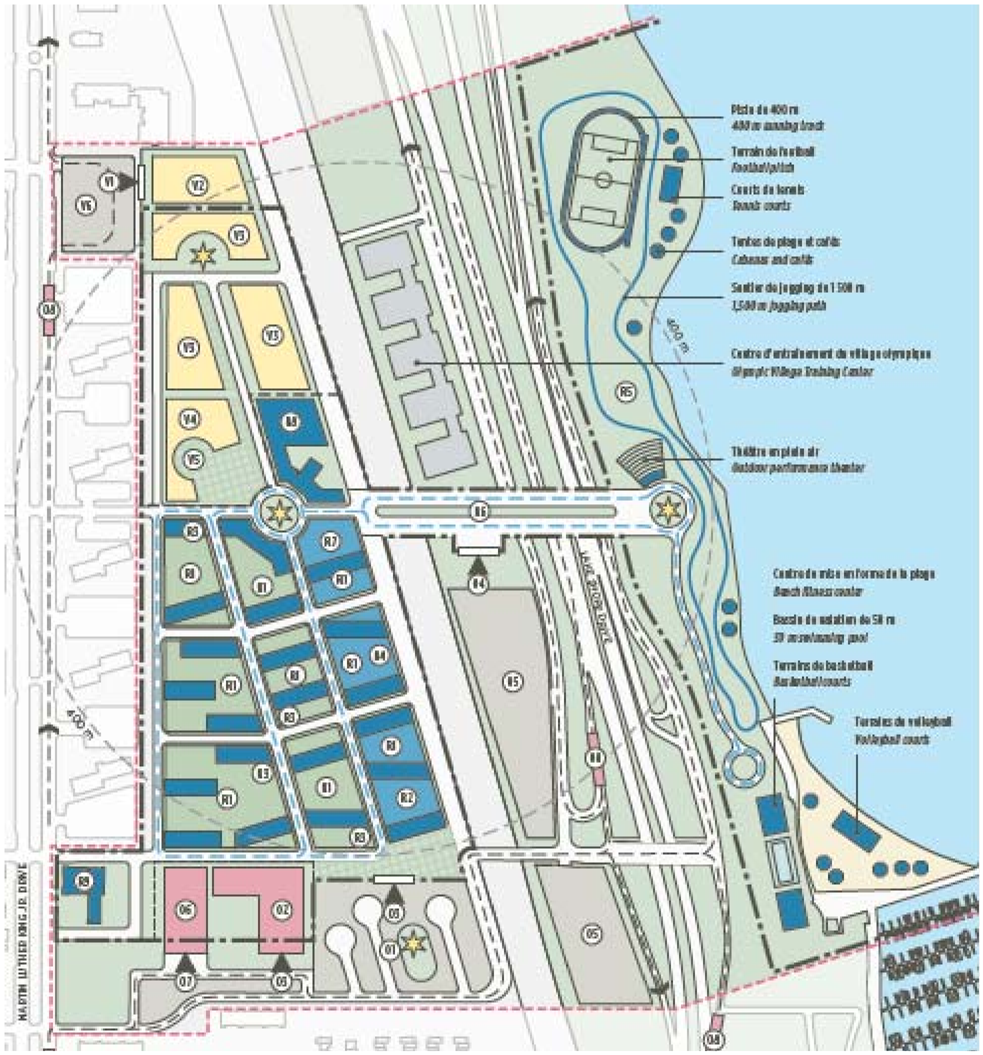


Figure 3.1 – Proposed Plan of Village, Olympic Mode – Chicago 2016, 2008

3.3.1 Project Design

The overall Olympic Village project is proposed to consist of similar buildings that will feature a modular floor plan that can be adapted to accommodate either Olympic offices or residential housing. This modular design is also expected to facilitate future conversion into market rate and affordable housing after the Games. Figure 3.2 visually represents the similarity currently being proposed for the residential structures. This current design could prove to be an issue as the "IOC favors buildings not more than 14 stories tall, while developers have favored much larger towers for condos near the lakefront to maximize their returns" (Pletz, 2009).

Figure 3.2 – Proposed Olympic Village residential structures – Chicago 2016, 2008

Building on Chicago's "long history of progressive urban planning and world-class architecture", the latest technologies and environmentally sustainable designs are scheduled to be incorporated into the overall design of the project. This goal correlates well with the global initiative of the Bid to promote the "Blue-Green Games". With this initiative, Chicago 2016 is interested in showcasing the seamless integration of environmental innovation and technologies throughout the Games.

3.3.2 Details of Accommodations

Residential accommodations in the Village will provide approximately 17 square meters[4], or 183 square feet, of gross living space per resident while providing a convenience variety of amenities in a mixed-use community atmosphere. The IOC prepares a technical manual for the Olympic Village that architects use as the "program" for design. A few of the specific details of design that are integrated into the Chicago Olympic Village are as follows:

- *no more than 2 residents per bedroom*
- *maximum resident/bathroom ratio of 4:1*
- *single rooms will also be provided for "chefs de mission"*
- *total of 600 single rooms and 8124 double rooms will accommodate 16,800 bed spaces*
- *single bedrooms will be 13.5 sq meters and double bedrooms will be 13.5-19 sq meters (exceeds IOC technical manual requirements)*
- *units will have individual thermostatic controls and extra sound insulation within walls and between floors*

[4] one square meter = 10.8 square feet

The IOC requirements for the Olympic Village are very specific and not necessarily transferable to the private market for the legacy use of the facilities. As a result:

> *"Much of the housing, which must be designed and built in just six years, will have to be reconfigured between the time the athletes use it and private owners take possession. A typical two-bedroom condo will require temporary walls so it can house eight athletes in four bedrooms. Kitchens will either be walled off or rendered inoperable because the IOC doesn't allow athletes to eat outside the dining hall. Athlete facilities such as an amphitheater and nightclub will be temporary, as well." (Pletz, 2009)*

All of these issues present additional challenges to a project of this nature and will be discussed further in the next chapter.

3.3.3 Financial Requirements and Assumptions

The proposed Chicago Olympic Village is unique to most other countries proposed Villages in that no national subsidies are provided for the 2016 Games. This provides additional challenges with financing and guaranteeing a project of this size, however the City of Chicago has agreed to support the site with a tax increment financing (TIF) subsidy that would fund infrastructure and other significant improvements. The City will also transfer the site to a private development team that will be required to deliver the Olympic Village to meet the requirements for both the Olympic Games and the City of Chicago. Upon executing this transfer, the development team is expected to be required to provide a guarantee for timely completion of the construction.

The overall development budget for the project is currently estimated at $976.6 million and would be privately financed by the development team. Olympic revenues are expected as CHICOG will lease the residential buildings in the Village for a total of ten months (before and during the Games). This rent is calculated to cover the development team's carrying cost during the rental period, estimated at $44.1 million, but will be no more than market rate rental costs. There has also been recent news suggesting that the City of Chicago may provide some type of guarantee for the Olympic development, but this has not been confirmed to date (Hersh, 2009).

3.3.4 Project Development

Chicago 2016 has already received responses from various development teams interested in the Olympic Village project and should select a team shortly after the IOC announces its selection in October, 2009. The development team will be selected to build the residential portion of the Village and to convert the residences to a new community following the Games where they will have direct responsibility for the design and construction of the Village. The City of Chicago and CHICOG will still maintain involvement by overseeing construction and monitoring progress to ensure compliance with the schedule and physical requirements. As a note, the private development team will not be responsible for the temporary structures on the site.

Development of the Village is expected to begin in 2012 and be completed by the end of 2015. During this time, the permanent residential structures will be built on the site to provide housing and office space for athletes and officials during the Games. These units will be pre-leased or pre-sold for new residents to occupy the spaces after the Games. Temporary facilities will also be constructed and when dismantled it will provide the private developer with the opportunity to add additional residential or commercial space for the Village. Chicago 2016 does anticipate a strong market response to the development as a previous Olympic Village.

3.3.5 Post Olympic Use

The plan for the Chicago Olympic Village is to transition it to a mixed-income, residential community, establishing an exciting new neighborhood on the near South Side. This is aligned with the City of Chicago's long range plans as the Village should act as a catalyst for the transformation of the City's near South Side. City of Chicago has, in fact, already approved rezoning of the site for development of the Village and a future lakefront mixed-use community. The City even expects this development project will occur whether or not Chicago is selected for the 2016 Games.

It is the City's objective for this new neighborhood to attract new business and retail establishments after the Games. With a mix of market rate and affordable units divided into condominiums and apartments and even a number of buildings targeted to seniors and students, the neighborhood would be the home of people of a variety ages and backgrounds. Also, with Paralympic considerations, "all streets, plazas, sidewalks and the lake promenade will be designed according to applicable accessibility standards, providing barrier-free access for all residents."

It is apparent that the detailed requirements of the Olympic Village would provide significant challenges to a project of this type. Many of these issues will be discussed further in the next Chapter.

4.0 Challenges of Olympic Development

There are many differences between Olympic Development and Real Estate Development in general, however the most significant difference is related to the scale and visibility of the two types of projects. Olympic venue development projects have many of the same characteristics as those of other more typical large scale, important projects, but these issues are elevated to an even higher level due to the world stage on which they sit.

Research on the challenges of large scale, important projects has been compiled and in a briefing paper by de Neufville and Scholtes (2006) large projects are identified as having the following characteristics:

- *More likely to be salient politically at the national or even international level, and thus sensitive to idiosyncratic changes in national priorities and public pressures*
- *Subject to much greater uncertainties – not only politically, but also associated with market fluctuations, technological change, and the organizational complexity of the special purpose consortia set up to run the project – over their extended lifetime*
- *Likely to have significant impacts on the sponsoring organizations. Indeed, the main sponsors of any large project will have limited ability to spread the risks over many projects, and are more likely to be 'betting their company' or their reputations on the major project.*

These points are reviewed in the context of Olympic development and are determined to be applicable to this type of development. The characteristics are further reviewed in the following discussion of the unique challenges of Olympic development.

4.1 Differences between Olympic Development and Real Estate Development

The following quote from a developer interested in the Chicago Olympic Village loosely sums up the challenges involved with such a development:

> *"The rest of the world would probably think getting into Olympic development looks like deciding it's OK to go rowing with the Marquis de Sade to the middle of the lake during a storm after dark for one's first swimming lesson. Of course there are a number of developers that have a different perspective because otherwise they wouldn't be developers." (Anonymous, 2009)*

With this being said, it is very important to understand the differences between Olympic Development and other types of real estate development. The following discussion of these key differences is compiled based on interviews with a few of the Chicago developers that are interested in the proposed

Chicago 2016 Olympic Village project. A few points were also either acquired or confirmed through public press and review of past Olympic Villages in Salt Lake City, Atlanta and Barcelona.

4.1.1 Suggested IOC Venue Requirements

One of the first points to be made by each of the interviewed individuals involved in Olympic development is the difference between IOC and private market requirements. The IOC provides a technical manual that is unfortunately not available to the public, however it addresses the desired requirements of the Olympic Village design. In it, it answers key planning questions such as how big a room has to be, would should the ratio of the size of buildings and amenities be per athlete, how many bathrooms should be provided and how quickly should athletes arrive via vertical transportation. Like many typical projects, this manual serves as the program for the building, but what makes the design especially interesting is then altering the design for convertibility of the venue to later uses. It is the architect or designers goal to keep the transition to a minimum and the resulting expense to a minimum.

The ability to design to the IOC criteria while also satisfying the post-Olympic market criteria such as good unit size, good bedroom size, etc. is a very complicated and challenging task. At a minimum, the design should allow for convertibility while minimizing the modification to any main structural or mechanical pieces. One example of this type of design that was suggested was the planning for different unit sizes and unit types. Looking at the sizing in terms of bays, if the design can keep structural elements like all building envelope and core components, as well as demising partitions between units in place and then also have mechanical (HVAC and plumbing) systems either roughed in or in place for the future use, this allows for a much easier conversion to other uses. The designer should always keep the following question in mind when laying out the Olympic plan: "How does the entire Olympic suite relate to a future unit?"

Another example of how IOC guidelines differ from that of the market requirements is that the Olympic use can not have kitchens in the units. This evolves from the desire for athletes to eat together in communal dining rooms and facilities, which are also available in the Olympic Village. To address this issue, the developer may choose to possibly install plumbing for future kitchens, install part of the kitchen without installing the appliances, or even build the kitchen and wall it off so it is not available for use by the athletes. Each of these options has a different cost and complexity that would need to be evaluated. The ability to build more than is needed up front and have it available for use following the games should be questioned and investigated.

As a final example, the requirements for elevators drastically differ for the varying uses. The number of elevators and size of elevators both need to accommodate the athlete traffic during the Olympics to meet IOC requirements, but would be overkill for a private residential building. The ability to be able to reclaim some of the vertical transportation for the post-Olympic use could prove economically advantageous if designed properly.

4.1.2 Security

The next challenges involve the security of the Village and the requirements during and post Games. In an archetypical mixed use real estate development, designers are typically looking to bring people into the development and integrate it with its natural surrounding neighborhoods. But, due to high security of an Olympic Village, the project needs to have defined perimeters. While many of these security perimeters may be temporary in nature, the project still needs to layout to allow for centralized use of services in the congregating areas for athletes.

How this transforms to the public market following the Games is a challenge as a developer of this type of project probably wants integration with the surrounding community and its services. Beijing 2008 can be used as an example of how this challenge still faces the community today, almost a year later. In a recent trip to the site, a visitor observed the "compound" that was built for the Beijing 2008 Olympic Village where the guards were still present to provide security to the enclosed "community" (Loewenberg, 2009). Whether this was a desired outcome for the venue or its one that can not be avoided is unknown, but it still exists as a challenge to meeting these various goals.

The Village in the end, at least in Chicago's case, needs to integrate with the surrounding community. A new village with the exclusive nature of a "gated community", especially in part of Chicago proposed for the Village, would most likely not be accepted by the market (Loewenberg, 2009). The Olympic Village model, however, requires a tightly centered community in order to provide all of the amenities to the athletes in immediate proximity, where a naturally created neighborhood would typically find these amenities dispersed throughout the neighborhood.

4.1.3 Delivery Schedules/Guarantees

This challenge stems from the issue that Olympic projects are required to be delivered despite changes in market or other conditions that may be out of the developer's control. Unlike those of other countries and Olympic Games, this Village is anticipated to be fully financed by a private developer and is not expected to receive any type of national subsidy. Recent press addresses this issue as the other 2016 bid cities (Madrid, Rio de Janeiro and Tokyo) are offering full government guarantees (Bergen and Hersh, 2009). Certain costs of the project will be borne by the Chicago Committee for the Olympic Games (CHICOG) or the City of Chicago via TIF financing, however all other financing and delivery risk will be the developer's responsibility. This is very different from a typical real estate development project where the developer would have the option to delay or abandon a project if conditions deem it unfavorable or nor longer profitable.

With recent changes in Chicago 2016's perspective on meeting the IOC's requirement to provide a financial guarantee, the City of Chicago may offer a guarantee for the Games, however the level of guarantee that may be presented directly for the Olympic Village is still unknown (Hersh, 2009). If a guarantee is put forward for the Village, this would create an interesting real option that would be similar to a put option on the project that would limit the downside exposure of the project (Trigeorgis, 1996).

4.1.4 Political and Visibility Issues

The nature of this type of project being large scale, extremely important and visible to the public introduces additional challenges for Olympic development. The early planning for the Chicago Olympic Village has already attracted many "interest" groups looking to benefit their cause and lobby their goals for the project. For example, affordable housing groups may want to see a higher percentage of post-Olympic units as affordable, while ADA interest groups may want to see high standards of accessibility planned for the project and environmental and sustainability focused groups want all units to be delivered at "green". Unfortunately, all of these considerations not only have costs, but may conflict with each other or those of the market requirements as a whole. While this is an extreme example, balance of all of these forces must be met, while still achieving a financially sustainable project.

With these challenges being identified, there may also be benefits to having the backing of the City and the Olympic Committee for such a high profile project. For example, the permitting and planning process may be expedited as a result of the delivery requirements and guarantees. Restrictions on flexible design may likely be less of an issue in a visible project. In the recent example of the BCBS building in Chicago, the developer was able to implement a vertical expansion option into the design which left either redundant or incomplete systems in the building. Even though all life safety issues were addressed and completed for the initial phase of this development, the City has been hesitant to allow this type of option in other residential projects in the City (Anonymous, 2009). If an option of this sort were to prove valuable and mitigate downside risk of a project, the City may be more amenable, especially if it were providing a guarantee, to allowing flexibility to be built into a project.

4.1.5 Duration of Use

The building use for this project is extremely different from a typical project that is developed. Investment properties may have an expected duration of use of 30, 40 or 50 years, while institutional users may even plan for durations of upwards to 100 years. An Olympic project, on the other hand, is designed to specific requirements that are utilized for a very short term; only 16-17 days for Olympic Games and then possibly an additional few weeks for the Paralympic Games. Integration of temporary facilities assists the effort to meet many of the short term goals of the Games and its venues, but all facilities can be temporary. This issue again suggests the need to create an efficient process for transforming facilities following the Games to their legacy uses.

4.1.6 Timing of Project

The development schedule for a project of this size presents a challenge as well. As the Bid Book currently suggests, planning would begin in mid-2010 with construction actually beginning in 2012, but unfortunately there is a fairly long duration until any revenue from the project is realized. The Olympics in 2016 would generate rents for the facilities as they are leased by CHICOG, however the entire project is being delivered at the exact same time. Typically, for large, multi-use project like the proposed Olympic Village, developers only spend the amount of capital as is required to start creating revenues on a project. The project then continues to be developed using revenues from other "parts" of the development. Additionally, the "real" revenue for this type of project is not realized until after the Olympics when the project is converted to its legacy use and then absorbed by the market. Because of this situation, it may be beneficial for the developer to consider legacy uses that come to market quicker such as "bulk" selling larger sections of the project or even below market, or affordable, housing units that are absorbed very quickly.

4.1.7 Scale of Project Delivered to Market

The size of these types of projects is significantly larger than most projects being delivered to a market in a single phase. As an example, Chicago may typically see absorption of 2500-3000 units per year, but this is for the entire City of approximately 146,000 acres. The proposed site for the Chicago Olympic Village is only approximately 128 acres and proposing to deliver upwards of 2500 units to market. It is expected that absorption for this area could be as high as 500-600 units per year, but even that assumption is aggressive. Instead, the developer needs to figure out potential other uses to be able to deliver larger "chunks" to the market at one time in the form of student housing, senior housing, hotel or other uses, or look for opportunities to minimize carrying costs while phasing a project in a more traditional market delivery.

4.1.8 Unknown Future Legacy Use

One of the biggest uncertainties of an Olympic project is determining the future legacy use post Olympic Games. While the market will dictate what the highest and best use for the site is, that use may not be able to be efficiently transformed from the Olympic use. For the proposed Chicago Village, a residential legacy use still seems to be a good fit for the project, but exactly what type of residential is an important question. Many buildings are coming online now in the South Loop area, which is less than a mile from the proposed site, and are delivering a quantity of units almost the size of Olympic Village itself. The ability for the market to continue to desire these types of units as well as the rate at which these units will be absorbed is uncertain.

The fact that the proposed site is in a "new" underdeveloped area of Chicago also can drastically affect the market response for uses following the Games. Value of the project can be significantly affected based on the surrounding neighborhoods (i.e. what happens with the adjacent rail yards and McCormick Place truck parking areas). Many of these issues are ones out of the developer's control, but should be considered when valuing the project.

Also, since the typical Olympic program develops around a central "Olympic Ring" which links the various venues, attractions and amenities for athletes, visitors and spectators, the buildings constructed in the Ring become a landmark of the City. The urban planning, redesigning and integration into the City therefore are determined by the post-Olympic use. This often makes it difficult for larger Cities to host the Games as it involves a very detailed, large-scale plan of the City forecasted far out into the future (Synadinos, 2002).

4.1.9 Lack of Diversified (Naturally Created) Community

Finally, the lack of a natural developed community could prove detrimental to the market response to the project following the games. As the IOC requirements would rather see all units and buildings to be "exactly" the same, as to ensure that all participants in the Games have access to equal facilities, the reality of this type of design leads to a more institutional look and feel, as opposed to a community that has been naturally developed over time. This may be why these uses have worked well in the past to create a similar look and feel across a campus setting with institutional users such as in Atlanta and Salt Lake City, but the legacy use requirements are very different for the Chicago site.

As discussed as part of the security challenges, the Olympic Village by nature is very compact design and of different scale than the immediately surrounding areas. The ability to locate various neighborhood amenities such as bars, restaurants, grocery stores and convenience retail throughout the community is crucial.

As part of the Olympic development use, the transportation network is also supplemented during the Games. Athletes and other residents of the Village are provided with temporary transportation during the Olympics to provide easy access to other venues and around the City, but this temporary transportation goes away after the Games. While the Chicago site is fairly closely located to existing transportation nodes with the Metra Rail (South Shore Line) and the CTA "L" and bus systems, the entrances and access points between these transportation hubs and the Village may be very different during and after the Games.

4.2 Opportunities for Design Flexibility/Real Options

The construction process is essentially irreversible because as buildings are constructed, it usually is not cost effective to demolish the building to then build again (Geltner et al, 2007). It should be noted though that many large scale sporting events do consider temporary structures as part of the solution to providing shelter and competition space for short duration. PGA golf tournaments and the Super Bowl often use tent structures to house and entertain guest during the events. Chicago 2016 is also proposing the use of a temporary structure for its Olympic Stadium. To effectively make this decision, the cost of the temporary structures should be compared to the proposed cost and returns of a permanent development that includes design flexibility. Other issues and decision points such as land/resource availability and political agendas may then cause particular decisions to be made, however these issues are beyond the scope of this study and will not be considered in determining optimal development strategies for the proposed venues of this study.

The idea of creating flexibility and a conversion plan to a legacy use, such as transforming Olympic housing to market housing, does not require that the final end use of the venue is completely known. The planning for the Olympic Games takes many, many years, and because of this, market conditions and the desires of the private market proposed to occupy these venues following the Olympics can change. This planning time is not necessarily significantly different from that of other large scale development projects, however one key difference does exist. The Olympic organizers, specifically the IOC, have very strict requirements for what must be delivered as part of the Olympic package and there is a very strict timeline by which the infrastructure and venues must be delivered. And while the Olympic requirements remain static, the market conditions could be changing drastically.

Here lies the opportunity to potentially create additional value in these venues by identifying opportunities for design flexibility. This design flexibility should be considered a real option that will allow the developer the option, or the right, to switch or modify a particular venue use, but not the obligation to make this switch. This right directly relates to the definition of an option in finance where it is "the right without obligation to obtain something of value upon the payment or giving up of something else of value" (Geltner et al, 2007). The real option cost ends up being additional construction, design and development cost, however if designed and planned properly should create additional value.

4.2.1 Types of Design Flexibility

Per the research conducted by Keymer (2000), there are essentially three commonly used types of design flexibility:

1. modularizing major components of a building
2. over-engineering a structure to accommodate additional load capacity
3. separation of systems

Keymer also discusses 37 distinct design strategies to pursuing building flexibility that are then categorized as Structure, Enclosure, Services and Finish. The value for each of these strategies is discussed and contrary to popular belief, the strategies for implementing flexibility are not always expensive. In fact, increases in the initial construction cost for each of these strategies varied widely.

Most strategies created an increase in construction cost of less than 3% and over half of the strategies created an increase of less than 1% (Keymer, 2000).

While many of these design flexibility types and strategies are currently being reviewed for the Chicago Olympic Village, the process is too early to adequately justify use of any particular strategy at this time. All strategies are not necessarily applicable to an Olympic Village Development and would need to be further investigated by the architect as the process progresses.

4.3 Types of Applicable Real Options

Real options both "on" and "in" the project are applicable to this type of project. Referencing the taxonomy of Trigeorgis as discussed in Chapter 2 and based on the challenges that exist in Olympic Venue development projects, the following types of real options are identified as potential sources of flexibility for this type of project.

4.3.1 Option to Switch

The "switch" option provides the developer the right, but not the obligation, to change uses of a project when transforming the development to its legacy use. As discussed as one of the main challenges of a project like this, the legacy use of the development is unknown due to a variety of factors, while the Olympic use has very specific delivery requirements. By designing for convertibility to two or more potential uses, it creates the option for the developer to choose the final use at the time of transforming the project. An example of this conversion could be athlete residential units transforming to rental, condo, mixed income, senior housing, student housing, or hotel. Another example may be to build Olympic storage and office facilities to be able to accommodate parking structures following the Games. As parking is not required during the Olympics, this could be an efficient transition to meet the needs during and after the Games.

By designing for convertibility, such as pre-installing MEP systems for more than one future use, splitting systems to accommodate various configurations, or overbuilding structures to accommodate different loads in the future, this option is implemented through that design flexibility. The market will dictate what the highest and best use of the site is at that time and the decision maker can then exercise the option accordingly.

4.3.2 Growth Options

Growth Options for the Chicago Olympic Village project are based on the ability for the developer to build additional buildings for expansion of the project at a later date. The timing for exercising this option is extremely uncertain as it is directly affected by the market response to absorb the base Olympic project. The option to abandon the temporary structures built for the Olympic Games (while expected, but not required) creates the growth option by opening up vacant, developable land. This growth option also allows the developer to wait to build new product only and when the new buildings can benefit from the value created by the initial Olympic Village development.

4.3.3 Option to Abandon

The option to abandon the project post-Olympic games is an extremely unlikely event, however does exist. However, this option is presented in multiple forms and is a very probable result for the temporary facilities that will be constructed for the village. As mentioned briefly in the growth option discussion, by exercising the option to abandon these temporary facilities, as a result the subsequent growth option is created. Unlike the option to switch, this option is considered "on" the project as it is less concerned with design features built into the project.

4.3.4 Option to Defer

The option to defer and wait a period of time before resuming operation is sometimes otherwise known as a type of phasing option and is yet another example of a real option "on" a project. This type of deferral option does differ from the time-to-build or staged investment option where the latter option category is an option "in" a project and therefore requires more detailed design and engineering flexibility to accommodate that staging approach to completing a project. For example, if a developer were to only complete a part of a single building, expecting that the remainder of the project would be completed at a later date, this would be a case of the staged investment option. As another example though, if one building was constructed of a master plan with expectation that other building may be built when the market can accommodate it, this would be a case of the option to defer as it does not require design flexibility built into the project itself.

The application of the defer option stems from the extreme uncertainty in the market response to a project of this type and size. Absorption rate of units can be assumed, but these assumptions can vary widely. By considering the option to defer a project, or part of a project, capital for that project is only deployed as necessary and the duration between the costs and revenues is decreased. This option along with the option to switch are determined to be key components of achieving financial success for a project of this type and will be evaluated an analyzed further as part of the Real Options Analysis section in the next chapter.

5.0 Real Options Analysis of the Proposed Chicago 2016 Olympic Village

It should be noted that this is an analysis of a hypothetical case study based on the present knowledge of and available information for the Proposed Chicago 2016 Olympic Village. Some figures are assumed based on market knowledge or other public information. The purposed of the thesis and this analysis is to present a concrete example of the framework to analyze real option opportunities in Olympic venues.

Traditional analyses such as discounted cash flow (DCF) analysis have their shortcomings and specifically seem to neglect to value flexibility in a project. Instead, they assume potential future cash flows are "known", static and unable to be changed. For a scenario where these attributes are true, then analysis using DCF or similar analysis will be sufficient, but most projects in real estate development are not as such (Mun, 2006).

As discussed earlier, the creation of a real option should always create additional value. Again, this is assuming that the option can and is exercised at an optimal time. The net change in value, however can only be determined after identifying the cost of the option and then quantifying the additional value created as a result of the option.

Net Change in Value = Additional Value Created – Option Cost

Considering the number of unknown conditions and therefore the significant uncertainty involved in an Olympic Village development, the process of applying flexibility and real options analysis may be able to overcome the typical post-Olympic hang over that many venues feel. ROA can be used as a tool to further analyze these areas of uncertainty, value the flexibility that is applied and help managers and key decision makers decide the most efficient course of action for their project.

As defined by Mun, the eight critical steps to performing a real options analysis are as follows (Mun, 2006):

1. Risk Identification – Qualitative Management Screening
2. Risk Prediction – Time-Series and Regression Forecasting
3. Risk Modeling – Base Case DCF Analysis
4. Risk Analysis – Monte Carlo Simulation
5. Risk Mitigation – Real Options Problem Framing

6. Risk Hedging – Real Options Modeling and Analysis
7. Risk Diversification – Portfolio and Resource Optimization
8. Risk Management – Reporting and Update Analysis

Each of these steps are reviewed in detail, and for those steps that directly apply to the proposed Chicago 2016 Olympic Village case study, the analysis and findings are discussed.

Understanding the explicit steps involved in ROA should help explain how the process is developed from traditional analyses (either DCF or NPV). Real estate financial analysis by many practitioners traditionally finishes after step 3 or occasionally step 4. The remaining steps 5-8 provide the detailed process for how users of this process can understand the full concept and power of ROA and how it can be applied in even more detail to further analyze a project and fully realize the benefits of the entire process.

The following steps should be considered a framework for analyzing projects with uncertainty where ROA should benefit the user to better determine the real value of a project with built in design flexibility and the ability to exercise that option at the optimal time. As almost all of the data specific to the proposed Chicago 2016 Olympic Village has either not been created yet, or is still confidential information, it is suggested that this process is completed when the actual proposal is being created for this proposed project after which a host city is selected. This model and process is also created with the ability to adapt to other host cities plans for their Olympic Village as well as other large scale, short term uses or Hallmark events (Syme et al, 1989).

5.1 Risk Identification – Qualitative Management Screening

During this step, the objective is to review various projects and or strategies that are viable for further analysis. In the case of the Chicago Olympic Village, looking at various projects or initiatives is not necessarily applicable, so the analysis instead targets various strategies for this particular project. These strategies start to be created by identifying the major challenges, risks and areas of uncertainty involved in the project. Any solutions to these issues, however, must meet the overall goals of the project while being inline with the firm's agenda as a whole.

For this particular project, many of these challenges and areas of uncertainty are a result of the project being an Olympic venue development, instead of a more typical real estate development. The differences between these two types of projects were identified in Chapter 4. These differences, by no means, represent all of the risks involved in this project, because virtually any developer is going to understand the many other risks involved with development. This risk evaluation leads to an overall assessment by the developer to determine how the project should be approached and quantifies what level of return is required to compensate for the incurred risk.

5.2 Risk Prediction – Time-Series and Regression Forecasting

The goal of this step in the process is to forecast certain variables for the valuation of this project. These variables will range from projected rents, construction costs, operating costs and financing terms. Forecasting values for these variables can be completed through 3rd party research firms such as Torto Wheaton Research or Real Capital Analytics, by consulting market experts, or through regression of historical data to determine trends in the change of value for the variables.

As noted before, the purpose of this thesis is not to complete a full feasibility study for the proposed Olympic Village. As a result, data for the analysis was collected from public sources and other market experts. Values are trended based on historical trends, or inflation, to determine assumed values for a 2016 analysis. The following table indicates assumptions used for this analysis:

Table 5.1 – Development Budget for Deterministic Model

Development Budget - Exhibit 1

SITE ACQUISITION:		
Michael Reese Hospital Parcel	$85,000,000	lump sum
Misc Closing Costs	5,000,000	lump sum
HARD CONSTRUCTION COSTS:		
Olympic Base Building	$150.00	/sf
Miscellaneous Hard Costs	$5.00	/sf
Contingency	$5.00	/sf
Retrofit Costs	$50.00	/sf
SOFT DEVELOPMENT COSTS:		
A&E	$15.00	/sf
Miscellaneous Soft Costs	$20.00	/sf
Developer Fee	3.0%	of hard construction costs
Flexibility Premium	0%	of total development cost excl. land
Gross Bldg sf	3,000,000	sf
% Development Costs Allocated to Residential	80%	of total development cost incl. land

Table 5.2 – Projected Revenues for Deterministic Model

Projected Revenues - Exhibit 2

Luxury-Average Condo	$	370.00	/sf
Luxury-Average Apartment	$	31.00	/sf/year
Student Housing	$	20.00	/sf/year
Senior Housing	$	30.00	/sf/year
Hotel	$	40.00	/sf/year
Olympic Residential Use	$	15.00	/sf/year
Apartment OpEx/RE Taxes & Comm		30%	of total apartment revenue /year
Expected Sales/Rental Rate growth		2%	/year
Average Apartment/Condo Size		1200	sf
Average Students /apt unit		8	people
Average Senior /apt unit		4	people
Average Hotel /apt unit		6	rooms
Olympic Residential Use		16,800	beds

Projected revenues were trended using an expected growth rate to determine each of these values in 2016 dollars. These assumptions were verified by market professionals for the Chicago market and were applied in the next step to conduct the Base Case DCF analysis.

5.3 Risk Modeling – Base Case DCF Analysis

The next step in the ROA process is to create a base case scenario using more traditional methods such as net present value (NPV) calculation or discounted cash flow (DCF) analysis. As a part of that analysis, anticipated cash flows throughout the project need to be discounted at an appropriate risk-adjusted rate. For this particular analysis, the following assumptions were made:

Table 5.3 – Assumptions for Projected Cash Flows

Projected Cash Flow - Exhibit 4

Condo Vacancy	0.00%
Condo Operating Expenses & RE Taxes	0.00%
Condo Sales Commissions	0.00%
Apt Vacancy	0.00%
Apt Operating Expenses & RE Taxes	0.00%
Apt Leasing Commissions	0.00%
Apt Capital Reserve	0.00%
Sales Absorption (units/year)	400
Lease up Rate (units/year)	400
NOTE: all costs assumed to be included in development soft costs and retrofit costs.	

Table 5.4 – Assumptions for Project Analysis

Project Analysis - Exhibit 5	
OCC of Spec Asset	9.50%
Stabilized Going-In IRR (2016 -> future)	8.50%
Terminal Cap Rate	7.00%
Sales Cost (%)	3.00%
Retrofit Cost discount for apartment vs. condo	10%
Projeted Gross Revenue - Condos	50%
Projected Gross Revenue - Apartments	50%

Running a full DCF analysis, which can be viewed in Appendix B-Exhibit 5, the following results are calculated for a condominium project, an apartment project and combined 50% condominium and 50% apartment project (50%/50% allocation was selected arbitrarily based on the knowledge that the project would need to have some combination of the two asset types):

Table 5.5 – Calculated IRR for Various Deterministic Projects (Condo, Apt and 50/50 Combined)

Project Analysis - Deterministic Results			
Return Type		Project Type	
	Condo Only	Apt Only	Combined
Project IRR	10.25%	9.57%	9.92%
Development IRR	12.19%	10.77%	11.49%

A few assumptions were made regarding this DCF that may be slightly different from ordinary real estate valuation methods. First, no additional costs (i.e. sales commissions, leasing commissions, operating expenses or capital reserves) were added (or subtracted) in the model and all values, as noted in Table 5.3, were assumed to be included in the expected revenues for each asset type. Second, the consideration of apartment revenue was calculated by dividing the Net Operating Income (NOI) for the apartment unit (on a yearly basis) by the assumed capitalization rate. This apartment value was fully realized in a single year, based on absorption rate, as if the unit (or at least its underlying cash flows) was sold. This method was used to correlate to the method used in the simulation that will be observed in the next step (5.4).

Casually reviewing these results, one may choose that the condominium project is a better project and therefore should be selected over the apartment or combined projects as it is providing the highest return (IRR) for both the development phase and overall project. Due to uncertainty in the expected sales revenues, however, this is not necessarily the best choice. Further analysis by real estate professionals is sometimes necessary through the use of Monte Carlo Simulation that helps factor in the uncertainty of particular variable inputs. This simulation runs multiple iterations of the same model using a specified potential range of values for the uncertain assumptions made in the static case. A range of results is then obtained.

5.4 Risk Analysis – Monte Carlo Simulation

As the static, base case DCF analysis produces only a single result, the only thing that is truly known is that the deterministic outcome of that analysis is either high or low. Based on the number of forecasts and assumptions placed into the calculation, there is little confidence that the result will be 100% accurate. Monte Carlo simulation, therefore, is used to evaluate a range of possible values for a specific input to determine its effect on the resulting value of a project. This resulting value is then often graphically represented in a Tornado chart, histogram or VARG curve (Hassan et al, 2005) to display the range of outcomes for that analysis. Even in the absence of flexibility, Monte Carlo simulation should provide a more accurate representation of the potential value of a project.

The goal of running a Monte Carlo simulation is to more accurately model uncertainty in a project. Monte Carlo simulation may not currently be an extremely widely used method for valuing real estate projects due to lack of client understanding, negative connotation with "gambling" and limitations as noted below (Foster and Lee, 2009), but it does provide a good method for evaluating uncertain assumptions. Another choice for modeling uncertainty is scenario analysis (optimistic, base, and pessimistic scenarios), however this method is not as robust as Monte Carlo simulation.

Monte Carlo Simulation effectively runs a large number of iterations of the traditional DCF (or NPV) analysis, but allows each iteration to randomly choose modifiable variables. This is different from traditional discounted cash flow analysis where these unknown variables are typically averaged over an expected period of time and used in their static form. The proposed use and size of a project is also static and unchanged in DCF.

The Monte Carlo Simulation for this ROA uses 2000 iterations where each iteration evaluates the proposed NPV for each of the possible legacy uses following the 2016 Olympic residential athlete use. All variables up to that point that are deemed "certain" (including hard and soft construction costs) are considered static for sake of example. Other variables though are considered "uncertain" and randomly generated for each iteration. In this model, absorption rate and expected sales price for both condominiums and apartments are uncertain. Other assumptions and uncertainty levels for this stochastic model are as presented in Table 5.6:

Table 5.6 – Baseline Assumptions used for all simulations in analysis unless otherwise noted

Simulation Entries (Base Assumptions) - Exhibit 6

Condo Base Absorption Rate, units/yr	400
Apt Base Absorption Rate, units/yr	400
Condo Absorption Uncertainty Factor, /yr	40%
Apt Absorption Uncertainty Factor, /yr	10%
Occupancy Hurdle Rate, %	80%
Max years per Phase	3
Absorption Weight Factor	30%
Option to Defer	OFF
# Units developed (each phase)	800, 800, 900
Price Uncertainty Factor - Condos, /yr	40%
Price Uncertainty Factor - Apts, /yr	10%
Price Weight Factor	30%
Override Project Discount Rate	15%

The results for this model are presented as VARG (Value at Risk Gain) Curves and histograms that represent the cumulative probability distribution of the project's outcome. In other words, the probability of a specific NPV being realized for the project is observed. The resulting VARG curve and histograms are displayed below for both the condominium and apartment project alternatives:

5.4.1 Stochastic Model Results – Without any Uncertainty

As mentioned in section 5.3, the simulation model has been calibrated to correlate with the static DCF analysis and uses the project IRR generated from that model to use for the simulation model. As the allocation of condominiums and apartments was arbitrarily decided to be 50% each, the combined project IRR observed in Table 5.5 is used for further simulation in this ROA. The calibration of the model can still be verified by setting the condominium/apartment allocations to either 100%/0% or 0%/100% and observing the NPV of the project in the simulation to be $0 for a particular asset when its allocation is set to 100%. These calibration verifications can be seen below (Note: Set all uncertainty and weight factors to zero in Exhibit 6 and set Option to Defer to "OFF". OCC Project Level should also be set to "Project IRR"):

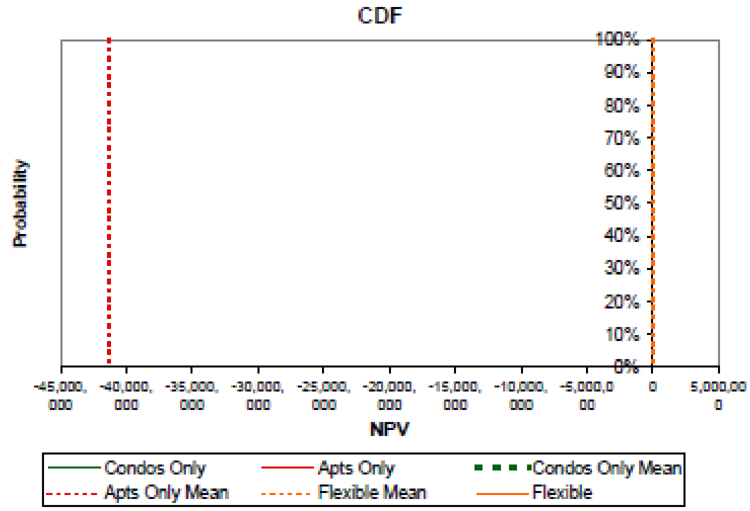


Figure 5.1 – Calibration Verification VARG curve – 100% condominiums

Table 5.7 – eNPV Results for Calibration Verification – 100% condominiums

	Condo Only	Apt Only	Flexible
Mean	**0**	**-41,279,830**	**0**
Max	**0**	**-41,279,830**	**0**
Min	**0**	**-41,279,830**	**0**
STD	**0**	**0**	**0**

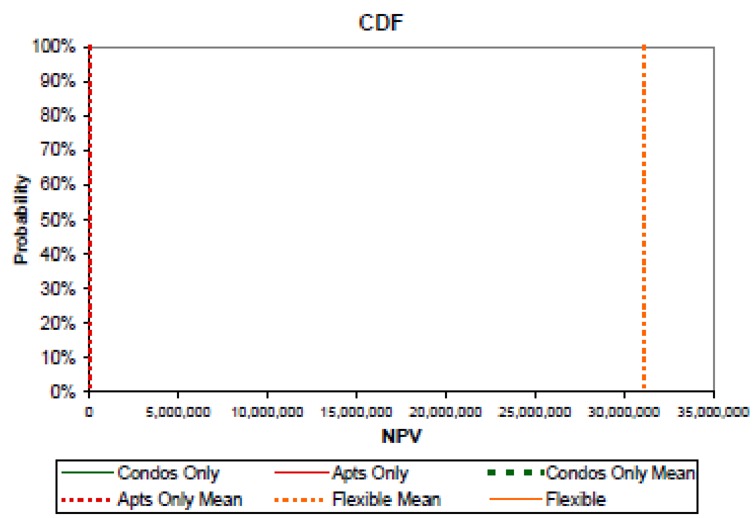


Figure 5.2 – Calibration Verification VARG curve – 100% apartments

Table 5.8 – eNPV Results for Calibration Verification – 100% apartments

	Condo Only	Apt Only	Flexible
Mean	31,115,052	0	31,115,052
Max	31,115,052	0	31,115,052
Min	31,115,052	0	31,115,052
STD	8	0	8

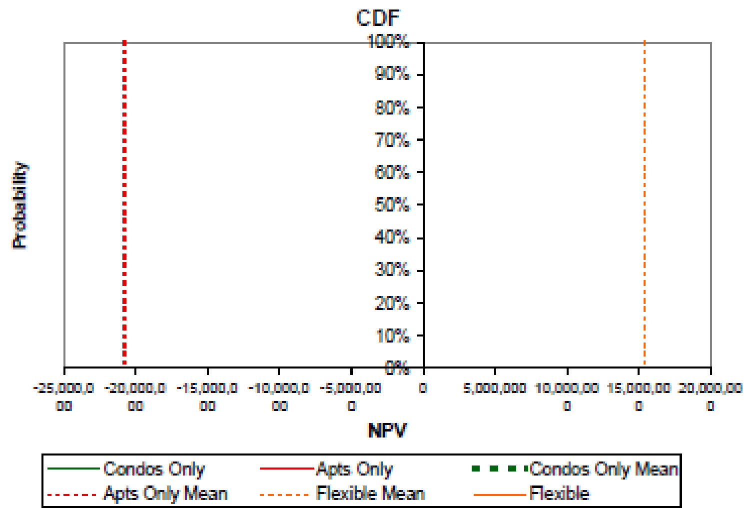


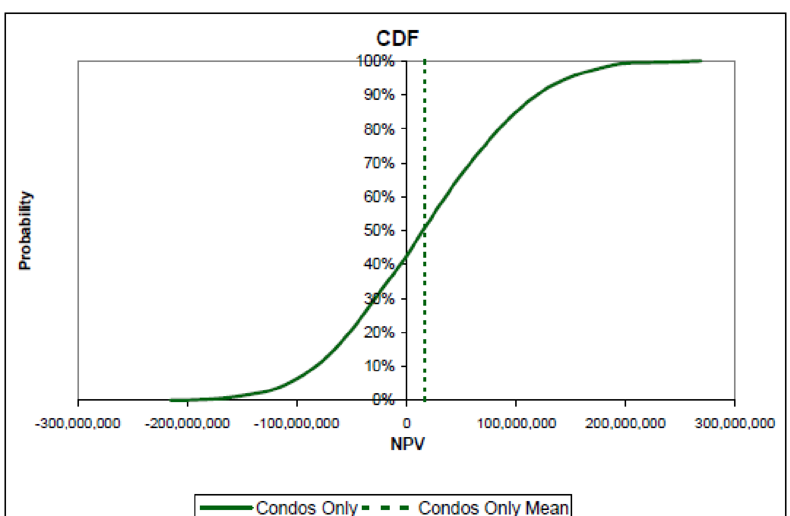
Figure 5.3 – Calibration Verification VARG curve – 50% condominiums / 50% apartments

Table 5.9 – eNPV Results for Calibration Verification – 50% condominiums / 50% apartments

	Condo Only	Apt Only	Flexible
Mean	15,374,500	-20,833,154	15,374,500
Max	15,374,500	-20,833,154	15,374,500
Min	15,374,500	-20,833,154	15,374,500
STD	1	7	1

5.4.2 Stochastic Model Results – Introduction of Sales Revenue Uncertainty

The next step in the stochastic analysis is to introduce uncertainty in the sales revenues for both condominiums and apartments. The ranges of uncertainties are noted in the base assumption in Table 5.6. Results in the form of a VARG curve, histogram and table of values of the Monte Carlo simulation for each project alternative are as follows:



Mean	Max	Min	StD
16,489,962	268,737,777	-215,557,715	78,243,425

Figure 5.4 – Condominium Project with Sales Revenue Uncertainty – VARG curve and results

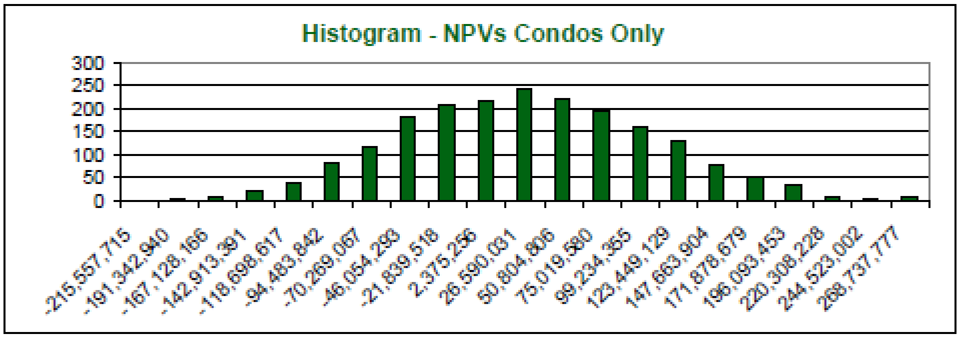
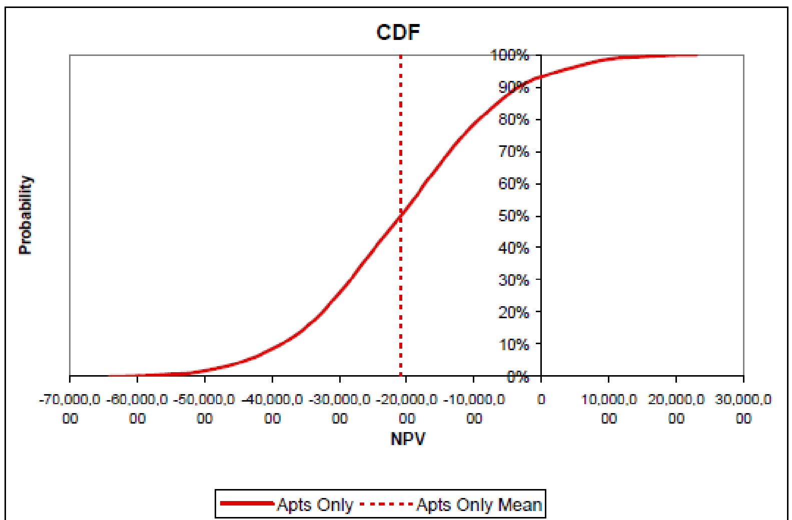


Figure 5.5 – Condominium Project with Sales Revenue Uncertainty – Histogram



Mean	Max	Min	StD
-20,925,185	23,077,259	-64,036,222	13,886,571

Figure 5.6 – Apartment Project with Sales Revenue Uncertainty – VARG curve and results

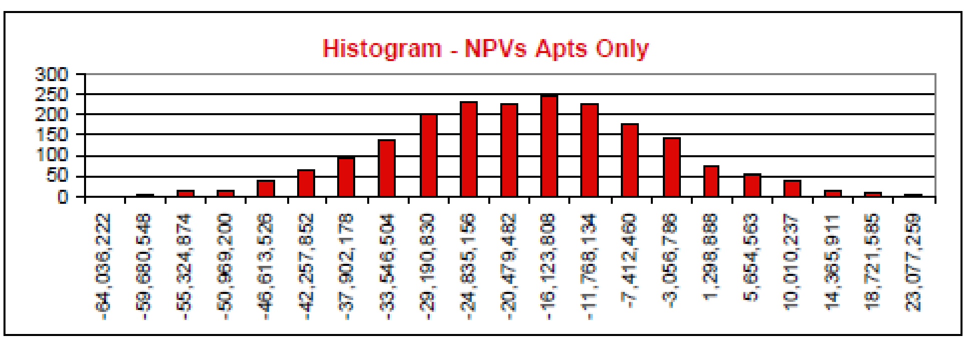
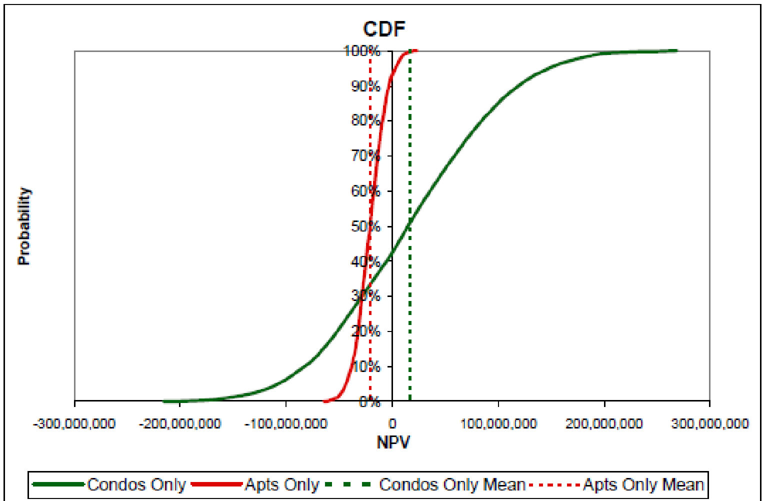


Figure 5.7 – Condominium Project with Sales Revenue Uncertainty – Histogram

5.4.3 Comparison of Stochastic Model Results for Various Alternative Projects

A few key observations of these alternative project results should be based on the stochastic model results and specifically the expected NPVs for either a condominium development or an apartment development. Results are shown below in Figure 5.8:



	Mean	Max	Min	StD
Condo	-24,837,076	-24,959,329	-26,803,107	-28,862,357
Apt	-20,925,185	23,077,259	-64,036,222	13,886,571

Figure 5.8 – Alternative Projects (Condo or Apt) with Sales Revenue Uncertainty – VARG curve and results

A casual observer, and someone that is not familiar with Real Options Analysis, may come to an early conclusion that the proposed condominium development is a more financially advantageous project because it has a higher expected NPV. This reasoning has been used for years as part of a DCF analysis or following the NPV rule. Using the next three steps of the ROA, this reasoning is investigated and challenged.

5.5 Risk Mitigation – Real Options Framing

The differences between this project and other real estate projects, as discussed in Chapter 4, provide an excellent opportunity to show how ROA can help mitigate the effects of the challenges presented by these differences.

All risks do not have the same magnitude of an effect on project returns, or in other words, do not have the same risk profile. The next part of this step in the process is to rank each of these areas of uncertainty to determine which should be further analyzed. If time was not an issue, all points of uncertainty could be integrated into the simulation, but this would be an extremely complicated task for this study. Based on discussions with interested developers of the site (Dickson, 2009; Harder, 2009; Loewenberg, 2009), challenges and sources of uncertainty were identified and subsequently coded to acknowledge general themes among the responses. As a result, the following list and rank of the top five concerns was determined[5]:

1. Unknown future legacy use
2. Scale of the project
3. Timing of the project
4. Venue Requirements
5. Schedule and Guarantees

The practical next step is to further review this list of areas of uncertainty to choose the one or two variables that will be addressed with the concepts of design flexibility and modeled in the simulation analysis for the project. For this hypothetical project, the four main options previously discussed were the options to switch, grow, abandon and phase. All of these options would have the opportunity to be exercised following the Olympic Games. The options chosen to model in this analysis will be identified in the next section.

5.6 Risk Hedging – Real Options Modeling

As discussed earlier, the ideas of flexibility or real options provide an opportunity for management of a project to modify their previous decisions. Specifically, managers have the ability to change what, how much and when of a product will be delivered to market. The few types of options discussed in Chapter 6 (Switch, Expand, Abandon and Defer) could be integrated into the model and then simulated. The ROA for this project, however, only analyzes the Option to Switch and Option to Defer for simplicity. Using the previous step of Real Options Framing, it appeared that the legacy use for the venue was the most uncertain and important issue of the project. Delivery of a large number of units into the market at the same time was also a critical issue.

Through the use of Monte Carlo simulation as reviewed in step 4, the implied volatility of forecasted values such as expected condominium sales price and expected apartment sales price will result in a range of anticipated value for the project under either of the proposed development scenarios. However, as a result of the uncertainty in forecasted sales prices, there may be times when apartments

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[5] This list was created based on qualitative interpretation of interested developers for the Chicago 2016 Olympic Village site. No specific ranking or survey data was requested from the interview participants.

are more valuable and there may be times when condominiums are more valuable. Here is the perfect opportunity to apply the "switch" real option, as identified in step 5, to the analysis model. By using the inputs of uncertainty factors, weighting factors and expected base sales prices, the real options modeling can obtain the project's "strategic option value".

5.6.1 Limitations of Analysis Model

While the benefits of ROA and Monte Carlo simulation are strong, limitation still exist for the method that must be evaluated as part of the results of the model. These limitations and consequences are as follows:

1. Due to correlation factors that are typical of trends in market pricing (differences between systematic and non-systematic changes), the model currently can only accommodate two choices in the flexible design (i.e. apartments vs. condos, or student housing vs. senior housing). There is correlation built into the model, identified as the Weight Factor, which partially models the systematic change in market conditions. As the integration with correlation of a third, or more, choice(s) in the model would be very complicated, if has not been considered as part of the scope of this study.
2. Each option must have similar returns in order for flexibility to have any value (i.e. if condos always have a higher value [NPV], then flexibility does not add anything to the analysis). This is because there is less uncertainty, if any, if the more valuable alternative is already known prior to even running the simulation.
3. Correlation of real estate projects and asset types is still very difficult to determine. Data is not developed enough to realistically forecast these correlations. (Foster and Lee, 2009)
4. Selection of an accurate distribution type (normal, uniform, skewed, etc.) is difficult to determine. Varying skewness in a distribution may also dramatically affect the possibility of returns (Foster and Lee, 2009).
5. The requirements to pick a range of potential values for the simulation will still always be deleting some extreme (either high or low) values from the possible range for the analysis (Foster and Lee, 2009). For this analysis, the RAND() function in Excel automatically uses uniform distribution.

5.6.2 "Pedagogical" Model vs. "Applied" Model

Two models are used as part of the simulation for this ROA. The first, which shall be referred to as the "pedagogical" model, was presented in an MIT Real Estate Finance course (11.431) by Geltner and

Cardin (2009) to conceptually portray the ideas of real option valuation. The second model, which shall be referred to as the "applied" model, was created specifically for this analysis and integrates many of the requirements and conditions of the proposed Chicago Olympic Village project.

5.6.2.1 Mechanics of the "Pedagogical" Model

The "pedagogical" model evaluates the option to switch uses between condominiums and apartments at each of 3 phases in a project. An example NPV calculation worksheet from the "pedagogical" model can be viewed in Appendix B. At each phase, the Net Present Value (NPV) is calculated for both alternatives of only condominiums and only apartments using the following equations:

$$\textit{Sales Revenue} - \textit{Construction and Sales Costs} = \textit{Net Cash Flow} \quad (1)$$

$$\textit{Present Value of Net Cash Flow} = \textit{Net Cash Flow} \,/\, (1 + \textit{discount rate})\hat{}\textit{number of years} \quad (2)$$

$$\textit{NPV} = \textit{PV Phase 1 Cash Flow} + \textit{PV Phase 2 Cash Flow} + \textit{PV Phase 3 Cash Flow} \quad (3)$$

The NPV for each type of development (condominium vs. apartment) is compared, and the highest NPV is selected as part of the Flexible development. This entire iteration is then repeated 2000 times in a Monte Carlo simulation. At each iteration, a random value between 0 and 1 is generated twice which are then used to calculate the randomly generated increase or decrease to the base line expected sales revenue per unit for both condominiums and apartments. This calculation for condominium Expected Sales Price is as follows:

$$\textit{Condo Expected Sales Price} = \textit{Baseline Sales Price} * (1 + \textit{Uncertainty Factor} * (\textit{RAND} + \textit{RAND} - 1)) \quad (4)$$

The calculation for apartments is slightly different as it includes a component to apply a correlation factor between the change to condominiums and the change to apartments. This is intended to mimic actual changes in realized sales prices as favorable or unfavorable market conditions will generally affect both asset types in a similar fashion, although not exactly proportional. As a result, the following equation calculates the change in apartment sales price as a percentage, or weight factor, of the change in condo sales price for that phase, and the remaining percentage as a randomly generated increase or decrease to the apartment baseline sales price:

$$((Weight\ Factor * \%\ \Delta\ of\ Condo\ Price + (1 - Weight\ Factor)*(RAND + RAND - 1)) * Uncertainty\ Factor + 1) * Apt\ Expected\ Sales\ Price \quad (5)$$

The use of the Weight Factor in this equation is similar to correlation in finance theory, but lower. The effect, however, results in the standard deviations of projected NPV for apartments to be lower than normal ranges since part of the change of expected NPV for apartment development is directly related to the change in expected condominium sales revenues.

This "pedagogical" model makes many assumptions to make the model easier to understand, however these assumptions may or may not mimic those of real project. Specifically all revenues and costs to develop a project are assumed to occur in the same year. Also, the only opportunity to modify phasing is by changing the number of years per phase, but this modification is not triggered by a change to expected absorption or lease up of a project.

Example results of this effect are as follows:

Table 5.10 – Table of Option Values from "pedagogical" model[6]

# of years /phase	Mean Condo Only NPV	Mean Apt Only NPV	Mean Flexible NPV	Imputed Value of Option	Option Value % of Highest Mean NPV
0.5	925,553,874	875,968,804	967,241,700	41,687,827	4.50%
1	775,497,604	733,295,749	803,663,185	28,165,580	3.63%
1.5	646,372,760	613,721,151	664,051,491	17,678,732	2.74%
2	546,853,563	518,299,607	557,586,100	10,732,537	1.96%
2.5	467,830,589	442,035,764	470,941,850	3,111,261	0.67%
3	397,647,545	379,234,855	396,948,498	**-699,048**	**-0.18%**
3.5	343,160,468	324,028,366	334,510,347	**-8,650,121**	**-2.52%**
4	296,870,078	280,589,443	285,335,013	**-11,535,065**	**-3.89%**

Table 5.10 above shows how the overall imputed value of the option dramatically decreases as the number of years per phase increases. This option value is critical in determining whether it is advantageous to use flexibility in a project. This value, subtracting the cost of the option, provides the net value created by the option. Using Table 5.9 as an example, as the benefits of the option are extended further out in time, and therefore increasing the duration between the time at which to purchase the option and the opportunity to exercise the option, the net value of the option decreases. This result may be counter intuitive to most real options analysis results as options typically increase in

[6] As the Monte Carlo simulation randomly generates variables, this table would not be recreated exactly if regenerated using the "simple" model.

value as the time to exercise them increases, however these results are observed because as you expend capital to purchase the option early on, you have to wait longer and longer to exercise the option and reap the benefits of it. In essence, there is less flexibility because there are fewer opportunities where you can change your decision.

A few of these assumptions of the "pedagogical" model are addressed in the "applied" model to create a more realistic model for the Chicago 2016 Olympic Village case study.

5.6.2.2 Mechanics of the "Applied" Model

The main goal of the "applied" model is to utilize the Excel technology that most developers and real estate professionals are familiar with along with the system already developed in the "pedagogical" model to create a more realistic valuation of the proposed Chicago Olympic Village project. Sample worksheets from the "applied" model can be viewed in Appendix C. As noted earlier, the actual data regarding this project is extremely sparse as it is either confidential in nature or not yet developed. Assumptions made in the static DCF model will still be the same for the analysis using the "applied" model, but the "applied" model is programmed to accept changes to any assumed value. These values are identified as blue text in the model and bold text in the printed worksheets.

Major differences in the "applied" model are as follows:

1. Five additional tabs are added to assist with creating the static model which then feed into the inputs for the Monte Carlo Simulation. These tabs (Development Budget, Projected Revenues, Construction Schedule, Projected Cash Flows, and Project Analysis) [exhibits 1-5] are sheets that are used in Step 3 for Risk Modeling – Base Case DCF Analysis.
2. Models two forms of real options: Option to Switch – flexibility in the ability to deliver condominiums or apartments to the public market; and Option to Defer – flexibility to phase a project and vary the duration of the phases depending on the absorption rate for that phase.
3. Ability to modify the project level discount rate for the entire project.
4. Correlation between change in expected sales revenues and absorption rate is integrated. A Weight Factor is again used that determines the percentage of change of the absorption rate that is directly proportional to the change in condo sales revenue.
5. Sales of phase "n" units will not begin selling until phase "n"-1 units are completely sold out. Sales rates are determined by the absorption rate, which is assumed to be the same for both condominiums and apartments.

6. Correlation between expected sales price of condominiums and apartments was modified slightly to reduce the effect that expected apartment prices converge on the expected condominium prices as the Weight Factor is increased. Instead the percentage change in expected price, with respect to the Uncertainty Factor, should converge as Weight Factor is increased.

5.7 Risk Diversification – Portfolio and Resource Optimization

Portfolio optimization is an optional step in the process and would only be conducted if there were multiple projects to analyze and select. If there were other projects to choose from, then portfolio optimization is very important and there may be opportunity to hedge and diversify risk through a portfolio of projects or assets. This step would also provide optimal allocation of capital across the portfolio of projects. Considering only one project is being evaluated for this analysis, and there are no other opportunities to select alternative projects, this step will not be evaluated for this analysis.

5.8 Risk Management – Reporting and Update Analysis

The real options analysis framework concludes with the presentation of the results in report or graphical form. These results should allow decision makers for a project to choose the most desired path based on the goals and requirements of the project, along with the characteristics of the investor (i.e. desire to take on higher risk to obtain a higher return). The template or framework created as part of the ROA should also allow the analyst to continue to iteratively run the analysis as the projects progresses through the development process and input data becomes more and more certain.

Overall, the analysis for this project performed mostly as hypothesized and the results from the "applied" model were very interesting. The base case, where neither the option to switch nor the option to defer were applied, was presented in Step 4 of the ROA process as results of the stochastic model for the two alternative projects (condominium and apartment). These base case results are compared to the application of the various alternative options "on" and "in" the project in the remaining results of this analysis that are split into the following scenarios:

- Without Option to Defer and With Option to Switch
- With Option to Defer and Without Option to Switch
- With Option to Defer and With Option to Switch

A summary of results for each of these scenarios is as follows:

Table 5.11 – Compiled mean eNPV results of various option strategies for ROA

	Without Option to Switch		**With Option to Switch**
	Condo	***Apt***	***Flexible***
Without Option to Defer	**11,229,497**	**-22,362,900**	**48,782,747**
With Option to Defer	**20,800,835**	**-10,664,558**	**58,579,656**

Table 5.12 – Compiled max eNPV results of various option strategies for ROA

	Without Option to Switch		**With Option to Switch**
	Condo	***Apt***	***Flexible***
Without Option to Defer	**268,623,573**	**17,028,826**	**268,623,573**
With Option to Defer	**262,359,475**	**35,575,509**	**262,359,475**

Table 5.13 – Compiled min eNPV results of various option strategies for ROA

	Without Option to Switch		**With Option to Switch**
	Condo	***Apt***	***Flexible***
Without Option to Defer	**-239,443,322**	**-70,131,886**	**-62,037,411**
With Option to Defer	**-237,440,288**	**-64,207,297**	**-64,207,297**

For each new scenario involving various types of applied options, the VARG graph and tabular results, including the expected mean, max, min and standard deviation, are presented along with the assumptions made for that particular scenario. This "multi-criteria" table is presented as different decision makers will have different criterion for which they will apply the results (i.e. some may choose to minimize losses by selecting the alternative with the highest min value, or another may be interested in selecting the alternative with the highest mean).

5.8.1 Without Option to Defer and With Option to Switch

After combining the results of the stochastic model in Step 4 for each alternative project, the flexible scenario is added to the VARG curve to observe the added value with the integration of this option. Here the additional value created by the flexible option can be calculated by subtracting the mean NPV value for either the condominium or apartment development from the flexible development. Under this set of assumptions, approximately $22 million in value is created. It should be noted though that the cost of the option has yet to be included to determine the overall value creation with flexibility.

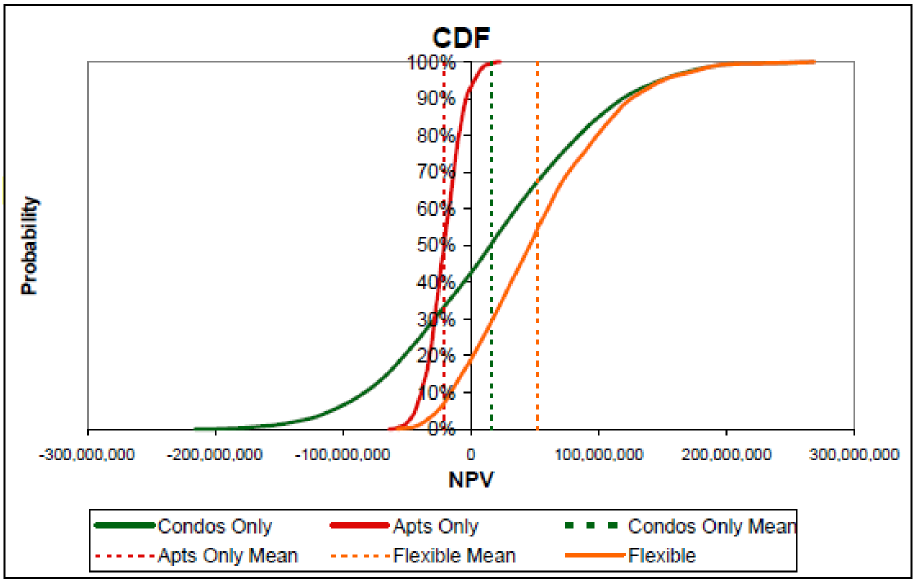


Figure 5.9 – Flexible Project without Option to Defer or Absorption Uncertainty – VARG curve

Table 5.14 – Flexible Project without Option to Defer or Absorption Uncertainty – eNPV Results

	Condo Only	Apt Only	Flexible
Mean	16,489,962	-20,925,185	51,700,392
Max	268,737,777	23,077,259	268,737,777
Min	-215,557,715	-64,036,222	-57,501,079
STD	78,243,425	13,886,571	55,005,518

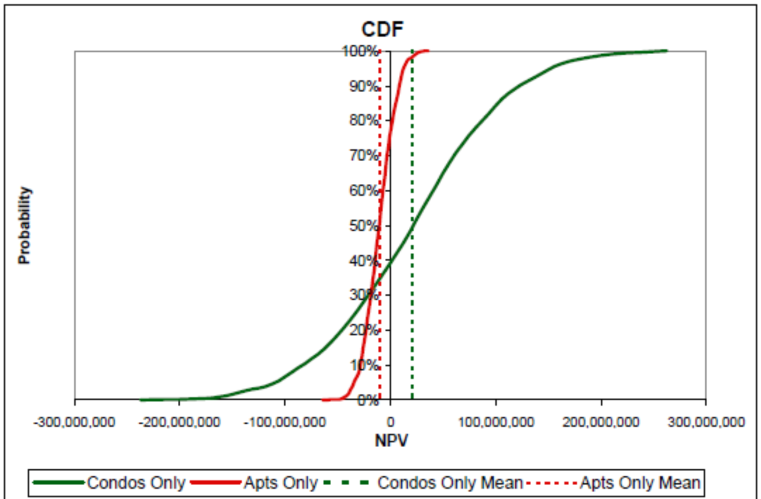
When applying absorption uncertainty to the model, the follow summary of results is observed:

Table 5.15 – Flexible Project without Option to Defer and with Absorption Uncertainty – eNPV Results

	Condo Only	Apt Only	Flexible
Mean	11,229,497	-22,362,900	48,782,747
Max	268,623,573	17,028,826	268,623,573
Min	-239,443,322	-70,131,886	-62,037,411
STD	80,993,018	14,649,561	56,097,916

Comparing the results in Table 5.13 with the results in Table 5.14 to determine the effect absorption uncertainty has on the eNPVs for the project, one can see that there is a decrease in values for most criteria. The next scenario will analyze the effect of integrating the Option to Defer into the model.

5.8.2 With Option to Defer and Without Option to Switch



	Mean	Max	Min	StD
Condo	20,800,835	262,359,475	-237,440,288	79,487,401
Apt	-10,664,558	35,575,509	-64,207,297	14,383,876

Figure 5.10 –Condominium and Apartment Projects with Option to Defer – VARG Curve and tabular results

Comparing this scenario results to those results of the condominium and apartment alternatives without the Option to Defer illustrates approximately the same increase in mean eNPV value for both alternatives. More details on this interesting result will be mentioned in the next scenario analysis. Resulting changes in the maximum and minimum eNPV values are also observed with the introduction of the Option to Defer, however these changes in value are not as significant as those of the mean eNPV values.

There are some limitations to the Option to Defer scenario that were implemented into the model for simplicity. These assumptions include:

- the maximum number of phases for the project is three, based on the structural ability of the model
- the number of years per phase will be constant for the project, but will fluctuate based on the time (rounded to the nearest year) it takes to obtain the desired occupancy hurdle rate for the condominium absorption for Phase 1 only – further development of these assumptions should be made in further expansion of the model
- for all phases, sales or "leases" for the next phase supply will not be sold until all units are sold out for the previous phase

5.8.3 With Option to Defer and With Option to Switch

For the last scenario, uncertainty is applied for both sales price and absorption, and both the Option to Defer and Option to Switch are evaluated. The results are as follows:

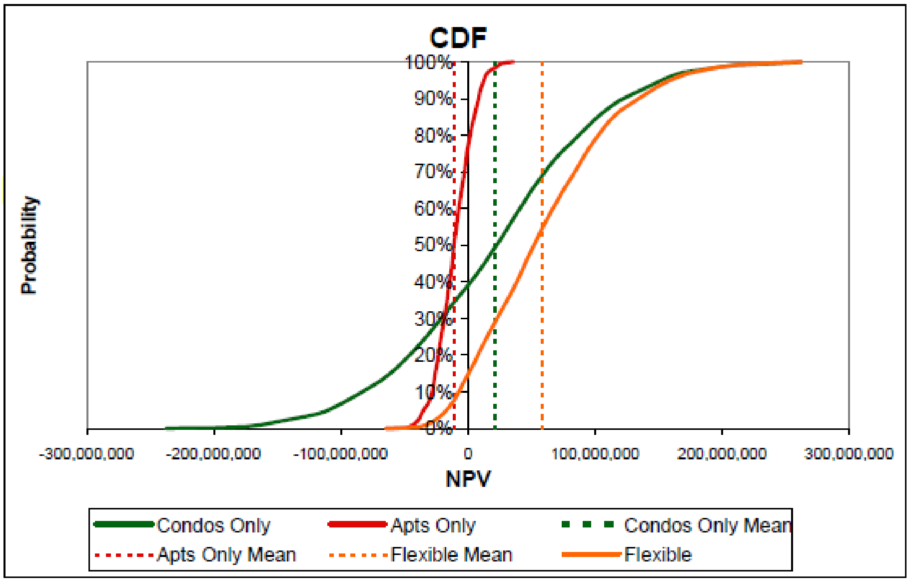


Figure 5.11 –Condominium, Apartment and Flexible Projects with Option to Defer – VARG Curve

Table 5.16 – Phased Condominium and Apartment Projects – eNPV Results

	Condo Only	Apt Only	Flexible
Mean	20,800,835	-10,664,558	58,579,656
Max	262,359,475	35,575,509	262,359,475
Min	-237,440,288	-64,207,297	-64,207,297
STD	79,487,401	14,383,876	54,701,373

Table 5.17 – Replicated Table 5.14 without Option to Defer to compare with Table 5.15 – eNPV Results

	Condo Only	Apt Only	Flexible
Mean	11,229,497	-22,362,900	48,782,747
Max	268,623,573	17,028,826	268,623,573
Min	-239,443,322	-70,131,886	-62,037,411
STD	80,993,018	14,649,561	56,097,916

Table 5.18 – Changes in values between Table 5.15 and Table 5.16 – eNPV Results

	Condo Only	Apt Only	Flexible
Mean	$ 9,571,338	$ 11,698,342	$ 9,796,909
Max	$ -6,264,098	$ 18,546,683	$ -6,264,098
Min	$ 2,003,034	$ 5,924,589	$ -2,169,886
STD	$ -1,505,617	$ -265,685	$ -1,396,543

The introduction of the Option to Defer simultaneously with the Option to Switch provides yet even higher results for all criteria of the project. It is also interesting to observe that the actual change in the mean eNPV, with the integration of the Option to Defer, is approximately the same for the flexible alternative as it is for the condominium and apartment alternatives. This would illustrate that the value created from the Option to Defer is cumulative to the value created from the Option to Switch.

5.8.4 Sensitivity Analysis

A final step in a the analysis process is to review sensitivity results, or now a certain return metric (in this case mean NPV) changes as another input variable changes. This step can help a decision maker understand the potential for predicted outcomes to change as a factor of the various sensitivity inputs.

5.8.4.1 Change in Flexibility Weight Factor

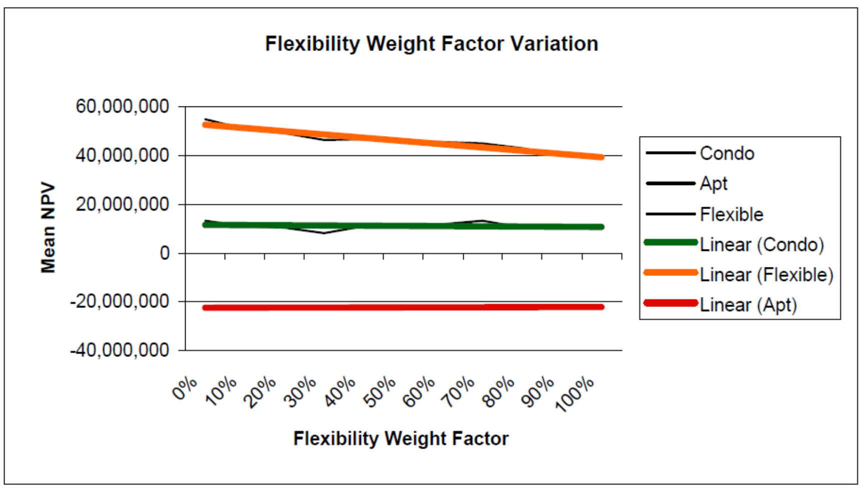


Figure 5.12 – Sensitivity Analysis – mean eNPV as a function of Flexibility Weight Factor

As observed in Figure 5.12, as the Weight Factor increases, the mean eNPV for the flexible alternative decreases. This is probably a result of less uncertainty being observed in the project between the two alternatives of pursuing condominium or apartment development. The value does not completely disappear as there is still uncertainty regarding the fluctuation in projected sales prices for both alternatives, however, variation in both asset types will move in the same direction and with the same relative magnitude.

5.8.4.2 Change in Condominium and Apartment Volatilities

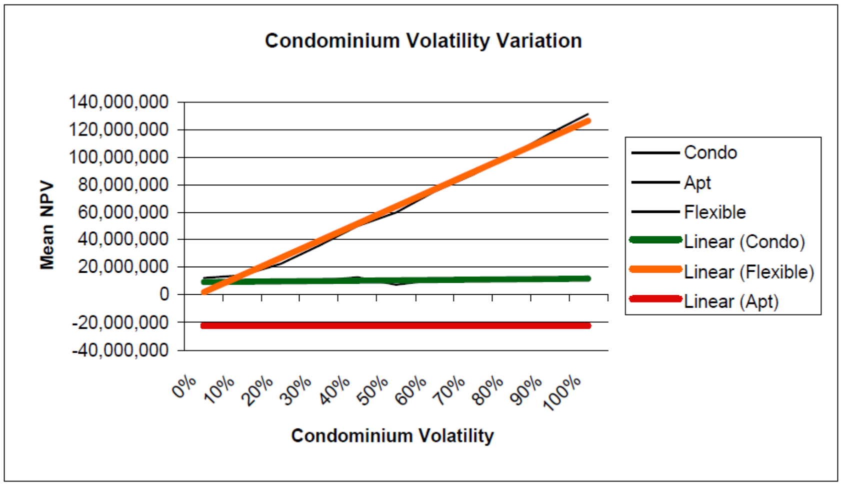


Figure 5.13 – Sensitivity Analysis – mean eNPV as a function of Condominium Volatility

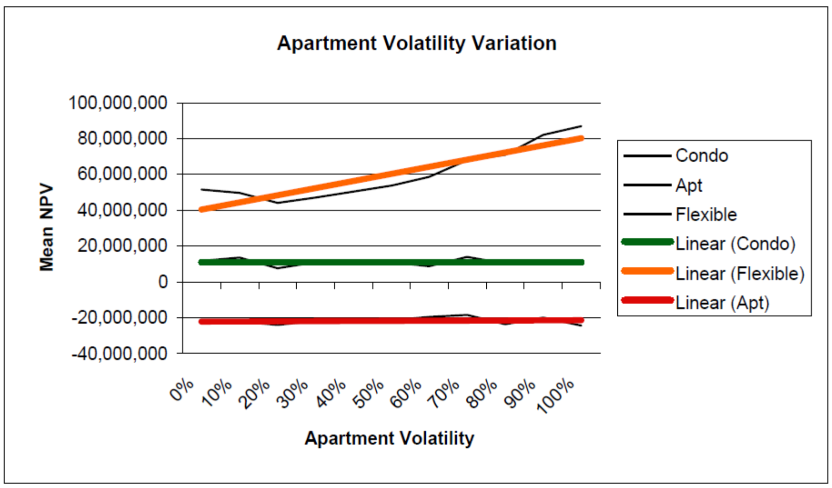


Figure 5.14 – Sensitivity Analysis – mean eNPV as a function of Apartment Volatility

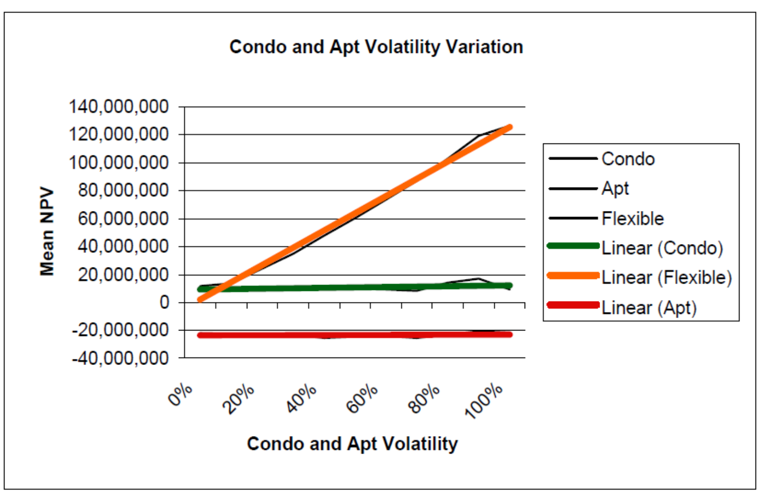


Figure 5.15 – Sensitivity Analysis – mean eNPV as a function of Condominium and Apartment Volatility

The important take away from this observation is that while each individual alternative does not change significantly with the variation in condominium and apartment volatility, the flexible alternative increases as each project becomes more volatile, or uncertain. When comparing the results of the individual changes in volatilities for condominium and apartment prices with those when both volatilities are changing at the same rate, it is observed that the additional value created for the flexible option is not cumulative, but rather only slightly higher, if any higher, in the combined scenario.

5.8.4.3 Change in Weight Factor for Option to Defer

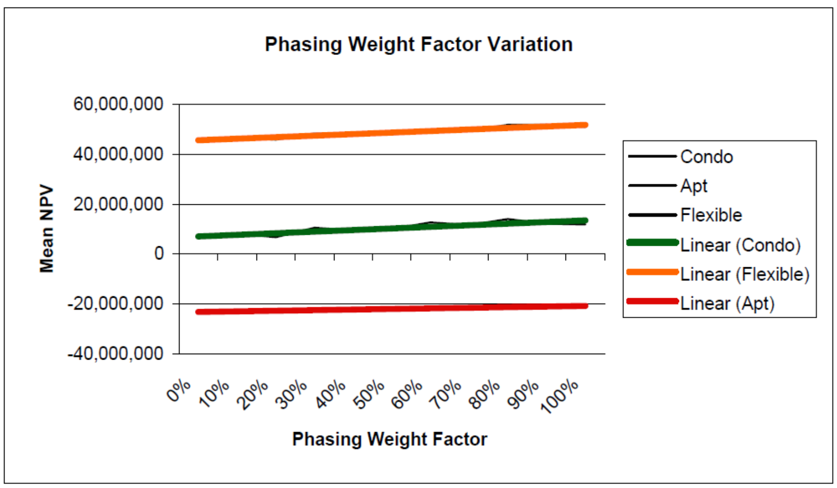


Figure 5.16 – Sensitivity Analysis – mean eNPV as a function of Option to Defer Weight Factor

The change in mean eNPV as a function of the Phasing (Option to Defer) Weight Factor appears to show the increase in value the more it correlates with the percentage change of either condominium or apartment sale price, respectively. The changes in value, however, are fairly small illustrating that the mean eNPV for the project is not very sensitive to the Phasing (Option to Defer) Weight Factor.

5.8.4.4 Change in Absorption Rate Volatility

This scenario evaluates the effect that change in Absorption Rate Volatility has on the expected NPV for the project. Interestingly, the change in eNPV with each change in volatility percentage is approximately the same for all three development options (condominium, apartment or flexible option). This is most likely a result of the mean absorption rate settling (or averaging) around the base absorption rate when spread out over a large number of simulation iterations.

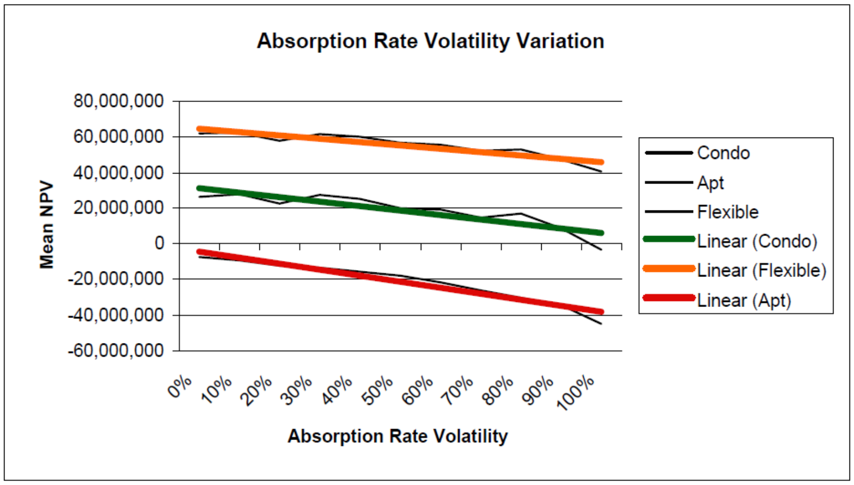


Figure 5.17 – Sensitivity Analysis – mean eNPV as a function of Absorption Volatility with Option to Defer "ON"

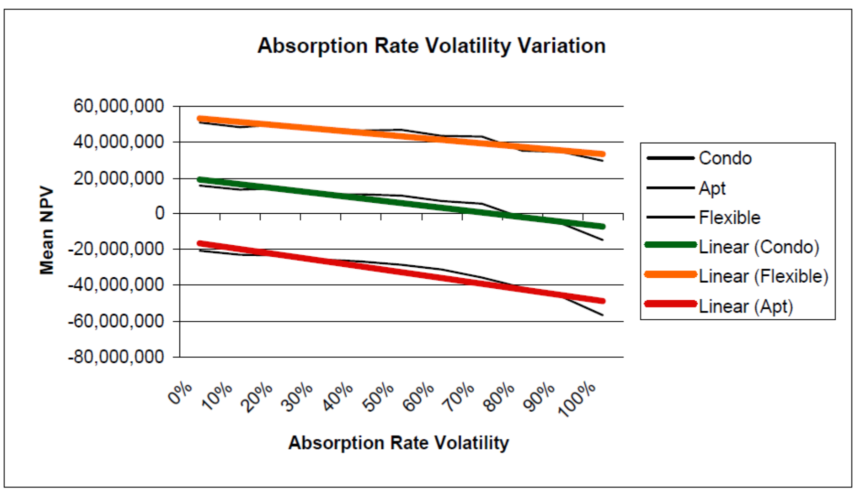


Figure 5.18 – Sensitivity Analysis – mean eNPV as a function of Absorption Volatility with Option to Defer "OFF"

6.0 Conclusion and Recommendations

The purpose of this thesis is not to present the "answer" to the many issues related to the proposed development of the Chicago 2016 Olympic Village, or of Olympic Venue development in general. It should hopefully provide another tool that can help identify ways to assess the complicated problems for this type of project and illustrates the usefulness of ROA.

After completing the analysis and working through the framework of how to value the flexibility in a project like this, it is too early in the process to guarantee value creation, however, the potential does exist for this additional value to be realized. Project financial assumptions and calculations at this point are educated guesses and "back of the envelope" at best. This process would continue to be refined as the development process progressed through the development stages.

Reviewing the hypothesis for this study, it was confirmed that those interested in the Chicago Olympic Village development were interested in the ideas of design flexibility for the project, but were not far enough along in the process to start discussing implementation strategies for this flexibility and more importantly were concerned with the cost of flexibility and how that would affect the overall returns of the project. Very few developers had implemented design flexibility into their projects previously and no one interviewed had heard of or used Real Options Analysis. All were interested in the topic and anxious to learn more about how it could be beneficial to the Chicago Olympic Village or other development projects. It should also be considered that this real options analysis methodology and example can be applied to other large-scale, important projects thereby expanding the possibilities where this "new" form of analysis can be beneficial.

Comparing the results of the "applied" model with the hypothesis for the study, the model did identify additional value in the project, based on the assumptions made for the analysis, however the cost of the option for this project was still unknown. The net value change on the project therefore was not calculated. This value would need to be identified in order to make an educated decision of whether flexibility would be an economically advantageous altnerative.

One of the very interesting results of the analysis involved the interaction of the two forms of flexibility (Option to Switch and Option to Defer) that were applied to the project simultaneously and modeled. The results illustrate that the value created by each of these options was virtually cumulative when applied together. This could be explained by the fact that one option is "on" the project while the other option is "in" the project. As discussed in the background information on real options, those options "on" the project have little interdependency with other options, but the opposite is true for those options "in" a project. As this is only one example of modeling this type of interdependency for this project, further research and testing of this phenomenon of cumulative results from various types of options would prove very useful for future modeling and analysis of these types of projects.

Further studies should also continue to investigate the challenges and uncertainties of Olympic venue development to identify areas where design flexibility can be implemented. The analysis models, while adapted to the requirements of the proposed Chicago 2106 Olympic Village, can continue to be developed to improve the representation of actual conditions for the project.

Overall, the information presented in this study should prove useful for those individuals looking to address the challenges with Olympic Village development. At the very least, it is another tool for decision makers to use in trying to identify potential sources of flexibility and value for a project.

Bibliography

Books

Brealy, R. et al. (2008) *Principles of Corporate Finance, Ninth Edition,* McGraw-Hill/Irwin.

Brennan, M. and Trigeorgis, L. (2000) "*Project Flexibility, Agency, and Competition: New Developments in the Theory and Application of Real Options"*. Oxford University Press.

Burbank, M et al. (2001) *Olympic Dreams: The Impact of Mega-Events on Local Politics.* Lynne Rienner Publishers, Inc.

CODA. (1993) "*Master Olympic Development Program for City of Atlanta"*. Corporation for Olympic Development in Atlanta.

Copeland, T. and Antikarov, V. (2003) R*eal Options: A Practitioner's Guide.* Texere.

de Moragas, M. and Botella, M. (1995) "*The Keys to Success: The social, sporting, economic and communications impact of Barcelona '92"*. Universitat Autonoma de Barcelona.

Geltner, D. and Miller, N. (2007) *Commercial Real Estate Analysis and Investments.* South-Western Publishing.

Maragas et al. (2003) *The Legacy of the Olympic Games 1984-2000,* International Olympic Committee.

Martorell et al. (1992) *The Olympic Village: Barcelona 92, Second Edition,* Editorial Gustavo Gili.

Mun, J. (2006) Real Options Analysis: Tools and Techniques for Valuing Strategic Investments and Decisions, Second Edition, John Wiley & Sons, Inc.

Strauss, A. and Corbin, J. (1990) *Basics of Qualitative Research: Grounded Theory Procedures and Techniques,* Sage Publications.

Syme, G. et al. (1989) *The Planning and Evaluation of Hallmark Events,* Avebury.

Townsend, E. (1969) "*Investment and Uncertainty: A Practical Guide".* Oliver & Boyd.

Trigeorgis, L. (1996) Real Options: Managerial Flexibility and Strategy in Resource Allocation, MIT Press.

Papers and Public Press

ACOG. (1997) "The Official Report of the Centennial Olympic Games", Peachtree Publishers.

Alkan, O. (2004) "Choices and Benefits: Alternative Access and Venue Sites for Istanbul Olympics" MSCP and MSArch Thesis, Massachusetts Institute of Technology.

Associated Press. (2008) "Chicago Games bid moves pool location" espn.com, 12 Dec accessed 11 May 2009.

Babajide, A. et al. (2008) "Integrated Method for Designing Valuable Flexibility In Oil Development Projects". Massachusetts Institute of Technology.

Baldwin Hills (2009) "1932 Los Angeles Olympic Athlete's Village in the Baldwin Hills". Accessed at http://www.baldwinhillspark.info/olympicvillage.html

Barman, B. and Nash, K. (2007) "A Streamlined Real Options Model for Real Estate Development". MSRED Thesis, Massachusetts Institute of Technology.

Bennett, L. et al (2008) "Chicago and the 2016 Olympics: Why Host the Games? How Should We Host the Games? What Should We Accomplish by Hosting the Games?" DePaul University, Chicago, IL.

Bergen, K. (2009) "With Michael Reese deal, Chicago will commit money to 2016 Olympics bid: City prepares to close on purchase of hospital site for Olympic Village, but questions remain". Chicago Tribune, 28 Jun.

Bergen, K. and Hersh, P. (2009) "Chicago Olympic bid taking risk without financial guarantee: 2016 team still seeking exceptions to IOC's standard contract". Chicago Tribune, 17 Jun.

Brealy, R. (2008) "Brealey, Myers, and Allen on Real Options" Journal of Applied Corporate Finance, Vol. 20, No. 4, Fall.

Bulloch, B. and Sullivan, J. (2009) "Application of the Design Structure Matrix (DSM) to the Real Estate Development Process". MSRED Thesis, Massachusetts Institute of Technology.

Cardin, M.A. and de Neufville, R. (2009) "A Direct Interation Approach to Identify Real Options 'In' Large-Scale Infrastructure Systems". Real Options Conference, 2009.

CBC News. (2006) "Quebec's Big Owe stadium debt is over". Accessed at www.cbc.ca/canada/monteal/story/2006/12/19/qc-olympicstadium.html on 12 Jul 2009.

Chicago 2016. (2009) "Chicago 2016 Candidature File - Bid Book". Accessed at www.chicago16.org.

Chicago Tribune. (2009) "Chicago's Olympic Village plans lack creative sparkle, aesthetic punch" Chicago Tribune, 14 Feb.

Childs, P. et al (1996) "Mixed Uses and the Redevelopment Option" Real Estate Economics, Vol. 24, No. 3, pp 317-339.

Cohen, L. and Bergen, K. (2009) "Chicago 2016 expects greater scrutiny of Olympic Village proposal". Chicago Tribune, 8 Feb.

COOB'92. (1992) "Official Report of the Games of the XXV Olympiad Barcelona 1992". COOB'92, Barcelona, Spain.

Cummings, D. (2009) "Beijing's Empty Venues Reveal Heavy Cost of Olympics" finding Dulcinea, 25 Feb accessed at http://www.findingdulcinea.com/news/sports/2009/feb on 21 Jun 2009.

de Neufville, R. et al. (2005) "Real Options by Spreadsheet: Parking Garage Case Example" Massachusetts Institute of Technology.

de Neufville, R. and Scholtes, S. (2006) "Maximizing Value from Large-Scale Projects: Implementing Flexibility in Public-Private Partnerships". Briefing Paper, Massachusetts Institute of Technology.

de Weck, O. (2007) "Strategic Engineering: Designing Systems for Flexibility in an Uncertain Environment". The Maastricht-Cambridge-MIT (MCM) Real Estate Finance and Investment Symposium. 12-14 Oct. Cambridge, MA

Demick, B. (2009) "Beijing's Olympic building boom becomes a bust: Many buildings in the city's impressive skyline are empty." LA Times, 22 Feb 2009.

Dixit, A. and Pindyck, R. (1995) "The Options Approach to Capital Investment". Harvard Business Review, May-June.

Donville, C. (2009) "Olympic Bailout Puts Vancouver Taxpayers on Alert for 'Big Owe'". Bloomberg, 27 Jan.

Emmons, G. (1996) "Keepers of the Flame: HBS's Olympic Organizers" www.alumni.hbs.edu/bulletin/1996/june/olympics.html accessed on 5 Jun 2009.

Foster, J. and Lee, B. (2009) "Sophisticated Sensitivity: Can Developers Guess Smarter?" MSRED Thesis, Massachusetts Institute of Technology.

French, S. and Disher, M. (1997) "Atlanta and the Olympics: A One-Year Retrospective". Journal of American Planning Association; Summer, Vol 63, No 3, pg 379.

GamesBids. (2009) "London 2012 Sells Olympic Village Housing Units" www.gamesbids.com accessed on 22 Jun 2009.

Geltner, D. and Cardin, M.A. (2008) "Real Estate Finance 11.431 Lecture Notes". Massachusetts Institute of Technology, Cambridge, MA. Fall.

Gesner, G. and Jardin, J. (1998) "Bridge Within a Bridge". Civil Engineering. October 1998, Vol. 68, No. 10, pg 44.

Greden, L. (2005) "Flexibility in Building Design: A Real Options Approach and Valuation Methodology to Address Risk" PhD.Arch, Massachusetts Institute of Technology.

Guay, M. (1996) "Legacy of the Olympic Games in Montreal – An Introduction". Canadian Olympic Association, 27 Apr 1996. accessed at www.montrealolympics.com/mg_legacy.php on 12 Jul 2009.

Guerrero, R. (2007) "The Case for Real Options Made Simple". Journal of Applied Corporate Finance. Spring, 2007. Vol. 19, No. 2.

Guma, A. (2008) "A Real Options Analysis of a Vertically Expandable Real Estate Development". MSRED Thesis, Massachusetts Institute of Technology.

Hardman, R. (2009) "The Olympic money pit: As Britain makes savage savings, 2012 spending is careering recklessly out of control" Mail Online 14 Feb 2009. www.dailymail.co.uk/news/article-1145257.

Hassan, R. et al. (2005) "Value-at-Risk Analysis for Real Options in Complex Engineered Systems". 2005 IEEE International Conference on Large Scale Infrastructures, Hawaii, 10-12 October in Volume 4, pp. 3697-3704.

Hersh, P. et al. (2009) "Daley ups the ante for 2016 Olympics: Chicago bid team insists taxpayers not at risk as city takes full financial responsibility". Chicago Tribune, 18 Jun.

Hevert, K. (2001) "Real Options Primer: A Practical Synthesis of Concepts and Valuation Approaches". Journal of Applied Corporate Finance. Summer 2001. Vol. 14, No. 2.

Hodder, J. and Mello, A. (2001) "Valuing Real Options: Can Risk-Adjusted Discounting Be Made to Work?" Journal of Applied Corporate Finance. Summer 2001, Vol. 14, No. 2.

IOC. (2007) "Olympic Charter". International Olympic Committee, Lausanne, Switzerland.

IOC. (2008a) "Games of the XXXI Olympiad 2016 Working Group Report". International Olympic Committee, Lausanne, Switzerland.

IOC. (2008b) "2016 Candidature Procedure and Questionnaire: Games of the XXXI Olympiad". International Olympic Committee, Lausanne, Switzerland.

IOC. (2009) – information accessed at www.olympic.org

Isgin, T. and Forster, D. (2005) "Using Real Options Theory to Analyze the Impacts of Urban Development on Farm Real Estate Markets". Turkish Journal of Agriculture and Forestry. Vol 29, No 5, pp 409-417.

Jakimovska, G. (2007) "Exploring Flexibility in Stadium Design" MSArch Thesis, Massachusetts Institute of Technology.

Keymer, M. (2000) "Design Strategies for New and Renovation Construction that Increase the Capacity of Buildings to Accommodate Change" MSCEE Thesis, Massachusetts Institute of Technology.

Kim, K. (2008) "Real Options: A Way To Deal With Market Uncertainty In Real Estate Development Projects" MSRED Thesis, Massachusetts Institute of Technology.

Kopytoff, V. (1997) "The 2002 Olympics are Transforming Salt Lake City" The New York Times, 9 Nov.

Lee, J. and Oh, J. (2008) "New Songdo City and the Value of Flexibility: A Case Study of Implementation and Analysis of a Mega-Scale Project". MSRED Thesis, Massachusetts Institute of Technology.

Lister, M. (2007) "Towards A New Real Estate: Innovative Financing for a Better Built Environment". MSRED Thesis, Massachusetts Institute of Technology.

Loomis, B. (2003) "The Value of Flexible Design: Real Estate Investment and Development Strategy Under Uncertainty". MSArch, Massachusetts Institute of Technology.

Masunaga, S. (2007) "A Comparative Study of Real Options Valuation Methods: Economics-Based Approach vs. Engineering-Based Approach". MSRED, Massachusetts Institute of Technology.

McDonald, R. (1998). "Real Options and Rules of Thumb in Capital Budgeting", Finance Department, Kellogg School, Northwestern University, March.

Millet, L. (1997) "Olympic Villages after the Games", in Miquel de Moragas, Montserrat Llinés & Bruce Kidd (eds.): *Olympic Villages: A Hundred Years of Urban Planning and Shared Experiences: International Symposium on Olympic Villages, Lausanna 1996*. Lausanne: International Olympic Committee, pp. 123-129.

Muñoz, F. (1997) "Historic evolution and urban planning typology of Olympic Villages", in Miquel de Moragas, Montserrat Llinés & Bruce Kidd (eds.): *Olympic Villages: A Hundred Years of Urban Planning and Shared Experiences: International Symposium on Olympic Villages, Lausanna 1996*. Lausanne: International Olympic Committee, pp. 27-51.

Neely, J. and de Neufville, R. (2001) "Hybrid Real Options Valuation of Risky Product Development Projects". International Journal of Technology, Policy and Management.

Pearson, J. and Wittels, K. (2008) "Real Options in Action: Vertical Phasing in Commercial Real Estate Development" MSRED, Massachusetts Institute of Technology.

Pletz, J. (2009) "Challenges rise in developing Olympic Village". Crain's Chicago Business, 13 May 2009.

Sandomir, R. (2005) "Atlanta a Model for Reusing an Olympic Stadium" The New York Times, 15 Jun.

Scholtes, S. (2007) "Flexibility: The Secret to Transforming Risks into Opportunities" Business Digest. No 174, May 2007.

Silver, M. and de Weck, O. (2007) "Time-Expanded Decision Networks: A Framework for Designing Evolvable Complex Systems". Systems Engineering, Vol. 10, No. 2, 2007.

Simmons, S. (2000) "Analysis of the 1996 Summer Games on Real Estate Markets in Atlanta". MSRED Thesis, Massachusetts Institute of Technology.

Slaughter, S. (2001) "Design strategies to increase building flexibility". Building Research and Information, Vol 29, no 3, pp 208-217.

SLOC. (2002)"Official Report of the XIX Olympic Winter Games". Salt Lake Organizing Committee.

SOCOG (2001) "Official Report of the XXVII Olympiad". Sydney Organising Committee for the Olympic Games.

Spielman, F. and Herrman, A. (2008) "City to borrow millions to buy Michael Reese Hospital". Chicago Sun-Times, 8 Jul.

Synadinos, P. (2002) "Post-Olympic Use: A Picture of the Future", *Olympism*.

Triantis, A. and Borison, A. (2001) "Real Options: State of the Practice". Journal of Applied Corporate Finance. Summer 2001, vol 14, no 2.

Trigeorgis, L. (2005) "Make Use of Real Options Simple: An Overview and Applications in Flexible/Modular Decision Making". The Engineering Economist. Vol 50, pp 25-53.

Wang, T. and de Neufville, R. (2005) "Real Options 'in' Projects" 9th Real Optiosn Annual International Conference, Paris, France. June, 2005.

Wilds, J. (2008) "A Methodology for Identifying Flexible Design Opportunities". MSAA Thesis, Massachusetts Institute of Technology.

University of Utah. (2002) "2002 Olympic Coordination Final Report". University of Utah, 30 Jun.

University of Utah. (2009) "2002 Olympic and Paralympic Villages". http://web.utah.edu/2002/venues/villages.html accessed on 11 Jun.

Xth Olympiad Committee. (1933) *"The Games of the Xth Olympiad – Los Angeles 1932 – Official Report"*.

Interviews

Dickson, Kerry. Senior Vice President, Related Midwest, LLC. Phone Interview. June 24, 2009.

Erickson, Beth. Associate, Skidmore, Owings and Merrill, LLP. Interview at Skidmore, Owings and Merrill, Chicago, IL. June 15, 2009.

Harder, Dennis. Senior Vice President, Joseph Freed and Associates. Email response to interview questions. June 24, 2009.

Lissner, Gail. Vice President, Appraisal Research Counselors. Phone Interview. July 17, 2009.

Loewenberg, James. Co-CEO, Magellan Development Group, LLC. Phone Interview. July 7, 2009.

McNary, John. Director Campus Design and Construction, University of Utah. Phone Interview. July 2, 2009.

Wright, Jane Cady. President/CEO, Hanbury Evans Wright Vlattas + Company. Phone Interview. July 2, 2009.

Appendix A – Interview Questions

Venue Background

1. Please tell me about your position related to the Olympic Games Planning?
2. Please tell me about the Olympic project you are involved with?
3. What are the requirements from the IOC for this venue?
4. How do you plan on using this venue following the Olympic Games?
5. Has this plan changed during the course of planning?
6. How well do you feel you are positioned to deliver the best product to the private market following the Games?
7. So far, do you consider this project to be a success? From the IOC's point of view? From your point of view? From the private market's point of view? How do you determine success?
8. What are the characteristics that make Olympic venue development different from typical real estate development projects?

Project Uncertainty

1. What are the major sources of uncertainty you face with this type of project?
2. How would you usually deal with this type of uncertainty in design and planning?
3. How does this project differ from that normal process?
4. How do these uncertainties affect the way you plan for this project?

Design Flexibility

1. What do you consider to be design flexibility?
2. What are different types or examples of design flexibility?
3. Have you consider the use of design flexibility for your project?
4. If so, can you explain this design flexibility and how it would be implemented?
5. How would this flexibility help you to meet the needs of the IOC?
6. How would this flexibility help you to meet the needs of the private markets following the Games?
7. How would design flexibility increase value in the project?
8. What kinds of flexibility would be useful for this project?

Real Options Analysis

1. Have you heard of Real Options Analysis?
2. Can you explain or give examples of types of Real Options Analysis?
3. Have you used or considered the use of Real Options Analysis to value flexibility for this project?
4. Have you used Real Options Analysis previously on other projects?
5. If so, how was this analysis conducted?
6. How do you feel Real Options Analysis can add value to a project?

Other

1. Are you willing to participate in a follow up interview session or answer additional questions if necessary?
2. Do you require that your interview remain anonymous?
3. Do you require that any part of your interview remain confidential?

Appendix B
"Pedagogical" model

NPV Computations: As of Time Zero (exclusive of land cost)…

NPV as Condo Project

		Phase 1	Phase 2	Phase 3
Year	**0**	**1**	**2**	**3**
Sales Price/Unit		$236,401	$195,263	$257,698
Sales Revenue		$23,640,080	$19,526,270	$25,769,770
(-) Constr & Sales Costs		15,500,000	16,000,000	16,500,000
Net Cash Flow		8,140,080	3,526,270	9,269,770
PV of Cash Flow		6,380,377	2,166,461	4,463,976
NPV (exclu land)	**13,010,813**			

NPV as Apts Project

		Phase 1	Phase 2	Phase 3
Year	**0**	**1**	**2**	**3**
Sales Price/Unit		$227,756	$192,368	$226,740
Sales Revenue		$22,775,613	$19,236,834	$22,673,973
(-) Constr & Sales Costs		15,500,000	16,000,000	16,500,000
Net Cash Flow		7,275,613	3,236,834	6,173,973
PV of Cash Flow		5,702,788	1,988,638	2,973,156
NPV (exclu land)	**10,664,581**			

NPV w Flexible Choise Each Phase:

		Phase 1	Phase 2	Phase 3	
Year	**0**	**1**	**2**	**3**	
Current phase developed as:		CONDOS	CONDOS	CONDOS	<==Decision Flexibility.
Sales Price/Unit		$236,401	$195,263	$257,698	
Sales Revenue		$23,640,080	$19,526,270	$25,769,770	
(-) Constr & Sales Costs		15,500,000	16,000,000	16,500,000	
Net Cash Flow		8,140,080	3,526,270	9,269,770	
PV of Cash Flow		6,380,377	2,166,461	4,463,976	
NPV (exclu land)	**13,010,813**	<== Net of up-front flexibilty-enabling cost			

(only applies to provide flexibility, not necessary for either type without flex).

Appendix C – "Applied" Simulation Model

Exhibit 1 – Development Budget
Exhibit 2 – Projected Revenues
Exhibit 3 – Construction Schedule
Exhibit 4 – Projected Cash Flows
Exhibit 5 – Project Analysis
Exhibit 6 – Simulation Entries
Exhibit 7 – Random Number Generation
Exhibit 8 – NPV Calculations
Exhibit 9 - Simulation

Exhibit 1
Chicago 2016 Olympic Village
Development Budget

	Line Item Cost, $	Cost, $ per GSF	% of Total Cost	Notes
SITE ACQUISITION:				
Michael Reese Hospital Parcel	**$85,000,000**	$28.33	10.1%	
Misc Closing Costs	**5,000,000**	$1.67	0.6%	
Total Site Acquisition	$90,000,000	$30.00	10.7%	
HARD CONSTRUCTION COSTS:				
Olympic Base Building	450,000,000	**$150.00**	53.3%	
Miscellaneous Hard Costs	15,000,000	**$5.00**	1.8%	
Contingency	15,000,000	**$5.00**	1.8%	
Retrofit Costs	150,000,000	**$50.00**	17.8%	
Total Hard Construction Costs	$630,000,000	$160.00	74.7%	
SOFT DEVELOPMENT COSTS:				
A&E	45,000,000	**$15.00**	5.3%	
Miscellaneous Soft Costs	60,000,000	**$20.00**	7.1%	
Developer Fee	18,900,000	$6.30	**3.0%**	<= based on total hard costs
Total Soft Development Costs	$123,900,000	$41.30	15.4%	
TOTAL DEVELOPMENT COSTS	$843,900,000	$231.30	101%	
Flexibility Premium	0	$0.00	0%	<= based on total dvlpmt costs
Total Development Costs incl. Flexibility	$843,900,000	$231.30		

Assumptions

Gross Bldg sf	**3,000,000**	
Total Development Costs (excl flex & retrofit)	693,900,000	
% Development Costs Allocated to Residential	**80%**	
Total Resi Development Cost incl flex	675,120,000	<= 100% flexibility allocated to resi
Total Resi Development Cost (excl flex & retrofit)	555,120,000	

Exhibit 2
Chicago 2016 Olympic Village
Projected Revenues

	Projected $/sf (/year)						Project $/unit (/year)					
	Phase 1	Phase 1	Phase 2	Phase 2	Phase 3	Phase 3	Phase 1	Phase 1	Phase 2	Phase 2	Phase 3	Phase 3
Use	Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022	Year 2017	Year 2018	Year 2019	Year 2020	Year 2021	Year 2022
Luxury/Average Condo	**$ 370.00**	$ 375.55	$ 381.18	$ 386.90	$ 392.70	$ 398.60	$ 444,000	$ 450,660	$ 457,420	$ 464,281	$ 471,245	$ 478,314
Luxury/Average Apartment	**$ 31.00**	$ 31.47	$ 31.94	$ 32.42	$ 32.90	$ 33.40	$ 37,200	$ 37,758	$ 38,324	$ 38,899	$ 39,483	$ 40,075
Luxury Apartment	Cap Rate	6.25%	OpEx	$ 11,160	<= per year		$ 416,640	$ 425,568	$ 434,630	$ 443,828	$ 453,164	$ 462,639
Student Housing	**$ 20.00**	$ 20.30	$ 20.60	$ 20.91	$ 21.23	$ 21.55	$ 3,000	$ 3,045	$ 3,091	$ 3,137	$ 3,184	$ 3,232
Senior Housing	**$ 30.00**	$ 30.45	$ 30.91	$ 31.37	$ 31.84	$ 32.32	$ 9,000	$ 9,135	$ 9,272	$ 9,411	$ 9,552	$ 9,696
Hotel	**$ 40.00**	$ 40.60	$ 41.21	$ 41.83	$ 42.45	$ 43.09	$ 8,000	$ 8,120	$ 8,242	$ 8,365	$ 8,491	$ 8,618
Olympic Residential Use	**$ 15.00**						$ 2,685					

Apartment OpEx/RE Taxes & Comm	**30%**							
Expected Sales/Rental Rate growth	**2%**	/year	Average Senior Room Size	300	gsf	# of Apts/C	2,500	units
Average Apartment/Condo Size	**1200**	gsf	Average Hotel /apt unit	**6**	rooms	# of Studen	20,000	units
Average Students /apt unit	**8**	people	Average Hotel Room Size	200	gsf	# of Senior	10,000	units
Average Student Room Size	150	gsf	Olympic Residential Use	**16,800**	beds	# of Hotel	15,000	units
Average Senior /apt unit	**4**	people	Average Olympic Bed Size	179	gsf			

Exhibit 3
Chicago 2016 Olympic Village
Construction Schedule

	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL
Michael Reese Hospital Parcel	**100%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	100%
Misc Closing Costs	**100%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	100%
Olympic Base Building	**0%**	**0%**	**10%**	**25%**	**25%**	**40%**	**0%**	**0%**	100%
Miscellaneous Hard Costs	**0%**	**0%**	**25%**	**25%**	**25%**	**25%**	**0%**	**0%**	100%
Contingency	**0%**	**0%**	**25%**	**25%**	**25%**	**25%**	**0%**	**0%**	100%
Retrofit Costs	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**100%**	100%
A&E	**10%**	**40%**	**30%**	**5%**	**5%**	**5%**	**5%**	**0%**	100%
Miscellaneous Soft Costs	**10%**	**40%**	**30%**	**5%**	**5%**	**5%**	**5%**	**0%**	100%
Developer Fee	**5%**	**10%**	**15%**	**15%**	**20%**	**20%**	**15%**	**0%**	100%
Flexibility Premium	**0%**	**0%**	**0%**	**30%**	**30%**	**40%**	**0%**	**0%**	100%

Total Development Costs	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL
Michael Reese Hospital Parcel	85,000,000	-	-	-	-	-	-	-	85,000,000
Misc Closing Costs	5,000,000	-	-	-	-	-	-	-	5,000,000
Olympic Base Building	-	-	45,000,000	112,500,000	112,500,000	180,000,000	-	-	450,000,000
Miscellaneous Hard Costs	-	-	3,750,000	3,750,000	3,750,000	3,750,000	-	-	15,000,000
Contingency	-	-	3,750,000	3,750,000	3,750,000	3,750,000	-	-	15,000,000
Retrofit Costs	-	-	-	-	-	-	-	150,000,000	150,000,000
A&E	4,500,000	18,000,000	13,500,000	2,250,000	2,250,000	2,250,000	2,250,000	-	45,000,000
Miscellaneous Soft Costs	6,000,000	24,000,000	18,000,000	3,000,000	3,000,000	3,000,000	3,000,000	-	60,000,000
Developer Fee	945,000	1,890,000	2,835,000	2,835,000	3,780,000	3,780,000	2,835,000	-	18,900,000
Flexibility Premium	-	-	-	-	-	-	-	-	-
Totals	101,445,000	43,890,000	86,835,000	128,085,000	129,030,000	196,530,000	8,085,000	150,000,000	843,900,000

Residential Development Costs ONLY	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL
Michael Reese Hospital Parcel	68,000,000	-	-	-	-	-	-	-	68,000,000
Misc Closing Costs	4,000,000	-	-	-	-	-	-	-	4,000,000
Olympic Base Building	-	-	36,000,000	90,000,000	90,000,000	144,000,000	-	-	360,000,000
Miscellaneous Hard Costs	-	-	3,000,000	3,000,000	3,000,000	3,000,000	-	-	12,000,000
Contingency	-	-	3,000,000	3,000,000	3,000,000	3,000,000	-	-	12,000,000
Retrofit Costs	-	-	-	-	-	-	-	120,000,000	120,000,000
A&E	3,600,000	14,400,000	10,800,000	1,800,000	1,800,000	1,800,000	1,800,000	-	36,000,000
Miscellaneous Soft Costs	4,800,000	19,200,000	14,400,000	2,400,000	2,400,000	2,400,000	2,400,000	-	48,000,000
Developer Fee	756,000	1,512,000	2,268,000	2,268,000	3,024,000	3,024,000	2,268,000	-	15,120,000
Flexibility Premium (100% allocated to resi)	-	-	-	-	-	-	-	-	-
Totals	81,156,000	35,112,000	69,468,000	102,468,000	103,224,000	157,224,000	6,468,000	120,000,000	675,120,000

Exhibit 4
Chicago 2016 Olympic Village
Projected Cash Flow

Chicago 2016 Olympic Village
PROJECTED NET OPERATING INCOME AND CASH FLOW FROM OPERATIONS
for residential components only

		Construction Phase:						OLYMPICS	Phase 1	Phase 1	Phase 2	Phase 2	Phase 3	Phase 3	Phase 3			
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Calendar Years Ending:		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CONDOS																		
Sales Absorption (units/year)	**400**	-	-	-	-	-	-	-	*400*	*400*	*400*	*400*	*400*	*400*	*100*	-	-	-
Cumulative Sales (units)		-	-	-	-	-	-	-	*400*	*800*	*1,200*	*1,600*	*2,000*	*2,400*	*2,500*	*2,500*	*2,500*	*2,500*
Projeted Gross Revenue (/unit)		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*444,000*	*444,000*	*457,420*	*457,420*	*471,245*	*471,245*	*471,245*	*0*	*0*	*0*
Projeted Gross Revenue		0	0	0	0	0	0	45,108,000	177,600,000	177,600,000	182,967,960	182,967,960	188,498,167	188,498,167	47,124,542	0	0	0
(-) Vacancy	**0.00%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expected Gross Revenue		0	0	0	0	0	0	45,108,000	177,600,000	177,600,000	182,967,960	182,967,960	188,498,167	188,498,167	47,124,542	0	0	0
(-) Operating Expenses & RE Taxes	**0.00%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET REVENUE		0	0	0	0	0	0	45,108,000	177,600,000	177,600,000	182,967,960	182,967,960	188,498,167	188,498,167	47,124,542	0	0	0
(-) Sales Commissions	**0.00%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(-) Capital Reserve		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROPERTY BEFORE-TAX CASH FLOW		0	0	0	0	0	0	45,108,000	177,600,000	177,600,000	182,967,960	182,967,960	188,498,167	188,498,167	47,124,542	0	0	0
NPV	9.50%	$ 508,241,487																
APARTMENTS																		
Lease up Rate (units/year)	**400**	-	-	-	-	-	-	-	*400*	*400*	*400*	*400*	*400*	*400*	*100*	-	-	-
Cumulative Lease up (units)		-	-	-	-	-	-	-	*400*	*800*	*1,200*	*1,600*	*2,000*	*2,400*	*2,500*	*2,500*	*2,500*	*2,500*
Projected Gross Revenue (/unit)		-	-	-	-	-	-	-	*416,640*	*416,640*	*434,630*	*434,630*	*453,164*	*453,164*	*453,164*	*0*	*0*	*0*
Projeted Gross Revenue		0	0	0	0	0	0	45,108,000	166,656,000	166,656,000	173,851,968	173,851,968	181,265,434	181,265,434	45,316,359	0	0	0
(-) Vacancy	**0.00%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Expected Gross Revenue		0	0	0	0	0	0	45,108,000	166,656,000	166,656,000	173,851,968	173,851,968	181,265,434	181,265,434	45,316,359	0	0	0
(-) Operating Expenses & RE Taxes	**0.00%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NET OPERATING INCOME		0	0	0	0	0	0	45,108,000	166,656,000	166,656,000	173,851,968	173,851,968	181,265,434	181,265,434	45,316,359	0	0	0
(-) Leasing Commissions	**0.00%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(-) Capital Reserve	**0.00%**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Property Before-Tax Cash Flow		0	0	0	0	0	0	45,108,000	166,656,000	166,656,000	173,851,968	173,851,968	181,265,434	181,265,434	45,316,359	0	0	0
PBTCF from reversion	7.00%																	0
Sales Cost	3.00%																	0
PROPERTY BEFORE-TAX CASH FLOW		0	0	0	0	0	0	45,108,000	166,656,000	166,656,000	173,851,968	173,851,968	181,265,434	181,265,434	45,316,359	0	0	0
NPV	9.50%	$ 483,787,120																

Exhibit 5
Chicago 2016 Olympic Village
Project Analysis

Input Assumptions:	
OCC of Spec Asset	**9.50%**
Stabilized Going-In IRR (2016 -> future)	**8.50%**
Terminal Cap Rate	**7.00%**
Sales Cost (%)	**3.00%**

NOTE: Analysis assumes a single investor and all equity.
*** all costs in thousands ('000s)

Cash Flows:		Construction Phase:						OLYMPICS	Retrofit:			Stabilized Operational Phase:						
		Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	Year	
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Calendar Years(Qtrs) Ending:		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Development Cost:																		
Michael Reese Hospital Parcel		(68,000)	-	-	-	-	-	-	-									
Misc Closing Costs		(4,000)	-	-	-	-	-	-	-									
Olympic Base Building		-	-	(36,000)	(90,000)	(90,000)	(144,000)	-	-									
Miscellaneous Hard Costs		-	-	(3,000)	(3,000)	(3,000)	(3,000)	-	-									
Contingency		-	-	(3,000)	(3,000)	(3,000)	(3,000)	-	-									
Retrofit Costs		-	-	-	-	-	-	-	(120,000)									
A&E		(3,600)	(14,400)	(10,800)	(1,800)	(1,800)	(1,800)	(1,800)	-									
Miscellaneous Soft Costs		(4,800)	(19,200)	(14,400)	(2,400)	(2,400)	(2,400)	(2,400)	-									
Developer Fee		(756)	(1,512)	(2,268)	(2,268)	(3,024)	(3,024)	(2,268)	-									
Flexibility Premium		-	-	-	-	-	-	-	-									
Retrofit Cost discount for apartment vs. condo	**10%**	-	-	-	-	-	-	-	6,000									
Total Development Costs		(81,156)	(35,112)	(69,468)	(102,468)	(103,224)	(157,224)	(6,468)	(114,000)									
Projected Operations:																		
Projeted Gross Revenue - Condos	**50%**							22,554	88,800	88,800	91,484	91,484	94,249	94,249	23,562	0	0	0
Projected Gross Revenue - Apartments	**50%**							22,554	83,328	83,328	86,926	86,926	90,633	90,633	22,658	0	0	0
(-) Vacancy on Apartments	0%							0	0	0	0	0	0	0	0	0	0	0
Expected Gross Revenue								45,108	172,128	172,128	178,410	178,410	184,882	184,882	46,220	0	0	0
(-) Operating Expenses & RE Taxes - Condos	50%							0	0	0	0	0	0	0	0	0	0	0
(-) Operating Expenses & RE Taxes - Apartments	50%							0	0	0	0	0	0	0	0	0	0	0
NET REVENUE/NET OPERATING INCOME								45,108	172,128	172,128	178,410	178,410	184,882	184,882	46,220	0	0	0
(-) Sales Commissions - Condos	50%							0	0	0	0	0	0	0	0	0	0	
(-) Leasing Commissions - Apartments	50%							0	0	0	0	0	0	0	0	0	0	
(-) Capital Reserve - Condos	50%							0	0	0	0	0	0	0	0	0	0	
(-) Capital Reserve - Apartments	50%							0	0	0	0	0	0	0	0	0	0	
PROPERTY BEFORE-TAX CASH FLOW								45,108	172,128	172,128	178,410	178,410	184,882	184,882	46,220	0	0	
PBTCF from Reversion	7.00%																0	
Sales Cost	3.00%																-	
PBTCF Total *(Olympic/Retrofit/Stabilized Phases)*								45,108	172,128	172,128	178,410	178,410	184,882	184,882	46,220	0	0	
PBTCF Total (all phases): IRR =	9.92%	(81,156)	(35,112)	(69,468)	(102,468)	(103,224)	(157,224)	38,640	58,128	172,128	178,410	178,410	184,882	184,882	46,220	0	0	
Development Phase Cash Flows: IRR =	11.49%	(81,156)	(35,112)	(69,468)	(102,468)	(103,224)	(157,224)	769,232										

Total Development Costs (excluding flex and retrofit)		(81,156)	(35,112)	(69,468)	(102,468)	(103,224)	(157,224)	(6,468)
Total Flexibility Costs		-	-	-	-	-	-	-
PV of TDC (excl. flex and retrofit, incl. Olympic Revenue)	9.92%	(420,134)						(695,829)
PV of Total Flexibility Costs	9.92%	0						0

Exhibit 6
Chicago 2016 Olympic Village
Simulation Entries

		Phase 1	Phase 2	Phase 3	Base
Condo Base Absorption Rate, units/yr		**400**	**400**	**400**	**400**
Apt Base Absorption Rate, units/yr		**400**	**400**	**400**	**400**
Condo Absorption Uncertainty Factor		**40%**	**40%**	**40%**	**40%**
Apt Absorption Uncertainty Factor		**10%**	**10%**	**10%**	**10%**
Condo Actual Change in Absrptn Rate, %		-4.09%	1.30%	7.24%	
Apt Actual Change in Absrptn Rate, %		-0.13%	-1.11%	4.38%	
Occupancy Hurdle Rate, %		**80%**	**80%**	**80%**	**80%**
Condo Absorption Rate, units/yr		384	405	429	
Apt Absorption Rate, units/yr		399	396	418	
Max years per Phase		**3**	*<= must be 1, 2 or 3 years*		**3**
Absorption Weight Factor		**30%**			**30%**

NOTE: correlation between condos and apartments is already considered below
*** factor for correlation with change in condo prices (i.e. as price goes up, so does absorption)*

Option to Defer		ON			**OFF**
Years per Phase	*1.67*	2	*<= rounded to # of full years to achieve occupancy hurdle rate*		
			**** assumes condo absorption rate for Phase 1*		
		Phase 1	Phase 2	Phase 3	Base
Units Developed (each phase)		**800**	**800**	900	**800**

Residential Construction Cost (as of Olympic delivery):

	Phase 1	Phase 2	Phase 3			
Base Cost	$278,332	$278,332	$278,332	*per unit*		
Added Cost to Retrofit & Sell:						
As Condos	$48,000	$51,000	$54,000	*per unit*	**3%**	<= increase per year
As Apts	$45,600	$48,000	$51,000	*per unit*	10%	<= *% discount to cost of condo finishes*
Up-front Cost to Enable Flexibility	$0	*per unit*				

Selling Price Expectations:

	Phase 1	Phase 2	Phase 3	
As Condos	$444,000	$457,420	$471,245	*per unit*
As Apts	$416,640	$434,630	$453,164	*per unit*

Uncertainty Factor in Price:*

	Phase 1	Phase 2	Phase 3	*Base*
As Condos	**40%**	**40%**	**40%**	**40%**
As Apts	**10%**	**10%**	**10%**	**10%**
Price Weight Factor	**30%**	*<= to model correlation*		**30%**

**Note: Bivariate Triangular Distribution. Inputs here are extreme ranges for raw uncorrelated distns and correlation weight.*
Weight factor is similar to correlation but lower. Standard deviations will be lower than extreme ranges.
Standard deviation of "Apts" distribution will be even lower as a function of the weighting factor.

OCC Project Level	9.92%	**Project IRR**	<= select from dropdown list
Development IRR	11.49%	<==*Note: Calculated from Resi Analysis (static)*	
Project IRR	9.92%	<==*Note: Calculated from Resi Analysis (static)*	
Override IRR	**15.00%**		

Exhibit 7
Chicago 2016 Olympic Village
Random Number Generation

	Uncertainty Factor Ph1		Uncertainty Factor Ph2		Uncertainty Factor Ph3	
As Condos	+/- 40%		+/- 40%		+/- 40%	
As Apts	+/- 10%		+/- 10%		+/- 10%	
	Min	Max	Min	Max	Min	Max
As Condos	$ 266,400	$ 621,600	$ 274,452	$ 640,388	$ 282,747	$ 659,744
As Apts	$ 374,976	$ 458,304	$ 391,167	$ 478,093	$ 407,847	$ 498,480

Baseline Price:	**Phase 1**	**Phase 2**	**Phase 3**			
As Condos	**$444,000**	**$457,420**	**$471,245**			
As Apts	**$416,640**	**$434,630**	**$453,164**	Actual % change from baseline		
Random Price:	**Phase 1**	**Phase 2**	**Phase 3**	**Phase 1**	**Phase 2**	**Phase 3**
As Condos	**$438,971**	**$338,386**	**$349,772**	-1.1%	-26.0%	-25.8%
As Apts	**$405,289**	**$428,589**	**$439,968**	-2.7%	-1.4%	-2.9%
	1	2	3	-3%	-65%	-64%

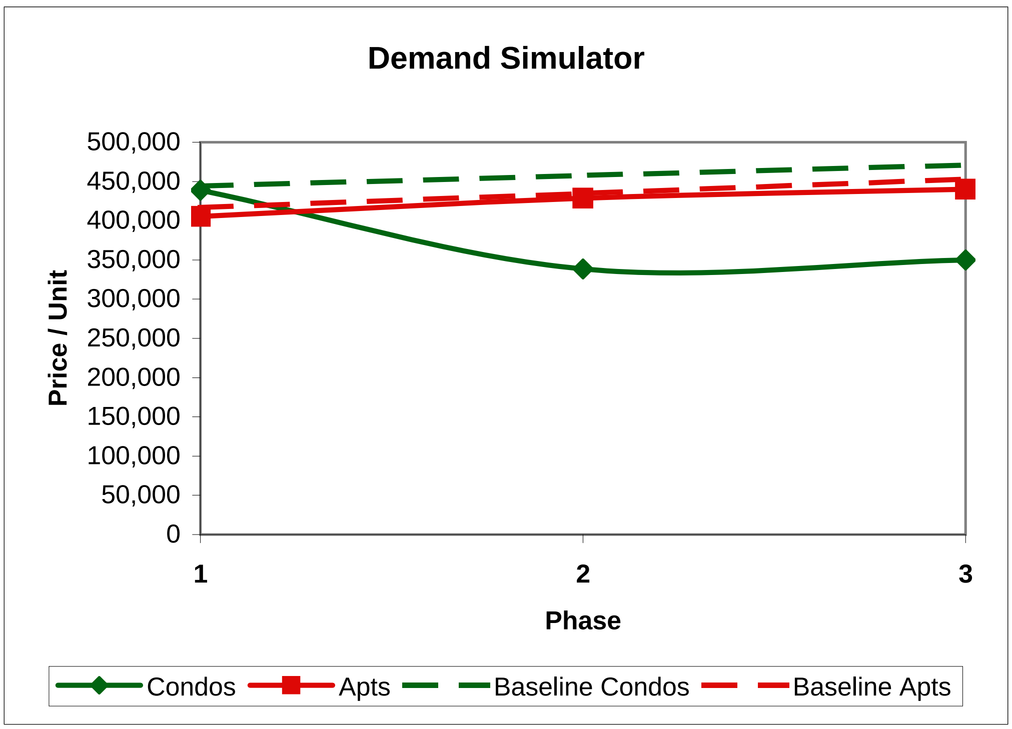


Exhibit 8
Chicago 2016 Olympic Village
NPV Calculations as of Time Zero (2016)

Years per phase	2.00

					2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
NPV as Condo Project	Phase	Units	Absorp	Sales $/unit		Phase 1	Phase 1	Phase 2	Phase 2	Phase 3	Phase 3				
Year					0	1	2	3	4	5	6	7	8	9	
Sales Price/Unit	*1*					438,971	438,971	0	0	0	0	0	0	0	
	2					0	0	338,386	338,386	0	0	0	0	0	
	3					0	0	0	0	349,772	349,772	0	0	0	
Sales Revenue	*1*	*800*	*384*	438,971	0	168,564,942	168,564,942	14,047,079	0	0	0	0	0	0	$351,176,963
	p1c					*168,564,942*	*337,129,885*	*351,176,963*	*351,176,963*	*351,176,963*	*351,176,963*	*351,176,963*	*351,176,963*	*351,176,963*	
units/year					*0*	*384*	*384*	*32*	*0*	*0*	*0*	*0*	*0*	*0*	*800*
total units phase 1						*384*	*768*	*800*	*800*	*800*	*800*	*800*	*800*	*800*	
	2	*800*	*405*	338,386		0	0	126,218,052	137,046,410	7,444,496	0	0	0	0	$270,708,958
	p2c					*0*	*0*	*126,218,052*	*263,264,462*	*270,708,958*	*270,708,958*	*270,708,958*	*270,708,958*	*270,708,958*	
units/year					*0*	*0*	*0*	*373*	*405*	*22*	*0*	*0*	*0*	*0*	*800*
total units phase 2						*0*	*0*	*373*	*778*	*800*	*800*	*800*	*800*	*800*	
	3	*900*	*429*	349,772		0	0	0	0	142,357,349	150,052,341	22,385,431	0	0	$314,795,121
	p3c					*0*	*0*	*0*	*0*	*142,357,349*	*292,409,690*	*314,795,121*	*314,795,121*	*314,795,121*	
units/year					*0*	*0*	*0*	*0*	*0*	*407*	*429*	*64*	*0*	*0*	*900*
total units phase 3						*0*	*0*	*0*	*0*	*407*	*836*	*900*	*900*	*900*	
total units /year						*384*	*384*	*405*	*405*	*429*	*429*	*64*	*0*	*0*	*2,500*
Constr & Sales Costs	*1*			-38,400,000	-222,665,285	-38,400,000	0	0	0	0	0	0	0	0	
	2			-40,800,000	-222,665,285	0	0	-40,800,000	0	0	0	0	0	0	
	3			-48,600,000	-250,498,446	0	0	0	0	-48,600,000	0	0	0	0	
Net Cash Flow	*ALL*				-695,829,016	130,164,942	168,564,942	99,465,130	137,046,410	101,201,846	150,052,341	22,385,431	0	0	
	1				-222,665,285	130,164,942	168,564,942	14,047,079	0	0	0	0	0	0	
	2				-222,665,285	0	0	85,418,052	137,046,410	7,444,496	0	0	0	0	
	3				-250,498,446	0	0	0	0	93,757,349	150,052,341	22,385,431	0	0	
PV of Yearly Cash Flow	*ALL*				-695,829,016	118,420,908	139,519,839	74,898,638	93,886,918	63,075,428	85,084,197	11,547,978	0	0	-109,395,110
PV of Phase Cash Flow	*ALL*					45,853,109	0	-59,817,492	0	-95,430,726	0	0	0	0	-109,395,110
NPV of Condo Alternative					-109,395,110										

NPV as Apt Project	Phase	Units	Absorp	Sales $/unit		Phase 1	Phase 1	Phase 2	Phase 2	Phase 3	Phase 3				
Year					0	1	2	3	4	5	6	7	8	9	
Sales Price/Unit	*1*					405,289	405,289	0	0	0	0	0	0	0	
	2					0	0	428,589	428,589	0	0	0	0	0	
	3					0	0	0	0	439,968	439,968	0	0	0	
Sales Revenue	*1*	*800*	*399*	405,289		161,710,227	161,710,227	810,578	0	0	0	0	0	0	$324,231,032
	p1c					*161,710,227*	*323,420,454*	*324,231,032*	*324,231,032*	*324,231,032*	*324,231,032*	*324,231,032*	*324,231,032*	*324,231,032*	
units/year					*0*	*399*	*399*	*2*	*0*	*0*	*0*	*0*	*0*	*0*	*800*
total units phase 1						*399*	*798*	*800*	*800*	*800*	*800*	*800*	*800*	*800*	
	2	*800*	*396*	428,589		0	0	168,863,909	169,721,086	4,285,886	0	0	0	0	$342,870,881
	p2c					*0*	*0*	*168,863,909*	*338,584,995*	*342,870,881*	*342,870,881*	*342,870,881*	*342,870,881*	*342,870,881*	
units/year					*0*	*0*	*0*	*394*	*396*	*10*	*0*	*0*	*0*	*0*	*800*
total units phase 2						*0*	*0*	*394*	*790*	*800*	*800*	*800*	*800*	*800*	
	3	*900*	*418*	439,968		0	0	0	0	179,506,831	183,906,508	32,557,612	0	0	$395,970,951
	p3c					*0*	*0*	*0*	*0*	*179,506,831*	*363,413,339*	*395,970,951*	*395,970,951*	*395,970,951*	
units/year					*0*	*0*	*0*	*0*	*0*	*408*	*418*	*74*	*0*	*0*	*900*
total units phase 3						*0*	*0*	*0*	*0*	*408*	*826*	*900*	*900*	*900*	
total units /year						*399*	*399*	*396*	*396*	*418*	*418*	*74*	*0*	*0*	*2,500*
Constr & Sales Costs	*1*			-36,480,000	-222,665,285	-36,480,000	0	0	0	0	0	0	0	0	
	2			-38,400,000	-222,665,285	0	0	-38,400,000	0	0	0	0	0	0	
	3			-45,900,000	-250,498,446	0	0	0	0	-45,900,000	0	0	0	0	
Net Cash Flow	*ALL*				-695,829,016	125,230,227	161,710,227	131,274,487	169,721,086	137,892,717	183,906,508	32,557,612	0	0	
	1				-222,665,285	125,230,227	161,710,227	810,578	0	0	0	0	0	0	
	2				-222,665,285	0	0	130,463,909	169,721,086	4,285,886	0	0	0	0	
	3				-250,498,446	0	0	0	0	133,606,831	183,906,508	32,557,612	0	0	
PV of Yearly Cash Flow	*ALL*				-695,829,016	113,931,423	133,846,247	98,851,529	116,271,486	85,943,513	104,280,530	16,795,503	0	0	-25,908,784
PV of Phase Cash Flow	*ALL*					25,722,761	0	-5,481,409	0	-46,150,136	0	0	0	0	-25,908,784
NPV of Apt Alternative					-25,908,784										

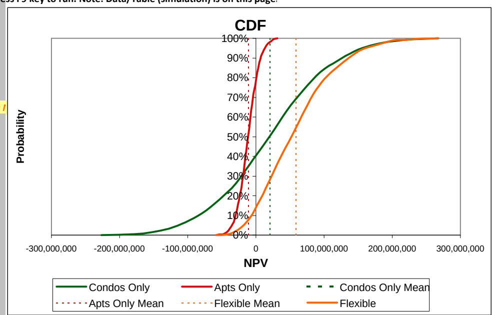
NPV w Flexible Choise Each Phase:		Phase 1	Phase 1	Phase 2	Phase 2	Phase 3	Phase 3			
Year	0	1	2	3	4	5	6	7	8	9
NPV of Condo Phase Cash Flow		45,853,109	0	-59,817,492	0	-95,430,726	0	0	0	0
NPV of Apt Phase Cash Flow		25,722,761	0	-5,481,409	0	-46,150,136	0	0	0	0
Current phase developed as:		CONDOS	n/a	APTS	n/a	APTS	n/a	n/a	n/a	n/a
PV of Flexible Cash Flow		$ 45,853,109	$ -	$ -5,481,409	$ -	$ -46,150,136	$ -	$ -	$ -	$ -
NPV of Flexible Alternative	-5,778,437	<== Net of up-front flexibilty-enabling cost (only applies to provide flexibility, not necessary for either type without flex).								

Exhibit 9
Chicago 2016 Olympic Village
Simulation Results

NPVs as of Time 0 (2016) - (2000 simulated future outcomes) Press F9 key to run. Note: Data/Table (simulation) is on this page.

	Condo Only	Apt Only	Flexible
Mean	20,330,111	-11,353,623	58,384,993
Max	267,729,540	31,387,203	267,729,540
Min	-226,820,930	-58,449,366	-58,449,366
STD	80,448,842	14,457,641	55,152,417

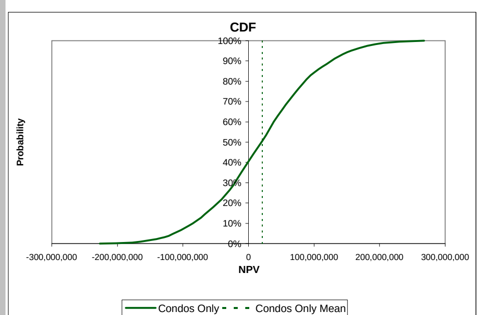
	Condo Only	Apt Only	Flexible
NPVs	*-109,395,110*	*-25,908,784*	*-5,778,437* <== I
0.01	48,896,820	-14,846,407	48,896,820
0.01	-37,668,559	-19,038,027	86,022,039
0.01	147,537,510	24,252,781	147,537,510
0.01	-44,509,570	-2,412,191	6,813,104
0.01	11,986,880	-31,428,127	66,463,881
0.01	68,194,398	-761,893	68,194,398
0.01	65,035,626	-31,857,079	65,035,626
0.01	66,456,456	5,442,414	131,242,454
0.01	26,326,192	-5,883,281	71,320,161
0.01	-26,640,385	-770,481	30,991,184
0.01	22,610,835	-9,988,651	75,058,408
0.01	93,723,240	-9,363,559	93,723,240
0.01	77,935,365	-11,345,018	77,935,365
0.01	-138,127,309	-33,125,755	-33,125,755
0.01	137,002,344	17,873,577	140,728,070
0.01	170,494,675	8,584,712	170,494,675
0.01	15,767,755	-12,119,443	79,240,589
0.01	85,040,800	-25,568,134	109,167,945
0.01	-16,001,839	-24,057,405	29,414,884
0.01	20,377,179	-10,061,604	63,116,463
0.01	-53,696,603	-21,982,252	25,577,491
0.01	89,594,742	-19,997,222	89,594,742
0.01	50,474,146	-641,716	102,065,048
0.01	4,374,701	11,995,470	74,316,947
0.01	-62,250,987	-17,842,204	6,077,680
0.01	58,927,722	8,312,134	84,549,157
0.01	220,724,157	22,613,538	220,724,157
0.01	-67,037,250	1,776,101	22,969,881
0.01	-78,730,280	-45,247,997	-42,961,514
0.01	43,307,881	-3,713,582	72,632,195
0.01	-54,128,753	-11,729,901	16,595,823
0.01	-72,957,719	-23,886,363	19,514,268
0.01	-62,686,927	-28,726,770	13,579,822
0.01	90,017,783	-4,221,400	90,017,783
0.01	59,043,306	-15,665,218	59,256,475
0.01	113,770,010	8,547,485	150,112,407
0.01	3,745,417	-34,615,757	45,354,132
0.01	56,190,092	-17,654,934	64,644,954
0.01	-13,646,247	-54,255,907	-6,814,363
0.01	35,893,996	24,552,271	55,456,165
0.01	52,135,473	-33,530,930	61,337,634
0.01	28,088,144	-16,754,733	34,846,441
0.01	-20,579,107	-8,296,131	19,645,762
0.01	-72,147,658	-10,076,126	16,664,793
0.01	13,450,965	-1,261,954	64,929,792
0.01	77,807,606	-23,484,752	77,807,606
0.01	-38,213,472	-6,904,939	5,106,805
0.01	-45,021,977	4,112,318	12,787,946
0.01	77,252,515	-15,027,623	77,252,515
0.01	-56,967,187	-2,398,663	5,091,601
0.01	45,133,681	-15,961,385	56,405,919
0.01	12,064,702	-22,005,551	84,802,314
0.01	-74,852,865	-4,223,299	10,044,328
0.01	106,522,723	-16,069,982	107,595,783
0.01	40,728,338	-15,288,560	55,490,070
0.01	-6,121,214	12,456,183	34,642,612
0.01	7,623,080	-8,745,301	26,321,799
0.01	-99,254,399	-9,682,144	26,314,599
0.01	12,246,842	565,710	63,796,466
0.01	-59,324,067	-33,553,726	27,001,625
0.01	30,275,011	11,999,070	34,186,216
0.01	174,257,546	-15,383,371	174,257,546
0.01	-83,280,865	-19,395,738	-19,395,738
0.01	14,635,834	-4,313,577	52,806,621
0.01	37,011,181	-1,363,355	99,856,313
0.01	111,315,807	-20,094,325	121,288,332
0.01	156,880,951	4,945,659	156,880,951
0.01	-66,374,582	-35,762,256	6,652,135
0.01	-25,581,477	-30,927,619	30,151,299
0.01	148,879,783	-30,132,544	148,879,783
0.01	15,261,806	522,805	39,647,077
0.01	42,157,618	-21,251,789	49,881,422
0.01	18,034,705	-36,739,717	23,639,969
0.01	45,134,461	16,331,240	81,525,083
0.01	-180,356,925	-21,291,269	-21,291,269
0.01	-140,630,882	4,111,398	4,111,398
0.01	-23,676,055	-34,283,761	16,832,479
0.01	-66,346,302	-35,708,864	-12,313,229
0.01	-15,621,658	-9,478,817	35,774,439
0.01	-114,266,931	-23,183,515	-4,181,758
0.01	-6,897,575	-26,393,648	-586,632
0.01	2,527,624	-7,796,885	70,979,835
0.01	126,686,528	-20,891,226	147,823,311
0.01	-10,274,334	15,636,396	28,129,540
0.01	-66,990,817	-23,692,212	12,926,923
0.01	-73,796,608	-15,181,793	-15,181,793
0.01	-4,766,398	-30,318,064	42,539,547
0.01	10,270,004	-6,971,987	32,853,733
0.01	-109,185,743	-6,766,357	-6,766,357
0.01	-57,808,034	-11,052,054	16,285,464
0.01	77,068,567	31,135,181	135,677,374
0.01	14,317,267	-10,034,285	30,577,279
0.01	50,710,105	-14,549,256	94,834,172
0.01	43,132,704	-13,877,751	80,319,877
0.01	-30,243,666	-10,354,228	-5,666,612
0.01	-7,331,925	-9,820,943	31,579,459
0.01	-38,011,708	-1,998,734	54,480,083
0.01	-39,435,694	-21,918,167	23,722,149
0.01	-16,593,822	12,581,336	25,164,674
0.01	81,736,359	-12,964,312	112,080,435
0.01	-39,603,005	445,077	445,077
0.01	90,336,678	-30,381,033	92,697,055
0.01	84,582,950	-8,088,229	90,461,070
0.01	-110,195,760	-33,859,643	8,477,698
0.01	111,658,121	325,471	124,772,607
0.01	78,115,024	-13,252,990	132,730,652
0.01	71,798,467	-18,752,468	71,798,467
0.01	-104,033,570	-4,753,797	-4,753,797
0.01	-138,384,746	-21,409,486	-21,409,486
0.01	128,926,530	1,103,396	129,898,011



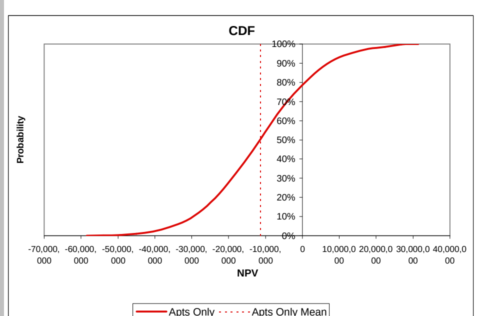
Condos Only			
10%	chance of NPV below	-85,377,264	million $
10%	chance of NPV higher than	127,261,996	million $
Apts Only			
10%	chance of NPV below	-29,393,262	million $
10%	chance of NPV higher than	7,063,709	million $
Flexible			
10%	chance of NPV below	-6,811,827	million $
10%	chance of NPV higher than	134,960,362	million $

Means graphing:

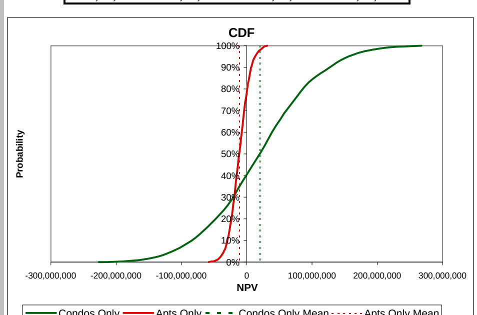
20,330,111	1	-11,353,623	1	58,384,993	1
20,330,111	0	-11,353,623	0	58,384,993	0



Mean	Max	Min	StD
20,330,111	267,729,540	-226,820,930	80,448,842



Mean	Max	Min	StD
-11,353,623	31,387,203	-58,449,366	14,457,641



	Mean	Max	Min	StD
Condo	20,330,111	267,729,540	-226,820,930	80,448,842
Apt	-11,353,623	31,387,203	-58,449,366	14,457,641