Flexibility in Ballpark Design

by
Kyle T. Ressler

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Abstract

This thesis documents the potential value of using flexible design to implement Major League Ballparks (MLBP). Credible evidence suggests that most ballparks were designed to fixed specifications that do not facilitate improvements after the park opens. By contrast, flexible designs include options such as increasing seating capacity, adding luxury boxes, installing a retractable roof, or even converting spaces to accommodate alternative uses.

The analysis estimated the economic value of flexible MLBP by comparing fixed and flexible designs. Fixed designs were based on deterministic forecasts of future conditions and largely ignore the uncertainties that affect the economic value of ballparks. Flexible designs recognize the great uncertainties concerning future attendance, concessions spend, weather, and inflation rate. Flexible designs both anticipate and plan for these uncertainties.

The economic evaluations used 30-year Net Present Value Monte Carlo simulations of possible futures. They used historical data available at the time of design to estimate the distribution of uncertainties. For the flexible designs, the analysis evaluated the options and determined key parameters such as strike point, base level, and option level.

The analysis is based on actual ballpark cases. These include two completed ballparks -- for a small market (Minnesota Twins) and a large one (New York Yankees). For these ballparks, the analysis compared the actual ballpark with a flexible design. Additionally the value of amenities such as multi-use spaces, museums, and other features are explored.

The results show that flexible design can significantly improve the long-term financial prospects of ballparks. It can lower initial investments and thus the Value at Risk (VAR). It can also increase the potential to cash in on favorable circumstances, that is, to increase the Value to Gain (VAG). While the specifics of each flexible design differ the overall conclusion is similar: Projects that embrace flexible design expect to achieve better long-term financial results.

Thesis Supervisor: Richard de Neufville
Title: Professor of Engineering Systems
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I would like to thank Professor Richard de Neufville for his patience and guidance. Your willingness to challenge the status quo of design has shown engineers a new way forward and inspired them to develop better systems for today and tomorrow.

Special thanks to John Deere, specifically Linda Wells, Roger Shirk, and Dave Knight, for their commitment to education and investment in their teams.

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“If I have seen further, it is by standing on the shoulders of giants”

Isaac Newton
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Chapter 1 - Literature Review
This literature review serves to present a portion of the existing body of knowledge in each of the following; Ballpark construction, sources of ballpark revenue, Major League Baseball (MLB) attendance, and analysis of flexibility in design.

Ballpark Construction
“**If you build it, he will come**” - *The Voice* from Shoeless Joe (Kinsella 1999)

When considering ballpark construction the topic can quite easily be broken down by considering the following questions: What are you going to build? How much is it going to cost? And lastly, who is going to pay for it? One should not assume that these questions are always answered in the order provided; in fact they are quite often not.

**What are You Going to Build?**
The decision of what to build is covered in depth by a host of architectural and civil engineering texts. (Sheard, Geraint, and Vickery 2012) (Serby 1930) (FIFA 2007) (UEFA 2011) Most of these offer guidance on everything from lavatories to scoreboard placement. However, the emphasis of this thesis is primarily on determination of larger scale decisions such as, ballpark capacity, retractable roofs, and luxury amenities. Surprisingly the literature is sparse and sometimes vague in methods for determining these types of large scale decisions. In this regard, there appears to be two primary schools of thought, the bigger is better approach and the deterministic approach.

An early treatise on modern stadiums and ballparks, “The Stadium” asserts that a structure should always be built to ultimate capacity so as to take advantage of economies of scale in construction. (Serby 1930) Likewise Federation International Football Association (FIFA) suggests that “It is not unusual for clubs to find that the provision of a bright, new, clean and comfortable stadium brings with it a dramatic increase in attendance levels. ...a club which normally attracts attendance of around 20,000 and is thinking of building a new stadium with a capacity of 30,000 might find it preferable to think in terms of nearer 40,000.” They later concede that “there are, of course no known formulas for determining a stadium’s optimum capacity.” (FIFA 2007)

In *Stadia* the authors support the deterministic approach and suggest that a “capacity should be calculated by assessing a typical programme of events over a season, and estimating a typical attendance for each event.” (Sheard, Geraint, and Vickery 2012) Similarly the United European Football Association (UEFA) asks the stadium body to consider that “the atmosphere will be at its best when the stadium is full to capacity and buzzing. It is therefore very important that projected average attendances are correctly gauged when determining the capacity” but later concedes “there is no set formula for determining the optimal capacity, this will depend on a variety of factors.” (UEFA 2011)
Architecture
Numerous architecture firms worldwide frequently take on stadium and ballpark projects. As of 2014, the leading firms with respect to stadiums are 360, HKS, and Populous. However, with respect to MLB, the firm Populous in Kansas City is in a class of its own. It is responsible for virtually all of the great modern ballparks. Through its development of Camden Yards in Baltimore it is often credited with starting the modern ballpark era. Much of Populous’ leadership in ballpark design is often attributed to one man, Earl Santee. Santee has been involved in the design of a staggering 19 Major League Ballparks, Table 1, and 40 minor league and spring training ballparks.

Table 1 - Ballparks Earl Santee Worked On

<table>
<thead>
<tr>
<th>Major League Ballpark</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angel Stadium</td>
<td>Anaheim, California</td>
</tr>
<tr>
<td>Astrodome</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>Baltimore Orioles</td>
<td>Baltimore, Maryland</td>
</tr>
<tr>
<td>Busch Stadium</td>
<td>St Louis, Missouri</td>
</tr>
<tr>
<td>Busch Stadium</td>
<td>St Louis, Missouri</td>
</tr>
<tr>
<td>Coors Field</td>
<td>Denver, Colorado</td>
</tr>
<tr>
<td>Dodgers Stadium</td>
<td>Los Angeles, California</td>
</tr>
<tr>
<td>Fenway Park</td>
<td>Boston, Massachusetts</td>
</tr>
<tr>
<td>Kauffman Stadium</td>
<td>Kansas City, Missouri</td>
</tr>
<tr>
<td>Kingdome</td>
<td>Seattle, Washington</td>
</tr>
<tr>
<td>Miami Marlins Park</td>
<td>Miami, Florida</td>
</tr>
<tr>
<td>Minute Maid Park</td>
<td>Houston, Texas</td>
</tr>
<tr>
<td>Montreal Expos</td>
<td>Montreal, Quebec, Canada</td>
</tr>
<tr>
<td>Nationals Park</td>
<td>Washington, DC</td>
</tr>
<tr>
<td>New Yankee Stadium</td>
<td>New York, New York</td>
</tr>
<tr>
<td>New York Mets</td>
<td>New York, New York</td>
</tr>
<tr>
<td>Philadelphia Phillies</td>
<td>Philadelphia, Pennsylvania</td>
</tr>
<tr>
<td>PNC Park</td>
<td>Pittsburgh, Pennsylvania</td>
</tr>
<tr>
<td>Safeco Field</td>
<td>Seattle, Washington</td>
</tr>
<tr>
<td>Target Field</td>
<td>Minneapolis, Minnesota</td>
</tr>
<tr>
<td>Tiger Stadium</td>
<td>Detroit, Michigan</td>
</tr>
<tr>
<td>Veterans Stadium</td>
<td>Philadelphia, Pennsylvania</td>
</tr>
</tbody>
</table>
Santee prides himself on making good decisions and emphasizes that success can be determined many different ways. From an architectural standpoint Populous and Santee have enjoyed tremendous success over the last three decades reigniting America’s love for the ballpark.¹

“Great architecture isn’t product design; it’s the result of an architect thinking about the right solution. That may result in an iconic building, a building that is strongly tied to the community, or a building that absolutely brands the team or city. All are good solutions.” – Earl Santee (Santee 2014)

Construction Firms

Focusing on MLB, there are three prominent Construction companies; Mortenson, Turner, and Hunt. Construction firms of this caliber are all-inclusive companies that can handle nearly all aspects of modern ballpark design.

The breadth of design challenges in the modern ballpark can span not just the expected infrastructure, seating, and luxury boxes but also amenities such as restaurants, paddocks, retractable roofs, waterfalls, high definition video walls, complex media and IT connectivity, and mass transit infrastructure.

How Much is it Going to Cost?

The determination of ballpark construction cost is primarily driven by site location, major architectural considerations (open air, dome, retractable roof, etc.), amenities (luxury boxes, specialty features, etc.), its size (seating capacity, area, etc.), and the current bond and finance market. (Rafool 1997)

There is no question that the modern sports stadium has gradually been increasing in cost, but the main question is why? (NSLI 2009) Eisinger, Seifried, Shonk and others believe it is because the modern facility has changed dramatically in scope and its ability to meet a wide range of stakeholder needs. (Eisinger 2000) (Seifried 2005) The modern stadium is more akin to a small city than a field with surrounding seats. (Gunts 1992) Amenities such as restaurants, stores, meeting centers, office space, hotels, and connections to mass transit are becoming commonplace in modern stadiums.

Seifried and Shonk outline how other trends could dramatically impact stadium costs, both up and down. Features such as community spaces attached to stadiums, environmentally friendly cooling and heating systems, advanced multimedia, and communication connectivity. (Seifried and Shonk 2007) There is evidence of many of these trends already occurring. A $3.1 million youth baseball park, Helfaer Field on the grounds of Miller Park in Milwaukee, WI (Figure 1), and the Miami Marlins and Minnesota Twins recently received LEED environmental ratings for their stadiums. (Hoffmann 2001) (Perrina 2012)

¹ The author would like to clarify that this thesis is not an opinion on the architectural design or choices made by Populous, Earl Santee, or the construction firms hired to erect the ballparks discussed. Rather it proposes some alternative ways of executing a project in light of flexibility in engineering that may improve their long term financial performance.
Who is Going to Pay for It?

Stadium and ballpark finance has received significant attention from the academic community since the 1990’s. This is most likely due to the increased number of projects being proposed and completed between 1990 and 2010. While there is a wide variety of research, the majority of papers and books are part of an ongoing debate about the merits of public stadium finance. In *Playing the Stadium Game*, Rafoul explains the five primary ways to finance stadiums and ballparks (Table 2): the general public can pay through new taxes or use of general fund resources. Users or fans can pay through sale of ballpark amenities such as seat licenses and private boxes. The ball club can directly fund the construction. Businesses and other firms that stand to directly benefit from the ballpark can fund the facility. Finally, some combination of the above public and private sources can come together to collectively fund a ballpark. In cases where some or all of the project is funded through public means, Rafoul emphasizes that it is important to have a restriction on the total amount of public funds available in order to be protected from excessive costs and/or overruns. (Rafoul 1997)
Table 2 - Rafool’s 5 Ways to Pay for a Stadium (Rafool 1997)

<table>
<thead>
<tr>
<th>Rafool’s 5 Ways to Pay for Stadiums</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General Public</td>
</tr>
<tr>
<td>2. Fans and Users</td>
</tr>
<tr>
<td>3. Franchise</td>
</tr>
<tr>
<td>4. Targeted Beneficiaries</td>
</tr>
<tr>
<td>5. Combination of Public and Private</td>
</tr>
</tbody>
</table>

While all of these funding sources are possible, Zaretsky, Long, Poitras, Hadley, and many others point to the fact that nearly all of the post-war MLBP were funded entirely or partially with public money. The typical stadium is about 78% public and 22% privately funded. (Long 2012) The 20th century saw roughly $20 billion spent on ballparks, arenas, and stadiums in North America with about $15 billion of that coming from public sources. (Keating 1999) In the 21st century the spending has accelerated, with 2000 to 2012 seeing approximately $13 billion of completed, under construction, and planned projects. (Seifried and Shonk 2007)

Zaretsky argues against the use of public funds. He uses studies showing that cities and metropolitan areas typically do not grow or attain any additional benefits from these facilities. In fact, he believes the diversion of funds from other public projects may actually hurt these areas. (Zaretsky 2001) Judith Long continues this dialogue by showing that the public is actually paying far more than often reported. This is due to omissions that come in the form of infrastructure improvements required for stadiums, land grants, municipal services, foregone property taxes, and the ongoing costs of operations. These omissions increase the typically reported costs of stadiums by about 40%. (Long 2005)

Poitras and Hadley offer an interesting perspective on private funding by analyzing the San Francisco Giant’s AT&T Park. Their research explains how this 100% privately funded ballpark succeeded in covering its construction and operation costs. They prepare this argument through detailed analysis and discussion of revenue sources. What is of particular interest in their work is their absolute agreement with Zaretsky and Long citing a lack of overall public benefit as a result of ballpark construction and therefore questioning the use of public funds in such projects. (Poitras and Hadley 2006) The main takeaway is their belief that if done right, ballparks can be funded successfully using private funds. This stance is further backed by similar works describing the success of Camden Yards in Baltimore. (Hamilton and Kahn 1996)

In considering the public funding of ballparks it is important to recognize that most are funded through municipal bonds that are then backed by some revenue guaranteed stream. It is common for this to involve multiple components such as a percent of gate receipts, income tax, sales tax, hotel taxes, or auto taxes. These bonds are traded freely and as a result are rated by agencies such as Moody’s. In recent years many of these stadium and ballpark bonds have come under scrutiny as the authorities or municipalities responsible for making the payments have
had difficulty servicing their debt. (Barr 2010) (Devitt 2009) The reasons for the inability to pay for the debt vary, but include lower than expected receipts or tax revenues. With governments often unwilling to accept default or the repercussions of lowered bond ratings, the result is often increased taxes or cutting of other public programs in an effort to generate the needed funds to service the debt.

**Ballpark Revenue**

“Buy me some peanuts and Cracker Jacks” – Jack Norworth and Albert Von Tilzer, Songwriters

The clubs of MLB have a variety of revenue sources that combine to $6.5 Billion annually, with the average team seeing revenues around $215 million. (Hambrecht 2012) Sources like media rights and licensing can net between $10 - $40 million per year for a team, (Rafool 1997) This thesis focuses on revenues tied directly to the ballpark, and as a result has placed emphasis on sources such as ticket sales, luxury seat sales, in park concessions and merchandising, and advertising including ballpark naming rights.

**Ticketing**

Home ticketing is a significant revenue source for all teams in the league, on average accounting for about 30% of revenue. (Hambrecht 2012) Despite this high percentage there is evidence suggesting that ballparks intentionally lower their ticket prices so as to maintain higher attendance. It is hypothesized that this is done to increase revenues in parking, concessions, and merchandising and thus increase sponsorships. (Krautmann and Berri 2007) Variable ticket pricing (VTP) has also become more popular in MLB. VTP adjusts the ticket prices based upon factors that contribute to specific game demand such as the opponent, day of the week, and special events. (Rascher et al. 2006)

**Concessions and Merchandise**

Major League ball clubs are private entities and therefore are not obligated to share detailed revenue data with the public. It is thus very difficult to get accurate data on concession and merchandising revenues. However, Team Marketing Report (TMR) has been calculating the Fan Cost Index (FCI) for ballparks for many years. The FCI is a measure performed every year for each ballpark and is the total receipt representing a typical family of 4 attending a game. The receipt includes 2 adult average tickets, 2 child average tickets, 4 small soft drinks, 2 small beers, 4 hot dogs, 2 programs, parking, and 2 adult size caps. As an example, the 2011 average MLB FCI was $197.35 with the average ticket price at $26.91 and premium ticket average at $85.16. (TMR 2011)

**Advertising and Naming Rights**

Advertising and naming rights have historically been a strong revenue stream for ball clubs. A typical club can secure 20 to 40 year contracts paying $1 million to $3 million per year. Larger markets can command much more: recently the New York Mets received $400 million for the naming rights to their stadium. (Jacobson 2008) Other contracts such as the Milwaukee Brewers teaming with Miller Brewing had a one-time $40 million payment to name their ballpark Miller Park. (Rafool 1997)
Major League Baseball Attendance

“If people don’t want to come to the ballpark, how are you going to stop them?” – Yogi Berra

Attendance at MLB games is a heavily researched topic. Most research seeks to understand how particular factors affect attendance and by how much. Because attendance is such a significant component of club revenue, it is not surprising that a wide variety of potential effects have been considered.

Non Ballpark Effects

Recent research has studies related to effects such as; dominant ball clubs, star players, static or dynamic lineups, USA terror alert level, the American League’s designated hitter, and promotional giveaways on game day. (Lemke, Leonard, and Thlokwane 2010)(Kalistr 2010)(Cooley 2010) (Coates and Humphreys 2005; Schmidt and Berri 2001; Schmidt and Berri 2001; M. McDonald and Rascher 2000) There are even studies indicating the fans and attendance themselves can have an effect on the team’s performance. (Smith and Groetzinger 2010) While all of these studies are interesting, most are outside of the scope of this thesis.

Ballpark Age

The facility itself and its age have been shown in some cases to have significant effects on attendance in both the short and long term. (McEvoy et al. 2005) Evidence of a historic stadium commanding strong attendance is Fenway Park in Boston, Massachusetts built in 1912. The ballpark hailed an 820 game sellout attendance streak that ended in April of 2013. (Edes 2013) A similar phenomenon has been recorded at Wrigley Field in Chicago, Illinois where the Cubs routinely report higher than normal league attendance. 2012 was considered a down year for the club, as it reported an average attendance of 35,596 compared to a league average of 30,895. (MLB 2012) On the other end of the spectrum is the so called “honeymoon effect” that describes the temporary increase in attendance that often results from a new ballpark. This effect is well studied and typically results in increases in attendance as high as 37% over 2 to 4 years (Clapp and Hakes 2005) (Coates and Humphreys 2005).
Chapter 2 - Flexibility Valuation

Uncertainty

"The pitcher is happiest with his arm idle. He prefers to dawdle in the present, knowing that as soon as he gets on the mound and starts his windup, he delivers himself to the uncertainty of the future." – George Plimpton, Participatory Sports Journalist

Uncertainty is an undeniable part of all projects, in that we are unable to predict future events. As such, any forecast or prediction being used in the planning of a project is inherently wrong. While present in all projects, the effect of uncertainty is especially challenging in the development of long term structural engineering projects such as ballparks, airports, or skyscrapers. When designing for long time horizons the engineer must attempt to plan for many unforeseeable events such as changing or new demands, new policy, environmental changes, and technological evolution. (Chambers 2007)

The reality is that any future circumstance, either due to the nature of the event or the magnitude, has the ability to dramatically change a project’s performance and in some cases rendering the structure obsolete. ([de Neufville et al. 2013]

One needs to look no further than most major metropolitan airports to see evidence of systems nearing obsolescence. The typical ticketing area is gradually seeing more automated kiosks and as a result more unstaffed agent counters. Certain runways were not designed to handle the increased takeoff distances, landing distances, or masses of modern airliners and thus are seeing less traffic. (de Neufville 2006)

Since future uncertainty can neither be completely known nor controlled it becomes increasingly important to plan for ways of dealing with it. The strategy employed and discussed in this thesis is flexibility in projects. By intentionally and proactively designing in flexibility we can engineer systems that can limit our downside exposure while also increasing our upside potential.

A basic ballpark example can illustrate the concept. Assume that MLB granted an expansion team to be located in Mexico City, Mexico on a 20 year commitment and that the national government is planning to build a new ballpark to host the club. Clearly there would be significant uncertainty surrounding a whole host of ballpark design variables; capacity, policy, attendance, weather, ticket prices, concessions prices, long term team viability, and parking to name a few. Focusing on the size and capacity of the ballpark one can imagine how building too small or large of a park could substantially limit the financial performance of the club by either capping revenue or having high overhead. One possible strategy could be to use a flexible design that would be initially constructed with a more conservative capacity, but allow for expansion in the future if demand justifies it.(Guma et al. 2009) Another strategy might involve designing the structure so that it could be converted to house a soccer field (football pitch) if future circumstances demand such a change.

The point of the example is to illustrate that the design circumstances and specifications of today will likely not be what is needed in the future and that there are ways of dealing with this uncertainty proactively. ([de Neufville, Lee, and Scholtes 2008])
It is also important to recognize that while the flexible design options available are effectively infinite, the flexible options that can actually be executed in a project are limited because they come at a cost. The issue then becomes how to evaluate or determine which flexibilities are likely to be beneficial and which are not.

**Flexibility**
When considering flexibility for a project it is important to understand the value it may add or subtract. This value can of course have upside or downside potential on a variety of project aspects, but the most commonly tracked are the initial or upfront investments and the short and long term financial prospects.

**Real Options**
To aid in this discussion of flexibility valuation it is important to understand that we are dealing with Real Options. (“Exploiting Uncertainty” 1999) A real option is basically a choice or flexibility available that usually involves a tangible asset, thus the term real. Real options should not be confused with a financial option, which is typically defined as a security that gives the right to buy or sell an asset, subject to certain conditions, within a specified period of time. (Black and Scholes 1973) It is important to note that the right to buy or sell that an option provides is obtained at a cost, and of course is subject to the existence of a readily available financial market for these instruments. While a real option certainly has some cost associated with the choices or flexibility it provides the executor, there typically is not a direct market for their sale or trade.

The primary benefit an option of any type provides is that of a choice. In actual circumstances this choice is in fact often the deferral of decision. As discussed prior, our inability to predict the future and the ever present of uncertainty can sometimes mean that there is tremendous value to delaying a decision until new information is available. (R. McDonald and Siegel 1986) In the prior ballpark example, there is potentially value in delaying the expanded capacity decision until after we have seen a few years of actual demand. Of course, this option or deferred decision would come at some cost.

There are two main types of real options, those that are acted on projects and those that are enacted in projects. (Wang and de Neufville 2005a) The difference between these two types of options appears subtle, but in reality is dramatic in both technological scope and execution.

**Real Options On and In Projects**
A real option on a project in its most basic form is simply deciding to proceed with an investment or not. (Wang and de Neufville 2005b) In more advanced forms it can involve securing the rights to acquire, divest, expand or contract various aspects of a project in the future. (Chambers 2007). Continuing with the Mexico City ballpark example, one possible real option on the project might be to secure a contract with the city that would allow the ballclub to buy land adjacent to the ballpark for the purpose of constructing a parking garage at a prescribed price at any point in the next 10 years. Initially the ballpark would rely on local or street parking, but at any point the club could exercise their option to purchase the land and build a parking structure if they deemed it appropriate.
A real option in a project is typically some type of flexibility designed into the project and as a result is often much more complex. Since virtually any design variable in a system can lead to some form of a real option in the system they can vary greatly in both scope and type. (Wang and de Neufville 2005b) This is an important distinction between in and on, because while real options on projects require little to no technical knowledge of the system, real options in projects often require extensive technical expertise and knowledge of the system in question. Some differences between these options are shown in Table 3. An example of a real option in the ballpark example project would be to build an attached parking garage that matches the current capacity, but has the ability to be expanded. (de Neufville, Scholtes, and Wang 2006) This could be accomplished through building a reinforced foundation and structure capable of 8 levels, but initially only building 4 levels. (de Neufville, Scholtes, and Wang 2006)

In the future the ballclub has the option of adding on additional parking levels to increase the parking capacity of the structure. An example of this type of strategy is shown in Figure 2, where the Court Squares Two building is shown with Phase I and Phase II.

Figure 2 - Court Square Two by Kohn Pedersen Fox (Pearson and Wittels 2008)

Reviewing the two hypothetical examples above, it is easy to recognize that both the in and on option are essentially deferring a decision; however they are doing so in very different ways. The on option is fairly easy to define and value. The in example is much more complex and requires in-depth knowledge of the structural design and some future planning scenarios in order properly design the flexible option into the system. Neither is better or worse, they are just different tools available to the engineer or planner to help combat uncertainty.
Flaw of Averages

A common tactic for dealing with future uncertainty is to utilize averages. The conventional wisdom is that if a project uses averages for their inputs, some will be a little low, others will be a little high, but in the end everything will sort of balance out. The problem with this type of heuristic is simple, it is wrong.

First it is important to recognize that by using averages a project is essentially making a forecast. That forecast is predicting that the future will be of average values. It is peculiar that although it is widely accepted that forecasts can be useful but are always wrong, for some reason an average is often treated as a sound estimate of some future circumstance void of major uncertainty.

Beyond the fact that it is highly unlikely that the future will transpire with all of the projects relevant factors being average, it is important to recognize a second major effect of this flawed logic; the fact that average inputs does not guarantee average outputs. In practice this is known as Jensen’s Inequality and is applicable if the function is convex and where $E(x)$ is known, Equation 1.

$$F(E(x)) \neq E(F(x))$$

Equation 1 - Jensen's Inequality

As a hypothetical example of how using averages can lead to sub optimal decisions and outcomes, consider the Minnesota Twins preparing to build a new ballpark in the late 1970’s and early 1980’s. Had the Twins adopted a strategy in ignorance of Jensen’s Inequality they may have opted to build a ball park suited to hold an average attendance. To calculate this they could have looked at historic data and calculated an average annual attendance. Doing so for the time period of 1961 to 1981 for both the American League and the Twins yields the results in Table 4. Both values are similar, around 1 to 1.1 million. Using a typical home schedule of 81 games that equates to a ball park with roughly 13,000 seats assuming every game sells out.

<table>
<thead>
<tr>
<th>Table 4 - Average American League and Twins’ Attendance (1961 - 1981)</th>
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<tbody>
<tr>
<td>Average American League Attendance (1961 - 1981)</td>
</tr>
<tr>
<td>Average Twins Attendance (1961 - 1981)</td>
</tr>
</tbody>
</table>

The Minnesota Twins did not build a facility with an annual capacity of 1.1 million, instead they built the Hubert H. Humphrey Metrodome with an annual capacity of about 3.7 million and a
per game baseball capacity of 46,564. As a result we have access to data showing that in many years the demand far exceeded the average attendance shown in Table 4. Figure 3 shows the annual attendance for the Minnesota Twins from 1982 to 2009 with the Twins’ 1961 to 1981 average attendance denoted by the grey dashed line at roughly 1,000,000.

![Figure 3 - Minnesota Twins' Attendance vs. Year (1982 - 2009) with (1961 - 1981) Average Attendance Reference Line](image)

Further investigation of Figure 3 shows that in one year the attendance was actually about three times the previously stated average and all but 2 of the 27 years shown exceeded the average.

Sam Savage has written extensively on this type of ill thinking, and coined the term *flaw of averages* to describe it. It is Savage’s opinion that this type of flawed thinking is what continually gums up investment management, production planning, and other seemingly well-laid plans. (Savage 2002)

---

2 It should be noted that this is a simplified hypothetical example. The Hubert H. Humphrey Metrodome was built to host both the Minnesota Twins and the Minnesota Vikings. This simplified example does not take into account the potential demands of the Viking’s attendance.
Simulation and Modeling

“It’s tough to make predictions, especially about the future.” – Yogi Berra, MLB Player and Manager

Accepting that forecasting and utilizing averages are flawed methods of designing systems we then propose an approach that offers increased utility for the engineer seeking to make valuation decisions with regard to flexibility in systems.

While numerical modeling can take many forms, the modeling being referred to in this thesis is the most typical form where a series of inputs, equations, decision points, and outputs are linked together using a program such as a spreadsheet.

Additional detailed discussion of modeling will occur in later sections, but it should be recognized that in general it is important to adequately size and scale the scope of the models being used. Failure to limit the model’s scope to the relevant factors necessary to make value based decisions can result in unnecessary complexity and even reduce the usability of the model.

Once a model of the system in question is established it is then possible to utilize simulation to capture some of the effects future uncertainty may have on it. Recognize that the prior discussions of analysis that would succumb to the “flaw of averages” would likely utilize the same model, the difference being that the user would be entering average values instead of inputs containing uncertainty via stochastic variables.

Monte Carlo Simulation

The simulation form emphasized in this analysis is Monte Carlo. The Monte Carlo simulation method was pioneered at Los Alamos laboratory during World War II. It was born out of necessity as scientists sought to understand the fusion occurring in nuclear weapons. They were increasingly trying to cope with differential equations that they were unable to solve and processes they were unable to experimentally observe. Essentially by using random numbers engineers could simulate a stochastic process that was too difficult to solve. The Monte Carlo simulation soon became a preferred alternate reality where virtual experimentation could be conducted. (Galison 1997)

The way Monte Carlo simulation works is to have a model with inputs and outputs defined and rather than just putting a static value or possibly a few defined scenarios into the model the engineer populates the model with stochastic variables and records the output. This process is then repeated until they are confident they understand the range or distribution of likely outcomes. The main costs associated with running this type of simulation is the construction of the model, establishing variable distributions, and computation time. Over time, Moore’s Law has helped contribute to an ever increasing computation speed and decreasing computation cost. (Moore 1965) This trend has allowed the number of runs being typically performed in Monte Carlo simulations to increase at a similar rate. It is quite common for even average users to perform millions of runs in a basic simulation.

The mechanics of a Monte Carlo simulation are quite simple, but should not detract from its power as an analysis tool. The following simple example is being used to illustrate how a Monte Carlo simulation works. Suppose we wanted to understand how ballpark revenue was affected
by the percent capacity utilization and average annual ticket price. We could construct a very simple model represented by the transfer function Equation 2.

\[ R = C \times U \times T_p \]

\[ R = \text{Revenue} \]

\[ C = \text{Annual Ballpark Capacity} \]

\[ U = \text{Annual Percent Utilization} \]

\[ T_p = \text{Average Annual Ticket Price} \]

**Equation 2 - Simple Ballpark Revenue Model**

In a spreadsheet the same model may look something like Figure 4. A typical non-stochastic simulation would likely define a few different scenarios and determine the related annual revenues. The most likely scenarios used are likely to be the worst-case, the best-case, and the average case. While this is better than simply performing the average case, it does not capture the probabilistic nature or distributive nature of the various revenue outcomes.

![Figure 4 - Simple Ballpark Revenue Model from Spreadsheet](image)

To capture this behavior we must treat \( U \) and \( T_p \) as stochastic variables by defining a distribution from which the Monte Carlo simulation can select values. Then we run the simulation a desired number of times and plot the resultant output values as a distribution or as a cumulative distribution function (CDF). To complete this task the spreadsheet model may take a form similar to Figure 5.

![Figure 5 - Simple Ballpark Revenue Model from Spreadsheet with Stochastic Variables](image)
To illustrate the process of successive runs, Figure 6 shows what is happening with each successive run. The first run is shown in black dots and black lines. Annual Ballpark Capacity is of course 50,000 because it is a constant, next the simulation randomly chooses an Annual Percent Utilization from the defined triangular distribution, in this case 0.9 or 90%, next the simulation chooses an Average Annual Ticket Price, for run 1 it is $32, and finally it uses these values to calculate the Annual Revenue. Run two is shown in grey dots and grey lines, this run has the same capacity because it is a constant, but different utilization and pricing values because those are stochastic variables, and because the values are different the calculated revenue is of course different.

Figure 6 - Simple Revenue Model Monte Carlo Simulation Showing Two Runs
Histograms and Cumulative Distribution Functions
If the simulation is completed for a total of 10,000 runs it then becomes possible to create the histogram shown at the bottom of Figure 6 or the Cumulative Distribution Function (CDF) shown in Figure 7. Notice that Figure 6 and Figure 7 are not smooth, that is because they are generated from the 10,000 discrete data points. Increasing the number of runs in the simulation would smooth out the curve, but often this is not necessary to draw the desired conclusions.

![Cumulative Frequency vs. Annual Ballpark Revenue (USD)](image)

Figure 7 - Simple Ballpark Revenue Model Cumulative Distribution Function

Value at Risk and Gain (VARG)
The histogram and the CDF are particularly powerful outputs of the simulation, because unlike the typical average or scenario model outputs, these plots help the engineer understand the probabilistic outcomes of a wide variety of scenarios. To help users make decisions and draw conclusions from this type of information it is typical to utilize Value at Risk/Gain, commonly referred to as VARG. VARG defines a confidence level to the simulations outputs which can help to establish a floor and ceiling for loss and gain. Value at Risk (VAR) is a common term used in financial analysis that refers to an amount that may be lost and an associated probability. Value at Gain (VAG) is complimentary to VAR as it describes what stands to be gained and the associated probability. (de Neufville and Scholtes 2011) As an example Figure 7 was recreated in Figure 8 with the 10% VAR and 90% VAG highlighted. As can be seen in the chart there is a
90% confidence that the value will be at or below about $1.75 million and a 10% confidence the value will be at or below about $1.10 million. Finally, it is important to note the 8% difference between the average value obtained by simply putting the perceived average values into the model, $1.572 million, and the average of the Monte Carlo simulation, which was $1.447 million.

Figure 8 - Simple Ballpark Revenue Model CDF with VARG

Figure 9 shows a comparison of the deterministic (average case) versus the stochastic (Monte Carlo simulation). Even though this was a very simple hypothetical example differences between the two methods emerged. Also, while the deterministic approach gives no indication of potential upside or downside results, the stochastic delivers a VAR and VAG (Figure 9).

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>90% VAG</th>
<th>10% VAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterministic</td>
<td>1.573</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Stochastic</td>
<td>1.447</td>
<td>1.738</td>
<td>1.136</td>
</tr>
<tr>
<td>Difference</td>
<td>125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Difference</td>
<td>8.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 9 - Comparison of Deterministic and Stochastic Models (Millions USD)
Additionally the CDF is particularly adept at comparing various strategies. Figure 10 shows a CDF of two different ballpark designs and their results from the Monte Carlo simulation. It is obvious even with minimal inspection that the dashed line represents a higher revenue producing strategy at virtually every outcome.

![Figure 10 - Simple Ballpark Revenue Model CDF Showing Comparison of Scenarios](image)

**Conclusion**

The previous sections have shown how uncertainty is an important aspect in projects. Forecasting and scenario planning based upon average conditions is simply not adequate to develop engineering systems that are able to add value and adapt to changes over long time horizons. Flexibility in and on systems are useful tools for coping with uncertainty. Stochastic simulations, such as Monte Carlo, are excellent tools for evaluating systems with and without flexible options. The output of these simulations can be used to generate probabilistic distributions such as histograms or CDF’s to help engineers understand the expected value, VAR, and VAG for a given system. In the sections to follow we will see these tools applied to various ballpark analysis involving flexible and non-flexible designs.
Chapter 3 - Major League Ballparks

Brief History
The first ballparks began to appear in the United States in the late 1800’s. As the sport gained in popularity new ballparks replaced the old and gradually over almost 150 years evolved from utilitarian structures in open fields to billion dollar monuments to America’s pastime. This section explores the various eras of ballpark design, trends regarding capacity and costs, as well sources of uncertainty in ballpark design.

Ballpark Eras
"Let me get this straight. We’re bulldozing real vintage ballparks like Tiger Stadium and Fenway Park to put up fake vintage ballparks?" - Rich Reilly, writer for Sports Illustrated

In 2013 Rob Neyer of Baseball Nation defined the latest paradigm in ballpark construction and described the prior ballpark eras. This approach is similar in form to the way MLB is often described over time, categorizing blocks of time by some common trait. For instance, the Dead Ball Era (1901-1919) defined mainly by the low number of runs and homeruns due to questionable pitching practices and the reuse of baseballs in games. Similarly, the Free Agency Era (1977-1993) defined by the player’s bargained right to free agency which resulted in dramatic increases in salaries and movement among lineups. In terms of ballparks, Neyer suggests 5 distinct eras; Utilitarian Era, Classic Era, Multipurpose Era, NeoClassical Era, and the Commercial Era, shown in Figure 11. (Neyer 2014)

Figure 11 - Timeline Depicting Major Ballpark Eras (1876 - 2010)
Utilitarian Era (1876-1908)
The utilitarian era was exactly as the name suggests, ballparks were created with little to no budget and very little planning for the future. Most were constructed in open fields with grandstands and fences made of wood. West Side Park in Chicago, Illinois shown in Figure 12 is an example of a utilitarian park. Other examples from this era include Sportsman’s Park in St. Louis, Exposition Park in Pittsburgh, Baker Bowl in Philadelphia, or the Huntington Avenue Grounds in Boston.

Figure 12 - West Side Park in Chicago, IL (“Chicago Daily News” 1906)

Classic Era (1909-1960)
The classical era is by far and away the most beloved era of MLB. It is this era that produced jewels such as Fenway Park in Boston (Figure 13), Ebbets Field in Brooklyn, Wrigley Field in Chicago, and the original Yankee Stadium in New York.

Figure 13 - Fenway Park in Boston, MA (Vincent 2008)
During this era utility gave way to architecture and style. This is the time when the ballpark ceased to be simply a place to watch men play baseball and became cathedrals that showcased America’s beloved pastime. Two of the most recognizable examples of classical era ballparks, known to all as simply Fenway and Wrigley, still survive today and are home to the Boston Red Sox and the Chicago Cubs.

**Multipurpose Era (1964-1988)**

The Multipurpose Era produced baseball’s most abhorred ballparks. This era characterized by efficiency and function resulted in millions of fans who preferred to listen or watch their team via broadcast rather than in person. The bland, artificial, and often domed facilities of this era may have been prudent investments, but they did little for the imagination. Figure 14 shows the Metrodome in Minneapolis, MN.

![Hubert H. Humphrey Metrodome in Minneapolis, MN](Mingo 2006)

Notice in Figure 15 how center field and right field are made of bleachers folded vertically that can be rolled out onto the field when football games are played. Just as little effort was made to hide the excess bleacher eyesores, little attention was paid to the artificial field which despite
being prep for a baseball game clearly shows evidence of an end zone and yard markers for football.³

Figure 15 - Metrodome Outfield Folded Seats

**NeoClassical Era (1989-2009)**

In 1989 Camden Yards in Baltimore, MD opened ushering in the NeoClassical Era. This beautiful ballpark, Figure 16, was clearly modeled after the gems of the Classical Era with retro architecture, unmistakable nuances, and character.

Figure 16 - Camden Yards in Baltimore, MD (Allison 2013)

³ Note the yard markers and 10 yard lines near the third base sliding zone and the large alternating dark to light pattern throughout the outfield. This alternating pattern is not a groomed turf design as is commonly seen in outdoor ballparks, these are the alternating 10 yard sections of a football field still visible.
Many attribute this single ballpark for the rush of construction that followed in the 1990’s and early 2000’s. While certain styles and architecture are clearly evident in this era, it is important to note that a return to natural playing surfaces was also a major component. Even ballparks that have covered playing surfaces, such as Miller Park in Milwaukee, WI, opted for a retractable roof accommodating natural turf (Figure 17).

![Figure 17 - Miller Park in Milwaukee, WI (Jannene 2005)](image)

**Commercial Era (2010–)**
What followed the NeoClassical Era should come as no surprise to anyone in tune with modern societies thirst for material things, endless media, and emphasis on experiences. We are currently in the Commercial Era, where ballparks still exhibit impressive architecture and style, the fields are still natural and manicured, but the whole scene has much more going on and it was not an accident. The additions to the modern Commercial Era field are impressive levels of advertising, attractions that go far beyond just the game on the field, and a whole host of amenities designed to extract as much money as possible from every person in attendance. A prime example of a Commercial Era ballpark is Citi Field in New York, NY (Figure 18).

![Figure 18 - Citi Field in New York, NY (Canam 2011)](image)
Some of the additional revenue producing ballpark features at Citi Field include increased numbers of concession and merchandise locations, five main corporate sponsored restaurants and clubs (Delta Sky360, Hyundai Club, Acela, Caesars, and Promenade), a hall of fame and museum, and the Metropolitan Hospitality venue that caters to a variety of large events (corporate meetings, trade shows, fundraisers, parties, proms, weddings, etc.).

**Ballpark Trends Over Time**

“The most beautiful thing in the world is a ballpark filled with people” – Bill Veeck Major League Baseball Franchise Owner

With over a century of data to analyze, there are some interesting long-term macro trends apparent in the construction of Major League ballparks. These trends primarily relate to the size and cost of the ballparks being built.

**Narrowing of Capacity**

Figure 19 shows the capacity at time of construction or conversion versus year built from 1871 to 2012. It is important to note that many of the facilities included in this data were multi-use. An example is the Los Angeles Memorial Coliseum. It was originally opened in 1923 as a football stadium for the USC Trojans, used for the 1932 Summer Olympics, and later was home to the Los Angeles Dodgers for four seasons from 1958 to 1961. This is a notable example because the Los Angeles Memorial Coliseum has the largest capacity in the data set at over 93,000 seats.

Figure 19 shows a clear trend of narrowing capacity over time. In the 1950’s and 1960’s there was a difference of over 70,000 seats between the smallest and largest completed ballparks. In the 1990’s and 2000’s this difference had shrunk to only 15,000. The implication of this trend is that the modern ballparks created in the last 20 to 30 years are all within a very small band of capacity ranging from about 35,000 to 50,000 seats. Figure 20 shows the 24 ballparks constructed since the 1990’s and illustrates this very narrow band of capacity.
Figure 19 - Stadium/Ballpark Capacity vs. Time (1871 – 2012)

Figure 20 - Stadium/Ballpark Capacity vs. Time (1990 - 2012)
One possible, but likely incorrect, reasoning for this narrow band of ballpark capacities is that only large cities of a certain population host MLB. Therefore the population range of these cities asserts a certain demand and that matches the sizes of these ballparks. Figure 21 shows 24 MLB opened between 2012 and 1991 plotted against their host city and surrounding area’s population. As the chart shows there is in fact a very large range in population, or market, of roughly 1 million to 20 million, yet the ballpark capacity is fairly flat following the 40,000 to 50,000 band across the entire population range.

Cost of Ballparks
The overall cost of Major League ballparks has been on the rise for over 30 years. Figure 22 shows the construction costs for the last 24 Major League ballparks when adjusted to 2012 dollars. Note the steady increase over time and the most expensive ballpark to date Yankee Stadium (III) at about $1.7 Billion dollars (2012 USD).
The rising overall cost of the parks is only part of the story. Previously we have seen that these 24 new ballparks are all within a very small band of capacity, so as Figure 23 shows, it is not simply a matter of larger stadiums costing more. It shows that the cost per seat is exhibiting near exponential growth over time, which indicates it is something other than capacity driving the costs up.

While many factors are contributing to the rising cost per seat, one of the largest is that specialty or unique amenities are now becoming commonplace and built into ballparks. Many of these amenities are discussed in previous sections, but include features like a retractable roof, more comfortable seating, luxury boxes, water falls, gathering spaces, atriums, restaurants, little league fields, children’s amusement areas, and even private clubs. All of these and many more are items that add cost to ballparks and thus drive up the per seat cost of the facility.
The current state of ballpark construction is clearly focusing on the fan experience. That does not just mean the fan’s ability to comfortably view the game being played; it also means providing a comfortable, memorable, and multi-faceted experience. Comfort is being added through features like wide walkways, additional restrooms, specialized seating, climate control, additional attractions, aesthetics, shopping, and mass transportation options. Additionally, the importance of efficiency and attention to the environment has gained popularity with some ballparks now attaining LEED certification.

The consequence of this change in focus is cost. As shown in Figure 22 and Figure 23, the trajectories of overall cost and cost per seat are increasing dramatically, and given the current appetite for sports venues of all types it is showing very little indication of slowing. Figure 24 shows the number of new ballparks opened by decade since 1980. With 30 total teams in the league and 24 new ballparks in the past three decades there likely will not be many new MLBs in the next 10 to 20 years, but there are likely to be a significant number of Minor League Ballparks and stadiums for other sports that may be affected by similar trends.
Sources of Uncertainty

“You can say, ‘Well, if they tore down Fenway Park, we can build a new one.’ But you wouldn’t build it right. It’s better to make the accommodations, to save the old ballparks. If Fenway Park needs sky boxes to bring in the poverty-stricken owners enough money to save the stadium before they tear it down and move it someplace else, then build the damn sky boxes. If Wrigley Field needs lights to survive, put up the damn lights…. Make the damn structural improvements, but save the ballpark because when you try to rebuild a cathedral five hundred years too late, it doesn’t come out the same.” - Tom Boswell, Sportswriter

On the surface a Major League Ballpark seems like a reasonably straightforward project, but as described in prior sections, under the surface there are a wide range of variables that contribute to the overall uncertainty. Many of these sources of uncertainty can dramatically impact the financial success or ruin of these facilities.

The sources of uncertainty that are the focus of this thesis are those related to the financial impact of the ballpark and are related to its’ design. For instance, typical major sources of uncertainty for any ballpark are attendance levels, ticket and concession spending, construction costs, luxury amenity spending, and parking. Additional sources of uncertainty that are larger
in scope are the changing expectations and uses of ballparks and stadiums. In prior sections we have seen that in the last 100 years MLB have gone through 5 main eras.

Figure 25 - View of Miller Park from the Soon to be Demolished County Stadium

These eras are indicative of changing values, expectations, and needs of ball clubs, fans, and the cities where the structures are located. In fact, history has shown over and over that a facility that is unable to adapt to new times is typically demolished and replaced, such as County Stadium shown in Figure 25 with Miller Park being constructed in the background and Figure 26 that shows the new Busch Stadium being constructed adjacent to the old Busch Stadium. It is then clear that a ballpark’s ability or inability to change with the times can have a dramatic effect on its long term financial outcomes.

Figure 26 - Old Busch Stadium Left and New Busch Stadium Right
An uncertainty that has been the source of numerous roof debates is weather. A ballpark’s ability to control or limit the effects of weather on both the game being played and the fan’s comfort can impact their revenue. There are three primary ways teams have opted to respond to this uncertainty; eliminate it by fully enclosing their facility, deal with it by installing a retractable roof, and acknowledging but accepting it. Each of these has its own financial implications and will be addressed in the modeling and analysis sections.
Chapter 4 - Valuation of Flexibility in Ballparks

The MLBPs have clearly had a long and storied history. Spanning well over a century and evolving through 5 major eras, the vast majority of ball clubs have remodeled parks, expanded parks, torn them down, relocated, and often built brand new parks.

While politicians, planning committees, and club owners have promised renewed downtown vibrancy, attracting new talent and improved amenities the real reason for building a new ballpark is almost always financial. While many fans and cities would proudly state “their team,” the fact remains that every Major League ballclub is a privately held business driven by the bottom line. (Long 2012)

Understanding that ballclubs and the ballparks they do business in are there to generate profits; the only sensible way to evaluate various ballpark projects is through financial output. The following sections propose a variety of flexible ballpark options designed into the parks. In the first two cases, the proposed alternative designs are compared against the actual completed park over an appropriate time horizon. In the third case, a scenario involving a specific ballpark amenity is analyzed. Key factors such as capacity, luxury boxes, and roof considerations will be compared.

Evaluation Method

“I could have played another year, but I would have been playing for the money, and baseball deserves better than that.” - George Brett, MLB Player

The evaluation method used in this analysis is a Monte Carlo based Discounted Cash Flow (DCF) method. The duration of the DCF will be 30 years. A variety of inputs to be discussed in later sections are fed into the model to generate annual revenue numbers for the ballpark. These revenues are then balanced with costs and a net annual discounted value is determined for each year in the simulation.

While it is recognized that DCF’s can be dramatically impacted by the discount rate used, in this evaluation every project variant is being compared against the same time horizon in an A to B fashion and a fairly typical 10% rate is used.

Since the DCF is being run as a Monte Carlo, the outputs are a collection of runs displayed as a distribution in the form of a CDF. Very specific measurements are then compared for each case, such as the 30 year expected Net Present Value (NPV), 10% VAR, 90% VAG, and the Value of Flexibility. In addition to the simulation, a deterministic run will also be calculated and compared when applicable.

Inputs, Outputs, and Decisions

The models being simulated will use a variety of inputs ranging from design variables, contextual factors, and flexible factors. Figure 27 depicts these inputs and outputs in a boundary diagram. The main contextual input and output factors are shown. The main system, being the ballpark design, is shown with the key design and flexible variables. Finally, the main outputs of the design are shown as NPV which feed into the simulation generating the CDF’s.
The main decisions to be made from the simulations are which flexibilities add value to the system. Those that do add value can then be further considered in the final project design and planning. As an example, suppose we wanted to build the ballpark without a roof, but wanted the flexibility to add the roof at a later date. The model and simulation will allow us to compare different designs with varying design variables and decision points to ultimately establish how much value the roof flexibility will add or detract from the project. There is really no limit to the number of design characteristics, variables, and decision points that can be tested.

**Selection of Case Studies**

The case studies used in this analysis were chosen to offer both breadth and perspective while using current and relevant projects. Target Field, the home ballpark of the Minnesota Twins was chosen because it represents a small to medium sized market. Additionally, the location and budgetary constraints of the project forced some interesting decision making, such as the decision to forego a roof or retractable roof option. Yankee Stadium III in New York was chosen because it represents a very large market and to date is the most expensive ballpark in the league.
The Minnesota Twins and Target Field

“I didn’t like The Astrodome or any of the Astro-Turf fields. Probably my worst ballpark was The Met in Minnesota; I hated that place. I was so glad when they tore that place down, you have no idea.” - Rollie Fingers, MLB Relief Pitcher

**History of the Twins and their Ballparks**

The Minnesota Twins entered MLB in 1961 as part of a relocation and expansion deal with the Washington Senators. The Twins moved into the existing Metropolitan Stadium, known as “the Met,” Figure 28. Metropolitan Stadium had been the home of the Minneapolis Millers, a minor league American Association baseball team and was an outdoor bleacher style stadium built on farmland south of the Twin Cities in Bloomington, MN.

![Image of Metropolitan Stadium](image)

**Figure 28 - Metropolitan Stadium (“Metropolitan Stadium” 2014)**

During the Twins’ time at the Met, the stadium underwent 3 main expansions which increased its capacity from 30,637 in 1961 to 45,914 in 1970, shown in Table 5. The Twins played in Metropolitan Stadium through 1981 when the Hubert H. Humphrey Metrodome was completed.

<table>
<thead>
<tr>
<th>Metropolitan Stadium Capacity 1960 - 1970</th>
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</thead>
<tbody>
<tr>
<td><strong>Year</strong></td>
</tr>
<tr>
<td>1960</td>
</tr>
<tr>
<td>1964</td>
</tr>
<tr>
<td>1970</td>
</tr>
</tbody>
</table>
In 1982 the Twins began playing in the Hubert H. Humphrey Metrodome, Figure 29. This stadium is a quintessential Multi-Purpose Era structure. It is a domed facility with artificial playing surfaces and was designed to easily convert from football to baseball. As such, it hosted not only the Twins but also the Minnesota Vikings, the local professional football team.

While initially heralded as an engineering achievement, the Metrodome quickly fell out of favor with baseball fans who longed for outdoor baseball played on real grass. With facility criticisms aside, it is important to note that the Minnesota Twins enjoyed tremendous success while playing in the Metrodome capturing two World Series victories (1987 and 1991).

**Governor’s Call for Proposals**

While genuine talk of a new ballpark had been going on since at least 1997 when Senator Janezich introduced legislature to fund a ballpark, it became very real in 2003 when the Governor of Minnesota, Tim Pawlenty, announced a call for ballpark proposals from cities, counties, private developers, and other interested parties. Janezich 1997), Janezich 1997), McCormack and Hove 2005), McElroy 2003) This proposal acknowledged that this was a preliminary call for ideas and specifically not a call for bids. Despite the seemingly premature nature of the document, it states that the Twins have requested a ballpark of approximately 40,000 seats. This document was issued on November 4th, 2003 and showed that proposals are due by 4:00pm on January 15th, 2004, approximately 50 working days later. It also states that 2 weeks later on February 2nd, 2004 reviews of the proposals will be complete and a recommendation will be passed onto the governor.
**The Twins Proposal**

On January 6th, 2004, about a week before proposals were due to Governor Pawlenty the Minnesota Twins gave a special presentation to the Governor outlining their needs and vision for a new ballpark. (Bell 2004) This 92 page document outlines many of the key decision-making factors and some of the rationale used to convince others included the statement:

“A new Twins ballpark *is the only way for Minnesotans to continue enjoying this competitive and affordable family entertainment for generations to come.*”

A common question facing the Twins organization with respect to the proposed ballpark was why now? The document very succinctly gives three primary reasons, shown in Table 6.

**Table 6 – Twins’ Response to "Why now?"**

<table>
<thead>
<tr>
<th>Reasons to Build a new Ballpark Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take advantage of low interest rates</td>
</tr>
<tr>
<td>Avoid future cost of inflation</td>
</tr>
<tr>
<td>16 new ballparks since 1990 in the league</td>
</tr>
</tbody>
</table>

The Twins then go on to describe their vision for the ballpark and factors that would make it a workable solution from their perspective. Of the 5 characteristics of a workable solution stated in Table 7, the most relevant to this case study are the need for financial efficiency and prompt construction. It is clear that the organization wants a ballpark that will achieve financial success and not be stymied in negotiations for years to come.

**Table 7 – Twins’ Criteria for a Workable Ballpark Solution**

<table>
<thead>
<tr>
<th>Characteristics of a Workable Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financially efficient structure</td>
</tr>
<tr>
<td>Private sector participation must consider several variables</td>
</tr>
<tr>
<td>Detailed negotiations should be left to the team and host community</td>
</tr>
<tr>
<td>Should allow for prompt construction</td>
</tr>
<tr>
<td>Legislation should not contain unachievable conditions</td>
</tr>
</tbody>
</table>

The Twins further the discussion by then proposing their vision for the new ballpark. The highlights are summarized in Table 8, and contain many of the attributes and amenities discussed prior.
Table 8 - Twins' Vision for a New Ballpark

<table>
<thead>
<tr>
<th>Vision for New Ballpark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tradition: Baseball and the great outdoors</td>
</tr>
<tr>
<td>Express Minnesota's natural beauty</td>
</tr>
<tr>
<td>Environmentally sensitive</td>
</tr>
<tr>
<td>Fans' dream</td>
</tr>
<tr>
<td>Twins' Walk of Fame and Museum</td>
</tr>
<tr>
<td>Fan-friendly amenities</td>
</tr>
<tr>
<td>Retractable roof</td>
</tr>
</tbody>
</table>

In addition to the lists shown above, the Twins also came prepared with architectural renderings of the facility they envisioned being built, shown in Figure 30 through Figure 33. The drawings clearly show a retractable roof, wide-open atriums, a variety of amenities, and a natural turf playing surface.

Figure 30 - Rendering of Twins' Vision for New Ballpark
Figure 31 - Rendering of Twins' Vision for New Ballpark

Figure 32 - Rendering of Twins' Vision for New Ballpark
With all of the detail and attention paid to this lengthy presentation it is not surprising that specifics about the ballpark are also included in the material. Relevant to this analysis are the discussions of attendance, which are of course in direct relation to future ballpark capacities. Slide 54 of the presentation titled “What Should the Twins' Attendance Be?” outlines the data shown in Table 9.

### Table 9 - Twins' Determination of Expected Attendance

<table>
<thead>
<tr>
<th>What Should the Twins' Attendance Be?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota Twins'</td>
<td></td>
</tr>
<tr>
<td>2003 (First Place Finish)</td>
<td>1.9</td>
</tr>
<tr>
<td>Three-Year Average</td>
<td>1.6</td>
</tr>
<tr>
<td>2003 Industry Average</td>
<td>2.3</td>
</tr>
<tr>
<td>2003 New Ballpark Average</td>
<td>2.3</td>
</tr>
</tbody>
</table>

The conclusion the Twins want drawn from this data is clear, the Twins are below the industry average attendance of 2.3 million, the average attendance of all clubs with new ballparks is 2.3 million, and therefore if the Twins had a new ballpark in 2003 they would have attendance of 2.3 million. Putting this attendance level in the context of Governor Pawlenty’s desire for a 40,000 seat ballpark, the facility would be operating at about 70% of capacity if it had annual attendance of 2.3 million. Excluding the post season, Major League schedules plan for 81 home games and a ballpark of capacity 28,395 operating at 100% capacity would achieve an attendance of 2.3 million.4

**Target Field Negotiations and Concessions**

With the new Twins ballpark gaining momentum more interested parties began to participate in the planning, and as a result more conflicts began to emerge. Most of the differences of opinion surrounded two main issues; whether or not the ballpark would have a roof and who was going

4 Calculation is made for comparison; the author is not suggesting a ballpark should be statically designed for 100% capacity.
to pay for it. The main parties engaged in these debates were the fans, Twins’ ownership, the Minnesota State Legislature, the Minnesota Ballpark Authority, and the media.

Initially many had assumed that the new Twins’ ballpark would be an outdoor ballpark with a retractable roof, similar to many recently constructed ballparks. In fact, in the years preceding the Governor’s call for proposals there had been 5 new ballparks opened with retractable roofs, Table 10.

Table 10 - Retractable Roof Ballparks

<table>
<thead>
<tr>
<th>Ballpark</th>
<th>Location</th>
<th>Year Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rogers Centre</td>
<td>Toronto</td>
<td>1989</td>
</tr>
<tr>
<td>Chase Field</td>
<td>Phoenix</td>
<td>1998</td>
</tr>
<tr>
<td>Safeco Field</td>
<td>Seattle</td>
<td>1999</td>
</tr>
<tr>
<td>Minute Maid Park</td>
<td>Houston</td>
<td>2000</td>
</tr>
<tr>
<td>Miller Park</td>
<td>Milwaukee</td>
<td>2001</td>
</tr>
<tr>
<td>Marlins Park</td>
<td>Miami</td>
<td>2012</td>
</tr>
</tbody>
</table>

The roof proved to be a divisive issue with one side claiming it’d be irresponsible to build a modern ballpark in a northern climate without a roof and the other side claiming fiscal responsibility. As shown in prior sections, the Twins organization was very squarely in favor of a retractable roof. However, as negotiations progressed the retractable roof became a sticking point. The roof was never an engineering question, it was an economic question. In fact, the President of the Minnesota Twins, David St. Peter succinctly stated in 2005:

“This is not a design issue, this is an economic issue. It is the art of the doable.”

To put the issue in financial context it is important to understand that the roof was going to cost between $90 million and $150 million. (Wikipedia 2010) (Shefchik 2010) (Aschburner 2009) (Price 2009)

The roof debate was further complicated by other financial discussions taking place. A variety of funding options were being discussed including but not limited to sales taxes, gambling taxes, private equity, and state funding. In a public report Patrick McCormack and Randy Hove stated that the proposed $438 million dollar price tag for the ballpark was not affordable using taxes and user fees. (McCormack and Hove 2005)

“It is fair to say that the proposed new Twins Stadium -- $438 million – is not affordable through tax and user fee revenue streams”

The most interesting aspect of these debates to the author is that the debate and considerations focused on either having a retractable roof or not and trimming amenities or not, there is little if any evidence to suggest that a flexible design was considered. That is, a ballpark built with the option of adding a retractable roof or amenities at a future date.
The Completed Target Field

Ultimately agreements were reached and plans secured for the construction of a new ballpark to be named Target Field and to be ready for the 2010 season, Figure 34. The Twins broke ground in August of 2007 on an open-air facility with no roof and a capacity of 39,504.5

The planned cost of Target Field was estimated to be $480 Million ($90 Million infrastructure and $390 ballpark), but in the end wound up costing $555 million ($120 Million infrastructure and $435 Million ballpark). The park is owned by the Minnesota Ballpark Authority and was funded through three main sources. The Twins funded about 35% ($195M), Target Corporation about 1% ($4.5M), and the taxpayers of Hennepin County, Minnesota about 64% ($355.5M). The taxpayer portion is being paid via a 0.15% sales tax increase in Hennepin County, MN (MBA 2014).

Figure 34 - Target Field Opening Day (MBA 2014)

Types of Modeling

As discussed prior the case study will be investigated using a Monte Carlo based DCF. In addition to this technique, a deterministic approach will also be presented. The deterministic method is being presented because there is strong evidence that many of the entities involved in the planning of the ballpark used these methods. Having this approach documented will allow us to highlight some of the differences that arise between deterministic and uncertain modeling.

5 Note the actual ballpark capacity is within 496 seats of Governor Pawlenty’s original request.
Finally, the basic completed ballpark design will be analyzed along with a variety of flexible options. These options will vary by the options being considered and the deployment.

### The Model

The model is a 30 plus year DCF that takes into account the factors shown in Figure 27 to calculate a NPV of the ballpark’s revenue. Note that the model duration is the construction period plus 30 years of operation. The model is in the form of a spreadsheet with various tabs corresponding to each of the different scenarios being analyzed (deterministic baseline, uncertain baseline, flexible options, etc.). Figure 35 shows a portion of the deterministic scenario.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Status</td>
<td>Construction</td>
<td>Construction</td>
<td>Construction</td>
<td>Operational</td>
<td>Operational</td>
<td>Operational</td>
</tr>
<tr>
<td>2</td>
<td>Year</td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td>2011</td>
<td>2012</td>
</tr>
<tr>
<td>3</td>
<td>Numerical Year</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Attendance</td>
<td>1051000</td>
<td>2300000</td>
<td>2364000</td>
<td>2410603.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ticket Price</td>
<td>$30.08</td>
<td>$32.91</td>
<td>$34.12</td>
<td>$36.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Concessions Spend</td>
<td>$20.25</td>
<td>$20.92</td>
<td>$21.61</td>
<td>$22.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Luxury Box Price</td>
<td>$3,500</td>
<td>$3,500</td>
<td>$3,500</td>
<td>$3,500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Ticket Revenue</td>
<td>$48,930,000</td>
<td>$51,631,000</td>
<td>$53,755,163</td>
<td>$88,379,333</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Concessions Revenue</td>
<td>$83,007,750</td>
<td>$84,111,975</td>
<td>$85,091,261</td>
<td>$54,385,838</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Luxury Box Revenue</td>
<td>$2,061,000</td>
<td>$2,477,017</td>
<td>$7,063,453</td>
<td>$7,201,740</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Ballpark Operating Cost</td>
<td>$(30,009,000)</td>
<td>$(32,406,408)</td>
<td>$(35,572,293)</td>
<td>$(35,542,690)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Ballpark Investment</td>
<td>$(185,000,000)</td>
<td>$(185,000,000)</td>
<td>$(185,000,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Net Value</td>
<td>$(183,000,000)</td>
<td>$(185,000,000)</td>
<td>$(185,000,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Discount Factor</td>
<td>1.00</td>
<td>0.91</td>
<td>0.83</td>
<td>0.75</td>
<td>0.68</td>
<td>0.62</td>
</tr>
<tr>
<td>15</td>
<td>Percent Value</td>
<td>$(183,000,000)</td>
<td>$(185,000,000)</td>
<td>$(185,000,000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Net Present Value</td>
<td>$(185,006,490)</td>
<td>$(188,181,638)</td>
<td>$(192,092,562)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Revenue Lost</td>
<td>$86,325,131</td>
<td>$52,493,120</td>
<td>$(51,075,223)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 35 - Snapshot of Deterministic DCF Financial Model Spreadsheet**

Other scenarios may contain additional information, calculations, and or sections based upon those particular scenarios needs. For example, Figure 36 shows a scenario with some design flexibility. That flexibility drives the need for additional cells (annual capacity, percent utilization, revenue lost, etc.) in order to assess if and when that flexibility should be exercised (retractable roof installed).
Figure 36 - Snapshot of Flexible Scenario DCF Financial Model Spreadsheet

Each of the model inputs (attendance, ticket price, concessions spend, luxury box price, etc.) used to calculate the NPV of the ballpark is fed by a host of other inputs located in the same spreadsheet (inflation rate, attendance growth rate, ticket price growth rate, seating capacity, number of luxury boxes, etc.). Some of the factors that feed these inputs are constants and others are variables. Within the variables it is also worth emphasizing that in the deterministic case they are treated as fixed values, often derived from averages.

Deterministic Approach

From the Governor’s initial 2003 call for a 40,000 seat ballpark to the Twins’ assessment of what the new ballpark attendance should be (Table 9), there has been evidence displayed that suggests a deterministic approach may have been used to evaluate many of the key design variables in the development of Target Field. The author wants to be clear that we are not condoning or suggesting the use of deterministic methods, but rather we recognize their broad use and are performing this scenario in a way that seems reasonable to assume the actual analysis may have been conducted. As a result, it serves as a useful baseline to be used later in this analysis. Additionally the results of the uncertain and flexible analysis will be normalized using the resultant deterministic value.

Typical of many modeling methods, the first step is to determine what are the key performance drivers in the system (de Neufville and Scholtes 2011). In this case, we limited our analysis to a set of ballpark specific factors: seating capacity, number of luxury boxes, ballpark cost, attendance, ticket price, concessions spend, and luxury box price. These are used to calculate
the ticket revenue, annual concessions revenue, and luxury box revenue. Finally, these revenues are balanced with ballpark operating costs and ballpark investments.

Since we are analyzing this deterministic approach over a 33 year time horizon (3 years of construction and 30 years of operation) it is necessary to establish some growth rates for the values above. To start we can look at attendance over time. Figure 37 shows the average annual attendance for the entire Major League and American League plotted with the Twins’ annual attendance. Two main conclusions that can be drawn from this plot are; first that there is an observable link between the three data sets with the Twins data having the largest variation year to year. This finding is expected as the summation of similar data from a variety of sources often has a cancelling or smoothing effect. Second, that there appears to be two distinct macro trends observable in the plot. The first trend spans from 1961 to about 1973, where attendance is relatively flat or in the case of the Twins declining. The second is from 1973 to 2007 where there appears to be evidence of growth for the league and sporadic attendance for the Twins.

![Figure 37 – Annual Attendance vs. Year](image)

Also, evident in the data are three significant MLB events; the 1972 strike, 1981 strike, and the 1994-1995 strike. The impact of these events on the league and Twins’ attendance is clearly seen in Figure 37.
There is some evidence suggesting the Twins management believed a new ballpark would change their attendance levels to be more in line with the league (Major and American) averages, see Table 9. Also, looking at Figure 37, I believe it is reasonable to utilize the latter of the two macro trends but since the Twins and the Minnesota Ballpark Authority made many of the decisions about the ballpark by 2004 we’ll use 1981 to 2003 data. Looking at the Major League and American League attendance growth rates from 1981 to 2003, Figure 38, it is clear that the two are very similar. Likewise, calculating the average value for each yields 2.89% for Major League and 2.80% for the American League. As a result, we will choose an annual growth rate of 2.8% for this scenario.

As discussed in prior sections the Honeymoon Effect is a well-documented phenomenon of new stadiums and ballparks. The average effect is about a 37% increase in the first year and then tapering off in the following years. So as not to ignore this very real boost in early attendance the deterministic analysis will apply a 37% increase for the first year’s attendance in our model.

---

*Figure 38 - Annual Attendance Growth Rate vs. Year (Major League and American League)*

Since Major League Ballclubs are privately owned businesses, certain datasets can be difficult to obtain. Luxury box attendance and demand is one of those datasets. Despite this, we recognize
that luxury box revenue is important to consider and include in the model. To remedy this situation we have opted to use the same growth rate for regular attendance and luxury box attendance (2.8%).

Next we must determine an appropriate ticket price growth rate. Figure 39 shows the average Twins ticket price by year. Similar to the attendance plots, there is an inflection that occurs in the early 1980’s.

![Figure 39 - Twins Average Ticket Price vs. Year (1961 - 2003)](image)

Using similar logic to the attendance decision, an average growth rate for the ticket price and the luxury box price was determined using an average of the 1981 to 2003 data. The resultant value used for both ticket and luxury box pricing is an annual growth rate of 6.7%.

Finally we need to determine a growth rate for concessions spending. As mentioned prior Major League Ballclubs are private businesses which can often make it very difficult to get reliable data sets. In this case I was unable to get a publicly available data set that was valid for the time.
frame of interest. Despite this challenge I was able to locate a FCI public data set that starts in 2002. (TMR 2011) Using the FCI in conjunction with the average ticket price data, I am able to determine the average concessions spend. Figure 40 shows the FCI and concession spend for 2002 to 2012. This method is shown for completeness as it is a reasonable approach to determining average concessions spend and concession spend growth rate. Since data are not available, I have opted to use the long term average inflation rate of 3.3% as our concessions spend growth rate.

![Figure 40 - Twins Fan Cost Index and Concessions Spend vs. Year (2002 - 2012)](image)

With all of the needed growth rates determined, it is then a matter of applying the various 2010 starting values, relevant design values, and performing the necessary calculations. Table 11 shows the values chosen for this particular analysis.

*Note that since the ballclub would almost certainly be involved in the ballpark’s decision making process they would have this type of data readily available.*
Table 11 - Deterministic Scenario Initial Input Values

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Games</td>
<td>81</td>
</tr>
<tr>
<td>Seat Capacity</td>
<td>39,504</td>
</tr>
<tr>
<td>Average Ticket Price</td>
<td>$ 30.00</td>
</tr>
<tr>
<td>Luxury Boxes</td>
<td>54</td>
</tr>
<tr>
<td>Luxury Box Price Per Game</td>
<td>$ 1,500</td>
</tr>
<tr>
<td>Average Concessions Spend</td>
<td>$ 20.25</td>
</tr>
<tr>
<td>Ballpark Construction Cost</td>
<td>$ 555,000,000</td>
</tr>
<tr>
<td>Ballpark Operating Cost</td>
<td>$ 50,000,000</td>
</tr>
</tbody>
</table>

Figure 35 shows the actual deterministic model output, with an NPV of about $996 Million. Recognize that this number is not intended to represent the entire revenue stream of the ballpark or ballclub, but rather is a deterministic estimation based on the revenue to be generated from the factors and costs included in this analysis. That is, this analysis does not capture the diversity of organizational cost and revenue structures in MLB nor does it attempt to generate an actual ballclub or organization revenue.

To create a model capable of generating revenue for the entire ballclub would require the analysis of significantly more factors well outside the scope of the ballpark itself such as organizational costs, player contracts, league collective bargaining agreements, advertising rights, and media rights. While this is feasible, this analysis should be considered as one component of a larger revenue system.

As previously stated, the deterministic NPV value of $996 Million will be used to normalize the results in the later sections. This will be accomplished through simply subtracting the deterministic value from each scenario’s results and thus placing the deterministic result at the zero point.

Uncertain Approach

Prior sections have emphasized the need to recognize and address uncertainty in our planning and design. This section will help us recognize the impacts of uncertainty in our models by generating the same baseline model as the deterministic approach, but this time with uncertainty applied to key variables instead of deterministic values or averages. There is one additional major difference in the two models, weather effects. Weather is clearly an uncertainty that can affect attendance, ticket sales, and concession spending. Note that weather does not just mean rain, it can also mean cold or other weather related conditions, note how Figure 41 shows fans sporting winter coats, mittens, and hats walking into opening day at Target Field.
Similar to the deterministic scenario the first step is to identify the key performance drivers. In this case, they are the same so we are simply adopting the same model structure, but with the addition of some weather uncertainty. Also similar to the previous scenario we then analyze the historic trends of key factors. The difference this time is that we are not simply interested in establishing an average growth rate or constant, we are interested in understanding the variation that can occur over time. A major factor in these variations over time can be trend breakers. (de Neufville and Scholtes 2011)

For instance, revisiting annual attendance shown in Figure 37 we’ll need to decide whether or not we want to accept the entire data set (1961 to 2003) or the subset we chose prior (1981 to 2003). Digging deeper into the historical trends and potential trend breakers may help us determine the best course regarding uncertainty.

The overall popularity of MLB as a spectator sport in the United States is an example of a trend breaking consideration. Figure 42 shows the total league attendance by decade, where it is clear that the league has enjoyed near a centuries worth of increasing attendance.
Figure 42 - Major League Total Attendance vs. Decade

While Figure 42 shows an example of a macro view, we could take a more targeted view of the system and consider the possible effect the Twin City’s population could have on demand. Figure 43 shows the Twins’ annual attendance plotted with the Twin City 7 county area’s population from 1970 to 2003.
While there is not enough evidence in this one chart to establish a positive relationship, it does seem reasonable to consider Twin City’s population growth as a factor that could affect this system.

Considering both the dramatic increase in overall MLB attendance across the last 50 years in conjunction with the fact that the Twin Cities population has grown by about a million people since the 1960’s, it seems reasonable that the more recent attendance trend from 1981 to 2003 is the appropriate choice. Instead of taking the average growth rate across this time frame as in the deterministic scenario we will instead use a distribution with a mean of 10.23% and a standard deviation of 39.9%. As with the deterministic scenario, we’ll use this same growth for the luxury box growth rate.

As with the deterministic analysis the honeymoon effect will be included. However, in this analysis the honeymoon effect will be treated as a distribution of mean 34.5% and standard deviation of 2.5%. This distribution will allow the effect to vary slightly for each Monte Carlo run.
When we run the model we allow the growth rates to change via a random function based upon this distribution. The simulation model is built to generate an attendance demand; if this demand exceeds the ballpark capacity then the actual attendance will be that capacity. Note that the demand can also go to zero resulting in an actual attendance of zero. In this case the generated years start in 2010, where a starting demand of 2.3 million is combined with a honeymoon effect. This effect is randomly sampled from the distribution described above and applied to the starting demand. The resultant attendance is then determined. For the next year the previous year’s demand is referenced and multiplied by the growth rate generated from the distribution described above. Again, the resultant attendance is determined and applied. This process is continued for the duration of the simulation, in this case 30 years.

An example of this is shown in Figure 44, where the distribution described above has been used to generate 15 different Monte Carlo runs starting with a 2010 attendance of 2.3 million plus a generated honeymoon effect and shown for 20 years into the future. Figure 44 was constructed by combining existing annual attendance data from 1982 to 2009 with the Monte Carlo output runs; the vertical dashed line represents the break between the actual data and model data. Doing so provides some interesting contextual comparisons and allows a visual review of the relative variation taking place historically and in the model.
Looking closely at Figure 44 one can see that this simple distribution of growth rates can result in a wide range of possible futures. Worth noting is the maximum achievable annual attendance of about 3.2 million, which corresponds to a full season of sellouts. While on the surface that may seem like an unreasonable achievement to have year after year of sellout seasons, prior sections have shown this can and does happen quite frequently. Conversely, history also shows that events frequently transpire that lead to seasons or streaks of dismal attendance which are also reflected in the runs above.

It is worth considering how this simulation compares to the deterministic scenario, where it is a line that grows at 2.8% annually until it reaches the ballpark capacity in year 2023. From 2023 on until the end of the 30-year analysis in 2040 the deterministic scenario delivers sellouts. The concern is not whether this is a possible future, which it clearly is; the concern is that the deterministic approach is only considering one possible future.

As with the prior deterministic scenario, we will now consider ticket pricing. Figure 39 shows the average ticket pricing history for the Minnesota Twins. While the deterministic simply took an average of the growth rates over a range, we will treat this data similarly to the attendance data and look at the distribution of growth rates over a range. The entire range of growth rates we have are shown in Figure 45. In Figure 45 one can see that there is actually a lot of change over time in the growth rate and as a result the average ticket prices are changing. Interestingly it is also clear that the first few seasons had a fixed value, notable by the flat line at the beginning of the plot.
Similar to attendance, the time frame of 1981 to 2003 is going to be used as the subset of data for ticket pricing. Looking at Figure 45, this time frame is characterized by greater variation in growth rates. The resultant distribution for this time frame is a mean of 6.7% with a standard deviation of 14.6%. Similar to the deterministic scenario this same distribution will be applied to the luxury box pricing growth rates.

As with the deterministic scenario we do not have a concessions data set so we will use the long-term inflation data, but in this scenario we’ll use the distribution containing a mean of 3.3% and a standard deviation of 4.9%.

The operating costs associated with this ballpark are an additional source of uncertainty. In the deterministic case they simply grew at the average inflation growth rate, but for the uncertain scenario they were treated as a distribution using the percentages stated prior.

Lastly, while weather effects were ignored in the deterministic scenario the uncertain analysis allows for weather effects. This is accomplished through a random number generator that assigns a range of 0 to 20 games affected by weather. Since the vast majority of tickets are sold
well before game day, the model uses these weather affects to reduce the concessions spend for those days.

The uncertain model utilizes the same starting values as the deterministic model, shown in Table 11. Running the Monte Carlo simulation for the uncertain model yields some interesting results. First, while the deterministic gave us a single value, the uncertain analysis gives us a range of values with associated probabilities. The difference between the two analyses can be seen most clearly in Figure 46 where the CDF shows the uncertain analysis as a curve spanning many values and the deterministic as a vertical line representing a single value. The mean or expected uncertain value or E(NPV) is also shown for comparison. Second, the probabilistic values associated with each value. These probabilities are important because they give us an understanding of how the different uncertainties are likely to play out in the future. This leads us to the third and final result, the non-linear nature of the model. By looking at the 50% probability point in the CDF we can see how the curves to the left and right of this point are shaped differently. This can also be seen by comparing the 10% VAR versus the 90% value to gain. If the system were linear these values would be evenly distributed beyond the 50% mark. This is critical to recognize because it can help us see if we have more potential upside or downside.

![CDF Comparing Deterministic and Uncertain Model](image-url)
Comparing all of the above points against the deterministic vertical line shown in Figure 46 it is clear that there is a lot more information and subsequent value in the uncertainty analysis. While the deterministic analysis gave us a single value of about $996 Million, normalized to zero in Figure 46, with no real appreciation for other possible outcomes, the uncertain analysis gives us a much different perspective on the project. In fact, the uncertain analysis shows a normalized 10% VAR of about $(1.4) Billion, a 90% Value to Gain of about $375 Million, and an E(NPV) of about $(515) Million.

The prospect of this project showing such significant losses in both the normalized 10% VAR and the E(NPV) is likely surprising to some, but a substantial body of literature has shown similar findings. Recently in 2012 a Colorado State football stadium analysis said:

"Capital budgeting analysis reveals that only under the most optimistic circumstances will the net present value of the revenue streams generated by the new stadium exceed the cost of the stadium" (Cotton 2012)

Similarly, Judith Long states that less than 60% of public facility owners with Major League tenants make money on their facilities and when foregone property taxes are included in the analysis fewer than 20% have positive revenue. (Long 2012)

Considering Flexibility

While moving from deterministic analysis to uncertain analysis was a big step in understanding the actual uncertainty surrounding ballpark projects, we have not yet used this information to improve the project’s financial performance. This is where the adoption of flexibility in our designs will come into play. Before we can employ the flexible strategy we need to first identify design factors that we can incorporate flexibility and then test them in our models to see what if any value they add to the project’s performance.

As previously noted, attendance concerning both seating and luxury boxes is a major uncertain component of ticket and concessions revenue and the weather is a significant factor that can reduce those revenues. As a result, we will explore flexible designs that seek to lower our risk due to these uncertainties and where possible maintain or exploit upside for the project. Three main areas of focus will be flexible seating capacity, flexible luxury box capacity, and flexible roof options.

The first scenario will be called the Flexible 2 Year Expansion. In this scenario the ballpark will be built with an initial seating capacity of 25,000, an initial luxury box capacity of 54, and no considerations for roof additions at an initial cost of $391 million. This initial cost is based upon an estimate of $13,700 per seat and $205,500 per luxury box and a 10% additional penalty to account for the flexibilities built into the design, these same estimates will be used for all of the Target Field scenarios. The simulation will keep track of the percent utilization of seating and luxury boxes. If either achieves two consecutive years of equal to or greater than 99%
utilization an expansion of that flexibility will occur. In this scenario a single expansion of each is allowed and if exercised will result in a seating capacity of 50,000 and a total of 79 luxury boxes. The costs associated with these expansions are the estimates stated above plus a 10% additional penalty to accommodate for the some of the complexities associated with expansions. To clarify there is a 10% penalty during the construction of the ballpark, which is actually just the cost of buying the option to expand the facility in the future, and there is an additional 10% penalty applied to the base seat and luxury box costs if they are added amenities.

Initial examination of Figure 47 shows some interesting results from running this scenario in our model: first is the positive shift in mean or E(NPV) relative to the base uncertain case. Second is the significant reduction in 10% VAR. Finally there is also an increase in 90% VAG.

Overall this scenario does some very positive things for our financial performance: it reduces the initial investment, limits downside losses, and thus increases both the expected value and the upside potential.

Next we consider a scenario very similar to the prior only this time we react with expansions after only one year at or above 99% utilization. We’ll call this scenario Flexible 1 Year Expansion. The initial capacities, maximum expanded capacities, and costs are all the same, the
only difference is the shift from 2 years of utilization to 1 year of utilization at or above 99%. The results of this scenario are shown in Figure 48 along with the prior uncertain and Flexible 2 Year scenario.

![Figure 48 – Twins CDF Comparing 2 Year Flexible, 1 Year Flexible, and Uncertain Scenarios](image)

Comparing the various scenarios in Figure 48, you can see that by simply changing the decision criteria for these basic flexible options we have improved the E(NPV) and increased the 90% VAG. It is worth noting that there is not a significant difference between the 1 and 2 year scenarios.

While significant gains have been made with even these basic cases, our final two scenarios explore a more complex set of flexibilities and decision points. We start with construction of a 25,000 seat facility with 50 luxury boxes, substantially smaller than the proposed Target Field. The flexible design will allow for incremental additions of seating and luxury boxes in 5,000 and 10 increments respectively. The seating has a maximum capacity of 50,000 and the luxury boxes have a maximum capacity of 150. The decision criteria are that any year that has a capacity utilization equal to or above 90% will result in an expansion. If these criteria are met one increment of flexibility will be utilized. In this particular case we do not explore a roof...
This scenario is called Multiple 1 Year Flexible No Roof and the results are shown in Figure 49.

This particular scenario is interesting because it has the best performing E(NPV) of the scenarios tried, and also the best 10% VAR and 90% VAG. The curves asymmetric nature is also becoming more pronounced as the curve extends further to the right in the upside conditions. Along with limiting initial investments, increased upside potential is a typical benefit of flexible designs.

Finally, we analyze the Multiple 1 Year Flexible with a roof. In this scenario our model keeps track of lost revenue due to weather. If any two year period results in lost revenue due to weather of greater than $10 million the retractable roof will be installed at a cost of $100 million. Also, the base ballpark configured includes an additional $25 million in infrastructure costs to facilitate the option of adding a retractable roof. The option of adding the roof is also constrained to only the first 20 years of the simulation, leaving the last 10 years without the option to add a roof to the ballpark. The rest of the seating and luxury box options remain the same as the prior scenario. The results of this scenario are shown in Figure 50.
This final scenario produced some very promising results with an E(NPV) almost equivalent to the 1 Year Multiple No Roof, a 10% VAR and 90% VAG comparable to the previous scenario. In fact the Multiple 1 Year with Roof is very similar to the without roof case but offset by $(25) to $(50) million. In addition, it also offers the greatest amount of flexibility going forward with the ability to expand seating up to double the base capacity in small increments, luxury boxes incrementally up to three times the original capacity, and even add a retractable roof within the first 20 years.

Conclusions
The analysis of various scenarios produced an array of interesting results summarized in Table 12. The table shows the various input factors at the top and the simulation results at the bottom. For each of the financial outputs the best performing scenario is shown in bold. Additionally the value of value of flexibility, that is the difference between the uncertain E(NPV) and the scenario E(NPV), is shown.
Table 12 – Twins Comparison of Scenario Results

<table>
<thead>
<tr>
<th>Simulation Ballpark Inputs</th>
<th>Deterministic Base Case</th>
<th>Uncertain Base Case</th>
<th>Flexible 2 Year Expansion</th>
<th>Flexible 1 Year Expansion</th>
<th>Flexible Multiple No Roof</th>
<th>Flexible Multiple With Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Seat Capacity</td>
<td>39,014</td>
<td>39,014</td>
<td>25,000</td>
<td>32,000</td>
<td>25,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Flexible Seat Capacity</td>
<td>0</td>
<td>0</td>
<td>15,000</td>
<td>15,000</td>
<td>5,000</td>
<td>3,000</td>
</tr>
<tr>
<td>Maximum Possible Seat Capacity</td>
<td>39,014</td>
<td>39,014</td>
<td>40,000</td>
<td>40,000</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Seating Strike Point</td>
<td>N/A</td>
<td>N/A</td>
<td>95</td>
<td>95</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Initial Luxury Box Capacity</td>
<td>54</td>
<td>54</td>
<td>54</td>
<td>54</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Flexible Luxury Box Capacity</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>25</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Maximum Luxury Box Capacity</td>
<td>54</td>
<td>54</td>
<td>79</td>
<td>79</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Luxury Box Strike Point</td>
<td>N/A</td>
<td>N/A</td>
<td>99</td>
<td>99</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Roof Option</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comparison of Normalized Financial Outputs (Millions USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment (Year 0)</td>
</tr>
<tr>
<td>30 Year E(NPV)</td>
</tr>
<tr>
<td>30 Year 10% VAR (Pro)</td>
</tr>
<tr>
<td>30 Year 90% VAR (Pro)</td>
</tr>
<tr>
<td>Value of Flexibility (NPV)</td>
</tr>
</tbody>
</table>

From this small set of scenarios there is a clear dominant proposal and it is also clear that flexibility is adding value in all of the cases. Although there appears to be a winner, one can also imagine a host of factors that would cause a committee to choose one scenario over another.

For example, suppose in order to get a ballpark built the committee wanted the lowest initial investment that would give them some flexibility to expand in the future while still maintaining solid financial performance. The Flexible Multiple No Roof would be an excellent choice because it provides the lowest upfront investment, tremendous expansion flexibility, and excellent downside and upside financial potential. Additionally, this case also has the highest E(NPV).

Another committee may have different objectives and take a firm stance on not losing money. In that case they may actually propose additional scenarios that improve the 10% VAR even better than those shown above.

The hypothetical committees stated previously are nice for discussion but not needed in this case because the Twins’ stadium debate was held in public forums and widely publicized. As previously stated we know many of the motivations and decision making criteria of the Twins Ballclub and the MBA; the Twins very clearly stated they wanted financial efficiency, long term financial flexibility, and had a strong want for a retractable roof. The MBA was focused primarily on delivering a new ballpark and making a prudent financial decision with the taxpayer’s money. As previously discussed in the end these entities came together to make what they felt was an appropriate compromise in the now completed Target Field. However, analysis of Table 13 shows that by not considering flexibility in their designs they may have missed some mutually beneficial opportunities.
What Table 13 shows is that the Twins Ballclub and the taxpayers of Hennepin County could have spent substantially less money upfront (Flexible Multiple No Roof) and had a ballpark that was much more likely to meet the objectives stated by the Twins and the MBA. In fact, if actual committed percentages are maintained the taxpayers upfront spend would be reduced by over $100 million and the Twins reduced by about $50 million, Table 14.

### Table 14 - Comparison of Upfront Investments (Millions USD)

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>Percentage</th>
<th>Actual Upfront Investment</th>
<th>Flexible No Roof Possible Upfront Investment</th>
<th>Flexible With Roof Possible Upfront Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twins</td>
<td>35%</td>
<td>$195</td>
<td>$137</td>
<td>$145</td>
</tr>
<tr>
<td>Taxes</td>
<td>64%</td>
<td>$356</td>
<td>$250</td>
<td>$266</td>
</tr>
<tr>
<td>Target Corp.</td>
<td>1%</td>
<td>$5</td>
<td>$4</td>
<td>$4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>$555</strong></td>
<td><strong>$390</strong></td>
<td><strong>$415</strong></td>
</tr>
</tbody>
</table>

The upfront reductions are so substantial that a retractable roof installed from day one could have been purchased outright and they would still have about $40 million in upfront savings or they could have opted to choose the Flexible Multiple With Roof option and simply pay the $25 million for the ability to add a retractable roof in the future and maintain $140 million in upfront savings.

The point is not that these are maneuvers to afford a roof or roof option, the point is that by nearly all measures these flexible strategies are an improvement. They offer lower upfront investment, better mean returns, lower risk, higher upside potential, and the ability to accommodate more party’s wishes through future flexibilities. This is all accomplished by
Post Construction Discussion
Since Target Field was opened in 2010 we have the benefit of reviewing at least some of the performance data to date. Figure 51 shows the Twins’ annual attendance for both the Metrodome and Target Field to date. As shown, Target Field benefited from a substantial boost in attendance the first two years, likely due to the Honeymoon Effect discussed earlier, and then two years of dramatically decreasing attendance.

Figure 51 - Comparison of Metrodome and Target Field Attendance (1982 - 2013)
In fact, 2013 attendance is approximately equal to the final year at the Metrodome at about 2.4 million. While critics would likely point out that there are many potential causes for these

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8 Interesting to note that the Twins’ management sought a new ballpark project in the years leading up to 2003 so that they could reach the 2.3 million attendance seen as the industry average and being enjoyed by other ballclubs with new parks, but by the time Target Field was funded and under construction they experienced four seasons of attendance at this level in their existing park, the Hubert H. Humphrey Metrodome.
performance levels including the economy, Twins’ on field performance, or possibly even scandals in baseball I would argue they are only bolstering my argument for flexibility. Try as we may, we cannot predict the future and as a result designs that allow us to minimize the effects of uncertainty through future flexibility and deferred decision making are often more likely to outperform static designs.

The above comparison concerns attendance, while it is among the most important, it is only one component among others that contribute to or alter a ballpark’s revenue. For instance, the lease arrangement with the ballpark owner or revenue sharing agreements could dramatically change the revenues reported. This point is being made because it is entirely possible that even with reduced attendance Target Field could provide increased revenues to the ballclub. However, one would need to be careful in their analysis to make sure they are capturing the whole picture and not being misled by one balance sheet when the costs are simply being carried by another balance sheet. In this analysis there is no distinction made between the owners, lessee, or other arrangement instead operating under the assumption that the flexible options shown benefit whoever is the primary owner.
The New York Yankees and Yankee Stadium III

“You talk about the magic, the aura, but what really makes a stadium is the fans. Concrete doesn’t talk back to you. Chairs don’t talk back to you. It’s the people who are there, day in, day out, that makes the place magic.” – Bernie Williams, New York Yankee

In April of 2009 the New York Yankees moved into their third ballpark: Yankee Stadium III. The beautiful yet controversial new stadium defined a new record cost, shown in Figure 22 over $1.5 billion, and a new high for cost per seat shown in Figure 23 above $30 thousand per seat.

The prior case study involving the Minnesota Twins’ Target Field went into great depth to establish both the typical concerns and patterns of deterministic thinking present in these types of projects. This case focuses primarily on the modeling and flexible proposals for the design, understanding that many of the previously discussed issues and deterministic methods were present in the actual projects execution.

While this study of Yankee Stadium III in New York explores flexibility of essentially the same variables recall that it was chosen primarily because it represents a substantially different market than the Twin Cities not because the demands of the ballpark are inherently different. The New York metropolitan area has a population of almost 19 million including New York City at about 8 million while the area surrounding the Twin Cities only has about 3.3 million people. The Yankees have called New York home for over a century while the Twins have only been in the Twin Cities for about 50 years. The intent was to assess the value of flexibility in ballpark design across a range of markets; because of their recently completed ballparks and their unique market situations these two teams provide an excellent contrast.

Deterministic and Uncertain Approach

As with the prior analysis it is first important to establish the key performance drivers in our model. While it is a different team in a different location, the main drivers are assumed to be the same but differing in their values such as growth rate. In an effort to establish some of these values we investigated historical data and trends.

First we explored the historical attendance for the New York Yankees from 1913 to 2005. The dataset is truncated at 2005 to represent data that was available to the decision makers at the time of the project planning and development. This attendance data is shown in Figure 52.
Figure 52 - Annual Attendance vs. Year (Avg. American League and Yankees)

Looking at the attendance trends of the Yankees over their history it is clear that it is typical for them to exceed the league average, often for substantial periods of time and by a significant amount.⁹

The decision of whether or not to use the entire dataset or a subset can often be difficult. Upon review of the attendance data in Figure 52, the growth rate data in Figure 53, and the Yankee’s ballpark history we choose to utilize the time period of 1976 to 2005.

⁹ It should be noted that many of these periods coincide with periods of exceptional on-field performance and post-season play shown later in Figure 59.
This time period corresponds with the Yankee’s move to Yankee Stadium II from Shea Stadium (1974 – 1975) and Yankee Stadium I (1923 – 1973). The reduced data set plots attendance and is shown in Figure 54 and growth rates are shown in Figure 55.

---

10 The Yankees played two seasons at the New York Met’s Shea Stadium during the construction of Yankee Stadium II.
Figure 54 - Attendance vs. Year (Avg. American League and Yankees)

Figure 55 - Attendance Growth Rate vs. Year (Yankees and American League)
Utilizing this reduced dataset the deterministic case uses an attendance growth rate of 5.6% and the uncertain case uses a distribution with a 5.6% mean and an 18.8% standard deviation.

Next we investigated the Yankee’s historic ticket pricing, shown in Figure 56. While a larger dataset would be preferred, reliable average ticket price data was only found dating back to 1991. This particular time period clearly shows about a decade of price increases and a shorter period of relatively stagnant prices.

![Figure 56 - Yankees Average Ticket Price vs. Year (1991 - 2005)](image)

Looking closer at the actual growth rates for this period in Figure 57 shows the percentage variation taking place. Again acknowledging that a larger more complete dataset would be preferable and that in practice this data would likely be available directly from the ballclub we are using this dataset because it was the most reliable set available to us. As a result, the deterministic analysis uses a growth rate of 7.49% and the uncertain analysis uses a distribution with a mean of 7.49% and a standard deviation of 9.9%.

Next we determine the appropriate values for the concessions spend. Similar to the Twins’ analysis, we utilized the available FCI data. Figure 58 shows the FCI and concessions data for this time period that results in a deterministic concessions growth rate of 4.43% and an uncertain distribution with a mean of 4.43% and a standard deviation of 5.9%.
Figure 57 - Average Ticket Price Growth Rate vs. Year (1992 - 2005)

Figure 58 - Yankees Fan Cost Index and Concessions Spend vs. Year (1991 - 2005)
Regarding trend breakers multiple potential sources were explored. Figure 59 shows a comparison of the New York City population and the Yankee’s annual attendance by year. While the population is largely unchanged over the 60 year timespan the Yankees have seen a doubling of their annual attendance.

![New York Annual Attendance and Population vs. Year](image)

**Figure 59 - New York Annual Attendance and Population vs. Year**

Figure 60 shows the annual attendance of the Yankees overlaid with their post-season appearances. From a trend breaking perspective on field performance can be a factor worth considering and monitoring. This is particularly concerning considering the 1995 to 2005 timeframe was both the primary planning period for Yankee Stadium III and also a decade of on field dominance.
With the deterministic and uncertain factors explored and a variety of trend breakers discussed we can now run our model and begin to explore the results. Figure 61 shows the normalized CDF result of both the deterministic and uncertain cases. These results were normalized using a $2.25 Billion deterministic result. As seen in the figure the E(NPV) of the uncertain case is actually very close to the deterministic value of $2.25 Billion, denoted by the proximity to zero, but the dramatic range of potential values shows the true breadth of future possibilities.

Table 15 shows a comparison of the inputs and results. It is clear that the inputs are identical, but differences emerge in the outputs. The table shows the actual normalized extent of the curve shown in the CDF, which is about a VAR of ($1.1) Billion to a VAG of $1.1 Billion. To the project planners and designers this is a substantially different potential outcome than what the deterministic case shows.
Figure 61 - Yankees CDF Comparing Deterministic and Uncertain Model
Table 15 - Yankees Comparison of Deterministic and Uncertain Results

<table>
<thead>
<tr>
<th>Simulation Ballpark Inputs</th>
<th>Deterministic Base Case</th>
<th>Uncertain Base Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Seat Capacity</td>
<td>50,291</td>
<td>50,291</td>
</tr>
<tr>
<td>Flexible Seat Capacity</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Max Possible Seat Capacity</td>
<td>50,291</td>
<td>50,291</td>
</tr>
<tr>
<td>Seating Strike Point</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Initial Luxury Box Capacity</td>
<td>466</td>
<td>466</td>
</tr>
<tr>
<td>Flexible Luxury Box Capacity</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Maximum Luxury Box Capacity</td>
<td>466</td>
<td>466</td>
</tr>
<tr>
<td>Luxury Box Strike Point</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Roof Option</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comparison of Normalized Financial Outputs (Millions USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment (Year 0)</td>
</tr>
<tr>
<td>($1,500)</td>
</tr>
<tr>
<td>30 Year E(NPV)</td>
</tr>
<tr>
<td>($)</td>
</tr>
<tr>
<td>30 Year 10% VAR (P10)</td>
</tr>
<tr>
<td>N/A</td>
</tr>
<tr>
<td>30 Year 90% VAR (P90)</td>
</tr>
<tr>
<td>N/A</td>
</tr>
</tbody>
</table>

Considering Flexibility
As with the previous case study, with the deterministic and uncertain models developed and run we can now focus our attention to adding value through flexible options. As discussed before, the major difference between this case and that of the Minnesota Twins is the market they serve; as a result the basic flexibilities explored are very similar but differ in the extent utilized.

The overall seating capacity, luxury box capacity, and the addition of a retractable roof will be explored with a variety of different strike points. The top portion of Table 16 outlines the various scenarios run and the factors used in them. The lower portion outlines the results of these runs in the same format as Table 12 for the Twins.
Table 16 - Yankees Comparison of Scenario Results

<table>
<thead>
<tr>
<th>Simulation Ballpark Inputs</th>
<th>Deterministic</th>
<th>Uncertain</th>
<th>Flexible 2 Year Expansion</th>
<th>Flexible 1 Year Expansion</th>
<th>Flexible Multiple No Roof</th>
<th>Flexible Multiple With Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Seat Capacity</td>
<td>39,251</td>
<td>39,251</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Flexible Seat Capacity</td>
<td>0</td>
<td>0</td>
<td>20,000</td>
<td>20,000</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Max Possible Seat Capacity</td>
<td>59,251</td>
<td>59,251</td>
<td>40,000</td>
<td>60,000</td>
<td>60,000</td>
<td>60,000</td>
</tr>
<tr>
<td>Seating Strike Point</td>
<td>N/A</td>
<td>N/A</td>
<td>92.8%</td>
<td>99.0%</td>
<td>97.5%</td>
<td>97.5%</td>
</tr>
<tr>
<td>Initial Luxury Box Capacity</td>
<td>466</td>
<td>466</td>
<td>400</td>
<td>400</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>Flexible Luxury Box Capacity</td>
<td>0</td>
<td>0</td>
<td>200</td>
<td>200</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>Maximum Luxury Box Capacity</td>
<td>666</td>
<td>666</td>
<td>600</td>
<td>600</td>
<td>650</td>
<td>650</td>
</tr>
<tr>
<td>Luxury Box Strike Point</td>
<td>N/A</td>
<td>N/A</td>
<td>92.2%</td>
<td>99.0%</td>
<td>97.5%</td>
<td>97.5%</td>
</tr>
<tr>
<td>Roof Option</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Comparison of Normalized Financial Outputs (Millions USD)

| Initial Investment (Year 0)        | N/A           | N/A       | ($1,950)                  | ($1,982)                  | ($1,995)                  | ($1,995)                    |
| 30 Year E(NPV)                     | ($8)          | $6        | $412                      | $576                      | $581                      | $595                        |
| 30 Year 10% VAR (P10)              | N/A           | ($1,917)  | ($1,972)                  | ($1,994)                  | ($1,995)                  | ($1,995)                    |
| 30 Year 90% VAR (P90)              | N/A           | $1,705    | $1,954                    | $1,994                    | $1,995                    | $1,995                      |
| Value of Flexibility E(NPV)        | N/A           | N/A       | $466                      | $570                      | $572                      | $499                        |

Graphically the normalized results are shown in Figure 62 where again each line style represents a distinct scenario. What is immediately obvious is the dramatic shift of the flexible scenarios to the right in the CDF. This represents a positive shift and in the case of all of the scenarios represents better VAR, E(NPV), and VAG. Inspection of Table 16 shows the same results and also shows that every scenario also has a lower initial investment.
While it appears clear that the flexible scenarios are in fact adding value across the multiple measures shown, we can then shift our focus to which flexible scenario is adding the most value. Similar to the Minnesota Twins’ case, the Flexible Multiple with No Roof is the best performing scenario. While the inputs and case are different this is not too surprising because it strikes a nice balance of low up front cost and tremendous future flexibility with its multiple opportunities to increase capacities. Table 16 has the leading scenario in each category in bold, where it can clearly be seen that the Flexible Multiple with No Roof is the best in all categories. A reduced version of this table is shown in Table 17.

In Table 17 it can be seen that the proposed scenario reduces the initial spend by almost $200 Million while improving both the VAR, VAG, and E(NPV) by about $366 Million, $867 Million, and $575 Million. These are substantial differences in financial performance that are a function of a facility that can be built with a lower initial investment and then adapt to a variety of future scenarios.
When considering flexibility for a project, a reduced initial or upfront investment is often one of the major benefits flexibility can add. In light of this and given the extraordinary cost of the actual Yankee Stadium III, a supplemental case that sought to dramatically reduce the initial investment was explored. In this case, the goal was to propose a candidate flexibility that reduced the initial investment to below $1 Billion. From a quantitative sense, there is really nothing special about the $1 Billion mark versus other numbers, but from an emotional and political response perspective, it is important to recognize that being below $1 Billion could have significant effects when public discourse and debate is considered.

Table 18 shows the proposed scenario, note that the initial seating capacity and number of luxury boxes is significantly reduced when compared to the base case or the other flexible scenarios explored. This dramatic decrease allows the ballpark to be completed at a similar amenity level but below the $1 Billion mark; in fact, this scenario has an upfront cost of $992 Million.
Reviewing the scenario results in both Table 18 and Figure 63 it is clear that this proposal performs better than the Uncertain Base Case, adding value in VAR, VAG, and E(NPV) while investing over $500 Million less initially. In fact, the gains in all of the mentioned are substantial with an E(NPV) gain of about $342 Million. However, this significant reduction in initial investment erodes some of the financial performance and results in lower financial performance when compared to the Flexible Multiple No Roof scenario. One interesting result was that the Flexible Multiple No Roof actually had better VAR performance than the Low Initial Investment option. Inspection revealed that this was because the Low Initial Investment scenario starts so low that it actually is well below initial demand and as a result misses out on early opportunities and essentially obviates the honeymoon effect.
Whether or not this scenario is one that should be executed is not the focus of this analysis, rather the point is to emphasize that these scenarios exist and are worthy of exploration and consideration. Projects with significantly lower initial investment often have a much higher probability of being approved and have a lower opportunity cost effect on available funds. These are important considerations as it is not uncommon for ballpark and stadium debates to drag on for years with the primary topic being funding.

Conclusions
“Fans don’t come to see the Yankees play; they come to see the Yankees win” – Buck Showalter, MLB Manager

Similar to the previous case study involving the Twins the most obvious conclusion is that flexibility in a variety of forms can add value to ballpark projects. The focus of flexibility in the Yankee Stadium case study was on capacity, luxury boxes, and a retractable roof. In all of the scenarios shown there was significant value added to the project and plenty of additional benefits including upside potential, downside protection, and lower initial investments.
While the Yankee’s market is significantly larger than the Twins’ market, they both benefited greatly from flexible options. The reason in both cases stems primarily from choosing a base design that is appropriate in light the potential future outcomes and has a certain level of flexibility available to take advantage of favorable futures.

**Additional Flexible Options**

Ballparks in the Commercial Era incorporate an ever increasing number of additional features and amenities. While many of these were discussed in prior sections they include recreation areas, multi-use atriums, hotels, restaurants, conference centers, museums, halls of fame, special seating paddocks, and large format video screens.

Most of these items are included in the design to improve the fans experience and the ballpark’s revenue potential. However, all of these things cost money to implement and are often the source ongoing debate in the development of a project. Additionally, some features are actually the result of compromises that end debates. The overall cost involved in many of these features is typically significantly lower than the items discussed in the previous sections, but nonetheless they can be viewed as flexible options in a project.

This section illustrates how these items can be analyzed as flexible options and some of the potential benefits that may be seen from deferred decision making or implementation. Specifically we discuss reduced initial investments, project compromise, additional honeymoon effects, and future adaptability.

**Multi-Use Facilities**

The facilities being addressed in this section are not the large multipurpose stadiums discussed prior, but rather areas specifically built into a ballpark to handle uses beyond the basic scope of hosting baseball games. These types of facilities often include but are not limited to conference areas, large open meeting spaces, museums, halls of fame, or general commercial space.

Given that most ballparks are constructed within major metropolitan areas and typically have excellent transportation access, nearby food and lodging, and access to significant parking one can see how it may make sense to try and expand the utility of these facilities. Also considering that many stadiums and ballparks are used for sporting seasons that last about 6 months, there is great potential to utilize them in the offseason.\(^{11}\)

Like nearly all professional sports, MLB fans place great importance on the history and tradition of the game. As a result, museums and halls of fame that preserve and promote the history of players, teams, events, ballparks, and eras are very popular destinations.

While historically it has been common for the major sporting leagues to have a primary hall of fame or museum, such as Cooperstown for MLB, in recent times it is becoming more common for teams and ballparks to have their own.

\(^{11}\) Many of these same arguments were used to justify and construct the multipurpose domes and other stadiums of the 1960’s, 1970’s, and 1980’s.
To illustrate how a project may consider an amenity in their flexible plans, we consider a hypothetical Hall of Fame Museum attraction to be built into the design of Target Field. The analysis is performed as before with a deterministic base case, an uncertain static scenario, and since the Flexible Multiple No Roof was the best performing flexible case we also build off of that scenario. The option of adding this museum in the future will have a $500,000 cost to the base ballpark and cost approximately $5 million to construct if the flexible option is executed while incurring about $500,000 in operating costs annually. Finally, it is assumed that as a promotion a ticket stub will gain you entry into the museum or on non-game days the museum will charge a $5.00 entry fee.

There are a few other important inputs to our model with the museum flexibility. We assume that in the first year of the museum opening it will have a non-game attendance of roughly 50,000 people and from there out that number will be subject to growth rates similar to the attendance demand. Also, we assume that there are merchandise and other revenue opportunities within the museum that equate to an average non-ticket spend of $10 per person attending that is only accounted for the non-game attendees.

With regard to the flexibility of the museum we use two possible strike points; first if the ballpark ever falls below 50% utilization the museum will be built in an effort to incentivize attendance. Second, if the 50% utilization is not met by year 10 of operation (year 13 overall) the museum will be built regardless. An important factor being included in this analysis is an amenity honeymoon effect. While we acknowledge that the opening of a museum or hall of fame on the grounds of or in a ballpark will likely not result in an average boost in attendance of 37%, we do believe it is likely that it could result in some temporary increased attendance. This effect becomes even more probable when combined with a ticket stub free entry promotion. As a result we have included a one year boost of 7.5% in the deterministic case and a mean of 7.5% and standard deviation of 2.0% for the uncertain cases.

The results of this scenario are shown in the CDF of Figure 64 and in Table 19. Note in Figure 64 that the results were normalized based upon the new scenario with the museum being constructed at the time of the ballpark opening, but the previous deterministic and uncertain results are shown for reference. Although the investment is small relative to the ballpark, the effects are obvious in the CDF.

As shown in the reviewed literature, promotions such as bobble heads, bat days, or other giveaways can have a dramatic impact on game attendance. While specific results were not found for museums or other amenities, the author believes such impact is a reasonable assumption and certainly one worth further exploration.
Reviewing Table 19 makes the potential effects of the museum even easier to discern. It is clear that the museum does have a positive impact on the project. In fact, other than incurring an initial upfront investment charge the VAR, VAG, and E(NPV) are all improved. The overall value of the flexibility in this proposal increases by about $115 million.

Figure 6.4 – Twins’ Hall of Fame Museum Scenario CDF
Table 19 – Twins’ Hall of Fame Comparison of Scenario Results

<table>
<thead>
<tr>
<th>Simulation Ballpark Inputs</th>
<th>Deterministic Base Case</th>
<th>Uncertain Base Case</th>
<th>Flexible Multiple No Roof</th>
<th>Flexible Multiple No Roof &amp; Hall of Fame Museum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Seat Capacity</td>
<td>39,504</td>
<td>39,504</td>
<td>25,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Flexible Seat Capacity</td>
<td>0</td>
<td>0</td>
<td>5,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Max Possible Seat Capacity</td>
<td>39,504</td>
<td>39,504</td>
<td>50,000</td>
<td>50,000</td>
</tr>
<tr>
<td>Seating Strike Point</td>
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<td>N/A</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Initial Luxury Box Capacity</td>
<td>54</td>
<td>54</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Flexible Luxury Box Capacity</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Maximum Luxury Box Capacity</td>
<td>54</td>
<td>54</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Luxury Box Strike Point</td>
<td>N/A</td>
<td>N/A</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Roof Option</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Hall of Fame Museum Option</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Hall of Fame Strike Point</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>50%</td>
</tr>
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</table>

Comparison of Normalized Financial Outputs (Millions USD)

<table>
<thead>
<tr>
<th>Initial Investment (Year 0)</th>
<th>($555)</th>
<th>($555)</th>
<th>($89.9)</th>
<th>($390.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 Year E(NPV)</td>
<td>$351</td>
<td>$351</td>
<td>$341</td>
<td>$190</td>
</tr>
<tr>
<td>30 Year 10% VAR (P10)</td>
<td>N/A</td>
<td>($1,392)</td>
<td>($1,352)</td>
<td>($1,095)</td>
</tr>
<tr>
<td>30 Year 90% VAR (P90)</td>
<td>N/A</td>
<td>$875</td>
<td>$853</td>
<td>$830</td>
</tr>
<tr>
<td>Value of Flexibility E(NPV)</td>
<td>N/A</td>
<td>N/A</td>
<td>$210</td>
<td>$325</td>
</tr>
</tbody>
</table>

Investigation of the simulation yields a primary reason for the improved results; the boost in ballpark attendance as a result of the museum being opened. Because the strike points were set to deploy the museum earlier than the 10 year planned date if attendance was below a 50% utilization mark it actually helped to dampen the effects of a downturn in attendance in some cases. From that point forward it then served as an additional revenue source for the facility with museum demand growing and shrinking with attendance demand.

The analysis is straightforward and clearly dependent upon the assumption that the museum or other similar amenity would actually draw additional attendance, but it raises a very interesting prospect for ballpark projects. Can facility additions, added amenities, or attractions cause a temporary increase in attendance? Perhaps in light of long term financial performance it would be wise to intentionally reduce the scope of the project and build in additional flexible amenities or attractions in an attempt to leverage additional honeymoon effects if needed in the future.
Summary

This thesis explored and showed that flexibility in ballpark design can add value. Specifically in large and small markets flexibility in seating and luxury box capacity, roof structures, and multi-use amenities was explored. In every case explored value was demonstrated across a broad range of financial measures including VAR, VAG, E(NPV), and initial investment. In fact, in the scenarios explored designs were proposed that outperformed the base non-flexible case in every one of the measures listed.

These findings are in stark contrast to some of the existing deterministic methods that emphasize economies of scale and designing for averages. These methods fail to capture the uncertainty of the future and as a result fail to protect in downside conditions and capitalize in favorable conditions. Additionally the static designs inability to adapt to changing times has an immediate and long term effect that can be addressed by flexibility. In the short term flexibility offers the prospect of significantly reduced up front investments lowering the threshold and liability faced by the project. In the long term this inability to adapt can result in obsolescence and demolition.

In an era where billion dollar stadiums are becoming common and the vast majority are funded with public money the lack of flexible stadium designs is concerning. The research suggests that at least some stadiums are having difficulty covering their costs of construction and operation. Perhaps if these structures were designed with flexibility and long term financial performance in mind this burden could be removed from the public tax base. The optimist can even envision a situation where flexible designed facilities financial prospects could be so favorable that ballclubs or private equity would want to finance them.

Financial performance, or lack of, is at the heart of most of the political debate surrounding ballpark projects, but inclusion of amenities is also a common topic. By designing flexible ballparks we can accommodate a wide range of stakeholder wants in the form of future flexibilities. This type of inclusive planning could help gain broader support from a wider variety of participants for projects decreasing the typical gridlock.

Future Work

As with any research effort, the scope and boundary of consideration must be limited in order to facilitate reasonable completion and publishing dates. During this research effort the author uncovered a variety of future work opportunities that fell outside the scope of this work but remain relevant and worth noting.

As the application and valuation of flexibility in engineering design to ballparks is new this thesis explored basic scenarios using a relatively high level model. A major factor in this decision was the lack of publicly available revenue data, a result of ballclubs being private entities. Since actual ballpark projects would have access to this data, recommended future work would involve an in depth study of a flexible ballpark involving all of the following and their respective data; ballclub, municipal and state government, architectural firm, construction firm, and if applicable a ballpark authority.
One of the most obvious targets of flexibility in stadium design is capacity. While it is recognized that event ticket prices are subject to the forces of supply and demand, the models used in this analysis did not attempt to raise or lower the ticket prices based upon increased or decreased supply. Since all of the proposed scenarios included an initial decrease in supply and did not adjust prices up for this imbalance of supply and demand it is possible that additional analysis could reveal additional revenue due from increased ticket prices. Related to this would be an acknowledgement and analysis of the increasing use of VTP, club seats, and season ticket sales. A more detailed revenue model could include the clubs VTP strategy and club seat designs and proposals which could serve to further refine the ticketing and concessions revenue.

Finally, this research focused exclusively on MLBP facilities. Future work of interest may include analysis of stadiums across a broad range of major league sports and other venues. The differences in demand, frequency of use, and ticket pricing could pose some differences worth of discussion. For example, National Football League stadiums have a significantly reduced usage due to their scheduling and the typical arena sees relatively high use since many host National Basketball Association (NBA), National Hockey Association (NHL), and college teams simultaneously. The types of flexible design options that need to be explored to find value may need to be expanded beyond those explored in this research.
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