Sustainable Architecture in Athletics: Using Mass Timber in an Old-Fashioned Field

Zach C. Lefever

University of Massachusetts Amherst

Follow this and additional works at: https://scholarworks.umass.edu/masters_theses_2

Recommended Citation
https://doi.org/10.7275/35387374 https://scholarworks.umass.edu/masters_theses_2/1301

This Open Access Thesis is brought to you for free and open access by the Dissertations and Theses at ScholarWorks@UMass Amherst. It has been accepted for inclusion in Masters Theses by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact scholarworks@library.umass.edu.
SUSTAINABLE ARCHITECTURE IN ATHLETICS: USING MASS TIMBER IN AN OLD-FASHIONED FIELD

A Thesis Presented

by

Zachary C. Lefever

Submitted to the Graduate School of the University of Massachusetts Amherst in partial fulfillment of the requirements for the degree of

MASTER OF ARCHITECTURE

May 2023

Department of Architecture
SUSTAINABLE ARCHITECTURE IN ATHLETICS: USING MASS TIMBER IN AN OLD-FASHIONED FIELD

A Thesis Presented

by

Zachary C. Lefever

Approved as to style and content by:

____________________________________
Robert Williams, Chair

____________________________________
Stephen Schrieber, Chair
Department of Architecture
DEDICATION

I would like to dedicate this thesis to my parents, Karen and Dave Lefever, who have supported me constantly through my architectural education and professional career. But most importantly for always encouraging me to pursue my dreams and that nothing is impossible with extreme determination.
ACKNOWLEDGMENTS

Thank you to my thesis advisor, Rob Williams, for the guidance he has given me during this thesis project and as an architectural mentor.

I would also like to thank my affinity group and classmates for always keeping me in check throughout the semester. This wouldn’t have been possible without all of you.
Sports have grown to be one of the largest industries in the United States and the world. Groups such as the National Football League, the Major League of Baseball, and the National Basketball Association, make billions of dollars every year. Along with this growing popularity has come the development of some of the most incredible pieces of architecture, showing off power, strength, and elitism. Teams are constantly competing to give their fans the best experience possible, including the greatest stadiums in the country. However, these technological and architectural feats come with environmental costs. Stadiums that hold over 80,000 spectators and a couple of thousands of employees are typically made entirely of steel and concrete and are responsible for incredible amounts of carbon dioxide. Often, they are fully utilized for a short amount of it. After a team relocates or decides their current stadium is not good enough, they destroy it to build a new one. In a field that is more concerned with the spectacle, this architectural study explores how the design of athletic facilities can be more sustainable through the use of long-span mass timber structures. It explores the history of stadium design and the

---

1 Gough, “Total Revenue of All National Football League Teams from 2001 to 2020.”
2 Steinbach, “7 Ways Stadium Design Has Changed.”
desire to create the next big thing. The author goes into detail exploring the use of mass timber in the field and presents how it not only can be sustainable but also a demonstration of the spectacle they desire. The design portion of this project will center around a new Indoor Track Facility for the University of Massachusetts. The structure will highlight the research from beginning to end, constructed from mass timber arches, beams, and columns.
TABLE OF CONTENTS

| ABSTRACT .................................................................................................................. vi-vii |
| LIST OF FIGURES ............................................................................................................. x |
| INTRODUCTION ............................................................................................................... 1 |
| CHAPTER |
| 1. Background ............................................................................................................... 3 |
| History of Stadium Design .......................................................................................... 3 |
| Mass Timber .................................................................................................................. 6 |
| Background .................................................................................................................. 6 |
| Environmental Benefits ............................................................................................. 8 |
| Limitation for Mass Timber ...................................................................................... 10 |
| Gathering Wood ......................................................................................................... 11 |
| 2. Modern Stadium Design .......................................................................................... 13 |
| Stadiums Social Impact............................................................................................. 13 |
| Gentrification ............................................................................................................. 14 |
| Designing a Modern Stadium ..................................................................................... 15 |
| Structure ..................................................................................................................... 15 |
| Unusual Program ........................................................................................................ 16 |
| 3. Precedent Studies .................................................................................................... 19 |
| TELUS ......................................................................................................................... 19 |
| Introduction ................................................................................................................. 19 |
| Wood Use ..................................................................................................................... 20 |
| Ocean Breeze Track and Fieldhouse .......................................................................... 22 |
| Introduction ................................................................................................................. 23 |
| 4. Site ............................................................................................................................. 26 |
| University of Massachusetts Indoor Track and Field Facility .................................. 26 |
| Introduction ................................................................................................................. 26 |
| Campus Connection ................................................................................................... 29 |
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>White City Stadium, London (Photo)</td>
<td>4</td>
</tr>
<tr>
<td>2.</td>
<td>Cross-Laminated Timber (Photo)</td>
<td>7</td>
</tr>
<tr>
<td>3.</td>
<td>State Farm Stadium Glendale, Arizona (Photo)</td>
<td>18</td>
</tr>
<tr>
<td>4.</td>
<td>TELUS Stadium Quebec City, PQ (Photo)</td>
<td>19</td>
</tr>
<tr>
<td>5.</td>
<td>TELUS Structure (Photo)</td>
<td>21</td>
</tr>
<tr>
<td>6.</td>
<td>Ocean Breeze Track and Fieldhouse Staten Island, United States (Photo)</td>
<td>22</td>
</tr>
<tr>
<td>7.</td>
<td>Ocean Breeze Passive Systems (Diagram)</td>
<td>24</td>
</tr>
<tr>
<td>8.</td>
<td>UMass Athletic Facilities (Diagram)</td>
<td>28</td>
</tr>
<tr>
<td>9.</td>
<td>Campus Users (Diagram)</td>
<td>29</td>
</tr>
<tr>
<td>10.</td>
<td>Circulation (Diagram)</td>
<td>31</td>
</tr>
<tr>
<td>11.</td>
<td>Local Track Facilities (Diagram)</td>
<td>32</td>
</tr>
<tr>
<td>12.</td>
<td>Prevailing Winds (Diagram)</td>
<td>34</td>
</tr>
<tr>
<td>13.</td>
<td>Program Relationships (Diagram)</td>
<td>37</td>
</tr>
<tr>
<td>14.</td>
<td>Floor Plans (Diagram)</td>
<td>38</td>
</tr>
<tr>
<td>15.</td>
<td>Exterior Rendering up Massachusetts Avenue (Render)</td>
<td>39</td>
</tr>
<tr>
<td>16.</td>
<td>Warm-up Track (Render)</td>
<td>42</td>
</tr>
<tr>
<td>17.</td>
<td>Building Shape Progressions (Diagram)</td>
<td>44</td>
</tr>
<tr>
<td>18.</td>
<td>Structural Section (Diagram)</td>
<td>46</td>
</tr>
<tr>
<td>19.</td>
<td>Structural Rendering (Diagram)</td>
<td>47</td>
</tr>
</tbody>
</table>
Introduction

Sport has been growing rapidly through popular culture and the architecture of the stadiums which showcase them should match. As sports continue to grow the amount of money that circulates through the industry continues to skyrocket. That increases the need for larger stadiums and teams can increase the amount of money they spend on these stadiums.

Stadium and facility design often lies on the edge of architectural, structural, and technological innovation. The Olympic games are a great example to showcase the crossroads of these disciplines. Every year the host nation tries to “one-up” the previous and this becomes a never-ending battle of progress. The Munich Olympics, for example, used a revolutionary lightweight tension structure made of metal cables and frames. This was met with architectural, structural, and technological praise and is an iconic display of design even today. A more modern example can be found in the 2022 Beijing Olympics speed skating oval. One of the only new venues built for the Olympics, it is made entirely of steel and concrete and creates a monument for the games. Something these buildings have in common is the afterthought of sustainability. These large structures rely on carbon-intensive steel and concrete to make their “grand” design possible.

Mass timber offers an environmentally friendly alternative. In a world where we are fighting a climate crisis reducing carbon emissions is as important as ever. Mass timber construction is more environmentally friendly than common building materials like steel and concrete and is lighter which reduces the size of the slab to build on. As this is first and foremost an exercise in architectural exploration, it is weighed heavily on the engineering and structural properties of long-span timber. This research had to be done
within the architectural background of stadium design, the use of mass timber in contemporary architecture, and in the statics that is associated.

There is relatively little exploration of mass timber in stadium design and this thesis explores the potential and encourages others to use it in the future. This project researches existing athletic stadiums for their materials, size, program, and the timeline of which they are built. Mass timber is analyzed for its structural properties, carbon sequestering, and user preference. The final project then combines everything in the design of a new Indoor Track Facility for the University of Massachusetts Amherst.
CHAPTER 1
BACKGROUND

History of Stadium Design

To first understand the modern-day stadium, there must be extensive exploration of some of the first athletics that were constructed and how we still draw from these early icons. The Greeks are credited with the first attempts to create the athletic stadium, which were originally long, narrow spaces in the shape of a U for chariot races with only a single turn. The Greeks then advanced their design and built the hippodrome\(^3\) stadiums, which were similar in layout but were broad enough to be used for chariot races, fights, and anything else that required large spaces. These early layouts were the foundation arenas for the ancient Olympic games.

These designs were then borrowed and improved upon by the Romans who built the circus and the amphitheater. The circus was a Roman version of a hippodrome, but much larger, as seen by the Circus Maximus in Rome.\(^4\) The amphitheater, however, had the most profound impact on stadium design. In this construct, the Romans took everything great about the hippodrome and circus and perfected it into one design. The amphitheater was a completely round or oval structure enclosed on all sides, typically used for gladiatorial contests. However, they were also used for large-scale spectacles, which required a lot of seating. The Romans designed their amphitheaters with precise dimensions on the field and its surroundings to allow for optimal viewing and seating for

\(^3\) Cartwright, “The Hippodrome of Constantinople.”
\(^4\) Zetlin, “Stadium.”
as many spectators as possible. The largest and most popular amphitheater of its time was the Roman Colosseum, which was constructed in the 1st century CE.  

After the fall of Rome, the amphitheater survived for a while until the decline of relevant sports and the spectacle that they represented. It wasn’t until the late 19th century that there was an emergence of stadiums again, with the growing popularity of large-scale sporting events. This was due largely to the revival of the Olympic Games, in 1896. The first modern Olympics, held in Athens, involved a stadium reconstruction of the ancient marble stadium constructed for a previous Olympics. Since then, the Olympics have placed an emphasis on developing a modern stadium in the host country to mark the importance of the event. The first modern stadium, White City Stadium, was designed and constructed in London (Figure 1.) for the 1908 Olympics. This innovative design included a partially roofed seating area, accommodating almost 50,000 spectators.  

---

White city stadium was designed so large that it could hold a 6-lane track and on the outside an 11-meter-wide cycling track. This size allowed for extra space on the interior of the ovals which housed archery, hammer throw, and enough room for the swimming and diving pool. The 1908 Olympics proved to be the peak of this stadium’s existence because in 1927 it was sold and later torn down in 1985.

The architectural innovations in stadium design that started with the Olympics soon spread to other sports and leagues. Almost every Major League of Baseball (MLB) team invested in new stadium construction in the early to the mid-20th century. One of the most iconic of these stadiums was the Polo Grounds. The stadium originally housed 2,000 fans but found expansions in 1911 and 1923, which increased the capacity to 34,000 and 55,000 respectively. The structure of the newly constructed stadium consisted of spread reinforced concrete piers which would reach the level of the first tier of seats. This tier was built of concrete slabs supported by beams that would span across the piers. Construction above the first tier was open steel framing with a cantilevered upper deck and roof. Some saw the new design as utilitarian, but it was decorated with frieze on the façade of the upper deck and the roof with the coats of arms of all the teams. The stadium also drew upon stadiums of the past in the design of upper-level boxes. They were designed with the lines of the royal boxes from the Colosseum with Roman-style pylons surrounding the grandstands.

In the 21st century, there are now stadiums that surpass 100,000-person-capacity and continue to grow. Even collegiate stadiums now represent eight of the eleven largest

7 Tomizawa.
8 Thornley, “Polo Grounds (New York).”
stadiums in the world. No matter the level of the team, they all have a continued reliance on steel and concrete. At all levels, stadiums continue to see growth which represents an even greater need for alternate building materials.

**Mass Timber**

**Background**

Mass timber draws on the technological advancements of heavy timber construction. It is typically made of large solid wood panels, beams, and columns engineered for greater strength, and is typically used for wall, floor, and roof construction. Mass timber’s high strength rating is like concrete and steel but is significantly lighter in weight. Thick layers of wood are compressed to create strong supporting pieces that can be combined and put together to form components. These elements are typically formed by laminating, fastening, or adhering to make one solid structural member.

The foundational elements of mass timber construction are the building blocks that allow designers to create tall buildings out of wood. Some of these foundational pieces include cross-laminated timber (CLT), which consists of layers of kiln-dried wood oriented in opposite directions of the previous layer. Glue-laminated timber (glulam) is a beam or column composed of wood laminations bonded together with durable, moisture-resistant adhesives. Nail-laminated timber (NLT) is created by turning dimensional lumber on edge and mechanically fastening the laminations together with nails. Dowel-laminated timber (DLT) is made from lumber boards that are held together with hardwood dowels. ⁹

---

As technology continues to advance, some more options and systems can be implemented with mass timber. Using different combinations and sizes, mass timber products can be used as roofs, walls, floors, columns, and beams depending on direction and strength. As opposed to the normal concrete and steel systems that tend to follow standard organizations, mass timber allows the designer and engineers flexibility depending on what type of system is chosen. Typically, options include post-and-beam, mass timber floor, and wall systems, and hybrid mass timber systems.

Post-and-beam is the most common option as they most closely resemble the common approach to construction. It is a skeletal framework of posts, beams, and decking supported on a standard foundation. The posts and beams are joined by fasteners and due to the construction and support there is no need for load-bearing walls. Glulam is the most commonly used technique for the posts and beams while the decking systems often are

Figure 2. Cross-Laminated Timber (CLT)
made of CLT or NLT panels. This design is most seen in office and commercial buildings due to the open plan allowance.

Mass timber floor and wall systems however take the opposite approach to post-and-beam by allowing the designer to take advantage of the mass timber panel’s two-way spanning capabilities. In systems such as this, mass timber panels can form both floor and wall with the walls taking the load of the structure. This type of design and construction is often seen to take the place of concrete in the core of buildings.

Hybrid mass timber systems can take a broader approach to the technique which refers to any combination of wood and any other possible material like concrete or steel. This system allows designers to focus on the strengths of each material and allows even more flexibility than post-and-beam. This is often found in nearly all-wood structures that combine mass timber paneling with light-frame wood construction that only has metal connectors and concrete foundations. Some designers prefer to include concrete floor finishes on upper floors purely for aesthetic and not structural reasons.

**Environmental Benefits**

Mass timber has several benefits, the most significant of which is the potential impact on sustainability. It is widely established that carbon dioxide emissions (CO₂) emissions and other greenhouse gases are in large part responsible for climate change. Unfortunately, the built environment finds itself playing a large role in this, as construction is responsible for 37% of all energy-related CO₂ emissions in 2020, and
heating and cooling needs are expected to increase by 79% and 84% in residential and commercial buildings respectively by 2050.\textsuperscript{10}

In response to this, there is growing research done on how designers can significantly reduce the number of emissions released pertaining to the built environment. At first, operational efficiency was examined, but it seemed to only put a small dent in the crisis. This then shifted the attention to ‘embodied carbon. The carbon emissions associated with a building include embodied carbon and operational carbon. Embodied carbon includes all emissions associated with the construction, rehabilitation, and eventual demolition of a building. Crucially, this includes the carbon emissions associated with the extraction and production of all the materials used in construction. Operational carbon, traditionally the focus of high-performance and green standards, includes the carbon emissions associated with the operation of the building including heating, cooling, and electricity. Recent studies show that mass timber is becoming the leader in sustainable design to combat embodied carbon because wood and other materials like bamboo photosynthesis during growth converting atmospheric CO\textsubscript{2} into oxygen. This process stores carbon in the material biomass; when these materials are used in buildings it can create long-term carbon storage.

As a part of the 2013 CLT research graduate design studio taught by Susan Jones, at the University of Washington, CLT was tested and investigated to analyze its technical aspects and their structural and construction requirements. Using the Athena Calculator, the study performed life-cycle carbon analysis comparing CLT assemblies to traditional

\textsuperscript{10} Robati, “The Embodied Carbon of Mass Timber and Concrete Buildings in Australia: An Uncertainty Analysis.” Page.1
assemblies such as concrete assemblies. Their research found that CLT performed significantly better than the concrete, which was expected, but by a much larger spread than hypothesized. The concrete assembly produced 39,129 MJ of fossil fuel consumption compared to the CLT’s 12,395. But the most important piece of data they extracted from the study shows that concrete assemblies have x3.2 ratio of global warming potential (GWP) when compared to CLT.\textsuperscript{11}

**Limitations for Mass Timber**

As mass timber is seen by most as the potential future of design and construction, there are critics as to how the material performs. Questions arise asking how a building made entirely of wood handles fires. Others question the strength of mass timber and how it would compare to conventional metal and concrete. Finally, clients are starting to question the cost-efficiency of this building type.

During a fire resistance test of a 5-ply CLT panel wall, the panel was subjected to temperatures above 1,800°F and lasted 3 hours and 6 minutes.\textsuperscript{12} This is far more than the 2-hour rating required by the building code. When a building of mass timber construction is subjected to fire, large pieces of timber char on the outside forming an insulating barrier protecting the interior wood from damage. This means that the interior wood cannot get hot enough to set on fire.

Recently constructed mass timber structures weighed approximately 1/5\textsuperscript{th} that of a concrete building of comparable size.\textsuperscript{13} This then reduces the foundation size and inertia

\textsuperscript{11} Jones, *Mass Timber*.
\textsuperscript{12} “Things to Know About Mass Timber.”
\textsuperscript{13} Jones, *Mass Timber*. 
that can relate to embodied energy. The reason this works so well is that timber has an incredibly high strength-to-weight ratio and can perform well during high seismic events. This is especially important for our argument as a sporting event contains extreme amounts of sound waves and pedestrian movement.

The argument for cost-efficiency requires a deeper dive into the construction process. While mass timber can be as much as five percent less expensive than steel and concrete construction, additional costs are minimized. Mass timber has a shorter construction time due to prefabrication. This requires less labor time and even more cost savings when you consider the decreased size of the foundation material.

**Gathering Wood**

Mass timber was invented in Austria and Germany in the 1990s and has grown rapidly in popularity since. Once used primarily in Europe, mass timber has seen its largest growth in the Northern United States and Canada. British Columbia now provides more than 30 percent of the timber used for the American building industry. Due to the pine beetle epidemic, there is a significant amount of impacted wood to harvest and process in these areas. The beetles have been known to kill the trees and therefore no longer serve a purpose besides harvesting them as a building material. There is only a certain amount of time before the trees fully die and become brittle, rendering them unable to be used for structural purposes. Since the start of the pine beetle epidemic in

---

14 Jones.
15 Jones.
1999 almost 45 percent of the mature pine trees harvested in British Columbia have been affected.

After a forest is destroyed by the pine beetle, with time, the dead wood fibers become drier and significantly more brittle. Eventually, they rot at the base of the tree, and this leads to difficulty while milling them. Due to this, they have a shelf life of about 8-12 years before they cannot be used anymore. They lose structural properties and are susceptible to fungus.
CHAPTER 2
MODERN STADIUM DESIGN

The Social Impact of Stadiums

Professional sports have always targeted the largest cities to locate their teams. Cities such as Atlanta, Cincinnati, Houston, Los Angeles, New York City, Philadelphia, Pittsburgh, San Francisco, Seattle, St. Louis, and Washington, D.C., hosted teams since the four major professional sports organizations were created. While being housed in the city is great for tickets sales, it is important to understand the type of social impact that comes with the franchise. Race, class, gender, neighborhood character, and preservation are just a couple of factors that must be taken into consideration.

On the topic of race, we will not explore the history of the players themselves, but of the demographics of the fans. Sport was, in the mid-20th century, something that could finally be viewed and played by a person of any color or nationality. However, rowdy, mix-race crowds, together with an increase in the population of African American neighborhoods inspired some owners to invest in architecturally distinct spaces to accommodate an increasingly wealthy and mostly white middle to upper-class clientele.  

Team owners claimed and advertised to build new stadiums that would reach a broader group of people but their methods and designs did the exact opposite of that. Lisle says that these stadiums, “claim to appeal to a broad public were couched in an “official” discourse that favored certain publics and employed the rhetoric of contagion to justify the destruction or abandonment of poor, ethnic, or African American neighborhoods in the inner city. These stadiums were typically separated from some of

---

16 Lisle, *Modern Coliseum.*
these neighborhoods whether physically or metaphorically. For example, the New York Mets built the new Shea Stadium on the edge of Flushing Meadows Park in Queens which had little to no social progress. This stadium was built far from the inner city which eliminated the chance of walking to a game and limited those who only could afford a vehicle to drive there. The design also featured large, cantilevered decks which got rid of obstructed view seating and removed bleacher seating all together which was almost always the cheapest seats at the ballpark where you could find the working class and younger fans. These seats were something that Polo Grounds, the New York Stadium before Shea Stadium, had readily available throughout the entire stadium.

**Gentrification**

The Merriam-Webster Dictionary defines gentrification as, “a process in which a poor area (as of a city) experiences an influx of middle-class or wealthy people who renovate and rebuild homes and businesses and which often results in an increase in property values and the displacement of earlier, usually poorer residents.” In the disciplines of architecture and urban planning, gentrification has always been in question whether it is good or bad for a neighborhood. This thesis is not meant to address the rights and wrongs of gentrification, but rather use it to analyze how a stadium can affect the people and communities that they serve.

Different from the stadiums built in the mid-20th century, modern stadiums find themselves constructed in low to moderate-income areas with high minority rates. Teams and owners target these areas for low-cost land and for the “Potential to find a
Bargain” as Wilkins says.17 Within a few years, these neighborhoods that previously thrived on locally and family-owned businesses are being overrun by corporations and startups. Generational housing can be seen being bought up and sold to make room for loft-style apartments for young professionals. While this thesis does not judge gentrification, it recognizes that the community is the backbone of the sports team franchise and that makes it the duty of the architect and designers to preserve community fabric in their built projects.

**Designing a Modern Stadium**

**Structure**

The structural element of a stadium is what has the most impact on the design and design development of the project. Understanding the number of users the building must accommodate in a three-to-four-hour span and how to support the live loads is how you begin to design the structure. For an average size professional stadium, there are approximately two to three million cubic feet of dirt removed from the site to start construction.18 This is because there are so many elements that you have to include in the program of a stadium that many end up below grade, so there will be no interference with the fans and normal site circulation. Usually, the site ends up being dug about 30 feet below grade, which allows enough space for one to two floors underneath (depending on how high the ceilings need to be).

---

17 Wilkins, “The Effect of Athletic Stadium on Communities With a Focus on Housing.”
18 How to Build a Football Stadium.
After this excavation, the next step involves placing the foundation and the stadium supports which hold up the entire building. Most stadiums now use concrete columns, but this is where mass timber can begin to help give stadium design a more sustainable approach. Three hundred thousand cubic feet of concrete are used to support the stadium from underneath which equates roughly to about forty million pounds of carbon emissions in the manufacturing of that concrete.\textsuperscript{19} Using mass timber for the same amount of structural elements would only emit two million pounds of carbon which is only five percent of the concrete construction.\textsuperscript{20}

The final element of structure in the stadium is the steel trusses that hold up the long-spanning roof. Truss systems are the most common of roof structures for stadiums because they need to allow as much space for spectators to view as possible and an arching truss system allows for the most viewing with the most strength possible. These systems are typically made up of three to four million pounds of steel which can be replaced by mass timber beams and only release a fraction of the carbon.

**Unusual Program**

Stadiums are different from normal buildings because they have a very complex program that is constantly changing for different uses. In addition, they need to accommodate an extremely large number of people in a very small amount of time and a lot of design and preparation needs to go into how they arrive, go to the bathroom, eat, drink, and leave in case of emergency.

\textsuperscript{19} How to Build a Football Stadium. 
\textsuperscript{20} Jones, Mass Timber.
As a fan arriving at a game, their path and circulation are somewhat straightforward. They park their car, go through security, and move on to their seat. With the exception of a bathroom break and dinner you only have so many places that you travel but there is so much more that happens behind the scenes of the stadium that a designer must plan for. The substructure of the building houses a multitude of different rooms and spaces for the franchise and employees. These include home and away team locker rooms which must be proximate to the tunnel to the field; offices for the coaches, managers, and other team officials with an emphasis given to the owners; and media rooms for post-game interviews, which are conveniently located close to the locker room, owner’s offices, stadium entrance, and exits. These are just a few of the many different rooms that go into a complex program and all need to be within a specific area of the stadium.

Another added difficulty with designing stadiums is their impact as a multi-use facility. The modern stadium isn’t only a place where fans gather to watch their favorite team play. It is also a destination for musicians, comedians, rallies, or even other sports such as MMA fighting or a monster truck rally. This flexibility of the program requires venues to adapt and change overnight, into something completely different.

Stadiums and designers have taken on the task to create the ultimate entertainment destination and be able to accommodate a multitude of events. Facilities such as State Farm Stadium in Glendale, Arizona (home of the Arizona Cardinals) have thought outside the box and that is the reason they can hold over fifteen different kinds of events every year.
They can hold football games, basketball games, soccer games, concerts, wrestling matches, and many more because they employed a retractable grass field that can be rolled outside revealing a concrete floor.
CHAPTER 3

PRECEDENT STUDIES

TELUS Stadium

Introduction

TELUS Stadium was designed for Laval University in Quebec to house their soccer, football, and rugby teams’ practice fields. The facility houses a 330’ x 200’ turf field large enough to accommodate every sport. TELUS can also host matches and games with the capacity to sit 450 spectators. Laval wanted a green building unlike any other athletic facility and the architect’s response was a timber structure that improves sustainability while also bringing a type of warmth to the sport. The overall shape of the

Figure 4. TELUS Stadium Quebec City, PQ (Courtesy of ‘Think Wood’)
building swoops across the roof and curves down the side of the building to the ground. This design was driven by ventilation and contributes to overall energy savings and enhances user comfort. The façade material is a metal cladding of different shades of gray with glazing matching the same shape as the panels.

The stadium was part of a larger athletic expansion that saw the entire region looking to expand its athletic prominence. The soccer stadium, which sits adjacent to the existing outdoor football stadium, provides an interaction between the two facilities, which can share services depending on the occasion. The building also houses a series of boxes with a superb view of the football field. Sanitation services and food concessions in the soccer complex are available to spectators at the outdoor stadium instead of the temporary facilities previously used during football games. TELUS is the perfect example of how to expand an already heavily trafficked athletic complex and create multi-purpose spaces capable of adapting to the occasion.

**Wood Use**

Mass timber construction gives Laval University a sustainable and professional stadium that allows an impressive clear span between the supports and a roofline that raises above the field. The long-spanning curved design gives the dark gray metal-clad exterior a fluid organic shape, minimizing the feeling of weight and making the structure appear weightless.

An abundance of wood gives this facility a warmer feel to the expansive playing fields. The long-span roof is comprised of a glulam main frame and straightening beams with steel struts—a hybrid assembly that makes for a flexible and graceful design. The
architectural volume provides maximum clearance over the center of the playing area and a 225-foot-long (68.5-meter) span between the supports and a raised roof line. Making use of prefabrication, the structure was quickly erected, in winter and notwithstanding the ambitious feat of installing 13 monumental, tapering three-hinged arches. An innovative technique involving steel dowels and self-tapping screws was used in the structural connection system comprising arch load-bearing joints and metal-wood connectors—the result is discreetly concealed, eye-pleasing connections.

The amount of wood used in the structure of TELUS totaled about 44,000 ft³. Laval University’s decision to use mass timber at this large scale reflects the environmental commitment companies have toward the future. As a result of this construction choice, approximately 1,500 fewer tons of CO2 were emitted during construction. The swooping nature of the roof was designed to maximize natural ventilation while the reflective shell limits heat islands in the summer months. These design strategies reduce air conditioning costs which, in addition to timber construction, make TELUS one of the most sustainable indoor athletic facilities.

Figure 5. TELUS Structure (Courtesy of ‘Think Wood’)
TELUS’s 13 arches meet the ground via concrete columns and are connected by metal braces. Wooden trusses link the columns together to create a cohesive structure for the metal-cladding roof. The metal cladding roof meets the arches at the top of the span but as it curves separates itself from the structure. Metal rods tie everything together as they connect the concrete columns, wood arches, and roof system.

Ocean Breeze Track and Fieldhouse

Figure 6. Ocean Breeze Track and Fieldhouse (‘Courtesy of ‘Sage & Coombe Architects’)
Introduction

Ocean Breeze was built as part of New York City’s Design Excellence program which includes the New York City Department of Design and Construction (DDC) and the Department of Parks and Recreation. The facility sits on a 110-acre park that was developed as a part of the mayor’s PlayNYC initiative which had the primary goal of bringing large parks into every borough of the city. The site is conveniently located on the Eastern Shore so the building has clear views of the Verrazano-Narrows Bridge, the Freedom Tower, and lower Manhattan.

Ocean Breeze is by far one of the most impressive indoor track and field facilities in the region bolstering a program that includes a 200-meter hydraulically banked track that can be either 6 or 8 lanes depending on if the track is raised or not to occupy more people during large practice sessions. This facility meets all of the United States of America Track & Field (USATF), National Collegiate Athletic Association (NCCA), and International Amateur Athletic Federation (IAFF) competition standards as well as seating capacity of up to 2,500 people, concessions, restrooms, meeting rooms, and a fitness center that serves the neighboring communities.

The stadium rises above one of the few remaining plots of native upland coastal grasslands on Staten Island. The building itself has a minimal interior footprint as it is largely comprised of an open-air parking area on the ground floor and program on the second floor. This enhances the views from the competition space while also the potential for natural ventilation and protects the building from rising tides and storm surges as you can see in Figure 7. The building also includes green building principles in the use of daylight harvesting, on-site stormwater management, photo-sensor-informed lighting
controls, recycled materials, and a “cool” roof that has spare structural capacity for future photovoltaic technology. All mechanical systems used throughout the building utilize high-efficiency equipment, which is controlled and monitored through a networked building management system. 21

Figure 7. Ocean Breeze Passive Systems (‘Courtesy of Sage & Coombe Architects’)

The most useful information of this study was the analysis of specific program and what needs to be included in the design and what can be excluded. Program like

21 “Ocean Breeze Track and Fieldhouse / Sage and Coombe Architects.”
locker rooms, concession, restrooms, and competition space are assumed but by studying ocean breeze other spaces like athlete check-in, warm-up corridors, athletic training rooms, and athlete lounges must be considered. Especially once considering the primary use of the new facility.
CHAPTER 4

SITE

University of Massachusetts Indoor Track and Field Facility

Introduction

The University of Massachusetts (UMass) has had a history of elite athletic programs and the track and field team is amongst the best. For collegiate athletic programs, one of the most important aspects of a coach’s job is recruiting and getting the best athletes in the country to their team. High school athletes are heavily recruited from teams across the country that are looking to show off their latest and greatest facilities as a tactic to woo the athletes into committing to their school. A state-of-the-art indoor track and field facility is the one thing missing from taking the UMass Track and Field program to the highest level in the country and this move would benefit not only the team but the university as a whole.

The site will be located on campus at the intersection of Commonwealth and Massachusetts Avenue. This site is the focal point at one of the largest entrances to campus. Access from most major highways comes to this specific corner and therefore allows this building a unique identity as one of the first experiences on campus. New students and parents visiting campus will be greeted by a new building that proudly bolsters the university’s commitment to sustainability and athletic success.

The site currently is a parking lot for different athletic buildings including Curry Hicks Gymnasium, Boyden Gymnasium, and Garber Field. The campus master plan however is shifting the focus of the university to a more urban feel. The plan attempts to move parking out, making room for expansion within the main roads and allowing the
campus to build up rather than out. This is already being done with examples such as the John Olver Design building, Newman’s Center, and the Slate and Artisan apartment complex. This project tried to follow the campus master plans agenda throughout the schematic and design development, to create a more realistic project that could reasonably be integrated into the campus.

In addition to the visual appeal of the site, it is located adjacent to the current athletic department buildings. The UMass athletic department carries 19 men’s and woman’s varsity athletic teams, 16 of which have facilities within a half mile of the site. Grouping athletic facilities is a key space planning method for the campus master plan for logistical purposes. However, for the sake of this project, the site was chosen adjacent to athletic facilities for the use of shared space. Boyden Gymnasium currently holds most of the soccer, lacrosse, and swimming team locker rooms, training rooms, strength training rooms, and nutrition center. It is also the main building that houses athletic administration, academic success, and professional development for student-athletes. The new Indoor Track facility will have its own training room, weight room, locker rooms, and lounges. But for student-athlete development, it is important to keep them within a comfortable distance to councilors and administration. Being within generally close proximity to other athletes promotes synergy within teams and allows for crossover in experience.

The athletic department has created a funnel down Commonwealth Ave and our site continues that and embraces the connection (Figure 8). Our site starts to create a connection to the rest of the athletic facilities on the southwest corner of campus across from Massachusetts Ave.
The site falls adjacent to The Curry Hicks Gymnasium (number 7 in the diagram) which currently houses the Track and Field Team. Curry Hicks was built in 1931 to be used as the physical education building and was dedicated in 1941 in honor of Curry Hicks, who was the athletic director at UMass since 1911. Nicknamed “The Cage”, Curry hicks was home of the basketball team, in addition to many other sports, until the Mullins Center (number 2 in the diagram) was built in 1993. After the construction of the Mullins Center Curry Hicks was solely used by the track team. The Cage has seen updates through the years including locker room renovations, coaches’ suites, and lounges but the once beacon of athletic performance is currently a difficult space to develop a high-
caliber track team. Although the track team has adapted the cage to their needs, to elevate the program, they need sufficient space to practice. A track surface thin as paper on top of a concrete structure is less than ideal and can lead to serious injury, ninety degree turns for a four-hundred-meter sprinter is a blown knee waiting to happen, and there just simply isn’t enough space to allow the entire team to practice.

The building façade has leaks that allow air from the outside to creep in. In the harsh New England Winters, it gets cold on the track surface which also creates an unhealthy environment for the athletes. Cold muscles are just asking to tweak the wrong way and end a student’s season. These reasons make The Cage almost uninhabitable and this project even that much more necessary.

**Campus Connection**

Figure 9. Users Diagram
It is important as you design on a college campus to keep the different user groups that circulate the site in mind. This site is even more interesting as it is the junction of athletics, academic, and residential users at the University (Figure 9). The site is divided by an existing path with creates two masses connected by a bridge. The track facility takes up the larger mass on the east and to the west is going to be a campus hub. The campus hub is something that will bridge the gap between all user groups on campus.

As the primary objective of this thesis is the design of the new track facility, the campus hub will be generally unresolved through the completion of the project. It will however assist the track facility at a later date and design would begin at that time. The campus hub will consist of a food court, study rooms, student lounges, and other amenities to support the athletic department, academics, and residence.

The circulation of students from parking lots, dorms, dining halls, and classes is essential in creating a connected campus. Because our site is surrounded by roads, walking paths, and bike paths (Figure 10), it is crucial to incorporate the pedestrian experience into the final design. Questions that arise from the circulation study are how do bicycles come from the path experience and combine with the walking students? Heavy pedestrian traffic occurs at all four corners of the building; how do the joints of the building respond to this? With the existing path going through the center of the site, do you redirect pedestrians, do they interact with the building itself, or is it an implied interaction? How do shadows influence the pedestrian experience and how can they enhance them?
Figure 10. Circulation
Practical Reasons for Site Location

This project is important for the Track and Field team for recruiting, student-athlete development, and health concerns. But it’s also a way to bring in more money for the team and athletic department. Hosting a high-performance track and field meet can bring in upwards of three hundred thousand dollars and these are the kinds of meets that the new track facility is designed to accommodate. To host meets of this caliber, a track and field facility must be equipped to pass the USATF and NCAA rules. Some of these rules would be the number of lanes on the track, the width of track lanes, spectator seating, proper warm-up areas, etc.

New England and New York are home to some of the best track and field teams in the NCAA and there are not enough high-performance tracks to accommodate the need.
for track meets. Between New York and New England, there are only four high-performance track and field facilities for over four hundred colleges and universities. These four facilities fall in only two cities only 3 hours from each other. This makes the site of the UMass track facility a central location in New England and New York and that is much more important.

Natural Site Elements

Passive Systems

Passive systems were a driving force of sustainability that wanted to be used in design and early development. One element that was particularly important to the sustainable design was passive ventilation with the prevailing winds. The prevailing winds in the micro-climate around our site run primarily south to north and therefore the design is needed to accommodate this (Figure 11). Glazing is to be put on the north and south façade which can be operable to get air in and out of the competition space.

Fresh air is extremely important in indoor athletic facilities due to the dry air that builds up indoors. This gets even more important when designing an indoor track facility due to the number of athletes and heavy breathing in a short amount of time. The athlete’s performance and health rely on proper ventilation and getting clean air on the competition floor. This strategy also cuts down on cooling in the summer months saving the university money, power, and cutting down on waste.
Another appeal of the chosen site was the interesting slope rising from west to east almost forty feet. The aggressive slope creates multiple interesting opportunities for design. There becomes the availability to put half of the building underground while the other is fully exposed. This affects the program and placement of key programmatic elements, asking questions about which spaces need light more than others. How does the light affect the user’s feeling in large spaces versus smaller spaces in the underground program? These questions helped shape the early schematic design of key programmatic elements such as the coaching suite, locker rooms, and warm-up track.

Figure 12. Prevailing Winds
Setting the facility into the slope also creates an opportunity for passive systems to be incorporated into the project. The soil underground holds temperature differently and can keep the temperature in the adjacent spaces more controlled. This reduces cooling loads for these spaces and therefore cooling loads for the entire building. Managing solar heat gain can also lower cooling loads.

**Slope Design**

In addition to the passive system benefits of designing the facility into the site, there are specific design features that using the slope can highlight. Having surfaces at different floor levels on the exterior of the building allows for different entrances on those floors. With these different entrances, you can create different conditions for different pieces of the program. The most important piece of the program is the competition track and spectator seating. Adding different entrances and different floor elevations allows the main piece of the program to be elevated onto the second floor.

By raising the competition space to the second floor, the rest of the program, therefore, gets pushed down to the first floor. The slope produces a condition in which half of the first floor is underground and the other half exposed, forcing the design to interact with the site from a programmatic approach. The warm-up track for example creates a condition for pedestrian views circulating down the slope on Commonwealth Avenue. As you walk east to west down Commonwealth Avenue the track is in full view of the pedestrian and when you meet the corner with Massachusetts Avenue the warm-up track becomes visible. This allows the pedestrian to experience the evolution of the race day experience.
The program was strongly influenced by the Ocean Breeze precedent study but revised slightly to fit the specific needs of a Varsity Athletic Institutional facility. The program is split into three categories: Competition space, support space, and the university hub. The competition space requires approximately fifty-thousand square feet and therefore must take up almost an entire floor.

The competition space was moved to the second floor as previously mentioned for site conditions and pedestrian views. Taking up the entire second floor allows it to dominate the space and drive almost every design element associated with it. The angle of the track was strategically picked to optimize the fan experience and visual cues. The choice of where to put the start/finish line was driven by fan interaction, sunlight and glare, and performance optimization. The location of the long jump, high jump, and throws pits were chosen to optimize space for warming up in addition to safety requirements and scheduling concerns.

The spectator seating is placed north of the track running the length of the wall and can hold five to six hundred fans. Positioned north of the track allows the south façade to bring in natural light deep into the competition floor eliminating the need for lighting throughout the day. The south façade has enough glazing to light the competition floor on even cloudy days without the need for artificial light. Positioning the spectator seating north of the track away from the pedestrian circulation allows for more interaction among the community, students, and athletes.
The organization of the rest of the program stems from relationships to the competition space. The warm-up space should be adjacent to the competition for easy access when it comes time for the race to start. This was later designed to be adjacent to all the locker rooms as well for a continued circulation path from the entrance to the locker rooms, to the warm-up track, and the competition track. The training room needed to have a connection to the locker rooms, warm-up track, and the competition floor which is why it was placed strategically on the first floor with a stairwell that leads directly to the track floor.
Circulation

User Groups

Figure 14. Floor Plans
**Spectator Experience**

You’re a fan coming to the track facility as a spectator. You arrive on campus and park in the southwest corner in parking lot thirty-three. A path brings you across University Drive and along the side of the southwest residential area of campus. To your right are a sea of brick buildings with a mix of low and high-rise dormitories and dining halls. To your left are the university’s intermural fields and turf facility. You wind up the path through a group of trees and arrive at the corner intersection of Commonwealth and Massachusetts Avenue. As you glance up you are greeted by a warm, dark copper-colored paneled façade with windows lining the street. Your eye follows the vertical windows up to the roof and you see the warmth of the mass timber arches supporting the monumental building in front of you.

![Figure 15. Exterior Rendering up Massachusetts Avenue](image-url)
As the walk sign permits you to continue you arrive at the corner of the facility and peer in to watch the athletes warm up for their upcoming event. You move along the front façade to the main entrance and enter. The athletes warming up haven’t left your right peripheral vision the entire time. The lobby has high ceilings making you feel comfortable and welcome in this monumental structure. To your left are elevators and in front of you a desk with a friendly face waiting to greet you. You can already hear the cheers for the race that just finished, and your anticipation is at an all-time high. You pay for entrance to the meet, receive your wristband, and take the stairs that lie just beyond the elevators. At the top you reach the sea of fans clapping and cheering for the fierce competitors. You find an open seat and wait for the next event to start.

**Kinesiology Student Experience**

You are a Kinesiology student living on campus going to class for the day where you are studying the cushion in the new Nike running shoe. As you are walking to class you realize you are a little early and decide to grab some breakfast before studying. You stop by the new university hub for a breakfast sandwich in the food court. The line is moving slower than normal for a Wednesday morning, but you get your sandwich and head across the floor to the lounge and grab a seat. After you relax and finish your sandwich you have five minutes to get to your studying but that is no worry as it is right next door. The path between Garber Field and your room is full of students commuting to class and admiring the building that your department calls home.

The path slopes down to the road alongside Boyden Gymnasium as you round the corner to the front entrance. You can’t help but notice the wooden arch that creates the canopy you are walking under. You take your last minute before the study begins to
admire the warmth of the wood and its intricate connections. You approach the main door and notice the elevators and stair to your left and think about unusually quiet it is compared to race day. The secretary at the front desk checks your ID and buzzes you into the lab space. You wind the corridors looking through the glass at experiments that have already begun until you reach your destination at the end of the hall. As you enter the lab your professor puts the final wire on the test subject’s back and they step on the treadmill. You pull out your notepad as they begin to run.

**Visiting Teams Experience**

You are a visiting athlete running the mile at the new UMass indoor track facility at their inaugural meet. Your bus ride from Albany is only an hour and a half but it feels like three and a half with your nerves. The bus is on a highway and as you look out the window you see a sign for route nine and you know you must be close. A couple of turns later, you are driving up Massachusetts Avenue and the facility comes into view. Your eye is immediately drawn to the huge arches that you’ve heard about. The bus makes the left turn onto Commonwealth Avenue, and you see your fellow competitors already warming up in the downstairs track. The bus makes its final turn into the drop-off area and your team clears the bus and moves inside.

As you walk through the doors some other athletes are sitting in a waiting area to your left. Some are doing last-minute homework before they must warm up. Others just looking for a place to charge their phone. Straight ahead is a long hallway leading to the warm-up area where your team is already putting their bags down. You have about an hour before your race, approximately when you begin your warm-up. Coach mentioned before the bus left that there is a nice path across the street to warm up in. But you
decided to warm up on the brand-new warm-up track below (Figure 15). Every lap around you through the glass wall at the hundreds of spectators waiting to get in. Your excitement builds as you hear over the intercom that your race is next. You take the stairs in the corner of the room and as you take the last step off a sea of fans is there waiting to cheer for the next race. You take one last stride down the track. Take the line, and your race begins.

**UMass Athlete Experience**

You are a UMass track and field athlete on a normal day of class and practice. You just got done with your afternoon class and have a little bit of time before practice starts. You decide to head back to the southwest residential area to your dorm to relax and do some homework to get everything done so you have the evening free. You wind
through campus, arrive at your dorm, relax for about an hour, and head off for practice. You like to get there early so you have time to change and stretch before practice starts. As the tunnel approaches you can barely see your destination through the trees and are already looking forward to your workout on the brand-new track. You emerge on the other side of Massachusetts Avenue and can see the track through the vertical windows on the east façade. The path brings you around to the entrance and you enter your new home. You veer left at the intersection of walls down the hallway that reads “UMass Suite”. You pass your coach’s office to the left as you take your final right turn to go toward your locker room. Straight ahead you notice some of the high jumpers hanging out in the lounge before practice. You wave to your teammates as you go into your locker room.

The locker room is extremely spacious to accommodate sixty grown adults and is equipped with a small lounge, lockers, showers, and a laundry room. Your locker is in the back corner, so you pass the other fifty-nine on your way and get ready for practice. As you sit in your locker you look up at the warmth of the solid wood above you and feel calm. Your eyes then shift down to the maroon on the floor. The UMass “Power U” logo looks back at you as you are hit with a rush of encouragement and pride. You leave the locker room with your teammates, head up to the track, and begin practice with your coach.

After practice, you and your teammates have weight room, which is no extra problem as it is directly across the hall from your locker room. The state-of-the-art weight room is equipped with everything from a treadmill to weight racks to push sleds. After your lift, you grab a protein shake from the lounge and head to the locker room to
rinse off in the shower. The shower is refreshing after a long three hours of practice, and you are grateful that you don’t have to walk back and shower at your dorm. Your meeting with the coach is in thirty minutes so you decide to head next door to see the trainer and have them massage your hamstring that started bothering you in the workout that day. The training room floods with the evening sunlight, and you notice the amount of glass that encompasses the room. Some of your teammates are stretching on the warm-up track through the glass but before you can wave to them the trainer finds the muscle that’s bothering you as you grip the table. You make your way down the hall for a quick talk with your coach before you decide to head back to your dorm for the night.

**Design Development**

Figure 17. Building Shape Progressions
Building Shape

The overall building design was approached systematically through steps, each of which was determined as a key factor of the overall design principles. This first shape was a result of the site boundaries and extruded up to create all of the possible areas that could be used for the building. The next steps were to respond to site restrictions that were in place. This is the existing path through the site and the extreme slope rising from the west to the east. At this stage of the design process, multiple options for long-span structures were considered to span the required two hundred and ten feet required for the track. Ultimately, the proposed design utilizes mass timber trusses because they are the most efficient way to span such a long distance. So, the following step was to create a rounded roof that would accommodate the arch and get to the specifics further on in the design. To create a main entrance along Commonwealth Avenue the west façade was recessed by 20 feet and allowed the arches to be visible from the exterior. The final stage was the façade design. Copper-colored metal panels highlight the warmth of the wood without detracting from its luster. Curtain walls and large windows were included strategically for reasons mentioned earlier such as program, passive strategies, and user comfort.

Structure

The structure of the building is glulam arches designed to span two hundred and ten feet across the competition space. To do this, it was determined that the arches needed to rise fifty feet with an arch depth of thirty-eight inches. Thirteen of these arches were used for the length of the building and connected to the foundation by concrete piers that distribute the weight of the roof and arch to the ground.
The first floor is supported entirely by CLT panels, glulam columns, and glulam beams where they are needed. The beams are needed particularly for the extra span required over the warm-up track. It was determined that an appropriate grid layout for the program of the building would be twenty-five feet by twenty-five feet. For this span, a nine-ply CLT is required which can span up to thirty-five feet without added support.

Exposing and celebrating the structure early in the design became the most important thing as decisions started to be made. Bringing the structure to the outside for pedestrians to see and interact with quickly became a driver. The intricate roof structure in Figure 18 is the result of this.

![Figure 18. Structural Section](image)

The roof was designed to slope along with the site. The armatures in the arches each have a different shape to achieve this. Therefore, the roof becomes an extension of the site and also highlights the unique structure supporting it. The design is meant to appear weightless, and the roof is a flowing structure that is almost hovering over the athletes.
Figure 19. Structural Rendering
CHAPTER 6

CONCLUSION

The project came out as planned and moving forward there is hope to resolve the university hub building further. This piece of the program is vital in the success of the construction, ultimately the goal of creating a more united campus. This addition will also be structured from CLT and glulam columns to further show its resourcefulness. The exterior, while not mimicking the track facility will have a similar language and work together to create a more unified building front on the southwest entrance to campus.

A main concern from the jury at the final review concerned the size of the arches. Although the sizing of the arch was done from a more static and engineered route, the jury encouraged me to rethink the architectural element and consider making the beams bigger for a more defined look. This exercise has taught me to take a step back from the hard numbers and mathematic approach to some elements and to not forget about the appearance and occupant feel in the spaces. Another element that was touched upon is the shape of the structural columns and how they could be more effectively used as a member of the structure rather than a pedestal that the arch sits on. This is a good point that was brought up and something that more research in the future should be dedicated to too.

The proposed design for the new University of Massachusetts Indoor Track and Field Facility highlights the innovation of wood construction and design on a large-scale level. The building serves as an example to the athletic world that a more sustainable approach to its long-span structure is a very reasonable option in the future. The need for huge concrete columns and slabs with steel trusses that create tons of carbon can be
replaced with a material that grows on its own and sequesters carbon rather than create it. Not only is it sustainable but creates a softer feel to the building occupants and pedestrians.
BIBLIOGRAPHY


“Things to Know About Mass Timber.” *Think Wood*, n.d.

https://www.thinkwood.com/blog/4-things-to-know-about-mass-timber.


Wilkins, Dominique. “The Effect of Athletic Stadium on Communities With a Focus on Housing.” Clark University, May 2016.
