MINIMALISM, TECHNOLOGY AND OPPORTUNITY
DEVELOPING A NEW OLYMPIC Prototype
SIGNATURE PAGE

A Design Thesis Submitted to the Department of Architecture and Landscape Architecture of North Dakota State University

By

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In Partial Fulfillment of the Requirements for the Degree of Master of Architecture

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# TABLE OF CONTENT

**COVER PAGE** .............................................. 1  
**SIGNATURE PAGE** ...................................... 3  
**TABLE OF CONTENT** ................................. 4  
**LIST OF TABLES AND FIGURES** ................. 5  
**THESIS ABSTRACT** ................................... 6  

**NARRATIVE**  
**THESIS THESIS STATEMENT** ................... 8  
**FOCUS-EMPHASIS-GOALS** ......................... 9  
**PROJECT TYPOLOGY** ................................... 11  
**USER/CLIENT INFO** ................................... 12  
**PROJECT JUSTIFICATION** ......................... 13  
**DESIGN PROCESS DOCUMENTATION** .......... 15-17  

**RESEARCH PAPER** .................................... 18-25  
**WORKS CITED** ........................................ 26-29  

**PRECEDENT ANALYSIS**  
**AND NARRATIVES** ..................................... 30-61  

**PROGRAMMING**  
**AND NARRATIVE** ...................................... 62-63  

**SITE ANALYSIS**  
**AND NARRATIVES** ..................................... 65-75  

**CODE ANALYSIS**  
**AND NARRATIVE** ...................................... 77-81  

**DESIGN METHODOLOGY** ............................. 83  

**PLANS FOR PROCESSING** ...................... 84-85  
**PROJECT SCHEDULE** .................................. 86-87  

**PROJECT JUSTIFICATION** ......................... 89-91  

**RESEARCH METHODS** .............................. 95-106  
**SOLUTION** ............................................. 107  

**SHIPPING CONTAINER PROCESS** ........... 108-113  
**FLOOR PLAN LAYOUT** .............................. 115  

**ITERATIONS** .......................................... 116-117  
**SUSTAINABILITY FEATURES** .................. 118-121  
**FINAL DRAWING|BOARDS|DISPLAY** .......... 122-127  
**APPENDIX** ............................................. 129
FIGURES AND TABLES

FIGURE 1: ATHENS KAYAK COURSE .......................... 19

FIGURE 2: ATHENS KAYAK COURSE - DRY ...................... 19

FIGURE 3: BEIJING STADIUM .................................. 21

FIGURE 4: BEIJING STADIUM .................................. 21

FIGURE 5: LONDON AQUATIC STADIUM FLOOR PLAN ..... 33
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 6: LONDON AQUATIC STADIUM ELEVATION .......... 33
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 7: LONDON AQUATIC STADIUM ELEVATION .......... 33
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 8: LAS PARK PERSPECTIVE ................................ 34
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 9: LAS AERIAL VIEW .................................... 34
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 10: LAS GROUND FLOOR PLAN - OLIMPIC MODE 34
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 11: LAS FIRST FLOOR PLAN - OLIMPIC MODE .... 34
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 12: LAS SECOND FLOOR PLAN - OLIMPIC MODE 35
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 13: LAS GROUND FLOOR PLAN - LEGACY MODE 35
http://www.archdaily.com/161116/london-aquatics-centre-for-2012-summer-olympics-zaha-hadid-architects

FIGURE 14: PERIS-TOTAL TEMP. PAVILION ELEVATION .... 38

FIGURE 15: PERIS-TOTAL TEMP. PAVILION ELEVATION 39

FIGURE 16: PERIS-TOTAL TEMP. PAVILION WIREFRAME 39

FIGURE 17: PERIS-TOTAL TEMP. PAVILION WIREFRAME 39

FIGURE 18: PERIS-TOTAL TEMP. PAVILION WIREFRAME 39

FIGURE 19: PERIS-TOTAL TEMP. PAV. FLOOR PLAN ...... 40

FIGURE 20: FOREST GREEN ROVERS STADIUM .......... 42-43
http://www.archdaily.com/798696/zaha-hadid-architects-competition-winning-design-for-forest-green-rovers-will-be-worlds-first-all-wood-stadium

FIGURE 21: FOREST GREEN ROVERS INTERIOR ............ 44
http://www.archdaily.com/798696/zaha-hadid-architects-competition-winning-design-for-forest-green-rovers-will-be-worlds-first-all-wood-stadium

FIGURE 22: FOREST GREEN ROVERS ......................... 44
http://www.archdaily.com/798696/zaha-hadid-architects-competition-winning-design-for-forest-green-rovers-will-be-worlds-first-all-wood-stadium

FIGURE 23: FOREST GREEN ROVERS INTERIOR ............ 45
http://www.archdaily.com/798696/zaha-hadid-architects-competition-winning-design-for-forest-green-rovers-will-be-worlds-first-all-wood-stadium

FIGURE 24: FOREST GREEN ROVERS ......................... 45
http://www.archdaily.com/798696/zaha-hadid-architects-competition-winning-design-for-forest-green-rovers-will-be-worlds-first-all-wood-stadium

FIGURE 25: FOREST GREEN ROVERS INTERIOR ............ 45
http://www.archdaily.com/798696/zaha-hadid-architects-competition-winning-design-for-forest-green-rovers-will-be-worlds-first-all-wood-stadium

FIGURE 26: FOREST GREEN ROVERS STADIUM .......... 46-47
http://www.archdaily.com/798696/zaha-hadid-architects-competition-winning-design-for-forest-green-rovers-will-be-worlds-first-all-wood-stadium

FIGURE 27: PROGRAMMING DRAWING ....................... 52

FIGURE 28: PROGRAMMING DRAWING ....................... 52

FIGURE 29: PROGRAMMING DRAWING ....................... 53

FIGURE 30: SEATTLE DOWNTOWN SITE MAP .............. 61

FIGURE 31: SEATTLE MONTHLY PRECIPITATION .......... 62-63

FIGURE 32: SEATTLE AVERAGE RAINFALL ................. 64

FIGURE 33: SEATTLE CITY DEMOGRAPHIC ............... 65
http://www.seattle.gov/dpd/cityplanning/

FIGURE 34: SITE TREE COVERAGE ......................... 65
Google maps
It is very important as designers to make design decisions that not only effect and create results for the immediate, current situation at hand, but it is also our responsibility to create and design with the intention of fostering an always changing, constantly adapting, sustainable environment that protects, conserves and even harvests our natural environment and preserves it for the betterment of our future generations. With that being said, we designers also have the responsibility of designing a place that has the ability to move its inhabitants emotionally and physically through the space without compromising its functionality. An exorbitant amount of money and resources is invested into designing and constructing stadiums of this day and age. However, most of the time these investments are not fully recovered as the stadiums fail to remain effectively operational regularly throughout the year or even after the major sporting event has concluded. This leads to a massive structural space that is unable to generate enough of its own resources to keep the building up and running. This leads to an abandoned building with a very high embodied energy. To alleviate this situation this thesis will be focused on developing new and innovative methods of designing, constructing and utilizing large scale stadium architecture through the use of robotics and 3d printing while also taking advantage and exercising the tactics and methods of temporary venue architecture.
RESEARCH QUESTION

HOW MIGHT TEMPORARY VENUE ARCHITECTURE BE USED TO POSITIVELY IMPACT THE SOCIO ECONOMIC ISSUES RELATED TO THE CURRENT TREND OF OLYMPIC STADIUM DESIGN
Stadiums today cost a large amount of money to build, and even more to maintain. Furthermore, the embodied energy required and the energy footprint that is left behind, is a cause for concern for a sustainable future.

To mitigate the socio-economic impact of stadium architecture on our environment, it is important to turn our attention to self-contained, temporary venue architecture and to rethink the future of stadium design.
Project Focus | Emphasis | Goals

Sustainability  Sustainability should be a key focus in any design but for this project, it is especially important because of the scale and size of these massive structures. The amount of resources used to construct such a building should be a major consideration when planning. Renewable energy strategies and renewable resources will be incorporated in construction and post construction decisions. The overall goal is to have a self-sustained, efficient building with as little embodied energy.

Cost  The high cost associated with this typology is another concern. It is vital to find a balance in aspect of building construction and maintenance. Looking into alternative energy is one significant methods of keeping costs of maintenance down post construction. This should be achieved with cohesive collaboration of today’s widespread technological advances.

Technology  I strongly believe that the key aspect to solving the problematic issues facing the design of this typology is in the incorporation of technology. Finding new methods that make a large venue like this possible will comprise of using strong, light weight materials that are movable with the help of automation and robotics.
Stadium Architecture

Typological research was based on stadium architecture, particularly that which is able to host events for large amounts of people. These structures need to have seating that provides a good view of an arena that is typically at the center of the stadium. Stadium Typology also focuses on effective and safe egress for these large groups of people. Another prominent aspect of stadium architecture includes amenities, which vary from convenient and accessible restrooms to concessions.

Temporary Venue Architecture

Another new research aspect for my thesis is looking into a partly or entirely temporary venue structure. The main reason for this is to minimize the impact on the environment and to reduce the carbon footprint. This would also solve the major issue of abandoned stadiums that are often the case with Olympic stadiums.
**User/ Client**

**Client** - Depending on the stadium type the client can vary from a government to a state or city council. At times the client could also be the governing body for the sporting institute i.e. The Olympics Committee, The Football Club etc.

**Users** - Sports enthusiasts of all ages. This will include little children to the elderly. It is imperative to meet proper ADA standards. Users will also include higher dignitaries and they will typically need viewing space from different stand/ box office. There would also need to be a designated location for media and their equipment. Finally, the stadium will need to have proper facilities for the athletes.
Project Justification

This typology uses a large volume of resources in every stage of its construction and even post construction. The measure of materials and resources that go in to maintaining these buildings need to be reduced substantially or at the very least this issue would be justified if the usage of the facility was such that the amount of resources that it needed was warranted. There should be no doubt that there is a problem in this system. The constantly depleting resources that we invest in these large structures should at least see a payoff that is worthwhile. Our planet cannot afford to keep ingesting their valuable assets into such projects. For these reasons it is important to find a new method for building and maintaining these sports arenas. Sports enthusiast should have the chance to still enjoy these spectacular sporting events without mankind and mother nature having to pay such a high opportunity cost.
DESIGN PROCESS DOCUMENTATION

Context Analysis
Conceptual Analysis
Spatial Analysis
Floor plan Development
ECS Passive Analysis
Section Development
Structural Development
Materials Development
ECS Active Analysis
--Midterm Reviews
Project Documentation
Context Redevelopment
Structural Redevelopment
Project Revisions
Presentation Layout
Plotting and Model Building
Preperation for Presentations
The plan of action for the design process will start much like many of the other studio projects. It is key to have a strong foundation to go off of for a thesis building design. Project design will begin by looking at the site, its elements and the culture and feel surrounding it. At this point conceptual design will start taking its course.

Conceptual design will lead into schematic design where soft geometric shapes will transform into defined functional spaces.

From there it will be prudent for the structural development to follow suit. Once the main structural elements are ironed out it will be time to look into materials and building envelop design.
Each of the steps above will need to be in collaboration with technological and systemic process of the thesis design. It is crucial that both of these aspects go hand in hand.

Revisions will need in to be made after each review and constantly throughout the project to have a successful end design.

Once these processes are completed to satisfaction I plan to translate them into video renderings and some still renderings for board layout. Model making is likely to begin at the latter stage once a concrete end design has taken shape.
Introduction

This year the world held yet another great Olympics. This international sporting event has become a tradition in human culture with more than 200 nations participating. And every four years the host country of the Olympic games will pull out all the stops and deliver an epic show. In the four years of preparation, the host country ingests many millions of dollars into infrastructure and resources and it is not uncommon for countries to hit over 9 figures. A major part of the costs is in designing and building the arenas or the Olympic stadiums itself. Australia spent nearly $700 million on the stadium alone. China - $480 million on the Bird's Nest and London - $537 million. The winter Olympics games in Sochi, Russia a whopping $51 billion. Not to mention the costs to maintain these massive stadium buildings year after year.

The Olympic Stadiums are built to accommodate thousands of people. When it is the largest sporting event that exists, with over 200 nations participating, the numbers for stadium seating will naturally have to be way above the normal stadium seating plan. There is very little chance that those seats will ever again see as many spectators as it did for the Games. So what happens as soon as that torch goes out?

This, in general, is the problem with the Olympics: the Games galvanize their host cities, create a festive atmosphere, spur economic development--and then they are gone. Olympic Villages usually turn into housing, parks and infrastructure remain, and smaller facilities can even be of use, but the major monuments that the Games apparently necessitate rarely serve their cities well. The Bird's Nest by Herzog & de Meuron has sat largely empty since the 2008 Games in Beijing. (Betsky 2013)
Sustainable Stadium design and Construction

Defining the Problem

In Beijing, host to the 2008 Summer Games, the Chinese government struggles to fill its Bird’s Nest stadium, which cost $11 million a year to maintain. Now seating 80,000 (after 11,000 temporary seats were removed following the 2008 Games), the site has become a tourist attraction, but lacks a regular tenant. [Kim 2014]. The Beijing stadium is and has been recognized as spectacular architecture. However, it still lacks the activity needed to keep the stadium current as a functioning building. The Bird’s Nest is not alone in this, there are many other Olympics stadiums that succumbed to the same fate.

To the left is Athens kayak course then and now. What was once a track filled and exuberant, is now bone dry. (Chester n.d.)
Beijing's beach volleyball stadium remains unused for the last eight years. Right next to that is the deserted and unmaintained kayaking centre for the Beijing 2008 Olympics. (Chester n.d.)

It takes many different entities and elements to ensure that these infrastructure projects are not abandoned or forgotten after the games are done. The way the Architects and designers approach the subject can have a vast impact on this dire situation. This thesis topic is driven by what can be done by us as designers to make these venues more sustainable.

Designers can look into different methods of repurposing. Making stadiums adaptable to more than one sport? Making structural components easy to disassemble and components easy to reuse and recycle.

Some arenas are just unusable because of technology or policy changes. Bigger crowds and better athletes also rendered Squaw Valley's facilities obsolete (Kim 2014). Adaptability should be a main focus when designing and constructing. We may not be able to see the exact changes that are going to take place in future sporting events, however, it is important to predict and build in a way that if needed, such measures can be taken to change certain parameters without having to claim the structure redundant from that point on.

It's a sad story, author and historian David C. Antonucci told TODAY.com. Either many venues just are no longer economically sustainable, or they are overtaken by technology or size. (Kim 2014).
Blyth Arena only sat 8,500, which is way too small to host a hockey game now, Antonucci said. Also, ski jumpers just became more adept at what they were doing and jumped longer distances, so the ski jump was no longer suitable or safe. (Kim 2014). There are many variables to consider, technology is changing so rapidly that it is becoming more and more difficult to predict what would happen in the span of five years. Therefore, we as designers need to be even more conscious of the buildings we erect. “That still leaves the question of why we insanely invest so many resources into structures of such little use. Somebody should devise a competition that would do for sports what Burning Man did for festivals: build it for the event, and then take it down, leaving no trace. Or we should figure out how to reuse and reconfigure existing structures in such a way that such renovations are in turn reversible and adaptable.” (Betsky 2013).
Possible Solutions

More Sustainable Stadium designs

Sustainable design or integrated design is definitely one solution. What I mean by this is using innovative tactics to first by, cut down building costs but more importantly to reduce post event maintenance and operational costs which is mainly what leads to the downfall of such a building after the games are over.

The Velodrome, London 2012’s flagship green building, is an outstanding example of integrated design. The most innovative aspect of the Velodrome is its tensile cable-net roof structure, which was made possible by early contractor engagement at Stage C. Initial costing had indicated that a conventional steel structure was more economical, but more detailed analysis revealed that the cable-net option enabled a cost saving of £1.5 million and shortened the programme by 20 weeks. It also significantly reduced the embodied carbon in the building.

Hopkins Architects’ carefully considered rooflights and natural ventilation also reduce operational energy loads. A targeted approach to services employs underfloor heating to keep cyclists on the track warm, while modular air-handling units under the seating tiers keep spectators comfortable. (AJ 22.09.11) (Hartman 2012). The Velodrome is considered one of the more recent, successful designs when it comes to the Olympics. This is the sort of planning that is done to ensure that the arena remains usable and effective long after the games.

The Japanese are considering a different approach for the 2020 games and incorporating the design into the daily lives of the community. One of our main ideas is Sora no Mori, meaning “forest in the sky.” It is an 850-meter running track ringing the top of the building and can be used by runners as well as pedestrians. It will be open to the public every day, even if there are events in the arena. The idea of Sora no Mori is that it can draw people to the building and create a new relationship between the stadium and its neighbors. (Pollock 2016).
**A Stadium that is slightly smaller**

Most stadiums seem to be designed with temporary settings such as seating that can be taken down post event. However, most of the time these temporary stands consist of 30,000 seats and the stadium is still left with about 80,000 seats. No matter how sustainable a design, if the stadium size is just too big for an event, it is more than likely that that venue will not be selected to host that particular event. There can be pre-tests and studies that can be done prior to construction to minimize this effect but doing studies on already existing stadiums is a good indicator and a place to start. One such stadium building is the one that hosted the Sydney Olympic Games. It takes years to come up with reasonable post games studies and after having 16 years to back up their research, the Australian government has come to this conclusion. The capacity of the stadium for the Games was 110,000, reverting to 80,000 post-Games.

It soon emerged that there were not enough major sporting or musical events outside the Olympics to generate large attendances beyond the capacity of existing stadiums. The state government's Sydney Cricket Ground and Sydney Football Stadium both had capacities of around 40,000, and there were few sporting and other events that could produce attendances beyond that level (Searle, 2002). A notable exception was the Rugby World Cup final in 2003, for which Stadium Australia's 80,000 capacity enabled Sydney to win hosting rights. Such events were too infrequent, however, and the consortium suffered large losses from the start: $24 million in 1998/99, $11 million in 1999/2000, and nearly as much in 2000/01 (Australian Financial Review, 7 September 2001). (Searle 2012).

The stadium in Sydney is an instance where the temporary seating cut down the size considerably yet, it still wasn't enough.
It is a difficult task to keep any sort of large scale stadium functioning and productively efficient let alone one with a capacity of holding 80,000 people. Buildings of this size and nature whether used or not face very large operational costs, and with no events to cover these costs, will eventually start running at a loss. Which is what the studies for the Sydney stadium indicate.

This was less than total debts ($198 million in 2004 (Masters, 2005)) and was only a fraction of final construction and post-Games reconfiguration costs of over $690 million. In 2007 the stadium was sold to the main creditor, the ANZ bank, for $10 million (Askew, 2006). The stadium pays South Sydney NRL club to play its home matches there to generate a greater number of events. But ordinary round rugby league matches have low attendances, with vast areas of empty seating, and are seen as lacking in spectator atmosphere, contrasting with occasional full crowds for international rugby union and interstate and grand final rugby league matches (Searle 2012).

In this case, not only did the stadium operate at a loss but ended up having to pay sporting teams to play at the venue.

**Repurposing of the Stadium**

A tried and tested and somewhat successful alternative of repurposing is to turn the stadium into an arena that can host large musical performances the SuperDome, now Acer Arena, has hosted a number of major popular music events since 2000 that might otherwise have been forced to be played outdoors or to reduced audiences at the Entertainment Centre. It is now claimed to be one of the most successful indoor entertainment complexes in the world (Meacham, 2010) (Searle 2012). This is not an indefinite answer that addresses the serious issues that were just discussed but is undoubtedly a practical and logical avenue for creating more use for an otherwise abandoned building. Other than the fact that it generates activity within the stadium the fact still remains that it is not a solution that is brought about by thoughtful and innovative design tactics.
Although I too like many others wait in great anticipation and excitement for the games, it still seems like a great waste of many different resources for something that takes place for such a short interval of time. Thus, it is my conclusion that in a world where resources are of a rapidly depleting nature, it is imperative that we design taking into serious consideration that these games only come to fruition once in a few decades and therefore the stadiums in particular should be constructed as temporary large scale structure which is designed in a way that can be taken almost entirely apart once the event has concluded. Where most, if not all the resources can be reassigned and reassembled in a different environment for a different purpose. In an age where prefabricated buildings and 3D printing is becoming the future, it is certainly an avenue to consider as a part of the solution.

Great architecture should not just be a beautiful gesture, but a sensible response to a need—something that celebrates the occasion without binding a place to that event for all time. (Betsky 2013)
Work Cited

Betsky, Aaron

This article conveyed the importance of considering a small scale stadium as a appose to a large austentacious structure. It draws attention to the fact that the Olympics is an event that draws huge audiences but only once in a few decades. Which supports my argument for a temporary structure.

Chester, Tim

This article provided many different photographs and was able to give a visual representation of the issue at hand. I feel that in this topic it is important to see the post games situations to further strengthen the importance of the issue. It will appeal to the auditory and the visual learners like myself to have images to follow the facts.

Hartman, Hattie

This article represented a structure that is considered successful. I believe it is important to give examples of projects that have gone well to know what the line is that we must measure up to. In this quote it is also mentioned that the better standard that they achieved was due to extensive research and innovations. Not to mention investing in sustainable design methods. Which is a key element to the solution.

Kim, Scott Stump and Eun Kyung
This article speaks of the failures of post games stadiums in a broader aspect. The quotes that were taken from this article points to the small changes that happen year by year but have significant impact on the utility of them. By quoting this article the reader is able to understand that there are technological changes, changes in sporting rules and also the capacity changes that need to be thought of when the designing and planning is in progress.

Pollock, Naomi R.

Like the article about the Velodrome this was another to give examples of environmentally sustainable, positive thing that can be done to ensure that the stadiums remain populated once the games are done. I chose this article in particular also because it is the where the next Olympic games will be held and where hopefully the most recent innovative solutions will be put to the test. The Japanese are also generally an environmentally conscious nation, hence, why I thought their ideas may have some success. However, we will not know for certain if this will hold true for at least another decade.

Searle, Glen
This is by far the most important article and one that had the most amount of post games research. The quotes I extracted were mostly factual and gave the reader evidence in the form of numbers. Having had nearly two decades of research done after the games, this article was able to give accurate predictions on what normally happens to the investments made for the games. It also provided numerical figures for the losses that can be obtained from a stadium that is not utilized but still needed continuous maintenance.
PRECEDENT ANALYSIS AND THEIR NARRATIVES
HOK Sport and Sir Peter Cook
London, UK
2011
Capacity - 80,000
Achieved a balance between the immediate needs of the Large Games stadium against a long term small scale venue.

Seating capacity started at 80,000 with temporary structures for the opening and closing ceremonies and was shrunk down to 25,000.

Transformation still cost close to $400 million.
MUNICH OLYMPIC STADIUM

Frei Otto, Gunther Behnisch, Hermann Peltz, Carlo Weber

Munich, Germany

1972

Capacity - 80,000
Otto's inspiration for this design was to imitate the alps. Wanted to show Germany in a new light after War.

The roof is a covering of transparent acrylic panels that are supported by a web of steel cables.

The canopy covers not only the stadium but also other smaller spaces to the side.
CIRQUE DU SOLEIL

circuses like Cirque de soleil puts on an elaborate show with an even more elaborate structure in a specific city during a specific time. However once it's done, they take down the structure, pack it up to move to a different place and do it all over again. This unique feature has become a main component in this prototype.
Although the scale is much larger for an Olympic stadium, with adequate planning it is possible to apply this same principal for this typology, to design an Olympic stadium that can have its resources used multiple times throughout its lifecycle.
LONDON AQUATIC CENTRE

Zaha Hadid Architects
London, United Kingdom
2005 - 2011

Olympic Footprint Area: 21,897sqm
Legacy Footprint Area: 15,950sqm
Zaha Hadid's London Aquatic Center is considered a successful example of what Architecture catered to the Olympic should embody and what typologies like stadium Architecture should characterize.

It captures the style, grace and novelty of what I feel a building such as this needs.

The stadium is a good indicator of how Olympic venues can still be successful post games due to transformations undertaken to adjust seating capacity.
The design is positioned on the south edge of Olympic park and therefore the pedestrians gain access to the Olympic park through the Stafford city bridge. The integration of the building and its surrounding is key here. By connecting the stadium to the park it ensures convenience and easy accessibility for visitors and athletes alike. Thus is an important aspect to consider for this thesis.
Perhaps the most important element of this design is the fact that the Aquatics Centre is designed with an inherent flexibility to accommodate 17,500 spectators for the London 2012 Games in Olympic mode while also providing the optimum spectator capacity of 2000 for use in Legacy mode after the Games.

The photos illustrate the transformation.
This design represents the use of inexpensive materials to create a functional yet elegant design. Although the scale of the project does not quite compare to a stadium, the project embodies the idea of using strong, lightweight material to build a functional facility. It also gives example to the efficiency of temporary venue architecture.
In this design polycarbonate panels are fitted to the scaffolding to create a tubular space within, while the exterior of the pavilion is wrapped in a layer of metal mesh and another of netting.

These facilities are constructed with scaffolding as their main structural element. Thus this means it can be disassembled once the event is done. The scaffolding gives the building the sense of permeability and invites the visitor to walk through the entire structure. At the same time it acts as a support structure to the building envelop that is necessary to give the building the sense of habitability.

The structure of the roof changes with the functions that go on within.
With the research of this project I was able to find out that scaffolding has become and increasing popular with architects to design temporary venue architecture especially ones that relate to public spaces. Its flexibility allows for quick and easy assembly and dismantle post event.

While it may not be possible to use scaffolding as a primary structural component for this thesis project, it is a good material to consider for many of the other temporary facilities.
FOREST GREEN ROVERS STADIUM

Zaha Hadid Architects
Strout, United Kingdom
Capacity: 5000 - 10,000
This project serves as a precedent for a few reasons. Most obviously it is a design that is visually and aesthetically incredible. The low sleek design reminds the spectator of an animal’s vertebra which translates and conveys lightness and strength. The stadium also adapts itself to the existing landscape. This cohesive integration enables the project to serve its purpose whilst not allowing it to disturb or change the site’s sense of place. This design has employed innovative research in the help of embodying low carbon construction and operational process. Not to mention as it is the first all wood stadium building, it will have the lowest embodied carbon of any stadium in the world.
With the structural element's close proximity to each other, the designers have allowed for even the seating terraces and floor slabs to be made out of timber. They go even further by having a transparent roof membrane while in the same breath enables turf growth which leads to minimizing the volumetric impact on the surrounding when viewing from a distance.

The stadium also promotes versatility. The design takes into consideration the club's future growth. Initially, the stadium will be built for 5000 spectators, which is subjected to double with the club's success. This expansion represents the kind of transformation I wish to achieve in my thesis project.

It is also even more impressive that is achieved without an increase in major construction costs
'as a building material, timber is highly durable, recyclable and beautiful,' explains JLM He-verin, director at ZHA. 'The proximity of the stadium's structural elements to each other has also been determined to enable the seating terraces and floor slab to be made from timber. In most other stadiums, these elements are concrete or steel. With the team's community and supporters at its core, fans will be as close as five meters from the pitch and the position of every seat has been calculated to provide excellent, unrestricted views of the entire field of play. The stadium's continuous spectator bowl surrounding the pitch will maximize matchday atmosphere.'
With the programming attention was primarily given to the seating capacity of stadium, its layout and its views. This was a main focus because without spectator satisfaction it would be extremely difficult for a stadium to be successful. Each seat will have a clear view of the performance arena. Premium seats will also be a part of the seating schedule for higher dignitaries and for others that choose to purchase for extra costs.

Then the focus was diverted to the athletes and their facilities. It is essential also that the athletes that these spectators come to watch, are comfortable and they have all their necessities met. For those reasons a therapy room, gym, lounge and preparation room will be included along with the locker rooms.
The other major requirements are that of the media and operational staff. Space will be allocated and designated to the media for their coverage with additional space for their equipment. The stadium operational staff will also have offices allotted in appropriate areas.

Restrooms will be located adequately throughout the building complying with ADA standards. Finally at this moment for a stadium of 40,000 spectators, 4000 parking spots will be assigned to ensure that the transportation portion of the event runs smoothly.
# SPACE LIST

<table>
<thead>
<tr>
<th>Function</th>
<th>Net Area</th>
<th>Net Area Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entry</strong></td>
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<td></td>
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<tr>
<td>Entry Lobby</td>
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<tr>
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<tr>
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<tr>
<td>Spectator Capacity</td>
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<tr>
<td>Suites</td>
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<td>Sideline Boxes</td>
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<tr>
<td>Stadium Box/ Loge Seat</td>
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<tr>
<td>Public Restrooms</td>
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<tr>
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<td><strong>Subtotal</strong></td>
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<tr>
<td><strong>Total Spectator Facilities</strong></td>
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<tr>
<td>Food Service</td>
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<td>Retail Sales</td>
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<td>Staff Lockers</td>
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<td>Sports Training and Weight Rooms</td>
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<tr>
<td>Equipment/ Laundry</td>
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<td>Support and Officials</td>
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<td><strong>Subtotal</strong></td>
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<tr>
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<td>Press Box</td>
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<tr>
<td>Media Support</td>
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<td>Media/ Press Support</td>
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<td><strong>Subtotal</strong></td>
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<td>Office/Operations</td>
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<tr>
<td>Dock/ Staging</td>
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<td>Storage</td>
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<td>MEP</td>
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<td>Janitorial</td>
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<td><strong>Subtotal</strong></td>
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<tr>
<td><strong>TOTAL APPROX. GROSS SQUARE FOOTAGE</strong></td>
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## LAND USE REQUIREMENTS

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<th>Land Use Area</th>
<th>PHASE 1</th>
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<td>PEOPLE GROSS AREA FLOOR BUILDING FOOTPRINT % GAC LAND AREA</td>
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<tr>
<td><strong>STADIUM FACILITY</strong></td>
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<tr>
<td>People</td>
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<td>Parking</td>
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<td>Visitor</td>
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<td>Service</td>
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<td></td>
<td>4110</td>
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<td><strong>Total Parking area Needed</strong></td>
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<tr>
<td><strong>Total Area with Building</strong></td>
<td>800,000 + 365,020</td>
</tr>
</tbody>
</table>
INITIAL SCHEMATIC DRAWINGS
**Function**

The building needs to maintain its functionality at all times. This means that the building must be able to cater to different capacities and still function as if at full capacity. This may mean the incorporation of movable seating or structure or both.

**Form**

Practical yet has a sense of place. Design should bring about excitement as would the games hosted within it. Floorplan layout should be designed for open and easy circulation. Circulation should be uninterrupted because the large number of people using the same. Fire exits at all appropriate locations. Concession stands easily accessible by all visitors. Restrooms should be the same. Box office or premium ticket holders should be viewing at a higher elevation. Space should be allocated for media coverage. The spectators as well as the field should be protected/shaded from the elements (nature). Seating should be designed and placed so that each spectator has a decent view of the event. Cross ventilation should be looked into as a crucial part of the design process.
Economy

It is very important to make a return on the investment that was taken to construct this building. Therefore, design should be elegant, practical and most of all adaptable and usable throughout the year. Sustainable practices should take effect through the design process as well as construction. Building should be designed to be self-sufficient to a great extent but with adequate maintenance when needed.

Time

Time maybe the most important aspect to consider with my project as it is the essence of my thesis. This building should be designed in order to change with time, whether it is from month to month or day to day.
The site I’ve picked has already been proposed for a new major stadium in Seattle. Right north to the picked location, are two more stadiums, the Century Link and Safeco Stadium. Hence, the picked site would already have the major infrastructure to support this project proposal.

In addition, the site is within close proximity to downtown which means that restaurants, bars and other commercial buildings that a stadium needs to remain successful are already present.
Seattle Monthly Precipitation

Yearly total: 44.83" (Average)

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<tr>
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<td>4.47</td>
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<td>3.72</td>
<td>2.71</td>
<td>1.94</td>
<td>1.50</td>
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<td>-------</td>
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</tr>
<tr>
<td>23</td>
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<td>4.81</td>
<td>8.37</td>
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<tr>
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<td>0.70</td>
<td>0.88</td>
<td>1.50</td>
<td>3.48</td>
<td>6.57</td>
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</tr>
</tbody>
</table>

(average: 37.49″)
Seattle is one of five rainiest major US cities measured by the number of days per year. Therefore, it has the significant number of cloudy days. This is important to know for the design. The average precipitation is 34.1 inches, while the number of days per year with precipitation is 152. Annual hours of sunshine is a total of 2019 hours.
The site currently lacks planted trees. It is known that landscape and foliage enhances the pedestrian experience and improves walkability. Thus is a priority for the overall design.
SITE

This thesis is not site specific. The stadium is a kit of parts that is able to move from location to location. Ideal conditions include all year round for the tropics and summer months for the temperate regions.
The idea was to have Seattle as the chosen site. However, as research progressed it was determined that the stadium design would be portable and not designed for one specific sight. The chart below shows the ideal regions and times that would be most suitable. Coastal areas are also favorable when taking transport costs into consideration.
Another crucial aspect to consider that is sometimes overlooked is staffing. Facility staff are critical for fire protection and life safety for building occupants during a game day event. Proper protocol and operational procedures for crowd control, security and way-finding should be well thought out and planned during the design stage.
The smoke control system must be designed so that the smoke will remain at least 6 feet above the means of egress.

Because of the size and nature of this typology, structural fire protection will need to be assessed based on and engineering analyses of anticipated fire exposures.

The sprinkler system protection will vary heavily with an open roof structure to an enclosed space.
WIDE: 125FT

CONSTRUCTION TYPE: TYPE I

MAXIMUM HEIGHT: UNLIMITED

SF PER GROUND AREA: UNLIMITED
CLASSIFICATION: ASSEMBLY_GROUP A-5

OCCUPANCY LOAD: UNLIMITED

MAXIMUM EXT.

CONSTRUCTION

[Diagram of seating arrangements]
Another crucial aspect to consider that is sometimes overlooked is staffing. Facility staff are critical for fire protection and life safety for building occupants during a game day event.

Proper protocol and operational procedures for crowd control, security and way-finding should be well thought out and planned during the design stage.
DESIGN METHODOLOGY

The design methodology used here is interpretive, qualitative and logical argument.

The interpretive is represented by research such as precedent analyses and site analyses. These will convey my take on what already exists.

For qualitative research I have produced hard facts which will be found in the research paper portion. Another qualitative method I plan to utilize is personal interviews. For this I will speak with professionals that have worked with and have experience with stadium construction.

Lastly, once I have done substantial research I plan to give my own iteration of what I have found. My ability to critically think and the education I have received thus far allows me to put forth an intelligent solution to this problem facing stadium architecture.
After a discussion with my thesis studio professor, I foresee many of my current ideas changing. While the main premise of creating a positive change in the socio-economic stance of stadium construction will remain the same, the path to it and the methods used to reconcile this issue will either take a small turn or even change completely.

Research will continue until mid-semester, even after the designing process is well on its way. If an idea or method seems more pragmatic than the current, a decision will likely be made to go back and revise the original argument.
If I find a break in next semester’s workload, I plan to make a visit to my chosen site, Seattle, Washington. Here I hope to get a sense of the site and document the more detailed elements of the site and its surroundings.

Professor Crutchfield mentioned getting me in touch with a few of his previous colleagues that work at Populous, the renowned architecture firm that specializes in stadium design and construction. With this, I hope to grasp a deeper understanding of the process that follows when designing for this typology. Lastly, I plan to have the design completed two weeks before presentations so that I am able to go back and revise this thesis book proposal.
<table>
<thead>
<tr>
<th>Task Description</th>
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<tbody>
<tr>
<td>Concept Analysis</td>
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</tr>
<tr>
<td>Conceptual Analysis</td>
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<tr>
<td>Spatial Analysis</td>
<td>1/18/17</td>
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<tr>
<td>Floor Plan Development</td>
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<tr>
<td>ECE Passive Analysis</td>
<td>2/1/17</td>
</tr>
<tr>
<td>Section Development</td>
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<tr>
<td>Structural Development</td>
<td>2/8/17</td>
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<td>Materials Development</td>
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<td>ECE Active Analysis</td>
<td>3/13/17</td>
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<td>--Midterm Reviews</td>
<td>3/29/17</td>
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<td>Concept Redevelopment</td>
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<tr>
<td>Structural Redevelopment</td>
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<tr>
<td>Project Deliverables</td>
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<td>Presentation Layout</td>
<td>5/17/17</td>
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<tr>
<td>Plotting and Model Building</td>
<td>4/25/17</td>
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<td>Preparation for Presentations</td>
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<tr>
<td>Final Thesis Review</td>
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<tr>
<td>CD Due to Thesis Advisor</td>
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<tr>
<td>Final Thesis Document Due</td>
<td>5/12/17</td>
</tr>
<tr>
<td>(Commencement)</td>
<td>5/12/17</td>
</tr>
</tbody>
</table>
PROJECT JUSTIFICATION -
COSTS OF STADIUMS

2000 Sydney Olympic Stadium - $690 million
New South Wales taxpayers are paying about $30.1 million a year to maintain

2004 Athens Olympic Stadium - $290 million
An annual maintenance cost of $10 million

2008 Beijing Olympic Stadium - $423 million
An annual maintenance cost of $9 million

2012 London Olympic Stadium - $605 million
Conversion costs - $355 million,
Maintenance costs - 6.5 million

2020 Tokyo Olympics Stadium - $1.26 billion
WHAT HAPPENS TO THEM
Montreal, Canada - This tower was originally built to open and close the Olympic Stadium roof for the Montreal 1976 Summer Olympics. Now it’s used solely to keep the roof, which is no longer retractable, from collapsing into the stadium.

Beijing, China - 'Bird's Nest' cost $423 million to be built which might take China 30 years to pay off. Hasn't been used since the Olympics.

Athens, Greece - The Greek government had to pay for everything, and, sadly, there just wasn't any use for most of the buildings, stadiums, and courses after the games.
Post-Olympic financial problems are common for Olympic host cities, particularly for the host of the larger and more expensive Summer Games. Spending billions to host the two-week event, cities almost never make a profit and usually spend years paying off their Olympic-size debt. Furthermore, these cities are often left with unused venues and “white elephant” main stadiums.

Cummings, Denis. “Beijing’s Empty Venues Reveal Heavy Cost of Olympics.”

“If the I.O.C. did more to encourage temporary venues or to reuse existing ones, then more cities would have a chance,” said former Salt Lake City Deputy Mayor Brian Hatch to Forbes. “Instead, the I.O.C. has encouraged gigantism; spending massive amounts on sports that come around every four years.”

For the Summer Olympics, a city must build an extravagant main stadium that tends to seat between 70,000 and 110,000 people. Often these stadiums have no primary tenant after the Games and cost cities millions of dollars every year in maintenance.

Cummings, Denis. “Beijing’s Empty Venues Reveal Heavy Cost of Olympics.”
RESEARCH METHODS

STRATEGIES

Interpretive - Precedents Or Previous Case Studies
Qualitative - Social and Economic issues
Simulation - Digital Models

TACTICS

Personal Interviews
Literature Reviews
Logical Iterations - Based on or with the help of my research
MODULAR DESIGN
MODULAR SHIP CONSTRUCTION
Ship construction goes through most of the same processes as building construction.

Highly efficient method of construction. Saves time and costs.

The same design can be used to build different ships (buildings) with slight variations specific to owner or client needs.

Main takeaways -

Size of modular components - Components have to fit in storage.

Capacity of lifting equipment - Components cannot be too heavy for lifting equipment.

Importance of scheduling and planning - Building components need to arrive in sequence. Storage takes space and costs money.
Modular design is a proven method of efficiency. The most important aspects of construction are alignment, scheduling, maintenance and adequate capability of lifting equipment.
TOURING THE FARGODOME
Main takeaways

Being able to finance a stadium with alternative methods. In this instance the Fargo dome rents out their own equipment for storage and mechanical

- A lot of stadiums run at a loss because the revenue from the ticket sales alone isn’t enough to cover its running costs. This ends up costing the city a lot of money
Touring the Fargodome was an unique opportunity that allowed for me to see into the back of house operations required to running, maintaining and sustaining a stadium. A clearer, more accurate plan was able to be formed through the information I gathered.

Not all stadiums end their fiscal year breaking even, let alone making a profit, this is one of the main setbacks of running a stadium. The Fargodome is successful in this department because it takes advantage of renting out their own equipment to clients that they play host to. I was told that they if not for this extra income the Fargodome may also not be able to cover it’s overheads.

I was also able to see first hand how a stadium setup works with respects to mechanical, electrical, staging and storage.

One of the main take aways that I took from this tour was importance of being able to finance the stadiums running costs. The other is the amount of storage needed for this type of venue architecture.
The truth is that it is now very difficult for a sports stadium to be financially viable without some degree of subsidy.
SOLUTION

Modular Components
    Risers (Folded Steel plates)

Kit of Parts
    Roof
    Riser (Structure) – Post and Beams

Usage Of A Temporary Canopy System Vs A Permanent Roof Structure

Shipping Containers
Shipping containers are integral part in this kit of parts

Serves two main purposes

It is the vessel that transports all parts if most parts needed to assemble the building

It also plays host to the spaces that make up a conventional stadium
<table>
<thead>
<tr>
<th>20' Container</th>
</tr>
</thead>
<tbody>
<tr>
<td>New - DNV, GL or ABS Certified</td>
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<tr>
<td>Used - Under IICL, Cargo Worthy, Wind Water Tight</td>
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<tr>
<td>Customized - Upon request</td>
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**20' GP**

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<th>H</th>
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<tbody>
<tr>
<td>External</td>
<td>20'0&quot;</td>
<td>8'10&quot;</td>
</tr>
<tr>
<td>Internal</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Door Opening</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Max Capacity (cu ft)</td>
<td>95380-47900 (lbs)</td>
<td>32.85-33.58 (m)</td>
</tr>
<tr>
<td>Tare Weight</td>
<td>5050-5960 (lbs)</td>
<td>2263-2460 (kgs)</td>
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**20' HQ**

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<th>H</th>
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</thead>
<tbody>
<tr>
<td>External</td>
<td>20'0&quot;</td>
<td>8'0&quot;</td>
</tr>
<tr>
<td>Internal</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Door Opening</td>
<td>19'4&quot;</td>
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</tr>
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<td>95380-47900 (lbs)</td>
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</tr>
<tr>
<td>Tare Weight</td>
<td>5330-5510 (lbs)</td>
<td>2427-2465 (kgs)</td>
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**20' DD**

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</thead>
<tbody>
<tr>
<td>External</td>
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<td>8'10&quot;</td>
</tr>
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<td>Internal</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Door Opening</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Max Capacity (cu ft)</td>
<td>95380-47900 (lbs)</td>
<td>32.85-33.58 (m)</td>
</tr>
<tr>
<td>Tare Weight</td>
<td>5050-5960 (lbs)</td>
<td>2263-2460 (kgs)</td>
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**20' Side Open**

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</thead>
<tbody>
<tr>
<td>External</td>
<td>20'0&quot;</td>
<td>6'10&quot;</td>
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<tr>
<td>Internal</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Door Opening</td>
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<td>7'6&quot;</td>
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<tr>
<td>Max Capacity (cu ft)</td>
<td>95380-116 (lbs)</td>
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<td>Tare Weight</td>
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**20' OT**

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<tbody>
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<td>External</td>
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<td>8'0&quot;</td>
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<tr>
<td>Internal</td>
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<tr>
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<tr>
<td>Max Capacity (cu ft)</td>
<td>95380-47900 (lbs)</td>
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<tr>
<td>Tare Weight</td>
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**20' FR**

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<tr>
<td>External</td>
<td>20'0&quot;</td>
<td>6'10&quot;</td>
</tr>
<tr>
<td>Internal</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Door Opening</td>
<td>19'4&quot;</td>
<td>7'6&quot;</td>
</tr>
<tr>
<td>Max Capacity (cu ft)</td>
<td>95380-116 (lbs)</td>
<td>32.85-33.58 (m)</td>
</tr>
<tr>
<td>Tare Weight</td>
<td>5050-5460 (lbs)</td>
<td>2263-2460 (kgs)</td>
</tr>
</tbody>
</table>

**20' RF**

<table>
<thead>
<tr>
<th>L</th>
<th>W</th>
<th>H</th>
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<tbody>
<tr>
<td>External</td>
<td>20'0&quot;</td>
<td>8'10&quot;</td>
</tr>
<tr>
<td>Internal</td>
<td>17'6&quot;</td>
<td>7'2&quot;</td>
</tr>
<tr>
<td>Door Opening</td>
<td>17'6&quot;</td>
<td>7'2&quot;</td>
</tr>
<tr>
<td>Max Capacity (cu ft)</td>
<td>95380-10200 (lbs)</td>
<td>26.4-26.4 (m)</td>
</tr>
<tr>
<td>Tare Weight</td>
<td>4850-6060 (lbs)</td>
<td>2230-2720 (kgs)</td>
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</table>
SHIPPING CONTAINER PROCESS
The images represent the process of loading building parts and components into containers from where they will be shipped to their destination venue.

After which the parts will be unloaded on site and the containers then used for other purposes throughout the event.

Once the event has ended the parts will be packed and loaded back into containers and on to a ship, where it will store the parts till the next event.
The graph seen here represents the spaces and their square footage. It shows how many shipping containers would be needed in order to make up the sqft needed for that specific space.

**SPACE**
- Concessions
- Offices
- Storage
- Bathrooms
- Lockers
- Utilities
- Warm up space
- Gym
- Risers
- Field
- Track
- Roof/ Wrap
<table>
<thead>
<tr>
<th>40x10 SF</th>
<th># of SC</th>
<th>Needs Mech.</th>
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<tbody>
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<td>20,000</td>
<td>50</td>
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</tr>
<tr>
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</tr>
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<td></td>
</tr>
<tr>
<td>75000</td>
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</tbody>
</table>

Total SC 391
Each square in the graph below represents 4 shipping containers. Making the square footing of each square 400 sqft. The primary spaces all lie on the first floor. The four corners by the stands are dedicated to the Entrance, Athletes Area, Concessions and mechanical. The restrooms, mechanical space and storage have been situated mostly under the spectator stands. Restrooms and concessions have also been provided on the 2nd, 3rd and 4th floors for convenience.
The risers and also spaces that are usually beneath them began as a modular block concept that would fit in to the constraints of a shipping container. However, it became obvious that that would not be feasible.
Kit Parts Concept –

All parts that would fit in standard SC models (columns, beams, girders, nuts, bolts) would be shipped accordingly.

Risers will be consist of folded steel plates, that are modular in size.

These will be welded on site to the girder.
SUSTAINABILITY FEATURES

Solar panels

Natural heat generation from solar panels can be used to reduce a stadium’s dependence on conventional sources and also reduce overall energy consumption.

For example, hot water for sinks and showers can be provided by the collection, storage and use of solar energy, produced by solar panels.
Photovoltaic panels

PV panels produce electricity whenever sunlight shines on them.

They require little maintenance and are highly effective.

Using these features can supply clean energy back to the main grid on a day to day basis and draw out energy on the day of the event.
MOBILE WASTE WATER TREATMENT PLANT

Using a waste water treatment plant is not only more sustainable but it can also ensure that the water demands of the stadium facility is being supported without adding too much strain on the city’s main water system.

HOW THIS FITS WELL WITH A TEMPORARY VENUE STADIUM DESIGN?

Container wastewater treatment plants are treatment systems fully installed in a container intended for the biological treatment of wastewater.

The plant will be installed in 20- or 40-foot containers.

Due to the modular design, plants can be configured easily and quickly according to the customers’ demands.
Features

Modular Construction

Simple Transport Because Of Container Construction

Multiple Usage Possible Due To Mobile Application

Fully Automatic System Operation

Ready To Use Delivery

Durable Uncomplicated Operation

Robust And Space-saving

Homogenization About 24 Hours
MINIMALISM, TECHNOLOGY AND OPPORTUNITY
DEVELOPING A NEW OLYMPIC PROTOTYPE
FINAL DISPLAY
APPENDIX

ADDITIONAL IMAGE CITATION

SITE PHOTOS

http://65.media.tumblr.com/7f4d6984cd817b49a88fd3b3a1f-3c9b/tumblr_nly01eGNS81qq9du0o1_1280.jpg

http://cdnfiles.hdrcreme.com/20972/original/Seattle.jpg?1426840961

https://upload.wikimedia.org/wikipedia/commons/e/e4/Bell_Harbor_Marina,_Seattle,_Washington.JPG


STADIUM IMAGES


http://www.umhb.edu/masterplan/sites/www.umhb.edu.masterplan/files/imagecache/original-image/stadium_concourse_0.jpg


https://qzprod.files.wordpress.com/2015/07/lead_ap_386989733038.jpg?quality=80&strip=all&w=1600

OTHER IMAGES

http://cdnfiles.hdrcreme.com/20972/original/Seattle.jpg?1426840961