LEARNING OBJECTIVE- Read “The Tectonics of Timber Architecture in the Digital Age”

- Tectonics is the art of integrating construction technology into the design process
- Tectonics are defined by the material, tools and design used to build a structure
- Timber construction consists of three phases: hand-tool technology, machine-tool technology and information-tool technology
- Three eras of wood building:
  - **Wooden age**- Carpenters were the designers and the builders and therefore utilized very diverse wood building strategies for connections and could keep the vision of the structure in mind while building.
  - **Industrial age**- Products were mass produced and there was less variability in each building. Modular style buildings became popular in order to build as quick as possible and carpenters became primarily just building erectors while architects and engineers took over the design process.
  - **Digital age**- New wood products, saw technologies and computer programs allow for a greater flexibility in design once again without losing valuable project time. Architects, engineers and builders can now be more integrated throughout the entire process so that one of them can change things and using set parameters, makes changes to the design at all steps of the building process.
Reflection- week 1

LEARNING OBJECTIVE:

Figuring out the basics of Grasshopper and Rhinoceros were one of my objectives for the week and although I still have a lot to learn, I feel like I have a much better understanding of how the two programs work together, their general layout and how powerful of a tool they can be. Below is an in-class example of a woven basket shape that we walked through that really helped me figure out how to set things up in grasshopper. Once I figured out the general concept of Grasshopper I realized how powerful of a tool it could be in modelling. I look forward to learning a lot more about and experimenting more with these tools and putting them to use in our project.
Readings Review- week 2

LEARNING OBJECTIVE- Read “The "EXPO-roof" in Hanover - A new dimension for ripped shells in timber”
• Out of all of the suggested reading examples I found this expo roof to be the most inspiring and relevant to something we could do for our pavilion project
• The unique umbrella-like gridshell is something that I have never seen yet along designed before so something like this would provide a very intriguing challenge
• Not only does it use a lot of mass timber elements in the design but the tree-like shape of the structure is a very cool possibility for a pavilion that we are designing that is supposed to help display the capabilities of not just mass timber projects but just the structural capabilities of a tree itself.
• They also went through a great deal of effort in order to solve moisture-related issues with this structure which I think is probably the most challenging part of building large structures out of wood

LEARNING OBJECTIVE- Read “Columns and Beams” Handout
• The main point of this handout was to describe how to analyze columns and beams with a focus on how pinned connections work vs. rigid connections
• A lot of this was review for me but it was helpful to review
• As the only member in my group with a lot of structural engineering knowledge it is important for me to have a deep understanding of this in order to help our group come up with a structurally sound design
• I also found this to be helpful because it showed a lot of innovative design concepts that I have not seen before that were pretty inspirational to see
• In particular, I found the timber column design on the right to be very interesting and thought provoking.
• The way they came up with a solution to use raw timber logs in their design was really cool and a unique concept of wood being used in its raw form
• I am also very intrigued by these types of hybrid designs that utilized the strengths of timber along with the strengths of steel or concrete to make them possible.
Reflection- week 2

LEARNING OBJECTIVE:

This experiment in trying to analyze a curved beam allowed me to understand how Karamba analyzes structures a lot better. I learned how to divide a beam up into a bunch of points to analyze and further understand the capabilities and layout of Karamba.

This will be very important for me to dive deeper into because as the structural engineer in my group I will need to have a good understanding of exactly how to analyze Rhinoceros models using Karamba.

Next, to develop my skills in Karamba, I plan to focus on learning the basics of analyzing trusses and frames during this Wednesday’s lecture. This will be very important to understand as the pavilion that we design will most likely utilize either a truss or frame structural system. Trusses and frames are also very commonly used in the wood building design industry so it will be a very useful skill to have obtained. Below is an example of how I converted a curve drawn in Rhino into a beam that could be analyzed in Karamba.
Readings Review - week 3

LEARNING OBJECTIVE - Read “Frames and Trusses” Handout

- The main point of this handout was to describe how to analyze frames and trusses and how they carry load throughout the system.
- A lot of the analysis was review for me but it was helpful to review and to also be introduced to all of the different types of commonly used truss systems.
- As the only member in my group with a lot of structural engineering knowledge it is important for me to have a deep understanding of this in order to help our group come up with a structurally sound design.
- I also found this to be helpful because it showed a lot of connection concepts that I have not been introduced to before and is something that I am very interested in.
- During lecture I was really interested in the steel-timber hybrid trusses where the wood members were used in compression and the steel in tension.
- This concept of engineering with multiple materials depending on their strengths is something that is very interesting to me.
Reflection- week 3

LEARNING OBJECTIVE:

Improving my Karamba skills were one of my objectives for the week and although I still have a lot to learn, I feel like I have a much better understanding of how you can analyze a simple model made in Rhino with Karamba and how powerful of a tool that can be. Below is an in-class example of a simple portal frame structure that we walked through that really helped me figure out the basics of Karamba. I finally feel comfortable applying different loads to simple structures and analyzing the moments and forces that those loads create using Karamba so this in-class example was very helpful. Because I am the most experienced with structural analysis in my group, I think it will be very important that I become even more familiar with Karamba, specifically with using more complicated structures.
Readings Review- week 4

LEARNING OBJECTIVE- Read “Wide-span Sports Structures”
• This reading was of particular interest to me because I am very passionate about sports and it has always kind of been my dream to design sports stadiums
• This particular aquatic center struck my interest because the tree-column is an idea that we have talked a lot about in class as an efficient way to carry gravity loads
• This structure is also pretty unique because of the double curvature glulam beams used as the ribs of the dome structure
• I think this structure is one of the most inspiring I have seen in this course due to its structural complexity but also because of the display of modern manufacturing technologies with wood products

LEARNING OBJECTIVE- Read “Arches and Domes” Handout
• The main point of this handout was to describe how to analyze arches and domes and how these structural systems can be used to span very large distances
• A lot of this was new to me so it was very interesting to learn about new structural design concepts
• I did not realize that a dome is basically composed of many arches and also how many different types of dome structures there were
• One of the most interesting things to see was how these designs used segmented members over very large spans due to the material limitations in length of a timber log
• The use of double curvature glulams is something that I have always thought was very cool and have always wanted to learn how to design as well
• The pedestrian bridge in Norway (I think) was the most inspiring case of these double curvature glulams that we looked at
Reflection- week 4

LEARNING OBJECTIVE:

This week I learned how to take a template grasshopper model with applied loads and support conditions and transfer those to a new model that I drew in Rhino. This seems very helpful especially for commonly used structural systems I would not have to create a whole new grasshopper script, I could simply transfer one from a similar model to my own in just a couple minutes. The one thing that I struggled with with this example was being able to display stresses on my model and also being able to make sure that the model was behaving like an actual truss, with no moment or shear induced. One way that I figured out you could do this is if you reduce the uniform load into point loads acting at the joints.

LEARNING OBJECTIVE:

Friday’s lecture in the lab was very helpful to have Nancy there in person to walk us through our issues. She taught me a lot about Karamba and I was able to solve my issue of finding stresses acting on an element and even creating a panel that just gives you the maximum stresses within an element as shown below. She also helped us solve the issue of the truss members bending and how to make the truss behave like a truss using a function in grasshopper so that was very helpful as well.
Readings Review - week 5

LEARNING OBJECTIVE- Read “Grid, Shells and Gridshells”

- I found this reading to be very interesting to me as it was all new information and fun to see how irregular shapes can be achieved through these types of structural systems.
- It was particularly interesting to learn about how loads are transferred from one element to another within these systems, as shown in the photos to the right.
- Gravity loads are transferred through shear stresses.
- I also found it interesting how specific wood species are used based on their strength and stiffness in order to achieve large enough deformations to create the shape yet high enough strength to resist loads.
- This often calls for the use of “green” wood in construction.
- I found the most inspiring project in this reading to be that of the CLT shell in the Elephant park.
- It was cool to see the use of CLT to create such a massive, irregularly shaped structure.
- To do this, the layup of the CLT consisted of dimensional lumber stacked, glued and pressed together at 60 degree angles instead of 90 degrees like usual.
What I’ve Learned

- Because our structural system of our pavilion is going to be composed of mainly trusses and an arch, there has not been a whole lot of new structural knowledge that I have gained due to my previous background in structural engineering.
- I have, however, learned a great deal about how to model and, perhaps more importantly, analyze these structural systems using Karamba.
- Turning lines into beams and points into structural nodes via Karamba and Grasshopper has been an interesting challenge to take on and is much different than traditional structural analysis software.
- It has also been an interesting challenge to create section and material properties within Karamba because while it does have a generic wood material definition, there are many different species of wood and types of engineered wood products that need to be defined accordingly within Grasshopper in order for Karamba to analyse the structure correctly.
What I’ve Learned

- While we did not end up utilizing any sort of grid, gridshell, plates or folded plate structural systems within or pavilion, it was really cool to learn how these systems work and how they are starting to become more and more popular due to the increased efficiency of parametric design and the manufacturing capabilities of wood materials.
- While I think we are a ways away from these types of designs becoming the standard for construction, it will be fun to see them become more popular as industry knowledge and technologies advance.
- Overall, it was extremely interesting to see things from the other side (architecturally) for a term and be able to collaborate with peers from the architecture and wood science fields throughout the design process.
- Regardless of how the field of parametric design advances, I do believe that this type of collaboration would be extremely beneficial in industry and is something that the construction industry really lacks right now.
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Key documents consulted:
“The tectonics of timber architecture in the digital age”