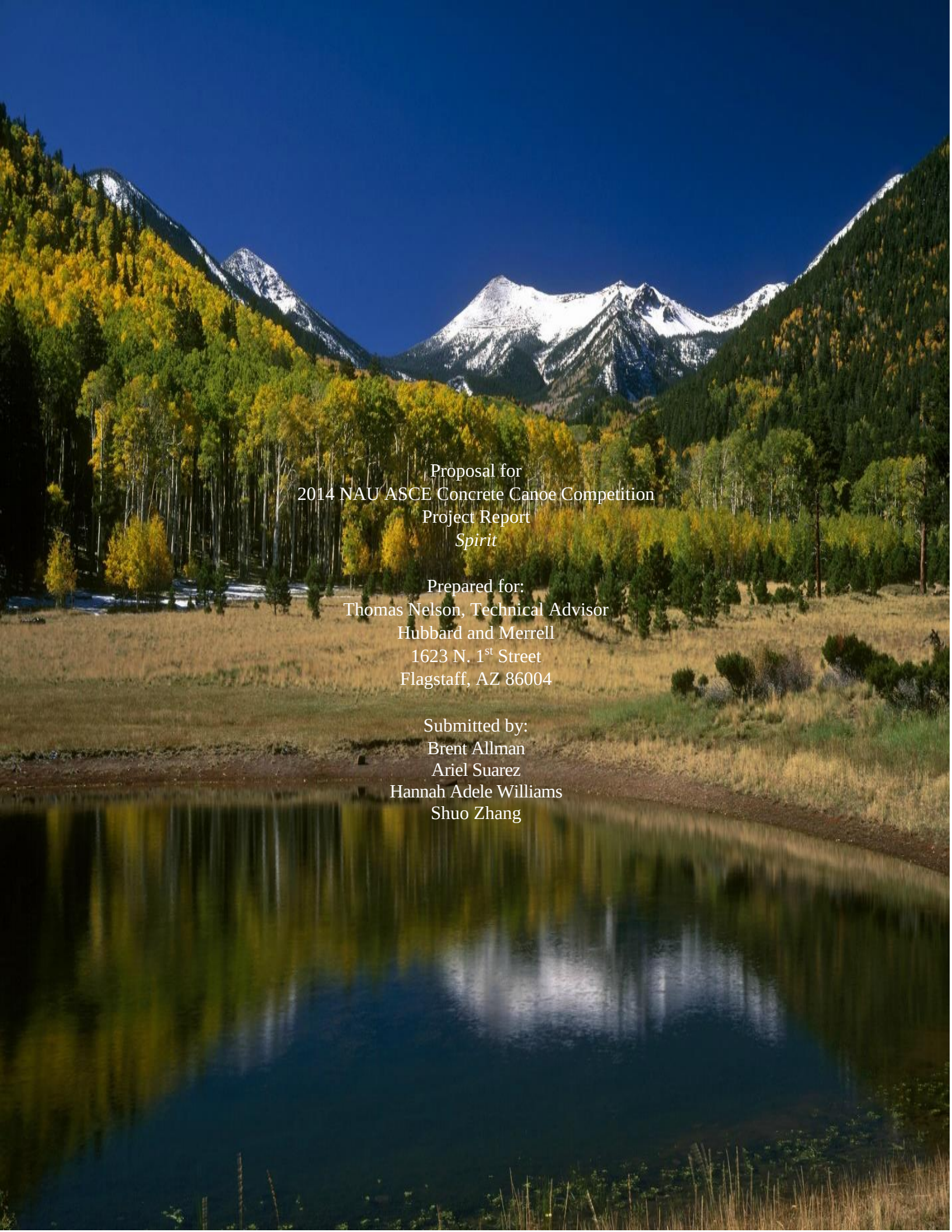


Proposal for
2014 NAU ASCE Concrete Canoe Competition
Project Report
Spirit

Prepared for:
Thomas Nelson, Technical Advisor
Hubbard and Merrell
1623 N. 1st Street
Flagstaff, AZ 86004

Submitted by:
Brent Allman
Ariel Suarez
Hannah Adele Williams
Shuo Zhang

Spirit

Lumberjack, Inc.
400 E. McConnell Dr. #3
Flagstaff, AZ 86001

Thomas Nelson, Project Engineer
Hubbard and Merrill
1623 N 1st St
Flagstaff, AZ 86004

December 6, 2013

Dear Mr. Thomas Nelson,

Attached is our final proposal for the American Society of Civil Engineers Concrete Canoe project. This document illustrates the team's project understanding, project scope and schedule, impacts and team member qualifications. The proposal will also highlight the major tasks with subtasks to be completed.

Thank you for your willingness to invest your time and effort into the team's future success. We look forward to working with you.

Sincerely,

Brent Allman Ariel Suarez Hannah Adele Williams Shuo Zhang

Brent Allman
Ariel Suarez
Hannah Adele Williams
Shuo Zhang

Table of Contents

1.0 Project Introduction

Lumberjack Inc. is comprised of a four-person team stemming from Northern Arizona University's ASCE Student Organization. Lumberjack Inc. was requested to design and construct a lightweight concrete canoe Lumberjack Inc. has been involved in constructing and racing concrete canoes on the local and national level since the late 1970s.

1.1 Office Location

Lumberjack, Inc.
400 E. McConnell Dr. #3
Flagstaff, AZ 86001

2.0 Project Understanding

The purpose of this project is to design and construct a lightweight concrete canoe to enter into the annual ASCE Pacific Southwest Regional Conference in April 2014. The canoe is to be constructed using materials permitted by the 2014 ASCE National Concrete Canoe Competition Rules and Regulations handbook. The final product needs to be transported to the event without any failures, and built by the students alone. Another main purpose of constructing the canoe is to ensure that the ASCE Northern Arizona University (NAU) chapter remains officially a part of the National ASCE organization.

2.1 Introduction

An essential aspect of this project is to apply the team's own individual strengths to the completion of the canoe. Successfully understanding the different components that designing and constructing a canoe entails will prepare the team for a lifetime of real world projects. Most importantly, the team will be able to relate all engineering knowledge to the step-by-step process of a design project.

2.2 Background Information Related to Project

To officially remain a part of the National ASCE, NAU must enter into the regional competition held each year. NAU was successful in placing in the top 3 nationally for several years. Later on in the 2000s, NAU placed fourth in the regional competition. The 2013 concrete canoe, Night Fury, was able to bring our school to sixth place, boosting the status and moral of our chapter to new levels once again.

2.3 Key Stakeholders

The stakeholders include the NAU Civil Engineering Department and the NAU ASCE Student Chapter. The performance of the canoe reflects the preeminence and quality of the NAU Civil Engineering Department as a whole. If the canoe does not perform to par, poor judgment falls upon the source of the student's education. The NAU ASCE Student Chapter directly depends on the complete participation of the canoe at the Pacific Southwest Conference. If for any reason the school is unable to participate in the races, they will be placed on probation and must have a race-able canoe the next year or the student chapter will be terminated.

2.4 Existing Conditions

The concrete canoe is a time consuming and demanding final project. This is because it serves as senior design capstone as well as an ASCE project meaning, the team has almost double the amount of work in comparison to other capstone teams. This project requires completion before most teams begin to design a solution to the other projects. It includes a taxing schedule but with hard work, dedication and a background of engineering knowledge, the project will be rewarding to the team.

The overall goal for this year's design and construction of the concrete canoe is to improve upon the construction and analysis completed by last year's concrete canoe team, Night Fury. The existing conditions include a wood strip mold that can serve as the basis of the overall concrete canoe shape, concrete mixes that proved to be successful in last year's competition, the hull designs, and reinforcement that was implemented into the final product. All conditions previously stated are to be improved upon and adjusted in compliance with this year's competition rules and regulations. They will serve as a starting point for the 2013-2014 concrete canoe team. However, more design and research will be conducted to improve the overall success of the canoe.

2.5 Potential Challenges

In order for the concrete canoe to meet the rules and regulations established by the competition rules, the canoe must be made entirely of concrete with few additions. The concrete canoe must be able to float thus, lightweight concrete must be utilized. Lightweight concrete is more expensive than regular concrete and poses different challenges as far as workability and how readily available certain aggregates are to the team. As mentioned in section 5.0, testing will be implemented to determine the best concrete mix and to determine workability.

Another challenge that may influence how the canoe is built is lab availability and available materials for testing. The lab availability will need to be determined based

on the schedules of other classes that may be utilizing the rooms. Working with the professors and determining a schedule that will allow the team to work in those labs is an influencing factor in the completion of the canoe. The materials needed for testing are, at the moment, limited and must be utilized efficiently. Ordering new materials can only be done if funding can be obtained. To overcome this obstacle, it is vital that the team receives funding by maintaining the relationship with CEMEX that last year's team initiated, contacting local contractors, and attending the ASCE golf tournament in October.

3.0 Project Scope

The design, analysis and construction of the concrete canoe will be completed in accordance with the following schedule. The major tasks have been listed below:

1. Begin
2. Concrete Mix Design
3. Hull Design
4. Structural Analysis
5. Reinforcement Design
6. Canoe
7. Construction
8. Design Report
9. Paddling
10. Oral Presentation
11. Conference
12. Deliverables

3.1 Task 1: Begin

Task 1.1: Rules and Regulations

Research and compare rules and regulations from last year's 2013 to this year's 2014 handbook.

Task 1.2: Fundraising

Research and implement different ASTM test methods that are in accordance with the 2014 rules and regulations. These test methods will include:

- Shrinkage rings to test the cracking of the concrete during curing
- ASTM standard test methods for tensile/compressive strength
- Concrete cylinders to determine the density of the individual concrete mixes
- Slump test to determine the workability
- Square sheets to get an overall idea of the strength, workability and cracking of the desired final product

3.2 Task 2: Concrete Mix Design

Task 2.1: Research
Research Night Fury's (2013) concrete mix design and improve to accomplish the goals set by the 2014 concrete canoe team. The goals of the team are listed below:

- Increase fiber to decrease cracking
- Adjust additives to help with workability
- Increase strength of concrete
- Create a finishing mix that will eliminate uneven surfaces and increase the aesthetics of the canoe.

- Research and implement different ASTM test methods that are in accordance with the 2014 rules and regulations. These test methods will include:
  - Shrinkage rings to test the cracking of the concrete during curing
  - ASTM standard test methods for tensile/compressive strength
  - Concrete cylinders to determine the density of the individual concrete mixes
  - Slump test to determine the workability
  - Square sheets to get an overall idea of the strength, workability and cracking of the desired final product

Task 2.2: Preliminary Mixes
Design initial mixes using team Night Fury's design mix as a starting point. Concrete must have a cement to water ratio of 30% or higher.

Task 2.3: Secondary Mixes
Improve upon the preliminary mixes that were successful.

Task 2.4: Final Mix Design
Choose a final mix design that adheres to the team's listed goals. Proceed with final mix design.

Task 2.5: Finishing Mix
Design a finishing mix to apply to the canoe after curing is complete.

Task 2.6: 3-Point Bending Test
Concrete sheets will be made to complete a 3-point bending test using the Tinius Olsen. This will measure the force that can be applied to a sheet with a certain thickness.
Task 2.7: Shrinkage Test
Design a method to measure the shrinkage of the concrete during its curing process.

Task 2.8: Compression Test
Using ASTM standards, conduct compression test on all concrete cylinders made from the designed concrete mixes.

3.3 Task 3: Hull Design

Task 3.1: Waterline Analysis
Complete analysis on the resulting waterline for the different load scenarios that will be inflicted on the canoe during competition races. The waterline analysis will determine the most sufficient placement for all loads to be applied to the canoe.

3.4 Task 4: Structural Analysis

Task 4.1: 2D Modeling/Analysis
Complete a simple beam analysis to determine locations where the maximum shear and moment occur within the canoe under the various load scenarios.

Task 4.2: 3D Modeling/Analysis
Complete a complex analysis of the canoe by locating the different nodes of the canoe to import into the RISA 3D. This will produce more accurate results for the shear and moments that smaller sections of the canoe will endure.

3.5 Task 5: Reinforcement Design

Task 5.1: Research
Research different reinforcement materials that will increase the concrete strength, reduce cracking and will be easy to form into the shape of the canoe.

Task 5.2: Rib Design
Design ribs in correspondence to the maximum shear and moment results determined through RISA 3D.

Task 5.3: Reinforcement Material/Layers
Determine type of reinforcement to be utilized based on values produced by the 3-point bending test and tensile strength test using the Tinius Olsen. Determine reinforcement layers based on rules and regulations set forth by ASCE NCCC.

3.6 Task 6: Canoe Construction

Task 6.1: Concrete Preparation and Safety
Determine location where canoe will be constructed and prepare all materials and tools that will be utilized. Prepare a safety plan that all persons involved with

making the canoe must adhere to. Quality control will be necessary in the construction of the canoe to ensure that the overall thickness remains uniform.

Task 6.2: Pouring
Construct canoe using chosen final mix design, rib design and reinforcement material.
Task 6.3: Curing
The canoe will be allowed to cure for a total of 21 days before removing from the mold. The canoe will cure for 7 more days so it reaches full compressive strength.

Task 6.4: Mold Removal, Patching and Sanding
Mold removal will take place after 21 days of initial pouring. The canoe will then be patched if any cracks should occur after removing it. Sanding will be done to improve the quality of the canoe.

Task 6.5: Finishing Mix Application
After patching and sanding the canoe, a finishing mix will be applied to increase the aesthetics of the canoe.

Task 6.6: Staining
Finally, stains will be applied to the canoe comply with the ASCE NCCC rules and regulations.

3.7 Task 7: Display Construction

Task 7.1: Cross Section Display
A cross section of the canoe will be constructed during pour day. The cross section is a required deliverable that must comply with the ASCE NCCC rules and regulations.

Task 7.2: Display Board/Stands
An informational board will also need to be constructed that conveys the theme chosen for the canoe as well as any information that the ASCE NCCC rules and regulations request. The stands to support the canoe will also be constructed to match the theme established.

3.8 Task 8: Design Report

Task 8.1: Theme
A theme will be established that will both motivate and represent the team. This will influence the overall design of the display and art on the canoe.

Task 8.2: Rough Draft

A rough draft of the final design report to be sent to the judges for the competition will be prepared in a timely manner that will provide enough time for peer edits and revisions.

Task 8.3: Peer Edits/Revisions

The rough draft will be edited a minimum of 3 times by the technical advisor, the team and another individual that will provide detailed redlines. The edits will be applied and the final report will be completed.

Task 8.4: Final Report

The design paper will need to be copied to 5 compact discs prior to going to the competition. A hardcopy of the design report will need to be made as well. The sections listed by the 2014 rules and regulations that will need to be included are listed below:

- Report Cover
- Table of Contents
- Executive Summary
- Project Management
- Organization Chart
- Hull Design and Structural Analysis
- Development and Testing
- Construction
- Project Schedule
- Design Drawings
- Appendices

3.9 Task 9: Paddling

Task 9.1: Recruitment

Rowers will be chosen based on experience and if the individual's weight meets the criteria the canoe was designed to support.

Task 9.2: Practice

Practice will be conducted to ensure that all rowers are sync with one another and can perform well during races. The smallest males and females will perform the 4 person endurance race. The 2 male and 2 female races will be performed by light but strong individuals.

3.10 Task 10: Oral Presentation

Task 10.1: Create Slideshow

The slideshow will be created in accordance with the ASCE NCCC rules and regulations. The presentation will compromise all that was addressed in the design report. The presentation will be made using Microsoft Powerpoint.

Task 10.2: Practice

Enough time will be scheduled to allow the team to practice the presentation until perfected.

Task 10.3: Presentation Day

The presentation will be scored based on the presenter's behavior, presentation quality and expertise in answers to judge's questions. The team will have a total of 5 minutes to present with 7 minutes for questions.

3.11 Task 11: Conference

Task 11.1: Engineering Notebook

The design paper will need to be copied to 5 compact discs prior to going to the competition. A hardcopy of the design report will need to be made as well. The sections listed by the 2014 rules and regulations that will need to be included are listed below:

- Report Cover
- Table of Contents
- Executive Summary
- Project Management
- Organization Chart
- Hull Design and Structural Analysis
- Development and Testing
- Construction
- Project Schedule
- Design Drawings
- Appendices

Task 11.2: Display Day

As part of the rules and regulations, the team's display will need to include a cross-section of the canoe. The cutaway section should be a minimum of 3 feet and should demonstrate the following:

- Concrete casting in various stages
- Finishing in various stages
- Reinforcement techniques
- Identifying labels

Task 11.3: Races

A total of five races will take place at conference:

- Women's endurance
- Men's endurance
- Women's sprint
- Men's spring
- Co-ed sprint

If time and nature permit, the canoe team will practice paddling before leaving for conference.

3.12 Task 12: Deliverables

Task 12.1: Project Description

The purpose of this deliverable is to portray a technical understanding of the 2014 National American Society of Civil Engineers (ASCE) Concrete Canoe project and how to apply the team's engineering skills to achieve the overall purpose of this project.

Task 12.2: Scope of Services

The purpose of this deliverable is to illustrate the list of technical activities that will be performed to execute the design and construction of the concrete canoe. The list of technical activities will establish what will be done in order to the meet the client's goals and needs.

Task 12.3: Presentation

The presentation will be on all tasks completed for the first semester of capstone.

Task 12.4: Website Assembly

The purpose of this deliverable is to present the project information to the interested party. The information found on the website will include, but is not limited to the following:

- Home Page
  - Project title and description
  - Sponsor and client information
  - Team information
  - Technical advisor information
  - Last updated date
  - Links to other pages
- Project Information Page
  - Project constraints
  - Design alternatives options and decision matrices
  - Details of final design
  - CAD drawings archive

  - Gantt Chart and internal team budgeting
  - Photo Gallery
  - Team meeting notes (restricted and only available to team members)
- Documents Page
  - All written reports and presentations (PDF format)
- Other pages as needed to clearly communicate final design

Task 12.5: Proposal

The purpose of the final proposal is to professionally document the following: project understanding, scope and schedule, staffing and cost estimates, technical aspects, design and design analysis.

Task 12.6: 80% Report

An 80% report will be completed before the fall semester ends as requested by the client, Mark Lamer. The 80% report will entail the progress made on the concrete mixes and calculations completed.

Task 12.7: 90% Report

A 90% report will be completed before the spring semester begins as requested by the client, Mark Lamer. The 90% report will include all tasks completed over the winter break. The final mix design will have been chosen and all structural analysis should be completed or close to completed.

Task 12.8: UGRAD Presentation

The final presentation will comprise of the entire years' work on the canoe project which will include all calculations, competition results, and the final product.

Task 12.9: Capstone Final Report

The UGRAD presentation will take place before spring finals and will include the information specified by the guidelines set forth.

3.13 Exclusions

Tasks to be excluded from this project include:

- Design strong back
- Building mold
- Drawing canoe AutoCAD Civil 3D
- Structural analysis on mode of transportation

These tasks are being omitted from this project because the 2014 concrete canoe team is building off of the 2013 team's canoe. Therefore, the current team will be using the same mold and all of the subsequent aides based off of their shape.

4.0 Project Schedule

The project schedule was completed using Microsoft Project Gantt Chart. It highlights all the major tasks, subtasks, dependencies, a critical path and milestones. Many of the tasks rely heavily upon each other, so it is important for this schedule to be followed as strictly as possible to prevent any delays in other tasks that must be completed. Please see appendix A for the detailed project schedule.

5.0 Impacts

The canoe project is not a typical project in which the impacts can be obviously identified, therefore, the impacts were to be identified on a deeper level. Constructing a canoe each year is expensive and throwing the canoe away after competition is a complete waste. This affects the department and sponsors financially since the money is being wasted to some degree.

The canoe also impacts the environment depending on the materials utilized. Since the canoe is tossed out each year, the impacts from the waste created can affect the environment.

The most important impact, is how the canoe will influence the education of the team. This project is one of the most time consuming, labor intensive capstones. However, the project encourages the team to gain new knowledge and how to apply existing engineering knowledge previously acquired.

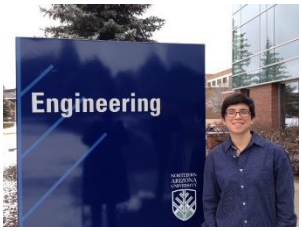
6.0 Qualifications

The team was selected based on the strengths of each individual member. Each member is intelligent and adds a unique personality that allows the team to push forward to complete the canoe.

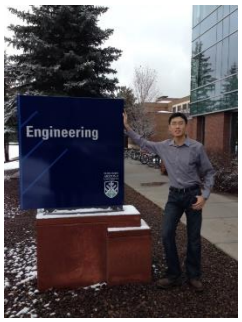
6.1 Project Management

The design and construction of a concrete canoe entails a wide variety of tasks. To ensure these tasks are completed successfully, tasks were assigned according to the strengths of each member. Depicted below is project management breakdown.

Hannah Adele Williams
Project Manager,
Reinforcement Lead



Ariel Suarez
Hull Design Lead



Shuo Zhang
Structural Analysis Lead

Brent Allman
Concrete Lead

6.1.1 Communication

Communication plays a vital role in the success of this project as well. The team communicates via email, text messaging, and phone calls. Hannah was selected as the lead contact for Thomas Nelson, and Ariel was selected as the lead contact for Mark Lamer.

6.1.2 Technical Advisor Meetings

In person technical advisor meetings are set up through Hannah and occur as often as once a week. Communication via email occurs multiple times a week, as needed.

6.1.3 Client Meetings

In person client meetings are set up through Ariel once given notice from Mark Lamer. Meetings take place as needed per the clients request and as questions come up within the team.

6.2 Experience

Project Manager, Reinforcement Lead

Hannah Williams was selected for this role due to her experience in leading teams in previous projects while attending Northern Arizona University. She currently is in her

senior working vigorously to attain a Bachelor's of Science in Civil Engineering. She is familiar with the work involved with designing and constructing a concrete canoe based on her 3 year involvement with previous year's concrete canoe teams. Hannah has been an officer for the past 2 years and was responsible for planning the 2013 conference details for the NAU ASCE chapter. She is hardworking and dedicated to all tasks that are appointed to her. Furthermore, she interned with METI, Inc (Management and Engineering Technologies International, Inc.) in El Paso, Texas during the summer of 2013.

Concrete Lead

Brent Allman is a senior engineering student pursing a degree in both Environmental Civil Engineering. Brent has experience in residential construction, heavy equipment operation and engineering inspection. Brent has been in the residential construction field since 2005 and has worked excavation for new build foundations, septic systems, pipe lines, electrical lines, and lot clearing. Furthermore, Brent has worked for the Arizona Department of Transportation as a certified inspector (ATTI Cert. # 16674F, ACI ID # 01259427) and Engineering Apprentice. Brent has handled payments and quality assurance for dozens of state projects. Brent's experience in quality assurance, project inspection management, and concrete certification will give him the ability to work well for this project, especially since he has experience with concrete materials and design.

Structural Analysis Lead

Shuo Zhang is a diligent and ambitious individual who refuses to give up. He is currently in his final year at Northern Arizona University and will be receiving a Bachelor's of Science in Civil Engineering. His experience with structural analysis led to his being perfect for the role as a structural analysis lead. Furthermore, he is currently a Supplemental Instructor for the Mechanics of Materials class taught at NAU. Shuo is more than exceptional as a structural analysis lead and is willing to learn new ways of solving problems. Additionally, he has experience using the drawing program AutoCAD Civil 3D through an internship he completed in the summer of 2013 with Smith Group JJR.

Hull Design Lead

Ariel Suarez is a senior Civil Engineering student at Northern Arizona University. She will be receiving a Bachelor's of Science in Civil Engineering. Ariel is a qualified member for the project due to her experience in leading team projects, organizing information, and applying learned concepts to structural analysis. Ariel has had past internship experience with the Arizona Department of Transportation doing inspections for a 2 mile section of an interstate in Tucson, Arizona. She is familiar with calculating quantities and doing safety checks. One of Ariel's greatest strengths is her ability to communicate with people which is essential for any project to be successfully and proficiently completed.

7.0 Cost of Engineering Services

The budget for this year's concrete canoe consists of billing time for the design and travel costs. Each team member will charge their time to the project based on the type of work performed. Table 1 depicts the overhead costs for the engineering services requested.

Table 1: Cost Estimate of Engineering Services

1.0 Personnel	Person	Hours	Rate, $/hr	Cost, $
	Project Manager	150	40	6,000
	Hull Designer	150	30	4,500
	Structural Analyst/Reinforcement Designer	150	20	3,000
	Concrete Designer/Lab Technician	150	10	1,500
	Total personnel			15,000
2.0 Travel	Local meetings			
3.0 Overhead				1,200
4.0 TOTAL				16,200

As seen in table 1 the cost for needed research design, and analysis are included. The second cost refers to travel for meetings which will not be included to cost. The third cost refers to the overhead cost which is based on the general cost of operations. The estimate is the complete estimated engineering cost.

8.0 Conclusion

Lumberjack Inc. has produced 4 decades of canoes. Several have successfully attained a top 3 spot nationally. This in itself is quite a feat. Lumberjack Inc. will continue this tradition by designing and constructing a lightweight concrete canoe that will accomplish objectives set forth by the team. The overall goals for this year's concrete canoe team consist of improving the concrete mix design, completing a thorough analysis using RISA 3D and improving in all report and presentation performances. The team has assembled an intense and detailed schedule that will aide in completing the necessary tasks. All members are well aware of what this project entails and refuse to give up until all tasks are achieved.