

2023

UT Tyler College of Engineering

Ratliff Relays

Cardboard Canoe Competition



*#42, Best Undergraduate Engineering Programs
— U.S. News & World Report, 2023*

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Introduction and Problem Statement

The University of Texas at Tyler was founded in 1979, and the College of Engineering was added in 1997. Currently the College of Engineering offers degrees across eight areas: undergraduate degrees in Civil Engineering, Chemical Engineering, Construction Management, Electrical Engineering and Mechanical Engineering, and graduate degrees in Civil, Electrical and Mechanical Engineering. Over the past several years, the College has opened a new teaching site at the Houston Engineering Center (where students can earn undergraduate degrees in Civil, Electrical and Mechanical Engineering), and grown to nearly 1000 students in total enrollment.

The purpose of this competition is twofold: (1) to provide students the opportunity to wrestle with an open-ended, practical engineering problem, and (2) increase awareness of STEM Challenges across the state of Texas. The competition focuses on three distinct aspects: (1) creating and displaying a cardboard canoe, (2) delivering an oral report and poster relaying design, technical and management information regarding the project, and (3) racing the cardboard canoes. The bulk of the activities that form the competition are analogues for the real-world skills that practicing engineers and project managers in the new millennium must possess.

As a final note, the rules and structure for this competition borrow heavily from the ASCE National Concrete Canoe Competition, an event involving collegiate competitors. No specific attempt has been made within the cardboard canoe competition rules to cite each individual instance of a similar rule, philosophy or structure from one competition to the other – as noted, the rules and structure of the cardboard canoe competition borrow heavily from the ASCE competition. More information for the ASCE National Concrete Canoe Competition can be found at <http://www.asce.org/rules-and-regulations/>.

Problem Statement:

Science is the field of study that makes hypotheses about how the world around us works and tests those hypotheses to see if they are true. The scientific basic mode of investigation is often trial and error. Science tends not to be interested in the application of proven principles. For example, $F = MA$ is a true basic scientific fact. This true equation is applied in several other disciplines but science itself is satisfied with the equation itself once proven true.

Engineering is the application of scientific truths. We use means, methods, and materials and combine them in a design to solve a problem. Engineers also use trial and error but rather than to validate the underlying principles of science, usually this process is applied to see if the DESIGN solves the problem. The design process is not complete until the problem has been fully solved to the satisfaction of the project owner.

Your design problem statement is: Using your knowledge of physics, mechanics, and materials, your team must:

DESIGN

PROTOTYPE

TEST

IMPROVE

And BUILD a final version

of a cardboard canoe that satisfies the “build” criteria in this set of rules and criteria and that is operationally capable of carrying 2 members of your team to successfully complete 2 separate races across a body of water similar to the UT Tyler pond (Lower Harvey Lake). Some minor repairs can be made by the team between races.

Chapter 1 – General Rules

1.0 Registered Participants

Student teams will consist of 4 or 5 students. Registered participants (i.e. one of the 5 team members) are the only persons eligible to present or answer questions during the Oral Presentation and are the only persons eligible to compete in the races. Each team shall designate a registered participant as their team captain.

1.1 Liability Waiver

Registration of participants will include the completion of the liability waiver included in these rules as Appendix B.

1.2 Team Sponsorship

The use of company names shall be permitted for information only in the Design Report, Oral Presentation and Product Display, but sponsorship is not to be recognized as part of any of these activities.

1.3 Ethics

Teams shall compete fairly in this competition. As such,

- a. Teams shall give proper credit to outside sources of help, including past classmates, websites, reference materials, etc. Plagiarism and false statements are clear violations of the ethos of this competition.
- b. Copyright infringement shall be avoided.
- c. False or malicious statements about other teams in the competition will not be tolerated.

1.4 General Information

General information about the competition, including the rules, may be found at: www.utt Tyler.edu/engineering/.

1.5 Spirit of the Competition

Under the “Spirit of the Competition,” the judges may take disciplinary action, including warnings, point deductions, or disqualification of a team or entry for inappropriate use of materials, language, alcohol, uncooperativeness, or general unprofessional behavior or unethical behavior of team members or persons associated with a team.

1.6 Appeals

Appeals during the competition shall be filed by the designated team captains using the Appeals Form (Appendix C) provided. The judges will make every effort to resolve an appeal. All appeals shall be resolved by the Awards Ceremony.

1.7 Canoe Removal

It is the responsibility of the participating teams to remove their entire canoe and any associated debris from the host site after the competition.

1.8 Safety

It is the responsibility of all participants to be knowledgeable of Occupational Safety and Health Administration (OSHA, www.osha.gov) policies. Refer to Chapter 7 for Safety considerations specifically for races.

1.9 Dates and Schedule

Teams should register to participate no later than March 1, 2023.

The competition will take place on Saturday, April 22, 2023. A preliminary Schedule of Events is shown below:

8-9 AM	On-Site Check-In
9-9:30 AM	Welcome and Technical Briefing
9:30 – 10 AM	Laboratory and Campus Tour
10AM – Noon	Canoe Design and Construction
Noon – 12:30 PM	Lunch (Provided)
12:30 – 1:30 PM	Poster and Presentation Preparation
1:30 – 2:30 PM	Poster and Presentation Judging
2:30-4 PM	Racing
4 – 4:30 PM	Award Ceremony

Chapter 2 – Canoe and Materials

Philosophy: The intent of this section is to provide the specifications for the cardboard canoe. In general, teams are to construct a canoe that (a) can withstand the rigors of competition including the transportation to and from competition, (b) is constructed of materials that are in strict compliance with these Rules and Regulations, (c) has been built within the current academic year and constructed and finished by the students.

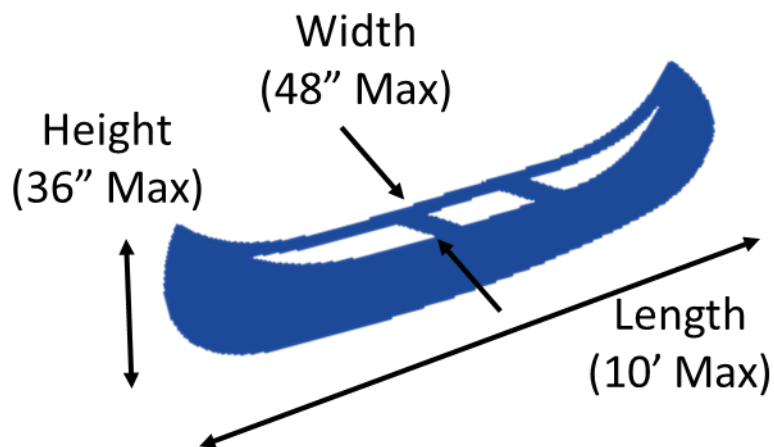
2.0 General

The term “canoe” shall be defined as any watercraft designed for paddlers using single-bladed paddles. The canoe shall be built with the durability required to perform in all activities, including transportation to and from the events. The canoe shall be built within the current academic year. Canoes shall be constructed and finished by the team members themselves. “Construction” relates to the placement of all cardboard and tape, and all aesthetic aspects of the canoe. For aesthetic considerations, see Chapter 3.

Canoes are subject to an official weigh-in at the competition with the measured weight of the canoe compared to the weight reported in the Executive Summary of the Design Report (see Chapter 4).

2.1 Canoe Dimensions

The length of the canoe, defined as the maximum end-to-end (bow to stern) measurement taking into account the outermost longitudinal dimension of the hull, is restricted to 10 feet. The maximum width of the canoe, defined as the outermost lateral dimension of the hull, is restricted to 48 inches. The location of the maximum width is at the discretion of the team. The height of the canoe is limited to a maximum of 36 inches.

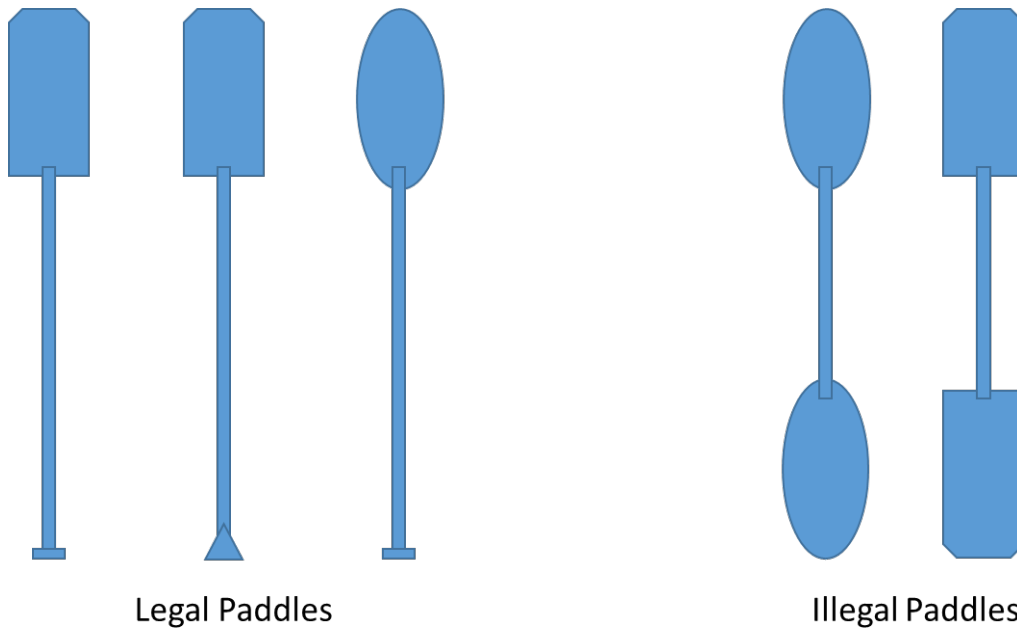


2.2 Paddler Restraints

Fixed paddler restraints, such as straps, seatbelts, Velcro®, or any other item that attaches the paddler to the canoe or that interferes with the paddler safely exiting the canoe in the event of capsizing, are not permitted. The judges shall prohibit the use of any paddler restraints if safety is deemed an issue.

2.3 Paddles

Paddles will be single-bladed, may be straight bladed or bent, and will be provided to teams the day of the competition. Spare paddles are permitted in the canoe during the races.



2.4 Materials

The canoe shall be comprised of only three types of materials: cardboard (See Chapter 2.5), tape (see Chapter 2.6) and aesthetic modifications (see Chapter 3). Procurement of all materials is the responsibility of the team.

2.5 Cardboard

All cardboard used in the construction of the canoe shall be corrugated cardboard that has not been treated with wax or other waterproofing substance. Cardboard will be provided to teams on the day of competition.

2.6 Tape

Any commercially available tape (i.e. masking tape, duct tape, “Gorilla” tape, etc.) is acceptable provided it meets the additional requirements in this section. More than one type or brand of tape may be used. Tape specifically marketed as “Slip Resistant” shall not be used. Tape used to construct the canoe shall be limited to a maximum of 6 rolls. Rolls shall be less than or equal to 60 yards, tape width shall be less than or equal to 2 inches. Tape thickness shall be less than or equal to 17 mil. The total tape used to construct the canoe shall be less than 1000 linear feet. **Tape should be brought to the competition by each registered team.**

2.7 Repairs

During the competitions, inclusive of all events and transportation to and from the events, repairs can be made only with tape and cardboard. Repair is limited to 1 roll of tape that fits the criteria of Chapter 2.6. and no more than 10 SQ FT of cardboard that meets the criteria of Section 2.5. Teams must notify a judge if they are making a repair and receive judge approval of the repair prior to continuing to participate in racing.

Chapter 3 – Aesthetics

Philosophy: The intent of this section is to provide the specifications for the materials that teams may use to finish the surfaces of the canoes. In general, teams shall provide the names of the team and canoe at their specified heights and locations.

3.0 Materials

The cardboard canoe may be decorated in any fashion teams see fit (provided the designs are in compliance with other rules within this document). Designs may be made with markers of any type or brand, such as Sharpie, Crayola, etc. Some supplies will be provided to teams at the event, but additional items may be brought to the event by registered teams, at their discretion.

3.1 Team Names, Canoe Names and Labeling

The team name (no initials) and canoe name shall be prominently displayed on the exterior of the canoe, on both sides. Note; each team shall have both a team name AND A canoe name – these WILL NOT be the same. All documentation submitted as part of this contest shall include BOTH the team name and the canoe name and shall clearly differentiate between the two, making it apparent which is which. For lettering, stickers are allowed, but if used, each letter must be an individual sticker. The team name shall consist of letters 4" \pm 1/2" high; the canoe name shall consist of letters 3" \pm 1/2" high. Letter height includes any outlines, shadows, ascenders and descenders, etc., used and may vary as long as it is within the specified range. Both upper and lower case letters may be used. The names may be abbreviated. The abbreviated names must still clearly indicate the specific team and canoe competing. The names shall be 'clean,' and 'professional.' Any dispute regarding the 'cleanliness,' or 'professionalism' of the team or canoe name is at the discretion of the judges – failure to meet this criteria will result in the loss of all race points, at a minimum.

Chapter 4 – Design and Construction Poster

Philosophy: The intent of this section is to provide the specifications for the Design Poster that will be presented orally to the judges (see Chapter 5).

4.0 General

The poster should be formatted to fit a 36x48” trifold foamboard that will be provided to the team on site. Teams should bring a set of markers and supplies in order to construct this poster during the contest period.

Complex, ill-defined design projects have many facets – between the first step of problem definition and the later step of construction, among the most important in-between are (a) project management, (b) analysis, (c) testing and materials development, and (d) design. Examples of these aspects for the current project are described in brief below.

Project definition – How does your team define the problem and what are your major success criteria, and how were these factors determined?

Project management – How was the workflow organized, including the team’s management of the overall project, materials procurement and/or construction.

Analysis – Examples for this include (1) quantitative results from the analysis of forces, stresses, etc., (2) description of loading cases (including racing, transportation, and display), support conditions, and assumptions and analysis tools used, and (3) discussion of buoyancy and stability of the canoe during any/all envisioned scenarios.

Testing and materials development – For this project, teams could consider: (1) descriptions of experiments and results for any tests that your team conducted to determine the structural durability and paddling performance of your canoe or its component materials, (2) describing the approach your team applied to translate testing results into design decisions.

Design – For this project, examples include: (1) Describing the integration of problem definition, testing, analysis, and construction, (2) describing the iterative nature of the project design development, (3) providing reasoning behind identification of major design criteria and how your team determined if they had been met.

Construction – Teams could for this project consider items such as: (1) describing construction methods and techniques, (2) discussing methods of quality assurance and quality control.

The poster criteria below have been designed to provide a broad overview of the team’s approach to the various elements above.

4.1 Contents

The poster should include specific sections as outlined below.

4.1.1 Problem Statement

The problem statement should include the team’s overall conception of the problem that they are trying to solve. What are the important features? What are the limitations?

4.1.2 Goals and Objectives

This section should be used to identify the top 3-5 goals and objectives that the team is seeking to accomplish.

4.1.3 Testing and Analysis

The testing and analysis section should be used to provide scientific evidence supporting the team's approach. Did the team perform any simple experiments to help choose materials, design elements or strategies? Did the team perform any analysis to ensure performance or safety? Potential examples include (but are not limited to): buoyancy calculations, force diagrams, tape tension tests, cardboard water immersion tests, and boat stability calculations

4.1.4 Construction and Construction Sketch

Construction - Describe construction methods and techniques. Discuss methods of quality assurance and quality control. Provide the total person hours required to complete the project.

Include a construction sketch. Include one (1) construction drawing and bill of materials for the canoe. The sketch shall show isometric, elevation, plan, and typical cross-section views of the canoe with applicable dimensions and other details as needed.

4.1.5 Bill of Materials

A bill of materials listing all material quantities used to construct the canoe should be displayed. Provide the total number of labor hours used to construct the canoe. Estimate cardboard at \$0.50 per square foot, tape at \$0.10 per linear foot and labor at \$25.00 per person hour. Provide an estimated cost to construct your cardboard canoe.

4.1.7 Optional

Use this portion of the poster, if space allows, to include any other information that your team wishes to present to the judging panel.

4.1.8 Summary and Conclusions

Provide a summary of the overall project.

Chapter 5 – Poster Oral Presentation

Philosophy: The intent of this section is to highlight the details of the Poster Presentation. In general, each team will discuss their poster with a panel of judges for approximately 5 minutes, and then have a question and answer period of 5 additional minutes.

5.0 General

The poster presentations should relay the important points of the project (presenting the key points of the Design and Construction Poster). All poster presentations shall be conducted in a professional manner (defined as a presentation that a professional engineer would give to a perspective client.) Oral presentations shall be presented in English.

Good engineering presentations usually include the following items:

- An introduction that allows an audience to relate immediately to the topic at hand and motivates them to engage with the remainder of the material
- A problem statement that is well organized and may include goals, objectives, issues, etc.
- An agenda and/or outline
- Well organized technical content that tells a logical, coherent story
- Good visuals that highlight the analysis, data and technical information
- Strong conclusions and/or summary statements that allow the viewer to key in on the important takeaways

The *MIT MechE* Communications lab provides a good set of materials regarding engineering presentations, available at: <https://mitcommlab.mit.edu/meche/commkit/technical-presentation/>.

5.1 Presenters

Presenters may be any of the registered participants who are officially on the team.

Chapter 6 – Final Product and Display

Philosophy: The intent of this section is to describe the various aspects of Final Product judging and describe the Product Display.

6.0 General

The Final Product (canoe and display) shall be consistent with the Poster and Poster Presentation. Final Product assessment consists of assigning a score to the canoe based on its overall aesthetic appeal and by applying deductions based on non-compliance with the rules and regulations. The purpose of the display is to show the results of your project to a larger audience and communicate the key features of your design and overall project experience.

6.1 Aesthetics and Workmanship

Judging shall assess the aesthetic appeal of the canoe. For aesthetics judging, all canoes shall be assembled in a common area.

6.2 Judging Criteria

The judges shall assess the aesthetics/workmanship of the canoe and product display (see Chapter 6.4) based on the Final Product score sheet as shown in Appendix A. Deductions shall be assessed against canoes as listed on the score sheet.

6.3 Durability of Canoe

Canoes shall be able to compete in both the preliminary and final race events. In the event that a canoe cannot compete in a race event, teams may repair with up to one roll of tape and using up to 10 SQ FT of cardboard (as Per Chapter 2). A canoe qualifying for a place in either of the final races but unable to compete due to durability issues will be required to give up this place to the next available qualifier (based on time).

6.4 Display

Each team shall provide a Product Display with the following configuration:

- a) Canoe
- b) Design and Construction Poster

Chapter 7 – Racing

Philosophy: This section describes the race portion of the competition. Racing will involve a preliminary and final race as described below.

7.0 General

A total of two races will typically be held: (1) Preliminary time trials, and (2) Final Heats. In each race, at least one male participant and one female participant must compete, if the team has the minimum number of members who identify as such. Each race is described below.

7.1 Race Rules

Good faith efforts must be made to start and finish all races.

In the event that a paddler is injured prior to a preliminary or final race, a substitution may be made. The substitute paddler shall be from the five registered participants.

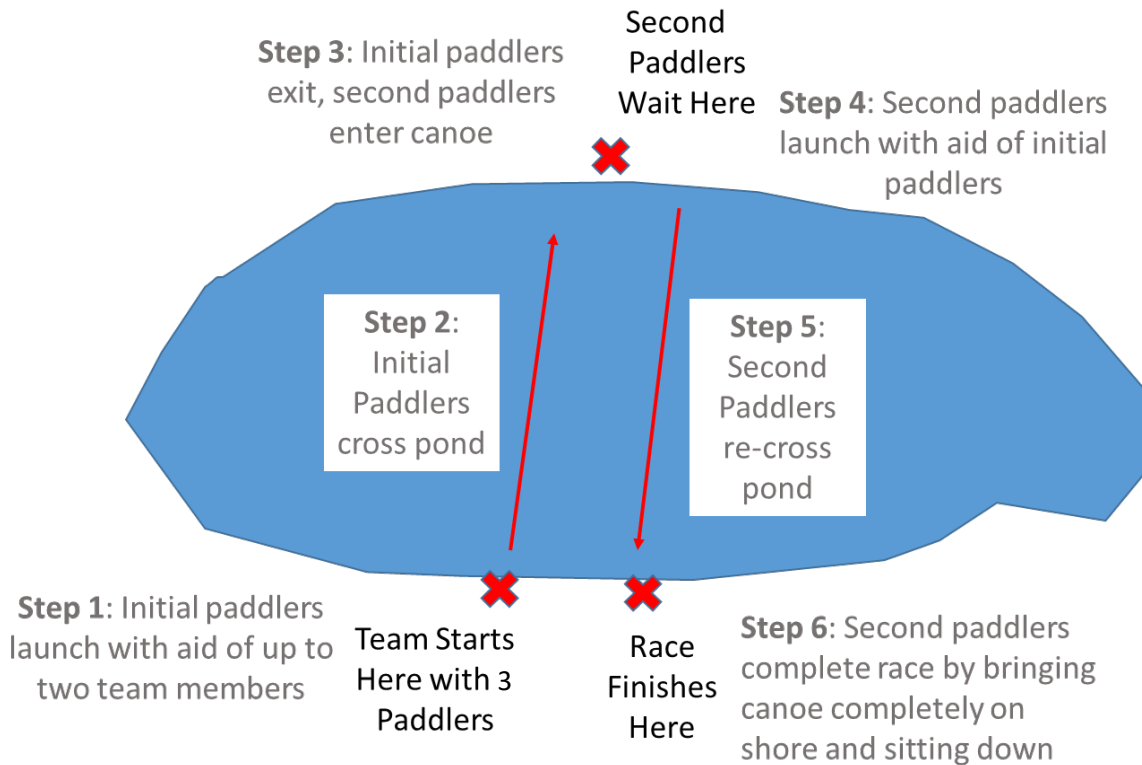
Teams competing in the preliminary time trials compete against the clock in a timed single event. The top five canoes advance to the grand final and the next five canoes advance to the petite final on the basis of qualifying times in the preliminaries. Points will be awarded based on the finish times in the finals. In the event that finals cannot be conducted, the preliminary times shall be used as the final times. If a team qualifies for a final event but cannot start the event, that team does not receive points and the team's slot is conceded to the team with the next best preliminary sprint time. For final races, if a team starts a race, but is unable to complete the race, they are awarded the points corresponding to completing the race last in their final.

7.2 Race Description

Two paddlers will enter the canoe and race from one shore location to a location on an opposing shore approximately 50 yards away. These two paddlers will exit the canoe on the far shore and three "new" paddlers will enter the canoe to paddle back to the original shore. It is permissible for any (or all) of the two original paddlers to be chosen as the "new" paddlers, however it is preferred that at least some of the "new" paddlers be different individuals from the original paddlers. During the transition, all team members will remove their life jacket and either pass it to a new paddler to be worn or put it back on themselves. At the start of the race, a team member may help push the canoe off, provided they do not enter water deeper than knee high. At the far shore, the second paddlers may aid the initial paddlers in exiting the canoe. The initial paddlers may push the canoe off provided that they do not enter water deeper than knee high.

The time recorded for a race shall be stopped when the canoe is **completely on the shore** and the three finishing **paddlers are seated** next the canoe. Two teammates may assist the finishing paddlers in exiting the canoe and bringing the canoe onto the finishing shore. A schematic of the race structure follows.

The races may be held in a swimming pool or small pond.



7.3 Capsizing Canoes

In the event that a canoe capsizes, the paddlers will have the option to continue the race by swimming while staying in contact with the remains of their canoe. Judges have the discretion to stop a race at any point in the interest of safety of participants or any other considerations, without appeal.

7.4 Sportsmanship

Commonly accepted rules of sportsmanship shall prevail. There shall be strict enforcement of racing etiquette by the judges. Any canoe willfully interfering with the performance of any other canoe or participant in a race shall be automatically disqualified. Any use of paddles to intentionally strike at an opponent's canoe, or at any person, shall be cause of disqualification of the offending team from the event. Good sportsmanship, cooperation, fellowship, and the spirit of competition shall be strictly adhered to.

7.5 Safety

Participant safety is always the first priority. Cold water can cause impaired judgment, loss of coordination and hypothermia within minutes. Paddlers, already excited about the races, may make unreasonably poor decisions when cold and becoming hypothermic. The American Canoe Association recommends wetsuits for water temperatures less than 60°F and/or if the combined air and water temperatures are less than 120 degrees. Races will not be held if these criteria are not met.

Lightning and storms are also very dangerous. The weather will be monitored and all water activities halted when lightning and/or strong storms threaten.

For any race held on a pond, at least two rescue boats will be on the water during all races, or races will not take place. For any race held in a pool, appropriate lifeguards shall be present.

A safety director will be located in a strategic position to observe the activities, especially those near the starting and finishing area. The safety director is responsible for stopping all activities involving violations of any of the safety rules. In addition, the safety director is responsible for briefing paddlers on all known hazards prior to any paddling or racing, and as conditions warrant throughout the race competition.

Any entry deemed unsafe or hazardous by the judges shall not be permitted in the water unless corrective measures are taken. If corrective measures are not or cannot be made the entry shall be disqualified from further competition. If repairs must be made to an entry prior to any race, the judges may allow the entry to reschedule for a later heat, but prior to the next event.

All paddlers shall be competent swimmers. All Paddlers shall wear a US Coast Guard approved inherently buoyant (no inflatables) Type I, II or III Personal Flotation Device (life jacket) at all times while in a canoe during competition and/or practice. Wet suit buoyancy pads shall not be used as a substitute for the Coast Guard approved Personal Flotation Device. Objects not required for safe operations shall not be permitted in canoes.

Chapter 8 – Scoring

8.0 General

Scoring is divided into 4 parts:

a) Design and Construction Poster	Maximum 25 Points
b) Poster Presentation	Maximum 25 Points
c) Canoe and Display	Maximum 25 Points
d) Racing	Maximum 25 Points

8.1 Ranking

Placing for each event shall be determined by the ranking of the overall scores. In the event of a tie, the average of the raw scores will determine the actual placing. In the event that the tie remains after averaging the raw scores, then the tie will remain. Competition points shall be determined by dividing points for the positions involved in the tie. For example, if a second place tie occurs in the Design Paper event, points for second and third places will be averaged and awarded to the tied teams, if a tie remains after an average of the raw scores. The team with the next highest score will receive points for fourth place.

8.2 Points

Points are awarded under the following rubric for each of the four events:

- 1st Place – 25 Points
- 2nd Place – 22.5 Points
- 3rd Place – 20 Points
- 4th Place – 17.5 Points
- 5th Place – 15 Points
- 6th Place – 12.5 Points
- 7th Place – 10 Points
- 8th Place – 7.5 Points
- 9th Place – 5.0 Points
- 10th Place – 2.5 Points
- 11th Place and Higher – Zero Points

8.3 Deductions and Disqualification

Teams may be disqualified for: (a) violations of the Spirit of Competition, (b) Sportsmanship violations, (c) Failure to follow safety rules, (d) Disrespect to other participating teams, judges, volunteers, etc.

Deductions are described in the scoring sheets provided in Appendix A.

8.4 Appeals

The judges will inform the team captains about the deductions that have been assessed against the canoe and/or team in the various events. The raw scores and standings shall not be provided to the teams, only the deductions being applied. The team captains will then be afforded the opportunity to appeal the deductions through a written response that will then be reviewed by the judges. Designated

team captains are the only individuals that may appeal the deductions. The decisions of the judges following their review are final and the judges will accept no further appeals beyond those decisions.

Appendix A – Scoring Sheets

Design and Construction Poster Scoring (Out of 100 Points)

Grammar, organization, clarity and overall quality of writing, graphics, etc.	30 Points
Technical, Engineering and Construction Content	30 Points
Project Management, goals, objectives content	30 Points
Creativity and Innovation	10 Points

Final Product Scoring (Canoe and Display) (Out of 50 Points)

Workmanship	20 Points
Finishing and Aesthetics	20 Points
Poster Quality	10 Points

Deductions

Failure to follow rules regarding size, labelling, etc.	-10 Points
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Poster Presentation Scoring (Out of 50 Points)

Verbal skills (voice projection, tone, confidence, etc.)	10 Points
Non-verbal communication (body language, etc.)	10 Points
Content of presentation	30 Points

Appendix B – Liability Waiver

A liability waiver will be included in a revision of the rules to be issued in early February, 2023.