



# SOCIETY OF PHYSICS STUDENTS

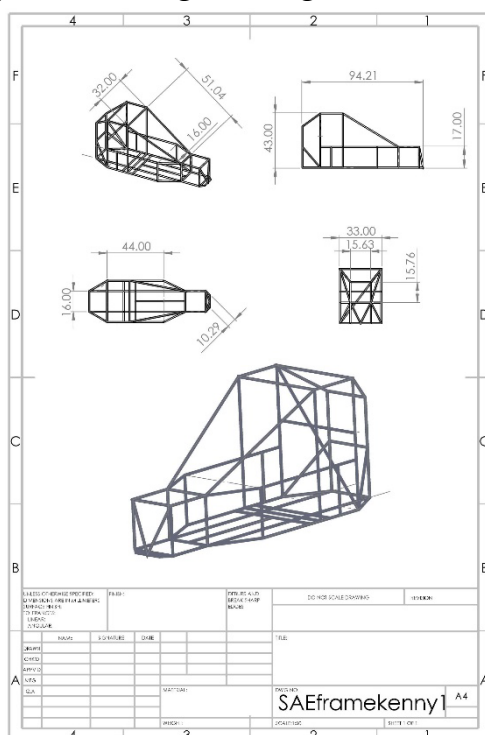
An organization of the American Institute of Physics

## SPS Chapter Research Award Proposal

Project Proposal Title	BAJA SAE 2023 Phase One: <i>Structuring the BAJA Blast</i>
Name of School	McMurry University
SPS Chapter Number	#4199
Total Amount Requested	\$600

### Abstract

The Society of Physics Students, at McMurry University, seeks to compete in the Baja SAE 2023 competition. During the 2021-2022 year, the proposed project is to construct a vehicle frame built to SAE standards. This will foster opportunities for members to participate in real world applications of physics and engineering.



# Proposal Statement

## **Overview of Proposed Project**

This project aims to build, test and compete in the BAJA SAE 2023 competition. McMurry's SPS Chapter will be designing a tube chassis capable of handling the exposure of harsh conditions and extreme forces. The chassis is designed completely by SPS members while still being within the set SAE competition requirements. Comprised of schedule #40 1.05" outer diameter steel tube designed in three primary layers connected by supports. The chassis is designed to fit the 95<sup>th</sup> percentile male as well a 5<sup>th</sup> percentile female. Once the project is done a tubular chassis will have been completed and tested to withstand sufficient forces applied. This phase will prepare the chassis for the next step of the project.

McMurry's SPS chapter selected the project out of the challenges it presents, the chapter wanted to apply what we have been learning into a real world application and benefit from it. The team working on it will formulate a design of what will work as a suitable candidate for the competition. As McMurry University Physics Department introduces an engineering physics degree this project will fit into the prescribed degree plan, allowing students to exercise their acquired classroom knowledge in a practical application. In addition to our local achievements, this project will demonstrate possibilities for any SPS chapter to compete in a nationally held engineering competition, instead of being confined to the realms of their own campus or degrees.

## **Background for Proposed Project**

Baja SAE is a collegiate design competition for aspiring engineering students in undergraduate and graduate programs across the globe. The program was founded in 1976 at the University of North Carolina under Dr. John Stevens. Since the creation of the program, participation has grown exponentially with competitors across the globe. The task placed before students is to design and build a single seat, all-terrain sport vehicle that can contain a single driver safely. The vehicle must be a dependable, functional, and a lasting prototype catering to the market of recreational users. The program's goals are to provide engineering students with experience in a variety of disciplines for their futures in related industries through real-world experimentation. Specific experiences may include project management, team collaboration, design, fabrication, and development and preparation of technical documents (Baja SAE, A1.1-1.4).

## Expected Results

Upon completion of this project, the following results are expected: It is expected that a Baja SAE vehicle chassis will be constructed and adhere to standards that the Baja SAE competition dictates. This frame will be reliable and withstand shock and stresses related to the off-road competition courses. The frame will also be structurally sound and adhere to the safety standards in the event of an on-course incursion. This frame will be suitable for future additions such as the engine, transmission, wheel and tires, and all other applicable hardware and assemblies. The design, planning, and construction of this project will allow our team of students to obtain real world experience in research & design and the ability to make connections with other students in the SAE competition.

## Description of Proposed Research - Methods, Design, and Procedures

The project in which the McMurry SPS chapter will be working on is designing and building a steel rollcage per 2023 BAJA SAE competition requirements. The build is being executed in phases to facilitate the varying schedules of the McMurry Physics students, as well as giving time to test and modify the design where needed.

The cage is broken up into layers: the bottom, midsection, top, and uprights. Each layer is setup to give the operator the minimum space required between any member of the cage and the operator before contact. This chassis will need to remain light and compact to handle tight corners and steep obstacles. The cage is made from schedule #40 1.05" OD steel tube to ensure safety of the operator and resist bending under wear and tear sustained during the competition. The tubes will be notched to ensure a perfect fit as well as making sure any cross member does not span too far of a distance, maximum of 40" per requirement, without any additional support. In addition, each support and junction will be named and analyzed to assess the final integrity of the roll cage build being proposed.

Pieces of small portions of the tube steel used, for destructive purpose in these tests, will be welded together and put under a press to measure the stress and strain of the weld and the metal. Each test piece will be observed during its elastic region until the point of failure. A stress vs. strain graph can be created for the tube and the welded tube sections. These tests will determine how much force the steel and welds can handle before failure, and to see if the welds made are sound and are sufficient for the project.

Each weld and bend on any member will be tested for integrity. This will include drop tests, where each member will be lifted to a height three times any expected drop and then dropped. After the welds are completed/inspected, a vastly greater than gentle force directed to the ground to see if any weld crack or break. The same will be completed with each layer until the final assembly of the cage is constructed. Upon completion of the steel cage, each bend and weld can be hit in multiple directions with a mallet to ensure a good safe weld. At this point, the cage can then be lifted, dropped, and rolled in multiple planes to ensure integrity and rigidity will not be an issue. Doing this will ensure the safety of the driver and the ability to move on to integrating the powertain and drivetrain to the frame in the next part of the intended two year build.

### **Plan for Carrying Out Proposed Project**

All personnel involved with the tube chassis will be any physics student currently and planning to be enrolled at McMurry during the 2021-2022 school year. SPS has approximately 13 members during the active school year, with a handful of the members having a background in manufacturing, welding, or some mechanical work. This experience will support the project with sufficient members capable of performing the work and/or showing others how to help on the project. The project will be assembled in the workshop of the McMurry Physics' department, and the SPS may decide on bending the tubes at an off-campus workshop to save money. SPS advisors will be present to oversee equipment being operated safely as well as give thoughtful advice when complications arise.

### **Project Timeline**

November:

- (12<sup>th</sup>) Order and pickup material and tools.
- (19<sup>th</sup>) Measure and cut top frame rails.

December:

- (3<sup>rd</sup>) Measure and Cut descending pillar rails.

January:

- (28<sup>th</sup>) Begin measuring and cutting mid-layer frame rails.

February:

- (4<sup>th</sup>) Measure and cut remaining mid-layer frame rails and upright tubes between base level and mid level.
- (11<sup>th</sup>) Cut remaining uprights from base level and mid level.
- (18<sup>th</sup>) Measure and cut base level rails.

March:

- (4<sup>th</sup>) Begin to measure and cut base layer frame tubes.
- (11<sup>th</sup>) Finish cutting base frame tubes.
- (25<sup>th</sup>) Assemble and tack weld base frame rails.

April:

- (1<sup>st</sup>) Assemble and tack mid layer rails and uprights to attach to the base frame.
- (8<sup>th</sup>) Begin Interim report.
- (15<sup>th</sup>) Collect all data and progress to fill in report.
- (25<sup>th</sup>) Polish and finalize Interim progress report.

May:

- (30<sup>th</sup>) Submit Interim report(end of school year).

August:

- (8<sup>th</sup>) Assemble top layer for welding.
- (19<sup>th</sup>) Begin tack welding each layer.
- (29<sup>th</sup>) Tack weld each layer together by descending rails and crossmembers.

September:

- (8<sup>th</sup>) Finish tack welding and check frame for symmetry and correct angles.
- (15<sup>th</sup>) Begin welding each section and layer together.
- (30<sup>th</sup>) Have all the joints in the frame welded together.

October

- (8<sup>th</sup>) Test each joint in the frame by hitting the joints with a hammer.
- (10<sup>th</sup>) Cut and weld test pieces for destruction.
- (17<sup>th</sup>) Run force experiments on test pieces.
- (31<sup>st</sup>) Finish experiment and have all data collected for report.

November:

- (1<sup>st</sup>) Run gravitational drop and small impact tests on frame.
- (7<sup>th</sup>) Inspect and repair, if needed, the tube frame.
- (14<sup>th</sup>) Scuff and prime frame for finished result.
- (21<sup>st</sup>) Begin Final report with data and progress recorded over project duration.
- (30<sup>th</sup>) Review and edit Final Report.

December:

- (7<sup>th</sup>) Finish report.
- (12<sup>th</sup>) Submit report.

## Budget Justification

The materials that we are using are coming from local companies as following, Mueller for metal, Airgas for air, Tractor Supply Co. for welding wire and Harbor freight for grinding wheels. The tube notcher will be ordered from Amazon.

The following is the budget for materials that will be used:

- \$353.28 for metal
- \$83.87 for gas
- \$34.99 for wire
- \$6.99 for grind wheels
- \$106.99 for tube notcher

## Bibliography

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