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[drive train/steering report]

detailing of the mechanical system and mechanisms used within the CAMS' Solar Cup boat.

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introduction

The Solar Cup team from the California Academy of Mathematics & Science (CAMS) consists of a collective student body of twenty interested in engineering. All of these students have been enrolled in Introduction to Engineering Design and Principles of Engineering courses, both organized by Project Lead the Way. On top of the engineering curriculum, each student also participates in other engineering or leadership elective courses, which include but are not limited to: Computer Integrated Machining (CIM), Robotics Manufacturing, Student Council, and Architecture Design. These students also take part in Team America Rocketry Challenge (TARC), VEX Robotics, FIRST Robotics and several other challenges. Most of these students are new to the Solar Cup Program, yet they are able to utilize the skills they have gained from these classes and activities to their advantage.

methodology

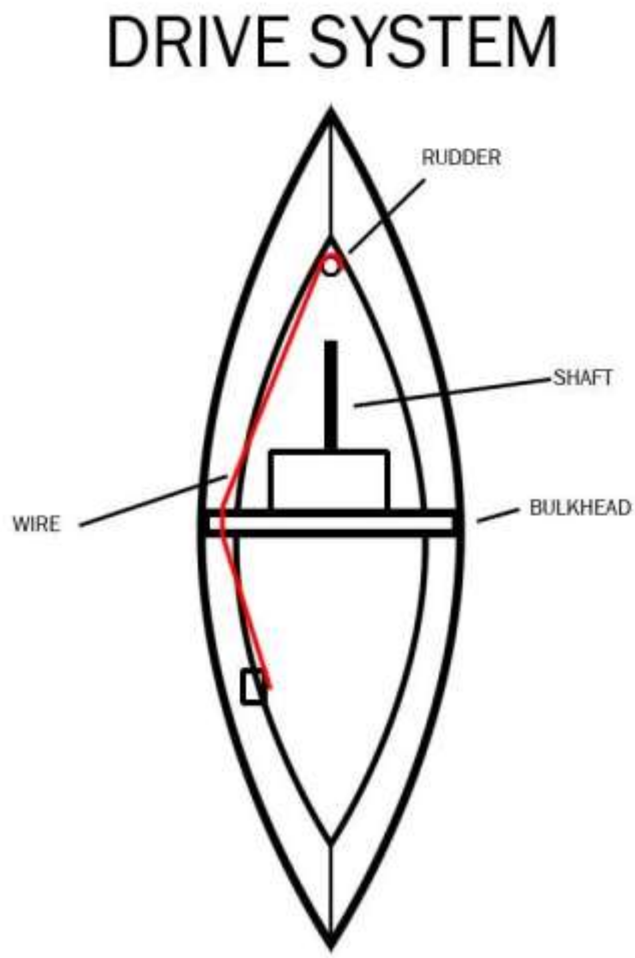
This would mark the CAMS Solar Cup Team's second year in the Solar Cup project. The team members utilize the engineering design process, taking into account their given constraints as well as their funds. With a new team, over double the size of last year's team, the veterans will be very diligent in training the new rookies. The veterans want to incorporate the idea of *function over form*, where a working boat is better than a physically appealing one. That being said, the team still keeps the boat's aesthetics in mind.

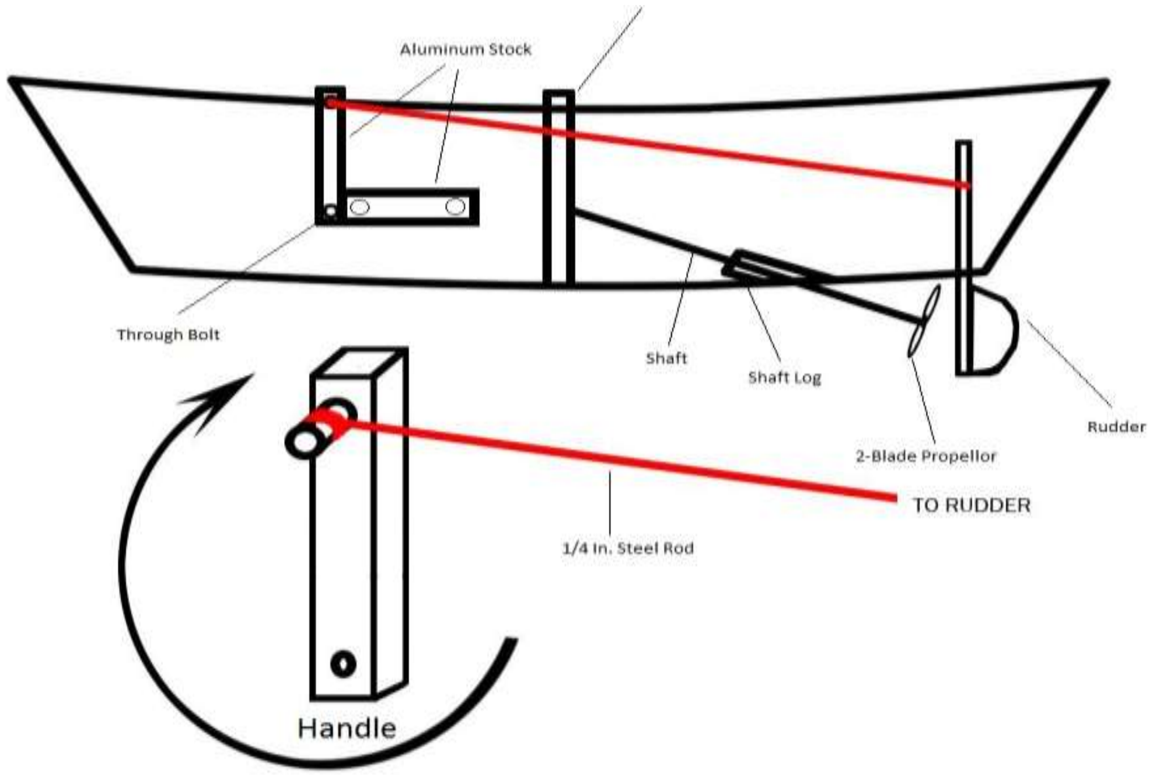
The CAMS Solar Cup Team's decisions are impacted by last year's results and other teams it has observed at the races. By looking over its scouting information and learning by consulting with other teams, the CAMS Solar Cup team has a new array of ideas to consider. As a sophomore team, they want to improve on aspects they didn't cover last year. The most limiting constraint is their budget, keeping in mind that the veteran finances are significantly lower than those of rookie teams.

steering system

There are three things that we kept in mind when designing our steering system. We wanted to keep the steering system simple, light, and efficient. Another thing kept in mind was improving on our design from last year. Our steering system from last year consisted of a PVC handle, a quadrant and a thick wire. One of the problems we encountered with the old steering system was that the PVC handle was very fragile and often times during the race against the force of the waves hitting the rudder came loose. Another problem we encountered was that the quadrant we used in our old steering design took too long to transfer the lengths displaced by the PVC handle. Based on our old steering design we looked to improve the stability and efficiency of our new design.

Our new steering system design is sturdier and simpler than our old design. The handle is composed of aluminum circular tube that was cut 5 inches long. The base of the handle and its mount are also composed of aluminum, but are made from rectangular tubes of stock rather than circular ones. The handle system is connected directly to a steel tiller that is attached to the rudder by a solid 1/4in steel rod, which is tensioned by a series of eye screws. We opted to use aluminum to compose most of the steering system because it provides much needed stability while still being lighter than steel. The rod connecting the handle system to the rudder is composed of steel because it needs to be sturdy enough to handle the constant force of pulling and pushing it will endure.

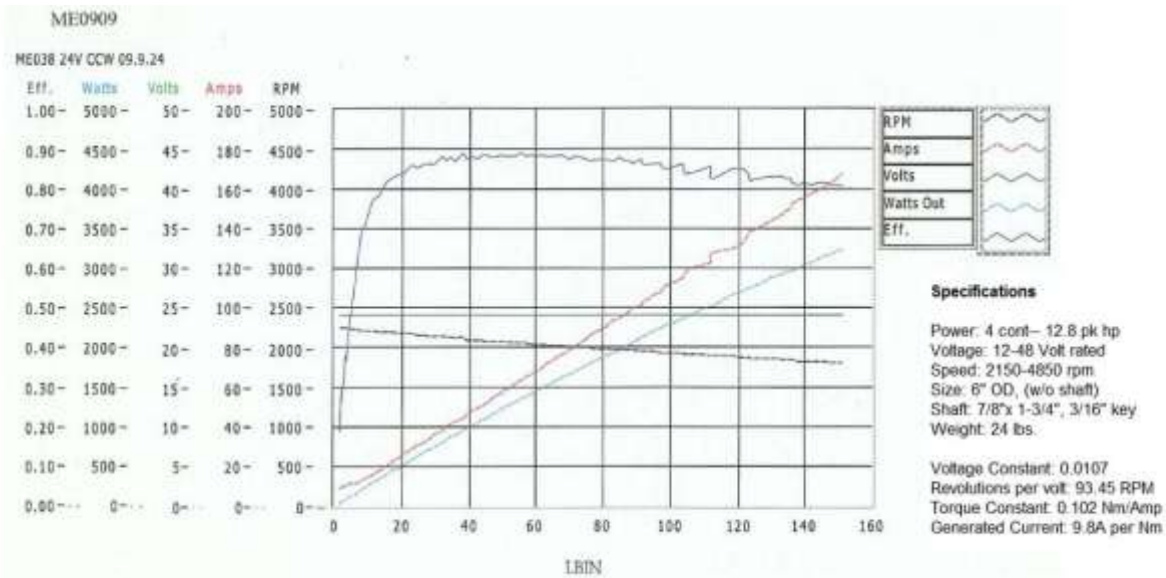




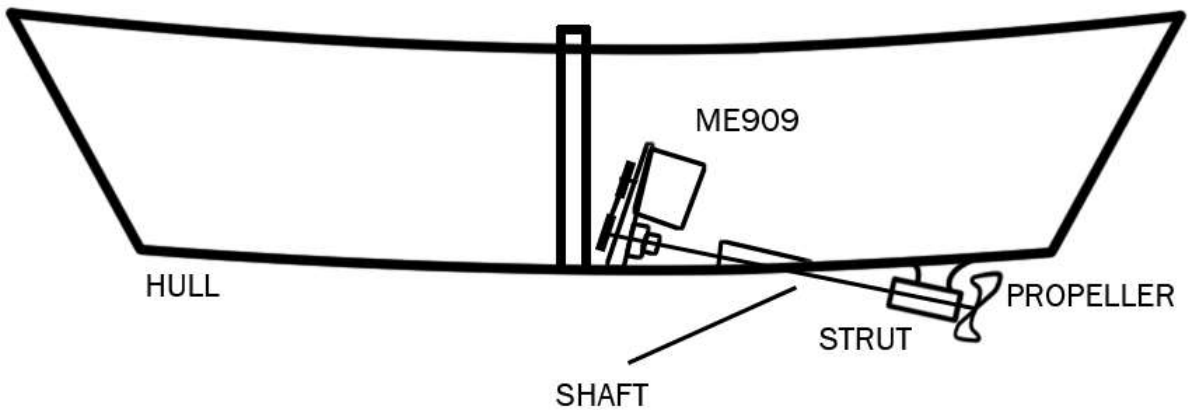
The unique thing about our steering system this year is that the turning mechanism is controlled by a through bolt. The through bolt attached at the bottom of the handle basically acts as an axle allowing the handle to move back and forth. The through bolt allows the steel rod connecting the handle to the tiller to remain straight, so when the driver pushes the handle forward the baot turns right and when the handle is pulled back the boat turns left. The steering system is light because it is mostly constrcuted from aluminum, it is simple because there is a single connection from the handle to the rudder, and it is sturdy because the components are welded and bolted to each other or the boat.

drive train

This year we wanted to improve on the success of our drive train from the previous year. Because we were a rookie team and didn't have much knowledge on drive trains we opted to puchase the "Donovan Kit" that was being offered to everyone. The kit came equipped with a drive shaft, flange bearing, stuffing box, strut, propellor, and a rudder. This kit was equipped with a ETEK-R motor that we puchased. During the competition we only used one sprocket ratio, something we hope to change this year. Although we had great success with the parts we were provided in the "Donovan Kit" we wanted to improve upon our design. This year we have upgraded pieces of our old drive train with money that would otherwise have been spent on soalr panels.



One of the key things about our drive train (pictured below) this year is that we are upgrading our motor to one that is lighter and faster. We had researched extensibley and came to the conclusion that the EMC-ME0909 (see specs above) was the best motor for the budget we had. The EMC-ME0909 motor is 4lbs lighter than our old ETEK- R motor and at 24V provided 2500 RPM while our old motor provided a measley 1000 RPM under the same conditions. Another thing is that we opted to use a aluminum stuffing box opposed to one made of PVC. An aluminum stuffing box provides more safety than a PVC stuffing box while also being as light as it. The stuffing box that we have have picked out also aligns our drive shaft to have a 15 degree angle from the hull of the boat. The 15 degree angle that the stuffing box provided enough room for our propellor to clear te bottom of the boat. Although we are keeping a sprocket and chain transmission, a small thing that we changed, to be able to be more competitive in the races, is that we have two sets of sprocket gear ratios opposed to one. Last year we had a 2:1 sprocket ratio for,but this year we will have a 1:2 ratio for the sprint race and a 1:1 ratio during the endurance race. The 1:2 ratio will provide much needed speed during the sprint race while the 1:1 ratio will provide more control for the driver during the endurance race while not giving up as much speed as a 2:1 ratio. We hope to change the ratio between the endurance and sprint races to maximize our boats effieciency. Lastly we will upgraded our old 3 blade propellor to a 2 blade propellor because two blade propellors are lighter and we believe they provide more speed.



conclusion

As a veteran we hoped to improve on design and decisions made from our rookie year, last year. For both our drive and steering system we opted to go for light, simple, effcient designs. For our steering system we decided to go for an aluminum tiller system that provided much needed stability from our PVC design last year. This years design will require less force from the driver to move the rudder in each turning direction. Our drive system is a great upgrade from last year's design as well. This year we decided to take the design process into our own hands opposed to buying the "Donovan Kit" that provided nearly the entire drive train for us last year. This year we also decided to upgrade from the ETEK-R motor to the lighter more efficient EMC-ME0909 motor. We found through researching that while the ETEK motor had better specs at face value once we looked at the performance of both motors at 24 volts, our optimal voltage, we found that the EMC motor performed better. Overall our Solar Cup team decided to make this year's boat an upgrade from last year's boat by gaining a greater knowledge of boats and their components while also having a bigger emphasis on the design process as a team.

resources

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