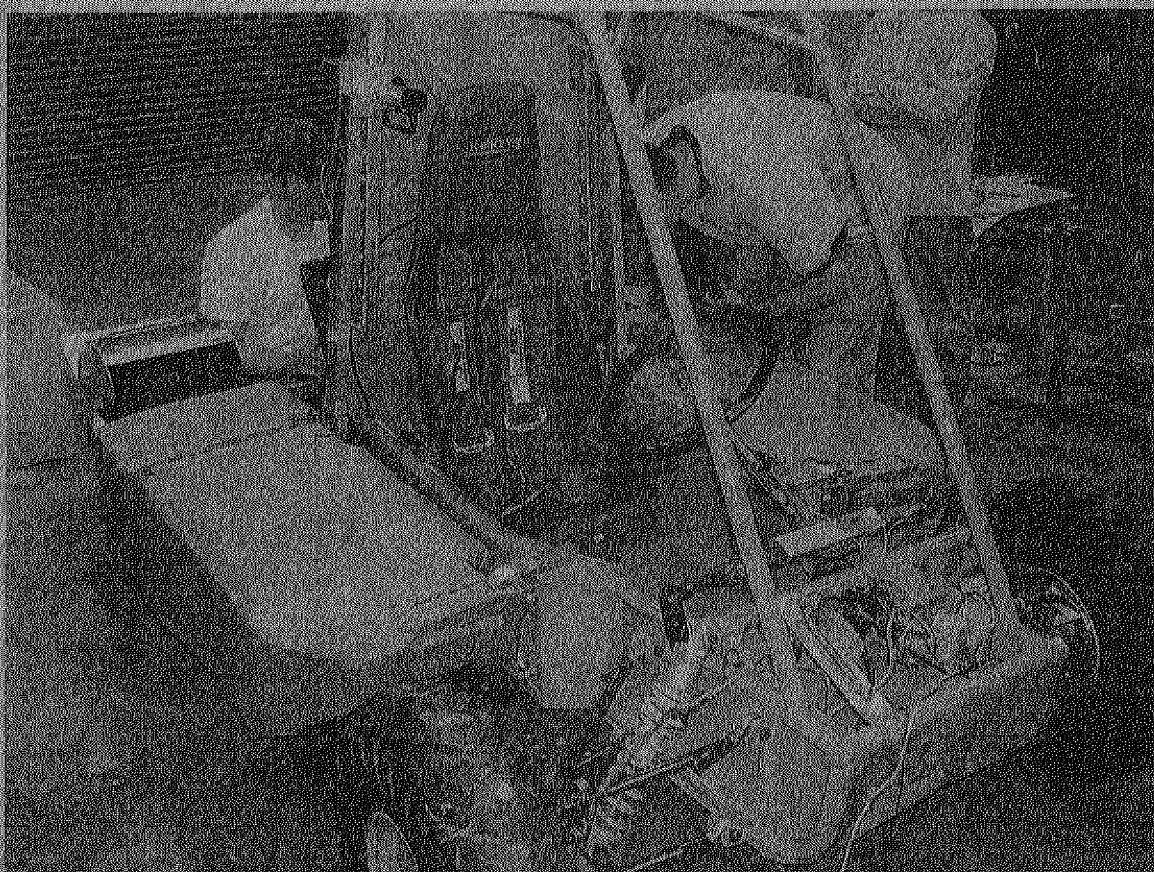
Tech 797
Mini Baja Floatation and Propulsion Team
April 2002



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Abstract:

The task at hand was to analyze and design a floatation and propulsion system for the existing mini baja car for the 2002 competition. The Baja car is an all-terrain amphibious vehicle, which will be raced in an East Coast completion in May of 2002. using previous years experiences the team will attempt to improve on the current designs to give the UNH Baja team an advantage over the previous years teams. The first objective of the project is to give the car the maximum amount of buoyancy while positioning the car at the optimum level in the water, as well as insure stability both stem to stern and port to starboard of the vehicle. The second objective is to give the car the maximum amount of forward propulsion with out hampering the land performance of the car. The project will be divided up into four phases. The phase break down accomplishes two things for the group, one being organization of design and construction the second being scheduling. The phase break down is as follows; Phase I is analyzing concepts for both floatation and propulsion. Phase II is building and testing prototypes. Phase III will be the final construction of the chosen design along with any mounting and debugging obstacles the team may face. Phase IV will be the final report and design.

Phase Break Down

Phase I

Three basic concepts for propulsion

1) Propeller
2) Jet boat pump
3) Redirecting fenders

Two concepts for floatation

1) Inflatable air bladder
2) Surface mounted foam floatation

Phase II

After analyzing the three designs for the propulsion they were tested in the test tank. This resulted in both numerical and physical proof of concept for further construction of a fender.

The floatation was designed by process of elimination, making a decision tree that allowed us to way the positives and negatives of each system. Additional constraints are placed on the floatation by the design of the Baja car, such factors as size, weight, location, durability and overall competition regulations.

Phase III

Construction of the final design will involve choosing materials and mounting concepts for the three designs. Such material as aluminum, stainless, and plastic will all be considered. Mounting of the fenders will involve careful consideration to maximize the amount speed and agility of the car while in the water.

Phase IV

The final report and final design.

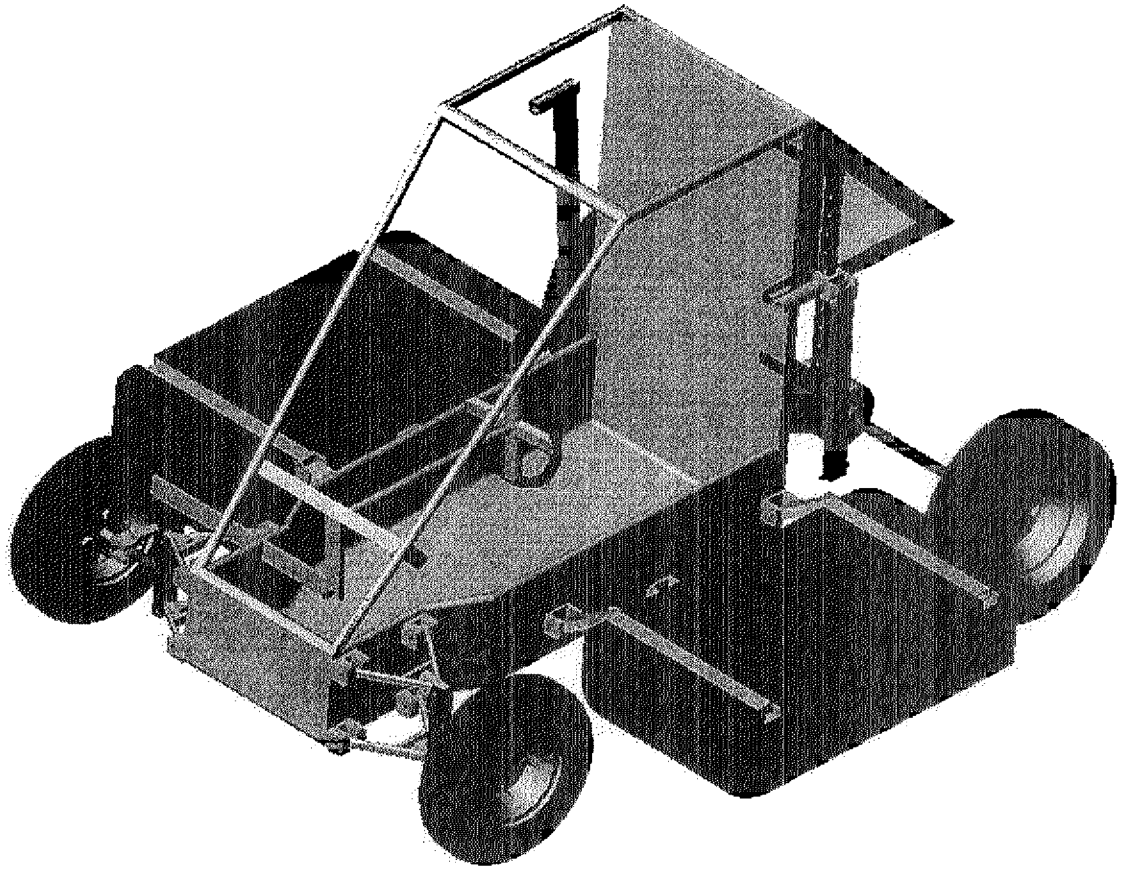


Figure 1
Mounted Buoyant System

The main objective for this project is to identify, design, and exploit a system which would have a hydrodynamic advantage in the competition. Given the nature of the water obstacle, the majority of our attention was directed towards two aspects. Here, we focused upon propulsion methods as well as buoyancy. Taking the lessons learned from previous year's designs, we devised a system which would meet strict criteria of requirements. For this project to be successful, the system must be lightweight, rigid, easy to use, as well as powerful.

Component Break Down

Fenders:

The fenders for our vehicle were designed to optimize the forward momentum created by the rear tires as they spin in the water. In addition, they will help keep the drive train dry, which is extremely important since the vehicle is primarily belt driven. The tread pattern of the tire is extremely important to the performance of the fenders. The tires that are used are similar to farm tractor tires, only the tires are mounted on the rim in reverse so that the V shaped fins points to the back of the car. This makes the fins work as paddles to help kick up as much water as possible. The objective of the fenders is to catch as much of the water thrown from the rear tires as possible and redirect it to the rear of the vehicle. This makes it is possible to transfer the vertical momentum of the water into forward momentum for the vehicle. Without the fenders present, this momentum would not be utilized and the vehicle would move slowly through the water.

The final design uses an enclosed shaped fender, which will serve to catch the water and direct it to the rear. The enclosed shape helps to entrap the side spray that spins off the tire while in the water. The fender had two redirecting vanes, one is at a low position just above the water line and the second is ¾ up the tire to catch any additional water left on the tire. Ideally, the vanes would be placed as close to the tire as possible and in the two locations where the most water separates from the tire. To determine the ideal location for the fender system, a test tank was constructed which would allow the team to test various fender designs, as well as test for optimum water depth of the rear tire. As depicted in *Figure 2*, the tank setup has two directions of motion, vertical and horizontal. The vertical motion allows the tire to be lowered to different depths in the water this motion is controlled by a pneumatic piston located under the engine mount. As such, the system can maintain fairly accurate increments and specific tire depths can be examined. The horizontal motion is controlled by a set of linear bearings that allots the tire and engine setup full range of motion from one end of the system to the other. At the end of the bearing set is another pneumatic piston that is sealed at one end by a pressure gauge. The pressure gauge measures the total amount of forward force exerted by the tire when the system is active. Essentially, this measurement is an accurate depiction of the actual test environment. Here, the force seen by the pressure gauge will represent the amount of positive force exerted by the jet of water during operation in an open body of water.

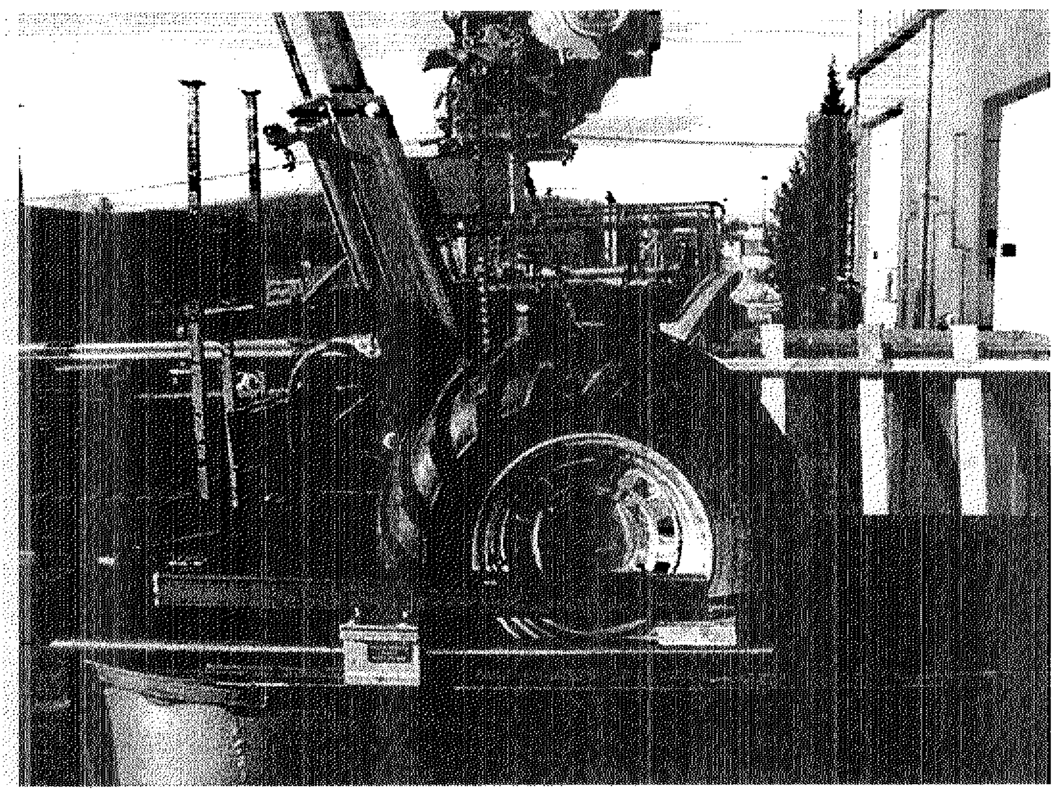


Figure 2

Mid-Construction View of Test Tank

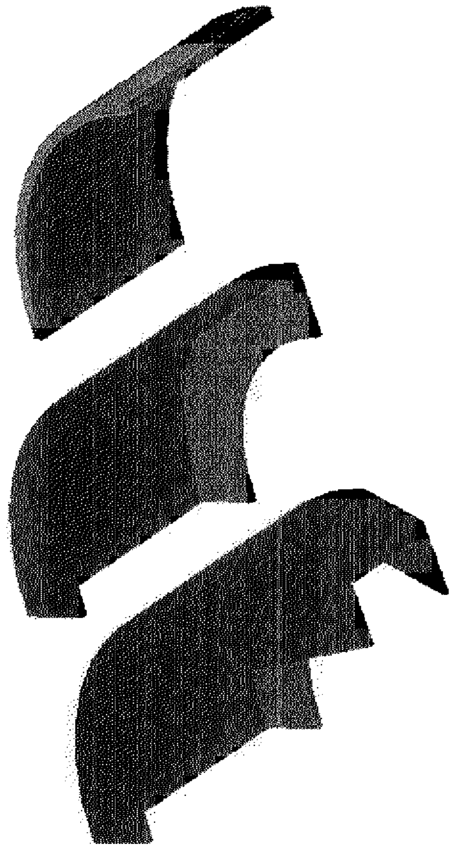


Figure 3
Proposed Fender Design

Utilizing the data from the test tank, the characteristics of three styles of fenders were explored. The basic design present in each case is clearly illustrated within *Figure 4.*

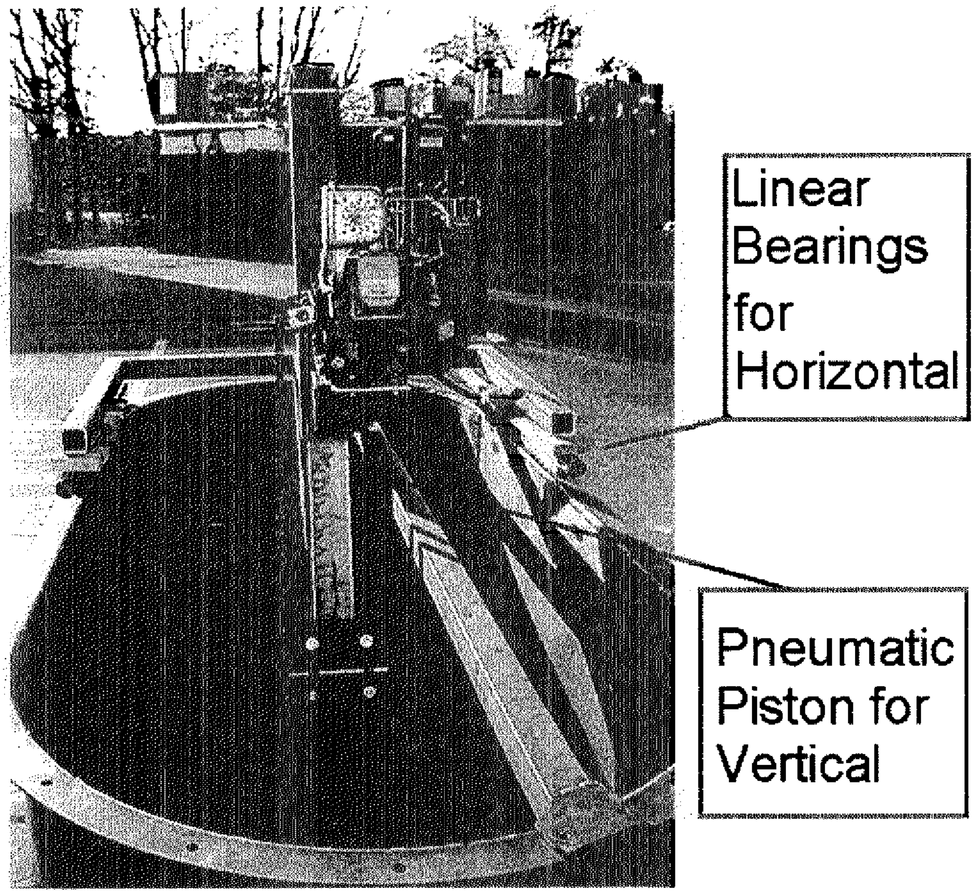


Figure 4
Tire Test Tank

Flotation System

The primary design objective of the flotation system is to make the vehicle float in a safe manner. To this end, stability and reserve buoyancy are key issues. Other design concerns include keeping the engine and CVT's above the water line, and the durability of the flotation. Also, in order to maximize the effectiveness of our water propulsion, the vehicle must be streamlined as much as possible.

After examining the flotation systems from other cars at previous competitions and studying UNH's earlier designs, we opted to implement a foam pod concept. This is a widely used means to obtain buoyancy because of its lightweight, durability, and modular design. Damaged pods can be easily replaced and more flotation can be added if the weight distribution of the vehicle is altered. An additional concern after studying the floatation of the previous year's cars was the location of the floatation on the car, the floatation simply was not mounted low enough on the car causing the car to sink lower in the water column. To solve this problem this year's team has opted to use a swing arm configuration that allows the driver to lower the floats as he or she approaches the water. There are two distinct advantages of this system which will be focused on. The first is that in the ordinary mode the floats don't affect the cars ground clearance. The second is that while in the water, the floats are below the skid plate of the car raising it farther out of the water therefore minimizing water drag.

The system is comprised of six main components (shown in Figure 5). The floatation is constructed of closed cell foam 10 inched thick by 20 inches wide by 36 inches long. The foam provides 60 pounds of buoyant force for every cubic foot. By placing the floats 6 inches deeper into the water we gain 144 pounds of buoyancy. After the floatation is properly shaped, it is coated by a company out of Maine called Floatation Technologies. The coating is a rubber spray on coating that make the float much more durable and less susceptible to damage. Given the durability of this coating, we can ensure that the initial amount of buoyancy present within the system will remain constant throughout testing and competition.

The next component is the float brace, which simply aids in the stability of the float. Since the floats will be deeper in the water there also will be a greater vertical force pushing on the floats. This necessitates an improved system for attaching the floats versus the traditional steel rods that were pushed through the center of the float in last year's system.

The third component is the Locking Pin Handle. The handle allows the operator to slide the float apparatus from one position to the other with minimum effort. Given the ability of the handle to lock the device in the appropriate position, we were given the opportunity to design a system where the extreme positions were adjustable by creating multiple access points for the pin which could be plugged when not in use. This would compensate for variations in driver dimensions and would also accommodate future modifications to the system as a whole.

The forth component is the raising bar. The length of the bar is very critical to the comfort of the driver. If the bar is to short then the driver will not be able to properly operate the floats. As such, the length must be a given dimension which will accommodate a variety of driver shapes and sizes.

The fifth component is the pivot arm, which is the pivoting connection from the swing arms to the raising bar. Once construction on the vehicle progresses and driver selection is made, the dimensions of this bar can be finalized and the physical part can be bolted to the vehicle.

The last component is the swing arms. There three total, two are mounted at the top of the float and the other is mounted at the center of the float. The reason for this is to add stability to the swinging motion of the system. If there were only two swing arms the float would not be constricted properly and could simply pivot up. The length of the swing arms is the key to how far into the water the floats will be lowered. In this case the swing arms are 5 inches long to insure that the floats do not hit the ground when in the lowered position while the car is on land. The reason for this is that if the driver waited to lower the floats after he or she entered the water they would be attempting to lift the entire weight of the car out of the water, which encompasses almost 400 pounds.

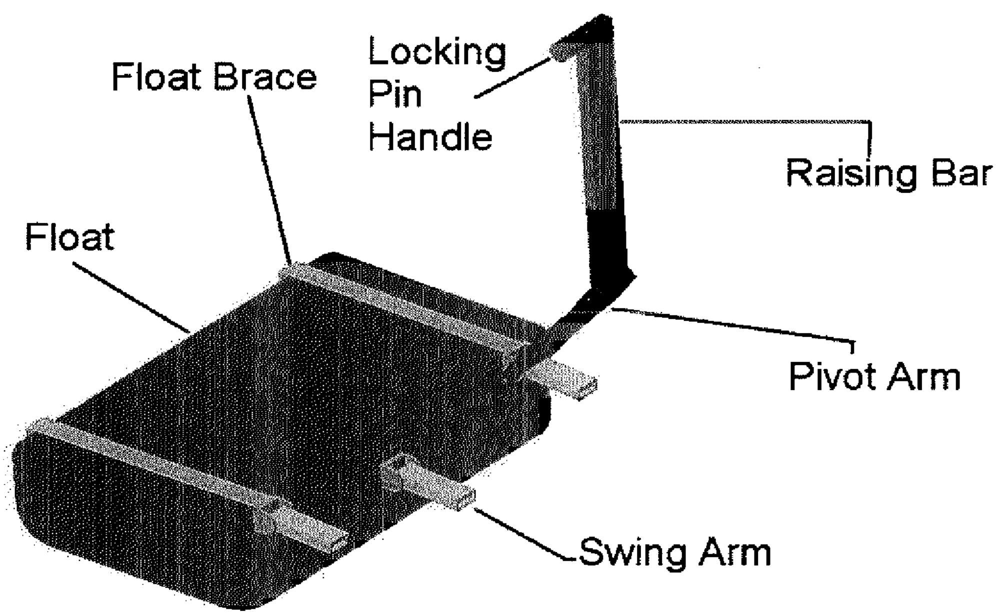


Figure 5
Floatation Mounting System

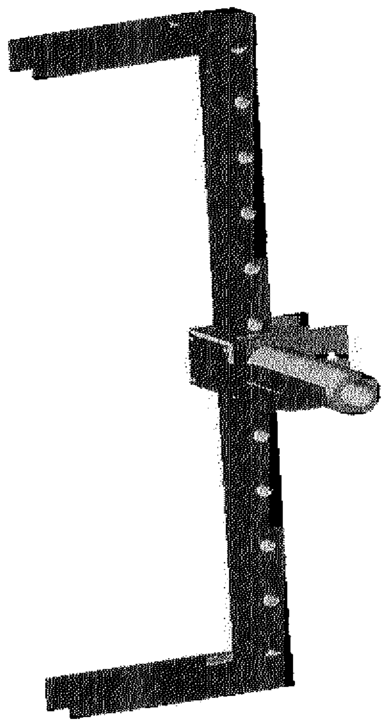


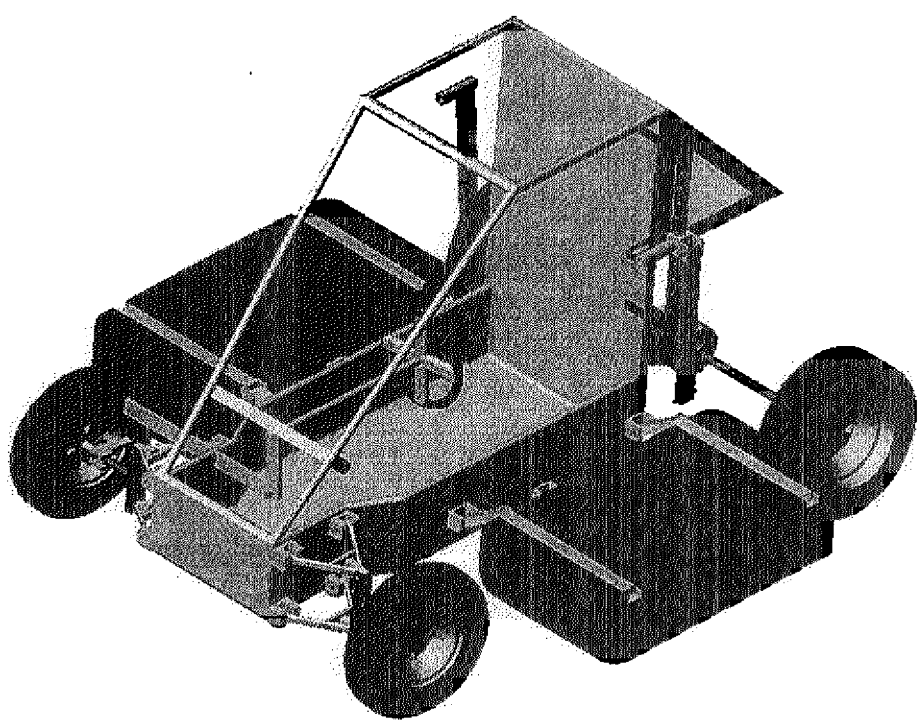
Figure 6
Handle Rail Assembly

The vast majority of the buoyancy is provided by two main floats which are located on each side of the car. The pitch of the vehicle is then corrected by adding or removing flotation to either the forward or aft ends.

Conclusion

Without a doubt, the UNH Mini-Baja team is making fantastic progress in the hydrodynamic aspect of the competition. Not only does this year's team have a system which proved to be a force to be reckoned with in the water portion of the competition, they also have a new testing apparatus to run trials with future designs.

Each year, the competition sees an extremely well-matched and competitive field. By directing more attention towards the water portion of the competition, the team is aiming to create and exploit a distinct advantage over the rest of the field. In doing so, they have dramatically increased their chances of success in the overall competition.



Appendix:

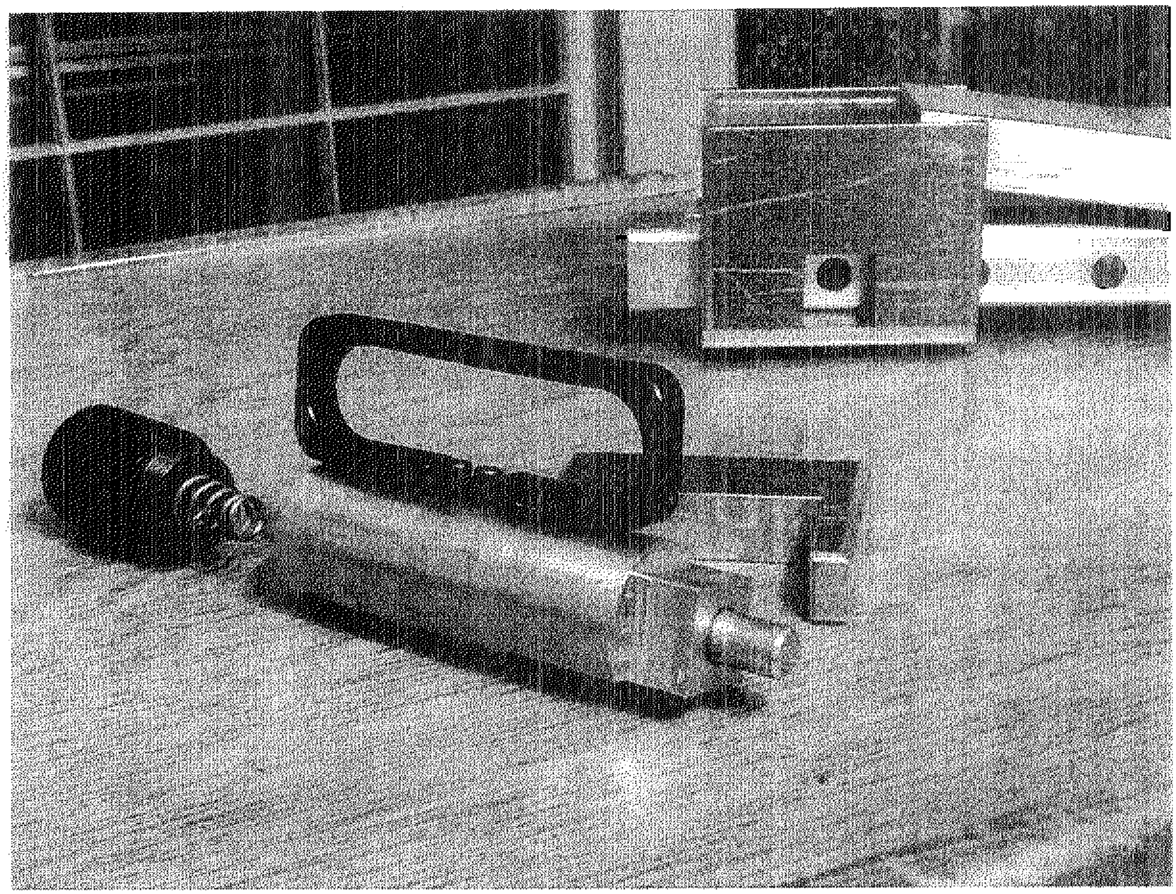


Figure 7
Component Visualization of Locking System

- The image represents the system which will serve to lock the entire buoyant system into place. Here, we see the manner in which the locking handle engages the support rail and prevents further motion of the system.

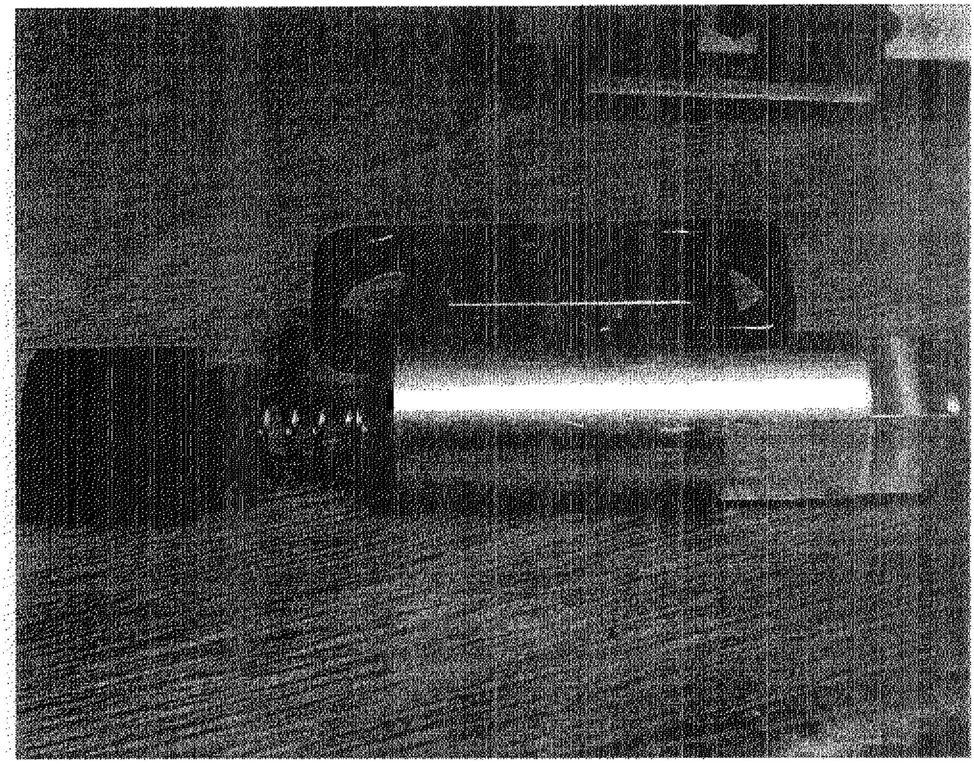


Figure 8
Locking Handle Assembly

- Here we see how the activation handle functions. As the black hand-grip is grasped and pulled forward, the spring pressing the pin is compressed and the lever is allowed to glide up and down the linkage support arm.

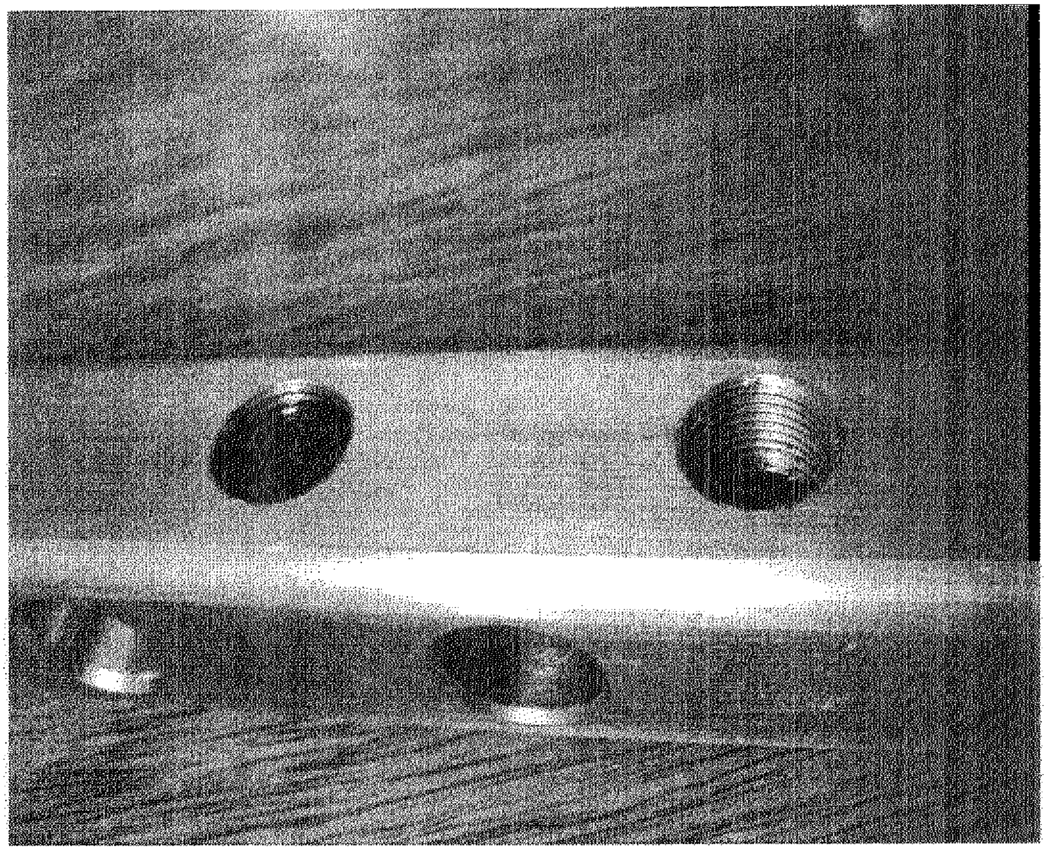


Figure 9
Support Rail Adjustability

- This photo illustrates the threaded plugs we will use to “fill” the unused spaces for the activation handle pin. In doing so, only the optimal positions will be left open to avoid improper placement of the system when activated.