1/5-Scale Remote Controlled SHERP
Summer 2026 Capstone 1 Report

Team 13
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Introduction

The remote control (RC) community extends to a range of vehicle types, sizes, and functions with only one consistent feature: remote operation. Within the RC world, cars and trucks remain the most commonly sold vehicles, though a large and growing community of water and air vehicles has taken shape. Some vehicles are designed for high speed and durability, while others are made to replicate full-scale vehicles as closely as possible. Despite this diversity, no vehicle presently exists at the 1/5-scale that offers fully amphibious, all-terrain capabilities, creating an evident gap in the market.

This gap likely results from the complexity and highly specialized nature of designing an amphibious all-terrain vehicle (ATV) at such a large scale. This project aims to fill that gap by designing a vehicle prototype based on the SHERP[1], per the request of the project sponsor, Primal RC. The SHERP was chosen as the foundation for this design due to its signature large, variable air pressure tires, capable of traversing difficult terrain while also allowing the vehicle to traverse through water. This product will focus on mimicking its full-scale counterpart while also providing a high degree of functionality and durability.

Background

Background Introduction

The goal of the background research was to gather information about the RC market and, specifically, the 1/5-scale segment. Topics included what amphibious vehicles exist in the real world and how they work, which of these vehicles would be appealing to a consumer as an RC model, and what types of amphibious RC vehicles are currently on the market. Existing systems for varying tire pressure across a range of industries were also investigated. Research was gathered from patents, RC webstores, peer-reviewed journals, and an interview with our sponsor, Primal RC.

Primal RC

Primal RC, based out of Nyack, NY, designs and distributes RC vehicles. They have infiltrated the niche 1/5-scale RC vehicle market by releasing products such as the Primal RC Monster Truck, Primal RC Dragster, and 1/5-scale Dodge Challenger, all of which are available in their catalog. The 1/5-scale market boasts fewer competitors compared to smaller scale RC on account of the vehicles being larger, heavier, and more expensive, which has allowed Primal RC to establish a strong presence and loyal customer base within the space. Given the larger scale,

[1] "SHERP" is stylized in all capital letters as a brand choice, not because it is an acronym [1].

these RC vehicles tend to retain characteristic features of their original designs such as light bars, posable doors, and winches [2].

Across Primal RC's lineup, each model is designed around a unique purpose that creates a more authentic experience for the customer. For example, the Primal RC Dragster specializes in high-speed straight-line racing, the Monster Truck is built for rough terrain and high-impact driving, and the Dodge Challenger focuses on scale realism and on-road handling. This purpose-driven approach to design has given each vehicle in their catalog a distinct identity rather than being a general-purpose product [2].

In an interview with Primal RC, they demonstrated interest in making an all-terrain amphibious vehicle due to the unique selling points and minimal competitors in the market. Developing amphibious RC vehicles at this scale involves complex engineering challenges such as waterproofing, buoyancy control, weight distribution, and propulsion systems, all of which are reasons that few manufacturers have attempted to create such a product.

For this capstone project, Primal RC has requested a prototype to help visualize the product and determine whether or not it should be "green-lit" for production. This prototype will evaluate the design's practicality and performance across different terrains, including its ability to maneuver in water. Other factors such as manufacturing cost and overall fit with the brand identity will also be considered with this prototype.

Amphibious Vehicles

Amphibious vehicles come in many shapes and sizes and have mostly been used for industrial and military purposes. One of the first successful amphibious vehicles was the tracked "Alligator" created by Donald Roebling in 1935 to facilitate search and rescue of hurricane victims in Florida swampland. Following the outbreak of World War II (WWII), interest in these vehicles grew and many versions were developed to facilitate amphibious landings of soldiers and supplies [3].

One of the most persistent amphibious vehicles created is the DUKW Amphibian Vehicle All-Wheel Drive Dual Rear Axle, colloquially known as the "duck boat" [4]. Originally created as a troop transport during WWII, duck boats are now popular tourist attractions in cities worldwide [5]. However, due to these vehicles' advancing age and that they were not originally designed as tourist vehicles, they have been the direct cause of multiple fatal incidents [5]. A 1999 duck boat sinking in Arkansas resulted in 13 fatalities, and a 2018 sinking in Missouri resulted in 17 fatalities [5]. Due to these drawbacks, a more purpose-designed vehicle would be favorable for use in this project.

The first purpose-built amphibious vehicle for commercial sale was the Amphicar, built in Germany between 1961 and 1968 and mostly sold in the United States [6]. It was shaped similarly to other cars of the day but could float and possessed two propellers for aquatic traversal [7]. It held a top speed of 70mph on land and 7mph in water [6]. Nearly 4000 of these vehicles were produced before the Motor Vehicle Air Pollution Control Act [8] and new Federal Motor Vehicle Safety Standards [9] effectively forbade their sale in America, and the company had to shut down [6]. While interesting pieces of technology, Amphicars were not designed for harsh terrain, maneuverability, or resilience under adverse conditions and would not have made good bases for this project.

The SHERP is a modern ATV, first produced in Ukraine in 2012 [1]. It possesses four large wheels and is equipped with a central tire inflation system (CTIS) [10]. CTIS allows the driver to increase and decrease tire pressure at the press of a button from within the cabin, enabling a suite of offroading capabilities from obstacle negotiation to being able to float across bodies of water, as the vehicle is fully waterproof [1]. This ability is aided by the tires which have large ridges and act as paddles to propel the SHERP forwards through water [10]. On land, the SHERP operates on a skid-steer system (similar to a tank) in which the left wheels and the right wheels operate independently to facilitate a very small turning radius [1]. A drawing of the SHERP from its original patent is shown below in Figure 1.

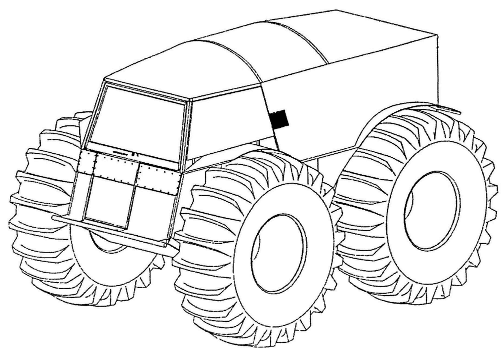

Figure 1: SHERP patent drawing [10].

The SHERP is designed for offroading and amphibious traversal, has a very recognizable shape which will be useful for branding and sales purposes, and its CTIS is unique in that it has never before been emulated amongst commercially available RC vehicles. The SHERP is thereby the best amphibious vehicle to recreate in 1/5-scale and fill the gap in the market.

Market Offerings

In the current RC market, there are no vehicles made to the 1/5-scale that have completely amphibious capabilities. While there are a few spin offs, made by small companies or even individuals, that mimic the aesthetics of the SHERP, they do not reach the same level of functionality. One of these spin-offs is the Kingkong RC All Terrain Transport Lurker Crawler Truck [11]. This vehicle is a 1/10-scale amphibious off-road RC that fits a similar niche but at a fraction of the scale, and it lacks a number of the SHERP's capabilities — most notably, true waterproofing. Despite being sold under the classification of amphibious and advertising that it can "play on the water", the user must add additional waterproofing for it to run properly [11]. Although the RC community is infamous for its use of customization and the ability to further improve or modify vehicles, the lack of out of the box ability to drive on the water is misleading. Additional requirements, such as the ability to adjust tire pressure, are not included, as the tires feature a fixed rigidity and leave no room for further modification. Though not directly listed, the Lurker's aesthetics resemble that of a Fat Truck FT2 and not a SHERP [12]. Fat Trucks operate very similarly to the SHERP, sharing a number of features such as adjustable tire pressure and the ability to cover amphibious terrain, but differ significantly in appearance. Fat

Trucks are boxier in nature and have smaller wheels relative to the vehicle size, sporting a mere 52 in tire in comparison to the SHERP's 71 in tire [1], [12]. Fat Trucks are also more commonly sold and marketed without the rear cabin in what is considered the Pickup model, a design choice reflected in the Lurker.

There are other market offerings; however, they are even more limited in terms of capabilities and scale. The only other commercialized vehicle is the JJRC Q210 4WD (Four-Wheel Drive) Amphibious Toy Car [13]. This is a 1/16-scale vehicle with little resemblance to the SHERP and it doesn't have the ability to adjust tire pressure. It also claims to be amphibious, but doesn't showcase the ability to drive on the water.

The last RC vehicle that is available to purchase is the RC SHERP by CustomRC. This is the most authentic mimic of the vehicle. Staying true to the visual aesthetics, the vehicle features a roll cage and rear cabin as well as logos, colorations, and markings that are identical to the actual company [1]. The vehicle also has some amphibious capabilities based on the marketed media through YouTube and Instagram that demonstrate it being able to drive and float on the water but it is not completely waterproof [14] [15]. The internal electronics are not housed within an ingress protection (IP) rated container. Despite these similarities, the vehicle is not consistent with the RC market for 1/5-scale and does not exhibit the signature characteristic of adjustable tire pressure as in the true vehicle. The vehicle is also not sold commercially. The only listed retail is inquiries through the vendors Instagram, as they are custom made on request [15].

Beyond these limited offerings, there are no RC SHERPs sold commercially that are 1/5-scale, exhibit complete amphibious capabilities, ready to go out of the box, have adjustable tire pressure, and visually mimic the true vehicle. With the gap in the market for large scale amphibious RC ATV and the lack of competition of existing market offerings, there is a need for the product.

Central Tire Inflation System Design

The most significant shortcoming amongst current market offerings is an ability to alter tire pressure during operation. CTIS is one of the key features of the SHERP, allowing it to traverse wider ranges of terrain, and will be an important differentiator between this vehicle and competitors. While this technology has not yet been miniaturized for use in RC vehicles, the original SHERP and tire inflation systems in other industries present useful concepts for the tire and hub designs. The SHERP's tires feature a novel design to better accommodate variable tire pressure as low as 0.42 psi [16]. The wheel, shown in Figure 2, is designed with an asymmetrical cross section when split perpendicular to the axis of revolution such that it mounts to a thin hub at the outside edge of the wheel and a thick hub at the inside edge [17]. This design increases the elastic area of the tire allowing for an increased contact patch at low pressures while still providing a sufficiently large hub along the interior of the wheel to accommodate elements for variable tire pressure. This design also incorporates elements to maintain an airtight seal at low internal pressures. The outside face of the tire is clamped to the outside face of a shaft running through the center of the wheel using a bolt. On the larger inside face, a metal ring with a circular bolt pattern is used with similar effect to clamp the tire against the hub [17]. This design prevents leaks at low pressure as the tires are held in place due to friction in the clamping interface rather than relying on the pressure of the tire to hold the wheel against the hub. These design features are novel to the full scale SHERP and useful for incorporation in the design of tires for the remote-controlled version.

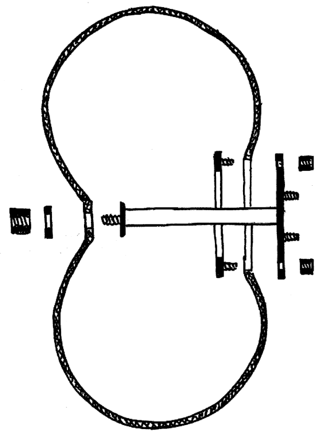

Figure 2: SHERP wheel patent drawing [17].

The CTIS also leads to specific design choices in the SHERP, but variable tire pressure systems exist across a broader range of vehicles. The SHERP has an internal combustion engine and utilizes its exhaust gas to inflate the tires [1]. This method will not be feasible for the remote control version as it is battery powered and therefore will not have exhaust gases. Other forms of CTIS are used in non-amphibious vehicles and provide more insight. Gravaa manufactures road bicycle wheelsets, shown in Figure 3, with a variable tire pressure system. This design relies on a compressor located in the wheel hub and powered by the rotation of the wheels and wireless control [18]. This design does not require a rotating pressure or electrical connection which would simplify the RC car design. Unfortunately, fully locating the pressure system in the wheel would require an air intake at the center of the wheel rendering the design unfit for an amphibious vehicle.

Figure 3: Gravaa x Reserve 42|49 Wheelset [19].

Agricultural vehicles may also be equipped with CTIS, and these designs are closer to meeting the requirements of the remote-controlled vehicle. One design, the flange-axle solution, shown in Figure 4, uses a pneumatic tube connected above the vehicle's mudguard and to a rotating connector on the wheel axle which is connected to the tire [20]. This design is a strong candidate for use on the RC vehicle as it does not interact with the wheel mounting, but is not preferred as it would reduce visual similarity with the SHERP.

Figure 4: John Deere tractor equipped with CTIS [20].

Another design found in agricultural vehicles is the bar-axle solution. This design, shown in Figure 5, utilizes a rotating connector with a hollow center allowing the wheel axle to pass through it. The stationary portion of the connector attaches to the body of the vehicle while the rotating portion attaches to the wheel. Pneumatic tubes then run from each side of the connector to the compressor and tire respectively [20]. This design improves visual similarity to the SHERP by keeping tubing behind the wheels and is a potential candidate for inclusion on the RC vehicle.

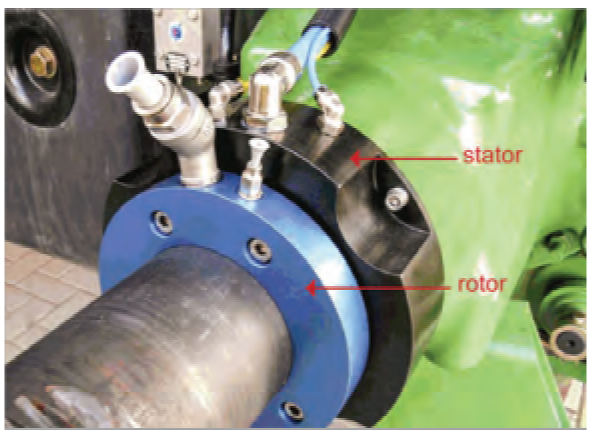

Figure 5: Air transmission unit for a bar axle [20].

The final design is the portal-axle solution, shown in Figure 6. This design relies on a hollow axle with a connection to the compressor on the inside of the vehicle and a connection to the tire on the outside edge. In agricultural applications a pneumatic tube is then connected between the outside face of the axle and the tire [20]. However, when used in conjunction with the SHERP tire design previously discussed, air could easily pass directly between the center of the axle and the tire via radial holes in the axle. The portal-axle solution is a second strong candidate for use in the remote-controlled vehicle and both options will be considered during the design process.

Figure 6: Self-propelled harvester equipped with CTIS [20].

Summary

Primal RC is a RC car manufacturer which specializes in making 1/5-scale vehicles. Primal RC has requested the development of a 1/5-scale amphibious ATV to fill a gap in the market. Various amphibious vehicles have been created in the last century, mostly for military and industrial applications [3]. Of the vehicles analyzed, the SHERP was the only good fit for the project. The DUKW was prone to fatal accidents and mechanical failure [5]. The Amphicar was created for civilian use but fell out of favor following updates to Federal environmental and safety guidelines [6]. The SHERP possesses a unique visual profile, purpose-built offroading and aquatic capabilities, and unique CTIS, all of which will make a model an appealing product for consumers in the RC community. Current offerings on the market include the Kingkong RC All Terrain Transport Lurker Crawler Truck [11] and JJRC Q210 4WD (Four-Wheel Drive) Amphibious Toy Car [13]. Both possess incomplete aquatic capabilities and are at too small of a scale, demonstrating a gap in the market. CTIS is common to agricultural and industrial vehicles, allowing the driver to remotely change pressure in the tires while the vehicle is in motion to adjust to changing terrain [20]. By creating a 1/5-scale RC SHERP possessing a CTIS, the best possible product will be created for Primal RC.

Project goal, objectives, and success criteria

The goal of this project is to design and construct an approximately 1/5-scale remote controlled vehicle modeled after a SHERP, capable of operating over land and water. To fulfill this goal, four objectives have been established and success criteria identified. First, the vehicle must be able to balance a speed of about 20 mph (per sponsor's request) while generating enough torque to propel itself through water, and climb over rough terrain and obstacles. This will be verified by submitting the vehicle to a field test in which it will have to successfully cross water and a set of obstacles such as large rocks, a boulder field, or small scattered logs. Second, the vehicle must float rather than submerge during normal aquatic operation, with its electronics being sealed to prevent water damage in the event where it capsizes. This will be achieved by inverting the vehicle in water and confirming no water ingress or loss of function once righted. Third, the tires must support adjustable inflation through an onboard compressor capable of inflating or deflating them on command to adjust for terrain. This will be validated by demonstrating adjustable tire pressure in operation. Fourth, the vehicle, which will be battery operated, must be roughly 31.5 x

20 x 22.5 inches and weigh no more than 80lbs, with an expected battery life of at least 30 minutes. This will be authenticated by measuring and weighing the vehicle, as well as timing the duration before needing to recharge. Finally, the vehicle must be operable by a simple interface to accommodate for varying levels of user experience. This will be confirmed by having a user with little to no experience operate the vehicle after a brief orientation.

Ethical Concerns and Potential Impact

Stakeholder Analysis

When engineers look to ethically design a product, they must consider all who may be impacted by its implementation. This includes direct users of the product, as well as indirect users who may be impacted by this product without choice. The direct users will generally be adult remote control (RC) car enthusiasts, typically aged 25 and older. Technical training varies, but most have a strong understanding of mechanical systems and simple electronics. Indirect parties to this product would be neighbors of RC owners (potentially exposed to noise or disruptive operation) and other users of public areas where RC vehicle operation is permitted. People present in mixed-use areas — such as a public park, where RC users and non-RC users are present — will typically be unaware of this product until an incident occurs. Without proper safeguards, they are also more vulnerable to injury because the operator may not be aware of their presence. This means the vehicle must be designed with their safety in mind. Environmental activists are not currently part of the design process and may have legitimate concerns about the vehicle's impact on the environments where it operates. In the case of a battery malfunction or short circuit, the vehicle might have unintended impacts such as pollution which would be a concern for them. These indirect parties see limited to no benefit from the product; the closest exception is a bystander who becomes a de facto direct user by operating someone else's vehicle. This risk is relatively minor provided the vehicle is operated only in permitted areas, and the design does not cause permanent damage to the operating environment. It is also a risk implicitly assumed by anyone entering an area that permits RC vehicle operation.

Human Subjects Considerations

An important consideration is the development of safe testing procedures for this vehicle. Humans are involved in teleoperational control of the system but do not directly interact with the vehicle during operation, other than the risk of an out-of-control vehicle. This risk is mitigated by initially operating the vehicle in a contained area, incorporating safe loss-of-connection behavior, and including a wireless E-stop. After purchase, the customer or user is responsible for obtaining the informed consent of anyone in the vicinity before operating the vehicle. They will also be responsible for ensuring that any aftermarket modifications do not compromise the health, well-being, or environment of others. While these are important considerations, data privacy is an ethical concept which will not be important for this project. The product will not collect individually identifiable data. Any data collected will relate only to vehicle performance and will not differentiate between operators since the design should accommodate a broad range of users.

Ethical Issues

One ethical dilemma faced by this project is that of accessibility. The controller is designed for simultaneous two-handed operation, which excludes users who have dexterous impairments. At 50+ pounds, the vehicle also excludes users without the strength to move, store, or repair it. This is a dilemma rather than a violation: fully accommodating adaptive use— for example, through an arcade-style button layout or a more accessible joy-stick— could require redesigning the control scheme and structure in ways that trade off against cost, timeline, and performance. In addition, lowering the weight of the vehicle would allow for users with decreased strength or mobility to maneuver the vehicle. However, given the size and capabilities of the vehicle, it would be hard to go below 50 pounds.

Another ethical dilemma of this product is its impact on people in nearby areas. Operation of this vehicle may affect neighbors and other people sharing the environment, particularly through noise and the risk of reduced control. Noise can agitate nearby people, and reduced controllability increases collision risk. This creates a genuine tension with the goal of building a more capable product, since greater capability tends to increase noise and momentum while reducing controllability.

One ethical violation of the product is its environmental impact. The vehicle must not contaminate its operating environment, whether through product failure or normal operation. Primary failure concerns are unexpected water ingress and battery damage; primary operating concerns are the vehicle's effect on ground, vegetation, and local animals.

We prioritize environmental impact as our highest ethical concern because, unlike accessibility or bystander effects, it is classified as a violation rather than a dilemma — the vehicle must not contaminate its operating environment regardless of other design tradeoffs. Failure modes such as water ingress, battery damage, or fire pose irreversible harm to a shared environment that no stakeholder consented to bear. The other two issues, by contrast, involve harms that are either exclusionary (accessibility) or partially mitigable through user behavior and context (bystander effects).

Impact Analysis

The global impact of the SHERP is somewhat limited. Large-scale adoption could overcrowd popular operating environments and damage them, similar to issues seen at some national park sites. This risk is limited, however, both because the vehicle is smaller and lighter than off-road vehicles carrying riders, and because reaching that scale of adoption would require growth well beyond the current RC market. Another global risk is that international shipping costs are higher than domestic costs, creating inequality in access. A network of international distribution centers partially mitigates this, but without large-scale adoption there is limited incentive to fully equalize access.

The SHERP will also have an impact on the economy. An expected price point above $1,500 will exclude many potential customers. Efforts will be made to minimize cost, but the vehicle's size will keep the price high enough to exclude some users. RC influencers stand to benefit by using the vehicle to generate content and revenue. Intellectual Property (IP) protection covers the specific implementation rather than the general function, so competitors may build similar vehicles without infringing. Licensing is handled by Primal RC; individual owners would only need their own licensing if a modification infringed on someone else's IP. The SHERP's introduction also supports increased trade between U.S. and Chinese suppliers, and with customers based abroad.

Environmental impact is a real concern for the vehicle, given its potential to damage its operating surroundings, though this risk is somewhat reduced by the expectation that operators will primarily use it in their own local area, meaning they share whatever environmental consequences result. Specific risks include the vehicle sinking irretrievably in water, and fire originating from the battery or electronics. On the design side, the vehicle's environmental footprint is reduced by making it repairable. The product is designed for repair and component replacement rather than full-unit replacement, extending its useful life; at the end of that life, functional parts can be reused and metal parts scrapped.That said, most parts sourced from China, which increases shipping distance and carbon footprint, and suppliers there may not meet the same environmental standards as domestic ones. The vehicle also relies on Li-Ion batteries, a standard in the RC community, but these are environmentally expensive to produce and difficult to recycle safely. Alternative chemistries do exist, but have not been selected since their lower power density would increase weight, raising cost or degrading performance for customers.

These environmental tradeoffs sit alongside a number of societal concerns. Many of these are inherent to the design itself, but still merit consideration in order to mitigate them as much as possible. One is that RC community members without the capital to purchase an expensive vehicle may be excluded from use. Another is that public unrest or concern generated by the product in shared places could damage public trust. These concerns can be addressed by reducing the vehicle’s cost as much as possible and by encouraging responsible behaviour among users respectively. A further concern is accessibility: users with physical disabilities, most commonly hand impairments, may be unable to operate the vehicle with the standard controls, which could be addressed through a custom controller or interoperability with standard adaptive controllers. Related to this is the ability of such users to move the vehicle when it is not in operation; while the vehicle’s weight is somewhat inherent to its scale, easily accessible lift points for individual and team carrying would let more users move it. Finally, product failures could damage Primal RC’s reputation, a risk mitigated through extensive testing by the team, by Primal RC, and by outside beta testers, who bring less familiarity with the design and can catch issues the team may have overlooked.

Weighing these against each other, environmental stands out as the highest-impact domain overall, given both the potential for damage through sustained use and the serious contamination risk posed by a design failure — for example, a break that releases battery waste into the environment. This connects to a global dual-use risk: a user modification that increases the vehicle's environmental impact would itself constitute an environmental violation. Cost, meanwhile, sits at the intersection of two domains at once, since the price point requires a degree of disposable income that determines who can benefit from purchase or resale (economic) and excludes certain populations from ownership altogether (societal).

Design Response

The team does not have direct control over how a user operates the vehicle after purchase, so the impact a user has on people or the environment cannot be fully mitigated — a limitation that should be disclosed to Primal RC and, where appropriate, to end users at point of sale. Two design modifications are under consideration to help close this gap: a carrying handle to improve the ergonomics of lifting and moving the vehicle, and an external emergency stop button. The latter is uncommon in RC vehicles and would affect the vehicle's appearance, but would improve safety during maintenance and for indirect users near the vehicle during operation — a tradeoff of aesthetics against safety.

Professional Responsibility Commitments

The vehicle's loss-of-connection behavior requires formal documentation before the project can be considered complete. The documentation should specify the exact behavior the vehicle exhibits when signal is lost (e.g. immediate stop, coast, or hold position), the conditions under which that behavior was verified, and any conditions that remain unconfirmed. There is also a genuine uncertainty to disclose to Primal RC before production begins: the team has not conducted long-term battery degradation or thermal-runaway testing, meaning the current environmental risk assessment relies on standard Li-Ion failure rates rather than data specific to our battery configuration. Finally, the team has a clear process for raising ethical concerns: any team member who identifies one raises it at the next weekly design meeting for team discussion. If the concern remains unresolved there, it is escalated to our design advisor, Dr. Scott Julien, and then to Primal RC before the related design decision is finalized.

Solution Approach

Prototyping

One of the largest challenges with the design was adhering to ⅕-scale. Although this was larger than the typical RC vehicle, which are about 1/10-scale, fitting all of the electronics and characteristic components of the SHERP, including its inflatable tires and waterproofing, become more difficult at small scale. In order to quantify the overall size of the vehicle, a cardboard prototype with an 80-20 frame was created. Basing it off the SHERP's true dimensions and utilizing RC tires from other Primal RC vehicles such as the monster truck, allowed the team to get an accurate scale of the vehicle in order to wrap their heads around the integration of all the components. A photograph of this prototype is shown below in Figure 7.

Figure 7: Cardboard prototype in the capstone lab.

Sponsor Feedback

Before further prototyping and ideation, the team met with Primal RC to understand the resources they were willing to provide as well as their concrete requirements and stretch goals. Their initial feedback focused on not constraining the vehicle to exactly ⅕-scale but rather fixing one element and building around it. For this design specifically, they requested 14in tires as they are the most iconic aspect of a SHERP. Regarding other features, such as inflatable tires it was asked that the user has control over tire pressure at all times and does not need additional components such as a compressor to fill a tank. As for other more cosmetic components such as the light bar and removable cabin these would be nice to have but not critical in the initial design. Although these were all measurable objectives, Primal RC prioritized that the user experience was the most important. As this would be a unique RC vehicle, unlike many others on the market, it is essential that it is approachable and fun to use. This feedback will guide the Capstone 2 process as the team is ultimately responsible for making the basis of a new product and the user's experience is more important than vehicle aesthetics.

Ideation
Initial ideation for the vehicle centered around the hardest technical challenges including waterproofing and inflatable tires. Analyzing the gap in the current market offerings with no central electronics system and building upon some team member's experience with underwater robotics, an electronics enclosure was considered. This enclosure would house all of the electronics, including the motors, electronic speed controllers (ESCs), compressor and more. With this integration, the enclosure could serve as the main body of the chassis in which the body panels and roll cage would be built around, simplifying the initial frame. As for the inflatable tires, the team needed a way to supply air with a continuously rotating joint. Drawing inspiration from the original SHERP patents, the team looked at hollow shafts and wheel hubs. Integrating these into the electronics enclosure, the compressor would split into four lines that would connect to each of the motor shafts with push to connect (PTC) fittings, as they would support 360° rotation. Although these ideas attempt to solve the challenges, no detailed computer aided design (CAD) or physical model has been created. A preliminary CAD model of the electronics enclosure is shown below in Figure 8. In future stages, the team will construct basic prototypes of each, such as purchasing a small IP67 weatherproof box and PTC fittings to validate the design.

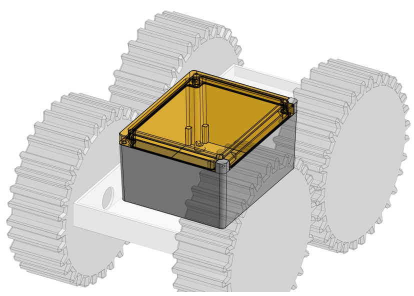

Figure 8: Basic CAD mockup of electronics enclosure location.

Planned Approach and Applicable concepts
The team's planned approach is to continue the ideation process and layout the initial design during Capstone 2. With the complexity and many different subsystems on the vehicle, the framework of the vehicle is crucial in ensuring proper integration and a successful design. Each subsystem will be prototyped extensively before its consideration and implementation to the overall vehicle. For subsystems such as the electronics enclosure, this could be submerging the system in the Cabot pool for 30 minutes showing no water ingress. For the tires, this could be cycling between the two tire pressures showing no pneumatic malfunctions and full drive capabilities at all times. It is noted that the team has not completed detailed CAD modeling or prototypes of specific subsystems; this will be done during the beginning of the fall semester. Mechanical engineering concepts applicable to this design include fluids, mechanics, electronics, and robotics. Fluid mechanics must be considered when designing the tires to act as paddles to drive across the water, ensuring the proper separation of center of buoyancy and center of gravity to ensure the vehicle is stable as well as the pneumatic system. Mechanics must be considered in

the deformation and strength of the roll cage ensuring the system can withstand static loading, cyclic loading from repeated impacts, and torque output of the motors for both high speed operation and high torque for off-road traversal. Electronics are considered in the design of the power architecture and safety mechanisms. Robotics is utilized in the integration of radio control and camera streaming.

Project Management

In order to have a fully working prototype by the end of Capstone 2, the team will divide the SHERP into manageable subsystems such as electronics enclosure and waterproofing, wheels, chassis, powertrain, exterior, and more. Before this is done, a preliminary CAD and master model of the vehicle will be completed. This will allow for the delegation of space and the development of the system. With the system divided with clear requirements and boundaries early prototypes can be created including basic electronics layout, a small scale molded tire, and 3D printed roll panels. Building upon the initial design work, the final SHERP will be rigorously tested with the sponsor Primal RC through a series of tests such as driving across a pool, traversing a boulder field, and cycling tire pressure. This will stress test the vehicle

Internally the team will be led by Joe D'Anna as he is the main contact to the sponsor Primal RC. Each member will be responsible for the integration, design, and fabrication of their specific subsystem such as electronics enclosure and waterproofing, wheels, chassis, powertrain, and exterior among others. Additional responsibilities for each member will be the overall testing, validation, and documentation of the system and the support of other subsystems, members, and designs. These roles and division of work will follow the framework laid out in Capstone 1, as the team has seen success in its utilization. Regular communication internally with the team, with the team's advisor Dr. Scott Julien, and with the team's sponsor Primal RC will continue to be on a weekly basis throughout the fall semester. These check ins will allow for consistent direction and support for the project ensuring that the product aligns with the sponsors goals and vision. To stay on top of any potential issues and concerns, the team plans to update and reevaluate the plan as necessary throughout the semester to ensure that each member has enough support, direction, and ownership over their work.

Regarding communication, the team utilizes slack. The use of separate channels such as "design" and "sherp-general" allow the designation between different ideas and topics. The addition of threads also allows for the organization of certain design choices to be maintained in a streamlined manner and easy to return to for tracking. The team also uses a group chat for other simple communication such as meeting times and or if a member will be out. These multiple methods of communication will allow for redundancy and ensure all team members are on the same page.

A Gantt chart, shown in Appendix A, has been implemented in Notion in order to track the team's work throughout Capstone II. This chart utilizes subitems in order to track individual tasks as portions of major subsystems and dependencies to understand the order in which tasks must be completed and what work must be completed ahead of the class deadlines included at the bottom of the chart. Tasks are divided by subsystem as most tasks will initially be able to proceed separately with limited dependencies between each subsystem and technical milestones are included in a separate integration section to allow for easy visibility into how the project will progress at a high level. Unlike the team's Capstone I Gantt chart, subtasks have not yet been included to show the required elements of class assignments as their details have not yet been published, but assignment deadlines are shown and this chart will be updated once details are available.

Assessment of Risks

This project possesses a number of intricate subsystems which all need to be researched, designed, fabricated, and integrated for the final prototype to work as intended. While this is an exciting task to undertake, setbacks are real and need to be planned for.

The molding of the wheels is likely to be the most challenging aspect of the design, both because of the intensive process and specialty tools required, as well as the fact that the team simply has less experience with this type of manufacturing. On top of these challenges, no viable commercially available alternatives have yet to be identified, meaning the team has to figure out the molding issue to successfully integrate the SHERP's CTIS, a key feature of the vehicle. Much research and planning has already gone into this problem to prepare for Capstone 2. One team member will be assigned this task so they can fully devote themselves to this problem, and they will have the full support of the rest of the team whenever needed. Work on designing the molds and testing the process will be performed early in the semester so more time is available for iteration, further research, and pivoting if implementation truly proves unattainable.

Another risk of this project is the team's lack of familiarity with widely used RC vehicle software. To program the controller some degree of coding knowledge will be required, and if a camera is eventually integrated into the design it will require further coding to get it connected to the display. These shortcomings will be negated using PrimalRC's expertise with these control systems, as well as the capabilities of artificial intelligence (AI) for supporting code development.

While many risks exist for this project, one of the largest is time. A prototype has to be near completion by December 4th, 2026, and a final prototype completed in time for Capstone Day on December 15th, 2026. This leaves approximately four months from the time of writing this to complete the project. Once the semester starts and intensive course schedules start taking up large amounts of the team's time, work on the SHERP may slow and become difficult to keep in the foreground. This risk will be combatted by adherence to the above Gantt chart, regular meetings to share updates on progress and support each other where needed, and keeping in mind that this product is being paid for by the sponsor and therefore needs to be delivered. By remaining organized and keeping clear communication, the team can mitigate the risks posed to this project and deliver an impressive prototype come the end of the semester.

Summary and Conclusion

Brief Summary

This project focuses on the development of a novel ⅕-scale remote control vehicle modeled after a SHERP, that is capable of operating over land and water. During Capstone 1, the team focused on the research of amphibious vehicles and aquatic locomotion, existing amphibious RC vehicles, as well as tire inflation systems such as CTIS. The team also met with the sponsor Primal RC to have a better understanding of their requirements and goals for the project including top speed, size, pricepoint, and more. The research, combined with the sponsor goals, allowed the team to have a clear direction and start ideating towards the final design. With the background research and initial brainstorming complete, the team will focus on CAD modeling, design, prototyping, fabrication, testing and validation of the final design before the end of Capstone 2.

Future Perspectives

Although the brainstorming and research completed during Capstone 1 was a foundational part of the design process, there are still several design choices and prototypes that need to be validated in order for the project to continue and be successful. One area of concern is the development of tires. Per the sponsor's request of 14in tires, there are no current commercial off the shelf (COTS) components that can be purchased to fill this gap. As a result, the tires will need to be molded by the team. Given the complexity of this process including the creation of a mold, degassing the silicone with a vacuum chamber, and casting time, the team needs to familiarize themselves with the materials and tools required. As the tires are integral to the SHERP's characteristic look, ability to drive on the water, and adjustable pressure system, it is a bottleneck for the design and needs to be worked on consistently to avoid being a roadblock.

Another area of important work is the overall integration of the vehicle and subsystems. With many intricate and systems including a waterproof electronics enclosure, robust roll cage, inflatable tires, and pneumatic system they are all mini capstone projects within themselves. Although they may work individually, ensuring they all work in tandem is going to be a challenge. The team will consistently work together to ensure that each subsystem will not detract from each other and when combined will result in a vehicle with all of the set out requirements.

Broad Impacts

The development of a ⅕-scale RC SHERP that can drive on both land and water will have a huge impact on the RC car community. Given a successful prototype and the choice to go into production, it will be the first commercially available vehicle that is completely waterproof, ready to go out of the box, and has inflatable tires. With its unique amphibious capabilities it will allow users to explore areas previously untouched and allow for even more creativity and novel usage.

Beyond its impact within the RC car community, it could have societal benefits in the forms of search and rescue. Given its ability to drive over water in swampy or frozen environments, it will be able to reach areas previously inaccessible by other rescue teams, dogs, or other robots. This will allow search and rescuers to survey larger areas while keeping all parties safe.

References

[1] "All terrain vehicle SHERP N 1200 | Official global website," SHERP® – Official global website. Accessed: Jul. 28, 2026. [Online]. Available: https://sherpglobal.com/en/sherp-n-1200-2/

[2] "Vehicles – Primal RC." Accessed: Jul. 28, 2026. [Online]. Available: https://primalrc.com/vehicles/

[3] "Alligator Amphibian." Accessed: Jul. 28, 2026. [Online]. Available: https://www.asme.org/About-ASME/Engineering-History/Landmarks/193-Alligator-Amphibian

[4] D. Dear and P. K. Kemp, "DUKW," in *The Oxford Companion to Ships and the Sea*, Dear and P. Kemp, Eds., Oxford University Press, 2007. Accessed: Jul. 27, 2026. [Online]. Available: https://www.oxfordreference.com/display/10.1093/acref/9780199205684.001.0001/acref-9780199205684-e-869

[5] National Transportation Safety Board, "Improving Vessel Survivability and Passenger Emergency Egress of DUKW Amphibious Passenger Vessels," *Saf. Recomm. Rep.*, no. M-19–15 and 16, Nov. 2019, Accessed: Jul. 26, 2026. [Online]. Available: https://www.ntsb.gov/investigations/AccidentReports/Reports/MSR1901.pdf

[6] "History of the Amphicar - International Amphicar Owners Club (IAOC)." Accessed: Jul. 28, 2026. [Online]. Available: https://www.amphicar.com/

[7] T. Hanns and O. Kreis, "Amphibious vehicle," US3114347A, Dec. 17, 1963 Accessed: Jul. 28, 2026. [Online]. Available: https://patents.google.com/patent/US3114347A/en?oq=US3114347A

[8] "Congress Passes the Motor Vehicle Air Pollution Control Act | History | Research Starters | EBSCO Research," EBSCO. Accessed: Jul. 28, 2026. [Online]. Available: https://www.ebsco.com

[9] "nht69-2.41 | NHTSA." Accessed: Jul. 28, 2026. [Online]. Available: https://www.nhtsa.gov/interpretations/nht69-241

[10] А. М. Гарагашьян, "Вездеход и подвеска вездехода," RU2564778C1, Oct. 10, 2015 Accessed: Jul. 28, 2026. [Online]. Available: https://patents.google.com/patent/RU2564778C1/en?oq=RU2564778C1

[11] "Kingkong RC 1/10 All Terrain Transport RC Vehicle Truck w/ Metal Chassis KIT /V2 RTR Set - AliExpress 26," aliexpress. Accessed: Jul. 28, 2026. [Online]. Available: https://www.aliexpress.us/item/3256804989358751.html

[12] "FT2 Pickup - Amphibious Off-Road Utility Vehicle," Fat Truck. Accessed: Jul. 28, 2026. [Online]. Available: https://fattruck.com/vehicles/ft2-pickup/

[13] "JHD 2025 New JJRC Q210 2.4G 4WD RC Car Remote Control Car Four-Wheel Drive All Terrain Off-Road Vehicle Rc Amphibious Toy Car - AliExpress 44," aliexpress. Accessed: Jul. 29, 2026. [Online]. Available: https://www.aliexpress.us/item/3256812350537336.html

[14] "Tomley RC," YouTube. Accessed: Jul. 28, 2026. [Online]. Available: https://www.youtube.com/@TomleyRC

[15] "Made by CustomRC (@rcsherp) • Instagram photos and videos." Accessed: Jul. 28, 2026. [Online]. Available: https://www.instagram.com/rcsherp/

[16] SHERP Ltd., "SHERP User Manual." SHERP ATV Sales, Aug. 2021. [Online]. Available: https://sherpatvsales.com/wp-content/uploads/2021/08/Sherp-Pro-Manual.pdf

[17] G. A. Maratovich, “All-Terrain Vehicle Wheel,” RU2673416C1 Accessed: Jul. 28, 2026. [Online]. Available: https://patentimages.storage.googleapis.com/82/51/ae/855fcea15bb1cd/RU2673416C1.pdf
[18] Gravaa, “How it Works.” [Online]. Available: https://gravaa.com/how-it-works
[19] Gravaa, “Grava x Reserve 42|49 Wheelset.” [Online]. Available: https://gravaa.com/products/gravaa-x-reserve-42-49
[20] M. Tigges, “Central Tire Inflation Systems for Agricultural Vehicles,” presented at the Agricultural Equipment Technology Conference, Louisville, Kentucky, USA: American Society of Agricultural and Biological Engineers, Feb. 2015. [Online]. Available: https://elibrary.asabe.org/data/pdf/6/ctsa2015/LectureSeries_38.pdf

Appendix A: Gantt Chart for Capstone II