Project Statement and Specifications
Project to Aid a Person with Disabilities - Go-Karts and Lawnmower

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1 Statement of Need:

1.1 Shane

Cerebral palsy (CP) is a neurological disorder that affects one’s motor control, which makes it extremely difficult for that individual to use traditional machines and devices, that those without such disabilities have no problem operating. This raises the need for modified devices, and for this project, a ride-on lawnmower and go-kart are to be customized. By implementing a proper joystick control, these projects will allow Shane the freedom to mow his family’s lawn as well as enjoy the mobility of a go-kart. Shane is a twenty-one year old male from Columbia, CT and not only suffers from cerebral palsy but spastic quadriplegia as well. These neurological disabilities cause Shane to have reduced control of his limbs and fine motor control; therefore his extremities suffer from such a disorder. These concerns will be the focus in modifying both machines, so that the finished products are as user-friendly as possible for Shane.

1.2 Nathan

Those suffering from developmental disabilities and cerebral challenges often lack sufficient mobility in their everyday lives. For children, this is especially true due to their eagerness to explore and enjoy outdoor activities with both their peers and family members. Due to these constraints, a go-kart is to be customized so that Nathan, and a parent, can control the kart by the simple use of a joystick. This will allow Nathan to be able to move much more conveniently and have enjoyment while doing so. Additionally, he will be able to fit among his peers more easily, as he can now share more common interests with those around him and be seen as a more independent individual.

Nathan is a twelve year old boy from Stonington, CT and has Spina Bifida, cognitive challenges, and suffers from autism as well. Developmental issues such as these make movement difficult and also hinder his social development with those around him. The proper customization of the go-kart will provide solutions to these problems and also give Nathan a much needed source of entertainment for him and his family.

2 Introduction and Overview

2.1 Shane

A ride-on lawnmower and go-kart are to be modified to fit the needs of Shane. Both of these devices have been previously worked on by other Senior Design groups, however, the finished products each experienced sub-par levels of success. Both projects contained faulty user controls (the implemented joysticks), which led to safety concerns and consequently, the devices are currently unable to be driven by Shane. The purpose of these projects is to properly modify a lawnmower and go-kart, so that Shane can easily, comfortably, and independently control the devices and be safe while doing so.

The lawnmower is presently equipped with a series of previously designed safety and assistive features from the original Senior Design team. These include a platform which
enables Shane to be able to get on and off the mower more easily, a modified gas tank, and a more supportive seat. Going forward, there are numerous adjustments that will be necessary in order to properly fulfill the expectations of the client. Most importantly, the unsuccessful joystick needs to be modified. Currently, the joystick controlled steering has been far too sensitive and needs to be brought to a usable level. Also, the gas pedal must be controlled differently since the dial configuration currently customized on the machine was difficult for Shane to use. It must be made sure that the other controls on the lawnmower are easily accessible to Shane due to the lack of mobility and dexterity of his limbs and hands. These controls include the gearbox, the blades, and the on/off switch. With these modifications, the lawnmower will be properly suited for Shane to mow the yard.

Like the ride-on mower, the go-kart was also previously worked on by a Senior Design team. The security of the seat has been increased and the controls of the kart (steering and gas) have been modified to where a joystick controls the steering and the acceleration of the go-kart, similar to that of an electrical wheelchair. The current kart is successful in its raw design since the kart’s control systems are properly accessible and the engine components themselves all work. However the joystick is not calibrated correctly, causing the kart to travel too fast and with an overly sensitive steering system. This problem creates the need for a device which limits the speed of the kart, to a reasonable level that the client agrees upon and is safe for Shane. Also, the steering mechanisms need adjustment so that the kart can turn at a comfortable rate. It is important that when the joystick returns to the center (idle position), the kart idles along with it. With fixes to the joystick, Shane will be able to safely and easily enjoy the mobility and entertainment of a go-kart.

2.2 Nathan

The two-passenger go-kart being worked on for Nathan was previously designed by another Senior Design team, however failed to meet the needs of the client. The purpose of this project will be to implement proper control systems using a joystick, making the kart drivable for Nathan, given his current conditions. This includes an effective steering and gas pedal control all by the use of a single joystick. Horizontal movements will control the steering, while vertical movements will control the acceleration of the kart. By releasing the joystick, the kart will return to its neutral position. In this case, there will be two sets of controls, one for each passenger, so that the adult accompanying Nathan can also control the kart. The adult control set will override Nathan’s when engaged, for safety purposes. An additional modification will involve expanding the roll bar. This will be accomplished by attaching two bars to range from the front of the frame to the current roll bar located above the heads of the passengers. To further ensure safety, kill switches for the kart will be placed on each set of controls.

Currently, the kart has many positive features that will continue to be used moving forward with the project. The suspension system, lights, tires, engine, and frame are all effective components and when combined with the proper control systems, the kart will allow Nathan and an adult to successfully travel in it.

3 Realistic Constraints
3.1 Shane

**Economic:** It is important to first recognize that Shane is in need of both a modified lawnmower, as well as a single passenger go-kart. While the main basis for the machines are there, the cost of the projects will quickly increase depending on how many new parts are integrated into the existing designs. There should also be cost accounted for various replacement parts, if necessary.

**Environmental:** Both devices must be assembled such that no working fluids contained within them can leak, causing contamination to the earth. All new devices implemented must be environmentally safe as well.

**Sustainability:** The seating and spacing of the devices must be set up so that they will be able to be used far into the future. If possible, adjustable seating can be implemented into the current designs. Additionally, proper cleaning and engine care will be needed in order to sustain the functions of the devices.

**Manufacturability:** No manufacturing constraints are involved since the devices are only being produced a single time.

**Ethical:** When making modifications to the devices, safety and reliability will be the most important concern. All of the funding will strictly be used for project parts and resources only.

**Health and Safety:** The finished devices should allow Shane to be able to safely and successfully operate them. Since Shane prefers using his left hand, the controls should compensate for this preference. He must also be able to move from his wheelchair to either device independently. Easily accessible emergency shut offs should be placed within each machine. Another safety constraint is the speed of the go-kart, which must be limited to a safe, yet enjoyable level. This can also be discussed with the client.

**Political/Social:** No political or social constraints are involved with these projects.

3.2 Nathan

**Economic:** The cost of all new or replacement devices must be accounted for since there are several modifications that need to be made to the existing kart.

**Environmental:** The go-kart must be assembled such that no working fluids contained within them can leak, causing contamination to the earth. All new devices implemented must be environmentally safe as well.

**Sustainability:** The seating and spacing must be set up in a way that allows for a lot of future use. This could be done by having adjustable seats for the driver and passenger. Proper cleaning and engine care will be needed in order to sustain the function of the go-kart.

**Manufacturability:** No manufacturing constraints are involved since the go-kart is only being produced a single time.

**Ethical:** When making modifications to the device, safety and reliability will be the most important concern. All of the funding will strictly be used for project parts and resources only.
Health and Safety: In order to allow Nathan to be able to operate the kart, the controls must be easily accessible to his left, more dominant hand. An emergency cutoff switch and vertical roll bars will be added to further the safety of the device. All other systems will be modified to ensure safety, if necessary. The overall speed of the go-kart must also be set to a comfortable level for Nathan.

Political/Social: No political or social constraints are involved with these projects.

4 Questions

4.1 Shane

- What is the budget for each of the projects?
- How can the lawnmower joystick successfully control the speed of the mower?
- How can the go-kart have a successful joystick, in terms of its turning sensitivity?
- Will an emergency cutoff switch be added to the lawnmower?
- Can Shane currently control the blades to the mower?
- What type of microcontrollers or chips will be used in the design?
- How will the bags of the mower be emptied while mowing the lawn?
- Are there any additional safety measures that can added to either device?
- Will a music player be implemented into the go-kart’s design?

4.2 Nathan

- What is the budget for the product?
- What material will the vertical roll bars be made of?
- What type of microcontrollers or microchips will be used in order to successfully drive the go-kart?
- Will the adult controls override Nathan’s set of controls?
- What should the top speed of the kart be?
- Will Nathan be able to get in and out of the kart with little to no assistance?
- Should there be turning signals added to each end of the kart for safety?

5 Specifications

5.1 Shane - Lawnmower

Operational Specifications

The mower is to be modified to allow Shane, a cerebral palsy patient, to control the mower with a joystick located on his left side. A proper type of microcontroller must be used as well. The mower currently has a system which helps Shane get on and off
of it and needs to remain implemented in this design. All other controls the mower contains must also be accessible by Shane. Any other supportive features the mower currently contains must remain. Additionally, there needs to be an emergency cutoff switch to the mower's engine.

**Technical Specifications**

*Environmental:*
- Operating Temperature: 45-120° Fahrenheit
- Operating Environment: Seasonal Connecticut outdoors, moisture/humidity, heat
- Operating Area: 2 Acres

*Mechanical:*
- Seat Size Width: 16.5”
- Ground to Chair Height: 20”
- Motors to control steering
- Actuators to control levers (throttle, break, gears)

*Electrical:*
- Joystick operated
- Actuators to operate levers and throttle
- Microcontroller to process input from joystick to actuators

*Safety:*
- The redesigned joystick controlled system must be safe for Shane to operate. An emergency cut off switch will need to be added to the device as well.

*Maintenance:*
- The mower must have proper levels for all fluids and be cleaned when necessary.

### 5.2 Shane – Go-kart

**Operational Specifications**

The go-kart must be able to be operated by Shane, a 21 year old with cerebral palsy. The current design must be modified so that the joystick, which controls steering and acceleration, functions much more safely and effectively. The speed of the kart must be reduced to a safe, reasonable amount. All other hardware, besides the joystick controlled system, is acceptable; however any increased safety features are welcomed.

**Technical Specifications**

*Physical:*
- Type of material (310 stainless steel, 6061 aluminum)
- Rubber tires, Cushioned seat, electric motor, rechargeable battery, five point harness

*Mechanical:*
Size: 57” long x 32” wide x 41” high.  
Weight: 400 to 600 lbs  
Speed: Adjustable from 0 to 30 MPH  
Power: 10 HP electric motor  
Brake: 2.5” disk with parking brake  

**Electrical:**  
Battery: High capacity dry batteries 48V rechargeable  
Steering: Wheel chair joystick controller  
On/Off: Stop run switch  

**Safety:**  
If driven improperly, a go-kart can crash into surrounding objects or even roll over, causing harm to the user. Prolonged use may lead to slight discomfort, given the terrain.  

**Maintenance:**  
Battery Recharge  
Tire Pressure  
Check fluids  
Clean  

### 5.3 Nathan – Two passenger go-kart  

**Operational Specifications:**  

The go-kart will be able to hold two passengers and Nathan’s seat must be on the left side of the kart. Each seat will have a joystick that controls the steering and acceleration of the kart. This will call for some type of microcontroller or chip. The other seat’s control will override Nathan’s if pressed simultaneously. There will be an emergency shut off switch to the engine as well. Two vertical roll bars must be added to the frame, extending from the back roll bar to the front of the chassis. Turn signals must be added to the front and back of the kart. All other hardware, besides the joystick controlled system, is acceptable; however any increased safety features are welcomed.  

**Technical Specifications:**  

**Physical:**  
Type of Material: Steel Frame  

**Mechanical:**  
Size: TBD  
Weight: TBD  
Speed: TBD  
Power: TBD  
Electrical: TBD  
Voltage range: TBD  
Current range: TBD  
Wireless range: TBD
Environmental:
    Storage Temperature: -10-125 degrees F
    Operating Temperature: 0-100 degrees F
    Operating Environment: Outdoors (various terrains).

Safety:
    Five-point harness system
    Buckled leg supports
    Roll cage
    Trunk and extensive head support
    Arm rests/supports
    Passenger and remote kill switches

If driven improperly, a go-kart can crash into surrounding objects or even roll over, causing harm to the user. Prolonged use may lead to slight discomfort, given the terrain.

Maintenance:
    Battery Recharge
    Tire Pressure
    Check fluids
    Clean