

Spring 2021 HPV Exhibition Capstone



Operations Manual

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The following operations manual details the basic operation of the child-sized human powered vehicle, vehicle maintenance procedures, and important safety information. For any topics not covered in this manual or questions relating to the material described here, contact the following email or phone number to set up an appointment.

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VEHICLE OVERVIEW

A view of the entire vehicle with important components is labeled and detailed below.

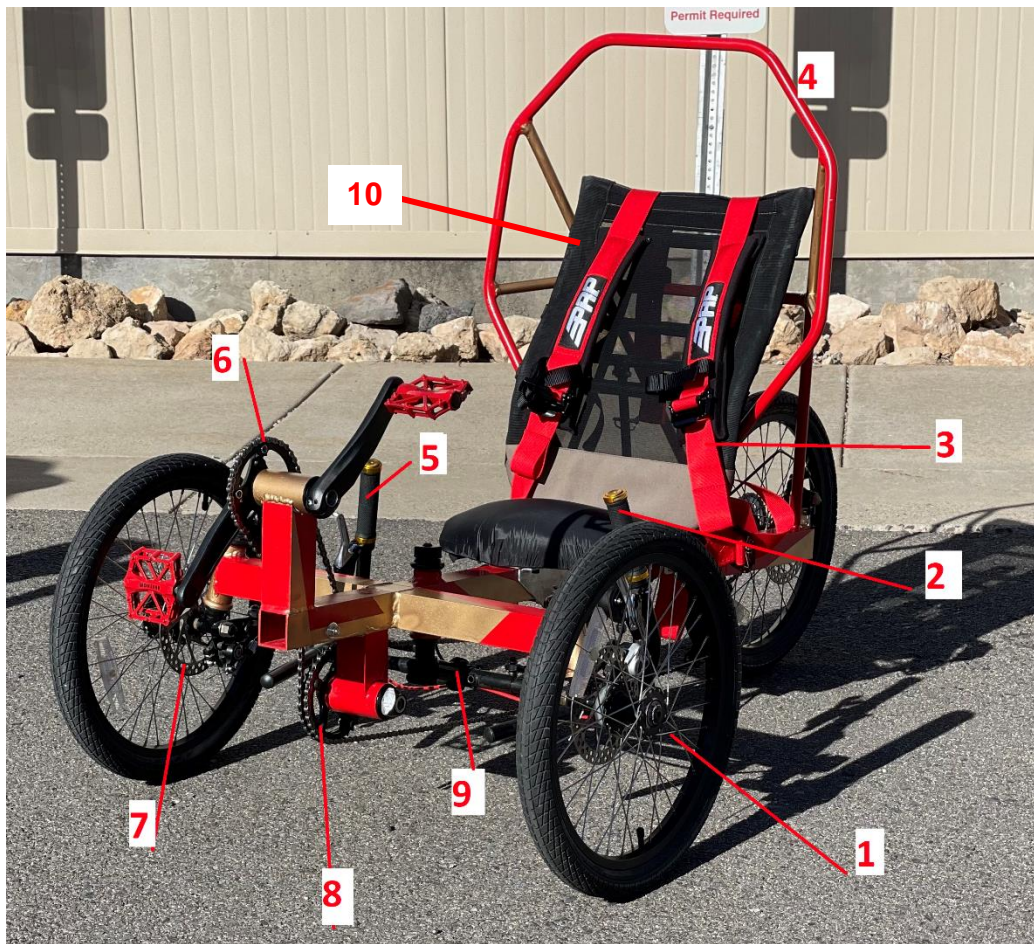


Figure 1: Final Product

LEGEND

1	20"x1.75" Wheels	6	170mm Crankset 32T gear
2	Steering, Rear Brake & 7-Speed Shifter	7	Disk Brakes
3	4.2 Point Harness	8	Intermediate Gear 1:1
4	4 Point Roll-Cage	9	"Landstrider" Indirect Steering
5	Steering, Front Brakes	10	Fully Adjustable Seat

VEHICLE OPERATION

Basic Operation

General HPV operation is very similar to a standard bicycle, which is operated by placing feet on pedals at the front of the vehicle pushing the peddles forward in a repetitive circular motion, use the shifter to cycle gears for the optimal speed and required energy input. To steer the vehicle, grasp the joystick actuators reposition seat as needed to the optimal position, and pivot joysticks in the opposite direction of desired turn. For example, to turn left swing the joysticks to right as if you want the right joystick to touch your right leg. In order to stop the motion of the vehicle, pull the black lever on either steering joystick, the left (driver-side) is the rear brake, and the right is both front brakes use caution if only using front brake at high speed. To move in reverse, come to a complete stop and you will manually have to push the bike back as moving the pedals backwards will free-spin the spindle.



Figure 2: Basic Operation

SEAT POSITION AND SEAT BELT



Figure 3: Height Adjustments

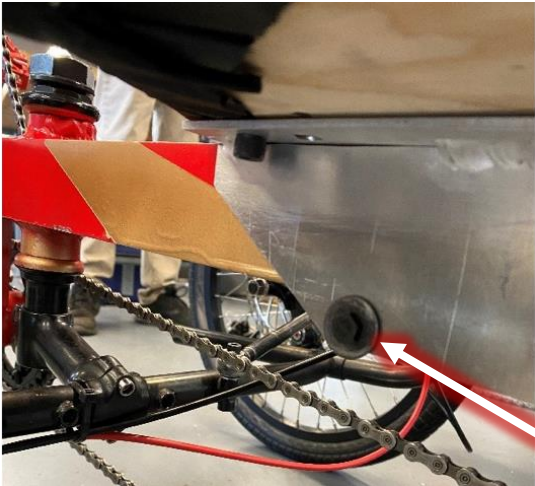


Figure 4: Axial Adjustments

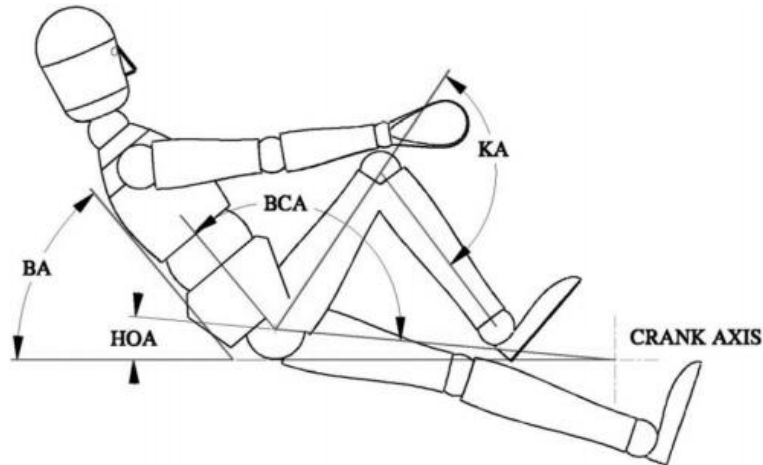


Figure 5: Seating Ergonomics [1]

Seat Adjustment

To adjust the seating position there are two adjustments that can be made to fit a large range of riders. The first is the angle of the backrest which is simply adjusted using a quick release pin as highlighted in figure 3, which can be removed to allow the backrest mount to slide vertically. It is recommended to position the backrest so that the rider sits at a body configuration angle of 130-140 degrees which can be seen on figure 5 above.

The second and likely more important adjustment is the axial adjustment of the seat itself. To slide the seat along the frame there is a quick release post clamp located as shown in figure 4 above, note the figure provided shows the bolt head on the opposite side of the post clamp but the location is accurate. It is recommended that the rider position the seat first then the backrest, the ideal position is roughly midway aligned with the rider's thigh but ultimately this is left to the rider's discretion as the width of the rider and what is most conformable to them.



Figure 6: Harness Front

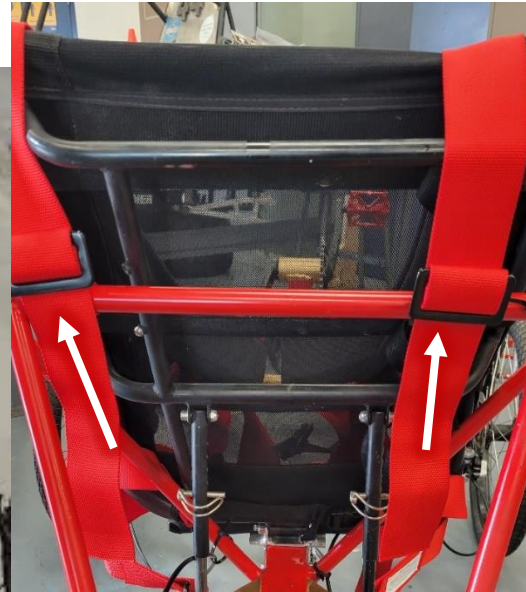


Figure 7: Harness Rear

Seat Belt

Always wear seat belt before operating vehicle.

Pull both straps over each shoulder and connect both the lower belt as seen in Figure 6 and the upper placement strap. The lower belt should be connected by inserting the tongue into the buckle until an audible “click” is heard. The upper placement strap should be connected by inserting the tongue into the buckle until a slight “click” is heard. Harness should be tightened on both left and right lower straps connecting to the lower frame by pulling on the excess slack towards the lower mounts. Harness should also be tightened on the upper straps by tightening slack lines connected to the upper roll cage. As seen in Figure 7, the right harness strap is perfectly tightened and ready to be used, the left strap is loose and not sitting flush with the roll cage; this can lead to failure within the harness resulting in injury. To release the lower belt, push down on the red button located on buckle. To release the upper placement strap, squeeze both sides of the buckle until the tongue is released.

DRIVETRAIN

The vehicle’s drivetrain operates in the typical expectation of other bicycles. To input power within the vehicle, the operator will position legs on each pedal. Furthermore, operators will push the pedals in a forward motion (spinning clockwise when viewing from the right) to push the vehicle forward.

On the left steering handle, a shifter can be found. The shifter will move up a gear when pushing forward and down a gear when squeezing backward. This will move the derailleur into the appropriate gear, as seen in Figure 8.



Figure 8: Rear Chain and Derailleur

STEERING

Once the rider is seated and understands how to propel the bike understanding the steering system is the next critical step. The system is fairly simple and straight forward, the steering system is a joystick style steering system commonly referred to as “landstrider” Ackerman steering which is an indirect steering system. Once the rider is properly seated and secured, they should then secure their hands onto the joystick grips as give the steering a quick test cycle to properly gauge the sensitivity and gain an understanding of its operation. When the operator wants to turn, they should pivot joysticks in the opposite direction of desired turn. For example, to turn left swing the joysticks to right as if you want the right joystick to touch your right leg. The left or driver side joystick houses the gear shifter and rear brake, while the right shifter has the front brakes. This steering system has moderate sensitivity as it has a turn radius of 1.7 meters which is enough to make a 180 degree turn within one street lane and handle most circumstances without being overly sensitive at risk of flip over.



Figure 9: Steering Overview

BRAKING

The next critical system to understand is the braking system, which is also straight forward. This HPV utilizes disk brakes all around which provides more plenty of stopping power, which are actuated by two brake levels positioned on the steering system. To actuate the brakes and bring the HPV to a stop the black lever on either steering joystick, the left (driver-side) is the rear brake, and the right is both front brakes use caution if only using front brake at high speed even though the front braking sensitivity has been adjusted to mitigate the risk of a “stoppie” which is where the back wheel lifts off the ground.

VEHICLE MAINTENANCE

Steering Alignment

This HPV offers easy toe adjustment of the wheels which can be adjusted by rotating the tie rods. This is done with a wrench or set of pliers, position the pliers onto the flat section at the end of the tie rod, be sure to adjust in $\frac{1}{4}$ turn increments evenly on each tie rod to prevent the steering from having a directional bias. The ideal toe alignment is to have both wheels perfectly parallel and facing straight forward, that is the wheels should be parallel with the section of frame in which the seat adjusts axially on.

Chain Replacement

Chains derailing off the gears isn't an uncommon issue on bicycles, but the fix is simple. In the case the rear chain derails its very simple to fix, just manually shift the gear derailer forward to provide sufficient slack in the chain and manually reposition the chain back onto the gear, it can be beneficial to rotate the crank to help the gears pull the chain back into position. The front

chain is slightly more difficult as you first need to position it around the gear connected to the pedal crank, then set it behind the gear tensioner as seen in figure 10 below also highlight the steps. Next position the chain onto the beginning teeth of the bottom gear, and lastly rotate the pedals causing the gear to pull the chain back onto itself.

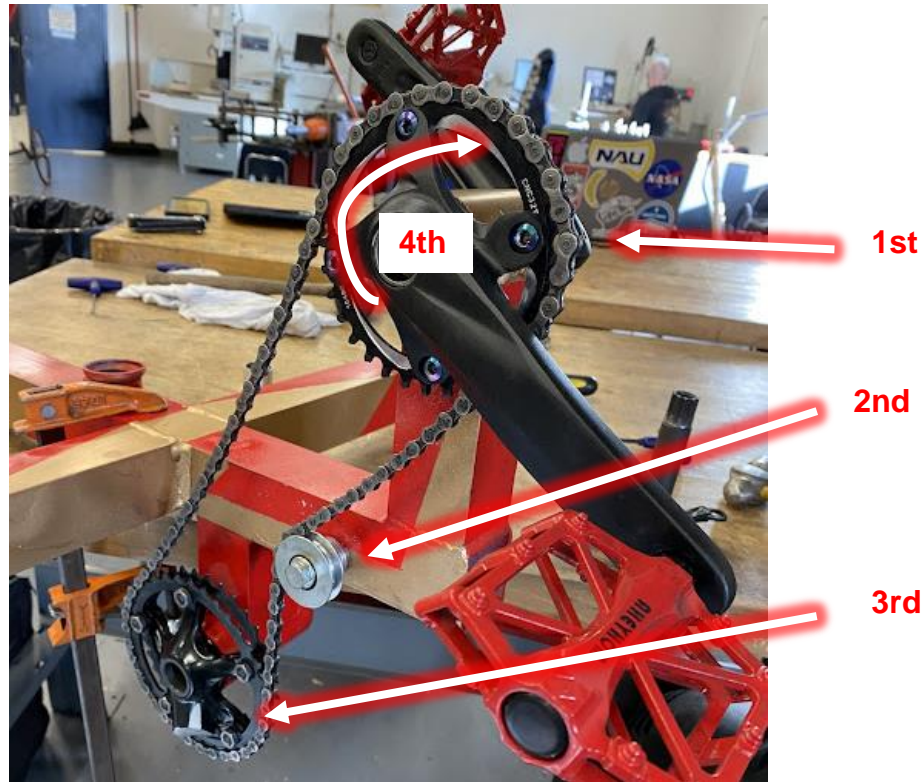


Figure 10: Front Chain

CABLE TIGHTENING

To tighten either the brake cable or shifting cable:

1. The operator should ensure both cables are free of kinks, damage, or separation.
2. Ensure cables are properly seated within either each brake or the derailleur as seen in Figure 11. Seating of cable can be adjusted with Phillips's screwdriver, applying tension to cable while re-assembling seat plate will achieve best results.
3. To further tension brake cables, unscrew the tension nuts located at the bottom of each brake lever, seen in Figure 12. After achieving intended brake tension, screw up locking nuts against brake levers to lock tension nuts in place.

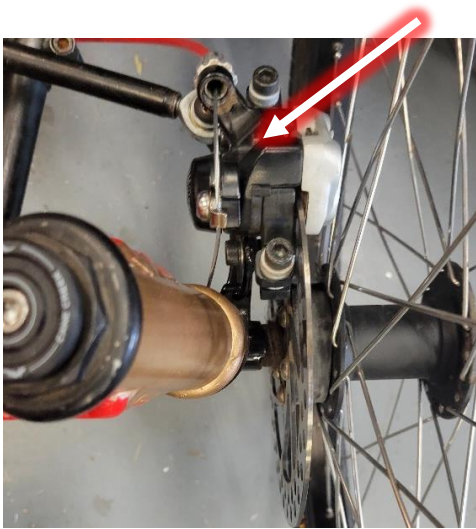


Figure 11: View of Front Brake



Figure 12: View of Front Brake

IMPORTANT SAFETY INFORMATION

- Seat belt and helmet should be always worn while operating this vehicle, ensure seat belt is snugly tightened to rider, children should be assisted by an adult. Failure to take proper precautions may result in serious injury.
- Vehicle should not be operated if any equipment malfunctions are present during start up procedure or operation.
- Improperly aligned wheels or brakes could result in serious injury. If problems are present, please repair accordingly or take vehicle in for maintenance.
- It is recommended that the vehicle isn't operated in speed excess of 15 mph especially by younger operators, to prevent loss of control, and maintain stability. Gearing has been limited to reduce top speed.
- Vehicle is intended for children or riders under 5' 4".

References

- [1] R. M. Horwitz, "The Recumbent Trike Design Primer," 2019. [Online]. Available: <http://www.hellbentcycles.com/Trike%20Design%20101%20%20part-1.pdf>. [Accessed 28 2 2021], [Online].