

Homework 13: User Manual

Due: Friday, April 18, at NOON

Team Code Name: The Two Wheel Deal Group No. 12

NOTE: This is one of the last sections needed to finish the Final Report. This homework will count for 4% of each team member's grade, and therefore all team members should participate equally in completing it. The User Manual should be about 5 pages in length (one page per bullet).

User Manual Outline:

- **Brief (marketing-style) product description**
- **Product illustration annotated with callouts for each control/display**
- **Product setup instructions**
- **Product use instructions**
- **Product troubleshooting instructions**

Evaluation:

SCORE	DESCRIPTION
10	<i>Excellent – among the best papers submitted for this assignment. Very few corrections needed for version submitted in Final Report.</i>
9	<i>Very good – all requirements aptly met. Minor additions/corrections needed for version submitted in Final Report.</i>
8	<i>Good – all requirements considered and addressed. Several noteworthy additions/corrections needed for version submitted in Final Report.</i>
7	<i>Average – all requirements basically met, but some revisions in content should be made for the version submitted in the Final Report.</i>
6	<i>Marginal – all requirements met at a nominal level. Significant revisions in content should be made for the version submitted in the Final Report.</i>
*	<i>Below the passing threshold – major revisions required to meet report requirements at a nominal level. Revise and resubmit.</i>

* Resubmissions are due within **one week** of the date of return, and will be awarded a score of "6" provided all report requirements have been met at a nominal level.

Preface

The Two Wheel Deal is a compact, two wheeled, and self-balancing personal transportation device. It will serve as an economical and practical alternative to most forms of short range transportation, including cars, bikes, and walking. The Two Wheel Deal is diverse in that it can travel on all types of terrains. The vehicle can be used by businesses in industrial settings for traveling throughout a plant, or for policing a mall. It can also be used recreationally in parks and trails.

Having only two wheels gives The Two Wheel Deal a small footprint for enhanced mobility over conventional means of transportation. Additional features such as high speed motors, emission free electric drive, and a zero turning radius make the Two Wheel Deal like walking, only better.

About This Manual

This manual is only a basic guide to riding and operating The Two Wheel Deal. The procedures and safety warnings outlined in this user manual are by no means exhaustive. The Two Wheel Deal is a powerful and dangerous vehicle with minimal safety features and must be treated as such. Your safety and the safety of persons around you is ultimately your responsibility. It is important that you follow all safety warnings outlined in this manual and use good judgment when riding The Two Wheel Deal.

The Risk of Personal Injury

The Two Wheel Deal utilizes a balancing algorithm to stabilize an inherently unstable vehicle. The algorithm cannot compensate for all situations, and injury may result if used improperly. If the vehicle gets out of control, the two powerful motors on board are powerful enough to propel the rider directly into the ground or into nearby obstacles at high speeds, causing injury, dismemberment, and/or death. Please use common sense and follow all safety warnings and vehicle limitations outlined in this manual.

The Risk of Electrical Shock

The Two Wheel Deal utilizes two high voltage lead acid batteries. They are highly dangerous and are capable of shocking or electrocuting a person if handled improperly. For this reason, the connections below The Two Wheel Deal should never be tampered with outside of the basic recharging and power on procedures. If an electrical problem arises with The Two Wheel Deal, contact Team 12 as soon as possible.

Getting to Know Your Two Wheel Deal

This section will help you learn how The Two Wheel Deal works. It will go over the parts of the vehicle, the information on the LCD, and the driver controls you will be using. Please have your Two Wheel Deal nearby so that you can follow along with this guide.

How the Two Wheel Deal Works

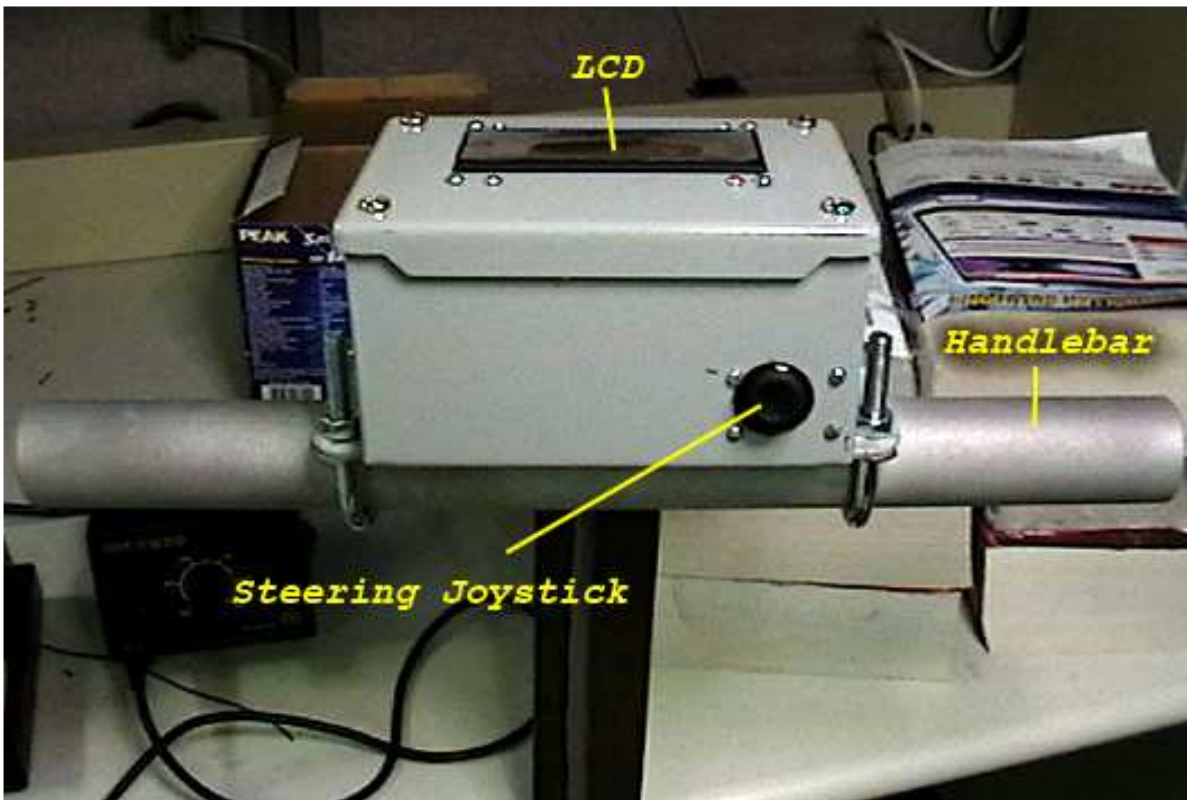
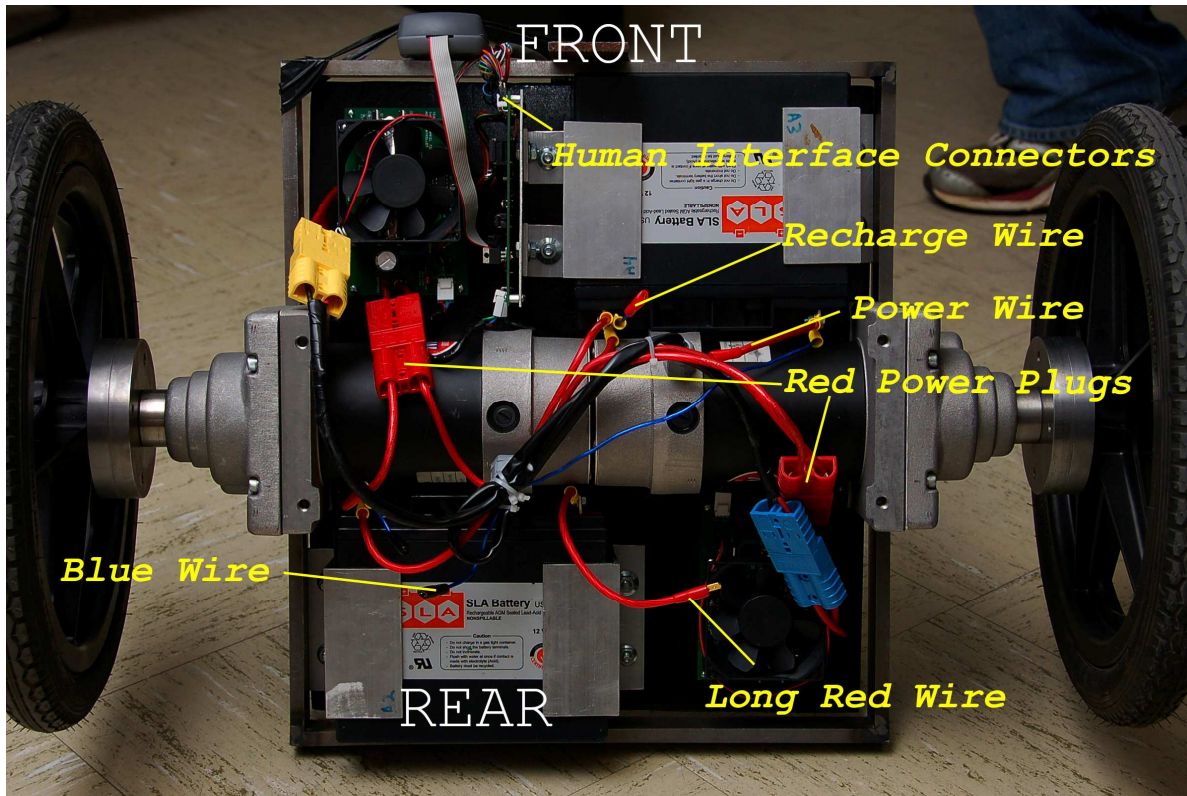
The Two Wheel Deal keeps you upright by constantly monitoring the balance of the vehicle and correcting any imbalance by moving the wheels back underneath you to maintain an upright position. If you lean forward, the vehicle will move forward to catch up with your lean. If you lean backwards, the vehicle will move backwards to again catch up with your lean. The same mechanism used for balancing is also used for moving forward and backward. Leaning forward will cause the vehicle to accelerate as it tries to catch up with your lean, and leaning backward will cause acceleration in the reverse direction. To maintain speed, keep the vehicle straight up.

Steering is done through the use of the steering joystick. Pushing the joystick to the left will turn the vehicle to the left, while pushing the stick to the right will turn the vehicle to the right.

The Two Wheel Deal actively works to stabilize only your forward and reverse stability. The side to side stability of the vehicle is your responsibility. Though the vehicle is inherently stable from side to side, specific terrains such as slopes and hills can cause side-to-side instability.

Using the Two Wheel Deal

All items in italics are located in the pictures below.





Powering On

1. Turn vehicle down so that it is lying on its front or rear.
2. Disconnect *blue wire* and *red wire* if connected.
3. Connect *red power plugs*.
4. Plug *long red wire* into the *power wire*.
5. Quickly turn vehicle upright and place on ground.

Mounting/Dismounting the Vehicle

1. Place right heel on footplate directly over the right motor.
2. Grab handlebars and ensure vehicle is stationary.
3. Place ball of left foot on footplate directly over the left motor.
4. To stay balanced keep equal weight on each foot rather than pushing or pulling the handlebars.
5. To dismount, safely bring the vehicle to a complete stop.
6. Take one foot off the vehicle while still holding it in a stable position.

Maneuvering the Vehicle

1. To accelerate forward, shift body weight to right foot by leaning slightly forward.
2. To continue forward at constant speed, bring the vehicle back to vertical by keeping equal weight on each foot.
3. To accelerate backward, shift body weight to left foot by leaning slightly backward.
4. To continue backward at constant speed, bring the vehicle back to vertical in the same manner as driving forward.
5. To steer, use the joystick on the LCD box. To turn left push the joystick to the left and vice versa for right. The degree of turn depends on how far the joystick is pressed.
6. The LCD will display real-time driving information.

Powering Off

1. Pick up vehicle and place it on the front or the rear to access the bottom. The wheels will stop turning when it is rotated past 45°.
2. Disconnect *long red wire*.

Recharging the Batteries

1. Pick up vehicle and place it on the front or the rear to access the bottom.
2. Disconnect *long red wire*.
3. Disconnect *red power plugs*.
4. Connect *blue wire*.
5. Connect *long red wire* to the *red recharge wire*.
6. Connect a 12V battery charger to the black terminal of either battery and the red terminal of either battery. Recommend "smart" battery charger that shuts off when the batteries reach full capacity.
7. Turn on battery charger. Use a low current charge to maximize battery life.

Transportation

1. Power down the vehicle.
2. Disconnect the *human interface connectors* at the base of the post.
3. Use the included $\frac{1}{2}$ " wrench to disconnect the upright post.

Storage

1. Follow the procedure for recharging the batteries.
2. Keep the battery charger on trickle charge to preserve the batteries.

Disposal

1. Power down unit for transport.
2. Follow Transportation procedure.
3. Take the vehicle to Team 12 for proper recycling.

Troubleshooting

Problem	Possible Cause	Solution
Vehicle will not power on.	<ol style="list-style-type: none"> 1. Low battery. 2. Bad connection. 	<ol style="list-style-type: none"> 1. Recharge batteries. 2. Ensure that red power plugs are connected.
Vehicle veers to one side.	<ol style="list-style-type: none"> 1. Uneven tire inflation. 2. Steering joystick not calibrated. 	<ol style="list-style-type: none"> 1. Inflate tires as necessary. 2. Ensure steering joystick is centered and cycle power on the vehicle.
Vehicle response sluggish.	<ol style="list-style-type: none"> 1. Low batteries. 2. Max passenger weight exceeded. 	<ol style="list-style-type: none"> 1. Recharge batteries. Follow recharge procedure. 2. Ensure that the maximum passenger + cargo weight has not been exceeded.
LCD data does not display correctly.	<ol style="list-style-type: none"> 1. Bad connection to LCD. 	<ol style="list-style-type: none"> 1. Ensure that the connectors on the front of the sensor board are snug.
Only one wheel turns	<ol style="list-style-type: none"> 1. Hardware Failure 2. Wheel Hub Failure 	<ol style="list-style-type: none"> 1. Contact Team 12 for repair 2. Contact Team 12 for repair
Vehicle nonresponsive	<ol style="list-style-type: none"> 1. Hardware Failure 	<ol style="list-style-type: none"> 1. Contact Team 12 for repair

Performance Upgrades

The Two Wheel Deal was designed with the performance minded users in mind. A number of optional components may be added at any time to improve the performance of the vehicle to your liking. The upgrades in the below list are the only approved upgrades available to The Two Wheel Deal. Please take your vehicle to Team 12 for safe installation of these items as well as software upgrades and updates.

High Voltage Batteries

The Two Wheel Deal comes standard with two 12V lead acid batteries, making the total voltage available to the motors 24V. A third battery can be installed to increase the power and the top speed of the vehicle by about 50%, while also increasing battery life. All of the circuits on The Two Wheel Deal are designed to work on a 36V supply.

Wheels

The Two Wheel Deal comes standard with 16" wheels. By increasing the wheel size to 20", the top speed of the vehicle can be increased by about 25%, while decreasing acceleration a small amount. This upgrade works particularly well when combined with the high voltage battery upgrade.

Short Shift Steer Stick

The steering response of the vehicle can be increased in two ways. The steering joystick can be replaced with a smaller unit so that a minimal amount of movement is necessary to initiate a turn, and the turning rate can be increased in software by your friendly neighborhood Team 12.

Warning: All of these upgrades increase the dangers associated with the vehicle. Please reread all safety warnings after having an upgrade installed.

Safety Warnings

1. Never wear long loose fitting clothing such as dresses, baggy pants, or wizard's robes.
2. Never reach under the vehicle at any time.
3. Follow all traffic and safety laws.
4. Yield to pedestrians.
5. Never exceed the maximum ratings listed in the "Capacities and Specifications" section.
6. Only one rider at a time on the Two Wheel Deal (therefore no carpool lane).
7. Never leave unattended children with the vehicle.
8. Do not drink and "Deal".
9. Never attempt to mount the vehicle while it is in motion.
10. Look out for obstacles such as tree branches, doorways, and low hanging digital fruit.
11. Do not ride in adverse conditions such as rain, tornados, and hurricanes.
12. The Two Wheel Deal does not float.

Capacities and Specifications

Maximum Passenger Weight	250 lbs (113 kg)
Maximum Speed	12 mph (indicated)
Maximum Tilt Angle	20° (indicated)
Maximum Tire Inflation Pressure	45 psi
Wheel Size	16"
Vehicle Weight	70 lbs
Vehicle Width	28"
Vehicle Length	18"
Vehicle Height	50"
Vehicle Ground Clearance	6"
Peak Power Output	3.3 hp (2460 watts)
Peak Torque	240 lb-ft
Battery Capacity	36 Ah