Electrathon Vehicle

EVA

Est. 1988

Period 7

Tyler Lee and Lucas Martin

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Electrathon America Mission Statement

To create and develop a sport that improves public awareness and understanding of electric vehicles through continuously improving vehicles and rules.

Challenge

Design an electric motor vehicle with the least amount of air resistance possible in conjunction with the rules and regulations set by Electrathon America so as to maximize the amount of traveled distance in an hour on a closed course track.

Design Constraints

Vehicle

- Maximum vehicle width is 4 feet
- Maximum vehicle length is 12 feet
- Maximum distance of separation between tires is two feet
- Vehicle must be three or four wheeled
- Vehicle wheels must remain in contact with the ground throughout the entire duration of the race
- Frame must be sturdy enough to withstand a collision from any angle
- A roll bar must protect the driver's head from any angle of rotation
- Roll bar must be triangular in nature and be mounted from at least three points
- Roll bar must be able to withstand vertical drop from at least one foot
- Driver's helmet must be below a straight line drawn from the top of the roll bar to the top of a front tire or the highest structural point when the driver is securely belted in driving position
- A suitable design structure must prevent the driver from being able to touch the ground
- The vehicle must prevent the ejection of the driver in the event of sudden impact
- The driver must be fully contained in the vehicle and not expose any body parts at any point in the race
- The vehicle must not have any sharp edges or protrusions
- The nose of the vehicle must have a minimum radius of 3 inches
- Vehicle must be built to be stable in a state of rest or motion

Steering, Braking and Tires

- Steering must allow the cornering of a circle with a 25 foot radius
- Steering must be constructed to disallow any sort of binding or looseness
- A minimum of two wheels must have braking systems
- Brakes must be mounted on the same axle
- Brakes must have separate actuation cables that may be conjoined to the same initial point (lever, pedal)
- Regenerative braking is permitted in addition to conventional brakes
- The vehicle must not roll if pushed while brakes are applied
- The braking system must be sufficient enough to stop the vehicle at 25 miles per hour in under 40 feet
- Dual wheel axles must have a diameter of at least 3/8 inches

- Single wheel axles must have a diameter of 1/2 inches
- Safety wire or cotter pins must be used to secure cantilevered wheel axle nuts
- Tires must be pneumatic type
- Wheels and tires of any diameter may be used
- Minimum ground clearance of 1 1/2 inches
- In driving position the driver must not be able to come into contact with the tires, wheels, or spokes

Battery

- Batteries must be lead acid or listed among exceptions below and may not leak when punctured
    - Nickel-Metal-Hydride (up to 41 pounds)
    - Silver-Zinc (up to 23 pounds)
    - Nickel-Zinc (up to 44 pounds)
    - Nickel-Iron (up to 58 pounds)
    - Lithium-Ion (up to 15 pounds)
    - Lithium-Polymer (up to 15 pounds)
    - Lithium-Iron-Phosphate (up to 29 pounds)
- Batteries must meet weight limit of 73 pounds or be among specified battery types:
    - Optima Yellow Top
    - Optima Red Top
    - Odyssey Genesis
    - MK
    - Exide Orbital Model
    - Champion Vortex
- Batteries must be commercially retailed and available to any competitor
- Batteries must display all original manufacturer's labels
- Batteries must be stock, unmodified, and meet all conditions of manufacturer's written warranty
- Batteries cannot be exchanged or charged from an outside source during a competition
- Batteries may be recharged via regenerative braking or solar panels
- Batteries must be securely attached so as to withstand an impact or rollover
- Maximum output of any battery combination must not exceed a one hour rating of one kilowatt/hour according to manufacturer data

Electrical Componentry

- A fuse or circuit breaker is required in any electrical circuit between the battery and any electrical device
- All fuses or circuit breakers must be mounted as close to the as practically possible to the source of power
- All fuses or breakers must be sized to protect the wiring to which they are connected (See Appendix A)
- An isolation switch (kill switch) must be included on vehicle with a break current rating that exceeds the maximum draw of the vehicle
- The isolation switch must be located in the main positive power cable between the battery and motor controller
- An actuator may be attached to the switch for remote operation provided that it is durable and reliable
- The isolation switch must be accessible to both the driver in racing position and race officials from outside the vehicle without reaching in
- Two switches are allowed but not necessary
- A circuit breaker may be used as the isolation switch
- The switch or actuator on the outside of the vehicle must be mounted within a solid red triangle whose sides are at least 4 inches, and must be visible and in contrast to the vehicle color or graphics
- Wiring must be well insulated and securely attached to the frame or body so as to avoid moving parts and chafing
- Wiring that passes through a hole with sharp edges or through sheet metal must be protected by an insulating grommet or other suitable device
- Terminals must be secured so as not to come loose or short out during a race
- No part of the electrical system may use the vehicle frame as a conductor
- The vehicle frame must not be grounded

<u>Motor</u>

- Vehicles must be powered by electric motors only
- All gears, chains, and sprockets must be covered if they could cause injury to the driver or others in the event of a mechanical failure
- Any type of power (speed) controller is allowed
- Power to the motor must be controlled by the driver and turn off automatically when the driver releases the accelerator (dead man cut off)
- Remote control of the vehicle is not permitted

- Computers on or off the vehicle are legal systems if they present information only and have no effect on control system or operation adjustments

Numbers

- All vehicles must clearly display assigned vehicle competition numbers at least six inches in height and visible on both sides of the vehicle
- Out of state vehicles must clearly display state abbreviation following the vehicle number in 3 inch high lettering

Mirrors

- Vehicles must be equipped with a minimum of 8 square inches of total usable mirror surface area
- The mirrors must allow the driver to clearly see the rear of the vehicle on both sides
- Electronic sensing devices or video cameras and monitors may not be used as a substitute for rear view mirrors

Safety

- Vehicle must be equipped with a five point automotive seat belt system (see Appendix B)
- The seat belt must be securely attached to the vehicle and be capable of lifting the entire vehicle from the ground
- Seat belt waist mount must be mounted to a structural point at least 3 inches below the driver's waist
- Seat belt shoulder mounts must be mounted to a structural point at least 3 inches below the driver's shoulder
- The seat belt, including shoulder mounts, must be able to hold the driver in a position that does not allow any excessive movement such as sliding forward or shoulder whiplash in a sudden stop as well as hold the driver securely in position if the vehicle rolls over
- All drivers must wear DOT approved full face hard shell helmet during race
- Chin straps on helmets must be properly and securely fastened while operating vehicle
- Drivers must wear long sleeve shirts, pants, and shoes as well as gloves for open cock pit vehicles
- Drivers must wear eye protection while operating vehicle with a suggested Z87 rating
- Hair must be contained in such a way that it can in no way touch a moving part
- All jewelry must be removed prior to race

- Driver must be seated in a reclined position, a head first position is not permitted
- Drivers must be able to enter and exit the vehicle unassisted in under 20 seconds
- Handicapped participants will be allowed 2 minutes assisted enter and exit

Communication Device

- Push to talk radios are allowed as long as the driver isn't being distracted from driving
- Cell phones are permitted only when the vehicle is at a stop (such as a breakdown) or when in hands free mode

Ballast

- Drivers must weigh a minimum 180 pounds including race clothing and helmet, and if driver weight is insufficient then not liquid ballast must be added
- Ballast cannot be performance related items such as communication equipment or computers but can be non-performance related items such as music systems or cameras
- Ballast must remain in place for the duration of the competition

Other

- Solar panels are allowed permitted are part of the body and do not protrude
- Wings or trailers are not permitted

Picture Ideas

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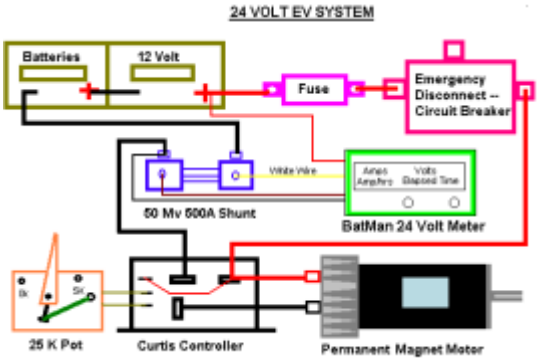
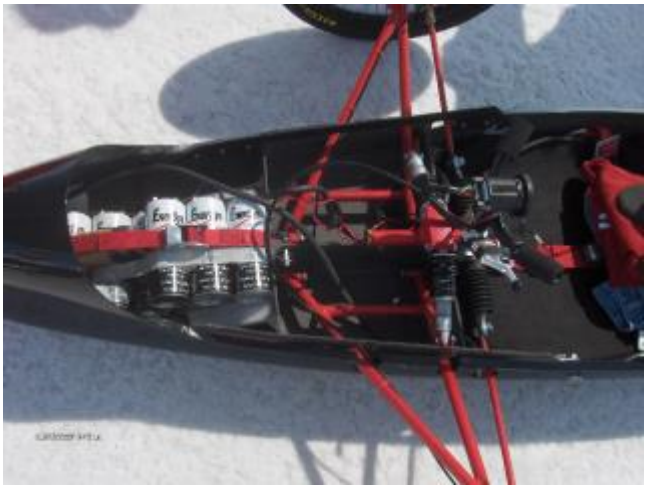
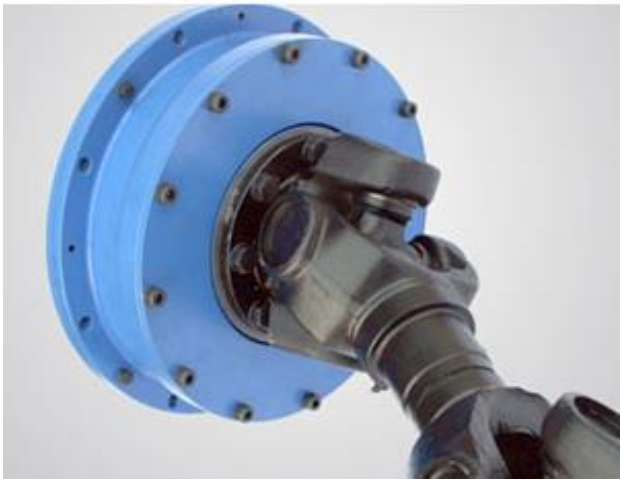
Picture Ideas







Basis Pictures

Research Websites

http://www.electrathonamerica.org/Rule_Book_&_Forms_files/HANDBOOK%202013.pdf

Official handbook provides deep insight into the Electrathon America completion including vehicle designs, history of races, rules, and recent changes.

http://www.electrathonamerica.org/Welcome_to_Electrathon_America.html

Official Electrathon America website includes thousands of pictures detailing past Electrathon vehicles.

http://electrathonoftampabay.org/www/Documents/Electrathon%20Tips/ElectrathonCarBuildingTips.pdf

Basic guide to part selection and construction of an Electrathon vehicle including a general guide of dos and don'ts as well as tips from successful vehicles.

http://en.wikipedia.org/wiki/Electrathon

Wikipedia provides basic information surrounding the history of the vehicles and references to the largest Electrathon competitions.

http://whitesalmonschools.net/ecar/

Several design processes are listed here up to completion in a blog-like fashion in chronological order. The website provides numerous ideas and innovations created by each student's own car.

http://brucesherrydesigns.com/batterymanagement.html

General information surrounding maximizing the battery output and information on the general principles of Electrathon batteries.

http://lhsteched.pbworks.com/f/new+Electrathon+Sponsor+ship+proposal.pdf

Briefing on an entire project from part selection to construction involving similar design aspects and equal level of involvement from high school students.

http://www.instructables.com/id/Build-an-Electric-Car-Powered-by-a-Bike-Motor/step2/Building-The-Body/

Outline of fiberglass body construction showing steps taken in developing a mold and sculpting with fiberglass in general.

http://www.cloudelectric.com/category-s/136.htm

Catalog built specifically for buying Electrathon vehicle auto parts ranging from batteries and fuses to plastic bodies and motors.

http://electrathonfl.homestead.com/Jimbuildproject/Electrathon_Build_Thread_11.pdf

Picture and caption guide to the steering portion of the vehicle with explicit information on creating an adjustable system for later fine tuning and maintaining low slop in the joints

http://www.cloudelectric.com/kb_results.asp?ID=10

Consist winner Cloud Electric motor and power consumption recommendations for startup builders.

http://explodingdinosaurs.com/saltflats/2007worldofspeed/electrathon/

Regarded as one of the best vehicles, Kirk Swaney's car is simple to understand, well built, and contains several key advantages over other cars such as smaller batteries, concise gear work, and solid frame design.

http://www.preblemotorsports.com/deltech.html

Pictures of vehicle construction largely pertaining to steering systems without suspension but allowing a large range of movement.

http://auto.howstuffworks.com/steering2.htm

Generally guideline on how rack and pinion steering works with provided diagrams emphasizing the necessary for the system.

http://challengewisconsin.org/wp-content/uploads/2014/01/EV-Regulations-2014.pdf

Wisconsin racing competition now regulated by Electrathon rules provides insight into stricter rules and improvements made to vehicles under those rules.

http://www.lasv.org/press/publications/other/pulse_report%20(2012-2013).pdf

General benchmarks and comparison tools involving air resistance and speed equations in an in depth guide to two Electrathon vehicle builds.

https://www.tcnj.edu/~asper/Electrathon2011.pdf

Guided inaugural year Electrathon vehicle build using circular tubing instead of square tubing as well as details for general construction with tips and tricks.

http://www.instructables.com/id/Fitting-Tubes-at-Home-for-Welding/?ALLSTEPS

Picture enhanced welding instructions for welding circular tubing which is a potential design modification that would enhance the difficulty drastically.

Basic Parts List

- Tires x3
- Battery x2
- Motor (low horse power) x1
- Kill Switch x1
- Ignition Switch x1
- Seat x1
- Brakes x2
- Axle Rods x2
- Steering Wheel x1
- Safety Harness x1
- Metal Floor plate x1
- Metal Tubing x1
- Throttle (pedal) x1
- Helmet x1
- Goggles x1
- Fastening Devices (zip ties) x∞
- Battery Charger x1
- Insulated Wire x∞
- Bolts x4
- Electrical Tape x∞
- Duct Tape x∞
- Electrical Meter x1
- Electrical System x1
- Fuse x1

Advanced Part List

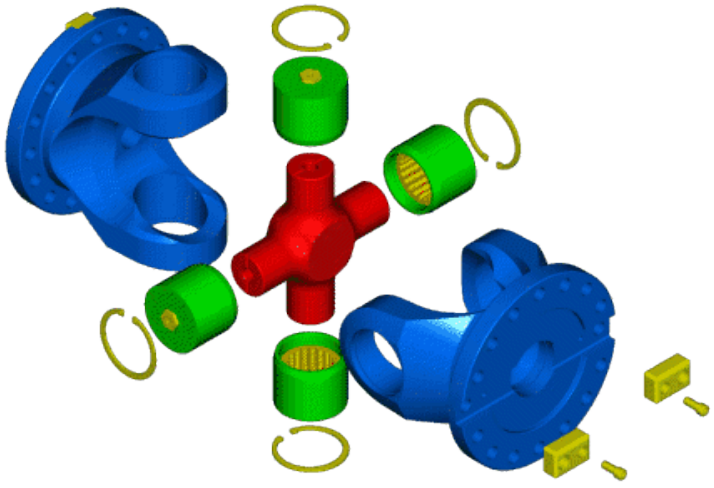
Item	Options	Ideal Cost
Wheels	– ACS z Mag 5 Spoke Rear Black Mag – ACS Stellar Mag Front Wheel Black 3/8" Axle	$50.00
Tires	– Alienation Graffiti Comp BMX Tire	$50.00
Battery	– Optima Red Top – Optima Yellow Top – Kirkland Signature (Costco Brand)	$350.00
Motor	– Motor Scott Upgrade PM 12-24 VDC 1.6+HP	$500.00
Kill Switch	– Carling 60 Amp Boat Circuit Breaker – Square D QO160, 60 Amp, 1 Pole, Circuit Breaker	$15.00
Ignition Switch	– Use kill switch as ignition switch – Red Keyed Master Cutoff Switch 500 amp	$0.00
Seat	– Build from metal supplies – Plastic school seat – Fold up lawn chair – Portable folding chair	$0.00
Brakes	– Typical bike brakes mounted on a disk – Idea from Thompson (PLACEHOLDER)	$0.00

Axle Rods	– Use bicycle axles	$0.00
Steering Wheel	– Bend tubing – Search junkyards –	$20.00
Safety Harness	– G-Force 5-Point Latch & Link Harness Set – 5 Point Seat Belt & Shoulder Harness (6.000.354)	$40.00
Floor Plate	– 0.125 (1/8) thick 3003 Aluminum Sheet – 16 GA. (.060 thick) Steel Sheet Hot Rolled Steel Sheet with primer coating – OSB sheet	$0.00
Metal Tubing	– 1-1/4 X 1-1/4 X16GA (.065 wall) A513 Steel Structural Square Tube x 84 feet	$150.00
Throttle (Pedal)	– Throttle Thumb 0-5K AWI-5K	$10.00
Helmet	– PGR X25 Youth Dragon Motocross MX BMX Dirt Bike Dune Buggy Enduro ATV Quad Off Road – Borrow from Dirk	$50.00
Goggles	– Helmet and google combination	$0.00

Fastening Devices (zip ties)	– Already obtained	$0.00
Battery Charger	– Donated by Lee family	$0.00
Insulated Wire	– Already obtained	$0.00
Bolts	– Donated by Lee family	$0.00
Electrical Tape	– Already obtained	$0.00
Duct Tape	– Already obtained	$0.00
Electrical Meter	– Digital LED Panel Meter Transformer AC 80~300V 100A Ammeter Voltmeter	$12.00
Motor Controller	– Alltrax Controller AXE4834 PM or Series Programmable	$360.00

Fuse	– Fuse ANL 325 Amp	$
Steering System	–	$
Battery Clamps	– Battery Terminal Clamps Brass Pair with Wing Nut	$
Battery Connectors	– Lug Magna Straight 4 GA 3/8" Hole – Lug Magna Straight 4 GA 5/16" Hole – Lug Magna Straight 4 GA 1/4" Hole	$
Body	– Great stuff foam cast using saran wrap and plastic sheet compacting – No body	$
Total		$

Steering Picture Ideas



Commercial Websites

https://chircoestore.com/sand-buggy-rack-and-pinion-steering-box.html?gclid=Cj0KEQjwm6CgBRC0zOmrydrqmosBEiQA_xoLRvhvHDsCKjXJ9LZp9NxrSx_ZBkk8Mlv1ad3UGOXMDTsaAjlS8P8HAQ

Parts supplier for performance vehicles of all kinds but specific sections cut out for small car or buggy type vehicles

http://www.desertkarts.com/productCat40912.ctlg

Desert racing vehicle part supplier with parts optimized for to prevent sand based erosion

http://www.metalsdepot.com/index.php

Metal supplier ranging from hot rolled sheet to square tubing in aluminum, brushed stainless steel, and steel unprotected from rust

http://www.shiftev.com/

Full scale supplier of small vehicle parts specializing in electrical componentry such as motors and motor controllers

http://www.bmikarts.com/

Another general purpose supplier started to help small parties create both gas and electric powered vehicles

Chassis Parts List

Item	Description	Cost
Square Metal Tubing	– 8 x 12 foot 16 gauge cold rolled square steel – 10 x 10 foot 16 gauge cold rolled square steel	$
Wooden Floor Panel	– ~1/2 inch OSB panel	$0.00
Total		$

Order Parts List

Item	Description	Quantity	Cost
Motor	– Motor ME0708 MotEnergy Permanent Magnet DC Pancake Brushed	1	$450.00
Motor Controller	– Alltrax Controller AXE4834 PM or Series Programmable	1	$423.62
Fuse	– Fuse ANL 325 Amp	1	$7.00
Battery Clamps	– Battery Terminal Clamps Brass Pair with Wing Nut	8	$22.08
Battery Connectors	– Lug Magna Straight 4 GA 1/4" Hole – Lug Magna Straight 4 GA 5/16" Hole – Lug Magna Straight 4 GA 3/8" Hole	2 6 4	$4.00 $12.00 $8.00
Throttle	– Throttle Pedal 0-5V Electric Car	1	$99.00
Cutoff Switch	– Red Keyed Master Cutoff Switch 500 amp	1	$17.95
Batteries	– Optima Yellow Tops	2	$

Rack and Pinion Steering System	–	1	$
Steering Post	–	1	$
Steering Wheel	–	1	$
Ammeter	–	1	$
Voltmeter	–	1	$
Total			$

Metal Tubing Dimensions

Label	Length	Width	Height	Quantity	Linear Feet
A	48”	1”	1”	4	16’
B	12“	1”	1”	10	10’
C	15“	1”	1”	1	1’ 3”
D	20“	1”	1”	1	1’ 8”
E	8“	1”	1”	4	2’ 8”
F	16“	1”	1”	4	5’ 4”
G	24“	1”	1”	3	6’
H	30“	1”	1”	1	2’ 6”
I	15“	1”	1”	2	2’ 6”
J	26“	1”	1”	4	8’ 8”
K	10”	1”	1”	2	1’ 8”
L	50”	1”	1”	2	8’ 4”
M	13”	1”	1”	2	2’ 2”
N	12”	1”	1”	1	1’
O	32”	1”	1”	2	5’ 4”
P	30”	1”	1”	1	2’ 6”
Q	12”	1”	1”	1	1’
R	40”	1”	1”	2	6’ 8”
Total					85’ 3”

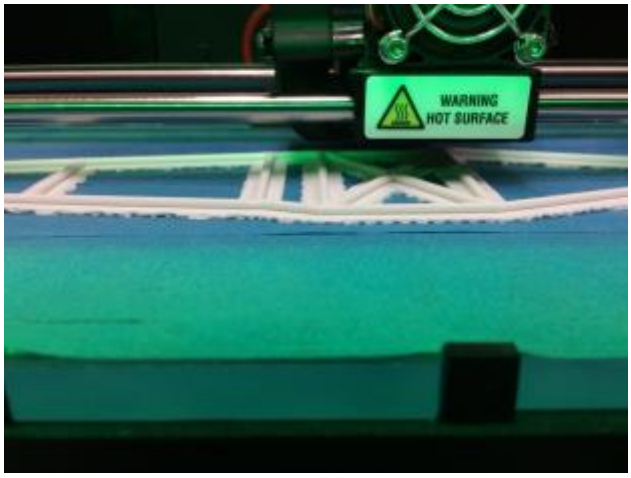
*See Appendix Q and R for Labels

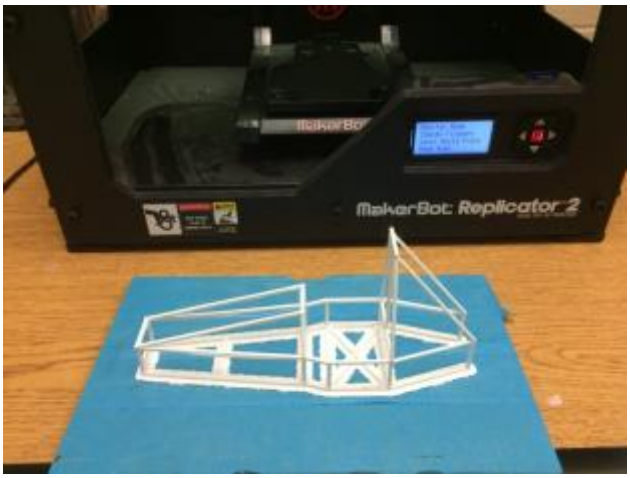
Simplified Dimensions

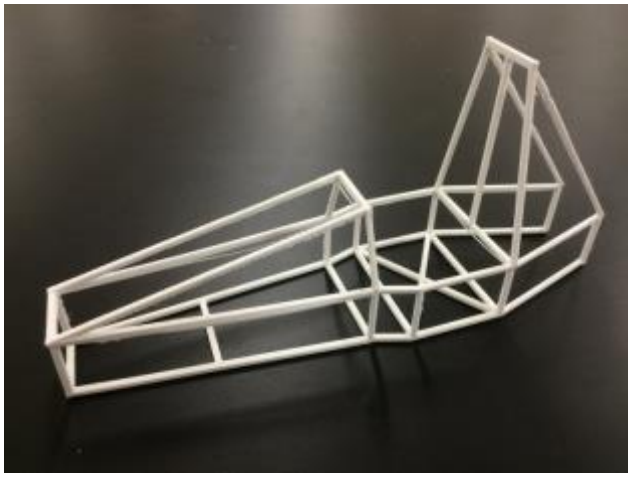
Length	Width	Height	Quantity	Linear Feet
50"	1"	1"	2	8' 4"
48"	1"	1"	4	16'
40"	1"	1"	2	6' 8"
32"	1"	1"	2	5' 4"
30"	1"	1"	2	5'
26"	1"	1"	4	8' 8"
24"	1"	1"	3	6'
20"	1"	1"	1	1' 8"
16"	1"	1"	4	5' 4"
15"	1"	1"	3	3' 9"
13"	1"	1"	2	2' 2"
12"	1"	1"	12	12'
10"	1"	1"	2	1' 8"
8"	1"	1"	4	2' 8"
Total				85' 3"

3D Printed Model

Using a Makerbot Replicator 2, the 3D model was printed by first converting the .ipt file to a .stl file and then scaling the model on the Makerbot software. It was then printed in roughly one hour and thirty minutes.







Appendices

Appendices Continued

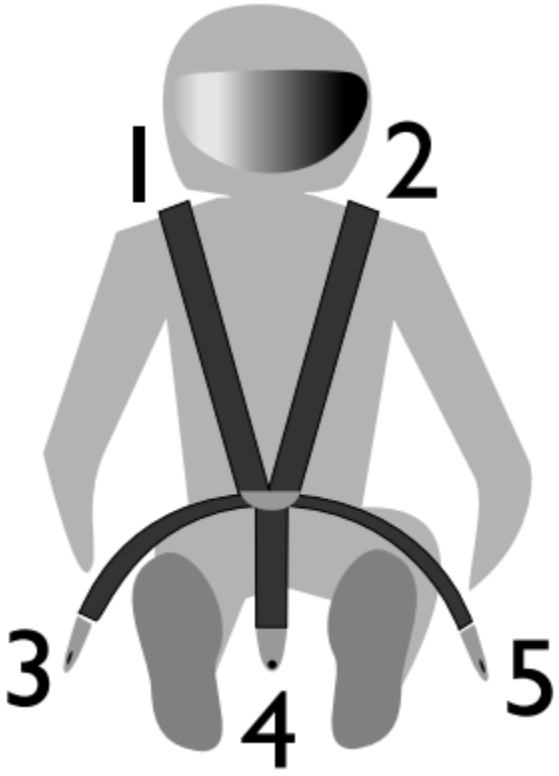
Appendix A (N.E.C. Standards)

Description: National electric code handbook standard automotive type cable requirements for circuit containing a single conductor

Wire size AWG	MAX Fuse or Breaker Size
20	5.5 AMPS
18	9 AMPS
16	12 AMPS
14	15 AMPS
12	20 AMPS
10	30 AMPS
8	80 AMPS
6	105 AMPS
4	140 AMPS
2	200 AMPS
1	250 AMPS
1/0	300 AMPS

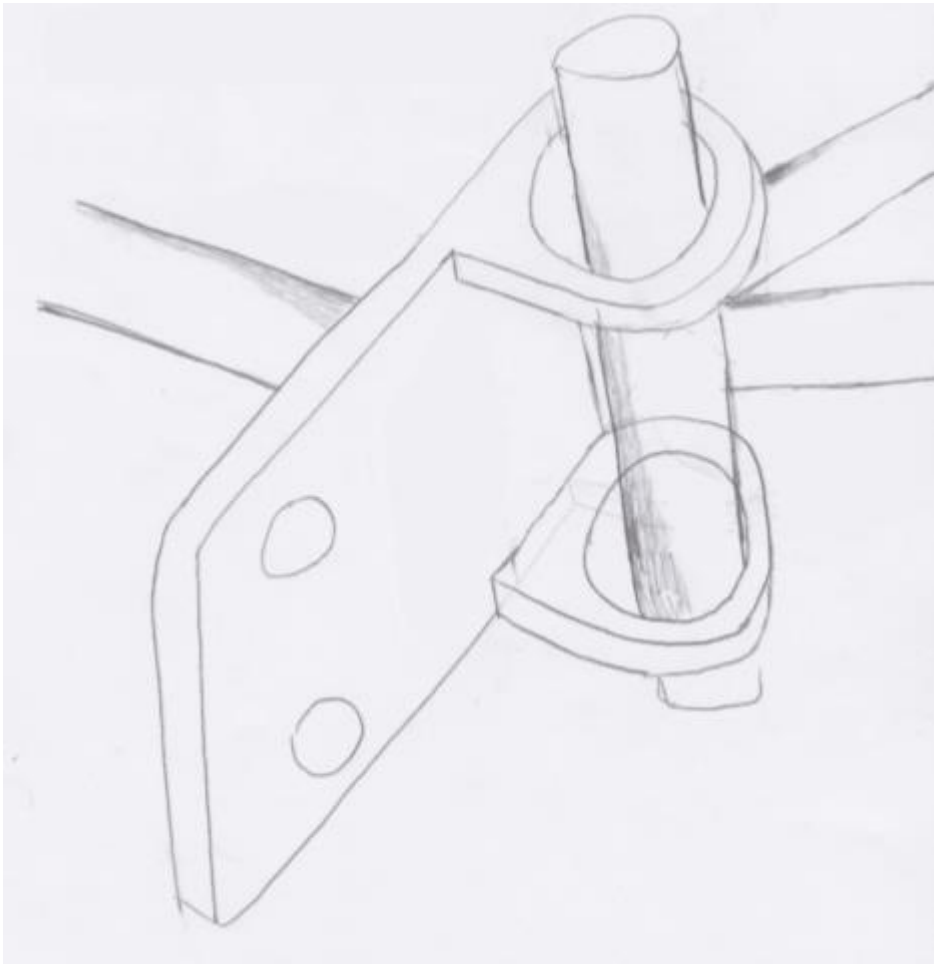
Appendix B (Five Point Seat Belt)

Description: Mandatory five point mounting guide for seat belt



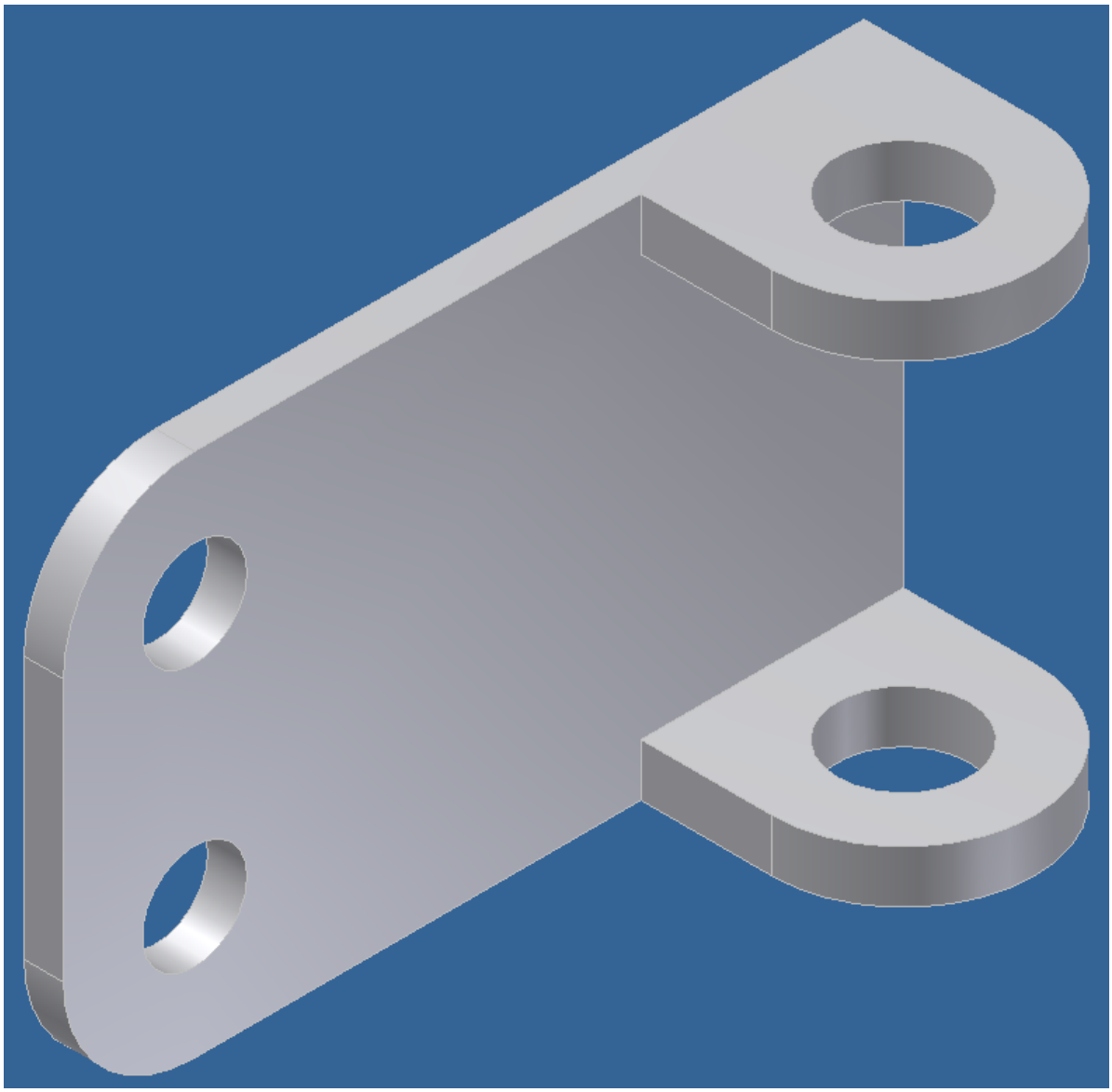
Appendix C (Steering Guide Design)

Description: Steering wheel attachment system with steering and support as well as possible suspension support



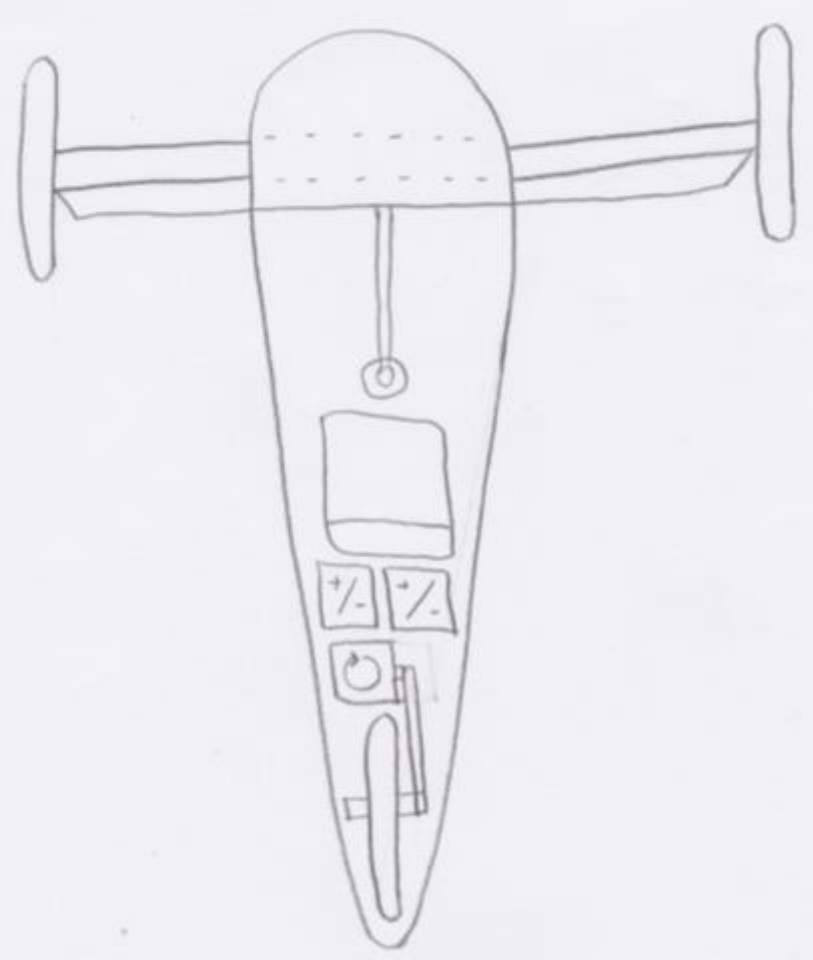
Appendix D (Steering Guide C.A.D.)

Description: Computer aided drawing of steering guide design to enhance visualization and proper dimensioning



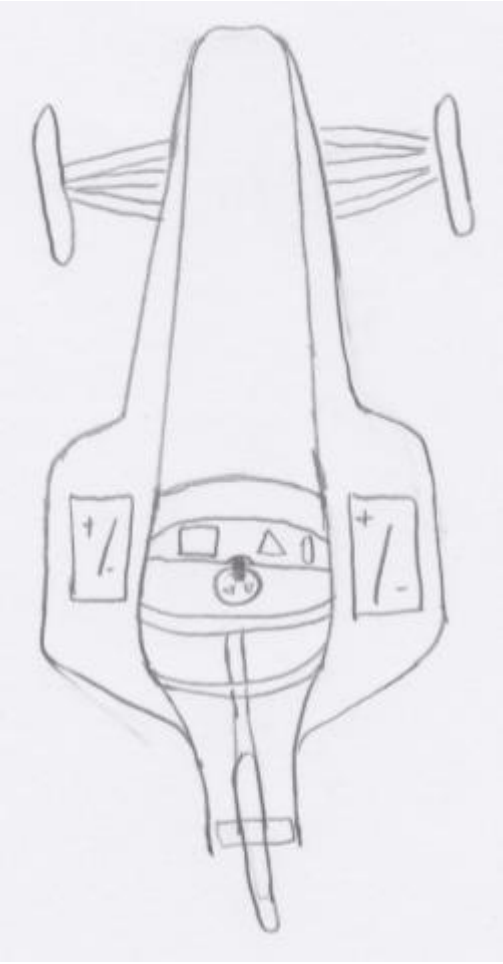
Appendix E ("Tear Drop" Design)

Description: Initial design drawing for a superb aerodynamic shape and back mounted motor for a good general design



Appendix F ("Enzo" Design)

Description: Ferrari inspired design allowing for large battery storage, proper steering, and increased safety to go along with an awesome looking vehicle

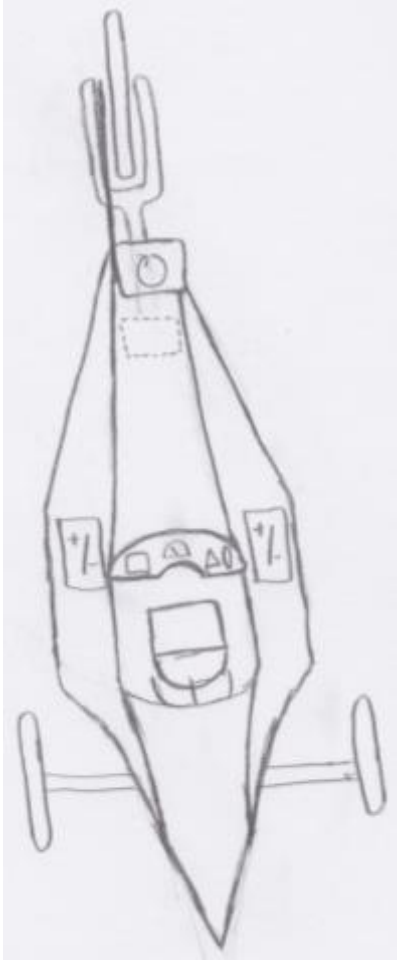


Appendix G ("Dragster" Design)

Description: Front motor design allows for airflow over the motor to ensure higher energy efficiency and easy steering with a single front wheel

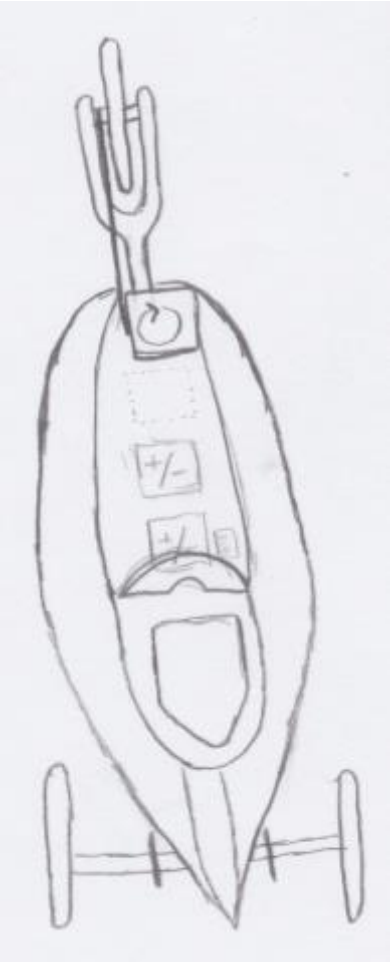
Appendix H ("Chopper" Design)

Description: Aerodynamic enhancement to the dragster design continue to allow for dual disk brakes on the rear axle, better motor efficiency, and easy steering



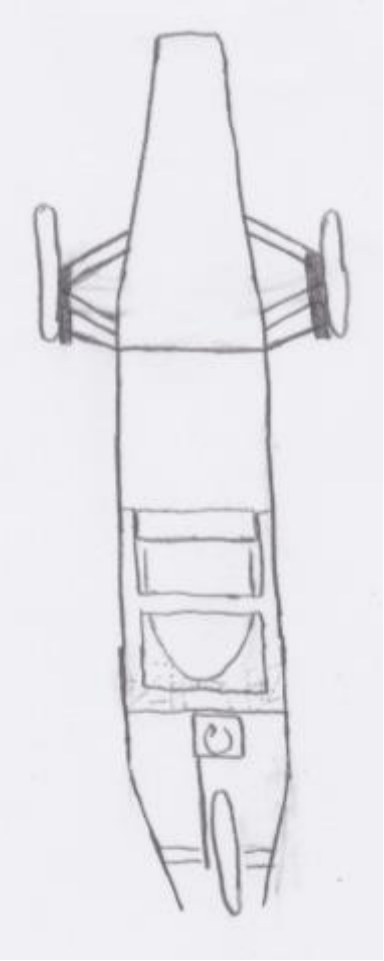
Appendix I ("Dolphin" Design)

Description: Front mounted motor alteration to the "Tear Drop" Design allows for a cooler motor and therefore greater thermal efficiency



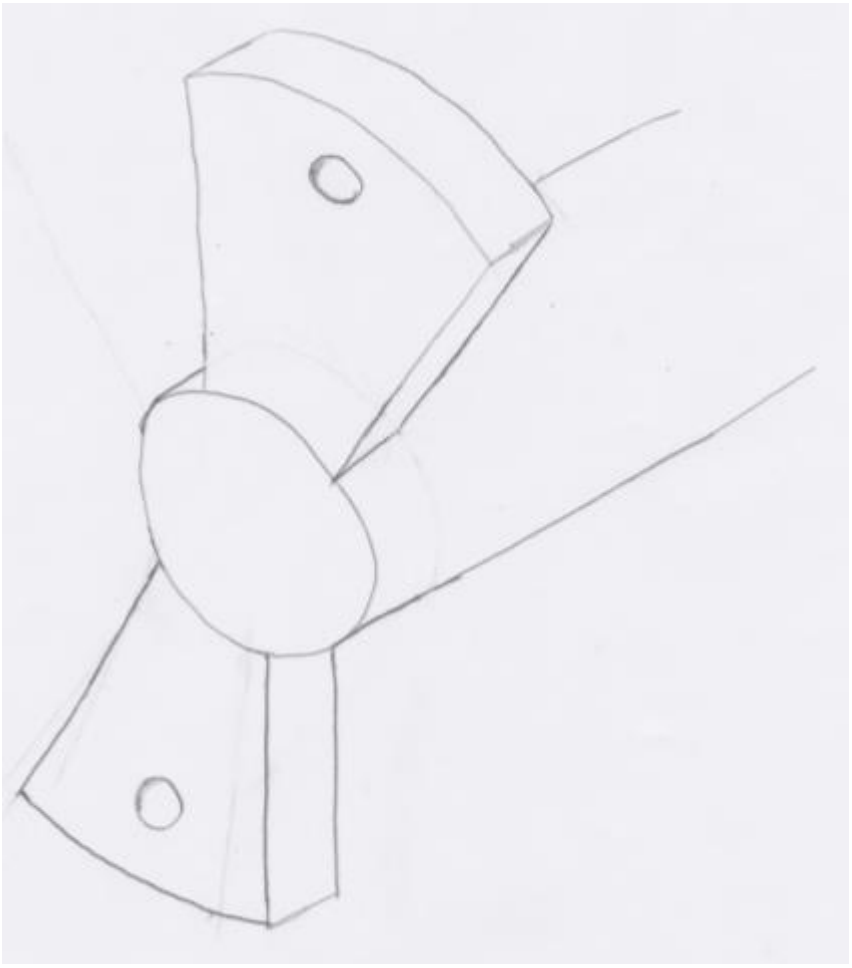
Appendix J ("Box Car" Design)

Description: Streamlined version of the "Enzo" Design to reduce wind resistance and take advantage of the long length parameter described by the requirements



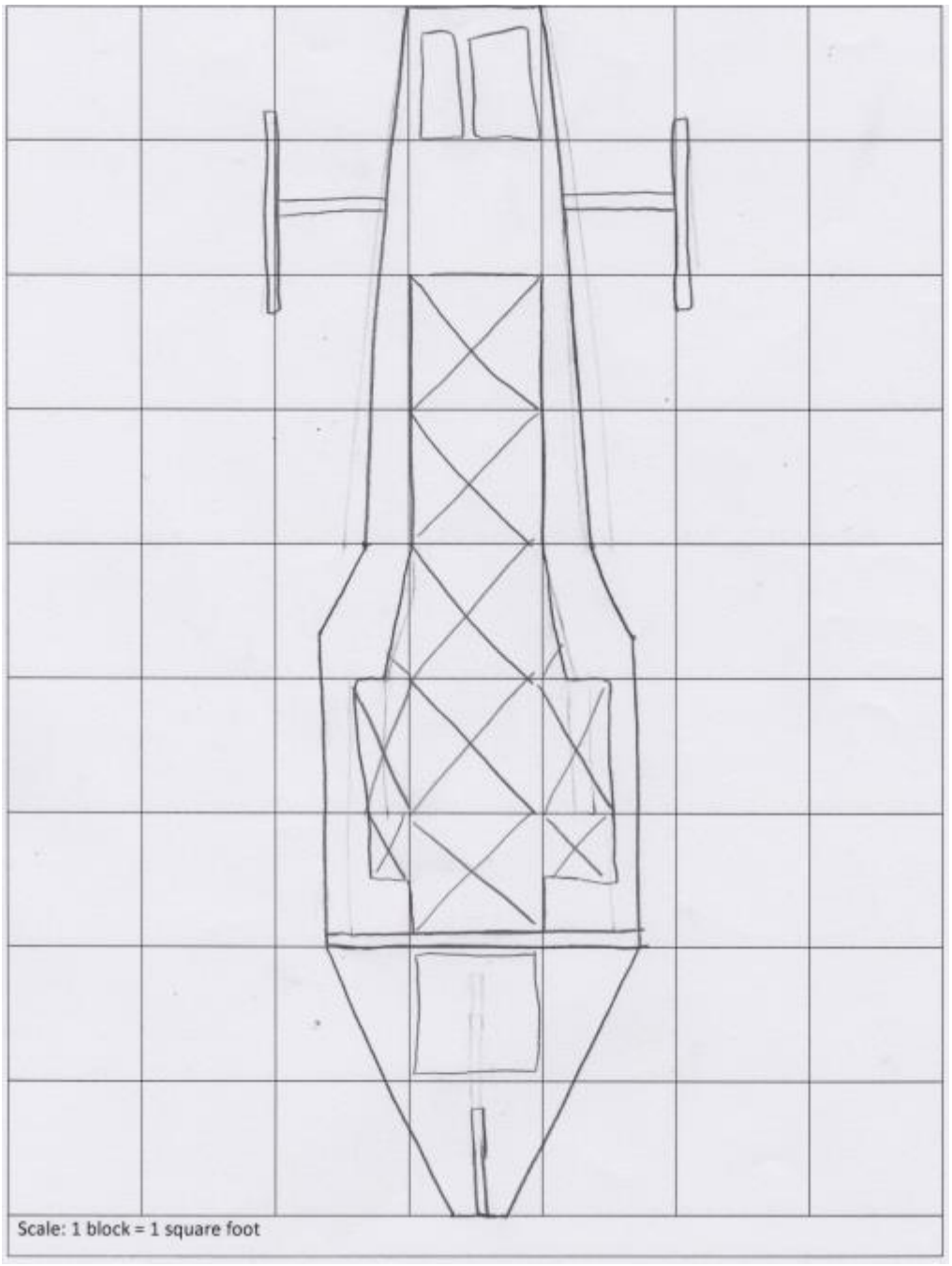
Appendix K (Flange Steering Pivot)

Description: Simple steering system using braced flanges attached to steering post to provide a sufficient range of steering



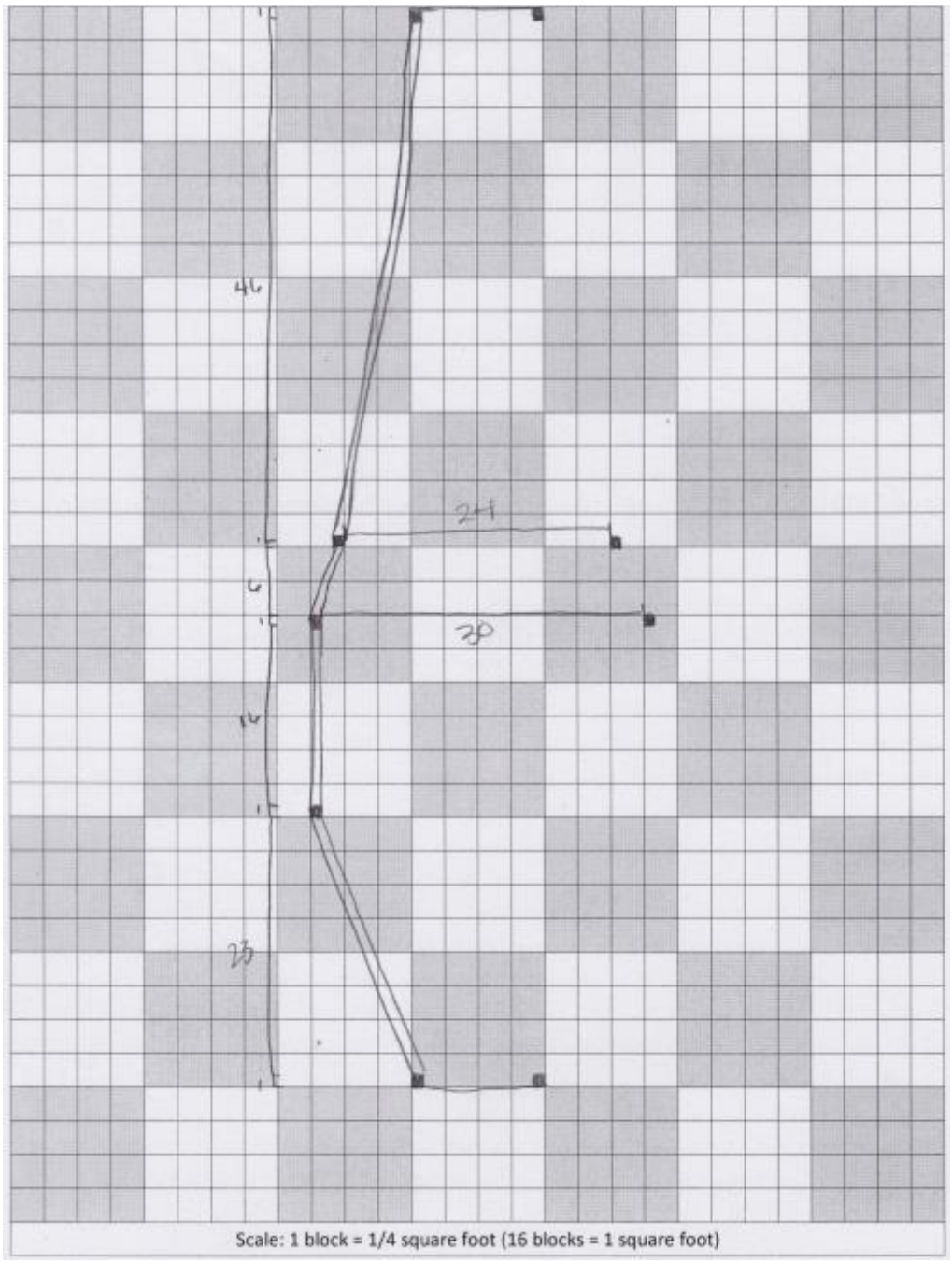
Appendix L (Graphed Enzo v1)

Description: More precise version of the "Enzo" Design showing the dimension of a human as well as relative proportion size of components such as the motor block, wheels, and battery



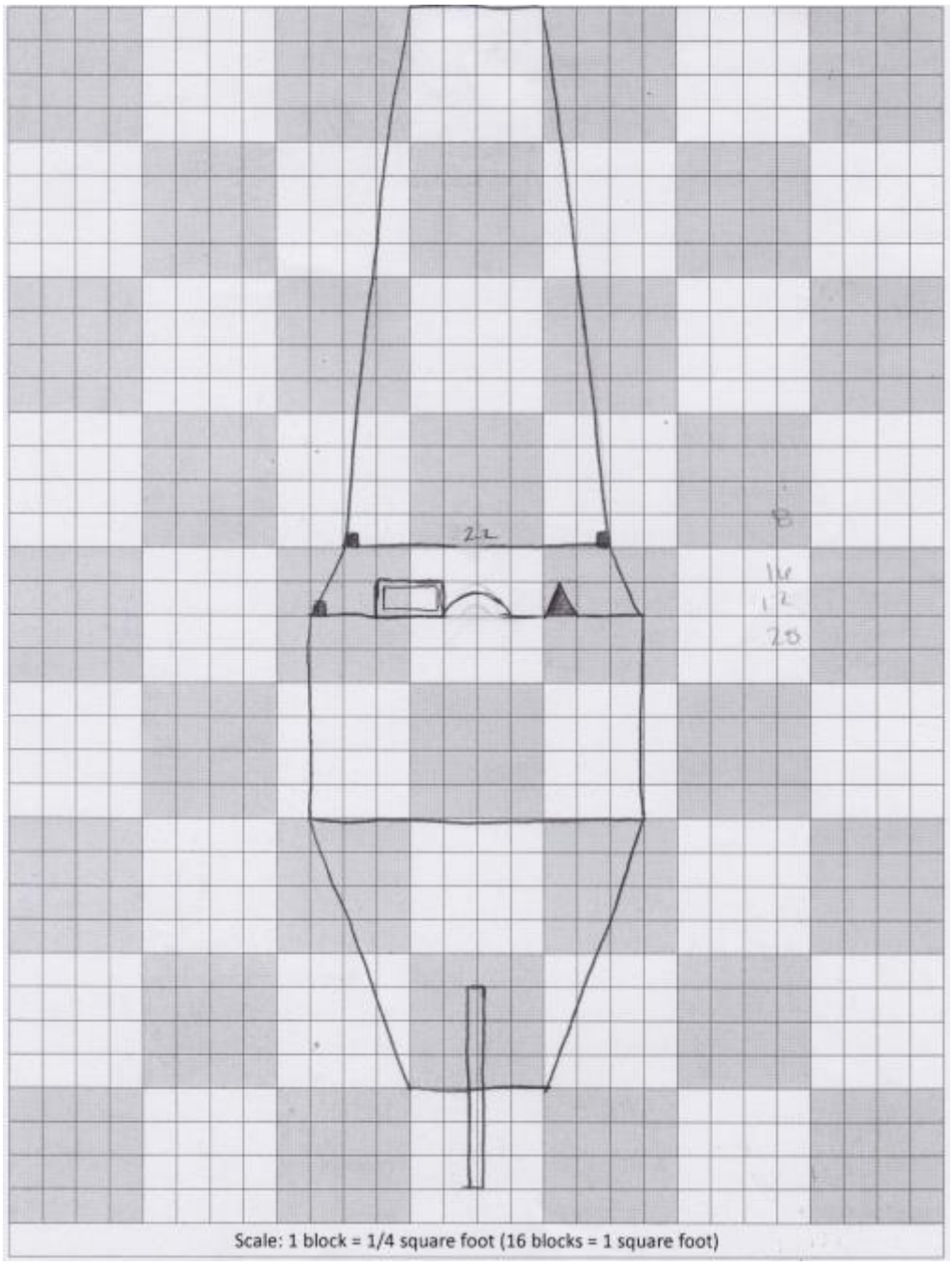
Appendix M (Graphed Enzo v2)

Description: More precise "Enzo" Design giving dimensions in perceived inches and design modification to base everything off of vertical posts to aid in the welding process



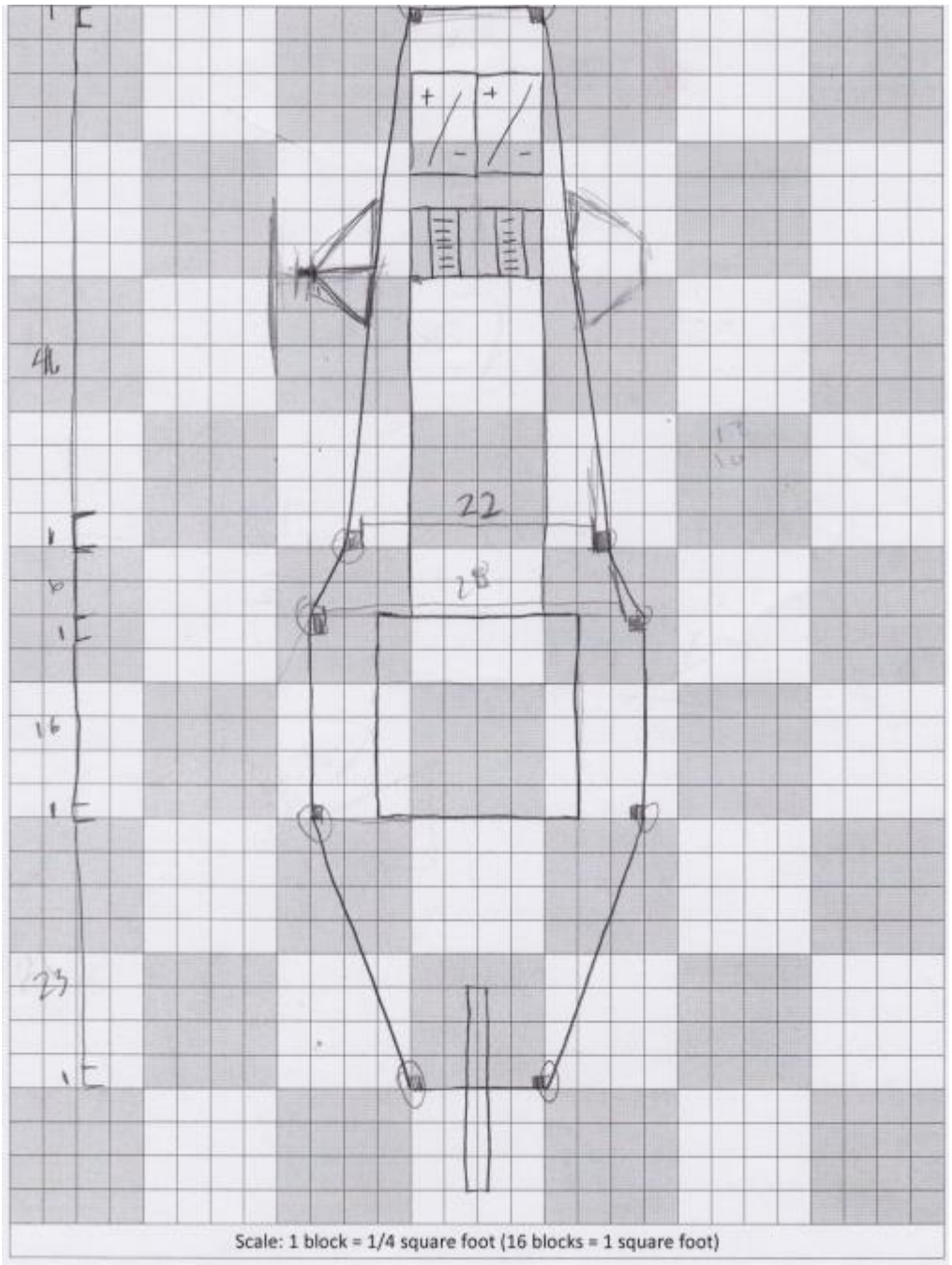
Appendix N (Graphed Enzo v3)

Description: Overhead view including dashboard layout to provide a better understanding of special dimensions for the driver cavity



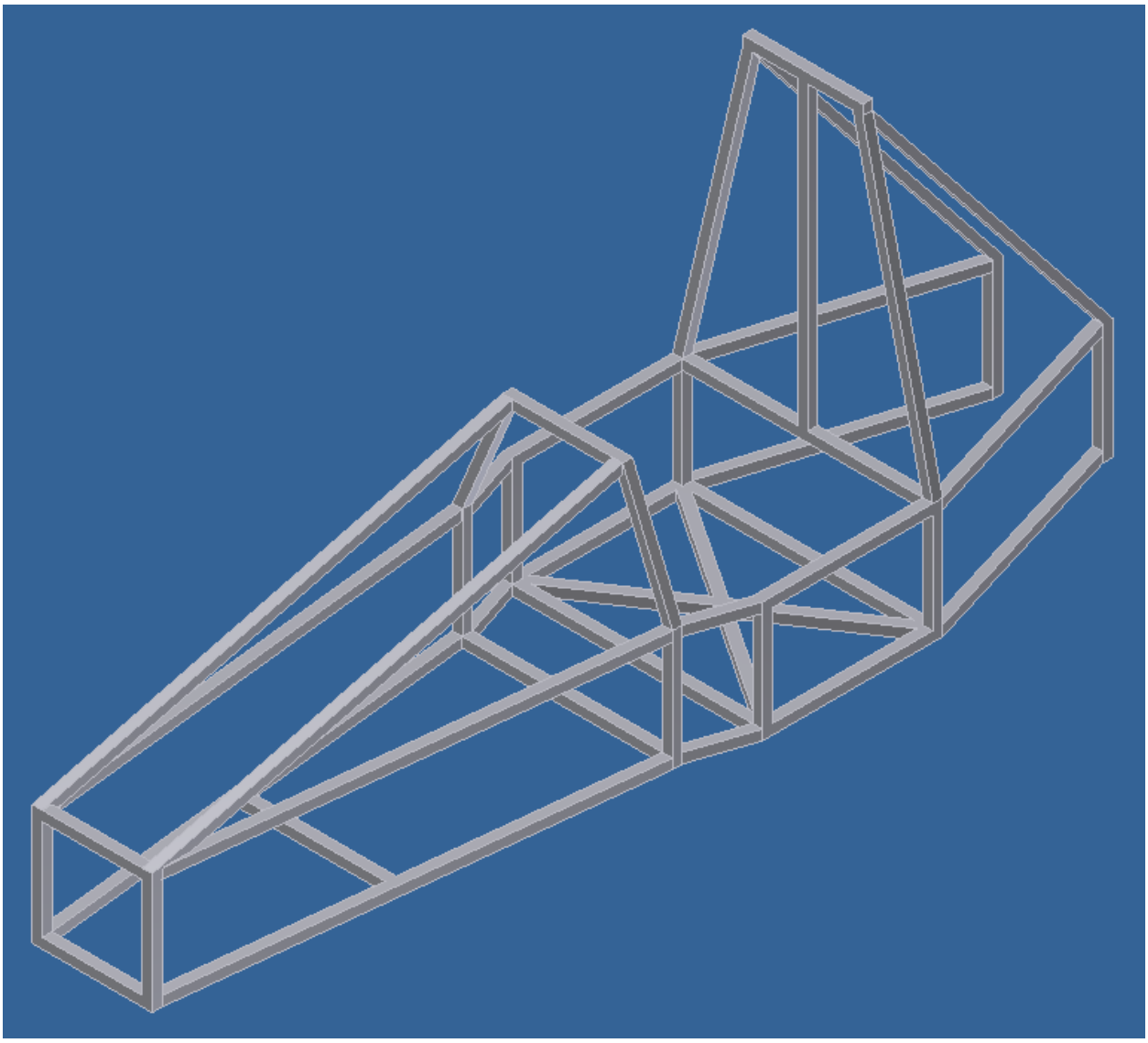
Appendix O (Graphed Enzo v4)

Description: More precise model minimizing width and showing initial steering considerations in relation to driver positioning



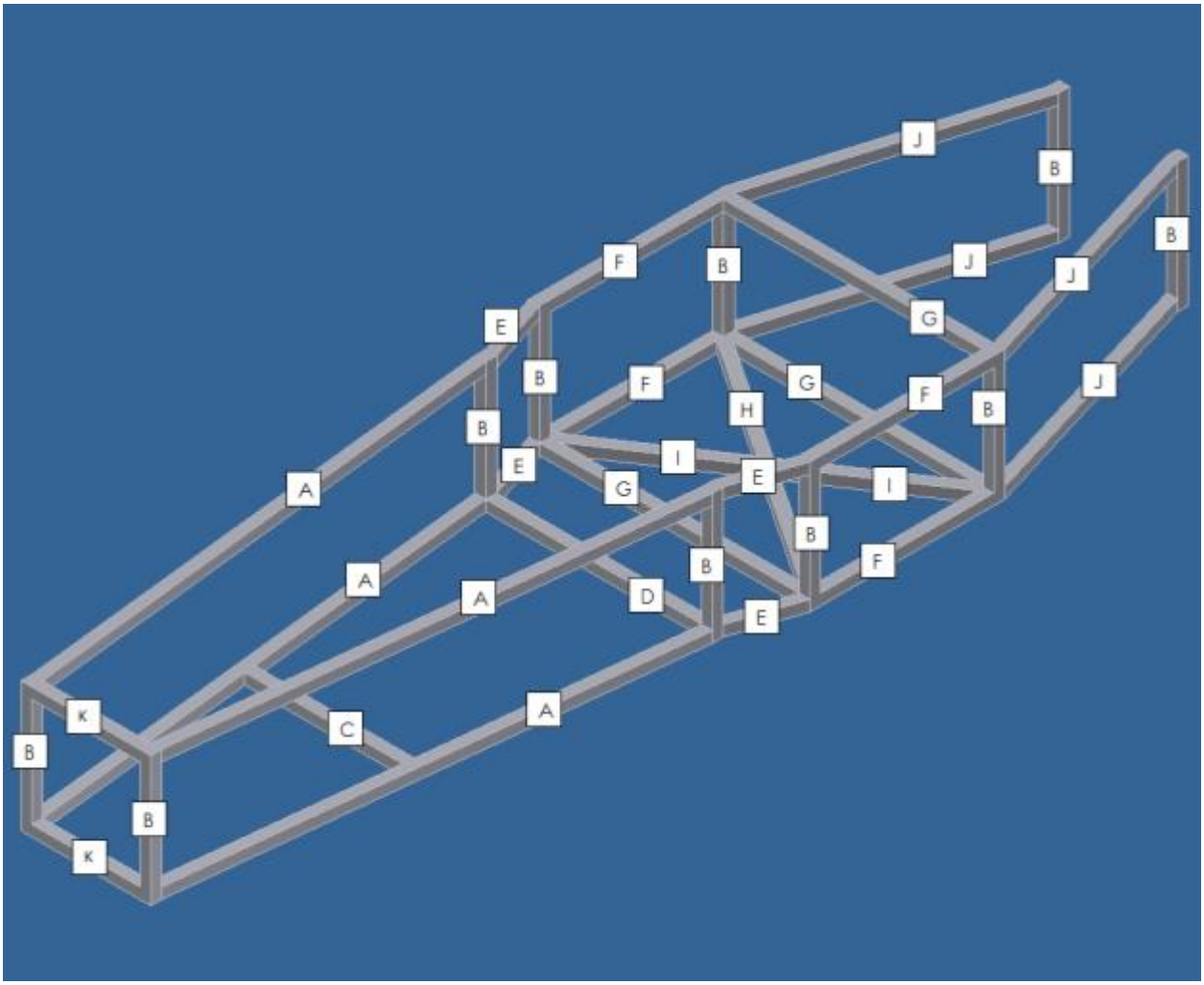
Appendix P (3D Enzo Model)

Description: Computer aided design model of the "Enzo" Design in preparation for 3D printing model and precise dimensioning for final build



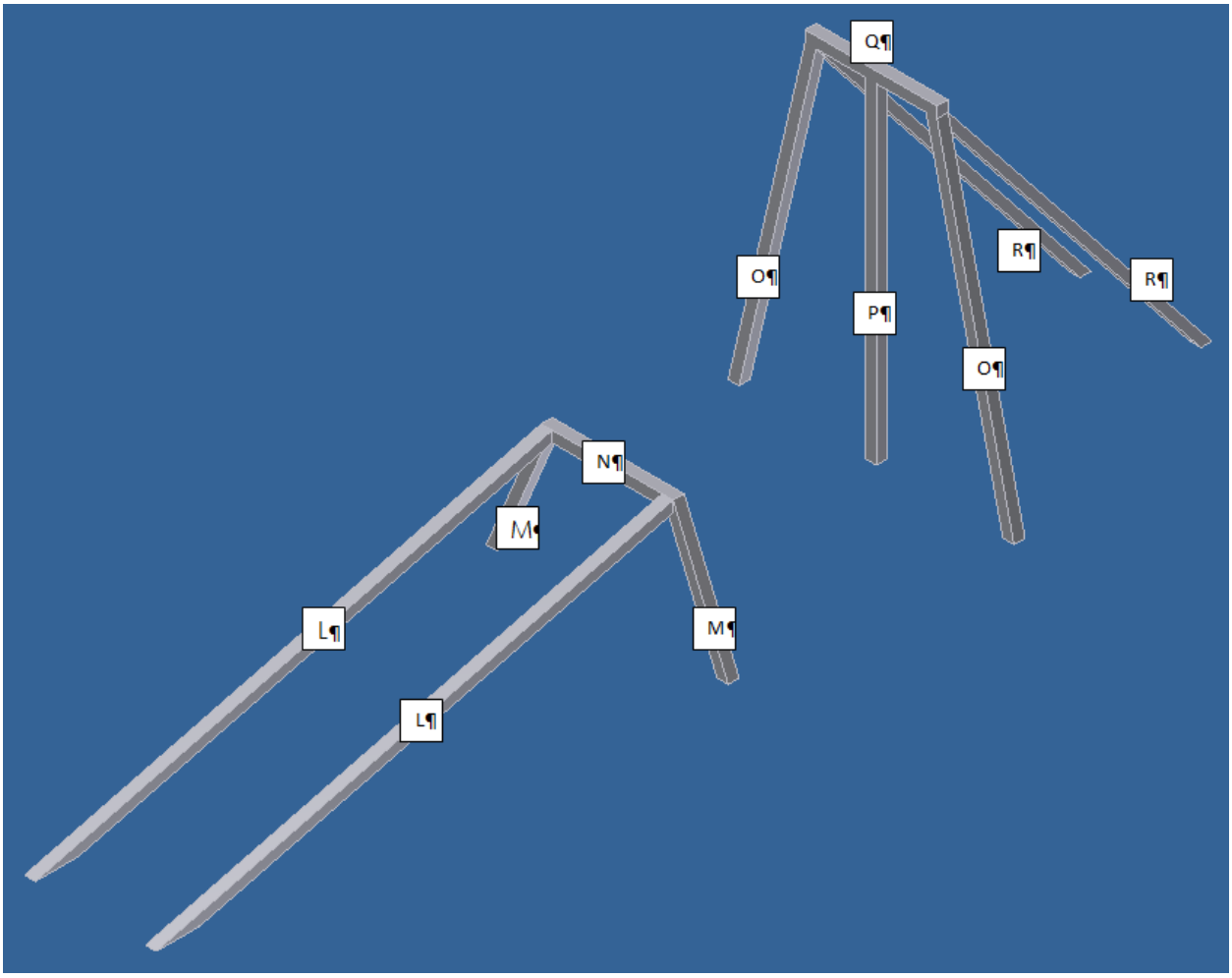
Appendix Q (Chassis Labels)

Description: Labels from Metal Tubing Dimensions Table (page 26)



Appendix R (Roll Cage Labels)

Description: Labels from Metal Tubing Dimensions Table (page 26)



Appendix S (Cloud Electric Kit)

Description: Cost table including shipping and sales tax for an order from Cloud Electric

SHOP FOR MORE ITEMS

	ITEM DESCRIPTION	QTY	EACH	TOTAL
✕	 Red Keyed Master Cutoff Switch 500 amp	1	$15.00	$15.00
✕	 Throttle Thumb 0-5K AWI-5K	1	$55.00	$55.00
✕	 Fuse ANL 325 Amp	1	$7.00	$7.00
✕	 Motor ME0708 MotEnergy Permanent Magnet DC Pancake Brushed	1	$450.00	$450.00
✕	 Lug Magna Straight 4 GA 3/8" Hole	4	$1.00	$4.00
✕	 Lug Magna Straight 4 GA 5/16" Hole	1	$1.00	$1.00
✕	 Lug Magna Straight 4 GA 1/4" Hole	2	$1.00	$2.00
✕	 Alltrax Controller AXE4834 PM or Series Programmable	1	$423.62	$423.62
✕	 Battery Terminal Clamps Brass Pair with Wing Nut	2	$3.00	$6.00

Click ✕ to remove an item from your cart

Empty My Entire Cart

Shipping Rates: (change my address)

UPS

No shipping selected

United States, GA, 30004

State Tax:	$38.54
County Tax:	$28.91
Total:	$1,031.07

RECALCULATE

Show gift options during checkout

Coupon code? Enter it here:

APPLY

Appendix T (EVA Electric Kit)

Description: Cost table excluding shipping for an order from Electrathon Vehicles of America

QTY	DESCRIPTION	UNIT PRICE	TOTAL PRICE
	DRIVE SYSTEM		
1	Mars Motor ME0909 Permanent Magnet (24V - 72V) 2HP - 12HP	$495.00	$495.00
1	AllTrax SPM-48300 Controller 24-48V 300 Amp Limit	$360.00	$360.00
1	Curtis FP-6 Footpedal with internal potentiometer $150- used	$90.00	$90.00
1	Albright Contactor SW-80 (24V coil)	$80.00	$80.00
	BATTERY SYSTEM		
4	1 Gauge Battery Terminal Protective Covers (Red & Black)	$1.50	$6.00
15	ft 1 gauge Cable	$3.00	$45.00
20	Heavy Duty Lugs- 1 gauge	$2.00	$40.00
3	ft Heat Shrink with sealant	$6.00	$18.00
	INSTRUMENTATION		
1	0-200A Ammeter 2 inch Rd Westberg	$75.00	$75.00
1	200A 50mV Shunt	$30.00	$30.00
	SAFETY		
1	ANN-250 Fuse and Fuseholder	$45.00	$45.00
1	Pair Anderson connectors SBX-175	$48.00	$48.00

Appendix U (EVA Electric Kit)

	TECHNICAL ASSISTANCE	
1	EVA Installation Manual	N/C
	includes schematics, manufacturers data, etc	
1	EVA "Safety First" Video	N/C

	SUBTOTAL	$1,332.00
	EVAmerica Package Discount	-$37.00

	TOTAL	$1,295.00

New Hampshire has no Sales Tax!

This saves people in some states - hundreds of dollars!

Appendix V (Cloud Electric Order)

Description: Final order from Cloud Electric including all taxes and shipping costs which were excluded upon ordering due to educational tax exemption

ITEM DESCRIPTION	QTY	EACH	TOTAL
 Battery Terminal Clamps Brass Pair with Wing Nut	4	$5.52	$22.08
 Alltrax Controller AXE4834 PM or Series Programmable	1	$423.62	$423.62
 Lug Magna Straight 4 GA 1/4" Hole	2	$2.00	$4.00
 Lug Magna Straight 4 GA 5/16" Hole	6	$2.00	$12.00
 Red Keyed Master Cutoff Switch 500 amp	1	$17.95	$17.95
 Fuse ANL 325 Amp	1	$7.00	$7.00
 Motor ME0708 MotEnergy Permanent Magnet DC Pancake Brushed	1	$450.00	$450.00
 Lug Magna Straight 4 GA 3/8" Hole	4	$2.00	$8.00
 Throttle Pedal 0-5V Electric Car	1	$99.00	$99.00

Click  to remove an item from your cart

Empty My Entire Cart

Shipping Rates: (change my address)

UPS

UPS Ground $70.83

United States, GA, 30004

State Tax:	**$44.57**
County Tax:	**$33.43**
Total:	**$1,192.48**

RECALCULATE

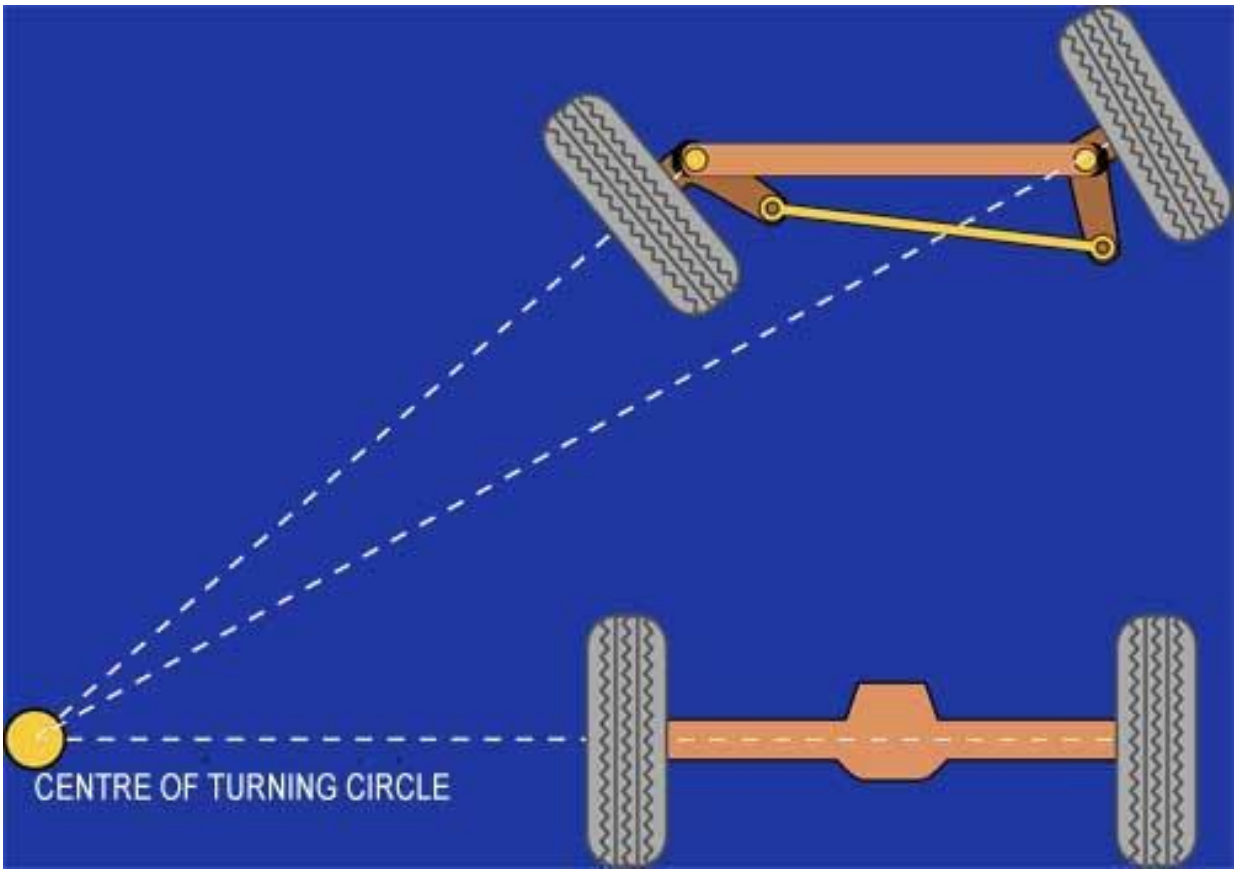
Show gift options during checkout

Coupon code? Enter it here:

APPLY

Appendix W (Ackermann Principle)

Wikipedia: Ackermann steering geometry is a geometric arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radius



Appendix X (Motor Controller Packing Slip)

Description: Confirmation of Alltrax Motor Controller Shipment

ALLTRAX
www.alltraxinc.com

1911 Cheney Creek Rd.
Grants Pass, OR 97527
Voice: (541)476-3565
Fax: (541)476-3566

PACKING SLIP
Sales Order Number
Sales Order Date
Ship By
Page:

Sold To:
Cloud Electric, LLC
204 Allison Street
Suite A
Clarksville, GA 30523

Ship To:
Cambridge High School
Aaron Archambeau
2845 Bethany Bend
Milton, GA 30004

Customer ID	PO Number	Sales Rep Name
CLOE0001	5464	Deborah K. Bagwell
Customer Contact	**Shipping Method**	**Payment Terms**
Steve Cloud	UPS Ground	Net 30 Days

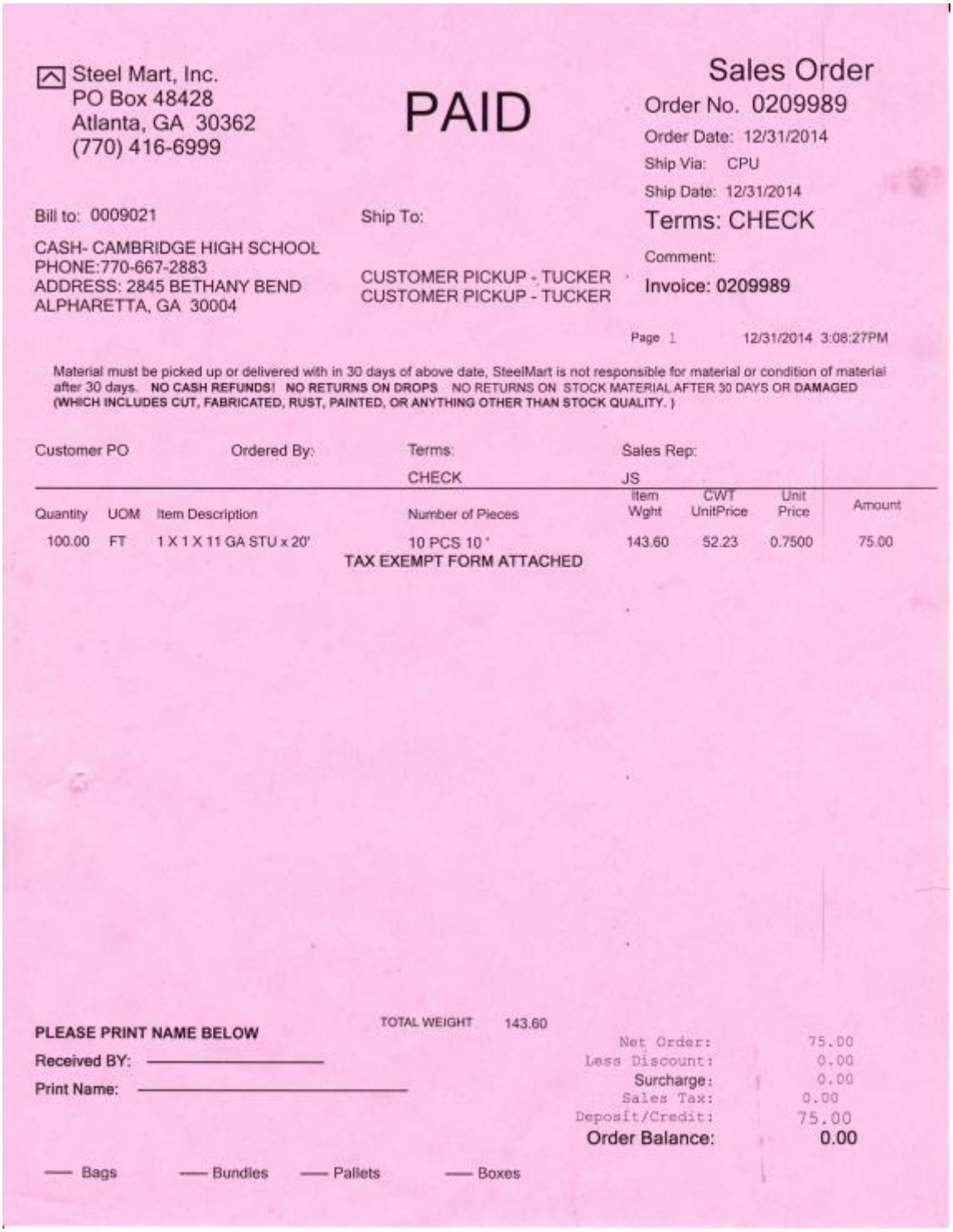
Quantity	Item	Description	Qty Shipped	Qty B/O
1.00	AXE 4834	24-48 Vdc, 300 Amps, 04 Size, Series Motor Controller.	1	Ø
	CONFIG 0-5K	Programmed for Generic 0-5k Throttle		

S/N 1.) 1536048

E/M T# 11/18

Appendix Y (Steel Sales Order)

Description: Square steel tubing receipt



Steel Mart, Inc.
PO Box 48428
Atlanta, GA 30362
(770) 416-6999

PAID

Sales Order
Order No. 0209989
Order Date: 12/31/2014
Ship Via: CPU
Ship Date: 12/31/2014
Terms: CHECK
Comment:
Invoice: 0209989

Bill to: 0009021

CASH- CAMBRIDGE HIGH SCHOOL
PHONE:770-667-2883
ADDRESS: 2845 BETHANY BEND
ALPHARETTA, GA 30004

Ship To:

CUSTOMER PICKUP - TUCKER
CUSTOMER PICKUP - TUCKER

Page 1 12/31/2014 3:08:27PM

Material must be picked up or delivered with in 30 days of above date, SteelMart is not responsible for material or condition of material after 30 days. **NO CASH REFUNDS! NO RETURNS ON DROPS** NO RETURNS ON STOCK MATERIAL AFTER 30 DAYS OR **DAMAGED (WHICH INCLUDES CUT, FABRICATED, RUST, PAINTED, OR ANYTHING OTHER THAN STOCK QUALITY.)**

Customer PO	Ordered By:	Terms:	Sales Rep:
		CHECK	JS

Quantity	UOM	Item Description	Number of Pieces	Item Wght	CWT UnitPrice	Unit Price	Amount
100.00	FT	1 X 1 X 11 GA STU x 20'	10 PCS 10 '	143.60	52.23	0.7500	75.00

TAX EXEMPT FORM ATTACHED

TOTAL WEIGHT 143.60

PLEASE PRINT NAME BELOW

Received BY: _____

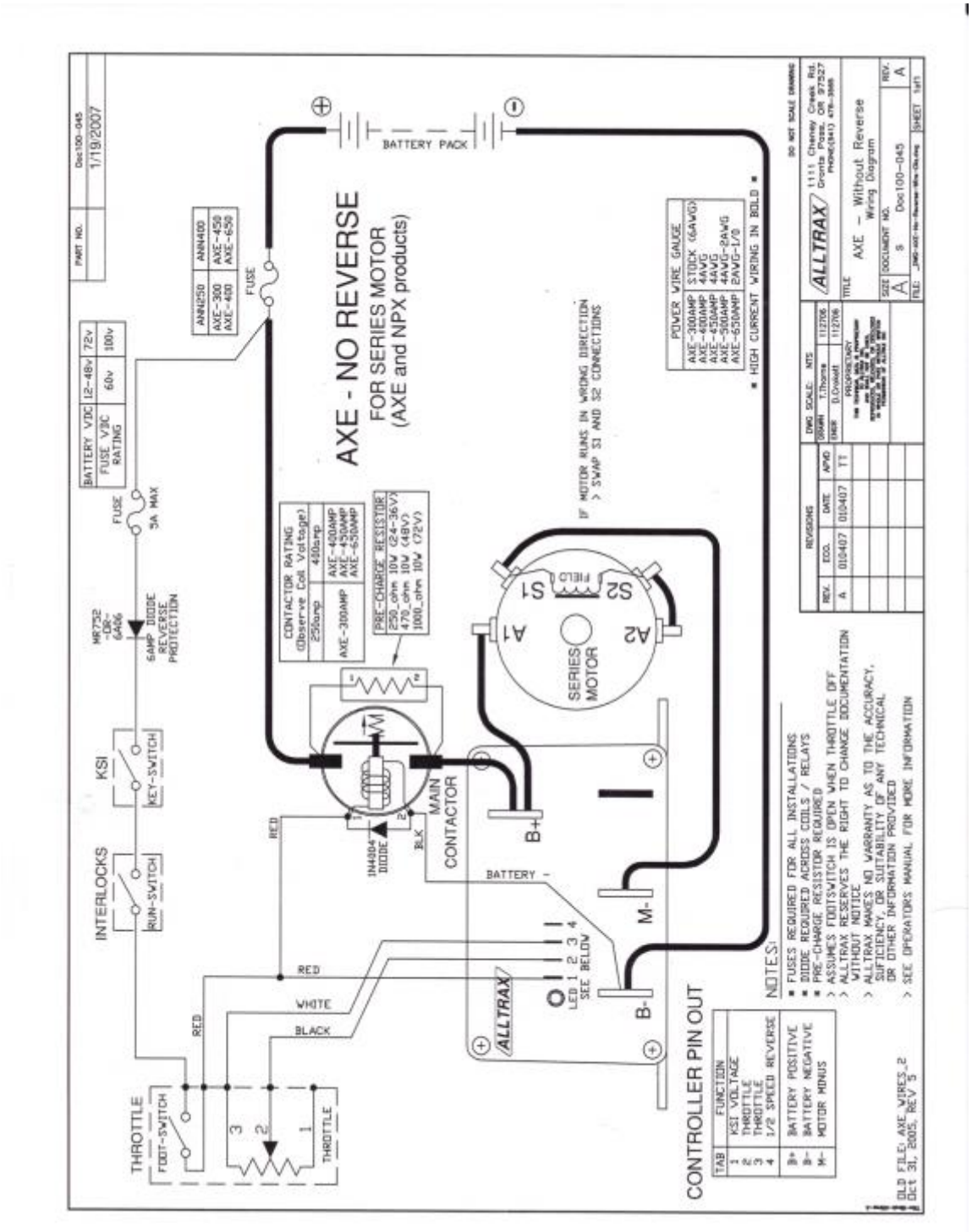
Print Name: _____

Net Order:	75.00
Less Discount:	0.00
Surcharge:	0.00
Sales Tax:	0.00
Deposit/Credit:	75.00
Order Balance:	**0.00**

— Bags — Bundles — Pallets — Boxes

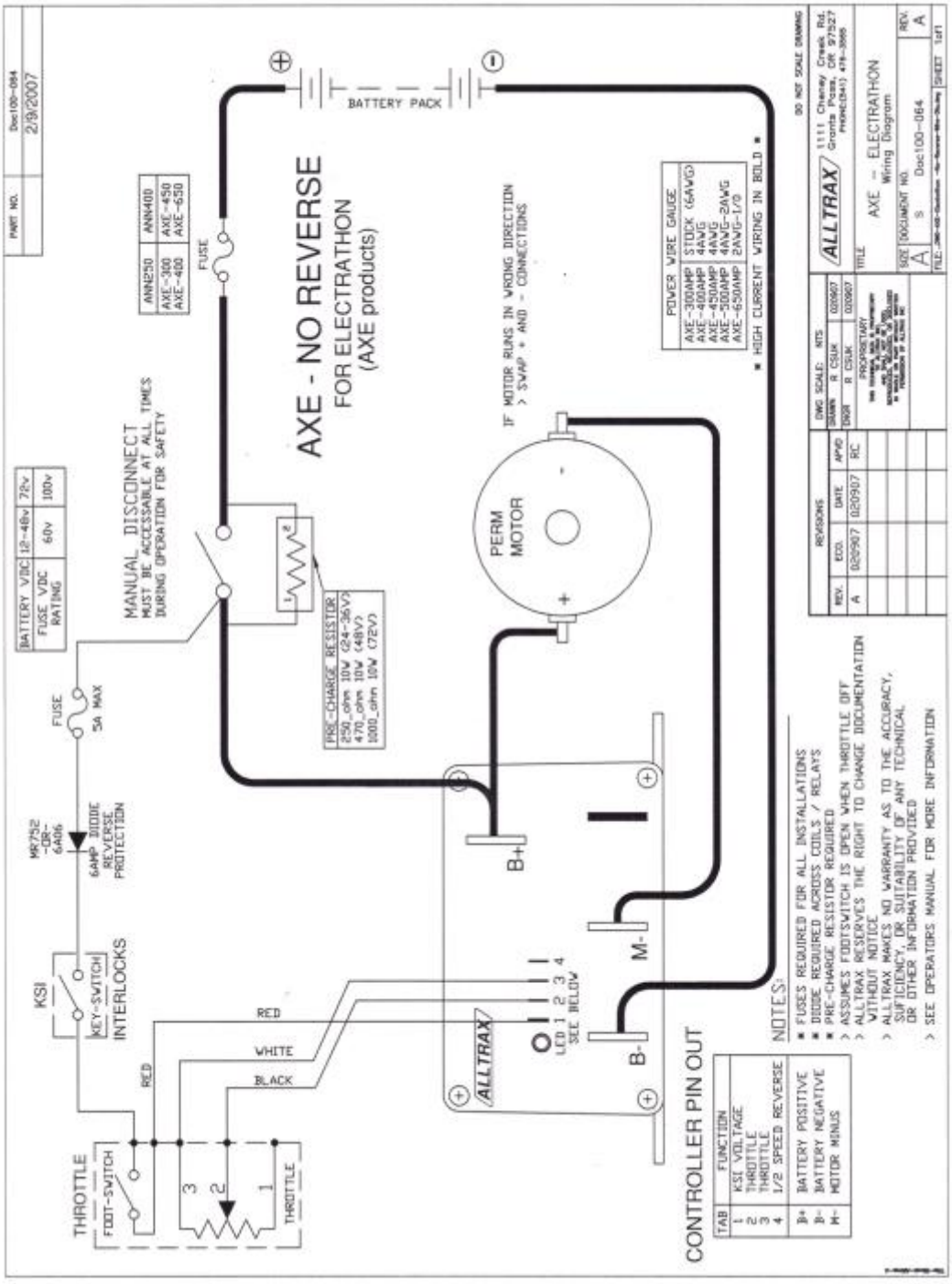
Appendix Z (No Reverse Schematic)

Description: AXE variant of Alltrax motor controller general non-reverse schematic



Appendix AA (E.V. Schematic)

Description: Electrathon Vehicle recommended schematic using Alltrax Motor Controller



Appendix AB (Mini-Manual)

Description: AXE variant of Alltrax motor controller quick information and warranty guide

ALLTRAX
www.alltraxinc.com
An Engineered Solution

AXE
Mini-Manual
For Golf Car Applications

- *Programmable*
- *300, 400, 500, & 650 Amp*
- *12 to 72 Volt DC*
- *Plug Brake Option*
- *For Series Wound Motors*

www.alltraxinc.com

LIMITED WARRANTY

Alltrax, Inc., (hereafter Alltrax) warrants that the product purchased is free from defects in materials or workmanship for a period of **2 years** from the date of manufacture. This warranty does not apply to defects due directly or indirectly to misuse, abuse, negligence, accidents, repairs, improper installation, submersion, alterations or use contrary to any instructions provided by Alltrax in verbal or written form.

In the event you should need warranty repair, contact Alltrax at (541) 476-3565 to receive warranty service authorization instructions for returning the defective product to Alltrax for evaluation. Products or parts shipped by customer to Alltrax must be sent postage paid and packaged appropriately for safe shipment. Alltrax is not responsible for customer products received without warranty service authorization and may be rejected.

Alltrax reserves the right to repair or replace merchandise at its option at no cost to the customer, except for shipping costs of sending the defect item to Alltrax. Replacement shall mean furnishing the customer with a new equivalent product to the defective item. Alltrax also reserves the right to make changes to any of its products or specifications without notice.

Alltrax assumes no liability for applications assistance or customer product design. Customers shall be responsible for evaluating the appropriateness of the use of any Alltrax product in any application. Customers shall provide adequate design and operating safeguards that are in compliance with standard practices of other similar applications or any standards of any governing agency.

THIS IS ALLTRAX INC.'S SOLE WARRANTY.

NO REPRESENTATIVE EMPLOYEE, DISTRIBUTOR OR DEALER OF ALLTRAX HAS THE AUTHORITY TO MAKE OR IMPLY ANY WARRANTY, REPRESENTATION, PROMISE OR AGREEMENT, WHICH IN ANY WAY VARIES THE TERMS OF THIS LIMITED WARRANTY.

ALLTRAX PRODUCTS SOLD TO CUSTOMER ARE INTENDED TO BE USED ONLY IN THE APPLICATION SPECIFIED BY THE CUSTOMER TO ALLTRAX. ANY OTHER USE RENDERS THE LIMITED WARRANTY EXPRESSED HEREIN AND ALL IMPLIED WARRANTIES NULL AND VOID AND SAME ARE HEREBY EXCLUDED.

DISCLAIMER OF IMPLIED WARRANTIES

ALLTRAX, INC., SHALL IN NO EVENT BE LIABLE FOR DEATH, INJURIES TO PERSONS OR PROPERTY, OR FOR INCIDENTAL, CONTINGENT, OR CONSEQUENTIAL DAMAGES ARISING FROM THE USE OR MISUSE OF OUR PRODUCTS.

EXCEPT SPECIFICALLY PROVIDED HEREIN, THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. HOWEVER, SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE PRECEDING EXCLUSION MAY NOT APPLY TO YOU.

Alltrax, Inc.
1111 Cheney Creek Rd
Grants Pass, OR. 97527
Phone: 541-476-3565
Fax: 541-476-3566

Doc100-004-B_OP-AXE-Mini-Man.pub, 12-1-2010

LED Status Indicator

LED Blink Codes:

At power up, # of green blinks indicates configured throttle type:

1 Green = 0-5k-ohm
2 Green = 5k-0-ohm
3 Green = 0-5 Volt
4 Green = EZ-GO inductive (ITS)
5 Green = Yamaha 0-1K
6 Green = Taylor-Dunn 6-10.5V
7 Green = CLUBCAR 5K-3-wire

Normal display status:

Solid Green: Controller ready to run

Solid Red: Controller in programming mode
Solid Yellow: Controller throttle is wide open, controller is supplying max output, and is not in current limit.

Trouble Shooting

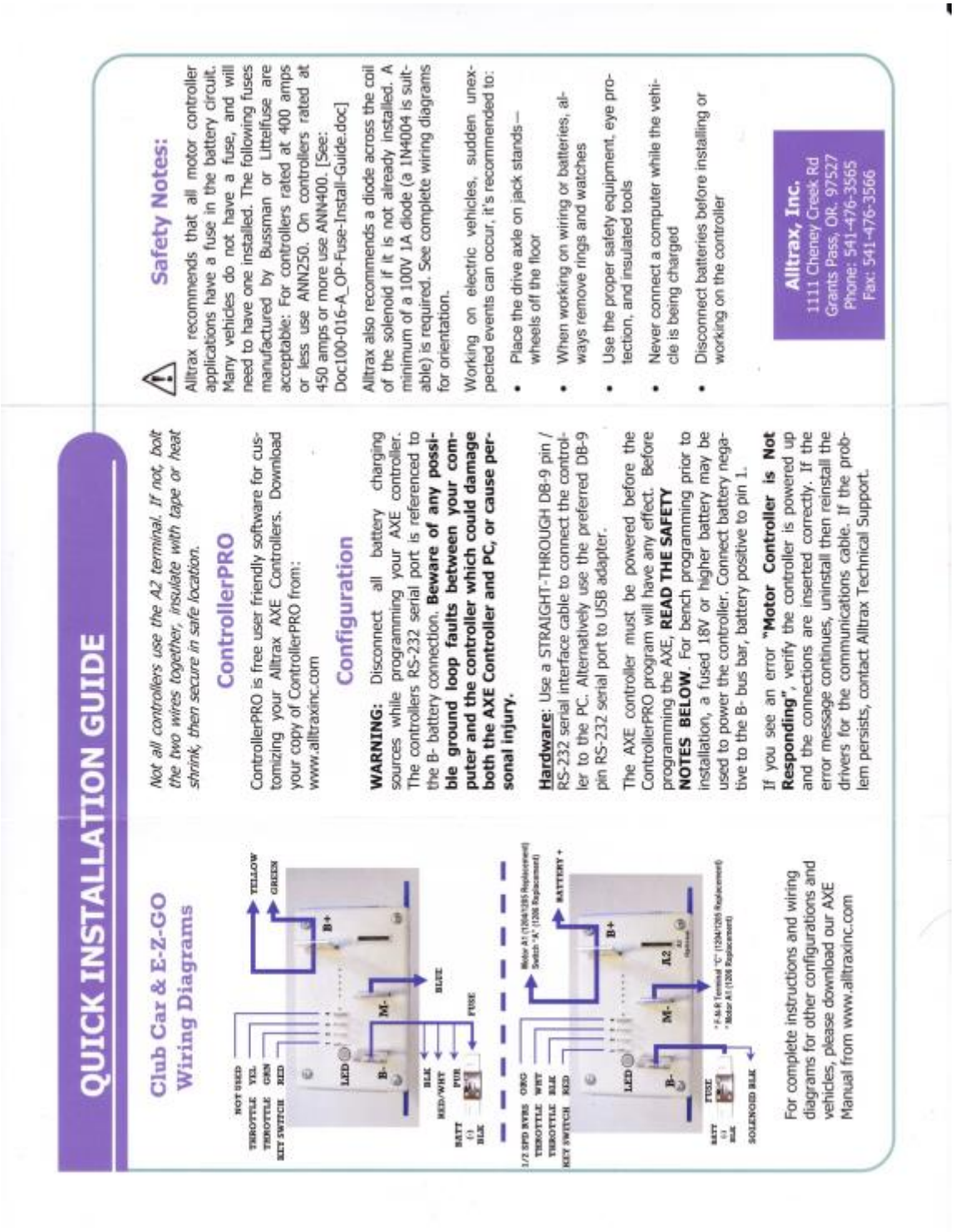
Error code display:# of RED blinks indicates any error conditions that might exist:

1 Red_ = Throttle Position Sensor Over Range. Check for open wires.
2 Red_ = Under Temperature. Controller below -25C
3 Red_ = HPD. Throttle hasn't gone to zero during this power on cycle.
4 Red_ = Over Temperature. Controller over 95C
5 Red_ = unused
6 Red_ = Battery Under Voltage detected. Battery V < under voltage slider
7 Red_ = Battery Over Voltage detected. Battery V > over-voltage slider

AXE

Appendix AC (Installation Guide)

Description: AXE variant of Alltrax motor controller quick installation guide



QUICK INSTALLATION GUIDE

Club Car & E-Z-GO Wiring Diagrams

For complete instructions and wiring diagrams for other configurations and vehicles, please download our AXE Manual from www.alltraxinc.com

Not all controllers use the A2 terminal. If not, bolt the two wires together, insulate with tape or heat shrink, then secure in safe location.

ControllerPRO

ControllerPRO is free user friendly software for customizing your Alltrax AXE Controllers. Download your copy of ControllerPRO from: www.alltraxinc.com

Configuration

WARNING: Disconnect all battery charging sources while programming your AXE controller. The controllers RS-232 serial port is referenced to the B- battery connection. **Beware of any possible ground loop faults between your computer and the controller which could damage both the AXE Controller and PC, or cause personal injury.**

Hardware: Use a STRAIGHT-THROUGH DB-9 pin / RS-232 serial interface cable to connect the controller to the PC. Alternatively use the preferred DB-9 pin RS-232 serial port to USB adapter.

The AXE controller must be powered before the ControllerPRO program will have any effect. Before programming the AXE, **READ THE SAFETY NOTES BELOW.** For bench programming prior to installation, a fused 18V or higher battery may be used to power the controller. Connect battery negative to the B- bus bar, battery positive to pin 1.

If you see an error **"Motor Controller is Not Responding"**, verify the controller is powered up and the connections are inserted correctly. If the error message continues, uninstall then reinstall the drivers for the communications cable. If the problem persists, contact Alltrax Technical Support.

Safety Notes:

Alltrax recommends that all motor controller applications have a fuse in the battery circuit. Many vehicles do not have a fuse, and will need to have one installed. The following fuses manufactured by Bussman or Littelfuse are acceptable: For controllers rated at 400 amps or less use ANN250. On controllers rated at 450 amps or more use ANN400. [See: Doc100-016-A_OP-Fuse-Install-Guide.doc]

Alltrax also recommends a diode across the coil of the solenoid if it is not already installed. A minimum of a 100V 1A diode (a 1N4004 is suitable) is required. See complete wiring diagrams for orientation.

Working on electric vehicles, sudden unexpected events can occur, it's recommended to:

- Place the drive axle on jack stands—wheels off the floor
- When working on wiring or batteries, always remove rings and watches
- Use the proper safety equipment, eye protection, and insulated tools
- Never connect a computer while the vehicle is being charged
- Disconnect batteries before installing or working on the controller

Alltrax, Inc.
1111 Cheney Creek Rd
Grants Pass, OR. 97527
Phone: 541-476-3565
Fax: 541-476-3566

Appendix AD (Fuse Installation)

Description: Alltrax battery fuse installation guide

ALLTRAX
www.alltraxinc.com

Installation Guide: Battery Fuse

Damon Crockett
Dir Engineering
ALLTRAX Inc.

June 01, 2006

FUSE INSTALLATION GUIDE

Alltrax recommends that all motor controller applications have a fuse in the battery circuit. Many vehicles do not have a fuse. Follow these guidelines to determine a suitable location. The fuse may be installed anywhere in the battery string or at either [+] or [-] end of the battery pack where it connects to the controller or solenoid.

Controller Rated Current:	Recommended Fuse:
400 amps or less	ANN250 Bussman or Littlefuse
450 amps or more	ANN400 Bussman or Littlefuse

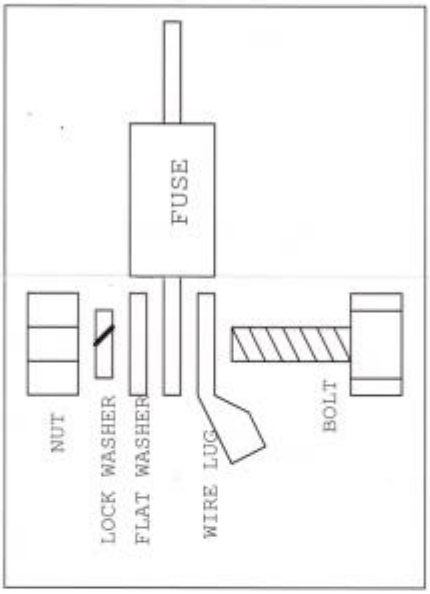
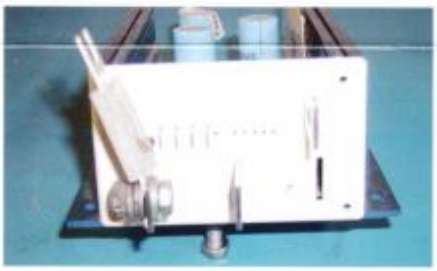


Diagram: Fuse terminal hardware

Example 1: On Battery



Example 2: On Controller B- bar

For Technical Assistance, please call 541-476-3565

ALLTRAX, Inc., 1111 Cheney Creek Rd. Grants Pass, OR 97527 541-476-3565

P/N: Doc100-016-A_OP-Fuse-Install-Guide

Appendix AE (Pot Box Schematic)

Description: Simple schematic for setting up light circuit using 5 volt potentiometer integrated within pedal