FLORIDA INSTITUTE OF TECHNOLOGY
COLLEGE OF ENGINEERING

Design Presentation

Project: 2007 R.E.V. Team

Presented By:

Elizabeth Diaz Jason Miner Jared Doescher Josh Wales

Kathy Murray AJ Nick Dave Wickers Oliver Zimmerman

Project Scope:

- Design and Build an electric racing vehicle
  - Promote community awareness of electric vehicles
  - Electric Car designed to compete in SCCA Autocross and Formula Hybrid competition
  - Will meet requirements for the 2007 Formula Hybrid competition and NEDRA race competition

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Formula Hybrid Competition:

- Competition to design and build a Formula SAE hybrid vehicle
  - Competing as “Hybrid-in-Progress” vehicle for one year only
  - Electric Car designed to compete in Autocross, Acceleration and Endurance races

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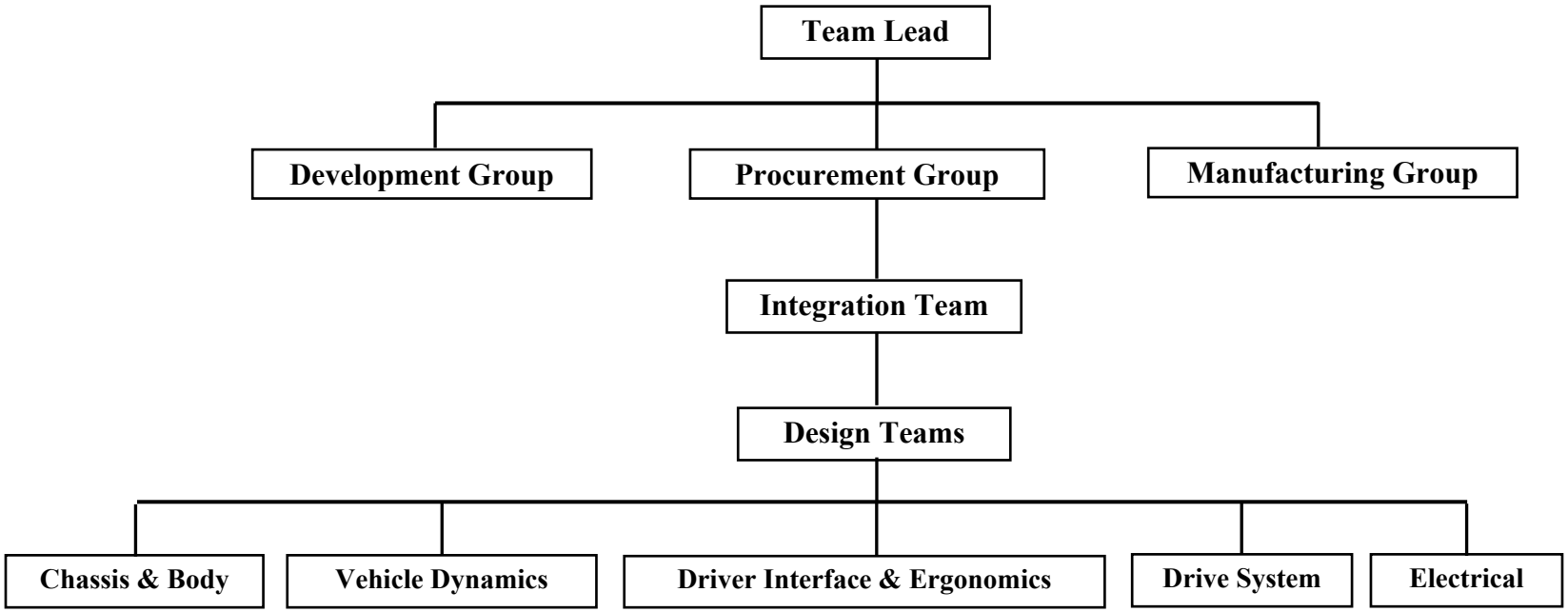
Team Organization:



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Team Organization: REV Design Teams

Team Lead:

Elizabeth Diaz

Design Teams

Drive System Team:

Josh Wales
AJ Nick
Kathy Murray

Vehicle Dynamics Team:

Jason Miner
AJ Nick
Elizabeth Diaz

Chassis & Body Team:

Jason Miner
Dave Wickers
Elizabeth Diaz
Jared Doescher
Kathy Murray

Electrical Team:

Matt Reedy
Kristi Harrell
Valerie Bastien
Audrey Moyers

Driver Interface Team:

Oliver Zimmerman
Elizabeth Diaz
Audrey Moyers

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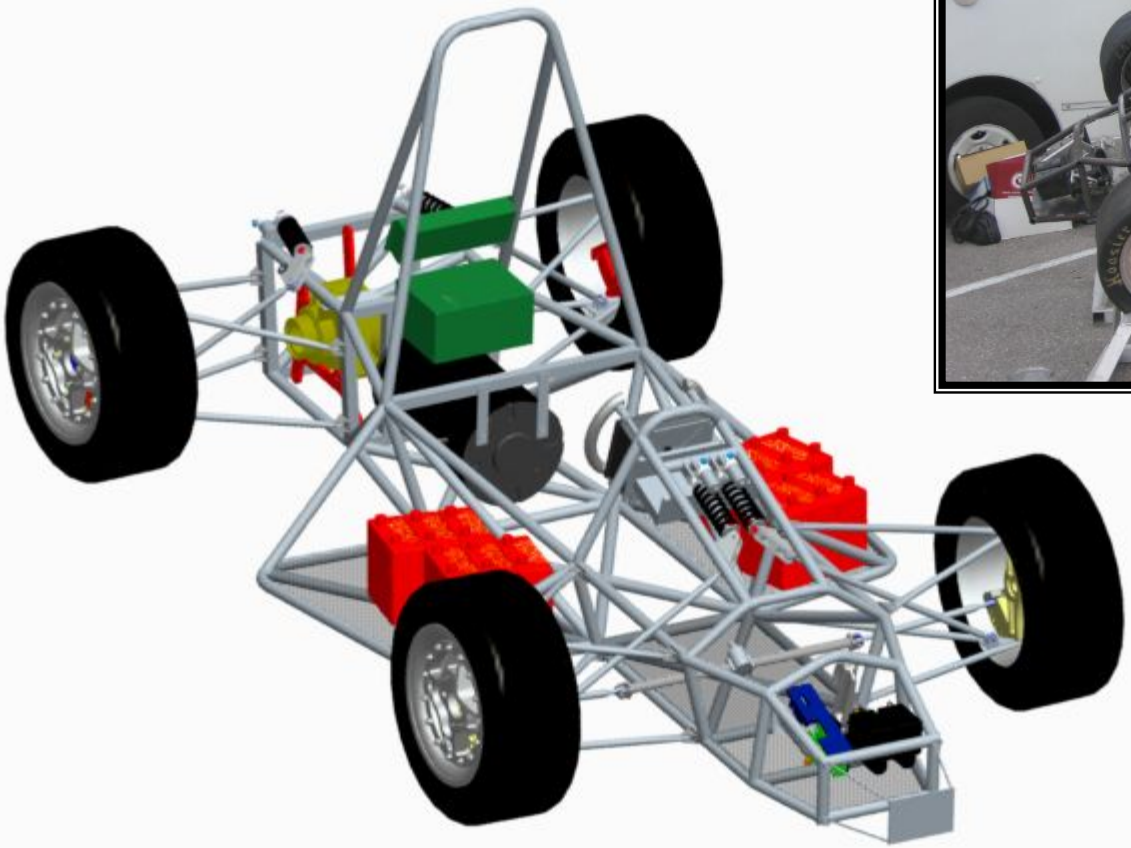
Engineering Objectives:

- Acceleration from 0 to 60 mph in under 5 seconds
- Top speed of 80 mph
- Maximum power available between 20 and 40 mph
- Lightweight (under 650lb with driver)
- 15 minute battery life for continuous draw

Florida Tech REV



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Design Changes: Electrical

- Lead Acid Batteries 174lbs, 10 usable Ah
  12 cells, cost approx. $1000
- Lithium Ion Batteries 90lbs, 28 usable Ah
  550 cells, cost approx $6000 + BMS

Odyssey Battery,
Model PC680

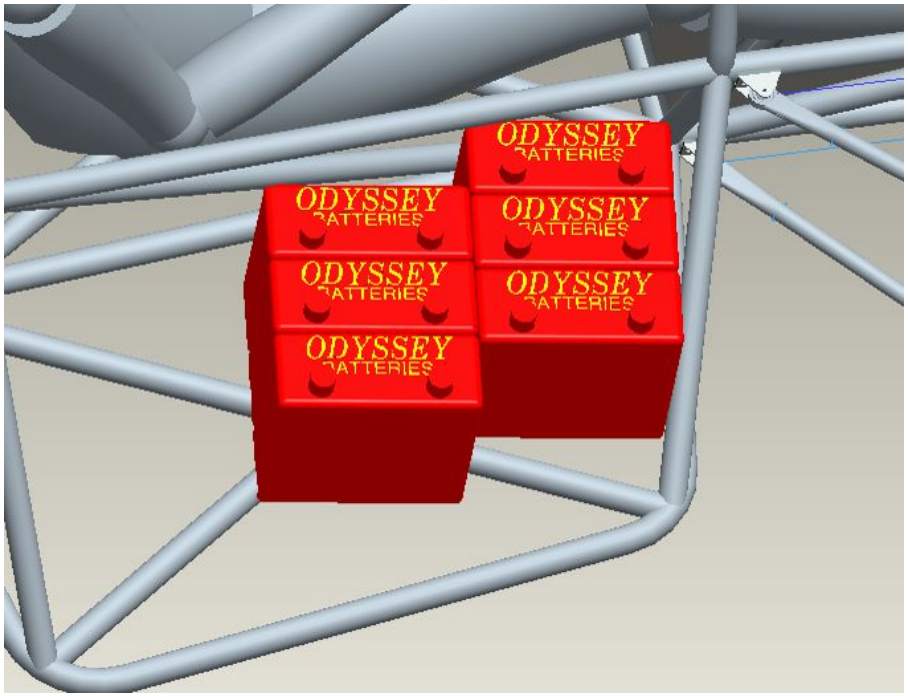
Design: Electrical Integration

- Warp 9” motor, 70hp, 127ftlbs
- 12 Odyssey PC680s, 14.5lbs ea.
- 550amps, 144volts from Zilla 1K-HV
- 2 min run time, 4.2s 0-60,
- Top Speed 85mph @ 6000 rpm
- Pic to PLC to LCD

Design Changes: Side Pod

- Using Odyssey Lead-acid batteries, PC680

- Diagonal Support tube thickness increased to .095”

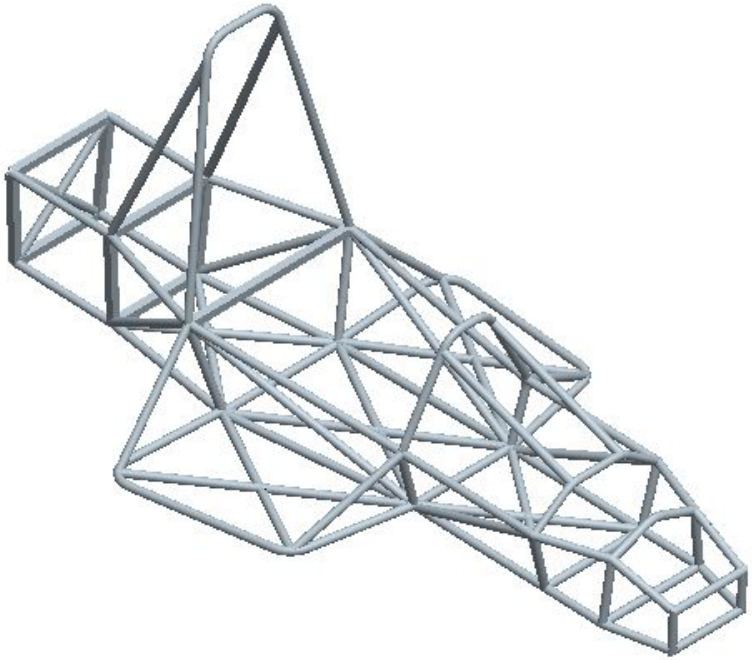


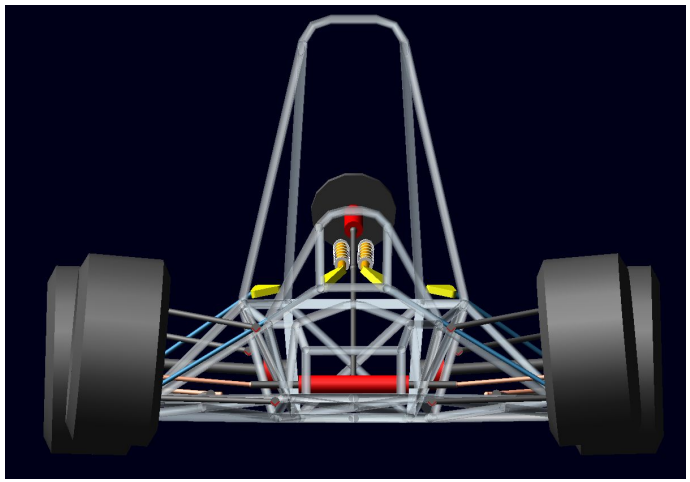
- Battery Layout
  - Strapped together then strapped to supports
  - Plexiglas to cover connections

Design Changes: Chassis

Revised Engineering Specifications

- Static deflection – 0.009in
- Torsional Rigidity – no change





- Dynamic Loading - insignificant change

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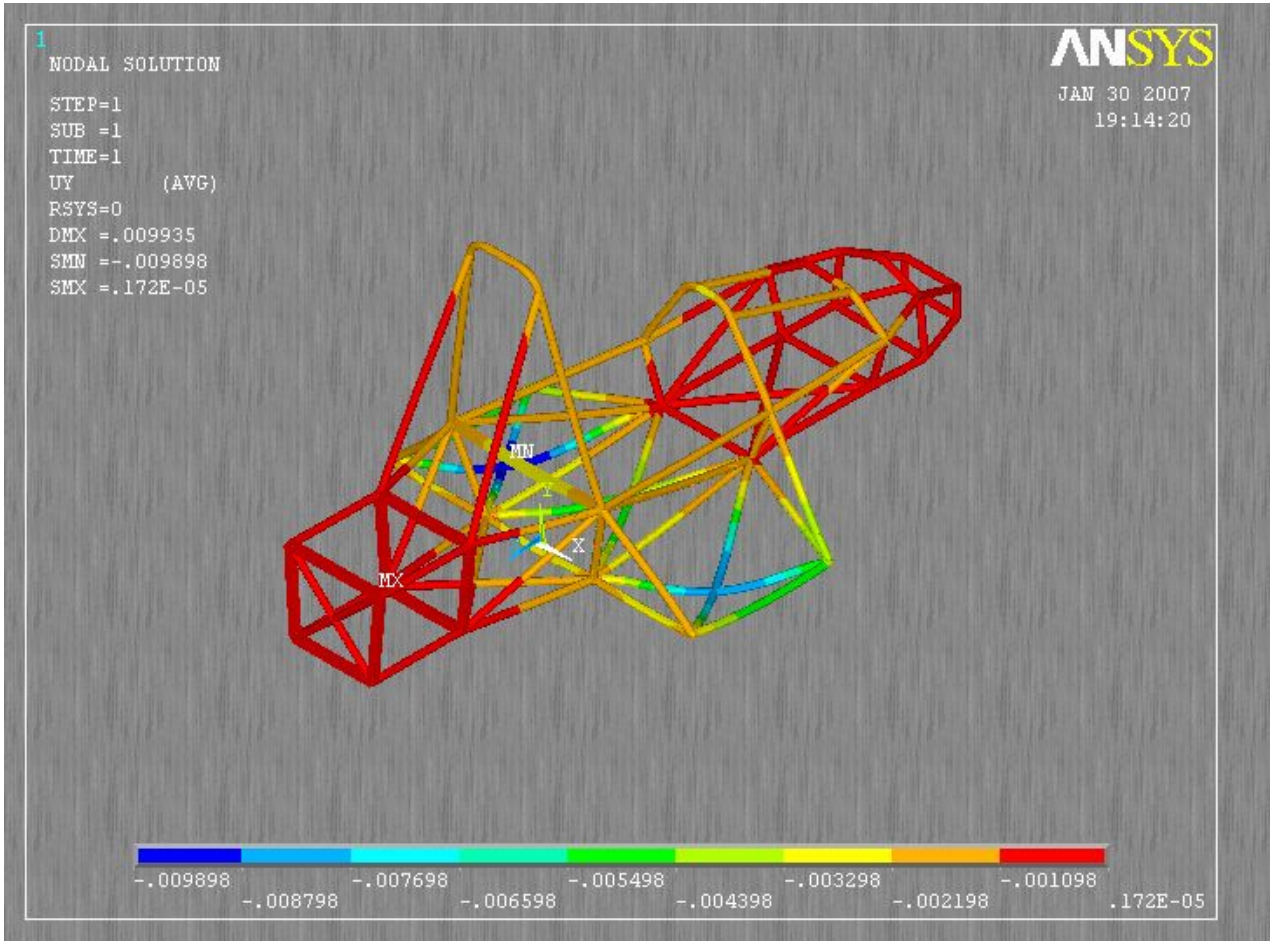
Analysis Changes: Chassis

Deflection Analysis



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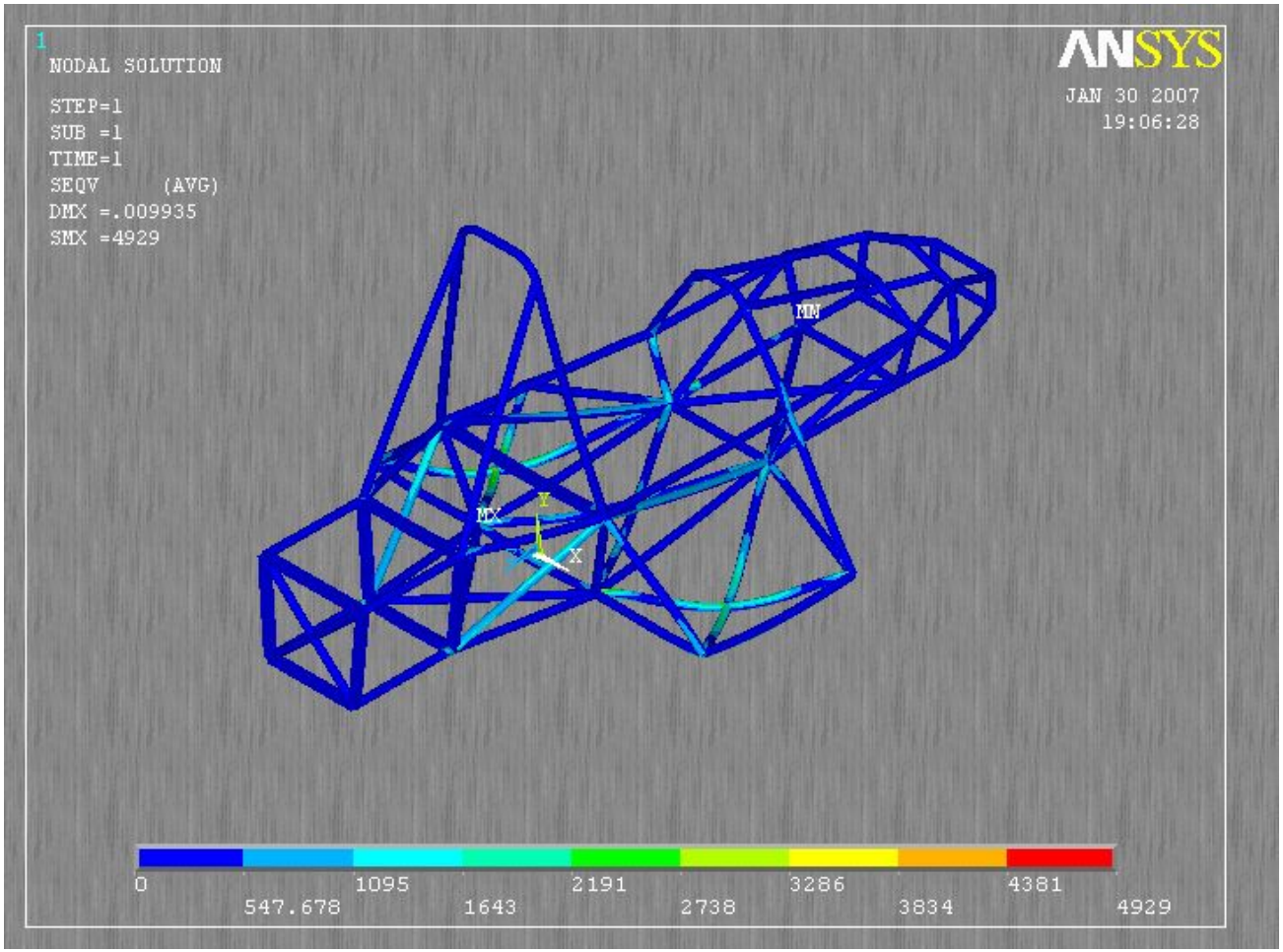
Analysis Changes: Chassis

Static Stress Analysis



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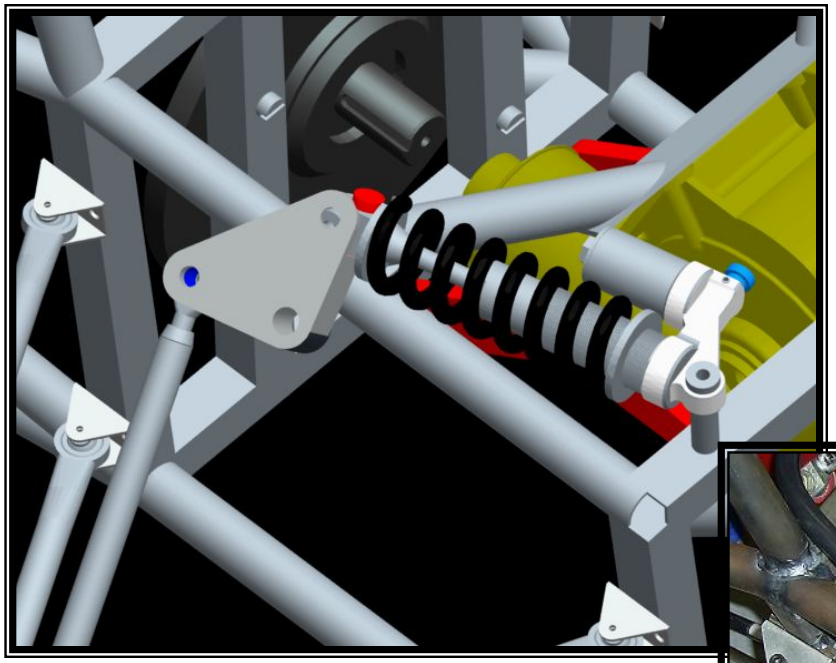
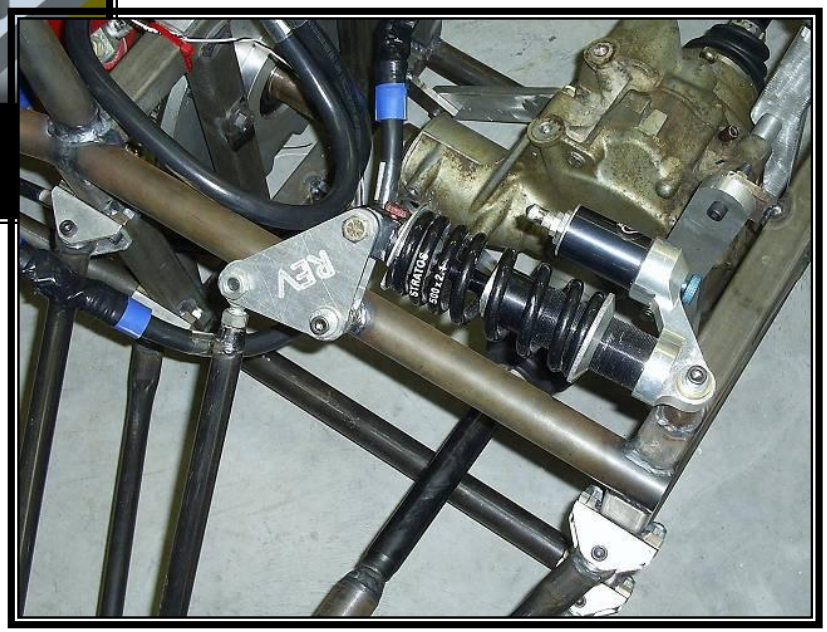
Design: Rear Suspension

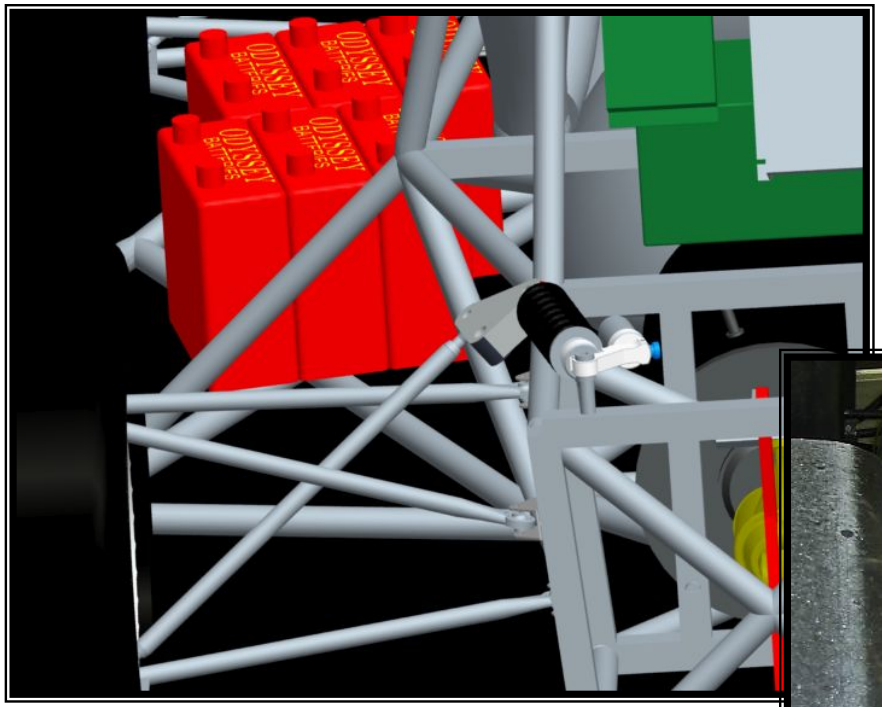


COILOVER ACTUATION DESIGN



COILOVER ACTUATION BUILD

Design: Rear Suspension



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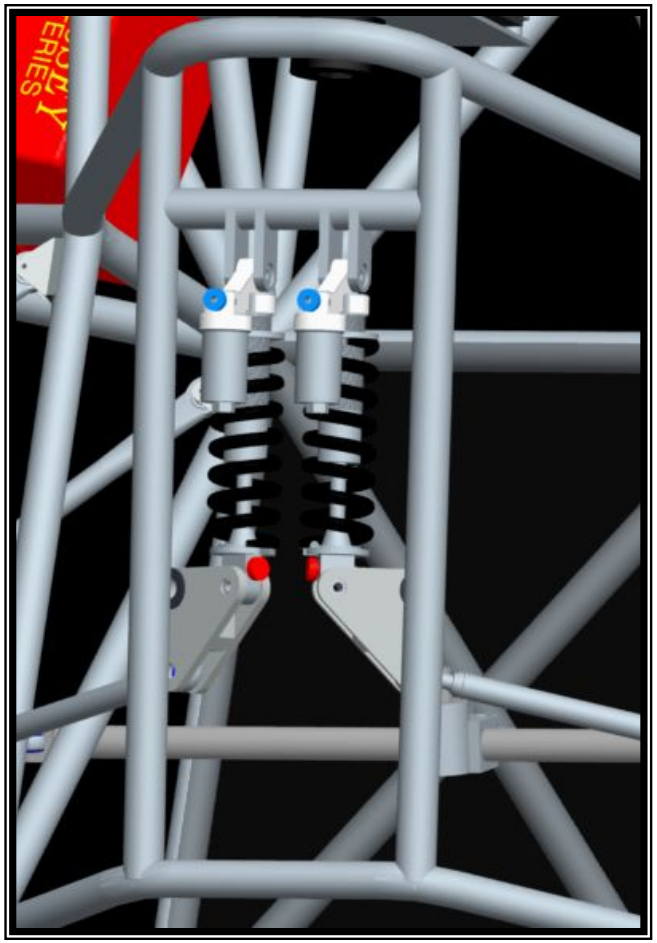
Design: Front Suspension



BELLCRANK POSITION CHANGE FOR CLEARANCE ISSUES

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Design: Suspension Spring Rates

FRONT

WF	UWF	UGF	TF	SWF	UtF	CF	CtF	SGF	SF	ArF	DrF	WtF
300	50	11	50	250	11	1.23	6.15	13	150	13083.33	0.481881	89.47294
300	50	11	50	250	11	1.23	6.15	13	200	17444.44	0.490966	90.83646
350	50	11	50	300	11	1.23	7.38	13	280	24422.22	0.494965	106.0154

REAR

WR	UWR	UGR	TR	SWR	UtR	CR	CtR	SGR	SR	ArR	DrR	WtR
350	50	11	48	300	11.45833	1.34	8.375	16	175	14067.2	0.518119	97.59496
350	50	11	48	300	11.45833	1.34	8.375	16	225	18086.4	0.509034	96.23145
400	50	11	48	350	11.45833	1.34	9.770833	16	310	24919.04	0.505035	110.6473

TOTAL

SW	WDR	TM	CM	GM	LM	St	Wt
550	0.545455	48.90909	1.29	14.63636	13.34636	150.0846	187.0679
550	0.545455	48.90909	1.29	14.63636	13.34636	150.0846	187.0679
650	0.538462	48.92308	1.289231	14.61538	13.32615	177.0535	216.6626

FRONT SPRING RATE ≈ 280 LB/IN REAR SPRING RATE ≈ 310 LB/IN

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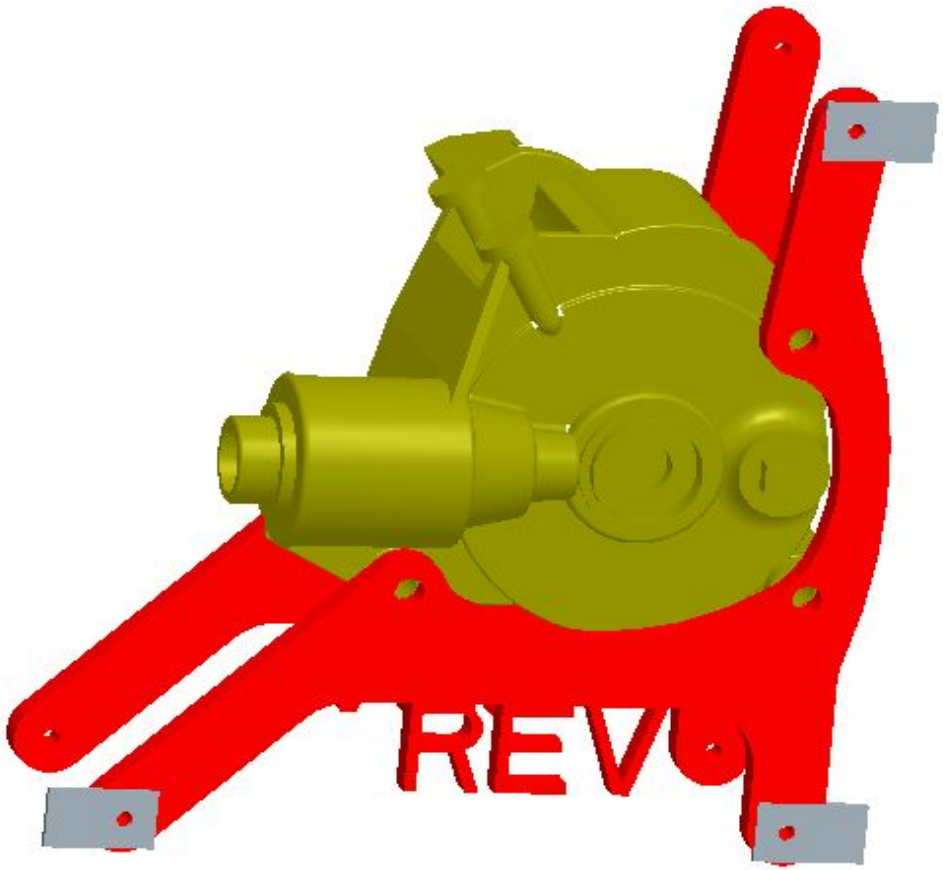
Design: Differential



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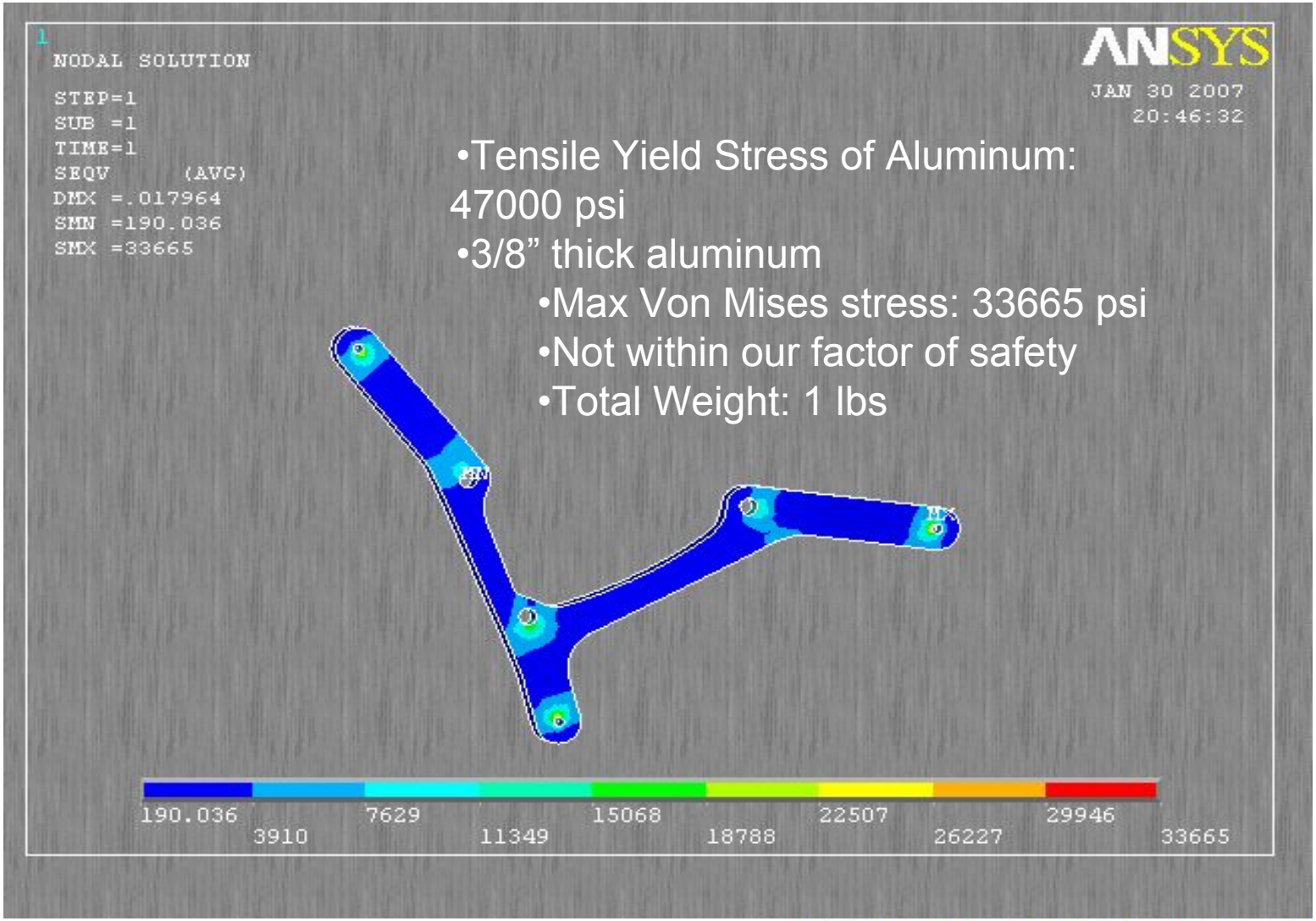
Analysis: Differential Mount



- Tensile Yield Stress of Aluminum: 47000 psi
- 3/8” thick aluminum
  - Max Von Mises stress: 33665 psi
  - Not within our factor of safety
  - Total Weight: 1 lbs

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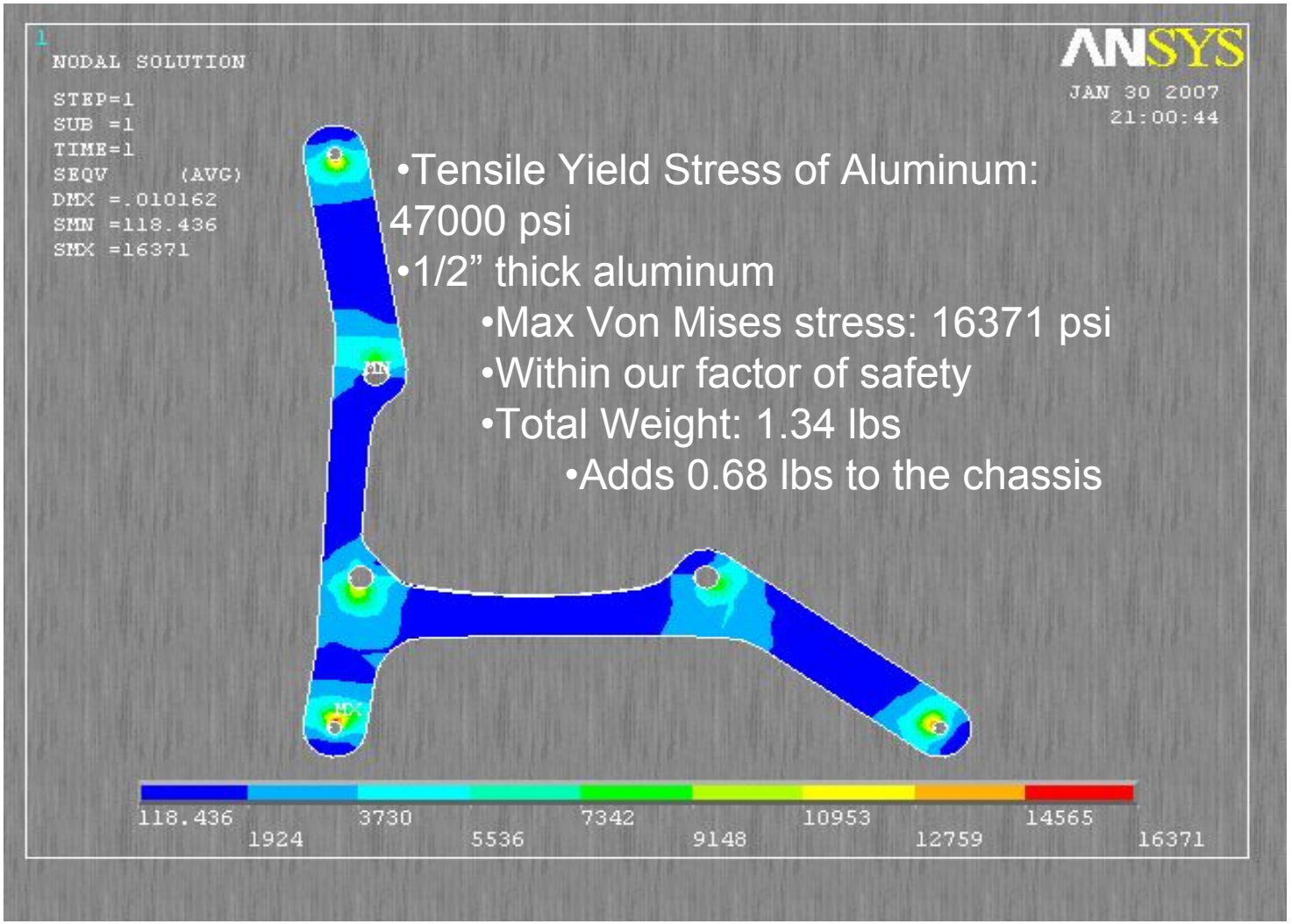
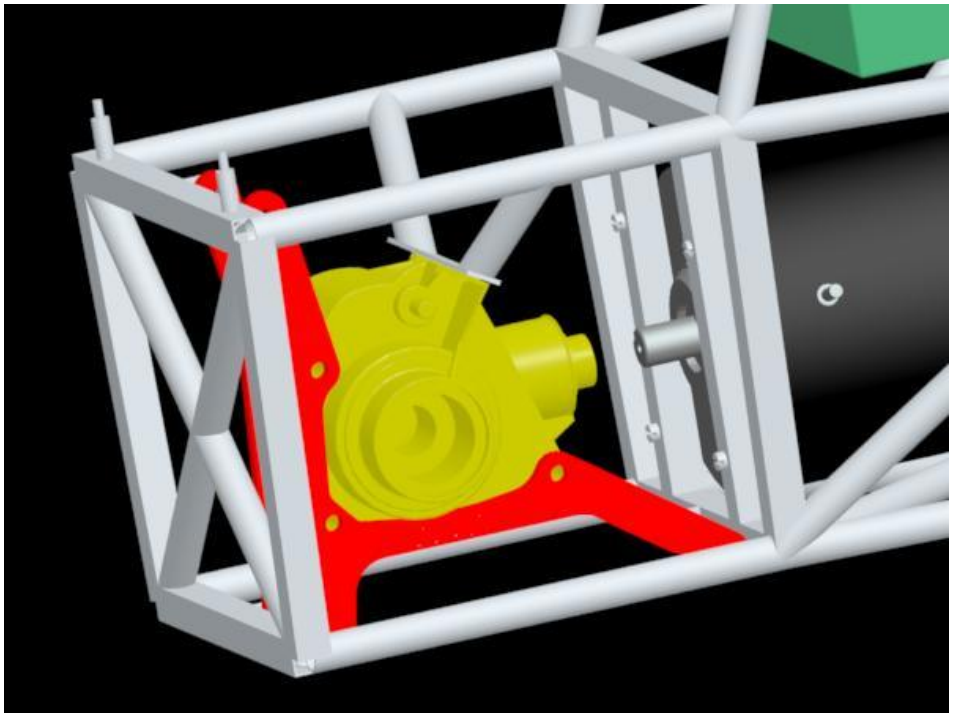
Analysis: Differential Mount



- Tensile Yield Stress of Aluminum: 47000 psi
- 1/2” thick aluminum
  - Max Von Mises stress: 16371 psi
  - Within our factor of safety
  - Total Weight: 1.34 lbs
    - Adds 0.68 lbs to the chassis

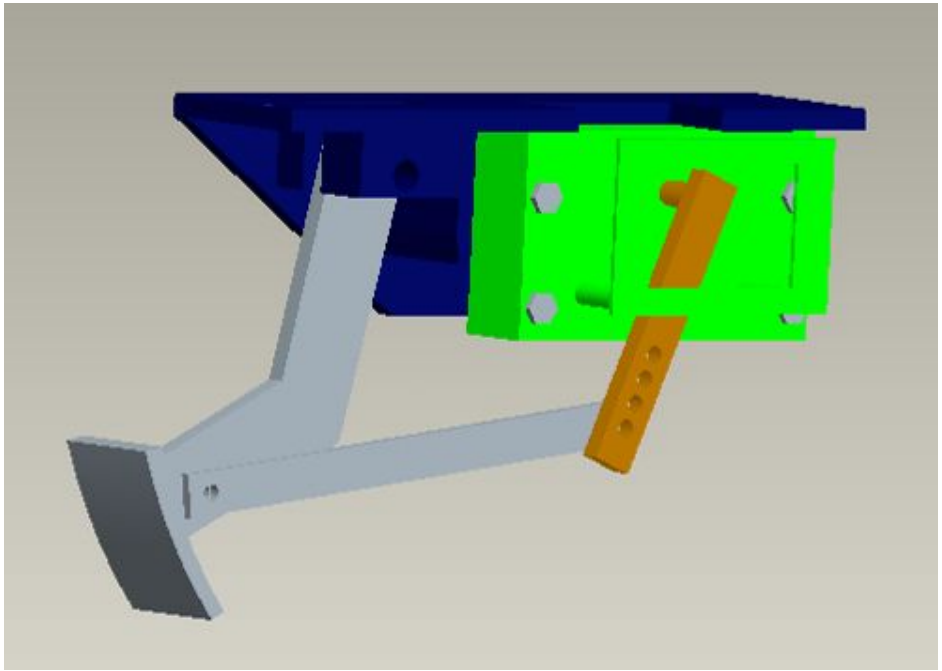
Design Changes: Differential Mount

- Added support to reduce vibrations



Design Changes: Acceleration Pedal

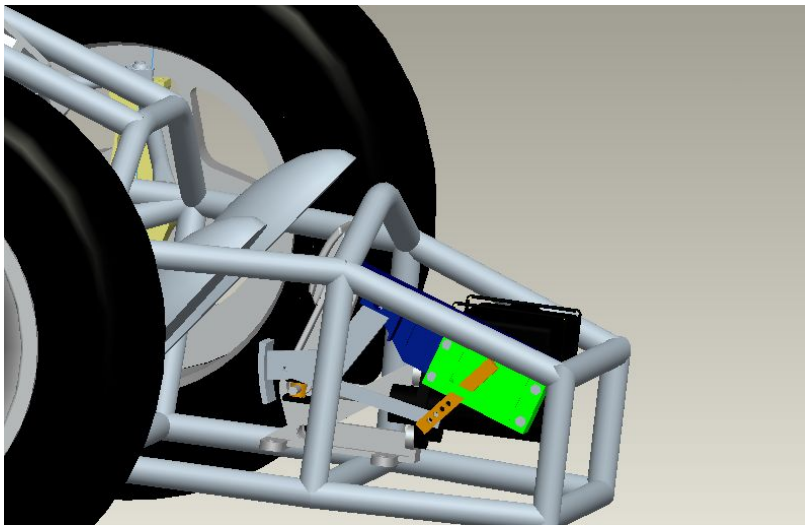
-Parts arrived to finalize design
-Redesign to incorporate ergonomics

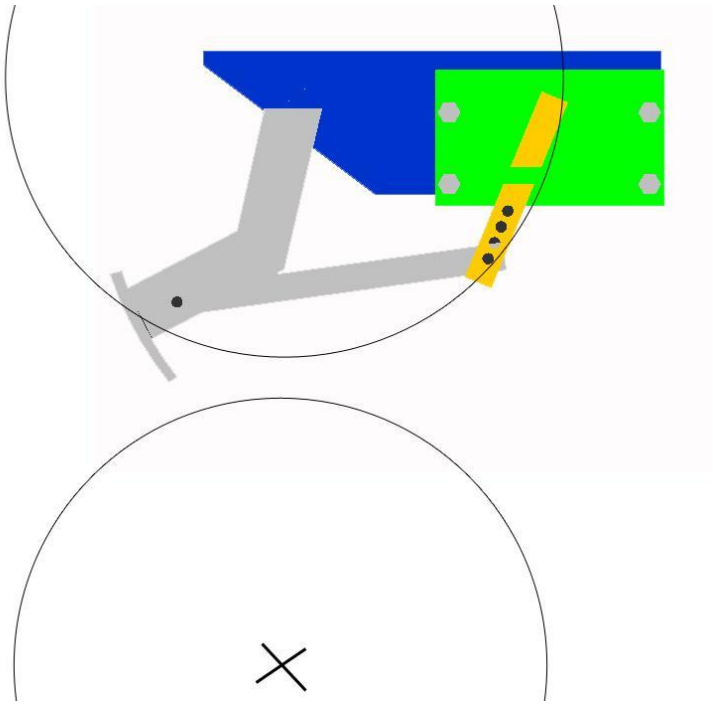


Design Changes: Acceleration Pedal

Ergonomics of Acceleration Pedal

-Foot has a natural downward motion
-Pedal mounted upside down incorporates
natural downward motion



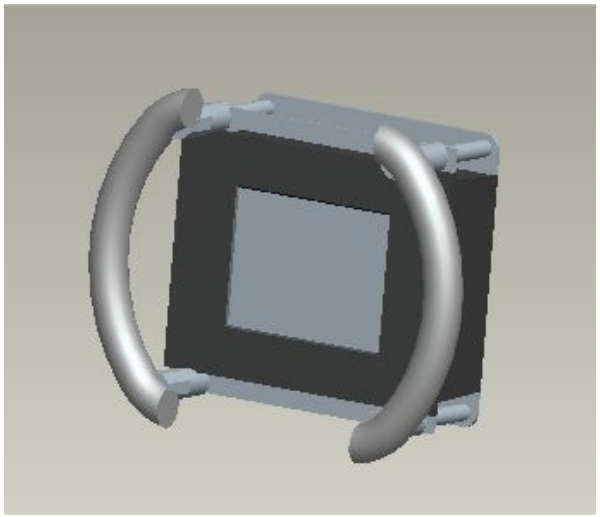


Design Changes: Steering Wheel

- Design Criteria
  - Must be able to hold the touch screen
  - Comply with SAE rules
  - Designed to be as light as possible while remaining rigid enough to protect touch screen
  - Designed for driver's comfort
- Alterations in Design
  - Changed because of the method of mounting provided from manufacturer
  - Will create new wheel to be fully closed loop IAW SAE rules

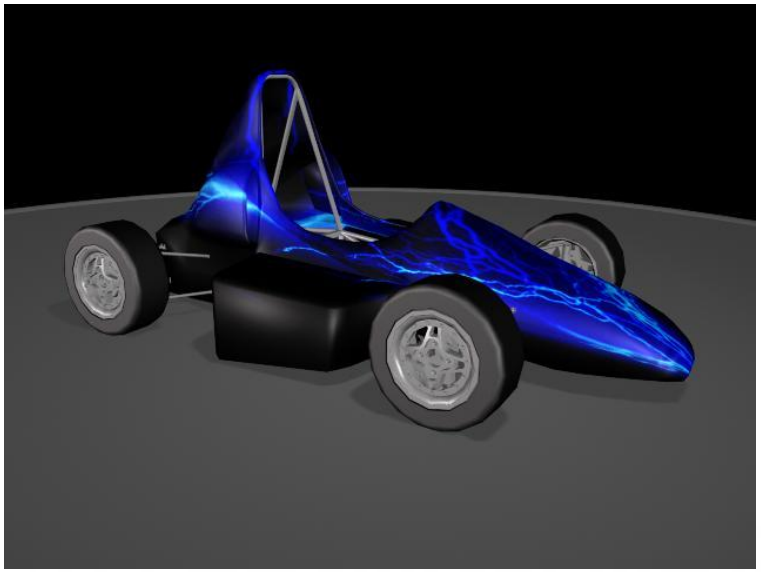
Previous Design

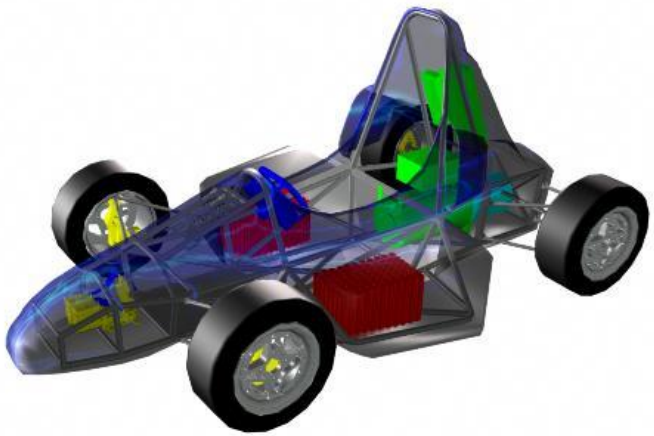
Current Design



Design Changes: Body

- Current Design
  - Fiberglass body
  - Using nose cone from previous Formula SAE car
- Future Changes
  - Aluminum sheeting rather then fiberglass because of time constraints
  - Alterations to the nose cone due to intersections with the suspension





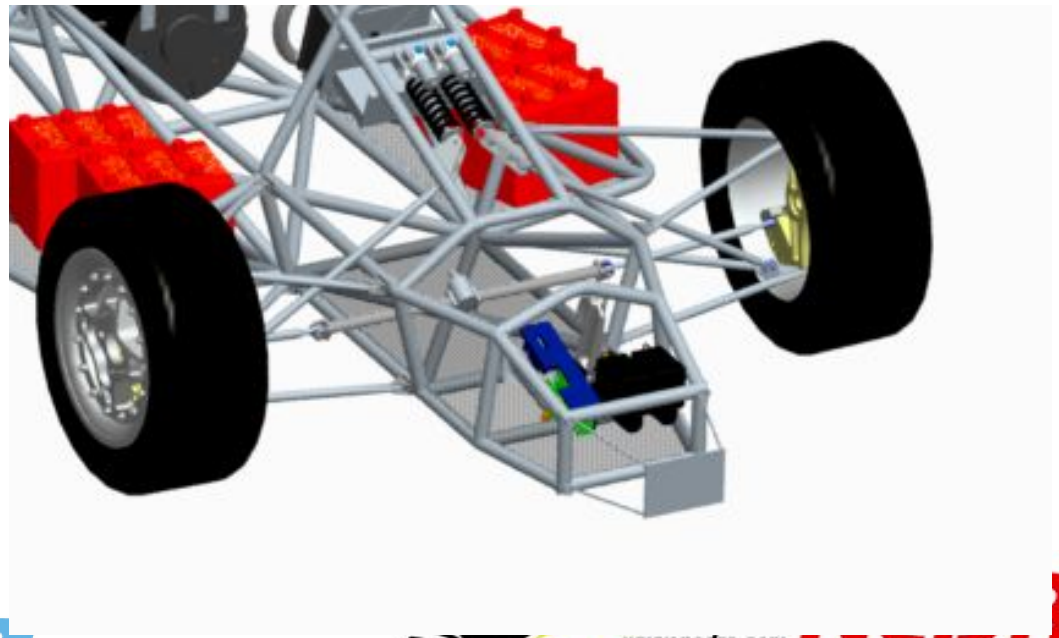
Major Challenges

- Complete the car
  - Suspension
  - Mechanical/Electrical Integration
- Create/Integrate Lithium-Ion pack
  - Resources and connections are in place
- More publicity
  - Autocross racing
  - More EV events
  - Local advertising
- Funding

Suspension: Plans

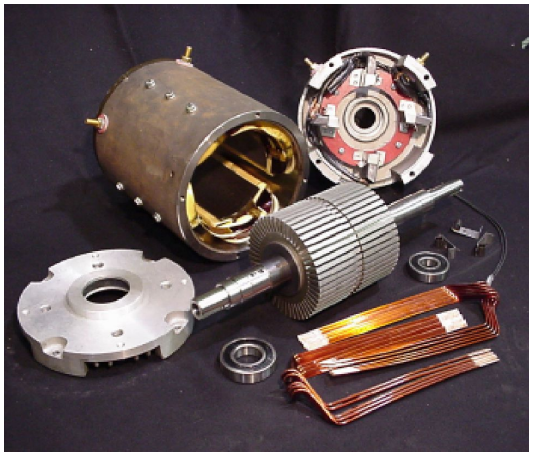
- Set ride heights
- Tune adjustable dampers
- Determine new spring rates if need be

- Anti-roll bars?
- Data Logging?



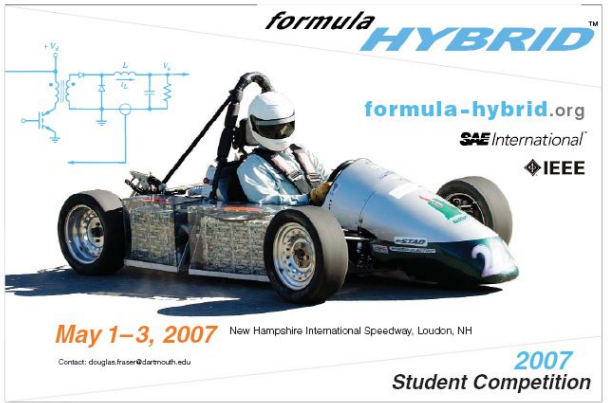
Electrical Integration: Plans

- To Do:
  - Obtain and Install new Controller
  - Build Battery Management System
  - Check and Adjust Differential Mounting
  - Test Real World Motor Performance
  - Locate Li-Ion/Li-Polymer Sponsor
  - Evaluate BMS (Battery Management Systems) options



Milestones and Deadlines

- Battery Beach Burnout, January 27th
- Finish build & start testing, February 12th
- Racing Opportunity at Moroso Speedway, March 1st **
- Complete testing, April 1st
- Design Showcase, April 13th
- EV Autocross Event, April 25th**
- Formula Hybrid Competition, May 1st – 3rd



** Dates are tentative

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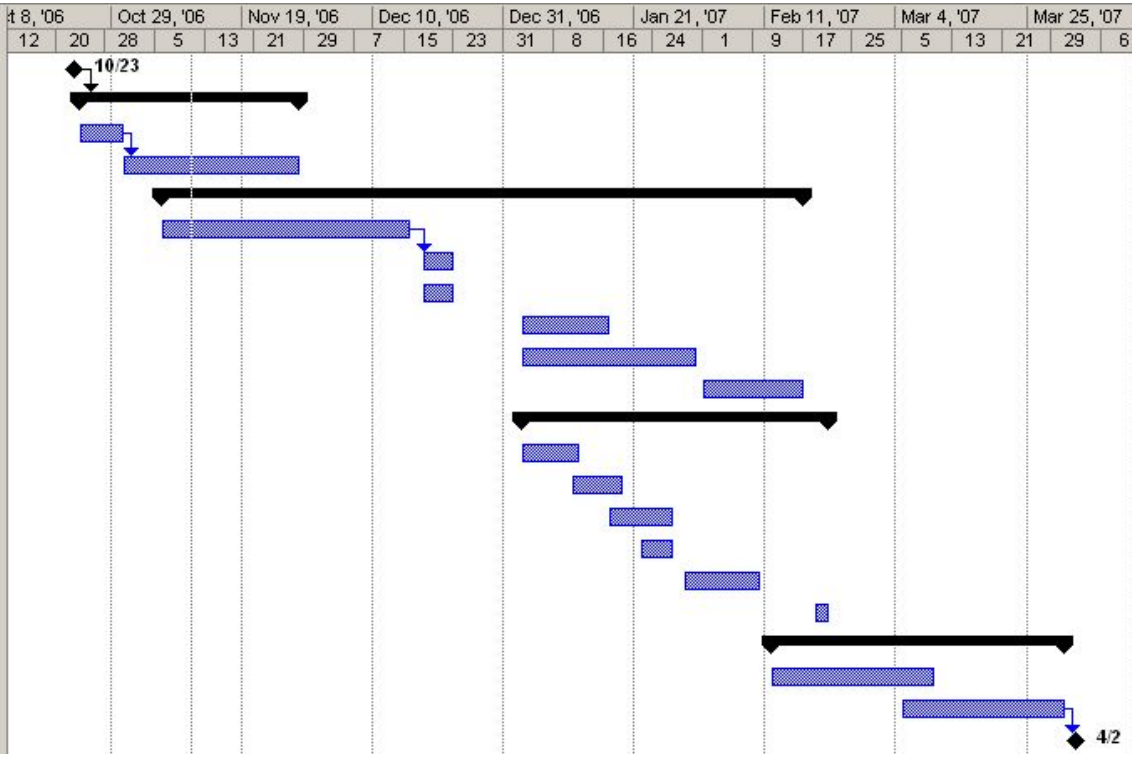
Gantt Chart: Mechanical Design

	Task Name	Duration
1	CDR	1 day
2	**Parts Acquisition**	**25 days**
3	Place Basic Part Orders	5 days
4	Part Lead Time	20 days
5	**System Building**	**75 days**
6	Chassis Build	30 days
7	Chassis Paint	5 days
8	Suspension Build	5 days
9	Mount Build (motor, controller, diff, etc)	10 days
10	Battery Pack Build	20 days
11	Body Build	12 days
12	**Assembly**	**35 days**
13	Assemble Chassis/Suspension	7 days
14	Assemble Wheels/Brakes	6 days
15	Assemble Electrical components	8 days
16	Assemble Driver System	5 days
17	Optimize assemblies	10 days
18	Assemble Body	2 days
19	**Final Testing and Integration**	**35 days**
20	Modify mechanical parts	20 days
21	Testing and Optimization	20 days
22	Final Product	1 day



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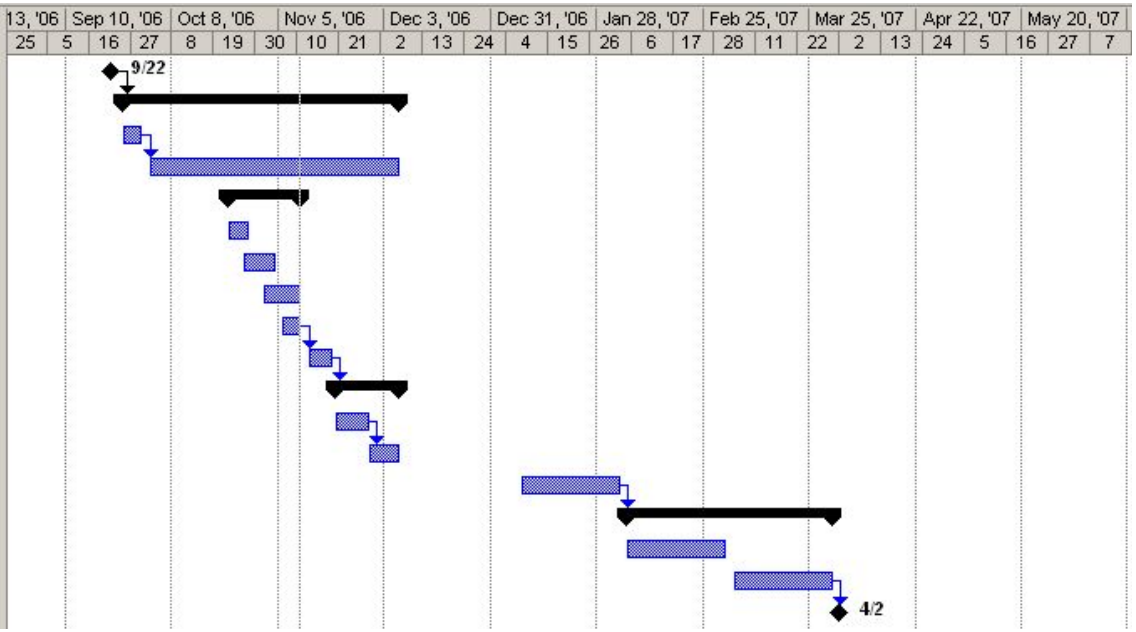
Gantt Chart: Electrical Design

	Task Name	Duration
1	CDR	1 day
2	**Parts Acquisition**	**53 days**
3	Place Basic Part Orders	5 days
4	Part Lead Time	48 days
5	**Parts Testing with System Optimization**	**15 days**
6	Extensive Battery Testing	5 days
7	PLC Testing	6 days
8	Motor Testing	8 days
9	Place Remaining Part Orders	5 days
10	Part Lead Time	5 days
11	**Further Parts Testing**	**13 days**
12	Controller Testing	7 days
13	PLC Integration	6 days
14	Insertion of Parts into Rolling Chassis	20 days
15	**Final Testing**	**40 days**
16	Modify Software Package	20 days
17	Modify Motor Controller	20 days
18	Final Product	1 day



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Budget: Preliminary

With a Preliminary Budget, we can get a vehicle running for less money and use that product to raise funds for future enhancements

Item #	Part	Manufacturer	Part Number	Description			
1	Chromoly Tubing	Chassis Shop	41-1-049	Round Chro			0
2	Chromoly Tubing	Chassis Shop	41-1-065	Round Ch			
3	Chromoly Tubing	Chassis Shop	41-1-095	Round Ch			
4	Chromoly Tubing	Chassis Shop	41-1-1-065	Square Ch			
5	Chromoly Tubing	Chassis Shop	41-58-058	Round Chrom			0
6	Welding Filler Rod	Chassis Shop	C73-002	#65 Filler Ro			.95
7	Differential	Kawasaki		Kawasaki E			$500.00
8	Motor Mounts	ALRO		Aluminum, 1/			$60.00
9	Differential Mounts	ALRO		Aluminum, 1/2			$60.00
10	Controller Mounts	ALRO		Aluminum, 1/8" THK pe			$60.00
11	Shielding	ALRO		Aluminum, 1/16" THK per S	.00	1	$60.00
12	Seat	Tillet	T11	Seat, Large	79.00	1	$179.00
13	Fiberglass Body	Fiberlay, Inc.		Fiberglass matting 3.2 oz.	$6.98	7	$48.86
14	Fiberglass Resin	Fiberglass Florida		Epoxy Resin Kit (3 Gallon Size)	$45.81	1	$45.81
15	Brake Lines	Summitt	SUM-220136	3/16" Steel Hard Lines, 25 ft	$19.95	1	$19.95
16	Brake Fluid	Jegs	950-290-0632	570-Brake Fluid, 12-ounce Can	$7.49	2	$14.98
17	Tires	Goodyear	20.0x6.5-13	Tires, Slicks, for 13" rims, 6.5 wide, D1385, R065	*Donated*	4	$0.00
18	DC Motor	NetGain Technologi	00-08219	32.3HP continuous series wound DC motor	$1,450.00	1	$1,450.00
19	Controller	Café Electric	Zilla Z1K-LV	72-156VDC series wound controller, 1000A max. w/ Ha	*Donated*	1	$0.00
20	Throttle Control	Curtis	PMC #PB6	Swinging arm throttle input, 5k ohms	$75.00	1	$75.00
21	Speed Sensor	Digi-Key	480-2015-ND	Hall Effect Sensor	$7.40	1	$7.40
22	Fuse	FERRAZ/SHAWMUT	A30QS800-4	Up to 800A systems	$42.00	2	$84.00
23	PLC	EZ Automation	EZPLC-D-96E	12 Slot EZPLC Base (96I/O Max)	$289.00	1	$289.00
24	PLC I/O	EZ Automation	EZIO-4THI	4 Thermocouple Input Module	$139.00	4	$556.00
25	PLC I/O	EZ Automation	EZIO-4DCIP4RLO	4 DC In, 4 DC Out Relay Module	$39.00	1	$39.00
26	PLC I/O	EZ Automation	EZIO-8ANV	8 Analog Input (voltage) Module	$99.00	1	$99.00
27	PLC I/O	EZ Automation	EZIO-8ANC	8 Analog Input (current) Module	$99.00	1	$99.00
28	PLC I/O	EZ Automation	EZIO-8HSDCI	8 DC High Speed Input Module	$24.00	2	$48.00
29	PLC I/O	EZ Automation	EZIO-8DCOP	8 DC Output (source) Module	$19.00	2	$38.00
30	PLC I/O	EZ Automation	EZIO-HSCM2	High Speed Counter Module	$99.00	1	$99.00
31	Touch Screen Display	EZ Automation	EZC-T6C-E	5.7 viewable Touch Screen LCD display	$719.00	1	$719.00
32	Contactor	Albright	SW200	400A continuous 12V contactor	$119.99	1	$119.99
33	Wire	Prestoflex	#2/0	00 gauge (Black) 33 feet	$99.00	1	$99.00
34	Wireless Device	PIC		Serial Wireless Adapter	$161.00	2	$322.00
35	Li-ion Batteries (1 set)	A123 Systems	ANR26650M1	Depends on Differential Ratio. 44S10P with 1 set	$18.00	250	$4,500.00
36	Battery Management	PIC	F877 & 1287	Voltage, Current, and Temperature Measurements	$100.00	20	$2,000.00
37	Misc Electrical Comp	Radio Shack	-	Electrical Stuff (wire, fuses, etc)	$200.00	1	$200.00
38	Misc Hardware	Ace Hardware	-	Hardware (nuts, bolts, etc)	$200.00	1	$200.00
39	Misc Expenses	-	-	Misc Expenses (Registration fees, shirts, cards, etc)	$500.00	1	$500.00
						Total Cost:	$12,906.62

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Budget: Secondary

Budget for Racing Electric Vehicle:							
Item #	Part	Manufacturer	Part Number	Description	Retail Price	QTY	Total Price
1	Chromoly Tubing	Chassis Shop	41-1-049	Round Chromoly Tubing, 1" OD, .049" THK, per FT	$3.24	15	$48.60
2	Chromoly Tubing	Chassis Shop	41-1-065	Round Chromoly Tubing, 1" OD, .065" THK, per FT	$2.52	15	$37.80
3	Chromoly Tubing	Chassis Shop	41-1-095	Round Chromoly Tubing, 1" OD, .095" THK, per FT	$4.68	20	$93.60
4	Chromoly Tubing	Chassis Shop	41-1-1-065	Square Chromoly Tubing, 1" OD, .065" THK, per FT	$6.96	8	$55.68
5	Chromoly Tubing	Chassis Shop	41-58-058	Round Chromoly Tubing, 5/8" OD, .058" THK, per FT	$2.16	25	$54.00
6	Welding Filler Rod	Chassis Shop	C73-002	#65 Filler Rod, 1/16"x36", per LB	$4.99	5	$24.95
7	Differential	Kawasaki		Kawasaki Bruteforce Front Diff, 4.375:1 ratio	$500.00	1	$500.00
8	Motor Mounts	ALRO		Aluminum, 1/4" THK per SHT	$60.00	1	$60.00
9	Differential Mounts	ALRO		Aluminum, 1/2" THK per SHT	$60.00	1	$60.00
10	Controller Mounts	ALRO		Aluminum, 1/8" THK per SHT	$60.00	1	$60.00
11	Shielding	ALRO		Aluminum, 1/16" THK per SHT	$60.00	1	$60.00
15	Seat	Tillet	T11	Seat, Large	$179.00	1	$179.00
17	Fiberglass Body	Fiberlay, Inc.		Fiberglass matting 3.2 oz.	$6.98	7	$48.86
18	Fiberglass Resin	Fiberglass Florida		Epoxy Resin Kit (3 Gallon Size)	$45.81	1	$45.81
19	Brake Lines	Summitt	SUM-220136	3/16" Steel Hard Lines, 25 ft	$19.95	1	$19.95
20	Brake Fluid	Jegs	950-290-0632	570-Brake Fluid, 12-ounce Can	$7.49	2	$14.98
21	Tires	Goodyear	20.0x6.5-13	Tires, Slicks, for 13" rims, 6.5 wide, D1385, R065	$119.00	4	$476.00
22	DC Motor	NetGain Technologie	00-08219	32.3 HP continuous series wound DC motor	$1,600.00	1	1,450.00
23	Controller	Café Electric	Zilla Z1K-LV	72-156V DC series wound controller, 1000A max. w/ Ha	$2,950.00	1	2,950.00
24	Throttle Control	Curtis	PMC #PB6	Swinging arm throttle input, 5k ohms	$75.00	1	75.00
25	Speed Sensor	Café Electric llc	2171S	Advanced DC Motor Speed Sensor	$42.50	1	42.50
26	Fuse	FERRAZ/SHAWMUT	A30QS600-4	Up to 600A systems	$54.50	2	109.00
27	Fuse	FERRAZ/SHAWMUT	A30QS800-4	Up to 800A systems	$42.00	2	84.00
28	PLC	EZ Automation	EZPLC-D-96E	12 Slot EZPLC Base (96I/O Max)	$289.00	1	289.00
29	PLC I/O	EZ Automation	EZIO-4THI	4 Thermocouple Input Module	$139.00	4	556.00
30	PLC I/O	EZ Automation	EZIO-4DCIP4RLO	4 DC In, 4 DC Out Relay Module	$39.00	1	39.00
31	PLC I/O	EZ Automation	EZIO-8ANIV	8 Analog Input (voltage) Module	$99.00	1	99.00
32	PLC I/O	EZ Automation	EZIO-8ANIC	8 Analog Input (current) Module	$99.00	1	99.00
33	PLC I/O	EZ Automation	EZIO-8HSDCI	8 DC High Speed Input Module	$24.00	2	48.00
34	PLC I/O	EZ Automation	EZIO-8DCOP	8 DC Output (source) Module	$19.00	2	38.00
35	PLC I/O	EZ Automation	EZIO-HSCM2	High Speed Counter Module	$99.00	1	99.00
36	Touch Screen Display	EZ Automation		5.7 viewable Touch Screen LCD display (outdoors)	$2,500.00	1	2,500.00
37	Contactor	Tyco Electronics	EV500	Kilovac 600A continuous 12V contactor	$931.00	1	931.00
38	Wire	Prestoflex	#2/0	00 gauge (Black) 33 feet	$99.00	1	99.00
39	Wireless Device	new micros	Xbee PlugaPodS	Connects 2 serial ports	$161.00	2	322.00
40	Wireless Device	new micros	Xbee Dongle	Connest to the user interface	$95.00	2	190.00
41	Li-ion Batteries (2 sets)	A123 Systems	ANR26650M1	Depends on Differential Ratio. 44S10P with 2 sets	$18.00	1000	18,000.00
42	Charger	A123 Systems		110 or 220 system charger	$2,800.00	1	2,800.00
43	Misc Electrical Comp	Radio Shack	-	Electrical Stuff (wire, fuses, etc)	$300.00	1	300.00
44	Misc Hardware	Ace Hardware	-	Hardware (nuts, bolts, etc)	$250.00	1	250.00
44	Misc Expenses	-	-	Misc Expenses (Registration fees, shirts, business card	$800.00	1	800.00
						Total Cost:	$34,008.73

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Questions?!?

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