Team Culver's

Final Report
2010-2011

FORMULA HIGH SCHOOL
Formulahighschool.com
RACING TO LEARN

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Formula High School

Formula High School was originally created by Mr. Jeremie Meyer and Mr. Mike Besel, both Technology and Engineering instructors from Wisconsin. The basic principle of the program is for students to come together as teams and each build a replica race vehicle within the time span of eight months. Each team is given a donated 16 HP Briggs & Stratton engine, a design for the chassis, and then are free to build from there (within the realm of some minor constraints). Each team needs to learn how to communicate with industries and present their ideas in order to locate their own sponsors to purchase parts for the vehicle. At the end of the year, each team takes their vehicle to Road America in Elkhart Lake, WI to race against all other teams. Each year, more and more schools join Formula High School, and the turnout at Road America is greater than ever.

Team Culver's

From right to left:

Logan Gareis- 3 years CAD experience and one semester of Welding

Kyle Jansen- 2 years CAD experience

Adam Jonet- 2 years CAD experience

Nathan Loberger- 1 year CAD experience

Dan Sierra- 5 plus years of welding, been racing since the age of 5, and 3 years of CAD

Zak Roeser- 2 years CAD experience, Motorsports experience since age of 4

Sam Sconzert- (not present) 1 year CAD experience, 1 year welding, 1 year of small engines

Rules And Regulations

Formula High School Rules 2010-11

All Formula High School vehicles are to be completed before all track events. Absolutely NO fabrication will be allowed at the track events.

FHS officials reserve the right to disqualify a team if the officials believe there is a safety hazard present on the team's vehicle.

Overall Sizes:

Wheelbase: 81" – 87" measured from center of front spindle axle to center of rear axle.
Width: 50" to 58" measured to the outside edge of the mounted tire.
Max Overall Length: 144" including body shell.
Ground Clearance: 2" MIN – 6" MAX

Vehicles not within these measurements will not be allowed to compete, even as an exhibition. Vehicle widths and wheelbases are set to ensure a safe and stable vehicle for the track day events. Specifications must be followed. **There will be no exceptions.**

Chassis: All teams must use the supplied chassis model as the base for their vehicle. Chassis MUST be constructed to the chassis model within 1" of specifications. All frame members shown on the model must be present in the completed chassis.

Roll Bar Tubing: 1 ½" round mild steel tubing, 0.083" (14ga) wall thickness. Roll bar tubing must be a single continuous piece. NO SPLICING ALLOWED. Driver's helmet should not be excessively forward of the roll bar protection when seated in the vehicle.

Bracing: 1" round mild steel tubing, 0.083" (14ga) wall thickness.

Floor: 0.0747" (14ga) mild steel sheet, stitch welded to the bottom frame rails. The minimum weld stitch pitch should be no more than 1-3.

Body Shell: Teams must use an approved FHS fiberglass body shell. If a team chooses to use an alternate body shell, that team must submit approval directly to FHS officials. The only approved body shell materials are: fiberglass, Kevlar, carbon fiber or 0.032" aluminum sheet. Aluminum must either be polished or painted.

Appearance: All FHS vehicles must be painted, gel coated, or powder coated with school and sponsor decals appropriately placed. Bare metal frames will not be allowed.

Mandatory Decal List (List may change at later date):

- Sugar Grove Custom Cars
- Fiberglass Solutions

- Road America
- Briggs & Stratton

Decals must be placed in a position where they are easily seen from both sides of the car. FHS officials reserve the right to add to the mandatory decal list at any time.

Firewall: .032" or thicker aluminum or mild steel sheet must be used for a firewall between the driver and the engine compartment. Teams must try to make all reasonable efforts to fully seal the driver's compartment from the engine compartment. Teams should try to keep all gaps to less than ½".

Safety Harness: All teams must use a 5-point safety harness, installed to safety harness manufacturer's specifications. Harnesses certification stickers must be within five years of event date.

Engine: Briggs & Stratton 16 HP Vanguard V-twin ONLY. To further clarify, we are accepting engines in the 3034xx and 305xx (horizontal) and the 3037xx and 3057xx (vertical) model line. Provided the engine is designated as a 30 cubic inch, OHV, "V-twin" engine that is rated at 16hp, and falls in the range listed above, it will be accepted. No other engine will be allowed. NO power adders or modifications to the engine allowed, except for wiring extensions, throttle and choke connections. Engine must have a throttle return spring attached directly to the throttle shaft arm. Governor may be removed/disconnected. See suggestions in regards to RPM limit.

Teams have asked if they can use an engine other than the recommended Briggs & Stratton. The reasons why there is only one approved engine manufacturer:

- Eliminates the need to use restrictor plates to equalize engine power levels.
- Common parts which allows teams to help each other out at the track.
- Limited availability of appropriate sized and capable engines from other manufacturers.
- Simplifies the inspections process for track officials.

Kill Switch: Two paddle type kill switches are required. One switch shall be located in easy reach of the driver and labeled appropriately. The second switch shall be located on the left side of the rear roll bar but above the body shell. This location is shown on the chassis model. The switch will be marked with a red vinyl or painted 3" equilateral triangle and labeled ON/OFF with .25" high contrasting color text. Both switches must be demonstrated to effectively shut off the engine.

Fuel system: Teams may relocate the stock Briggs and Stratton vacuum fuel pump to allow proper fuel supply to the pump. NO electric fuel pumps. Fuel tanks/cells must be commercially available, designed for fuel use and installed to manufacturers specifications.

Exhaust: Exhaust outlet(s) must extend past the body shell by a minimum of 1".

Transmission: Centrifugal clutch with a single overall gear ratio. No CVT or multiple gear transmissions allowed.

Overall Gear Ratio: Open. Teams are allowed to gear for various track configurations.

Tires: DOT rated tires. No racing slicks or trailer tires allowed.
Overall tire diameter: 24" maximum

Suggested tires sizes: Front: 175/50-13 Rear: 205/60-13
Rim: 13 x 6 steel rims, 2.5" back spacing suggested

Front Spindles: All teams must use standard VW Beetle spindles, ball joints, eccentric adjusters, rotors and disk brake calipers. No modifications allowed to these parts.

Rear Brake: All teams must utilize a standard VW Beetle brake caliper, actuating a single brake rotor keyed or splined to the rear axle. At least one rear tire must transmit braking power to the ground. This caliper will also be on a separate hydraulic circuit from the front brakes.

Suspension:

- All teams must have a minimum of 1 successful year of FHS experience before they may incorporate an IFS/IRS suspension.
- Teams designing/building and IFS/IRS system must incorporate production spindles, brakes and uprights.
- Teams must supply engineering drawings and or pictures of their design to FHS officials for approval before manufacturing their system.

Minimum Rear Axle Diameter: 1 ¼"

Steering: Rack and Pinion ONLY, no go-kart steering allowed.

Steering Wheel: Steering wheel must be either a continuous round or "D" shaped wheel. No butterfly style steering wheels allowed.

Minimum Tie Rod Diameter: ¾"

Driver Safety: All drivers must use the following safety equipment:

- DOT or Snell rated full-face helmet, manufactured within 5 years of event date
- Neck collar
- Closed toe shoes
- Long pants
- Long sleeve shirt/jacket
- Gloves
- Impact rated eye protection, minimum rating of Z87.
- No sweats pants or windbreaker pants allowed.

Safety Glasses: All team members must be wearing safety glasses when actively participating in repair or adjustments to the team vehicle.

Overall Rule of Conduct: Students must present themselves in a professional manner. Teams will be disqualified and removed from the track in any team member does not follow directions

Parts List

Part Description		Manufacturer	Model Number	Price	Qty	Cost
Master Cylinder Assembly		California Import Parts	VWC-113-611-015-BH	$39.95	1	$39.95
Brake Fluid Reservoir		California Import Parts	VWC-113-611-301-L	$5.50	1	$5.50
Thrust Washer		California Import Parts	VWC-111-405-661	$1.75	2	$3.50
Ball Joint Eccentric		California Import Parts	VWC-131-498-319	$28.45	1	$28.45
Clamp Nut - Left		California Import Parts	VWC-131-405-669	$5.50	1	$5.50
Clamp Nut - Right		California Import Parts	VWC-131-405-670	$5.50	1	$5.50
Upper Ball Joint		California Import Parts	VWC-131-405-361-F	$12.95	2	$25.90
Lower Ball Joint		California Import Parts	VWC-131-405-371-G	$12.95	2	$25.90
Disk Brake Conversion Kit Rotors	Blank	California Import Parts	ACC-C10-4121	$339.95	1	$339.95
Disk Brake Caliper Used for rear axle		California Import Parts	C13-98-1150-B	$64.95	1	$64.95
Front Brake Rubber Hose		California Import Parts	VWC-311-611-701-B	$9.45	4	$37.80
Dust Cap		California Import Parts	VWC-111-405-692-B	$2.75	2	$5.50
U Joint for Rack and Pinion		California Import Parts	C26-425-160	$24.95	1	$24.95
Splined Shaft for U-Joint		California Import Parts	C26-425-164	$8.50	1	$8.50
Universal Chrome Steering Shaft		California Import Parts	C26-425-011	$32.95	1	$32.95

Chrome Steering Bearing			California Import Parts	C26-425-013	$12.95	1	$12.95
14" Rack and Pinion			California Import Parts	C26-425-150	$99.95	1	$99.95
Quick Release Steering Wheel Hub			California Import Parts	C26-415-100	$16.95	1	$16.95
Brake Hub for 1 1/4" Axle			BMI Karts	600253	$15.00	1	$15.00
Sprocket Hub - 1 1/4" Axle			BMI Karts	600243	$28.95	1	$28.95
35 Series RLV Extreme Chain			BMI Karts	400635GG	$14.95	1	$14.95
Steering Wheel 10" DIA			BMI Karts	410200	$21.99	1	$21.99
1 1/4"" Tubular Steel Axle Bearing Mount Kit			BMI Karts	400415	$24.95	2	$49.90
44" 1 1/4"" Tubular Chrome Moly Axle			BMI Karts	601444	$43.50	1	$43.50
13 x 6 Steel Wheels 2.5" BS BC	4 holes on 4"		Bassett Racing Wheels		$57.00	4	$228.00
Sumitomo HTR 200	175/50-13		Tire Rack		$48.00	2	$96.00
Sumitomo HTR 200	205/60-13		Tire Rack		$56.00	2	$112.00
Formula High School Fiberglass Body Shell			Fiberglass Solutions		$350.00	1	$350.00
Azusa Split Sprocket tooth, 35 Series	89-97		Reiken's Racing	AZ-2699-XX	$35.06	1	$35.06
NORAM Enforcer Clutch tooth, 35 series chain	12		Reiken's Racing	NAENF12	$206.44	1	$206.44
16 HP Briggs & Stratton Vertical Shaft V-twin engine			Preble Motorsports		$0.00	1	$0.00
1 1/2" Square Tubing 14 ga	40 feet		SI Metals		$1.47	40	$58.80
1" Round Tubing 14 ga	60 feet		SI Metals		$1.19	60	$71.40
RCI Aluminum Fuel Cell			Summit Racing	RCI-2010A	$95.95	1	$95.95
R.J.S. Racing 5 Way Harness			Summit Racing	50502-18-23	$69.95	1	$69.95
Drive Hub 1 1/4" Axle BC and Lug Nuts	4 on 4" 1/2" Studs		Jegs.com	056-9030	$25.99	2	$51.98
Two Piece Shaft Collars			McMaster Carr	6436K21	$5.01	4	$20.04

Threaded Tube Inserts RIGHT HAND	3/8-24	McMaster Carr	94640A115	$5.04	2	$10.08
Threaded Tube Inserts LEFT HAND	3/8-24	McMaster Carr	94640A119	$5.04	2	$10.08
Rod End 3/8-24 RIGHT HAND		McMaster Carr	2458K141	$5.39	2	$10.78
Rod End 3/8-24 LEFT HAND		McMaster Carr	2458K142	$5.39	2	$10.78
Round Base Weld Nut 1/4-20		McMaster Carr	90596A029	$5.84	1	$5.84
Axle Snap Rings		McMaster Carr	97633A340	$5.62	1	$5.62
Female Pipe Elbow 1/4 Hose to 1/4 NPT		McMaster Carr	5346K122	$7.42	1	$7.42
Stainless Steel Socket Head Bolts		McMaster Carr	92949A542	$9.15	1	$9.15
Stainless Steel Bonded Washers		McMaster Carr	94709A416	$14.56	1	$14.56
#8 AN Aluminum Cap		ANPLUMBING.com	992908	$3.49	1	$3.49
#8 AN to 1/4" NPT Adapter		ANPLUMBING.com	916107	$8.48	2	$16.96
Wheel Stud		NAPA	BK 641-1632	$1.99	8	$15.92
Battery Switch		NAPA	NW 785121	$26.99	1	$26.99
Fuse Holder		NAPA	BK 7825334	$2.29	1	$2.29
Oil Filter - NAPA Gold (WIX)		NAPA	7035			$0.00
Starter Button		NAPA	ECH STB6301	$9.99	1	$9.99
						$2,514.51

Design Specifics

At the beginning of the year, we all agreed that we wanted to build our car differently than the previous years. We not only wanted our car to be unique, we also wanted to make these adjustments affect the overall performance of our car in order to improve efficiency, increase driver comfort, and achieve higher speeds. Therefore, after comparing and contrasting possible solutions, we decided on the following applications for our build:

- Ceramic (UDL Coated) Bearings
  - Low coefficient of friction
  - Increase power efficiency
- Professional Race Seat
  - Increase driver comfort
  - Better access to pedals and steering
  - Improve overall look of vehicle
- Shaved Tires
  - Achieve better traction
  - Slightly reduce overall weight

- Balancing and Weight Distribution
  - 51% front to 49% including driver
  - Added weight for equal weight distribution
  - Lowered Steering and tie rods for more responsive handling
  - Tires pumped to help balance weight

The Design

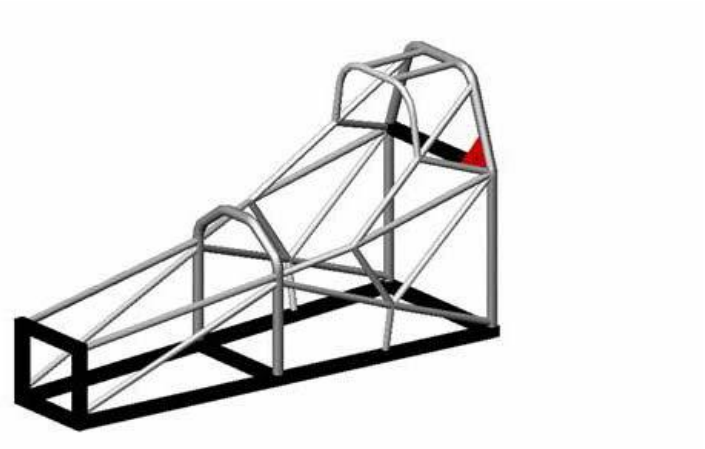
The Formula High School program is a very student driven program. This means that the students come up with the design for the car, with an exception to the chassis. However, our goal in the end is to have the fastest car come race day. Because of this, we created a design we thought would be lightest, have the best weight distribution, and have the best overall performance. We believe our design is intuitive and efficient, and will give us a better performance. First, we decided to move the battery to the front of the formula car. This greatly helps the weight distribution of the car itself.

Also, for better performance on the track, our team decided to drop the steering column. In previous years there was a large gap between the steering rack and the axle. The steering rack itself sat slightly above the chassis. Our team decided to move the steering rack down under the front crossbars. This will give us much better handling when taking tight corners while racing.

To make the car lighter and perform much better, our team decided to go with a different gearbox. The new gearbox our team received is about half the weight of the old gearbox, which in turn makes the car lighter. Also the gearbox has a differential that causes the outside tire to spin faster than the

inside tire when in tight corners. This should increases performance of our car greatly at race day.
Next, our team had to agree on a design for the rear end. This was the most difficult aspect of the car for our team to agree on because there are so many different directions we could've taken for the design . The rear end's main purposes are to support the rear axle, the engine and the gear box. So with all of these things in mind, we created a very simple design that should give us maximum performance on race day. Our design is a simple rectangular structure coming off the back of the car. What makes our design stand out is its simplicity. It consists of is four 1 ½" pieces of rectangular tubing and two pieces of angle steel that run across the back of the car for the gearbox support. We choose to use angle steel because it's lighter than putting a plate on the car to mount the gear box and it gives the back end a lot of strength.

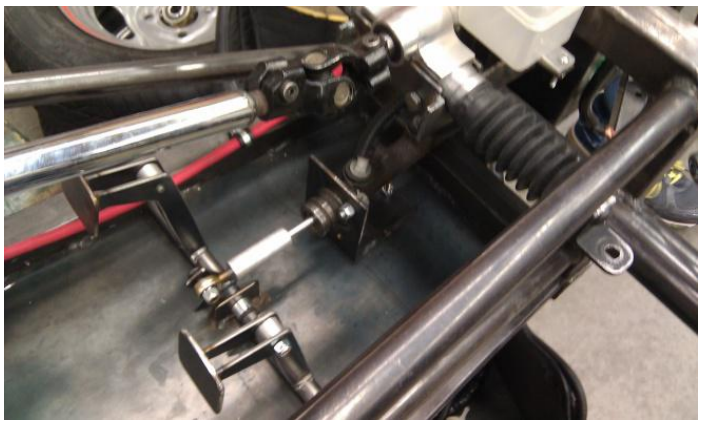
Construction



The main goal in the Formula High school is, after all, the actual construction of the vehicle. The first step towards completing the vehicle is the construction of the chassis. Every team is given a standard chassis design that they must follow within a +1/-1 inch tolerance. Pictured above is the 2010-2011 required chassis design.

Another important step is cutting, milling, fitting and welding the front axle and rotor mounts. Pictured right is our axle completely mounted on the front end of our car.

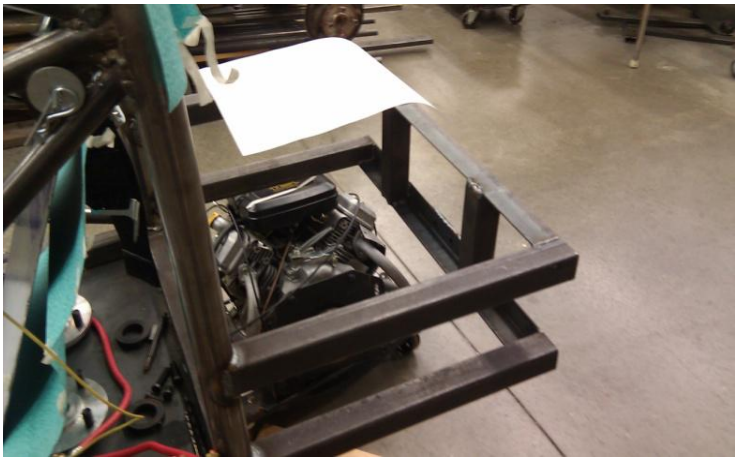
Next we designed and created most of the front end parts, including gas and brake pedals, steering rack and shaft mounts, the master brake cylinder mounts, and the battery mount.



 Our front end design.

We decided to use a real race seat to improve comfort and performance. This seat was donated by our teammate's uncle. We believe it is a better seating solution than that of the other teams'.

Next is the creating and mounting of the body. We were lucky enough to be able to use an old body from a previous year. Teams that do not have a body from years before have to lay up the body for the car themselves. Components for laying up the body are all thanks to Fiberglass Solutions Inc. They donate the time and materials to make the car bodies possible.
The next order of business was to design and mount our rear end assembly, including our differential and engine. We are currently in the process of finishing the basics of our design.



After this, we will have our engine mounted and ready for wiring. Once all of the steel work was completed we sent the chassis to be sand blasted and painted a nice gloss black. Along with body that was sent to paint to match our main sponsor's color. After the all the parts came back from paint all that was necessary was final assembly and detail work. This would include both things like the final wiring harness and attaching all the components like brakes and brake lines. Once all those parts where installed we turned out attention mounting the engine and clutch. While the chain was adjusted and leveled to match the clutch all the sponsor decals were cut and placed on the newly painted body.

Race Day- April 30th/ May 1st, 2011

Road America: Race day at Road America is over, and it was a great experience! The Formula High School program was a great success this year, with 7 schools and 16 separate teams all attending. Each car was completely unique, with every team bringing their own ideas and innovations to the track. Through hard work and dedication, all the teams had an opportunity to run the track and test their creation, with almost everyone spending some of the time in the pits either modifying their designs or fixing a broken part. Relations between the teams couldn't have been better; all teams were willing to lend a helping hand to others who may have been missing a part or having a rough time fixing something.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DEGRAVE


BOCA BEARING


Hilliard
Culver's
BUTTERBURGERS & FROZEN CUSTARD
BRIGGS & STRATTON
Canales
LAWN CARE

The Culver's Car: The Culver's car proved to be one of the best on the track that day; with consistent times and a reliable build, the Culver's car excelled. On the first day, a major problem with our front bearing greatly reduced our time on the track, but after fixing the problem, each team member was able to at least take the car out on the track once before time was called. The second day was a much greater success, with only very few, minor problems showing up (such as a loose throttle cable). On the second day, each team member had multiple runs with the car, and the times we achieved on each track exceeded our expectations.

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