Team Canadeo Lawn Care

2010-2011

Contents

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Pictured left to right: Daniel Cape, Lizzy Lovering, Eric Torbenson, Alex Jandrin, Sean Doering, Nathan Grobarchik, Aaron Figgins, and Phillip Witte

- Daniel Cape: Senior
  - Has complete IED (Intro to Engineering Design) and AED (Advanced Engineering Design)
- Lizzy Lovering: Junior
  - Has completed IED and AED
- Eric Torbenson: Senior
  - Has complete IED and AED and completed welding
- Alex Jandrin: Senior
  - Has Completed IED and is currently in AED
- Sean Doering: Junior
  - Has completed all welding classes
- Nathan Grobarchik: Junior
  - Has completed IED and AED
- Aaron Figgins: Senior
  - Has completed IED and has experience with welding
- Phillip Witte: Junior
  - Has completed IED and AED

Formula High School
"Racing to learn"

Formula high school is a program created by Preble High School's technology and engineering teacher Jeremie Meyer. Formula High school is designed for students who are interested in using their engineering skills to create a formula racecar within 9 months, and then take the completed car to race on a track. Students are given the 3D model of a basic chassis that must be used by all participants to ensure safety. Everything else is up to the students to design and build. Students face many challenges such as finding sponsors to finance the car, ordering parts, working in teams, and meeting the race day deadline. On race day students show off their car to the other teams and are given the opportunity to test the vehicle at Road America in Elkhart Lake, WI. Formula High School gives students the chance to use the skills they have learned to create something functional.

Rules and Regulations

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 rim, 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 from the officials.

SUGGESTIONS:

Rear axle bearings should be placed as close to the inner side of the wheel hub as possible to limit axle bending/twisting. Some teams have run up to a total of four bearings across the rear axle.

Chrome Moly Steel axles suggested. Low quality axles have bent under load.

Gear ratios: A good rule of thumb is to start with an overall gear ratio of 8:1 and then gear for the existing track conditions and individual vehicle response.

Chain tensioning devices: Use a sliding engine base set-up to adjust chain tension. There was a much higher incidence of thrown chains when using idler sprocket assemblies.

Install shaft collars on both sides of the rear hub assemblies. This is extra insurance to keep the hubs in place on the axle.

Fasteners: Teams should try to use at least grade 5 or higher fasteners, with nylock nuts, when possible.

Standard Formula High School wheel bolt pattern: 4 on 4"B.C., 2.5" back spacing.

Exhaust: Teams have run both open pipes and mufflers. The engines seem to work the best with some type of muffler. Individual team chassis dyno testing is suggested.

RPM: Engines should be limited to 4500 RPM. Teams run a risk a valve float above that RPM.

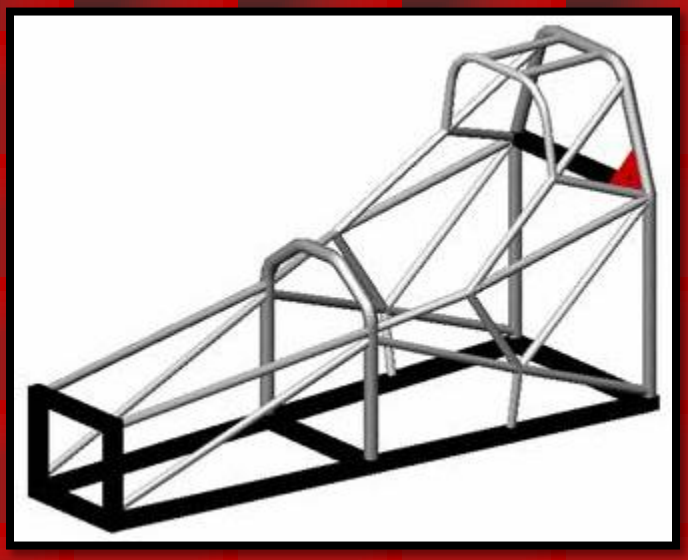
NORAM Enforcer clutches have shown a much higher durability than the NORAM Mini-Cup clutch.

When using a NORAM Enforcer clutch, install a spacer behind the clutch to eliminate the chance of the clutch sliding towards the engine.

Use Loc-tite on the crankshaft bolt. This reduces the chance the bolt will come out, dropping the clutch on the track.

Design Process

At the Beginning of the year all the teams were given the design for the chassis of the formula cars. None of the teams were allowed to modify the chassis design. This is to ensure the safety of the students. The chassis consisted of roll bars, halos, and support bars. Other parts of the chassis that the teams had to design were the front and rear axles, the engine mount, pedals, and the seat. As a team we brainstormed and came up with the best solutions for our designs. Once the designs were complete we had to construct the parts.



The chassis design that is required of the FHS teams

Our completed chassis that was built following the guidelines of FHS

Construction

After designing the chassis on Autodesk Inventor we were eager to get into the shop and start construction. We first laid out the bottom of the chassis and attached the roll bars and floor frame together. We then created the side supports using circular tubing and then using the milling machine to make the ends fit to the chassis. When creating the halo bar, the toughest part of the chassis to create, it took our team two attempts to get it correct. After all of the supports and roll bars were installed, we went to Northeast Wisconsin Technical College, NWTC, to cut out the floor of our car using the water jet. The floor was then stitch welded to the bottom of the chassis. With the completion of the floor our chassis was complete.

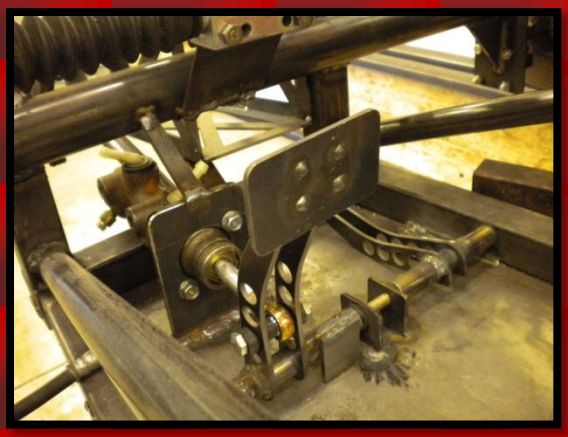
Sean welding one of the roll bars to the bottom of the chassis

Our completed chassis

Construction

After the completion of the chassis, we moved on to building the front axle. We cut the tube and created the 5 degree angles that were required on each side of the axle. Then we again used the milling machine to mill two slots in the tube so the axle can easily connect to the chassis. We then welded the front axle to the car. After we welded the axle to the chassis we realized we had made a mistake. The axle was 5 inches to long. To fix this problem we had to cut off the extra length on both sides and then grind the axle's ends by hand back to the 5 degrees needed. This mistake set us back 3-4 days. We then had the spindles pressed into the mounts and had the mounts welded to the front axle. After the axle was mounted to the chassis we had to build our battery box on the front of the chassis. We had the battery mount plates cut out at NWTC on the water jet. The battery mount was welded to the chassis and then we moved on to work on the pedals. Our pedal designs were also cut out on the water jet at NWTC. Once the pieces of the pedals were made we welded them together. Then we made small pieces of metal and welded them to the pedals to keep them from being pressed to far down or from falling forward. To attach the brake pedal we had to make a mount for the master cylinder and then had to use plastic bushings and a bolt to attach the pedal to the master cylinder. After our pedals were installed in our car we started the design on our back end. We had to wait for our rear differential to be delivered from Hilliard so we were temporarily set back because we could not start the design of our back end until we knew how to attach the differental to the car.

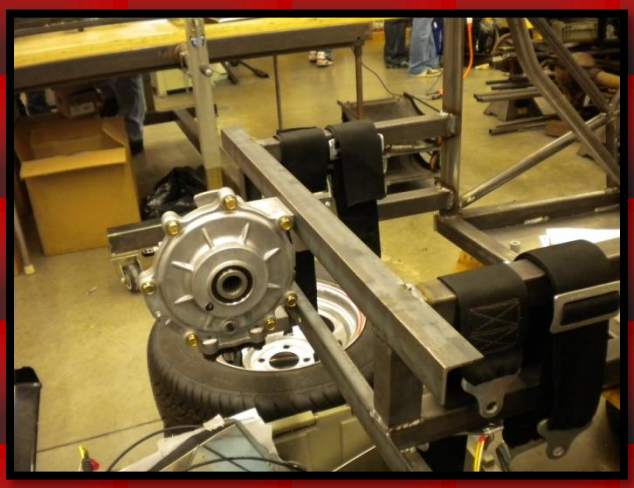
The battery mount we designed for our car



The brake pedal after it was attached to our master cylinder

Construction

Once we received our rear differential from Hilliard we were faced with the challenge of attaching it to the back end and then aligning it with the motor so the chain can be attached. We decided to attach the differential by drilling holes in the back bar and then attaching the differential with bolts. One problem that we had to deal with was finding a way to bolt the bottom side of the differential the chassis. There was an inch gap that would allow the differential to move around and not be secure. We solved this problem by fitting two spacers, one for each bolt, between the differential and the back end of our formula car. As the differential of the car was being installed other team members worked on making a plate for the starter. We made a plate out of steel and then we welded two pieces of round steel tubing to either side, as spacers, to the plate so we can attach it to the middle rollbar. The seat was also being cut out and bent to fit in the car. The seat was cut out at NWTC with the shear. It was then brought back to Preble to be bent at the correct angles so it would fit in our frame we had in the car for the seat. As we were making the seat we had to create a hole in the bottom so the bottom strap of the 5-point harness could be attached to the floor of the chassis. We had to also create a mount for the throttle cable. This was done by taking a small piece of steel with a hole drilled in it and welding it to the chassis of our car.These final pieces completed our chassis.



The differential once it was installed on the back of the chassis

The plate that was created to hold the starter button.

The mount the holds the Throttle cable in place.

The bottom of the seat where we had to cut a hole for the strap of the 5-point safety harness to come through.

Construction

After our chassis was completed we brought it to the paint booth to prime and paint our chassis. Our chassis was painted black by teammates. This took us about two days to complete. The body of our vehicle was sent to NWTC to be sanded down and repainted. We had our car painted bright red to match the colors of our sponsors. Our body returned to Preble freshly painted and then we decided that we wanted to add black stripes to the front of the body. This change sent us back to the paint booth. It set us back one day while the black stripes were being added to the red body. The body of our car was finally finished with the painting process. We then had to go back to the computers and start working on making the decals to place on our car body. Our decals were made of black and silver. These colors looked best with the red color of our body. After a few weeks of cutting out vinyls and making sure they were level on our car body, all the decals were finished. After 7 months of hard work and effort we finally done building our formula high school vehicle.

The chassis after it has been primed and painted black

Completed Vehicle

After many months of preparation and hard work, we have finally completed our car and it is ready to be loaded up and raced at Road America in Elkhart Lake, WI. These are some of the pictures of our vehicle at the Briggs and Stratton Motorplex within Road America.

Completed vehicle

Race Day

On Saturday April 30, 2011 and Sunday May 1, 2011 Formula High School held races at the Brigg's and Stratton Motorplex at Road America in Elkhart Lake, WI. All 15 vehicles from Wisconsin and one Indiana high school got a chance to show off all the work they have put in throughout the year. Even with the sometimes strong winds all teams were successful. There were two variations of the track. First was the small oval track, that each driver was allowed three laps. On the oval track, for our team, Sean had the best time of 19.0 seconds. Aaron Figgins followed Sean with a time of 19.22 seconds. Daniel Cape had the third fastest time of 20.05 seconds with Alex Jandrin coming in at 20.37 seconds. As a whole our team did very well on the oval track. Later in the day the track transitioned to the road course. This course challenged teams with sharp turns. Our fastest time for the road course was again Sean Doering with a time of 51.47 seconds. Phillip Witte came in second with a time of 52.34 seconds. Aaron Figgins brought in our third time with 55.75 seconds. After all the teams had a chance to drive the car in the time trial the top three times from three different drivers on each team were taken. With the top three times from each team they averaged them. Teams were put in places based on the average of the top three average time trial times. Overall the race day was a success. The only problems we had were our chain becoming loose and we had to tighten down our back tire because it kept slipping in. None of these small problems kept us off the course for long. We fixed the problems in a timely manner and returned to the track.

Nate Grobarchik racing on the oval course.

Lizzy Lovering racing the car on the road course.

Race Day

Aaron Figgins and our team waiting for our first run on the oval track

Phillip and Daniel pushing out the car to get it up to speed faster without ruining the clutch

Alex Jandrin racing on the oval track for the first time

Nate Grobarchik getting ready to race on the road course

Special Thanks to our Sponsors

Canadeo Lawn Care

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