Iowa State University
Formula SAE

CYCLONE RACING

Newsletter March 2015

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IOWA STATE UNIVERSITY FORMULA SAE
Iowa State University
2025 Black Engineering
Ames, IA 50011

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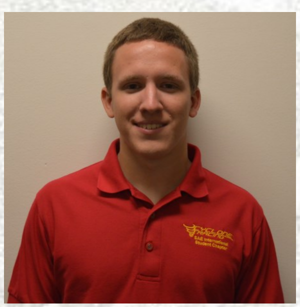
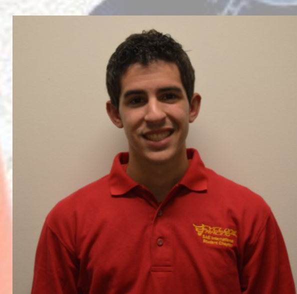
This year's car is similar to our last car, CR-19, in many respects. Most changes were made to fix problems we encountered last summer at competition and to further reduce weight, manufacturing time, and complexity. The SolidWorks CAD model is incredibly intricate and accurate down to the plumbing and oil lines. This will be the first year since the early 2000s that an ISU Formula car has had an aerodynamics package. One Aerospace and two Mechanical Engineering undergrads spent the Fall 2014 semester modeling wings using Computational Fluid Dynamics to create an aerodynamics package that will generate 290lbs of downforce at 60mph. Three team members also used the Fall Semester to research improvements for our engine, including installing a 14:1 high compression piston and tuning for E85 fuel. These new developments coupled with the team's continual refinement of each subsystem should make CR-20 our quickest, best looking, and most effective car yet.

Above: Rendering of the 2015 car, CR-20.
CR-20 is the 20th car produced by Cyclone Racing.



Tyler Jones | Junior | Mechanical Engineering | Project Director, Vice-President, Controls Co-Lead



Mike Hauptmann | Junior | Mechanical Engineering | Technical Director |Chassis Team Leader

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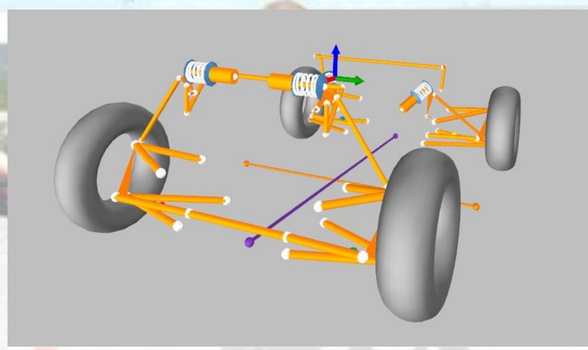
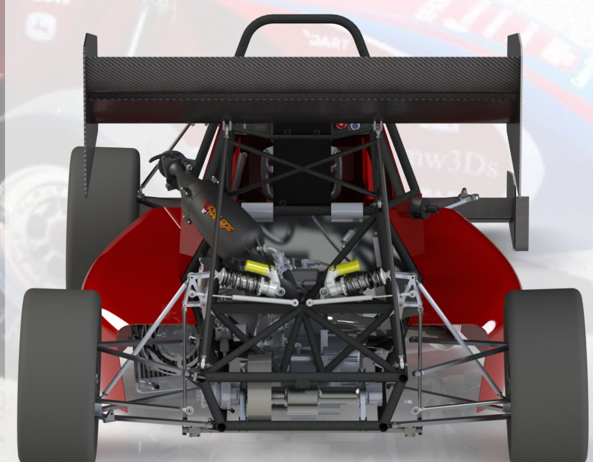
Chris Harrison
Junior | Mechanical Engineering | Vehicle Dynamics/Suspension Team Leader

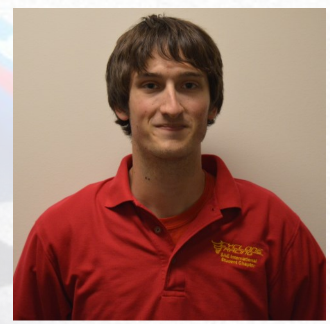


Optimum Kinematics Visualization

Suspension:
Suspension components will continue to be produced from machined aluminum. The biggest change was the rear damper mounting location. They were moved from the firewall to the center of the rear sub-frame to help with serviceability and to cancel the forces generated by the push-rods, as well as reduce bending on the rear push-rods by shortening their length. Overall these changes should help obtain our goals of reducing weight and manufacturing time, while increasing serviceability.

Vehicle Dynamics:
The goal of vehicle dynamics design for CR-20 is to further advance the platform that was developed two years ago. This year we are using some new software to further analyze the parameters of the vehicle. Some of the results of this include: moving to a 45% front weight distribution, revised suspension kinematics, and improved anti-Ackermann steering. The car will continue to use the 10” Hoosier LC0 tire front and rear. For damping, we have decided to continue to use pushrod-actuated Ohlin’s dampers. They are centrally mounted for ease of adjustment. These parameters will provide a responsive, balanced, easy to drive, and even faster race car.



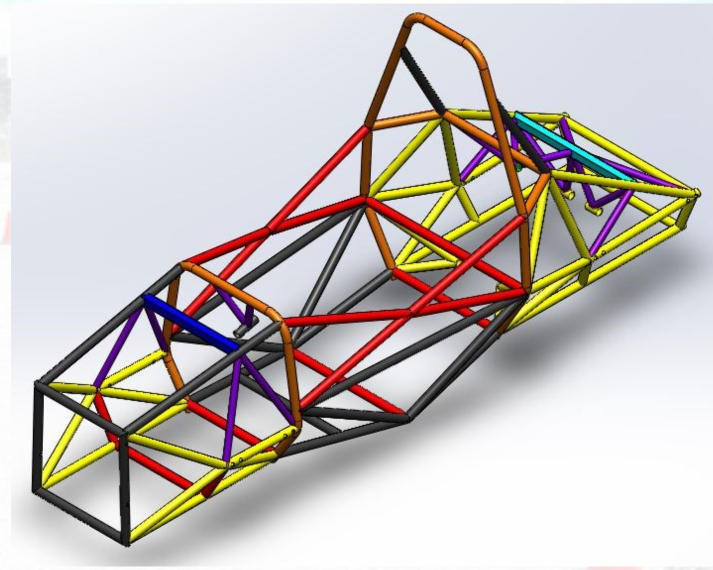


Alex Nowysz
Senior | Mechanical Engineering | Vehicle Dynamics/Suspension Team Leader

Mike Hauptmann
Junior | Mechanical Engineering | Chassis Team Leader

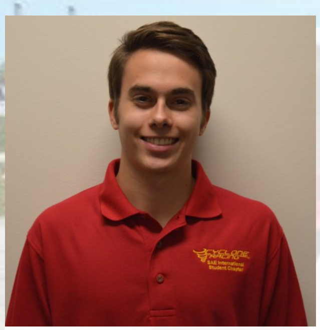
Chassis: Our chassis this year will look to build upon the successes of last year and refine some of the mis-haps. The initiative to improve accessibility to the engine and its components last year will continue this year with the help of simplified rear tube geometry and hard-mounting the engine instead of using a bolt-in cradle. This will also assist our frame's stiffness and strength by making the engine a semi-stressed member.

The simplified triangulation further condensed the car's frame into three distinct sections: the front, the cockpit, and the rear engine box. In loading the front control arm directly into the front roll hoop, we eliminate six small frame members on each side, significantly reducing manufacturing time with our jigging setup.



SolidWorks Model

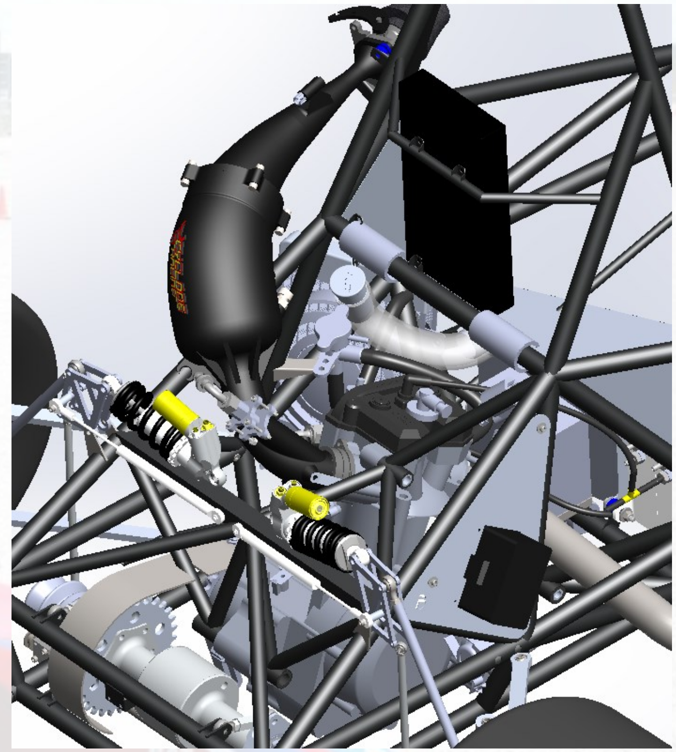
Ergonomics: Our ergonomics jig was made out of wood to easily adjust seat-back and thigh angle, steering wheel position and angle, and pedal position. With this, we were easily able to save time establishing our cockpit dimensions, rather than using a mock-up frame, for our best fitting car yet. With a huge help in supplying material and laser cutting our tubes, we owe a big thanks to State Steel and Co-Line Manufacturing. We could not do it without such amazing help!



Patrick Kalgren
Junior | Mechanical Engineering |
Powertrain Systems Director

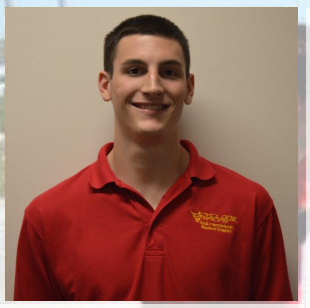
Engine:

The goals for this year's powertrain are to increase performance and reliability while reducing manufacturing and assembly time. In order to accomplish these goals, a Yamaha YFZ 450R engine was again used because it is light weight, has a flat torque curve, and is very fuel efficient. E-85 was also chosen as our fuel because of its high octane rating and evaporative cooling characteristics. A 14:1 high compression piston was used to get a higher thermal efficiency out of the E-85 fuel.



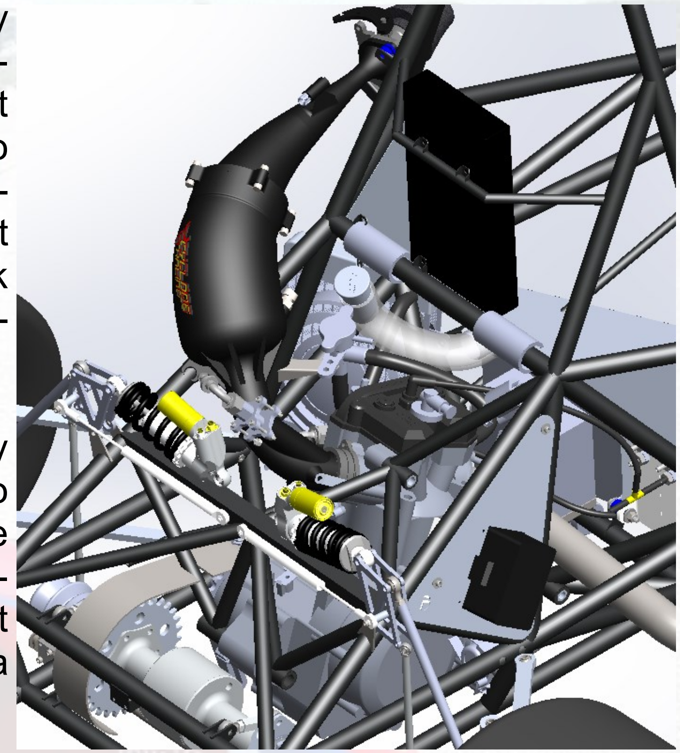
Intake:

This year the intake is again being 3D printed out of Stratasys's Ultem 9085 material for its excellent mechanical, thermal, and chemical properties. The volume of the intake was increased by over 25% and the shape was altered to allow better airflow. The intake and exhaust lengths were optimized together to increase torque across all engine speeds. A single compact EV 14 fuel injector from DeatschWerks is being used to decrease complexity and increase reliability. A waterproof PE3 ECU was again chosen for its easy tuning capabilities and its reliability.



Kevin Kassel
Junior | Mechanical Engineering | Engine Integration

Engine Integration:
This year the focus was on refinement and organization. By the end of the semester, our hope is to not only have everything for the car prepared and made, but also to have great models and databases for next year. Nothing should have to be redone next year with the aid of well modeled components and spreadsheets containing information about bought parts like fuel fittings and fasteners. All of this work should lead to more time for innovation and research for future cars.



Gas and Overflow Tanks:
Some design changes for this year's car include a newly shaped gas tank with an efficient capacity and baffles to minimize weight while increasing flow performance. The coolant and oil overflow tanks will be made from welded aluminum sheet metal. The coolant fill neck will be the highest component in the cooling system, eliminating the need for a higher fill tank.

Muffler and Electricals:
A third mount will be used on the Muzzy's Performance muffler to improve rigidity and impede vibration from the engine. The electrical components and wiring have not been efficiently placed and routed in previous years, making our engine bay cluttered and unappealing. The plan this year is to place components such that minimum wiring length is needed and the wires are able to be consolidated and hidden. All in all most of the design changes for this year will help to improve reliability and appeal of the Formula car.

Nate Lenz
Sophomore | Mechanical Engineering |
Controls Team Leader

Controls:

The focus for controls this year was to reduce the weight of all the components of the system while also designing for manufacturability and cost.

Steering:

The steering wheel will once again use a waterjet cut carbon fiber sandwich panel for the profile and utilize 3D printed ergonomic grips. It was also designed with paddles in mind for paddle shifting, should that be implemented later.

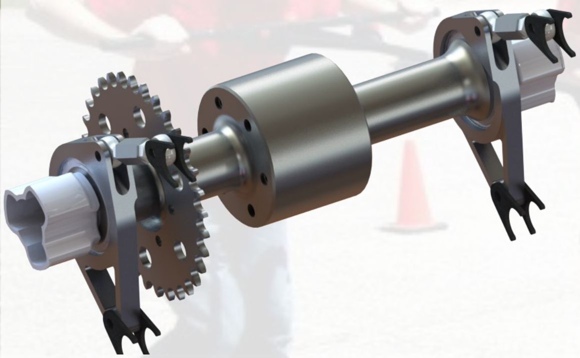
Pedal Tray:

The pedal tray assembly this year shifted from a large, heavy aluminum plate spanning both pedals to two independent mounts that significantly reduce the weight of this system. 3D Printed heel cups were implemented this year to provide a place to rest the drivers' feet and reduce fatigue on the driver's legs. The brake pedal is aircraft-grade 7050 series aluminum alloy which was waterjet cut to reduce manufacturing time. The throttle pedal is lasercut 1020 mild steel which is folded and welded into shape. The throttle cam is 3D printed and integrated into the throttle pedal. Both pedals use carbon fiber faces to increase the surface contact of the drivers' shoes against the pedal.

Tyler Jones | Junior | Mechanical Engineering | Project Director, Vice-President, Controls Co-Lead

Differential:

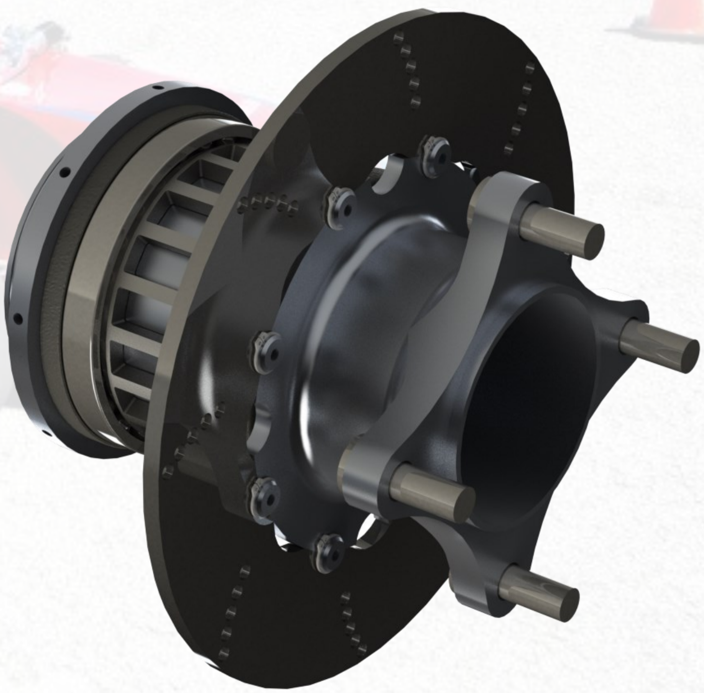
The differential assembly on this year's car is composed of a custom machined aluminum differential housing, the gear set from a Torsen T-1 limited slip differential, RCV Performance gun-drilled stub shafts and machined aluminum mounts. The primary improvement for the differential on CR20 is the addition of roller bearings between the shafts and the differential housing. The bearings will help reduce rolling resistance and component wear for the differential system. The differential mounts are asymmetric, with the right mount being slimmed down in consideration of its lesser load.



Nick Grady
Senior | Mechanical Engineering | Final Drive Team Leader

Hubs:

The hub assembly has been shortened this year, reducing weight of the hub itself, the bearing spacer, and the upright. The thin section deep groove ball bearings we use are large enough for a CV joint housing in the rear of the hub, while still thin enough to allow good packaging within the uprights.



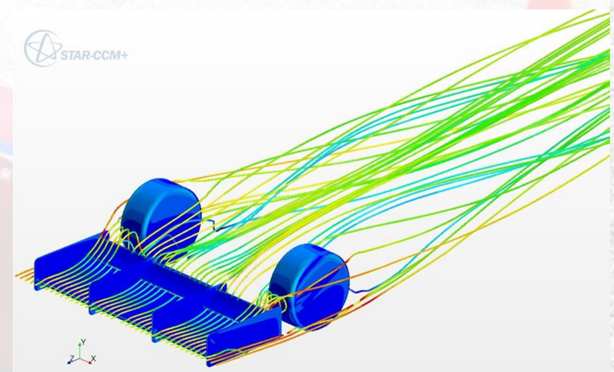
Sean Salzer
Senior | Mechanical Engineering | Aero-dynamics Team Leader

Aerodynamics:

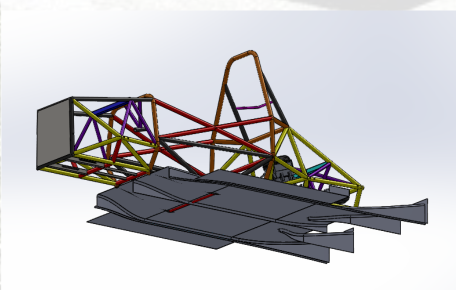
This is the first year since the early 2000s that the car will feature an aerodynamic package, which includes a under-tray and a front and rear wing. Aerodynamic downforce, produced by the multi-element wings and under-tray will increase the vehicle's cornering ability, effectively decreasing lap times.

Roger Steinforth
Senior | Mechanical Engineering | Aero-dynamics Team Leader

Wings: A downforce goal of 80lbs at 40 mph, and an overall wing system weight of 20lbs was set for this year. The size of the wing design is constrained by the rules set by Formula SAE, but aside from that the team is free to design the wings how they see fit. The aerodynamics team began by taking a modest approach to the wing design with the selection of a dual-element wing at both the front and rear of the car. The team then went through an iterative process using computer simulation software to find the best pairing of airfoils and to find the optimum sizes and angles of attack for these airfoils.



Under-tray: In addition to our wings we are hoping to utilize an under-tray to generate down-force along the bottom of the car. Due to the large amount of material required to make it as well as the requirement of a large oven to cure the material, it is not certain that it will be finished and ready in time for competitions. Nevertheless from the experience we will be better prepared for next year.



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