

From Concept to Checkered Flag: How a Team at KU Builds a Racecar from Scratch



Members of the Jayhawk Motorsports team fine-tune key components of their racecar during the construction phase, pushing to ensure every part meets competition standards.

Inside Learned Hall, the hub of KU's engineering complex, Room 1109 thrums with the whirl of tools, the pulse of machinery and the focused chatter of the Jayhawk Motorsports team.

Students weave between workstations with practiced composure, each movement feeding the controlled chaos of a car coming to life.

Everything they do in this room points toward a single goal: building a machine worthy of the world stage.

Jayhawk Motorsports gives students hands-on experience designing and building a racecar from the ground up to compete in Formula SAE — one of the world's most demanding collegiate engineering competitions, where universities from across the globe race to prove their technical prowess.

"You have 100 engineering programs with their smartest engineering students all at the same place at one time," said manufacturing director, senior Kyle Maddox.

Since 1994, JMS has provided students with the opportunity to design and construct a machine optimized for speed and acceleration, enabling them to apply their engineering knowledge and skills to a real-world application.

The program has welcomed not only engineers from every discipline — mechanical, aerospace, civil, computer science and beyond — but any student eager to take on the challenge of designing a vehicle born to shoot across the asphalt.

One of those students, senior Christian Cox, has been a part of Jayhawk Motorsports all four years of his college career, starting as a freshman volunteer and now heading the organization as team lead.

“My job is to solve problems, so if something needs to be done, I get it done or find somebody who can,” Cox said. “My goal is to keep the team on track, and make sure where we need to go, where we need to be and where we are are all in line with each other.”

As team lead, Cox’s duties start well ahead of the fall semester, with months of design work on paper and screen laying the foundation for the car’s performance before the first bolt is fastened.

“We’re all engineers, we get really excited if we say we’re going to go design a new car,” Cox said. “It’s not feasible for us to redesign every single part on the car every year, so we really take into account what the previous designs were and figure out how we can improve them.”

The design process for a new racecar begins in the summer before the fall semester, providing JMS members an ideal opportunity to collaborate and outline the vehicle’s schematics and details before classes and coursework start to demand their attention.

Drawing on over three decades of experience from past builds, every team member contributes something to the car’s design, bringing distinct perspectives and voices to the blueprint that will eventually come to fruition later in the semester.

Consisting of nearly 40 individuals, ranging from volunteers to full-time team members with specific roles, the JMS team ensures that they are well-equipped to begin construction once the fall semester kicks off.



Senior Noah Alsup tinkers with the interior of the racecar on Oct. 23, 2025. Alsup is part of the electronics team and is responsible for high-voltage components, the inverter and cooling.

Funding and the Workshop

Constructing a racecar is no small feat, and it demands extensive manpower, extraordinary precision and a significant amount of financial support.

"If I had to give an estimate, I'd say it's around \$100,000, but we have fundraising we do ourselves, we get donations from companies and we are funded through the engineering department and endowment," Maddox said.

"Count all donations we get, and it might be about a million dollars – definitely at least \$500,000 worth of material and machining each year."

This extensive backing allows the team to turn their most ambitious ideas into reality each year. They remain deeply grateful to the university, engineering departments and donors whose contributions make such progress possible.

"It's inspirational because that support goes back into the team, so that new young engineers can continue the cycle of doing this program," Maddox said.

The impact of that support is clear, with last year's car relying on a meticulously assembled system of more than 1,300 parts.

JMS receives support from alumni contributions, corporate donations from companies like Tesla and sponsorships from organizations such as the Kiewit Corporation.

That funding turns immediately into shop-floor action in the basement of Learned Hall, fueling a workspace where students fabricate most of the car's parts amid rows of mills, saws, lathes and drills.

It's a collection of high-performance tools that demand skill and steady hands to produce the parts needed for a car built for top-tier handling, acceleration and control.

However, the human touch can only go so far, so the team turns to computer numerical control (CNC) machines for precision work.



The interior of the CNC machine sits idle, its precision tools ready to fabricate custom parts for the Jayhawk Motorsports team.

CNC machines are advanced automated tools that follow digitally coded instructions to create custom parts and are used across industries such as aerospace and telecommunications.

Senior Miles Worick is one member of the team who can operate the intricate machine instrumental to the racecar's construction.

"I do manufacturing, and I know how to run the CMC, which makes a lot of parts for the car," Worick said. "Right now, I'm working on the outer wheel hubs, which help with support and rotation for the tires."

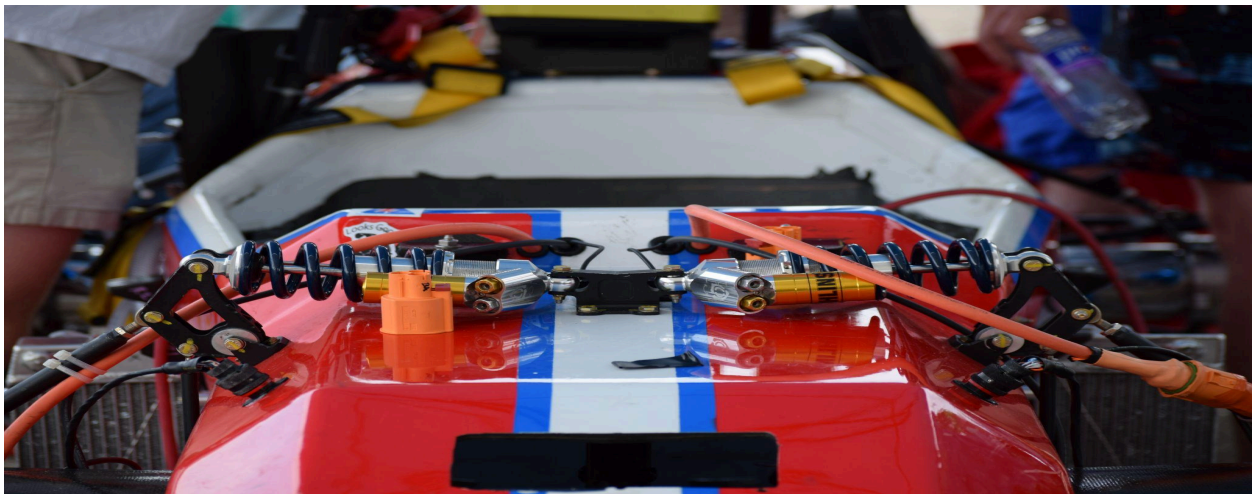
Outer wheel hubs aren't the only part the machine makes, as it can carve metals, composites and advanced materials like carbon fiber using precision techniques such as milling, turning and drilling, all of which are invaluable during the design stage.

The design process typically wraps up by the start of the fall semester, just as students return to campus, after which the JMS team transitions into the construction phase.

Construction Phase: Electronics

Operating as a cohesive unit, the team is divided into four subgroups that focus on different aspects of the car's performance: electronics, aerodynamics, chassis and vehicle dynamics.

"Working with a team provides a really good perspective on how the industry looks," senior Elliott Fortmeyer said. "All engineers work on teams, and this is less of a project and more of good job practice because we have deliverables and people we report to, like in the real world."



The racecar's front assembly reveals the high-voltage wiring and control hardware that the electronics team designs. Maintaining it ensures the vehicle's power and safety systems perform reliably.

Fortmeyer is one of seven members on the electronics team, which is responsible for designing and implementing the vehicle's electrical systems, including the battery and control systems that are critical for performance and safety.

Fortmeyer takes care of the wiring and the low voltage box that powers everything under 30 volts on the car.

“We’ve had a lot of issues with wiring, and my goal is to make a modular, organized harness that can be easily accessible, so we can work on things and take them in and out of the car without having to organize the spiderweb of wires,” Fortmeyer said.

The other electronic team members handle aspects from the cooling system and steering wheel to high and low-voltage pieces.

Electronics lead, senior Hayden Grenier, is responsible for key electrical components, including the accumulator, which is essentially the racecar’s battery pack, storing the power that feeds the motors, giving the car the energy it needs for quick, silent bursts of acceleration.

“The impact is pretty significant because this is an electric car, and I have to keep track of progress and the overall goal of the group as a whole,” Grenier said.

Other university motorsports teams choose to implement an internal-combustion system to run their racecar, relying on fossil fuels like oil for power, but the JMS team believes electric is the superior option.

“We continue to choose EV [electric vehicle] because we believe the highest potential for the fastest possible car is in EV,” Grenier said. “The best teams are competing in EV, and we want to be competitive with the best.”

Electric racecars deliver instant torque, rapid acceleration and greater control, all while relying on fewer moving parts, which keeps operational costs low.

In contrast, internal combustion racecars generate more horsepower, feature advanced cooling systems and boast greater durability, allowing for higher top speeds and superior endurance.

“One pro I will mention about combustion is we do tend to have a lot of knowledge on it through our classes, whereas electrical it takes more out-of-the-box thinking,” Grenier said. “We are still fully capable of producing a working electrical system, though.”

While electricity serves as the vehicle’s primary power source, the three other teams contributing to the racecar’s development are equally vital.

Aerodynamics Team



This car, one of the JMS team's previous builds in the 2020s, utilizes several aspects of aerodynamic design, including diffusers and wings.

The aerodynamics team, which focuses on optimizing the vehicle's performance to maximize speed, stability and efficiency, is co-led by seniors Monique Vieux and Daniel Estingoy.

Vieux and Estingoy are tasked with creating the front and rear wings on the vehicle, which are both crucial aerodynamic pieces that generate downforce, helping the racecar grip the track and maintain stability during cornering.

"It's not debatable, aero cars are multiple seconds faster than non-aero cars, and we increase lap times," Estingoy said. "Aero allows the car to accelerate at 2 G's force through most turns, and it really shows maturity in a program to have good aero on the car."

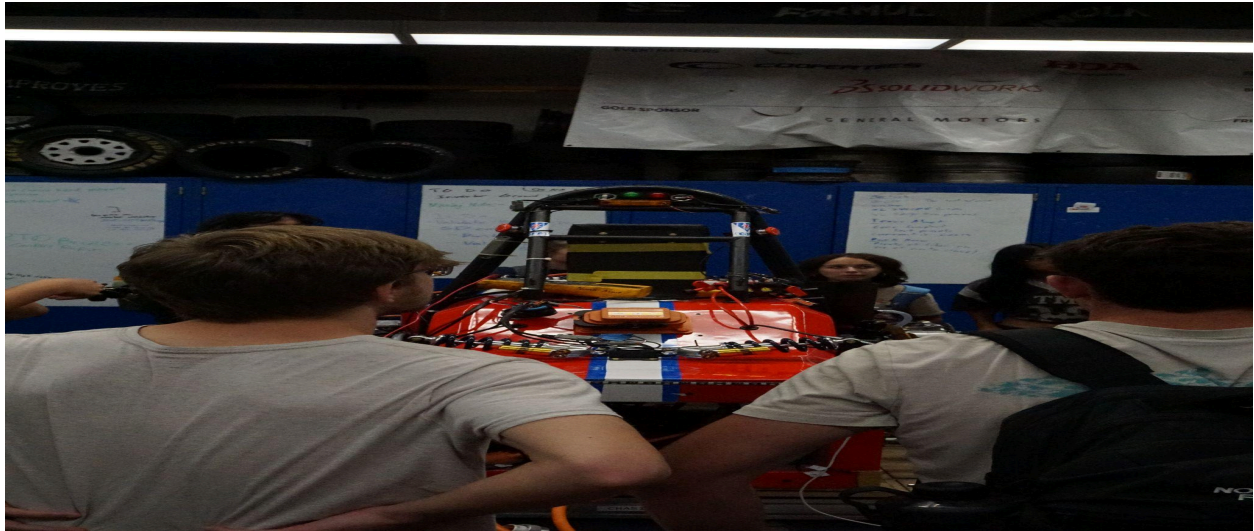
Poor aerodynamics can severely limit a car's performance, while well-designed components, such as wings, spoilers and diffusers, reduce lift, increase downforce and minimize drag to keep the car planted and performing at its peak.

"You could just call the aero decoration, but this is a once-in-a-career point where I get to apply myself at a high degree, making cutting-edge parts for a racecar," Estingoy said. "I get to show what I'm worth beyond my GPA."

Far from mere decoration, the aerodynamic innovations developed by Estingoy, Vieux and their team enhance the vehicle's capabilities, working in tandem with the chassis team's structural design.

Chassis Team

The chassis serves as the racecar's backbone and base frame, forming the structural framework that connects the engine, suspension and body. It supports every major system, making it a fundamental factor in how the car functions on the track.



Members of the JMS team surround a near-completed chassis, guaranteeing it's structure can hold up against the intense forces of racing.

Designed to be both lightweight and rigid, the chassis shapes the car's stability across different tracks.

It also plays a key role in weight distribution during high-speed maneuvers and serves as a protective shell for the driver, absorbing impacts and shielding vital components like the fuel tank and steering system.

"I'm doing all the structural testing for it to ensure safety," said chassis team lead, senior Ben Hylton. "We make sure that what we're building is safe for the people around us. We wouldn't want to get crashed into and have the accumulator box rupture and pose a fire hazard for the driver or anyone else."

As the heart of the racecar, the design and execution of the chassis is paramount to the success not only of the team, but the driver behind the wheel, too.

However, even the most well-built chassis can't reach its full potential without the vehicle dynamics team — the group responsible for every moving component of the racecar, from the motor to the steering system.

Vehicle Dynamics Team

The vehicle dynamics team studies the interactions between the car's systems, such as tires and suspension, to ensure that the vehicle responds predictably under various conditions.

Vehicle dynamics team lead, senior Noah Kaster, oversees every dynamic component of the racecar, and his primary focus is on the steering and cooling systems.

Kaster is glad he can help be an integral part of building the car and appreciates the program's immersive nature.



The backside of the team's 2024 car, made up of thousands of moving parts, each integral to the functioning of the racecar. Most racecars have over 2,000 moving parts.

"It's not like a class where my professor says, 'Here's a slide, go do something with that information,'" Kaster said. "I actually get to apply real-world aspects of engineering by helping build a race car."

Another member of the vehicle dynamics team, senior Jaeden Parker, oversees the suspension and the anti-roll bar (ARB), both of which play a big role in the car's handling.

"I'm responsible for overall suspension geometry," Parker said. "That essentially affects how well the car can handle, making sure the tires have the most consistent force between all of them, and using things like springs and dampers to make sure that happens."

A consensus among drivers at the collegiate and pro level is that tires are the most important part of a race car, providing grip, traction and control to navigate the track at high speeds.

"Obviously, without tires, you can't go anywhere," senior Nick Campbell said. "The awesome thing about our tires is that we are one of the few universities to incorporate carbon fiber in them."

Campbell, who is part of the electronics team and is responsible for the steering wheel and sensors, recognizes the importance of crafting the best version of wheels possible, especially with a material like carbon fiber.

"Carbon fiber is lightweight, is a lot stronger than aluminum, which is what other teams use in their builds, and also helps improve braking and handling," Campbell said. "Our chassis is built of carbon fiber, too."

This emphasis on advanced materials like carbon fiber helps push the team's engineering skills to their limits.

"Our carbon wheels are the most complex part of the car to build," Maddox said. "The mold was designed by one of our graduate students, and he stuck around for another four years to complete it in-house. It's not something easy to do."



The team's carbon fiber wheels is a staple of its build, and gets constant attention and awe from other Formula SAE when competition arrives.

While many components of the car, including the tires, are complex and striking in design, the team ensures that the build process remains approachable for every member.

"We take a lot of pride in what we do, and it's more about the experience than spending a lot of money to improve our build," senior Dang Nguyen said. "We don't want people to feel like they're putting together pieces of a massive LEGO set; we want them to feel comfortable."

Compared to traditional building materials in racecars like aluminum, fiberglass and steel, carbon fiber stands out for its flexibility, race-day durability and corrosion resistance, helping extend the life of not just the chassis but the tires as well.

Building with such advanced materials demands collaboration and countless hours of hands-on work, and it's a challenge the team meets together.

Weekly Work and Testing

Throughout the year, every Tuesday and Thursday at 6 p.m., and again on Saturday at 9 a.m., all members gather for a brief meeting before dispersing into the engineering complex to work on the car.

Sometimes, the team works into the next morning, spending at least 30 or more hours a week laboring over each component of the vehicle.

It's a hive of craftsmanship, hard work and resourcefulness, as each subgroup is a crucial piece of the puzzle, working side by side to shape the car from scratch.

No outside help, just ingenuity, sweat and teamwork.

"I am in charge of the bill of materials, which is essentially a huge document that lists all of the components that we make and buy throughout the year," Maddox said. "Practically every part that is on that document is made by hand by students."

While anyone is welcome to join the team, most members are juniors and seniors who take it as part of their engineering capstone course.

The project serves as a culmination of everything they've learned over their collegiate careers and a chance to see their ideas take shape in the form of a fully functioning racecar.

However, before members can see the car take shape, months must pass before it's ready to compete against other universities, which is when the team conducts testing.

Testing typically begins in May, once the car is fully assembled after hundreds of hours of meticulous work in the engineering shop.

The team sets aside time for practice and smaller-scale testing, and one key component of this is the use of go-karts to familiarize students with seating positions, handling and the fundamentals of vehicle dynamics without the risks or pressure of a full-speed racecar.



This go-kart, one of several the team uses for testing, makes it easier for students to acclimate themselves to the rigors of driving a racecar.

“My favorite memory so far was the day we took the go-kart out for the first time,” Grenier said. “I wasn’t expecting it to rip as hard as it did, and it really put a big smile on my face. That was probably my greatest memory so far.”

With university approval, the team rolls the go-karts and eventually the racecar out to a parking lot on the west side of campus, where a few chosen members take turns behind the wheel, putting the vehicle’s most critical functions to the test.

Testing is the primary way the team evaluates how its MoTeC (Motor Technology) and suspension setup perform.

The MoTeC system works like the car’s brain, managing the engine, traction and data logging so the team can calibrate performance and keep the car running at its best.

Suspension setup fine-tunes the car, adjusting elements like ride height, camber, toe and spring rates to keep the car balanced and responsive. These adjustments improve handling and traction while helping the car adapt to different track conditions.

Together, these systems enable the team to monitor and adjust nearly every aspect of the car’s dynamics, and their reliability, adaptability and precision make them essential tools in the high-stakes environment of racing.

Heading to Competition

After testing wraps and the data is analyzed, the JMS team makes its final adjustments and refinements before heading to the Michigan International Speedway in Brooklyn, Michigan, for the annual Formula SAE competition. This year’s competition spans five days, starting June 17 and ending June 21.



Getting to competition takes months of hard work and dedication, and the JMS team is always proud when they’re able to showcase and roll the car out for the first time in front of opponents.

The Formula Society of Automotive Engineers challenges teams of students to imagine, design, build and race their own small formula-style cars, each team working through a full cycle of design, fabrication and preparation for competition.

The vehicles are evaluated through a mix of static events, such as cost analysis, design reviews and presentations, and dynamic events including performance trials and endurance runs.

The process gives students a real taste of what it takes to go from concept to competition, with over one hundred universities from all over the world coming to test their mettle.

“It’s not just a U.S. competition,” Maddox said. “There are Spanish, Singaporean, Japanese and German teams, and it really gives you a perspective on how hard people are working.”

JMS enters this season hungry for redemption, as it brought a car to last year’s Formula SAE, but did not compete.

“Last year’s team went to competition, but they did not ever track the car there due to technical and mechanical problems,” Maddox said. “We want to prove everything that last year’s team has done.”

Each day is packed with rigorous tests as each car is evaluated under the sharp eyes of judges with engineering degrees and years of hands-on experience in the automotive industry.

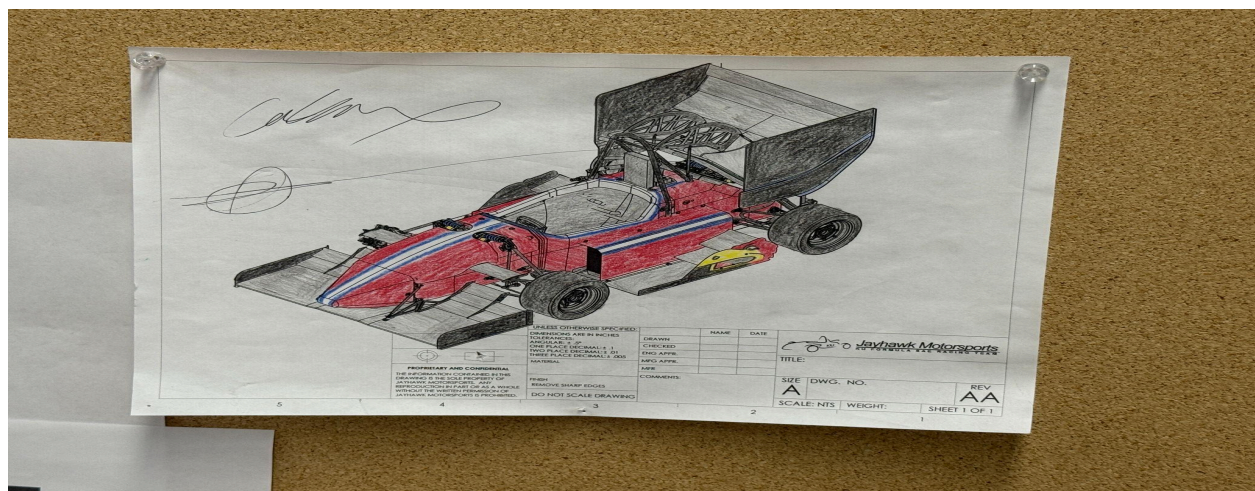
Before any engines roar to life, each car undergoes a detailed technical inspection to ensure it meets the strict standards of the FSAE rulebook, a document exceeding more than 140 pages.

It’s an exhaustive but necessary process, with judges inspecting components such as aerodynamics, batteries and braking to ensure no team gains an unfair advantage.

Static Events

If the team passes the inspection, is is cleared for static events, which include presentation, cost and manufacturing and design.

The presentation event tests how well the team can develop and pitch a solid business, production or technical plan that would persuade potential investors to back its concept.



The design stage paves the way for all the hard work that follows later in the season, an aspect that returns when JMS has to present during the static events.

Building a racecar is not simply about how well it performs on the race track, but how well students can effectively communicate their ideas, challenges and solutions during each process of the racecar's construction.

"To me, the most important thing they can learn is how to work on a project, and how to explain things to people that don't see it your way," JMS faculty advisor Dr. Robert Sorem said.

Next, the cost and manufacturing event evaluates how well the team managed a budget and designed their car with production efficiency in mind.

The event is crucial for ensuring that the vehicle is not only competitive in terms of performance but also financially sustainable in its production.

Lastly, the design event assesses the team's engineering effort and how effectively its design meets market expectations for innovation and overall value.

This is one of the prime opportunities for students to showcase engineering skills and receive constructive feedback on their final blueprint.

"The best part of competition is when we roll our car out and the students are proud of what we've produced compared to other teams," Sorem said.

Each event carries a specific point value — 75 points for presentation, 100 for cost and manufacturing, and 150 for design — with higher scores reflecting stronger overall performance.

The static events highlight teamwork and preparation, proving just as crucial as the dynamic ones in showing judges that teams care about both how their car performs and how it's presented.

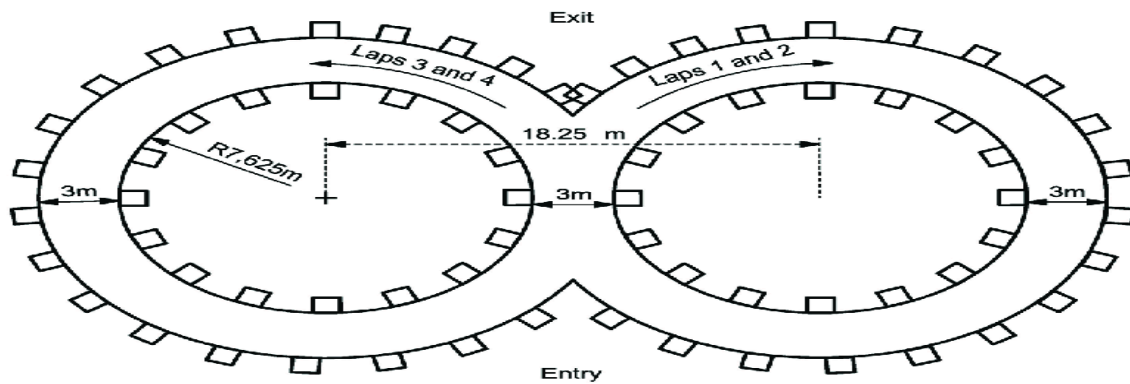
Dynamic Events

When the static events end, teams gear up for the dynamic stage, putting a driver behind the wheel to finally hit the asphalt and burn some rubber.

There are five dynamic tests designed to simulate real-world racing conditions: acceleration, skid pad, autocross, efficiency and endurance.

It begins with the acceleration event, where cars sprint 70 meters from a standing start on flat pavement, racing for the fastest time in up to four runs while avoiding penalties for hitting cones or going off course.

From there, the skid pad tests cornering skill, measuring how quickly a car can complete one left-hand and one right-hand circle, emphasizing suspension performance, lateral grip and stability.



This diagram is the exact path drivers must take to complete the skid pad test, a dynamic event worth 75 points.

Next comes autocross, a half-mile, cone-marked course packed with slaloms, hairpins and chicanes, challenging each car's maneuverability and handling at average speeds of 25 to 30 mph, with teams given multiple attempts to post their best time.

The competition then ramps up with endurance, a 13-mile multi-lap test, requiring two drivers to share the distance with a mandatory driver change while navigating designated passing zones and avoiding penalties, all without any stops or repairs during the run.

Finally, the efficiency event rewards smart engineering, measuring how much energy an electric vehicle consumes over the endurance course and awarding points for completing the distance efficiently.

Like the static events, each dynamic event carries a specific point value: skid pad is worth 75, acceleration and efficiency 100 each, autocross 125 and endurance 275, reflecting their impact on overall competition performance.

Combined, the static and dynamic events offer teams a maximum of 1,000 points, with the team earning the highest total over the five days of competition crowned the overall winner.

The JMS team was unable to compete in 2024, but placed 45th out of 114 competitors during the 2023 FSAE competition, earning a total of 417.7 points.

The team still has some work to do before the students feel comfortable competing come this June, but they're confident they can come back stronger, ready to take on elite opponents.

"I wasn't able to go my first two years, but last year I was finally able to go with the team, and it was just an incredible time," Cox said. "A whole week of a lot of hard work out in the sun, but a lot of fun anyway."



Even though the JMS team wasn't able to track their car during the 2024 Formula SAE, it was still a great learning experience for several of its members.

Competition is still a semester away, but the team has faith it will be ready for the checkered flag, guided by Sorem, who has been a steadfast mentor of the program for more than three decades.

A Pillar of Guidance

Sorem has been a professor in the engineering school since 1994, and stepped in as the faculty advisor of the program in 1995-1996, a position that was entirely new to him.

He solely inherited the role after the departure of the program's creator, Dr. Don Gerag, and co-advisor Robin Dillard, just two years after the JMS program began on campus.

"I'd never been to competition; I had no idea what it was like," Sorem said.

That year, the team's car fell short of passing technical inspection at the 1996 FSAE competition, the first event Sorem attended with the group.

It was a turning point.

"If we're going to do it, either we're going to do it and do it well, or we're not going to do it," Sorem said.

It was advice the team took to heart, passing technical inspection the next year, tracking the JMS car for the first time.

"I made the commitment, and really the students made the commitment after that point, and we just have grown on that and built on that," Sorem said.

The team would make advancements over the next several years, becoming the first in several categories, including the first to introduce a monocoque chassis, a one-piece body-and-frame design no other team had adopted at the time

That momentum would set the stage for a pivotal shift in the mid-2000s.

“We really made a breakthrough starting in the '04, '05 season,” Sorem said. “We had a couple of underclassmen who were good drivers, and that's when we started becoming a good team.”

Typically, the focus is so heavily placed on building the racecar that finding a good driver can fall to the background; yet, securing a skilled person behind the wheel becomes a major asset when competition arrives.

As faculty advisor, Sorem wears countless hats, shifting from cheerleader and encourager to technical advisor and analysis expert, all while guiding the team through a semester that requires immense dedication.

“This is a hard project, and as you talk to the students, there’s a time commitment tied with everything they have to do, and sacrifices they have to make,” Sorem said. “Each year, Formula SAE has a slogan, and one year its slogan was ‘FSAE: What a way to wreck a relationship.’”

Sorem joked that many students’ significant others aren’t exactly thrilled to see them disappear into the shop for hours on end, but the students show up anyway because they genuinely love the work.

“One of the coolest things I remember was the '07 team, because it was the first year the students planned and set up a big unveiling,” Sorem said. “I walked in in the morning and saw students’ heads pop up in the lab, with smiles on their faces. They’d worked all night, but they were having fun.”

To an outsider, the motorsports program may seem defined by the racecar it builds, but the program is about far more than the car.



The interior of the JMS team’s racecar is compact and narrow, while the steering wheel provides drivers with supreme levels of control and realism.

The program's roots stretch back more than three decades and are interwoven with the work of thousands of students, each adding their own chapter to a long history of innovation, collaboration and hands-on engineering.

"It's not a year-to-year project," Sorem said. "It's a program. You've got a lot of support, and you've got a lot of people watching over you."

Some of JMS's biggest contributors are alumni who were deeply involved in the team long before they graduated.

Their work often follows them well beyond their time at KU, opening doors professionally and helping them build careers rooted in the skills they developed in the shop.

One example, Sorem said, is a freshman student named Colin Snyder, who arrived at KU in 2006 and helped the team develop its unique carbon rims — technology no other team has been able to reproduce.

"Colin spent a lot of time developing how to lay them out, and he got his own company started doing carbon rims," Sorem said. "He developed it to the point that they are original equipment available on upper-end performance, with companies such as Stellantis, Chrysler and Dodge."

Watching alumni grow and succeed in the real world has been a pleasure for Sorem, and it has given him a front-row seat to the team's evolution over the years.

"It used to be pretty much a bare-bones car," Sorem said. "Everything has gotten more and more complicated along with all of the sensors and everything else on the car, and we've made huge leaps and dramatically improved."

Yet those leaps forward haven't come without obstacles, most notably, having to navigate the disruptions of COVID.

The pandemic hindered students' ability to work together, with social distancing making collaboration and communication more difficult. It also left people feeling isolated and separated.

"We lost a lot with COVID, and I think students lost a lot of understanding and ability to work on teams," Sorem said. "We struggled, I have anyway, rebuilding the team and getting students working together on it."

Even though COVID disrupted the learning of students everywhere, it didn't stop Sorem and his team from persevering.



The 2024 JMS team poses for a photo inside David Booth Memorial Stadium at the end of their season.

“I’d say we’re pretty much back to where we started before COVID,” Sorem said. “We’re a small program, so seeing students that probably never talked to each other before, that are now interacting on a daily basis on it, that’s cool.”

Another challenge for the JMS team comes from the sheer size and scale of many of the schools they compete against.

“Most people, when KU shows up, think a major university, a major player, a large program, but we’ve got 500 ME students, maybe 550 ME students,” Sorem said. “Texas A&M and some of the other schools have 10 times that.”

Although JMS may have far fewer students to draw from, it can still go toe-to-toe with some of the biggest programs out there.

“We have a much smaller pool that we’re pulling students from, but we’re competing against the big boys in and of itself, and that’s rewarding,” Sorem said.

While the team has navigated challenges during its time in the program, such as COVID, and faced obstacles after graduation, like learning to adapt in environments where members start at the bottom, Sorem said there is one thing that remains most important to him during every student’s time with the program.

“The personal interaction, to me, that’s the most important thing they learn and walk out with,” Sorem said. “How to work on a project, and come up with a common solution that everybody’s in agreement with moving forward.”

Learning to work as a team is something students carry long past graduation, and this June, when the engine hums and the tires bite into the track, it won't just mark another race — it will carry forward a legacy built on the belief that effort and curiosity can take you anywhere.

"If you understand what it takes, and you're dedicated and willing to learn, you can do just about anything," Sorem said.