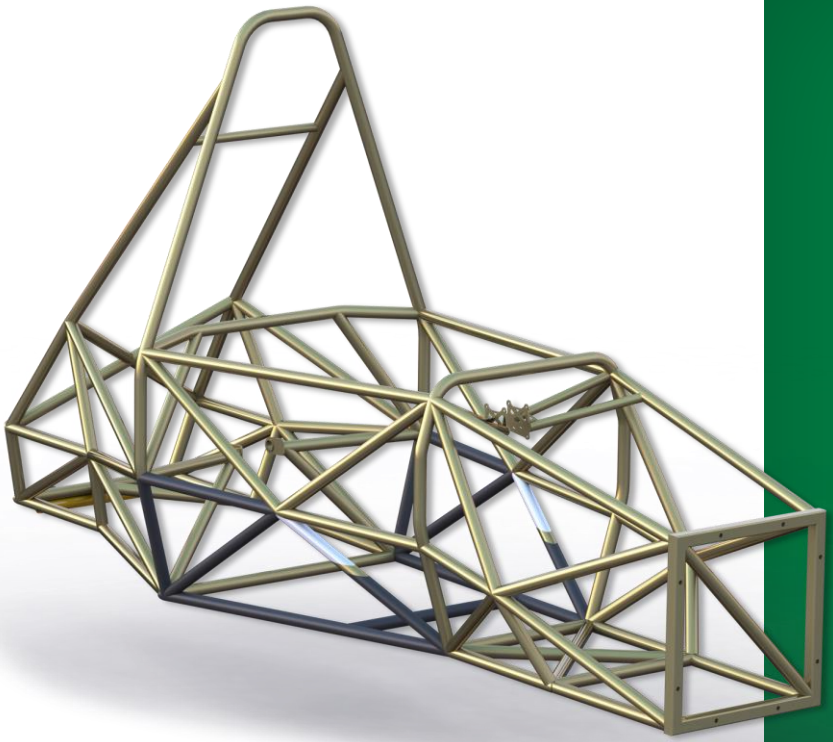
UNIVERSITY OF ALBERTA
FORMULA
RACING

UA-20 VIRTUAL REVEAL

FACULTY OF
ENGINEERING
UNIVERSITY OF ALBERTA

Following several challenging years, the UA-19 proved to be our most competitive car in almost a decade. The goal of the UA-20 was to refine our engineering designs using an iterative approach and incorporating the lessons learned from an extensive testing campaign and success at two competitions. We set out to create a cohesive package based on well defined and complimentary design goals. Changes were only made if they contributed to the objectives that were laid out and attention was given to the full development process, from design through to manufacturing. The result is a car that we believe is simple, effective, and well thought out, which is why we are thrilled to introduce to you: **UA-20**.



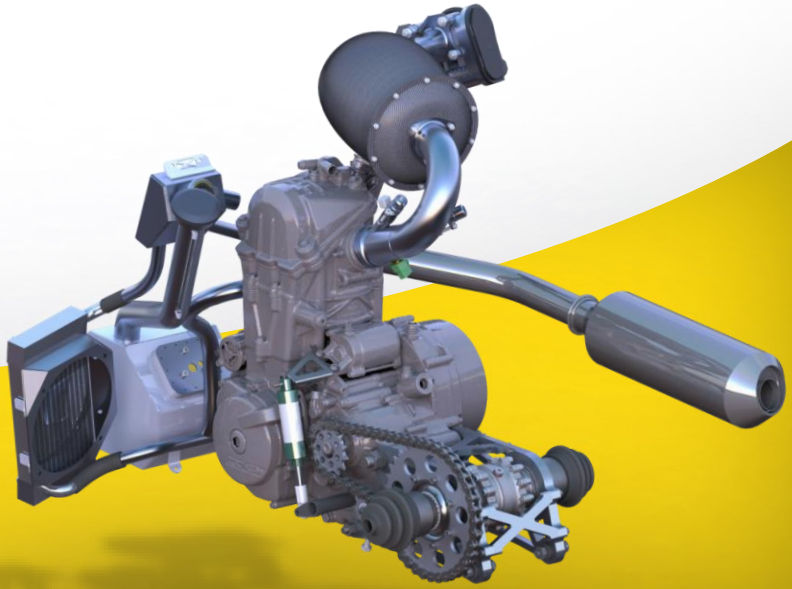
CORE STRENGTH

The chassis can be considered one of the defining features of a vehicle; dictating weight, stiffness, and packaging. The UA-20 chassis is formed of 4130 steel tubing, selected for its high strength and energy absorption compared to traditional low-carbon steels. The tube-frame is fabricated using laser-cut steel jigs ensuring close dimensional tolerances. SOLIDWORKS Simulation analysis is used to create a lightweight chassis that still meets rigidity targets and rules compliance.

Roll hoops are narrowed *from the UA-19 to increase driver visibility. Minor changes have been made throughout to* ***mitigate applied bending stresses*** *and major changes in the rear improve drivetrain geometry and powertrain mounting.*

POWER AND RELIABILITY

The UA-20 powertrain consists of a polyurethane soft-mounted KTM-supplied LC4 690 cc single-cylinder engine that extracts 60 hp and 48 lbf·ft of torque from E85 fuel, as tuned on our in-house dynamometer. Electronic throttle control uses a 32 mm Bosch Motorsports throttle body and an optimized carbon fibre intake plenum to achieve enhanced throttle response and improved combustion – all while utilizing the 19 mm inlet restrictor required for competition. Engine temperature is maintained with dual internally mounted radiators. Pull-type fans assist air through the carbon fibre cooling ducts developed in conjunction with the aerodynamics package.

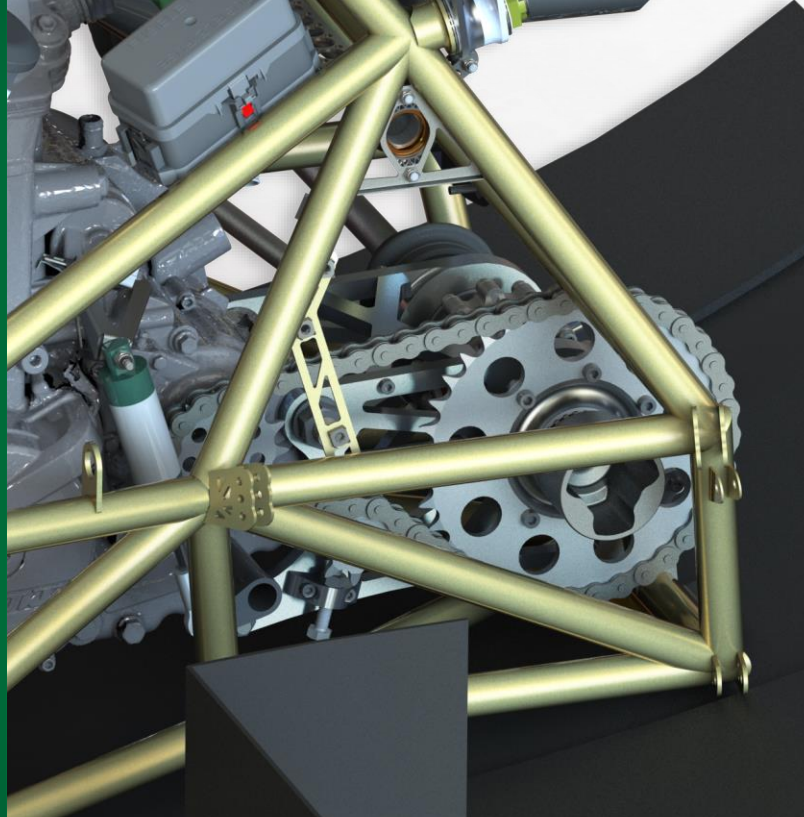


*The UA-20 changed to **soft mounting the engine** to increase drive comfort and mitigate the damage seen due to vibration on the UA-19, including failed electronic circuit boards and a cracked chassis tube. **Electronic throttle control** improves throttle response issues seen on the UA-19.*

DRIVING FORCE

Extensive work was put into developing a drivetrain that packages nicely with the new KTM LC4 power plant while still reliably transferring the power. Six forward gears and a chain drive send torque to the rear wheels via an adjustable Drexler limited slip differential and constant velocity drive shafts. Gear ratios have been optimized with a 5.8:1 final drive to ensure the driver is able to put power down in any competition event. The differential mount hangers double as engine mounts, with the entire powertrain and drivetrain soft-mounted to reduce vibrations transferred to the chassis.

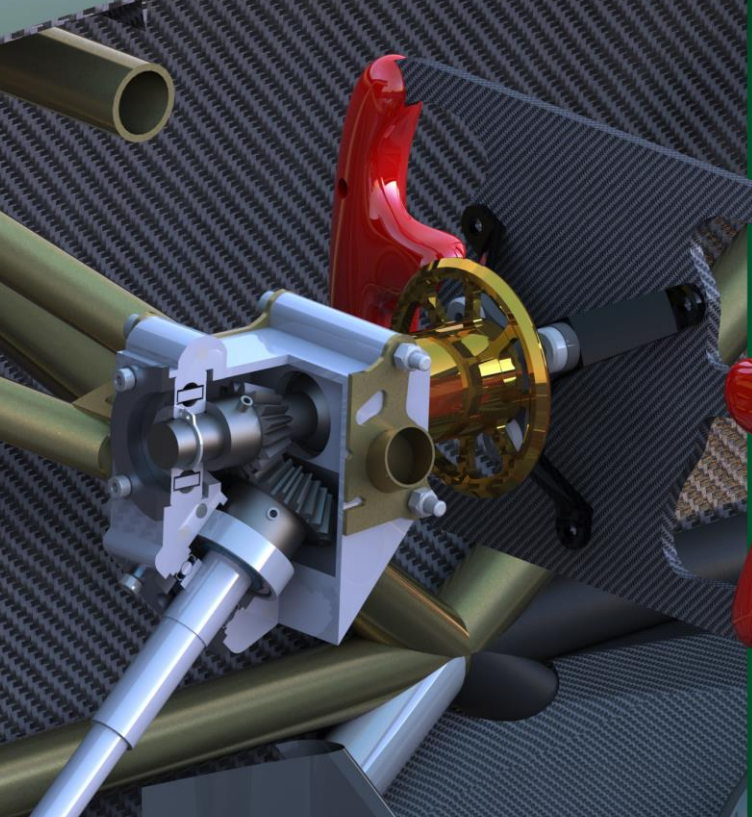
*The **differential has been moved** forward to correct the UA-19's high drive shaft angles and to remove bending forces applied to the chassis tubes. The cam-type chain tensioner of the UA-19 has been replaced with an **idler-type tensioner** to ease adjustment and maintain correct drive shaft angle.*



AERODYNAMIC FORM

The UA-20 features the first ever full aerodynamics package for the University of Alberta Formula Racing team. Experimentation with composite manufacturing techniques also led to the adoption of a new carbon composite layup strategy that when combined with our vacuum resin infusion process, brought both increases in component strength and significant decreases in weight.

*An investment into a **tailor-made computing station** and support from **ANSYS and Beta CAE** and their respective software suites, the team has been able to simulate and engineer the UA-20's aerodynamics from the top down. **Evonik and their ROHACELL Foam Cores** have also been used to cut weight and improve tolerancing of aero parts manufactured for the UA-20.*

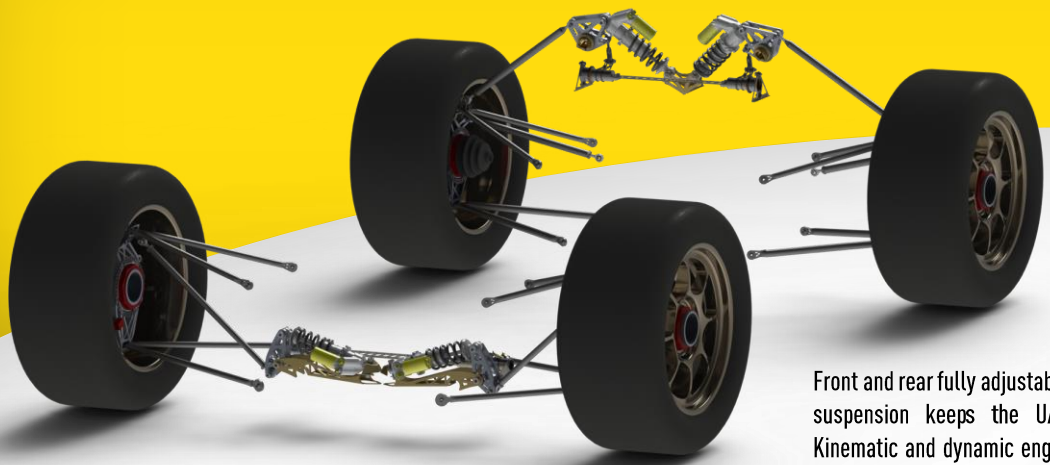


CONFIDENT CONTROL

A confident driver is a fast driver. Ergonomically positioned controls keep drivers confident behind the wheel of the UA-20. Optimized steering geometry and ratio selection, thanks to a custom bevel gearbox, provide reduced steering effort and maximum driver feedback. Carbon fibre, aluminum, and steel are carefully used to balance rigidity and weight savings.

Steering compliance *has been an ongoing issue for several years. Improving on the UA-19's steering column support tube, the* ***driving position and feedback*** *of the newly developed gearbox is expected to significantly improve driver confidence.*

MAXIMIZED GRIP



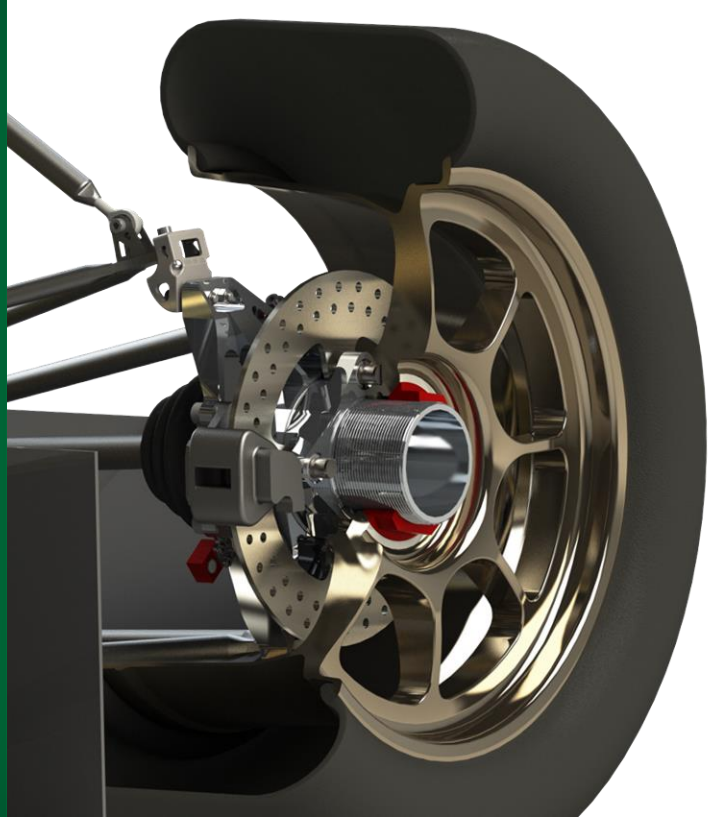
Front and rear fully adjustable independent double-wishbone suspension keeps the UA-20 planted on the tarmac. Kinematic and dynamic engineering began with an in-depth tire model developed using OptimumTire for the Hoosier R25B slick tires mounted on lightweight yet rigid center lock OZ Racing magnesium wheels. UA-20's manufacturing methods result in lightweight assemblies with fewer components.

Upright failure during post-season testing of the UA-19 sent the team back to the drawing board to validate our simulation modelling. With high confidence in our updated simulation, the UA-20 design ***weighs 20% less with a higher safety factor****.*

STOP *BEFORE* THE DIME

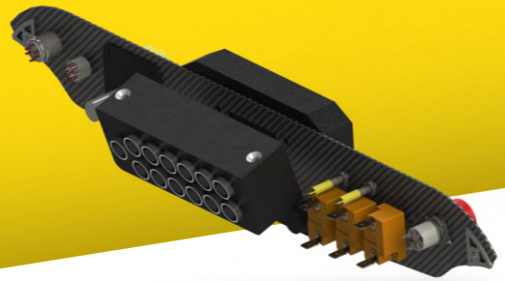
A powerful and balanced braking system composed of Brembo and AP Racing opposed piston brake calipers clamp steel full-floating 220 mm rotors front and rear. Tilton 78-Series master cylinders provide reliable and repeatable braking with on-the-fly driver-adjustable front/rear brake bias. Suspension and braking forces are controlled with lightweight aluminum hubs and uprights with adjustable 3D-printed titanium upper ball joint tabs.

Positive testing and driver feedback *on the braking system of the UA-19 meant that the brakes have carried over mostly unchanged. Improvements to the caliper mounting and added* ***on-board brake temperature sensors*** *will allow for data validation and further improvements during testing of the UA-20.*



SWEAT THE DETAILS

Beneath the easily visible, lies some of what sets the UA-20 apart. Electronic throttle control and increased data acquisition allows for traction control strategies to be implemented. Integration between the AiM EVO4S datalogger, GS Dash display, and Haltech Elite 1500 engine computer with CAN bus expansion available via auxiliary ports ensure data is available for real-time control strategies as well as post-race analysis. The data collected provides the basis for further improvement and allows us to validate the design choices we made in order to come full circle in the development process.



THE VIEW FROM HERE

The University of Alberta Formula Racing team looks forward to seeing the UA-20 move from the virtual world to the real world later this summer. We are excited to test out our designs and find the areas where we can continue to improve as we iterate, learn, and grow as future engineers together, either in person or online.

*The UA-20 furthers the **extensive efforts past team members** have contributed. As we move forward, we also aim to keep **building on this foundation** so that future members can make the most out of the opportunities they will have.*

SPECIFICATIONS AND EQUIPMENT

Dimensions

Weight	kg	186
Weight Front / Rear	%	50 / 50
Length / Width / Height	mm	2746 / 1473 1258
Wheelbase	mm	1550
Track Width Front / Rear	mm	1250 / 1250
Centre of Gravity Height	mm	275
Frame Construction		4130 Chromoly Space Frame
Frame Stiffness	N·m/deg	2400

Engine

Model		KTM LC4
Type		Naturally Aspirated Single-cylinder DOHC
Bore / Stroke		102 / 84.5
Compression Ratio		12.6:1
Total Displacement	cc	690
Maximum Output	kW (hp) @ RPM	45 (60) @ 6800
Maximum Torque	N·m (lbf·ft) @ RPM	65 (48) @ 5600
Engine Control		EFI with electronic throttle control
Throttle Body		Bosch Motorsport 32 mm
Fuel Supply Method		Dual port injection, Injector Dynamics ID1050x
Fuel Type		E85
Fuel Tank		6.0L aluminum fuel cell with Holley Hydramat

Electrical

Power System	Sealed fuse and relay box with polarity protection with battery charging port
Battery	Antigravity AG-1201 12V 360 CCA Li-Ion
Charging System	Integrated 12 V, 19 A alternator
Safety	Brake overtravel protection, brake/accelerator/throttle plausibility protection, external emergency stop switch, driver emergency stop switch
Instrumentation	AiM GS Dash with LCD screen, system indicators on dash panel
Datalogging	Brake pressure, brake temperature, wheel speed, accelerometer, gyroscope, GPS, suspension travel, steering position, fuel pressure, oil pressure, oil temperature, engine knock, air temperature, water temperature, air/fuel ratio

Steering, Suspension, and Brakes

Steering Type		Kaz Technologies rack and pinion
Overall Steering Ratio		6.68:1
Suspension Type	Front	Unequal-length double wishbone, pull rod type, adjustable ride height, bound and rebound damping, and anti-roll bar stiffness
	Rear	Unequal-length double wishbone, push rod type, adjustable ride height, bound and rebound damping, and anti-roll bar stiffness
Camber Gain Front / Rear	deg/cm	-0.51 / -0.55
Caster Angle	deg	3.5
King Pin Inclination	deg	6.0
Tire Type		Hoosier R25B 20.5x7.0-13
Wheel Type		OZ Racing Magnesium CL 13x7.0
Brake System	Front	Brembo P34 opposed 2-piston caliper, 220 x 5 mm solid cross-drilled full-floating rotor
	Rear	AP Racing CP4226 opposed 2-piston caliper, 220 x 4 mm solid cross-drilled full-floating rotor
Brake Hydraulics		Tilton 78-Series master cylinders with Tilton 900-Series bias bar with driver bias adjustment
Pedals		Combined brake and accelerator pedal assembly with 100 mm adjustment and a 4.5:1 pedal ratio

Transmission and Drivetrain

Configuration		Chain-driven, rear wheel drive
Differential Type		Drexler adjustable Salisbury-type limited slip differential
Ramp Angle Accel. / Decel.	deg	40 / 50
Transmission		6 speed Manual
Gear Selection		Hydraulic single-motion shift/clutch mechanism
Sprocket Drive / Driven		14 / 37 tooth
Gear Ratio	1st	2.50:1
	2nd	1.75:1
	3rd	1.33:1
	4th	1.10:1
	5th	0.96:1
	6th	0.87:1
	Final	5.80:1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TO OUR SPONSORS

On behalf of the entire Formula Racing team, we would like to express our gratitude to all of our sponsors that give us the chance to engage in a type of learning that has evolved into a deep-rooted passion for many of us. Without your support, we would not have the opportunity to push the limits of our engineering knowledge in the way that Formula SAE allows. We would also not have a chance to develop the meaningful relationships with colleagues, faculty, and sponsors that form each year. The current world events have stopped us from taking part in our scheduled competitions, but we still look forward to representing all of our sponsors as we work to finish the UA-20 and make the best of this situation we find ourselves in. Thank you again, and best wishes to you all through these unpredictable times.

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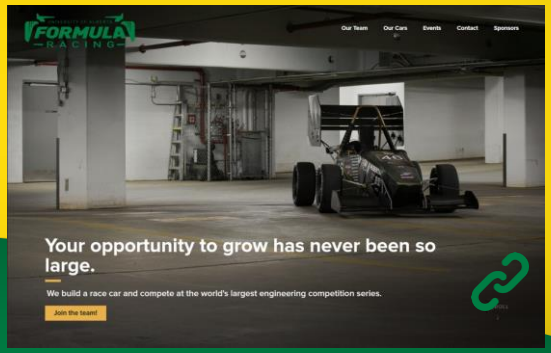

FORMULA RACING BRANDING

In another initiative for the 2020 season, the University of Alberta's Formula Racing team has undergone a rebranding to better communicate the high standards of the work we do, the university we represent, and the sponsors that make what we do possible. We truly could not maintain this program without the generosity of our sponsors and therefore we want to ensure that we are doing our utmost to be effective ambassadors for those who support us. We hope our new logo and redesigned website reflect the level of professionalism we strive for.


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