TuksBaja goes international

Engineering students from the University of Pretoria have been participating in the South African Sasol Baja SAE Competition since its inception 13 years ago. This is an annual event hosted by the Society of Automotive Engineering (SAE) and gives engineering students from different South African institutions an opportunity to design and manufacture, according to a specific set of rules, all-terrain vehicles that can compete against one another. All the teams are provided with the same 10 hp Briggs & Stratton engine.

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The competition consists of static judging, and a thorough safety and technical inspection. The cars are then put through rigorous tests for acceleration, hill-climbing ability, maneuverability and pulling ability. The competition culminates in a four-hour endurance race. The TuksBaja team is preparing to take part in the USA Baja competition in May 2011, which has a similar format to the national event.

The University's team consists of a group of dedicated students ranging from first-year to final-year students in different engineering disciplines, who gain hands-on experience solving real engineering problems. To ensure that the vehicle is ready for the USA competition, three final-year students are working on the TuksBaja vehicle as part of their final-year projects. These projects address the continuously variable transmission (CVT) setup, theoretical modelling of the vehicle dynamics and further development of the hydropneumatic suspension.

As participation in the American competition is a costly exercise, the team needs to ensure that the vehicle is capable of peak performance. During the 2009 December holiday, the team members identified three key areas of improvement. These were the drive train setup, suspension setup and reliability. The drive train consists of three reduction stages: the Polaris P-90 driving clutch and P-85 driving clutch, which forms the CVT, a belt reduction box and two hub reduction boxes, located at the hubs of the driving wheels.

The aim is to optimise the CVT that is implemented on the vehicle and improve the performance of the vehicle in the dynamic and endurance events to such an extent that participation in one of the Baja challenges to be held in the USA in 2011 becomes a viable option.

During the 2010 July holidays, the students performed extensive testing of different CVT configurations at the Gerotek vehicle testing facilities. Tests included performing hill climbs, and doing a skid pull and a 100-metre run. Different configurations of both the primary and secondary clutches were then compared to find the optimum configuration for participation in the Sasol Baja SAE challenge.

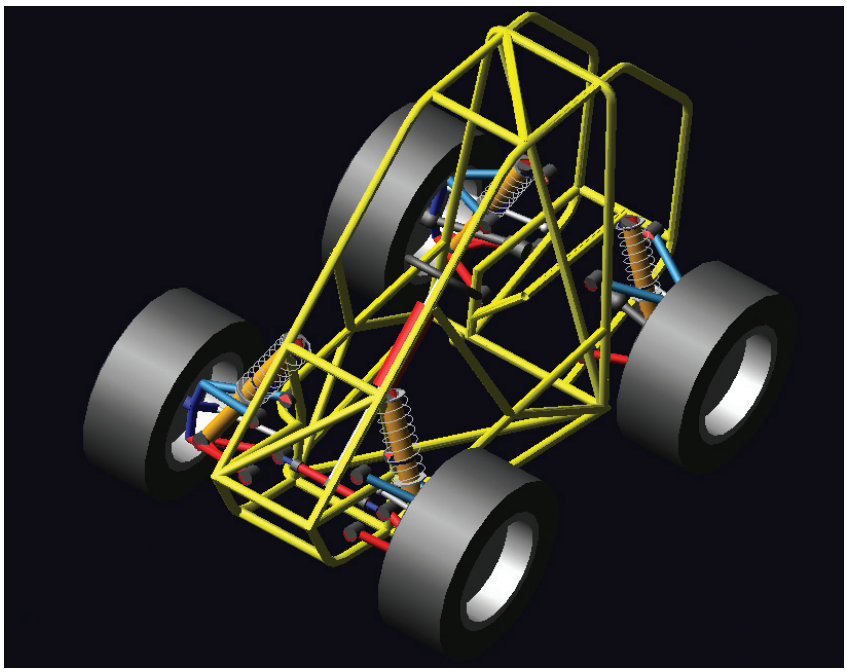
Variables investigated were flyweights used in the primary clutch, pressure springs used in the primary clutch and helix ramp angles implemented in the secondary clutch. The parameters monitored during testing were primary clutch rotational speed, secondary clutch rotational speed, vehicle speed, skid pull force and distance travelled, as well as the time taken to travel 30 metres from a standing start. The results were then processed and compared. Comparisons were made of different pressure springs for a specific weight and helix ramp, of different weights for a specific spring, and of different helix ramps for a specific weight and pressure spring.

To optimise performance in the various tests that form part of the competition, the damper system needs to be changed to conform to the changing road conditions. The road conditions vary from a concrete road during the speed and acceleration test to a muddy and rugged off-road track during the endurance race. The Tuks Baja is therefore equipped with a hydropneumatic spring damper system.

The advantage of this design is that the spring and damper characteristics can be changed quickly and easily. To alter the spring force, the gas pressure only needs to be increased or decreased. To change the damping coefficient, the damper pack dimensions, number of holes and orifice size need to be altered. Finding the best spring stiffness and damping coefficient through physical test is impractical and time-consuming. It is thus desirable to have a mathematical computer model, where various damping characteristics can be tested in the shortest time possible. This was achieved by creating a complete model of the car, using Adams/Car software.

The most important aspect of this research project was to create an accurate Adams model from the existing Baja. The better the mathematical model, the better the results will be. To achieve this, the dynamic properties of the Baja must be determined. The masses, centre of mass and moments of the sprung mass were determined experimentally. Due to the complex geometry of the unsprung mass, dynamic properties were taken from the CAD model. With this data, an Adams model was created.

To be sure that the model is an accurate representation of the prototype, the model needs to be verified by comparing data obtained experimentally to that acquired from an Adams simulation. If these two sets of data do not relate to each other, the Adams model must be refined until the two sets of data converge. With an accurate Adams model, different spring damper configurations can be tested and compared to find the optimum configuration of the hydropneumatic damper system. Applying these changes to the dampers will result in the mini Baja having optimum handling, ride comfort and jumping capabilities.



→ *The Adams TuksBaja model.*