In order to determine the motor that would be needed to vary the load of the Hot Wheelz team vehicle motor the proper calculations had to be completed to know the maximum load that would need to be varied.

The Formula SAE Hybrid rules provide a few guidelines for track layout that were essential determining the nominal torque output needed throughout the track during the endurance race. Under section D7.4 endurance course specifications and speeds, the constraints of the course can be identified as the following:

*D7.4 Endurance Course Specifications & Speeds*

*Course speeds can be estimated by the following course specifications. Average speed should be 48 km/hr (29.8 mph) to 57 km/hr (35.4 mph) with top speeds of approximately 105 km/hr (65.2 mph). Endurance courses will be configured, where possible, in a manner which maximizes the advantage of regenerative braking.*

*(a) Straights: No longer than 77.0 m (252.6 feet) with hairpins at both ends (or) no longer than 61.0 m (200.1 feet) with wide turns on the ends. There will be passing zones at several locations.*

*(b) Constant Turns: 30.0 m (98.4 feet) to 54.0 m (177.2 feet) diameter.*

*(c) Hairpin Turns: Minimum of 9.0 m (29.5 feet) outside diameter (of the turn).*

*(d) Slaloms: Cones in a straight line with 9.0 m (29.5 feet) to 15.0 m (49.2 feet) spacing.*

*(f) Miscellaneous: The organizers may include chicanes, multiple turns, decreasing radius turns, elevation changes, etc.*

First and foremost the force the motor must overcome to power the car in a given situation has to be calculated. At all times the car will have rolling resistance present, rolling resistance is the force the vehicle must overcome based on the weight of the vehicle and the coefficient of friction between the tires and the road surface.

The next force to consider is the drag force the car will experience based on the frontal area, the density of the air, and the speed of the vehicle.

The competition may feature slight inclines therefore as a worst case scenario a grade resistance force of an estimated four degree incline was added to the calculations.

The car will experience various acceleration forces based on the scenario on the track. The acceleration will vary depending on cornering or straightaway accelerations. Force from acceleration can be calculated various ways as seen below.

In order to account for all of these forces acting on the car the sum must be taken. The total sum of these forces is referred to as the Tractive force.

The torque that needs to be applied to the wheel is based off of the radius of the wheel and the Tractive force. The following equation for wheel torque includes a 15 percent error addition as the actual wheel size and vehicle weight is still being determined by the RIT Hot Wheelz team.

In order to relate the wheel torque to the motor torque a gear ratio between the axle and motor must be assumed. This gear ratio can be altered in order to optimize the relationship between RPM and torque from the motor.

It is important to consider not only motor torque but the RPM the motor needs to output based on the speed the vehicle is traveling. Angular velocity of the wheel must be known to find RPM.

By using an Excel spreadsheet a variety of scenarios can be calculated to find nominal torque and RPM used on the track. In order to carry out the calculations unknown values for the vehicle were assumed.

* Mass of Vehicle = 340kg
* Gear Ratio from Motor to Axle is 1:6
* Drag Coefficient of .95
* Frontal Area was over estimated to be 0.8354m^2
* Wheel Diameter =23 inches = 0.5842 m

Based on the calculations and speed estimates stated in the rules the following nominal torque values were calculated:

* Torque(Hairpin)= 248.94 Nm
* Torque(Straight Away)= 252.76 Nm
* Torque(Constant Turn)= 245.86 Nm

The resulting RPM was found:

* RPM(Hairpin)= 1095.99
* RPM(Straight Away)= 5520.59
* RPM(Constant Turn)= 1972.79

The resulting average torque and RPM was calculated to be:

* Torque(Average) = 249.19 Nm
* RPM(Average) = 2863.13