**Function of System:**

* View dynamic event point sensitivities for different car parameters
* Develop an overall concept to follow for the 2016 car and to discuss possible tradeoffs such as mass vs aerodynamics

**Simulation Notes:**

* Reasonable parameter minimums and maximums were used, where values from the 2015 car were generally used as the midpoint of parameter sweeps
* The simulation runs a skid pad, accel, autocross, endurance and fuel economy where autocross the autocross and endurance track is based on the Michigan 2012 endurance layout (this was done to be able to compare with Optimum Lap times for roughly the same track). Michigan is the main event of the year and the track does not undergo drastic changes
* The endurance/autocross tracks are composed of straights (acceleration and deceleration) and steady-state corners (there are no transient corners)
* Fuel economy is calculated using energy lost in straights and corners
* Grip is limited by tire data which has been approximately fit to Hoosier LC0 data
* Each tire is assumed to be generating maximum grip which is calculated knowing the normal force on the tire (with weight transfer and downforce included)
* Iterations are performed to calculate weight transfer and acceleration as they both depend on each other
* A time is generated for each event and compared to the top time using the current scoring formulas

**System Goals & Metrics:**

|  |  |
| --- | --- |
| Parameter | Value |
| Dynamic Points | Maximum |
| Dynamic Event times | Minimum |
|  |  |

**Parameters Studied:**

* Mass
* Center of gravity height
* % Rear Distribution
* Coeff of Drag
* Coeff of Lift
* Frontal Area
* Engine Torque Scaling Factor

**Methods of Analysis:**

* A Matlab code was developed to include the parameters noted above as variables
* An additional sweep function was added to create a parameter sweep
* Dual parameter sweeps are also an option

**Results:** *(Attach results to end)*

* For 1-D simulations most parameters when swept showed that in order to be optimized they must either be minimized or maximized
* %Rear bias showed a peak however between 50-55%
* The largest contributors to performance were shown to be Coeff of Downforce and Coeff of Drag
* There did not seem to be any parameters that adversely affected other although it is clear that the increase in downforce likely comes with an increase in drag as both coefficients are likely to increase at the same time

**Analysis:**

* Clearly most parameters would be at one end of the spectrum to optimize performance and ultimately maximize competition points
* Aerodynamics proved to have the highest points sensitivity and serves to as large area for future development and improvement
* When designing for aerodynamics a balance between downforce and drag will need to be found to optimize straight line and cornering performance
* Drag however cannot be varied as much as downforce due to the rules stating the car must be opened wheel and have large roll hoops
* The sensitivity results show that centre of gravity and %Rear distribution do not have significant effects on points but should never the less still be optimized
* -optimization of the engine system without noticeable mass gains can also provide a large points advantage

**Sensitivity Results:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Default | Minimum | Maximum | Sensitivity Unit | Points Change per unit increase |
| Mass with driver | kg | 220 | 190 | 260 | kg | -1.1 |
| Center of Gravity | m | 0.27 | 0.22 | 0.32 | mm | -0.2 |
| Wheelbase | m | 1.6 | - | - | - | - |
| Track | m | 1.2 | - | - | - | - |
| Weight Distribution | - | 0.55 | 0.5 | 0.75 | % | -0.8 |
| Engine Scaling | - | 1 | 0.8 | 1.8 | % | 1.4 |
| Car Frontal Area | m^2 | 0.8 | 0.7 | 1.3 | dm^2 | -1.0 |
| Wing Planform Area | m^2 | 1 | - | - | - | - |
| Coefficient of Downforce | - | 0 | 0 | 3 | 0.1 | 3.2 |
| Coefficient of Drag | - | 0.8 | 0.5 | 1.3 | 0.1 | -10.3 |
| Air Density | kg/m^3 | 1.2 | - | - | - | - |

**Conclusions:**

* Although the added mass that comes with a larger 2 or 4 cylinder engine will most likely increase competition points it has been chosen to stick with a single cylinder concept for many reasons such as simplicity
* The addition of wings would increase the center of gravity, mass and coefficient of drag of the car although the addition of downforce would be worth its compromises. By the nature of the vehicle style adding wings may not increase drag significantly
* With the single cylinder chosen it is clear that a high downforce, low mass concept is in order
* As usual the engine should be optimized to provide the highest output possible

**Testing and Validation:** *(attach results to end)*

