Wheel assembly analysis and design for a formula student car

- **Design Presentation**
  - **Purchased Components**
    The calipers and the rims were purchased from AP Racing and OZ Racing, respectively. Bearings were also acquired.
  - **Self produced components**
    The upright is the main component of the wheel-packaging. It supports the bearings, that allow wheel hub rotation, and transmits all the forces from the wheel to the suspension members. The upright also supports the brake caliper. The caliper is mounted so that it «wraps» a part of the disc and brake pads are on each side of the disc. The brake disc has been machined in order to guarantee a good evacuation of water, brake dust and heat generated by friction. Finally the driveshaft link has been machined in order to transmit all the power from the differential to the rear wheels.

- **Force Estimation**
  The goal of this section was to obtain an estimation of the load exerted on the wheel assembly. These loads were then used in the finite element analysis of the components. In order to ensure the worst stress scenario for our components, braking and cornering conditions were considered at the slipping limit of the tyres.
  - **Braking Condition**
    In the braking condition the inertial force corresponds to the maximal braking force that is provided when the four tyres are locked. Moment equilibrium equation in the origin of our coordinate system, with vertical force equilibrium equation provides the vertical load repartition between front and rear.
  - **Cornering Condition**
    The vertical load between internal and external wheels, that in braking condition was supposed equally distributed, undergoes now a load transfer. To analyze the behavior of the upright in cornering condition, the connection spots between the upright and the suspension arms have been considered fixed. The forces have been applied on the bearings bores. These have been determined starting from the forces acting on the tyres.
  - **3G Bump Condition**
    The last critical condition in which our car could be involved is a bump. This condition has been studied on one rear wheel assembly. To obtain the total vertical force on the rear wheel axis, the inertial force caused by a 3g bump as well as the static vertical force, have been considered.

- **Braking Simulation**
  The graph on the left represents the force exerted by the driver on the brake pedal which can be updated as desired. All other graphs depend on it. In fact the graph representing the pressure in the brake lines is proportional to the pedal force. The difference between front and rear lines pressure is due to the setup of the balance bar. The last figure shows the braking torque on the front and rear axis, as well as the slipping limit torque.

- **Finite element analysis**
  Max Von Mises stress : 216 MPa
  Safety factor : 2.5
  Max Von Mises stress : 120 MPa
  Safety factor : 4.5
  Max Von Mises stress : 95 MPa
  Safety factor : 5.5
  Max Von Mises stress : 25 MPa
  Safety factor : 15