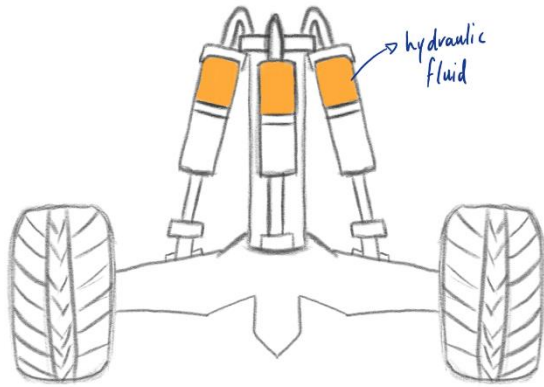


# Turning System

## Hydraulic Tilting Wheels



A hydraulic tilting system sketched below uses three hydraulic cylinders to generate tilt. Alongside tilting this system also helps assist the suspension, via its middle cylinder. This concept aims to tilt the wheels of the vehicle using hydraulic systems.

### Advantages

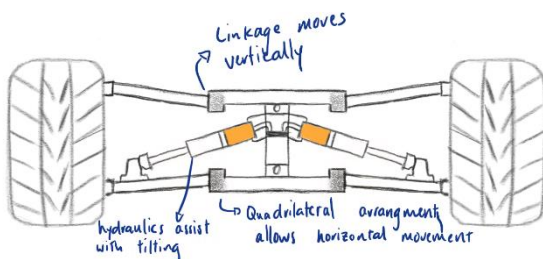
This system tilts all three wheels, this could mean the time taken to reach the  $\pm 45^\circ$  would be well within the given regulations. Having three hydraulic actuators also means the suspension of the vehicle

would be rigid and have a sustainable life expectancy.

### Disadvantages

As mentioned previously the concept aims to tilt both the rear wheels, this leaves the vehicle more vulnerable to toppling as the front end of the vehicle is also designed to tilt. If this concept design is implemented this could limit the angle of tilt due to safety reasons. Another disadvantage is regarding the manufacturing costs. Having three hydraulic cylinders could lead to a potentially higher production cost. This would be an unnecessary expense specially if it could be easily replaced by a suspension spring (ideally replacing the central hydraulic cylinder). Considering the compatibility with the drive train, the engine would optimally be placed in front of this tilting system. This could lead to issues like restricting access to the engine for maintenance.

## Quadrilateral Tilting Wheels



A quadrilateral tilting system as shown on the left, allows tilting of the wheels as well as the vertical movement of the entire vehicle. This concept is like the previous one as this also tilts the rear and front wheels as well as the chassis. Two hydraulic cylinders are placed horizontally to precisely tilt the vehicle to the requirements.

### Advantages

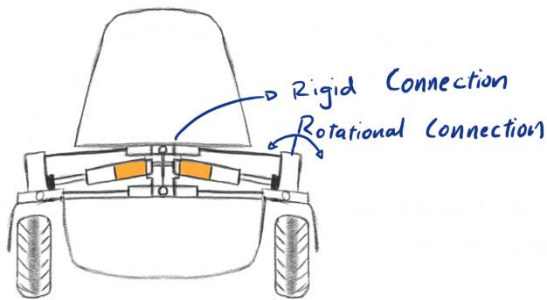
With respect to the engine, this system occupies less space, which in turn allows easy access to the engine bay for maintenance. As discussed previously, if all three wheels tilt, the vehicle could reach maximum tilt in a shorter period, therefore outperforming the regulations.

### Disadvantages

A great disadvantage of this concept is that, like the previous one it tilts the front and rear wheels alongside the chassis. This would in turn restrict the angle of tilt due to the dangers of toppling. Another disadvantage is that this mechanism is prone to scraping the ground on bumpy roads. Unlike the last concept this one doesn't have a rigid support which holds the mechanism up, it relies

solely on the wheels to keep it upright. If for example if the vehicle goes over a speed breaker at a higher speed the mechanism could be damaged due to a lower alignment.

## Hydraulic Tilting Chassis (Quadrilateral Arrangement)



This concept is like the previous one, however instead of connecting to the wheels this system rigidly connects to the chassis. Two hydraulic cylinders are used and located horizontally within the system. The entire is submerged within the chassis as shown on the left. This connects to the blocks above the wheel casing which allow rotational motion, therefore producing tilt.

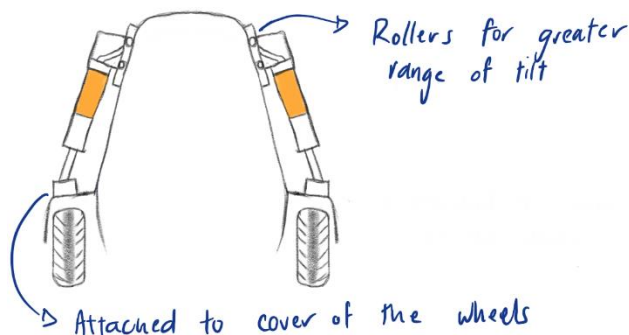
### Advantages

This improved version of the previous system targets to move only the chassis rather than the rear wheels which leads to more stability. Due to the encased style of this concept there is no accountability for scraping.

### Disadvantages

Due to the arrangement of this mechanism the biggest disadvantage is that its fully submerged within the chassis. This means less space for the engine, transmission, storage etc.

## Chassis Tilting System



This system slightly coincides with the first hydraulic tilting system discussed. This version however is attached to the chassis as compared to the wheels. The mechanism operates two hydraulic cylinders located on top of the cover of the wheel as shown in the sketch below. Unlike the quadrilateral tilting chassis system, this mechanism doesn't affect the shape of the chassis.

### Advantages

An advantage of this concept is again the mechanism is connected to the chassis rather than the wheels. This would increase the stability of the entire vehicle. Alongside stability, this concept's compatibility with the engine spacing and shape of the chassis is greater than all the previous concepts discussed.

### Disadvantages

A disadvantage of this system its arrangement. The biggest issue we would face is where the other hydraulic components such as valves and fluid tank would be placed.

