1. **Technical overview** 
   1. **Motor characterisation**

The track used to test the buggy consists of slopes (ramp) of maximum height of 15°. For buggy to go up the ramp, it needs more torque, therefore a gearbox is required, which changes the torque and speed of the buggy depending on the situation e.g. going up the ramp or moving on flat surface.

Data collected from the load measurement experiment showed that the torque required to go up a ramp of inclination of 15° is 0.0786 Nm for a buggy of mass 1.25 Kg, however this was based on an early estimate of the buggy mass. Mass of the buggy decreased after it was decided to use ball castor instead of castor wheel and a more accurate mass of chassis plates was calculated using . The new buggy mass is 1.10 Kg; therefore, the new wheel torque is 0.07981 Nm.

Without gearbox, the required current across the motor will be 9.938 A, however the motor drive board is only capable of supplying maximum current of 1.4 A to each motor. To avoid any risks, a safety margin is taken and is assumed maximum current is 1.12 A. Using 1.12 A, the calculated motor torque is 0.008 Nm. Using the two torque values, the calculated gear ratio is 9.975.

Based on this, the chosen gearbox is gearbox 2, which has gear ratio of 15, but efficiency is 85% therefore 10.84, as it provides a higher torque than the minimum required for the buggy to set off. Gearbox 2 will allow buggy to move at a faster speed than gearbox 3 and will provide higher torque than gearbox 1.

* 1. **Chassis design**

Chassis design is an integral part of the overall project, and therefore many factors had to be considered when designing chassis.

Firstly, the material chosen for chassis is Acetal, as it has low weight, cost and is easy to manufacture. Low weight of the chassis will reduce the overall weight of the buggy therefore will influence the speed and torque of the buggy when going up the ramp. Lighter the buggy lesser the torque required for it to go up the ramp and therefore it effects the gear ratio selection. Low cost is important as the overall budget of the project is £40, which must not be exceeded. Acetal is easy to manufacture and can be cut easily using laser cutter, which will be used by university to cut the material.

Secondly the shape and design of the buggy is important as It influences driving and handling of the buggy. To improve the control and handling of the buggy the size of the buggy must be small and compact and to achieve this, two plates for chassis are used instead of one large as shown in fig1.1. This will improve the manoeuvrability of the buggy. Lengths of lower and upper plates are 21 cm and 11.4 cm respectively; maximum width of lower plate is 15 cm and upper plate is 9.1 cm wide. The shapes of two plates are in a way to reduce the waste of material which will also add unnecessary weight e.g. lower plate is 12 cm wide and is only 15 cm wide for area where motor drive board will fit.

* 1. **Winning features**

in order to win buggy must finish the race and in the quickest time. To ensure the buggy finishes race, it must stay on the white line. White line will be detected by sensors therefore sensor choice and implementation are very important.

As discussed above 6 TCRT5000 optical sensors will be used in a smiley face implementation as shown in fig 1.2. this implantation is used, as it will allow buggy to detect a turn in the track in more effective way than a straight-line implementation therefore reducing risk of buggy going off the track. Sunlight can affect the performance of the sensors and to deal with this, sensors will be covered using tape in order to reduce external influences on the sensors. Another option being considered is use of a variable resister to finely tweak the threshold of the sensors, to make them more or less sensitive on the day based on the conditions. The track will also have a break in white line of 6mm, two vertically aligned sensors in the middle will deal with this as they are 1cm apart therefore break of 6mm gap will have no effect on the buggy.

Secondly the chassis design of the buggy is compact and small, which will decrease the overall weight of the buggy therefore the buggy will be able to reach faster speed consuming same amount of power compared to heavier buggies, therefore finishing the race in a quicker time.

Furthermore, the positioning of the components e.g. sensor circuit, battery pack etc, is important. The sensor circuit is placed before the caster ball as shown in fig 2.2, this will ensure that when buggy goes up the ramp the sensor circuit does not hit the ramp as castor ball will reach the ramp first and buggy will be on its way up by the time sensor circuit reaches the ramp. Components are placed on chassis so that the weight is evenly distributed to reduce the risk of buggy turning over.