# 1.0: Summary of initial design concepts

Initial robot prototyping was developed based on subsystems developed in team members’ preliminary investigative report (PIR). These subsystems included the landmine marking system, sensor system, drive system and chassis system. Additional subsystems, including control and power systems, were developed after, as no team members had developed these in their PIR.

## 1.1: Initial Marking System Design:

Initial marking system design consisted of a 12v linear actuator, with a paintbrush, coated in red paint, fitted to its shaft. Upon activation, the paintbrush was pushed downward toward the landmine, and marking would occur when the paintbrush contacts the landmine. This system is activated by a signal sent from the Arduino, when the robot is close enough to a landmine, and facing in the correct direction, to mark it. The total budget needed for this marking system was $11.67.

A sketch of the marking system is shown in **APPENDIX**

This prototype was improved in several ways, to produce the Proposed Design. Actuator pricing errors revealed that the actual cost for the actuator was much larger than expected ($150). Additionally, the actuator was intended to be triggered by the Arduino, however the actuator voltage and Arduino voltage varied, so the purchase of a relay or motor controller would be needed.

The key concept of the marking system; to mark landmines with a paintbrush, was preserved, however the paintbrush is moved using a small servo motor, which also produces lateral movement, thus potentially improving marking performance.

## 1.2: Initial Chassis Design

The initial chassis design was based on a 5mm thick piece of aluminium, with a shallow chamfer on one edge to reduce weight and to assist with landmine marking. This chassis design was simple and effective, however modifications were needed to fit all components on the robot, in consideration with other subsystems. Several 3d printed components were also developed, including a battery tray and sensor mounts, to supplement the chassis design.

## 1.3: Initial sensor design

Two initial proposals were put forth for design and specification of sensors systems in the robot.

Proposal One included the use of a high range Melexis MLX90393 Magnetometer and one STmicro VL53L0X laser distance sensor. These sensors had a combined cost of $20, and proposed accurate distance sensing performance without impact of factors like acoustic noise. The magnetometer used was more expensive than some competing models, however its detection range was wide enough to accurately measure field strength close to the magnets.

Proposal Two suggested using two ultrasonic distance sensors, and two hall effect sensors. The use of hall effect sensors limited the activation resolution of the landmine detection, as the activation threshold for hall sensors cannot be controlled. Additionally, the use of a three-axis magnetometer is advantageous as it allows a control system to pinpoint the direction and magnitude of a magnetic field.

The final proposal is a combination of the two; it includes two ultrasonic sensors for measuring distance, and one Melexis MLX90393 magnetometer for landmine measuring.

## 1.4: Initial Software Design

No team members had developed an initial software design, so one was drafted based on a random search algorithm. Given that no real-world testing can occur, it is difficult to quantify the performance of the search algorithm or software. Literature suggests that random search algorithms may be useful in similar environments, like robot vacuums.

The initial search algorithm would turn away from walls by a random angle when close, and after marking landmines, it would reverse and then turn randomly.

This was refined by implementing a system to ‘aim’ the robot toward landmines using the XYZ information from the magnetometer and a PI control loop.

## 1.5: Initial Power System

The initial power system consisted of a two cell, 7.4v nominal lithium polymer battery, which provided power for both the motor-shield and the Arduino. Power for other systems, including sensors, was supplied by inbuilt regulators in the Arduino.

No modifications were made to the power system, as it was calculated to supply sufficient power, at appropriate voltages.

## 1.6: Initial Drive-System design

The initial drive-system was developed with two DC brushless motors to drive the left and right sides of the robot. Each motor was connected to the front and back wheels for its side though a set of gears, which spun wheels 5cm in diameter. A system of gears was used to provide drive power to all four wheels, thus increasing the contact area of drive wheels, and preventing possible failure modes in which wheels cannot provide power (on low-friction surfaces or similar). Motors were run at 500rpm.

Brushless motors require more complicated and expensive circuitry to drive, and are more expensive, so the drive system was modified to use the supplied Tamiya 70097 Twin Motor Gearbox, which uses a 58:1 gear reduction, and power is transferred through additional gears to all four wheels through an even gear ratio to provide no additional reduction.