The Direct Current Motor

The aim of my assignment was to construct a simple DC motor from everyday materials that could run for two minutes.

I began by researching DC motors on the internet. The models that I looked at were small and I wanted to build a motor that was bigger. The model that seemed to work the best had four bolts welded to the axel coming off at 90^{o}. I based my design on these models but on a larger scale. (DIY MOTOR School Project DC Electric Motor with Commutator, http://www.youtube.com/ watch?v=vg2dOxxwcA0)
The majority of my components came from Bunning's Warehouse. I sourced other parts from my home and my teacher supplied the neodymium magnets. No parts were commercial motor components.

I made sure I accurately measured all parts, testing to make sure each part worked before continuing. Soldering the bolts on was complicated so I started with only two bolts. The wire was coiled around the bolts and I connected it straight to a power pack but it did not work. My physics teacher could not understand why it would not work; she asked several other physics 'people' but no one could help me. I increased voltage, number of magnets, distance of magnets, number of coils of wire, weight of bolts nothing worked.

I had to start again. I decided to look at the simplest motor I could find. It came down to the little match box motor we had made in science classes years before. A simple coil of copper on an axle suspended by two paperclips, it's speed was impressive with little to no voltage. (Simple DC Motor Demonstration, https://www.youtube.com/ watch?v=9Wby4aHyXJQ)

I combine both designs into one, taking from each only the best aspects. I took the axle on bearings from my original motor and applied the coil from the matchbox motor but on a much larger scale. However the design still had limitations. The motor worked, but the movement was very lumpy. I decided to add another coil at a 90 degree angle. This was the most difficult parts; intertwining the two coils together over the axel and then fixing it so it would not move. It made the motors movement much smoother and allowed the motor to reach much faster revolution speeds.

The new coil system needed an effective commutator to handle the new faster rotation speeds. The axle's surface area was not large enough for me to do this. I decided that using a door stop would work well as it was rubber and would prevent any short circuits. The larger surface area allowed me to change the gap between conducting plates, letting me perfect the motor's timing. After getting the timing right I was able to connect up the coils and test the motor by simply using alligator clips as mock up brushes. It worked and I found the motor was working best when there was pressure applied to make the wires have full contact.

I needed a new way to create the brushes. They needed to be in direct contact but they were two high up for a length of wire just to rest on the commutator. I decided to use gate hinges hoping their weight would keep a connection as they leaned on the commutator. The hinges being metal shorted the motor out at first so I used electrical tape under the copper wire to prevent this. It worked well but as the motor gained speed the hinges began to bounce causing the wires to lose connection. I used a rubber band at first to secure the hinges across from each other but the pressure was too great causing too much friction and creating short circuits because the wires started connecting to all of the connection plates. I then replaced the rubber band with fabric elastic used in clothes. This allowed me to have a weaker tension while maintaining the strength. It maintained the connection and allowed the motor to function at higher speeds.

Friction and the heat generated due to this friction is a limitation of this motor.

Safety:

When soldering the wires onto the commutator the appropriate precautions should be taken to avoid burning yourself. After the motor has been operating for some time the copper is very hot. Care should be taken handling the device shortly after function. The power pack used contains a fuse to prevent major short circuits and electrocution, but care should still be taken when handling electricity. The hot glue gun used to secure the different elements also is very hot and should be used with care. Care should also be taken when using the other tools required building the motor.

Improvements:

The electrical design was changed completely from the original bolt design to a new more effective loop design. The commutator was changed and corrected for better results. The brushes had to be changed several times to get the desired amount of touching wire the commutator.

I had to reposition the bearings to minimise the incorrect movement of the armature. The coils where adjusted to find a balance for a quicker start.

I added four more neodymium's increasing the magnetic field strength and I moved the magnets closer to the coils again increasing the magnetic field strength.

The failures of the first motor lead me to a totally different design that is very streamlined and required far less technical calculations. My first design failed because angles between bolts and magnets were not correct. My new design worked without calculating angles between coils.

While staying within the guidelines of the aim there are only a few improvements that could be made; more coils of copper wire could be added to increase repulsion and stronger magnets could be used to repel the copper wires. The magnetic field could be changed to radial also.

I was able to construct a motor using only every day materials on a relatively tight budget that ran for two minutes. The motor is tidy, well constructed, easy to use and it works.