EPQ Draft Script:

**Title slide:**

My epq is the design and manufacture of a robotic arm.

**00 Contents:**

In this presentation I’m going to take you through what my project was about; the research I did; my plan; prototypes mk1 – mk3; the actual prototyping; the final design; and the manufacturing of the arm.

**Video Slide:**

This is roughly the idea of what I wanted the arm to be like at the beginning and you will see the full evolution of my design through the presentation.

**01 Overview:**

I decided early in the process of brainstorming my EPQ that I wanted to make a robotic project. I had many ideas from a quadruped robot, like Spot from Boston Dynamics, to making my own drone. Eventually I landed on a robotic arm, the simplest of all my ideas. With that I had an overall goal and I needed to work out the details I decided that it needed upwards of 5 degrees of freedom, how much the arm can move around, and be able to lift about 0.8kg (800grams). With this I began my research.

**02 Research:**

There are many ways to find information about robotic applications, people’s personal blogs; forum posts; and of course, YouTube. As you can see from the chart most of my research came from YouTube, the algorithm obviously knowing me too well. Lots of my research was into 3D printed reducers and transmissions.

**03 The Plan:**

I originally planned for the project too only take me 5 and a half months: in reality it has taken me well over a year, with many breaks for exams, young enterprise, generally forgetting that I had to do the project. I documented what happened through a development journal, this ended up becoming incredibly long. At the end of April, I had a block out for mk1 and then put the project on hold for exams.

**04 Mk1 – Mk3:**

In June I picked the project back up after salvaging aluminium hinged pieces from a scrapped screen soldering machine, from my work experience at Offshore Electronics. Mk1 featured a mixture of different types of geared reducers, planetary gearboxes and harmonic drives. However, the arm contained many bespoke parts, and weighed far too much for it too lift itself. Mk2 was lighter and featured more common components to reduce the complexity of manufacturing. Even though there was many improvements from mk1 to mk2 there was still room for improvement as the arm was still very heavy and unable to meet the lifting goal I was aiming for. Mk3 improved on Mk2 by reducing the weight of the arm by roughly 10%, and featured component coverings that reduced the number of exposed parts. Now you might be wondering what a harmonic drive is.

**05 How it works:**

A harmonic drive is a type of reducers, they are also called Strain wave gearing. You might be wondering why the name harmonic drive, well that’s because it’s named after the company that manufactured the first series of strain wave gearing, from Germany called Harmonic Drive SE. On the right you can see my 3rd version of a harmonic drive with a good reduction for the size. Strain wave gearing works by rotating an elliptical plane that forces a flexible gear, called the flexspline, to mesh with a fixed internal gear. In an industry standard design, the flexspline is attached to the output of the reducer, however due to the nature of 3D printed materials this is not possible as the flexspline will crack and fracture. In a 3D printed design another non-flexible internal gear is placed on top and used as the output, this design is inspired by the work of both 3D printed life and Levi Janssen both people who appear often in my research.

**06 Prototyping:**