

HND Electrical and Electronic Engineering

Group Project

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Original Concept / Introduction

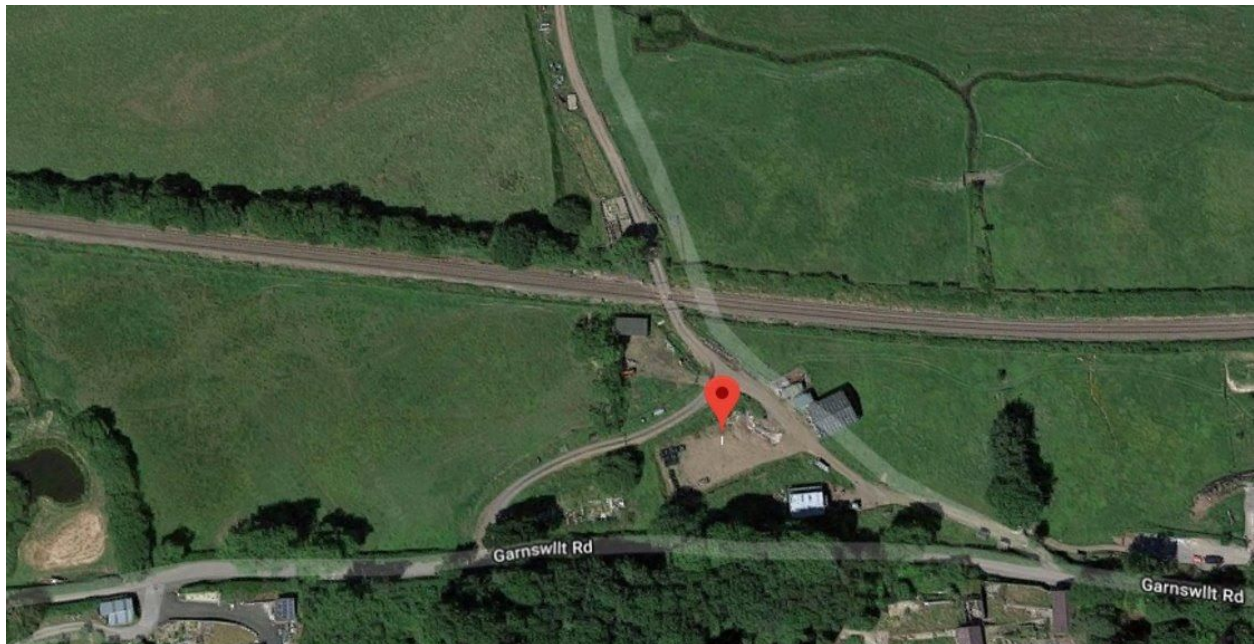
Our original concept for this project was to present as a small business who specialises in designing and producing smart gates. The company, *Programmable Logic Gates (PLG)*, in theory would have consisted of a small team, thus giving us the advantage of having no middlemen between our customers and us. Being small in size would have enabled us to tailor-make our designs to all unique situations and circumstances, therefore offering a more bespoke product.

In this report, I will discuss my part in this group project in terms of research, design decisions and any conclusions made.

Project proposal

PLG Limited have been contacted by Mr Cook from Ganswllt farm. Mr Cook has land just outside the Welsh village of Pentrebach which has a single train track running through it along with a dirt track that intersects it. Mr Cook uses the dirt track to move his livestock to different fields either side of the track, but most importantly as a main route to drive across in his agricultural vehicles. Mr Cook has requested us to design a twin automatic gate system to allow safe access to either side of the tracks.

In designing the way this system will work it is essential that we consider the various uses of this dirt track - it must be safe for livestock, vehicles, and pedestrians.



Aerial view of Ganswllt Farm taken from google Maps

Plan

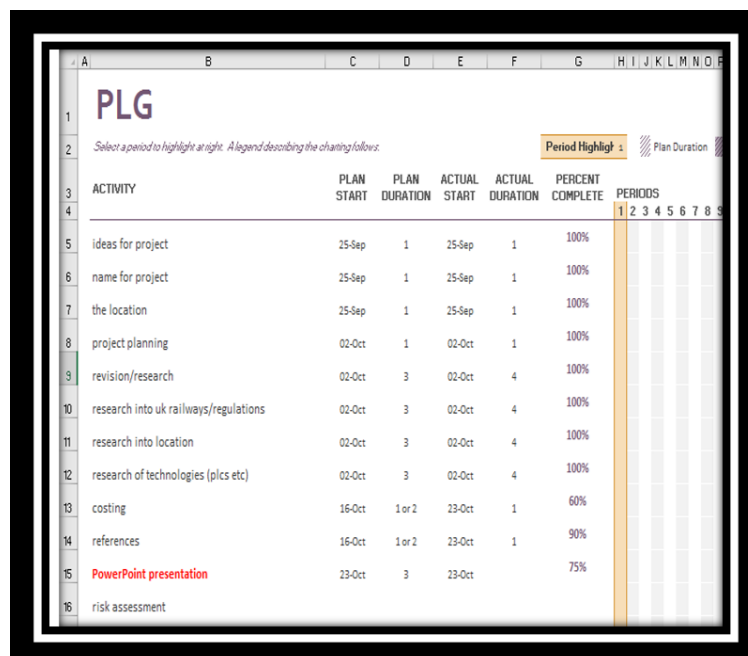
Our group is made up of 3 members, Tomos Day, Farlin Farook and myself. As a group we worked collectively, internally delegating jobs and roles to complete projects that we each undertook.

As a group we discussed the project assignment and outlined areas that we needed to research into. The areas of research to be delegated were: the mechanical operation and materials for the gates, rail service rules and regulations, a microcontroller and optical sensors and HMI.

As a group we split the research up and allocated a portion to each person.

Tom researched possible materials that would be suitable for the gate and different methods of mechanical operation. Farlin undertook research into rail services and the rules and regulations that the tracks are governed by. My research focused on the automation of the system and how it would be logically processed - e.g, microcontrollers, etc.

We used a Gantt chart in order to illustrate our project schedule. This would allow us to complete tasks in order of their relevance and importance to the preceding work, meaning that we could follow a logical schedule. In this way, using a Gantt chart helped us to establish a critical path by setting out the key jobs that need to be completed in order to enable further progression throughout the project.



My Research

Microcontrollers

My first job within my delegated research area was to find a suitable microcontroller. I decided to compare both the Arduino Uno rev 3 and the Siemens range of PLCs. Overall, I found that both devices can perform the tasks as needed, however under the microscope the two devices differ vastly. The Arduino is extremely cheap at only £20, whereas the PLC costs over £400. Whilst the PLC is considerably more expensive, the longevity of the device is worth the cost. Due to the nature of the system that these devices will run, it is required that the chosen microcontroller will be in a constant live and active state. This is an essential consideration as constant use could eventually cause the Arduino to burn out, whereas the PLC is built to withstand 24/7 use. It is far more beneficial in this situation to have a microcontroller that will need as little interaction and maintenance as possible, despite the higher cost, to ensure a safer and more reliable system.

The PLC is also tested to a higher standard which should ensure that every PLC performs with minimal fault. The PLC is advantageous in this situation as additional testing would have to be carried out on the Arduino to ensure it was fit for usage. This would take up valuable time in the testing process, and it is likely that the performance of the Arduino would still not be as suitable for this task as the PLC. Therefore, it seems that the most sensible decision as informed by my research would be to utilise the Siemens PLC for its overall durability and longevity.



Arduino UNO REV3



Siemens PLC

Sensors

As a group, we decided to use optical sensors to detect passing trains. I have calculated that the system will need 6 pairs of sensors - 6 emitters and 6 receivers - all split into 3 sets of 2 pairs.



Each pair within sets 1 and 3 will be 10m apart, meaning that anything that is 10m or greater will be sensed by both pairs of sensors within set 1 or 3 simultaneously, thus ensuring that the 23m passenger trains and any larger trains that pass can be detected. Both pairs of sensors within the sets will have to be triggered together to confirm that there is a train approaching the gates. Both sets 1 and 3 will be 12.5 miles from the gates in each direction. This will allow for a minimum of 10 minutes before the train reaches the gates. The 2nd set of sensors will notify when the train is clear of the gates and allow the gates to open.

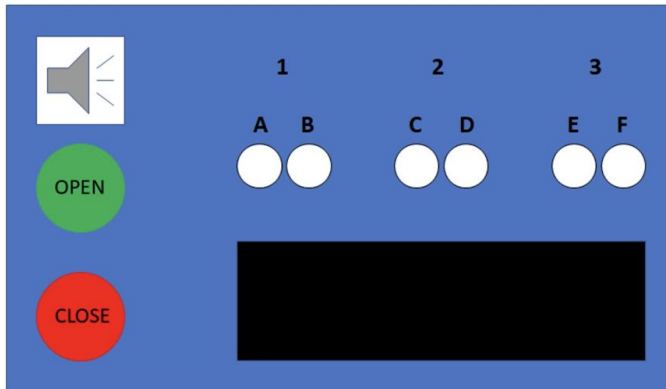
In considering the sensor type, the following things should be considered: the chosen sensor must be effective over a minimum of 9m to cover the width of the track, have a fast response time and sense objects efficiently. Upon researching sensors I found 3 different types of optical sensors: diffuse-reflective sensors, retro-reflective sensors and through-beam sensors. When comparing these different types of sensors, I found that the through beam sensor is most suited to this scenario as it has the greatest sensing distance, virtually no restrictions when sensing objects, the fastest response time and the highest resolution.

All four of these factors are crucial. The through beam sensor that I will be using is the Sick W260 as it exceeds the necessary criteria for this situation.



HMI

In considering the HMI and what it should encompass, I decided that it should include two human inputs - an open and close button.



This is an initial design of our HMI. It is relatively basic, but represents all of the vital parts which include two human inputs - the open and close buttons.

The open button can only be activated when the correct conditions are met. For example, if either sets of sensors 1 or 3 have been triggered then the open button will not perform the gates opening sequence. However, if the tracks are clear, the open button will cause the gates to open.

The close button must be held for a minimum of 3 seconds to initiate the gates closing sequence - this is to ensure that the gates do not accidentally close due to a false press. As this is an automated system, if the correct sensors are triggered then the gates closing sequence will begin. This starts with an announcement on the speaker and is then followed by subsequent beacon alerts and notices on the LCD screen.

After 8 minutes have passed, the gates will close. Once set 2 of the sensors have been triggered in the correct sequence, the gates will then be able to open again if requested. There will be a HMI on either side of the tracks in order to allow gate control from both sides.

Considerations / Conclusions

Despite completing most of the tasks on our Gantt chart, the current lockdown situation put a halt to the final aspect of this project - the risk assessment.

As a group, we had planned to set up and test a layout of this gate using a model train set. We would have designed this so that the miniature system had the same motor configurations along with the use of a PLC and our proposed HMI. This would have allowed us to potentially identify any faults that we had not picked up on in our research as well as help us to decide the direction of which the gates will open, which was a topic we had previously been debating, e.g horizontally, vertically, upwards. This was not able to go ahead due to lockdown, which meant that we had to make a logical decision based on our research.

Without observing physical models of our setup, it was somewhat difficult to foresee any minor or major faults with our design as we were not able to test the system. This would not happen in a real-life scenario, and we wouldn't give the go ahead for a product such as this without some relevant testing. This means that our final design as outlined in this report may not be as structurally sound as we would have liked due to the current circumstances.

This project helped to teach me in particular the importance of logical planning through critical pathing. This was especially helpful in terms of working as a group, because we worked from an agreed upon schedule that allowed us to make progress quickly and efficiently, whilst helping us to know where we were in terms of our product's development. In terms of technicality, I also learnt about the vast differences between the microcontrollers that I researched, which I believe helped to strengthen my skills in choosing appropriate hardware for certain situations.