The Problem

Restating the Problem

The problem for me, the engineer, is as follows. A transportation company needs a computerised gate operator that raises and lowers depending on set variables. The goal for the design is for a computer system to be able to lower the gate when a train is approaching or if a vehicle is on the tracks, and to raise the gate when it is safe to do so (when there aren't any trains approaching or vehicles on the tracks). This is all an effort to ensure safe travel for oncoming trains or crossing cars.

Inputs and Outputs

Input 1, Train on approach. True if any train is detected approaching the gate
Input 2, Vehicle on tracks. True when any vehicle is detected on the track

Output 1, Lower Gate.
Output 2, Raise gate.

Context, Constraints and Stakeholders

To contextualise what I am designing here, it's important to remember certain factors. The railway crossing is a potentially very dangerous section of the road where a train which cannot stop quickly can be approaching whilst a vehicle is still on the tracks. Because of these potentially risky scenarios, the gate must be reliable in its detection of oncoming trains, and vehicles on the track. The system must prioritize safety, responsiveness and fail safe operation to protect train staff and passengers and any road users.

Many possible constraints come to mind when exploring a potential design. First, the system must prioritize safety at the sacrifice of potential efficiency. For example, a train may have been detected 2-3 minutes away from the gate, leaving enough time for many to cross before any collision. Still though, the gate may be lowered, leaving many to wait, sacrificing others time to ensure safety in any scenario. Sensor reliability also comes into question, the sensors that detect the vehicles and trains must be able to accurately tell the difference between a vehicle and any other disturbances that may be present on the track. Finally, the gate system must also have a fail safe in case of error like a sensor failure or short circuit, in which case the gate would have to default to the safest state (gates lowered).

The stakeholders, or the ones who will interact with the gate are important to consider. First there are the pedestrians and road users who must rely on the gate to know when it is safe to cross. Next there are the train conductors and passengers who rely on the function of this system to avoid crashes or derailments. Next there is the authority, who are concerned with making sure the system meets safety standards and ensuring traffic efficiency, as well as contacting first responders or technicians in case of a breakdown in the system. And finally, there are the engineers, tasked with the design and implementation of the system.