Aaron Cox
Andrew Wilhelm
Chenjie Wu
Siwei Zhang
ENGR 1182
Dr. Herak 8:00
10/24/2019

A16: Prototype Requirements, R&D Methodology

1. Correlation matrix

	Time compiling and sending code	Time to complete a full loop with max possible power	Mean braking distance from full power	Acceleration to full speed	Maximum power of passing bend safely	Stop precision	Time to stop the train when experiencing electricity cut-off	Power consumption	Maximum allowable height of train cabin
Ease of Use	1	1	3	3	0	1	0	0	0
Fast Commute	0	9	0	9	3	0	0	0	0
Safe	1	0	9	0	9	0	9	0	1
private	0	0	0	0	0	0	0	0	3
Always Ready	9	0	0	0	0	1	0	0	0
Reliable	1	0	3	0	3	3	9	0	0
Low cost	0	0	0	0	0	0	0	9	0
Internet Connectivity	3	0	0	0	0	9	0	0	0
Customizable	0	0	0	0	0	0	0	0	3
Environment friendly	0	0	0	0	0	3	0	9	0
Total	**15**	**10**	**15**	**12**	**15**	**17**	**18**	**18**	**7**
Top req.	false	false	false	false	false	false	**true**	**true**	false

According to the model system requirements correlation matrix, It can be inferred that power consumption and time to stop the train when experiencing electricity

cut-off are the top requirements. Stop precision is the second most important, and mean braking distance, time of compiling and max power of passing bends are all the third important ones. Therefore, In our model system design, we would focus more on the braking system of our model train, because it relates to three important system requirements. Also, we would buy a power supply that has high transfer efficiency (ideally 80%+) to meet the important requirements of power consumption. In contrast, we would not focus too much on maximum allowable height of train cabin, as it only scores 7.

2. Prototype Design Requirements
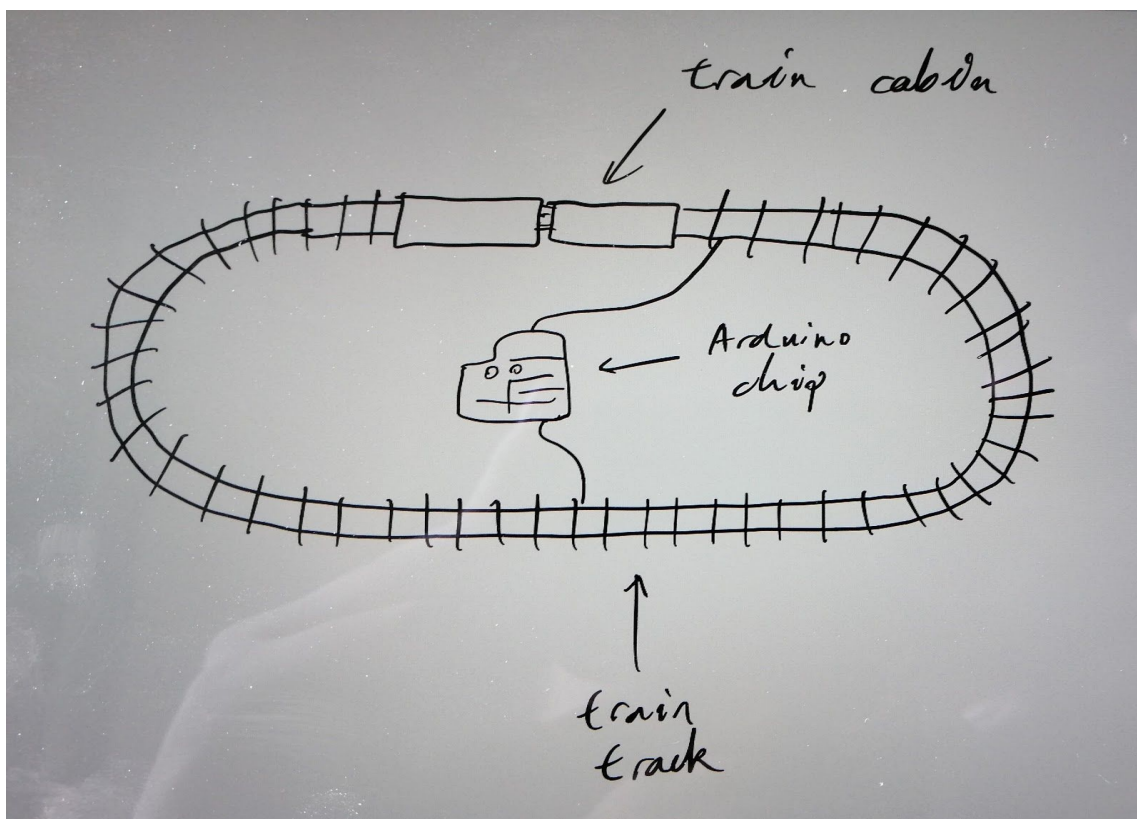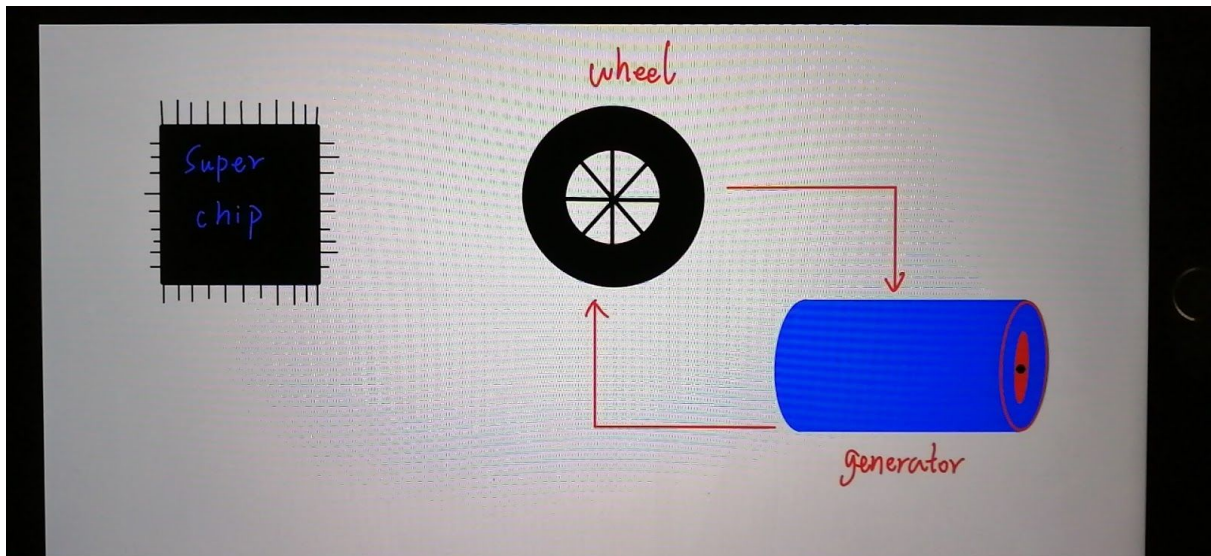
System requirements	Range	Ideal	Vehicle Requirements
chip processing speed	1.2GFlops-2.4GFlops	2.4GFlops	2.4GFlops
power supply efficiency	72~80%	80%	80%
regenerative brake energy recovering efficiency.	55~75%	83%	83%
backup electricity system reaction time	1s - 5s	1s	1s
Train cabin's weight	0.8-1.2	0.8kg	0.8kg
Mean braking distance	2.5-3 in	<2.2 in	< 2.2 in

The requirement table illustrates that we need to purchase a good arduino chip that has a good calculation capability. Also, we may consider using the 3D printer in Hitchcock hall to make our train cabin, since the 3D printed components are usually lighter than traditionally made. In addition, we need to add some capacitors on the train to temporarily store the electricity generated by regenerative brake.

Appendix.

Chip speed -- write a C++ program or find it online that measures the time used to process a series of codes.

Power supply efficiency: use a power meter to measure the electric power on the end side, and comparing it to the power on the beginning side.

Brake energy recovering rate: measure the speed and mass of train before braking. Then brake, and measures how much electricity is generated. Convert to standard energy unit and divide by kinetic energy of the train, and get the convert efficiency.

Backup electricity system reaction time: simply unplug the power supply and measure the time.

Train cabin's aluminum content: measure train cabin's weight, then put it into water to measure its volume, and we can get density.

Mean braking distance: set too full power and apply full brake, measure distance.