Year 8 Technology (Mandatory)
Electric Toys (Engineering)

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Insert an image that illustrates the unit

❖

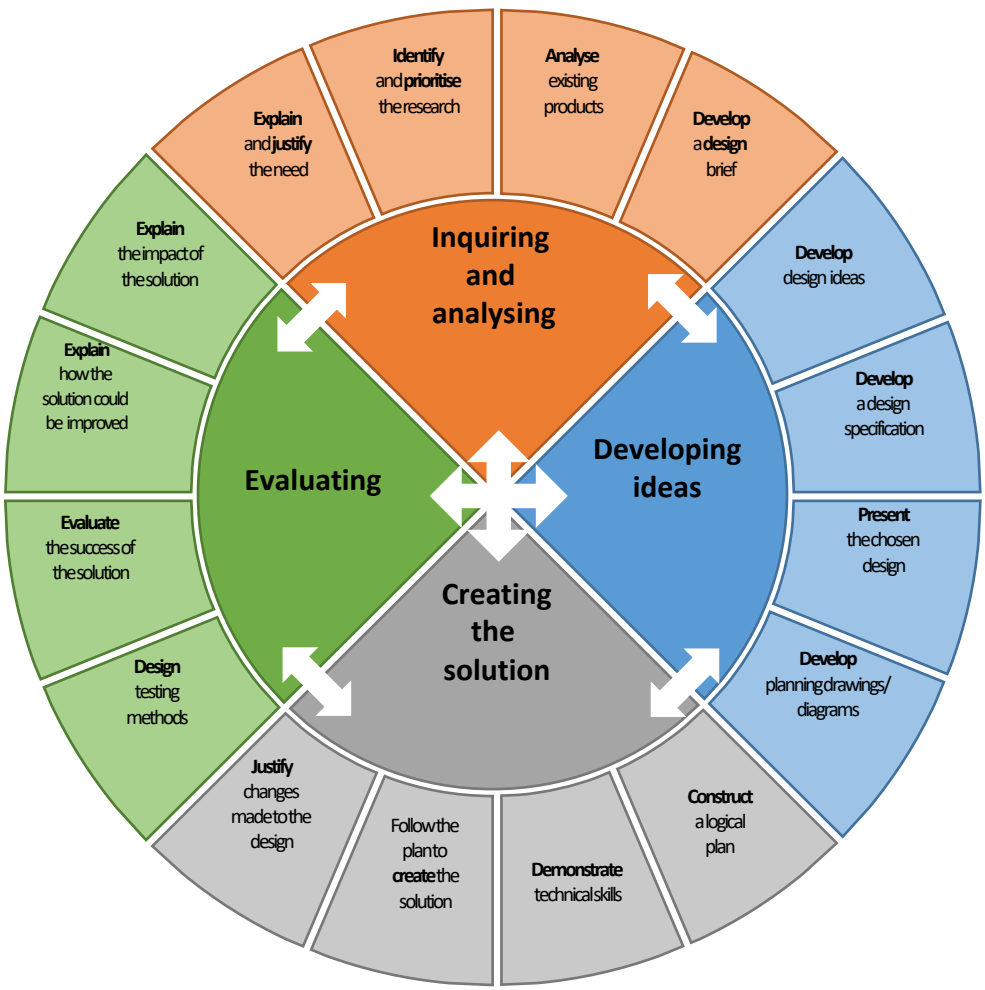
Format the page with your own personal style

Stuff about MYP

What is innovation?

How can we innovate education?

Does good learning need to be fun?



Project Overview

Goal: Students will be able to design an electric toy to meet the needs of a particular child age range. Students will design a prototype to appeal to purchasers of electric toys using 3D modelling and printing and laser cutting (if applicable).

Role: Your role is a toy engineer.

Audience: The audience children of a defined age-range and their parents.

Situation: The toy industry is continuously evolving, driven by innovation, technological advancements, and changing consumer preferences. Children are increasingly drawn to interactive and engaging toys that incorporate technology, offering both entertainment and learning opportunities.

Product: Your challenge is to design a prototype of a toy that has a moving element or performs a particular task, to sell to children from a particular age-range and their parents.

Specifications (Requirements) and MYP Criteria:

You are following the design cycle to create a wooden dragster and an innovative electric toy.

You will be graded on Criterion A, B, C and D in your Design Portfolio.

Feedback Log

DATE:	FEEDBACK:
25.07.2024	Design Specs: - My toy must… - This is important because… - To test this, I will…
24.09.2024	Jaidyn: How did you do that? (+), too detailed (-), you put the carriage at the back (?) Titus: Its impeccable (+),

Criterion A

You need to explain the problem, plan research and investigation, evaluate existing products and write your Design Brief.

Answer the questions, or otherwise explain and justify the problem to be solved.

The Problem

What is the problem to be solved?

The task at hand is that I need to create a motorized, interactive toy for a child. Toys are driven by innovation, technological advancements, and changing consumer preferences. 10-year-olds are getting bored of traditional toy trains and need a more innovative toy, due to the target market's changing preferences. They are also losing creative and imaginative skills due to not playing with toys that are realistic enough. According to MiniLandEducational, interactive toys "encourage cognitive development in children from a young age. They will start to recognize shapes and colors, patterns and numbers, as well as a number of different things." My toy is going to be an interactive, technologically advance train with electric components that will keep the child occupied. The train will be very realistic, so that the child can immerse themselves into an imaginary world, so it will be modeled on a real late 1800s steam locomotive. It will be made of sustainable and safe materials and be quite durable.

https://usa.minilandeducational.com/family/understanding-the-role-and-importance-of-interactive-learning-toys-in-kids-development/#:~:text=Cognitive%20skills,a%20number%20of%20different%20things.

Who is the client or target audience?

My target audience is 10-year-old children who are tired of standard wooden toy trains and want a more interactive toy but still want to play with trains. They also really like old steam trains. My target market likes to play with locomotives and would like a product with new and interesting features that they haven't seen before. An additional client is the parent of the child who want a safe toy for their kids that will occupy them for a long time and will not break very easily. The parents also like cheap toys, and since it is common for young children to lose interest in toys and break them, it is vital that the product is interactive as well as affordable.

Why is it a problem? How do you know?

This is a problem because children need to play to increase their imagination and creative skills. This results in children with poor cognitive abilities and resuced skills in recognizing and creativity. Additionally, many young kids like train toys however old designs are not interactive, boring, and are too dangerous to play with due to being made of hard materials and having sharp corners. Toy trains are slowly going out of fashion due to more interactive online games and electric toys, and my product is designed to keep children interested in toy trains. There are very few old-fashioned toy trains that are new and cheap on the market, and almost none that also feature interactive components and electrical parts.

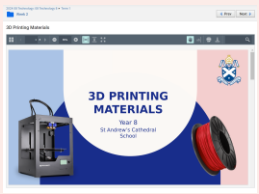
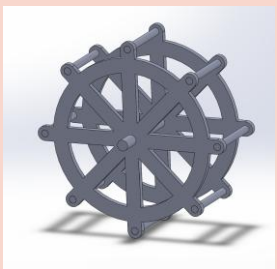
Teacher Directed Research Plan

Complete the table with the research conducted in class

Topic	Primary/ Secondary	Evidence of Completion (photo)	Priority (high medium low)	What I learned
Introduction to Electricity	Secondary	Refer to appendix	Medium	I learned about electricity and what voltage, amps and current mean. I also learned about Ohms Law and how I can use that to find resistance, amps and voltage. By learning about this, I will be able to better understand how electric components such as wires, motors and batteries work, and thus be able to create a toy train that has interactive electrical parts. This is important because one of my design specifications is that my train must have moving parts and an electrical component. However, this introduction is not necessary since you can still make circuits without knowing the science of electricity.
Orthogonal Drawings	Primary	Refer to planning drawings	High	Making some orthographic drawings of my electric train toy would be reasonably helpful for me. These planning drawings can help me easily refer to the dimensions of my toy and are important if I am going to create my product out of wood The orthogonal drawings also developed my skills in technical drawing and computer design, which are very important skills when creating an electric toy. Despite that, I can still make a good electric train without this, due to my product being 3D printed.
Remote Control Solidworks Car tutorial.	Secondary		Medium	Watching the RC car tutorials for Solidworks is quite important because it will allow me to improve my 3D modelling skills in Solidworks, which will help me build skills to create a product that is better suited to my target audience. Even though I am not making an RC car for my final product, the Solidworks skills can still help me understand how to create a different toy type and allow me to create a more complex project in the future, which is why this piece of teacher-directed research is ranked “Medium”.

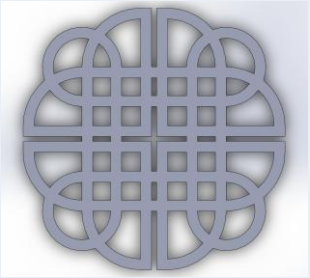
Teacher Directed Research Plan

Complete the table with the research conducted in class

Topic	Primary/ Secondary	Evidence of Completion (photo)	Priority (high medium low)	What I learned
OnGuard v3 NeXT GeN	Primary		High	Completing the OnGuard v3 NeXT GeN tests is extremely vital to making a dragster. This is because it is important to stay safe and not get injured in the workshop, and by completing the tests provided by OnGuard, I am ensuring that when I use workshop tools I do not hurt myself or anyone else in the vicinity.
3D Printing Materials	Secondary		High	This lesson about 3D printing materials and types of plastic filaments is quite high on my priority list because my final product was very likely to be 3D printed, and valuing the positive and negatives of the different plastics was very important. I learned that TPU is quite soft and rubbery, whereas ABS and PLA were harder and stronger.
Ferris Wheel Tutorials			Medium	Through watching the Ferris wheel tutorials for Solidworks, I learnt foundational skills and an understanding of how the software works so that I can then create my own unique electric toy design. Even though I am not making a Ferris Wheel, the Solidworks skills can still help me understand how to create a different toy type.

Think of some research you need to conduct just for your project and complete the table here

Student Directed Research Plan

Topic	Primary/ Secondary	Evidence of Completion (photo)	Priority (high medium low)	What I learned
PMI	Primary	 	Medium	Analysing existing products is an important part of the design process. By analysing existing dragsters, I will look at the positive, negative and interesting parts of the product. This will allow me to construct a toy train from the various good ideas that I found on the internet. The resulting toy will incorporate aspects of these existing products, ensuring that my final design is good. The PMI table is an easy way to organise these pros and cons. However I would still be able to create a viable solution without the need to analyse current products, ranking this piece of research “Medium”.
Celtic Dara knot Solidworks Design	Primary		Medium	Creating my own Solidworks design was also helpful, and I was able to practice and utilise my Solidworks skills and practice my 3D design skills. Since I am making a remote-controlled train, I will be using similar things in Solidworks, so this will help me create an interactive electric toy.

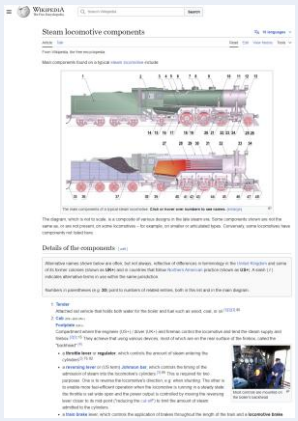
Think of some research you need to conduct just for your project and complete the table here

Student Directed Research Plan

Topic	Primary/ Secondary	Evidence of Completion (photo)	Priority (high medium low)	What I learned
Creating the TPU ring	Primary	Refer to logical plan	High	Through doing this research, I learned that when an object is printed in TPU, the scaffolding leaves behind marks when removes as a pose to PLA that has scaffolding that easily comes off. So I created a TPU ring in Solidworks. This research is rated “High” because it is a vital component of my electric toy.
Researching the Motor Specifications	Secondary		Medium	I learned about the specifications of the motors I was going to be using, which was helpful because it could help me figure out the dimensions that my train should be. I learned that this motor had a 15,500 RPM and the dimensions of 37x20x15mm. This is ranked medium because it would be helpful to know what some of the electrical components are capable of, but it is not necessary.

Think of some research you need to conduct just for your project and complete the table here

Student Directed Research Plan

Topic	Primary/ Secondary	Evidence of Completion (photo)	Priority (high medium low)	What I learned
Train Reference Image	Secondary	 https://www.etsy.com/au/listing/460961304/steam-train-engine-vintage-downloadable	Medium	From this reference image of an 1800s style steam train, I learnt the basic parts of an old-fashioned train that I should include in my Solidworks 3D model and the general proportions of the locomotive's specific elements. This was very useful to creating my complex Solidworks design, but it was not full necessary.
Steam Locomotive Components	Secondary	 https://en.wikipedia.org/wiki/Steam_locomotive_components	Low	I researched about the names of the various parts of an old steam locomotive. This allowed me to search up detailed photos of individual parts, as well as let me precisely refer to parts of my design. This Wikipedia page could help me refer to positive and negative aspects of my final product in criterions B, C and C. However, this is not essential to creating my electric toy, which is why this research is ranked "Low".

Analyse Existing Products

Find images of three products to inspire a solution to the problem. Analyse them to show what you've learned.

 Lionel #5 Special 0-4-0 Standard ga. loco circa 1910-11	This "Lionel #5 Special" locomotive has a traditional colour scheme that looks like it is from the late 1800s to early 1900s. It also looks like the train is the right sort of size and has lots of detail. However, these details might be hard to make using plywood and acrylic, which are the materials provided. However, I could still 3D-print this train. I found it interesting how there are only two wheels on each side of the train, and that it is towing a carriage.
	One positive aspect of this toy train is that it is running on tracks, which makes it more realistic as well as giving it a set route to travel on. The train also has a realistic and proportionally correct aesthetic. A minus of this is that the train is controlled from the outside (likely meaning that electricity is running through the tracks). This makes it slightly dangerous and hard to execute. Additionally, the train is quite large, which may be to help the child immerse themselves into the train's imaginary world.
	This train is made of wood, which is the right material. It also has a nice, vintage look which contributes to its aesthetic. However, this train looks very simple and scratched, which might not appeal as much to the target audience. It is interesting how the locomotive's back wheel is larger than the other wheels and that the smokestack is relatively short. This might be to conserve resources.
	This train has an aerodynamic front as it is pointed. This could make it faster and more enjoyable for the user. It is also made of plastic parts, which could be mostly replicated with painted 3D-printed parts. Another plus is that you can add additional parts, making it more customisable. A negative of this is that it is made of LEGO, which is copyrighted and is made of ABS plastic which is harmful to print. Its texture is also not very smooth, and the train does not look as if it is motorised. The train has an interesting green and black colour palette and has little figurines.

	One plus of this toy train design is that it has an old-fashioned 1800s design. It also has lots of detail and the train runs on a looped track with a similar style. Although the train is controlled from the outside and the locomotive has a front light that I cannot make from the available materials. I found it interesting how the train has a smoke-emitting smokestack that could add to the visual effects but could also harm the child who is playing with the train.
	This train is made of plastic that I could 3D-print and has a tunnel and tracks that the child can interact with. The train can go under the tunnel, appealing to the target audience. However, the train looks very modern and does not it the criterion of having an antique or old-fashioned design. The train has an interesting theme of the London Underground, appealing to children that live in the UK as they are familiar with the tube.
	The train is made of plastic which is a permitted material. The train is also relatively compact, making it easy to move around for a child. It also has lots of bright and fun colours that the target market would like. A minus of this design is that the train is made for a younger demographic and that the track is overly simple. It is interesting how the train is themed “Thomas the tank engine”. This could be nice for children who are Thomas the tank engine enthusiasts, however that is not my audience.
	The train has a very intricate, detailed aesthetic and there are lots of external features such as bridges, houses and trees that can help the user immerse themselves into the imaginary world. Additionally, the train has a 1970s design, which is aesthetically pleasing. Although the train set would take a long time to complete due to the amount of objects I need to make, and the model is made from a variety of materials that are not available to me. The fact that the train is very big and long and has lots of external accessories is interesting.

Answer the questions, or otherwise develop a design brief, which presents the analysis of relevant research

The Design Brief

What were the most important things you learned by doing the teacher directed research?

Teacher Led Research on slide 5 (you need to summarise your research)

In the teacher directed research, I learned about electricity and how it works, as well as how to create a complex object in Solidworks 2021. Additionally, I learned about planning drawings and how to create orthogonal drawings in Solidworks. However, the most important thing that I learned through the teacher directed topics was safety in the workshop. This is because it is vital to keep yourself and others safe when creating an electric toy.

What were the most important things you learned by doing the student directed research?

Student Led Research on slide 6 (you need to summarise your research)

Creating a TPU ring and researching the motor specifications were extremely important as they were necessary to ensure that my final product works. This research let me complete my product with fewer difficulties, which is important. Additionally, analysing existing products using PMIs (Plus, Minus, Interesting) allowed me to use the pros and cons of current electric toys to create an interactive toy that meets my design specifications and the need. Furthermore, creating a complex 2D Solidworks design allowed me to practice my 3D modelling skills which will allow me to create a product with a higher level of detail.

Describe your project based on all that you've learned.

In conclusion, my project will use all of my relevant research to create a solution to the problem that will please my audience, who are young children who want an interactive toy that is an electric train. I will ensure that I combine the good aspects of existing designs to create a product with a variety of electrical components that will ensure that the child and its parents are satisfied. I will create a dragster that conforms to the aspects that I want my final solution to have. Through the extensive research and analysing process, I will identify the ways in which I can make a good dragster that will solve the problem of my intended audience. I have 13 weeks to create the toy.

Criterion B

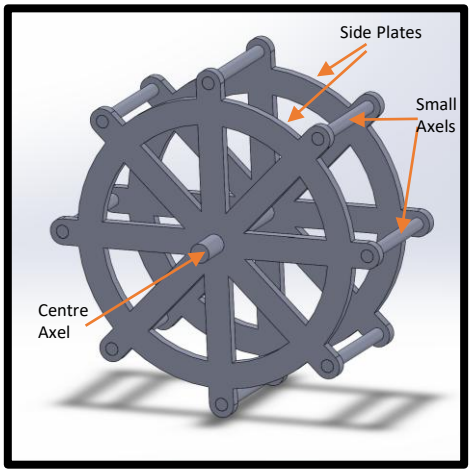
You need to write design specifications, draw design ideas, choose and justify the one to make and make detailed planning drawings

Make sure they are SMART goals: Specific, Measureable, Achievable, Realistic and Time-based

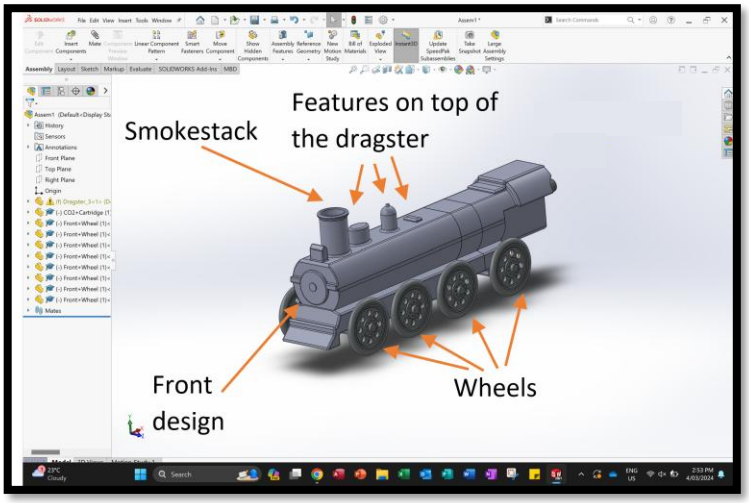
Design Specifications

Success Criteria	Outline specifics of this to your solution as decided in your brief
Target age	My toy must please the target age - 10-year-olds, primarily boys who like realistic train models that are interactive. This is important because that is the audience my product needs to appeal to. I will test this by interviewing some 10-year-old siblings of my friends.
Colour	The colour of my electric train will be mostly black, with a few other colours such as gold on it. This is key to my design because it determines the overall feel and mood of my product, which must interest my target market. I will test if my design has met this by… (either survey or shining light and seeing how much is reflected).
Toy type	My product must be an electric toy train that is motorised and looks like a locomotive. This is vital, as the need states that I must create a product that is technologically advance. I will test this by opening up a Microsoft forms survey and asking my peers to fill out if they think my train met the design specifications.
Safety features	My toy train will have safety features such as rounded corners and no small parts that a child can ingest. It will also be made out of non-toxic plastics. This is important because my ty also has to appeal to the child's parents, who would not like to buy a product that could harm their child. I will test this by measuring the dimensions of my train's parts and researching the toxicity of my toy's materials. I will also ask Titus if my train has rounded corners.
Electric components	There will be a variety of electric components in my train, such as wires, motors, LEDs (light emitting diodes), transistors, a microbit and a battery pack. This is important because my train has to be interactive for children of 10-years of age to like it. I will test this by asking Mr. Pierotti if I have included all of the listed electrical components.
Durability	My toy must be very durable and made out of strong plastic. This is important, as children often break toys, and my product needs to be durable to withstand daily use. I will test this by putting it through a drop test.
Weight	My electric toy train will not weigh more than 300 grams. This is vital because it will increase the toy's durability and can be more easily handled by a child. It is also safer if it is dropped. I will test this by using a scale to measure the weight of my product.
Dimensions	My toy train must have dimensions that are under 350x150x80mm. This is crucial to my design to ensure that the child can handle it and keep the theoretical production cost lower to appeal to the child's parents. I will test this by using a digital calliper set to mm to measure the toy's width, height and depth.
Shape	My train will have the shape of an old-fashioned, late-1800s-looking train. It will be mostly black, with some red and gold on it. This is essential because my target market is interested in electric trains. To test this success criterion, I will create a Microsoft Form. Then I will post the link on Schoology and get my peers to fill it out.

Draw 3 sketches of possible dragsters you could make and analyse the pluses and minuses of each

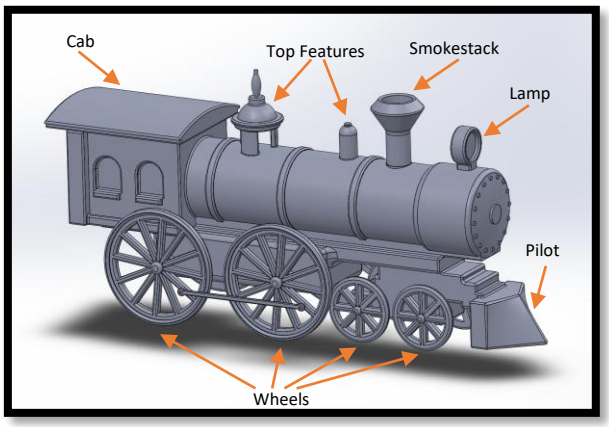


This Solidworks Ferris wheel could be an electrical toy, which is a positive since my toy will be an electric train. It is also a 3D model and could easily be 3D-printed, which is the material that my train will be made out of. It would conform to the design specifications of electric components and weight, however it is not shaped like a train and has a lot of sharp parts, which is not suitable for the target market and the target age. This product will include a centre axel, side plates and 12 supporting rods. This toy idea will be laser cut because the design is mostly flat, and a wooden Ferris wheel would be quite aesthetically pleasing



This toy design is shaped like an old-fashioned steam locomotive from the 1800s, so it conforms to one of my design specifications. It also has eight wheels and is very detailed, making it quite aesthetically pleasing. This train will have features like a smokestack, cab, features on the train's top, a front design and wheels. Its high detail would also be a good thing as it conforms to one of my design specifications. This design will be 3D printed, because that is the easiest method, while also looking smooth and being lightweight and detailed.

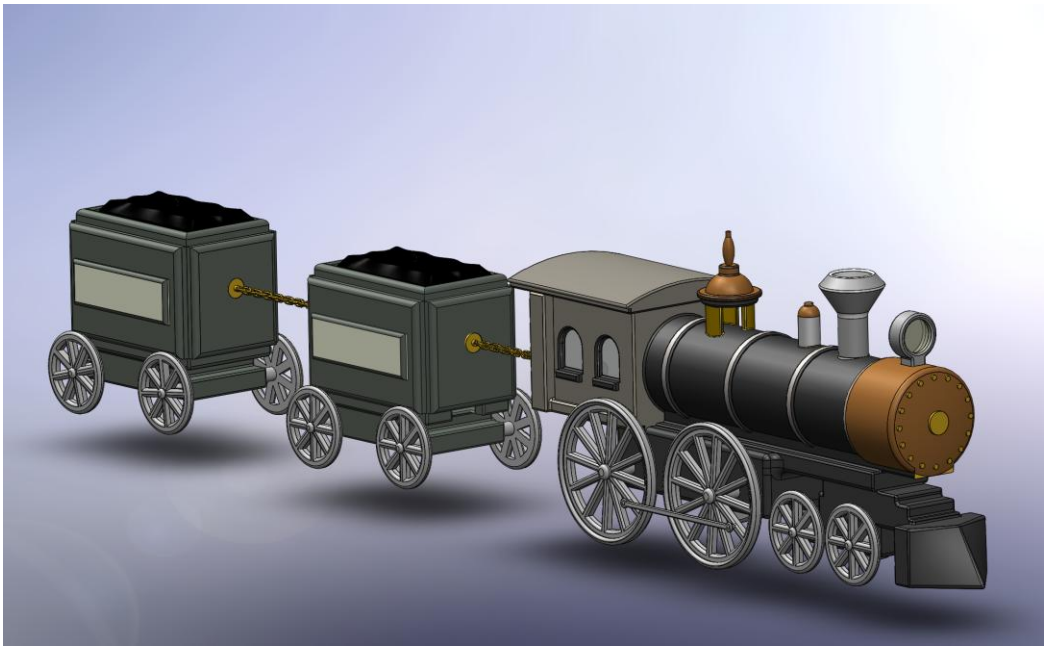
Design Ideas



This train will have electric components, which is one of my design criteria. It has a variety of interesting aesthetical features and has an overall look of an 1800s steam train. It has a high level of detail, and since it is 3D printed, it is not an issue. The locomotive has a suitable size for the target market, being under the maximum desired size of 350x150x80mm. However, it would take a relatively long time to print and the wheels are quite fragile, making it sub-optimal for production and a young audience. This train will have a myriad of features, including a cab, 8 wheels, wheel connectors, a smokestack, top features, pilot and lamp. It will be 3D printed because it is extremely detailed and would be hard to effectively execute when carving out of wood or laser cutting.

Present your chosen design with annotations and outline the reasons for selection

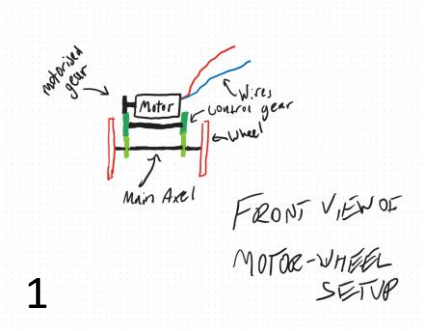
Chosen Design

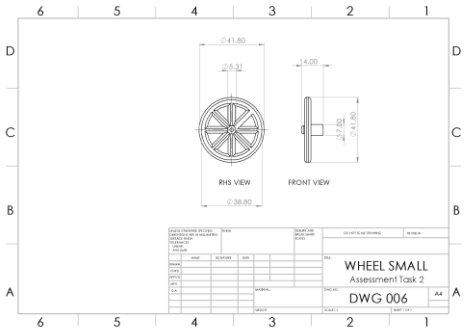


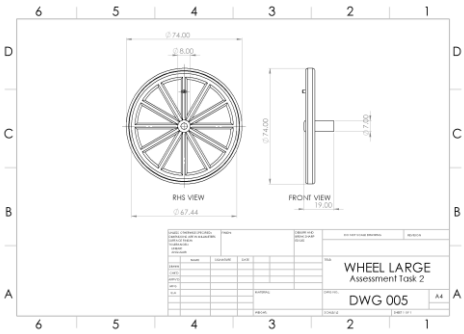
I have chosen this electric train design as my final design as it conforms to most of the design specifications stated at the beginning. It has a recognisable old-fashioned steam locomotive design and has a compartment at the bottom that can allow for various electronic components to fit inside, conforming to one of the design specifications. It is smooth and contains detailed features such as a smokestack, pilot and cab that were present in many 1800s steam trains. The main locomotive also has four axel holes designed to hold eight wheels, and the general design of this dragster has a very detailed look. Additionally, I chose this design because it seemed the most fun for a young audience, as it has multiple removable carriages and magnetic attachment.

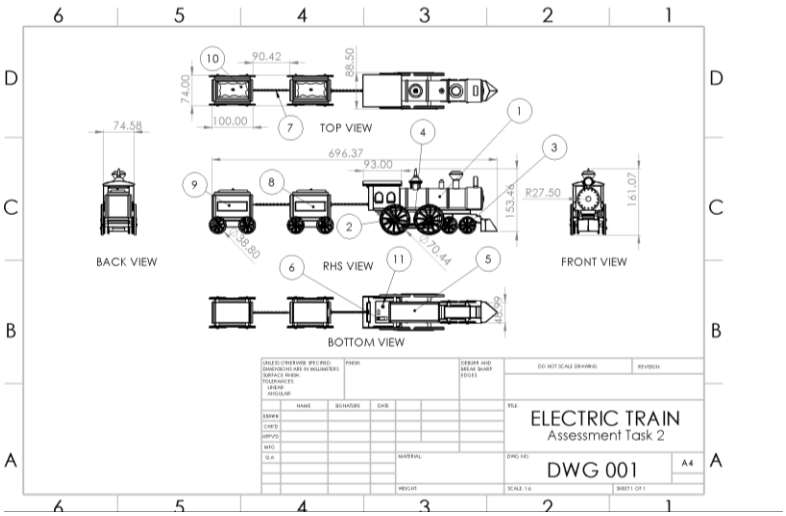
Although this was one of the most complicated designs I made, I chose this design because the final result would be a very engaging electric toy that follows many of my original design criteria, while also being possible to execute. I have also had some experience in designing trains, which would give me an advantage at creating such a toy.

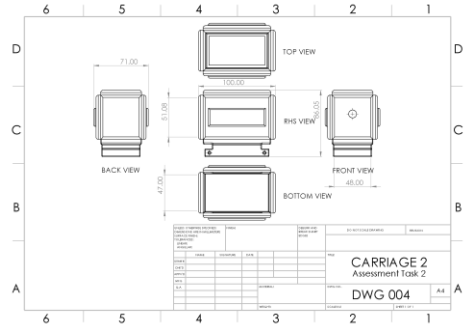
Develops accurate planning drawings/diagrams and outlines requirements for the creation of the chosen solution

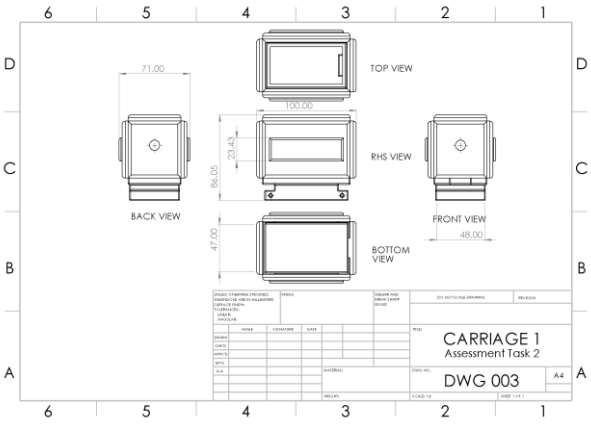


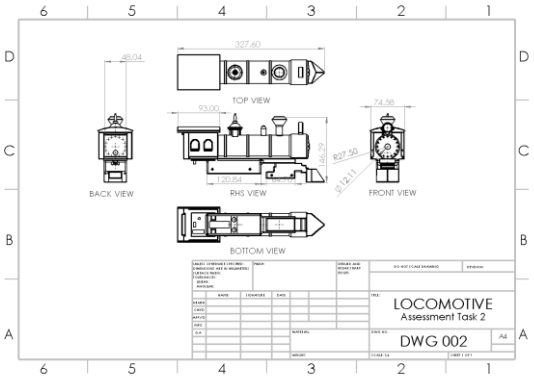












Planning Drawings

List of Requirements

Base-plate.SLDPRT 101 KB	Carriage-1.SLDPRT 390 KB	Carriage-2.SLDPRT 372 KB
Locomotive.SLDPRT 2 MB	Switch-plate.SLDPRT 107 KB	Wheel-Connector.SLDPRT 125 KB
Carriage-top.SLDPRT 211 KB	Chain.SLDPRT 1 MB	LED-ring.SLDPRT 80 KB
Wheel-large.SLDPRT 446 KB	Wheel-small.SLDPRT 289 KB	

4 x Metal Axles
2 x Motors
Switch
2 x Wire Pieces
1 x Battery Pack

4 x 8x1mm Magnets
Black Spray Paint
2 x AA batteries

Don't forget your list of requirements!!

Criterion C

You need to plan your project, show technical skill while making it, show that you have followed your plan and make adjustments to the design.

Constructs a logical plan, which outlines the efficient use of time and resources sufficient for peers to be able to follow to create the solution.

Logical Plan

Step No.	State the Step	Resources needed	Time (min)
SOLIDWORKS			
1	Download Solidworks 2021 off the Company Portal	Computer Company Portal	10-60 minutes
2	Open a new Solidworks Part File.	Computer Solidworks 2021	1 minute
3	On the front plane, sketch a circle from the point of origin, and press enter. Then use “Smart Dimension” to make the circle have a radius of 50mm.	Computer Solidworks 2021	3 minutes
4	Then, draw a centre rectangle on the circle and trim the lines so that you have a keyhole shape.	Computer Solidworks 2021	5 minutes
5	Extrude boss/base the shape to 180mm.	Computer Solidworks 2021	1 minute
6	On the front plane, draw another circle, where the bottom of the circle meets the bottom-most point of the previous shape. Press enter.	Computer Solidworks 2021	3 minutes
7	Extrude boss/base that shape to 40mm.	Computer Solidworks 2021	1 minute
8	On the top plane, sketch an arc from two points on the circumference of the circle and connect both ends with a line.	Computer Solidworks 2021	5 minutes
9	After that, sketch a line through the middle of the segment and trim the left side. Then revolve boss/base the shape to form a curved disc.	Computer Solidworks 2021	8 minutes
10	Sketch a centre rectangle on the top plane and extrude it from the bottom face down 10mm.	Computer Solidworks 2021	10 minutes
11	On the right plane, draw two rectangles with lines and connect them, before extruding them through the mid-plane to 40mm.	Computer Solidworks 2021	10 minutes
12	On the right plane, boss extrude a right-angled triangle for the pilot to 50mm.	Computer Solidworks 2021	8 minutes

Step No.	State the Step	Resources needed	Time (min)
13	On the right plane, sketch the smokestack and boss revolve the shape around the y-axis.	Computer Solidworks 2021	6 minutes
14	Then cut extrude a circle the size of the smokestack into the top of the smokestack.	Computer Solidworks 2021	2 minutes
15	Go to the front plane and boss extrude a rectangle to 70mm.	Computer Solidworks 2021	2 minutes
16	From the far face of the newly created rectangular prism, extrude a roof shape made using lines and an arc to two blind directions: 20mm one way and 75mm the other.	Computer Solidworks 2021	15 minutes
17	Boss extrude a rectangle to 5mm from the bottom part of the cab's roof.	Computer Solidworks 2021	2 minutes
18	Draw two windows onto one of the sides of the cab and cut extrude it to 3mm.	Computer Solidworks 2021	15 minutes
19	Mirror the cut extrude to the other side of the cab about the right plane.	Computer Solidworks 2021	1 minute
20	Boss extrude windowsills to the windows of one side of the cab to 3mm then mirror it to the other side about the right plane.	Computer Solidworks 2021	10 minutes
21	Boss extrude two pillars from the bottom face of the cab up to the bottom of the roof.	Computer Solidworks 2021	8 minutes
22	Boss extrude four horizontal beams from the bottom of the cab's rectangular prism and boss extrude a bottom rectangle to 3mm the other way from the same plane.	Computer Solidworks 2021	15 minutes
23	Boss extrude a rectangle to 25mm from the bottom of the locomotive.	Computer Solidworks 2021	3 minutes
24	Go to the front plane and do an offset extrude boss of a circle onto the main part of the train. The offset should be 80mm and extrude the circle to 5mm.	Computer Solidworks 2021	12 minutes
25	Do a linear pattern of the recently extruded circle twice with 50mm even spacing.	Computer Solidworks 2021	5 minutes
26	Filet all the extruded circles to 1mm.	Computer Solidworks 2021	3 minutes
27	Boss extrude a keyhole shape from the front plane on top of the train to 10mm.	Computer Solidworks 2021	8 minutes
28	Cut extrude a circle from the extruded keyhole's front to 3mm.	Computer Solidworks 2021	5 minutes

Step No.	State the Step	Resources needed	Time (min)
29	Filet the keyhole shape.	Computer Solidworks 2021	3 minutes
30	Boss extrude 16 circles to 15mm in a circular pattern from the front plane onto the front of the train.	Computer Solidworks 2021	8 minutes
31	Boss extrude another lager circle in the middle of the train to 18mm. The circle should be 8mm in diameter.	Computer Solidworks 2021	3 minutes
32	Boss extrude a cylinder to 40mm onto the top of the train from the top plane.	Computer Solidworks 2021	3 minutes
33	Use the function “Revolve boss/base” to create a dome on top of the cylinder.	Computer Solidworks 2021	5 minutes
34	Boss extrude another smaller circle to 46.5mm on top of the half-capsule shape on the train.	Computer Solidworks 2021	3 minutes
35	Boss extrude 3 curved pillars onto the top of the back of the main train part to 37.5mm.	Computer Solidworks 2021	8 minutes
36	Revolve boss a shape to 360 degrees using arcs and lines and splines on top of the three pillars.	Computer Solidworks 2021	15 minutes
37	Filet the cab and the features on top of the train to various radii from 0.2mm to 3mm.	Computer Solidworks 2021	15 minutes
38	Cut extrude axel holes into the rectangular prism on the bottom of the train. The axel holes should be 3.2mm in diameter. Extrude the cut through all (both).	Computer Solidworks 2021	5 minutes
39	Filet the axel holes to 0.5mm.	Computer Solidworks 2021	5 minutes
40	Cut extrude the pilot and boss extrude a rectangle onto the pilot’s holder from the right plane, midplane to 40mm.	Computer Solidworks 2021	8 minutes
41	Create two reference geometry planes, one at the bottom of the train and one just above the recently created rectangular prism.	Computer Solidworks 2021	5 minutes
42	Using lines, sketch the top view and bottom view of a pilot onto either plane that was created.	Computer Solidworks 2021	12 minutes
43	Use “Loft boss/base” to create a loft between the two profile sketches.	Computer Solidworks 2021	5 minutes
44	Use lines and rectangles to sketch and expand the front section of the train. Sketch onto the right plane and boss extrude midplane to 40mm.	Computer Solidworks 2021	10 minutes

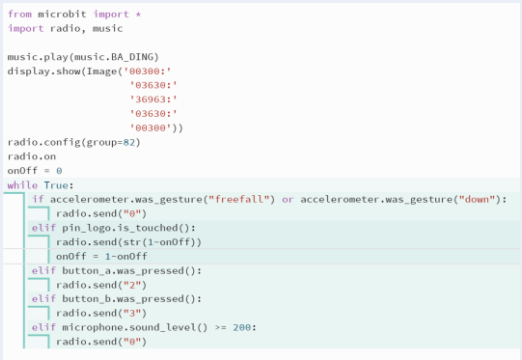
Step No.	State the Step	Resources needed	Time (min)
45	Filet the entire front section of the locomotive to various radii from 0.1mm to 5mm.	Computer Solidworks 2021	20 minutes
46	Cut extrude circular axel holes with a diameter of 3.2mm into the front section of the train through all (both).	Computer Solidworks 2021	10 minutes
47	Extend the back section of the train.	Computer Solidworks 2021	8 minutes
48	Filet the rest of the unfilleted edges to various radii from 0.5mm to 3mm.	Computer Solidworks 2021	15 minutes
49	From the back surface of the back compartment, use lines to cut-extrude a square dovetail joint into the back compartment.	Computer Solidworks 2021	5 minutes
50	On the bottom surface of the back compartment, cut extrude a rectangle to 22.5mm.	Computer Solidworks 2021	5 minutes
51	On the plane at the top of the back compartment, boss extrude a rectangle from the middle to 22mm.	Computer Solidworks 2021	5 minutes
52	On the new rectangular prism's bottom surface, draw two circles 8.5mm from the edge of the compartment of diameters of 7mm.	Computer Solidworks 2021	12 minutes
53	Cut extrude the circles to a 3.2mm depth.	Computer Solidworks 2021	3 minutes
54	From the side of the centre rectangular prism, cut extrude a circle to 16.7mm.	Computer Solidworks 2021	5 minutes
55	From the end part of the locomotive, cut extrude a small rectangle to 13.7mm.	Computer Solidworks 2021	8 minutes
56	From the same face, sketch two circles and offset boss extrude them by 25mm to 5mm.	Computer Solidworks 2021	15 minutes
57	On the bottom face of the train's cab, sketch a rectangle 8x25mm on the left side, and then cut extrude the shape to 12mm.	Computer Solidworks 2021	10 minutes
58	In the centre of the back section of the bottom face of the rectangular prism on the bottom of the train, draw a rectangle of dimensions 15x45mm.	Computer Solidworks 2021	10 minutes
59	Then cut extrude the rectangle to 52mm into the main part of the locomotive.	Computer Solidworks 2021	3 minutes
60	Cut extrude a square from the front section of the previously cut extruded switch compartment to 25mm.	Computer Solidworks 2021	5 minutes
61	Cut extrude another square to tunnel from the main electronics section to the switch compartment.	Computer Solidworks 2021	3 minutes
62	Filet the surrounding edges to 2mm.	Computer Solidworks 2021	8 minutes

Step No.	State the Step	Resources needed	Time (min)
63	Cut extrude a circle 10.5mm in diameter to 3mm from the back of the locomotive's cab.	Computer Solidworks 2021	5 minutes
64	Mirror the square boss extrude from the bottom of the main rectangular prism about the right plane.	Computer Solidworks 2021	8 minutes
65	Cut extrude a circle of diameter 5mm to a depth of 20mm on the right side of the bottom of the train's cab.	Computer Solidworks 2021	5 minutes
66	Cut extrude a circular tunnel leading from the LED compartment to the main electronics section.	Computer Solidworks 2021	3 minutes
67	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
68	On the new part file, normal to the right plane.	Computer Solidworks 2021	1 minute
69	Create a sketch and draw two circles from the origin point: one that is 74mm and one that is 60mm.	Computer Solidworks 2021	8 minutes
70	Sketch a smaller circle from the origin point, about 1/3 of the diameter of the 60mm circle.	Computer Solidworks 2021	2 minutes
71	Draw two lines from the smallest circle to the 60mm circle and make a circular pattern 12 times of the lines.	Computer Solidworks 2021	10 minutes
72	Boss extrude the shape to 4mm.	Computer Solidworks 2021	2 minutes
73	From the front surface, boss extrude a small circle to 4mm.	Computer Solidworks 2021	5 minutes
74	Then boss extrude two large circles from the same surface to 2mm. The outer circle should be 74mm in diameter.	Computer Solidworks 2021	8 minutes
75	Boss extrude a circle 7mm in diameter to 12mm from the back of the wheel.	Computer Solidworks 2021	5 minutes
76	From the end of the newly created rod, cut extrude a circle 3.1mm in diameter to 10mm.	Computer Solidworks 2021	5 minutes
77	From the top pole of the wheel, boss extrude a circle of 2mm diameter to 4mm.	Computer Solidworks 2021	5 minutes
78	Filet the entire wheel to various radii from 0.5mm to 3mm.	Computer Solidworks 2021	12 minutes

Step No.	State the Step	Resources needed	Time (min)
79	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
80	On the new part file, normal to the right plane.	Computer Solidworks 2021	1 minute
81	Sketch two circles close together, with the larger one being 41.8mm in diameter.	Computer Solidworks 2021	5 minutes
82	Then sketch two lines from either side of the inner circle and mirror it about the centre point 8 times.	Computer Solidworks 2021	3 minutes
83	Use “Trim Entities” to create a filled shape.	Computer Solidworks 2021	3 minutes
84	Boss extrude the shape to 4mm.	Computer Solidworks 2021	2 minutes
85	Boss extrude a small circle from the centre to 2mm.	Computer Solidworks 2021	5 minutes
86	Filet most of the wheel to 2mm, except for the centre disc.	Computer Solidworks 2021	8 minutes
87	From the back of the wheel, boss extrude a circle of diameter 7mm to 8mm.	Computer Solidworks 2021	5 minutes
88	Cut extrude a circle of diameter 3.1mm to 11mm into the back of the wheel.	Computer Solidworks 2021	5 minutes
89	Filet the rest of the small wheel.	Computer Solidworks 2021	5 minutes
90	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
91	On the new part file, normal to the right plane.	Computer Solidworks 2021	1 minute
92	Draw a centre rectangle of length 83.84mm.	Computer Solidworks 2021	3 minutes
93	On either end of the rectangle, draw two circles, each of diameters 5mm and 2.15mm.	Computer Solidworks 2021	10 minutes
94	Trim the shape and boss extrude it to 1.5mm.	Computer Solidworks 2021	8 minutes
95	Filet the connector piece to 0.5mm everywhere.	Computer Solidworks 2021	3 minutes
96	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
97	On the new part file, normal to the top plane.	Computer Solidworks 2021	1 minute
98	From the origin point, draw a rectangle of dimensions 25x8mm.	Computer Solidworks 2021	3 minutes

Step No.	State the Step	Resources needed	Time (min)
99	Then draw another rectangle from the origin of dimensions 12x7.2mm.	Computer Solidworks 2021	3 minutes
100	Boss extrude the shape to 1mm.	Computer Solidworks 2021	2 minutes
101	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
102	On the new part file, normal to the top plane.	Computer Solidworks 2021	1 minute
103	Sketch two circles of diameters 3mm and 7mm.	Computer Solidworks 2021	5 minutes
104	Boss extrude the shape to 1mm.	Computer Solidworks 2021	2 minutes
105	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
106	On the new part file, normal to the front plane.	Computer Solidworks 2021	1 minute
107	Sketch a wide “T” 43.65mm wide.	Computer Solidworks 2021	8 minutes
108	Boss extrude the shape to 120.8387mm.	Computer Solidworks 2021	3 minutes
109	Filet the end sides to 2mm.	Computer Solidworks 2021	3 minutes
110	On the top surface of the plate, draw a centreline through the middle of the rectangle.	Computer Solidworks 2021	1 minute
111	Then draw two circles of a diameter of 10.2mm on the centreline 11mm from the edge and trim the centreline.	Computer Solidworks 2021	5 minutes
112	Cut extrude the circles into the plate to 1.7mm.	Computer Solidworks 2021	2 minutes
113	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
114	On the new part file, normal to the front plane.	Computer Solidworks 2021	1 minute
115	Draw a centre rectangle from the origin and put four rectangles of sides 6mm on each of the corners.	Computer Solidworks 2021	3 minutes
116	Then trim entities and boss extrude the shape to 100mm midplane.	Computer Solidworks 2021	5 minutes
117	On the right plane, draw an upside-down “T” shape and boss extrude it midplane to 50mm.	Computer Solidworks 2021	8 minutes
118	From the top plane, cut extrude four squares of sides 6mm on the corners through all (both).	Computer Solidworks 2021	5 minutes

Step No.	State the Step	Resources needed	Time (min)
119	Repeat step 118 for the right plane.	Computer Solidworks 2021	5 minutes
120	On the right surface of the carriage, boss extrude a centre rectangle to 3mm.	Computer Solidworks 2021	5 minutes
121	Mirror the boss extrude to the left side of the carriage.	Computer Solidworks 2021	3 minutes
122	Filet the carriage to various radii from 3mm to 10mm.	Computer Solidworks 2021	10 minutes
123	On the bottom section of the carriage on the right face, cut extrude two circular axel holes 3.2mm in diameter through all (both).	Computer Solidworks 2021	10 minutes
124	On the top face of the carriage, cut extrude a centre rectangle about 1/3 of the way.	Computer Solidworks 2021	3 minutes
125	Then cut extrude a smaller rectangle from the new top face to the bottom of the carriage.	Computer Solidworks 2021	3 minutes
126	Filet the rest of the carriage to various radii from 0.5mm to 5mm.	Computer Solidworks 2021	15 minutes
127	On the front face, sketch a circle 10.2mm in diameter and extrude cut it to 1.5mm.	Computer Solidworks 2021	8 minutes
128	Save the current part file and open File Explorer.	Computer Solidworks 2021	2 minutes
129	There, duplicate the Solidworks file and open one of them.	Computer Solidworks 2021	2 minutes
130	On one of the Solidworks files, mirror the circular hole on the front to the back about the front plane.	Computer Solidworks 2021	5 minutes
131	Then cut extrude a rectangle onto the bottom of the front of the carriage.	Computer Solidworks 2021	3 minutes
132	Filet the rectangle’s edges.	Computer Solidworks 2021	5 minutes
133	Save the current part file and open a new Solidworks part file.	Computer Solidworks 2021	1 minute
134	On the new part file, normal to the right plane.	Computer Solidworks 2021	1 minute
135	Sketch a small capsule shape of dimensions 2mm by 3.5mm centre-distance.	Computer Solidworks 2021	6 minutes
136	Then sketch a larger capsule of dimensions 4mm by 3.5mm centre-distance.	Computer Solidworks 2021	6 minutes
137	Boss extrude that shape to 1mm and filet the edges to 0.5mm.	Computer Solidworks 2021	5 minutes
138	On the top bar, press “Insert”, and then “Body Move/Copy”. Then copy the body 10 times, offsetting it by about half the length of the individual link.	Computer Solidworks 2021	10 minutes

Step No.	State the Step	Resources needed	Time (min)
139	Then copy the first link with no offset and use the “Rotate Bodies” tool to rotate the link 90 degrees along the x axis.	Computer Solidworks 2021	8 minutes
140	Then move the horizontal link to connect two of the vertical links and move/copy the link to connect all the vertical chain links.	Computer Solidworks 2021	10 minutes
141	On the front side, boss extrude a circle slightly from the link.	Computer Solidworks 2021	2 minutes
142	Then boss extrude another circle of diameter 10mm another 1mm from the other cylinder.	Computer Solidworks 2021	5 minutes
143	Use “Reference Geometry” to insert a plane halfway between the two ends of the chain.	Computer Solidworks 2021	5 minutes
144	Mirror the two cylinders previously created along the new plane.	Computer Solidworks 2021	3 minutes
145	Save the Solidworks file. Then email all the Solidworks train part files to Mr. Zimmermann, then close Solidworks 2021.	Computer Solidworks 2021	10 minutes
MICROBIT PROGRAMMING			
146	Open Google Chrome and type in the link: https://python.microbit.org/v/3/	Computer Google Chrome	2 minutes
147	On the python editor, type in the following code: 	Computer Google Chrome	12 minutes
148	Name the file: “Train-Toy(micro_bit_controller)”	Computer Google Chrome	1 minute
149	Then click the button “Save” at the bottom of the editor and save the code as a hex file on your computer.	Computer Goole Chrome	1 minute
150	Click on the microbit logo on the top right of the screen, then click the black button saying: “Python editor”.	Computer Google Chrome	1 minute

Step No.	State the Step	Resources needed	Time (min)

151	On the python editor, type in the following code:
	`from microbit import *`
	`import radio, music`
	
	`music.play(music.BA_DING)`
	`display.show(Image('00300:'`
	`'03630:'`
	`'36963:'`
	`'03630:'`
	`'00300'))`
	`radio.config(group=82)`
	`radio.on`
	`strength = 0`
	`while True:`
	`acceleration = accelerometer.get_x()`
	`message = radio.receive()`
	
	`if message == "0":`
	`strength = 0`
	`elif message == "1":`
	`strength = 500`
	`elif message == "2":`
	`if strength >= 100:`
	`strength -= 100`
	`elif message == "3":`
	`if strength <= 900:`
	`strength += 100`
	
	`pin1.write_analog(strength)`
	`pin2.write_analog(strength)`
	`display.scroll(strength)`
		Computer
		Google Chrome
			15 minutes

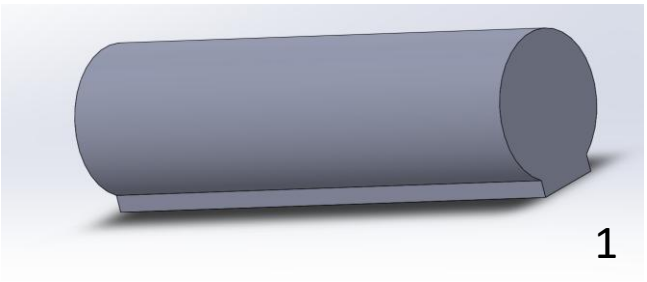
152	Name the file: “Train-Toy(micro_bit_main)”	Computer Google Chrome	1 minute
153	Then click the button “Save” at the bottom of the editor and save the code as a hex file on your computer.	Computer Google Chrome	1 minute
	ASSEMBLY		
154	Once the train and all the components have finished printing, remove all the scaffolding with pliers.	3D-printed parts Pliers	60 minutes
155	Then, use 180-grit sandpaper to smooth out the bottom of the train, and sand the baseplate holder slightly.	3D-printed parts 180-grit sandpaper	45 minutes
156	Then use 400-grit sandpaper to lightly sand the entire train and all the components to make it very smooth.	3D-printed parts 400-grit sandpaper	45 minutes
157	Then put on safety glasses, an apron and a mask.	Safety Glasses Apron Mask	5 minutes
158	Using a can of black spray paint, spray a thin layer of paint across the main locomotive, the base plate and the carriages.	3D-printed parts Safety Glasses Apron Mask	15 minutes
159	Let the paint dry.	3D-printed parts Safety Glasses Apron Mask	20 minutes
160	Repeat step 158-159 until the train is fully black.	3D-printed parts Safety Glasses Apron Mask	60–180 minutes

Step No.	State the Step	Resources needed	Time (min)
161	Put a 3mm metal axle into a metal vice.	Metal axle	1 minute
162	Cut the axle into two pieces of length 60mm with a hacksaw.	Metal axle Hacksaw	8 minutes
163	Connect a hot glue gun to an electricity port and wait 3 minutes.	Hot Glue Gun	4 minutes
164	Hot glue gun the end of one dowel to the axle hole of a small wheel and let it dry for 1 minute.	Hot Glue Gun Small Wheel Axle	5 minutes
165	Repeat step 164 with the other axle and another wheel.	Hot Glue Gun Small Wheel Axle	5 minutes
166	Place the other ends of the axles into the two holes at the front of the main Locomotive.	Locomotive Small Wheels Axle	1 minute
167	Hot glue gun another wheel onto each axle end and let it dry for 1 minute.	Hot Glue Gun Small Wheel Axle Locomotive	6 minutes
168	Take two small, 12-toothed plastic gears and attach them to a vice.	12-toothed gears	2 minutes
169	Using a 3mm drill piece, drill a hole into the centre of each of the gears	12-toothed gears 3mm drill piece Hand drill	5 minutes
170	Cut another 3mm metal axle into two pieces of length 100mm with a hacksaw.	Metal axle Hacksaw	8 minutes
171	Repeat steps 164-166 with large wheels on the new axles.	Hot Glue Gun Large Wheels Axle Locomotive	12 minutes
172	Slide the 12-toothed gears into the axles.	Axle Locomotive 12-toothed gears	2 minutes
173	Repeat step 167 with the large wheels on the new axles.	Hot Glue Gun Large Wheel Axle Locomotive	6 minutes
174	Place two 8-toohed gears onto the end of the motor's axles.	8-toothed gears Motors	8 minutes
175	Place four 8mm disc magnets into the four holes on the baseplate and the bottom of the locomotive.	Locomotive Baseplate 8mm disc magnets	3 minutes
176	Using a hot glue gun, put some hot glue onto the top of the bottom of the locomotive compartment.	Hot Glue Gun Locomotive	2 minutes

Step No.	State the Step	Resources needed	Time (min)
177	Slowly place the motors onto the hot glue, lining up the gears.	Motors Locomotive	5 minutes
178	Connect one set of opposite-coloured wires together by twisting the ends together.	Motors	2 minutes
179	Insert a switch into the back rectangular section and feed the wires through into the bottom compartment of the locomotive.	Switch Locomotive	3 minutes
180	Connect one of the switch's wires to the closer motor's free wire, twisting the ends together.	Switch Motor	2 minutes
181	Cut two lengths of wire, each 20cm long from a spool of wire.	Wire	1 minute
182	Using a pair of wire-strippers, strip about 1.5cm of rubber coating from each of the ends of the two wires.	Wire-strippers Wire pieces	3 minutes
183	Feed both wires through the loop at the back of the locomotive and through the hole at the back of the bottom section of the train.	Wire pieces Locomotive	3 minutes
184	Connect one end of one wire to the free wire coming out of the switch.	Wire pieces Switch	1 minute
185	Connect one end of the other wire to the free wire of the motor further away from the switch.	Wire pieces Motor	1 minute
186	Repeat steps 161-167 with the small wheels on the additional carriage with a hole at the front.	Hot Glue Gun Small Wheels Axle Carriage Hacksaw	30 minutes
187	Place a "AA" battery pack into the carriage and connect the two wires coming from the battery pack to the two wires coming from the Locomotive.	AA Battery Pack Wires Locomotive Carriage	5 minutes
188	Cover the carriage with a 3D printed cover-plate	Carriage Cover-plate	1 minute
189	Place two blobs of hot glue gun on the hole on the back of the locomotive and the hole on the front of the primary carriage.	Carriage Locomotive Hot Glue Gun	2 minutes
190	Connect either end of the 3D printed chain to the carriage and the locomotive on the hot glue blobs and wait for it to dry.	Chain Carriage Locomotive	2 minutes
191	Repeat step 186 with the other carriage.	Hot Glue Gun Small Wheels Axle Carriage Hacksaw	30 minutes
192	Repeat steps 188-190 with the other locomotive and the primary locomotive.	Chain Carriage 1 Carriage 2	5 minutes
193	Attach the wheel connectors to the train.	Locomotive Wheel connectors	1 minute

Demonstrates excellent technical skills when making the solution. Here's your chance to show off your skills

Process Photos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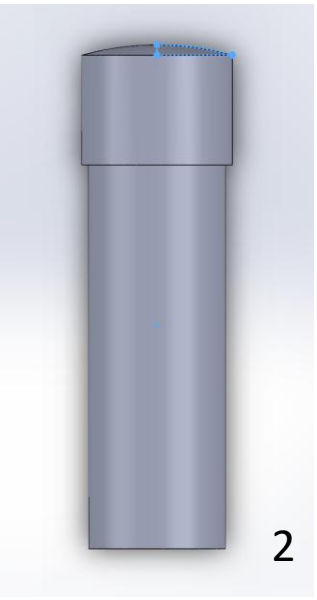
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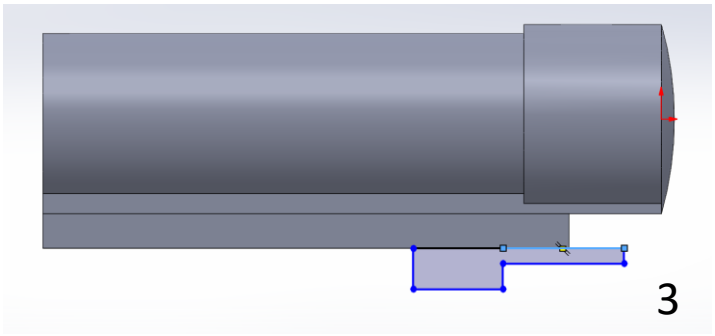
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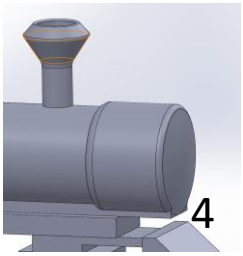
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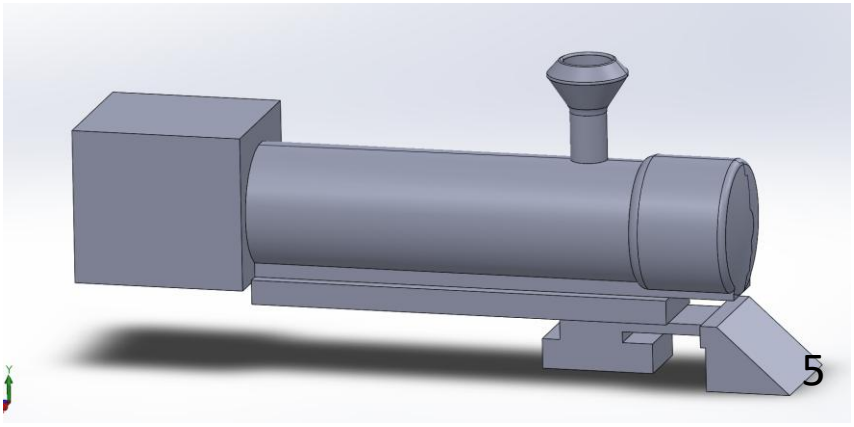
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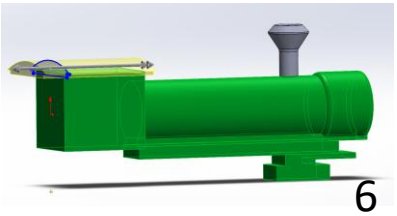
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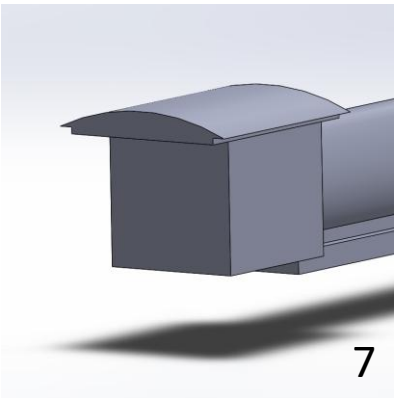
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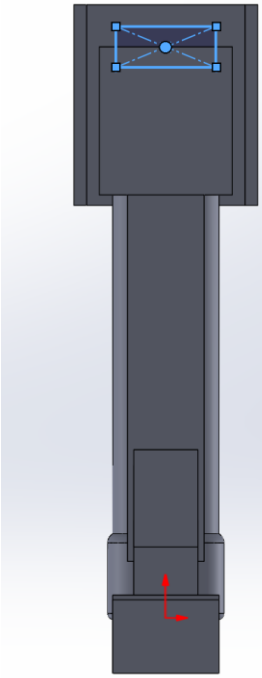
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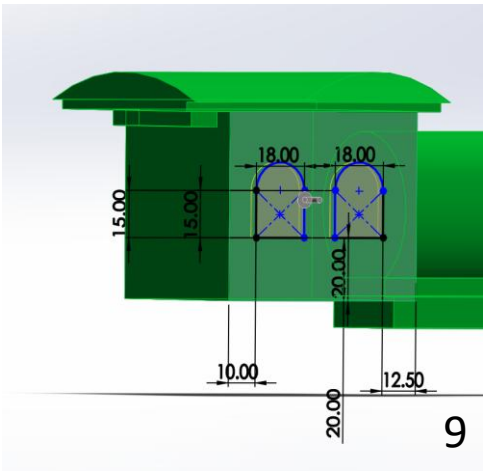

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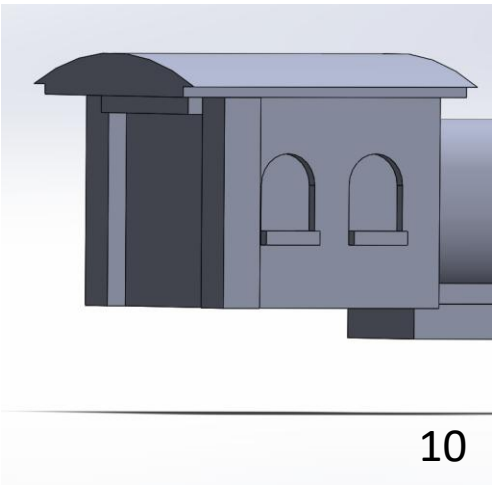
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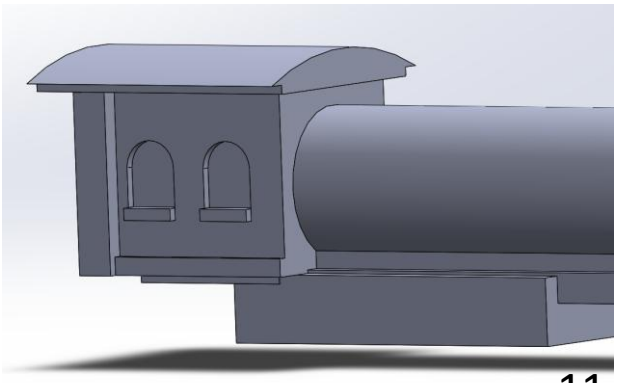
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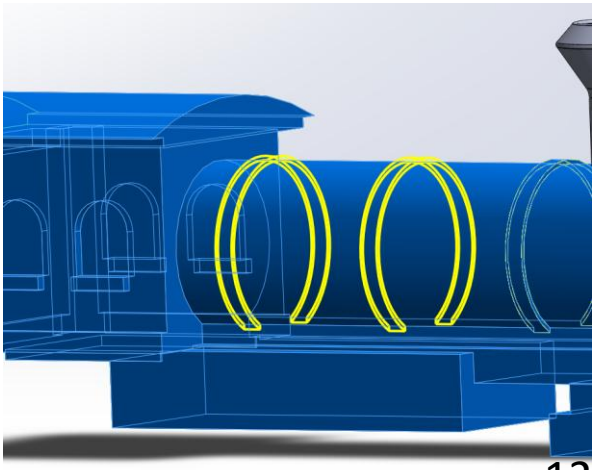
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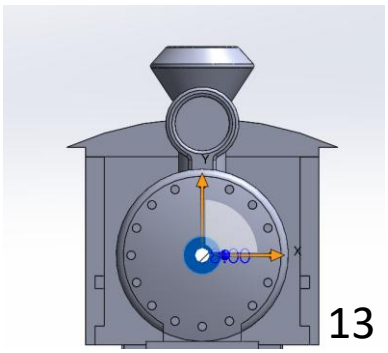
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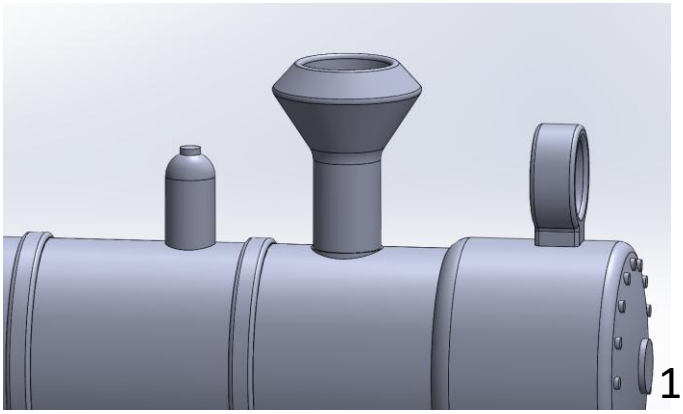
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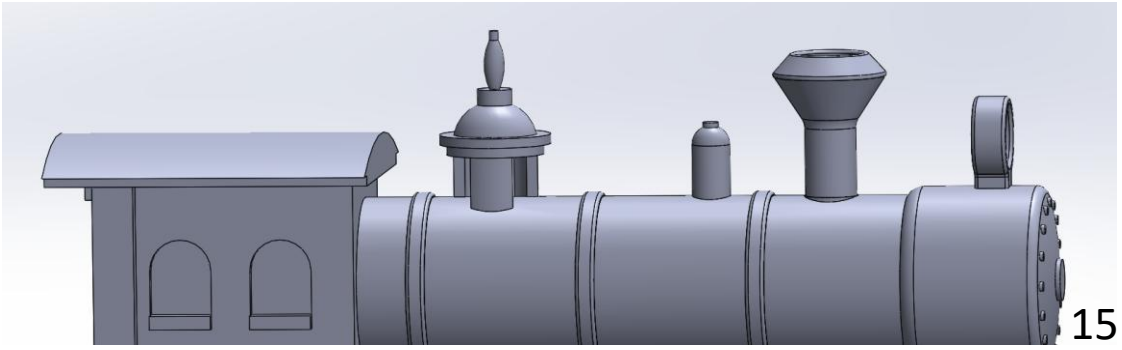
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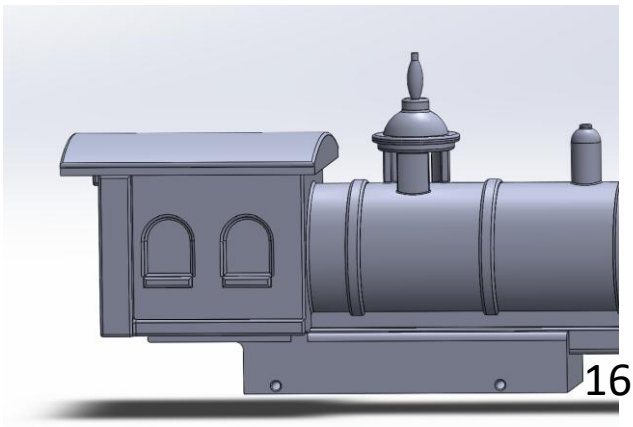

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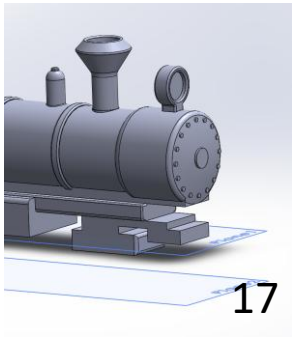

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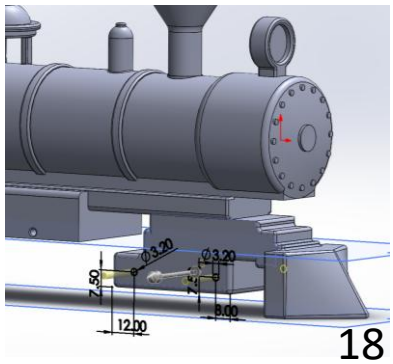

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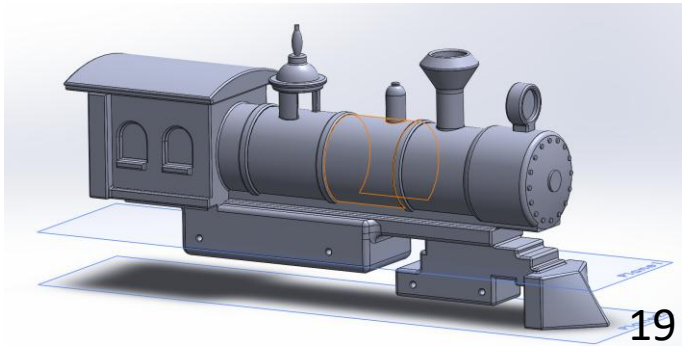

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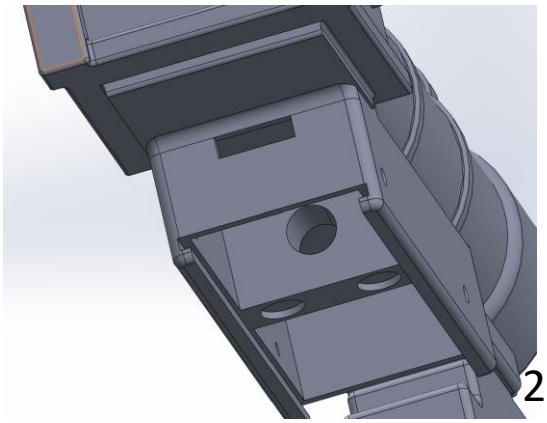

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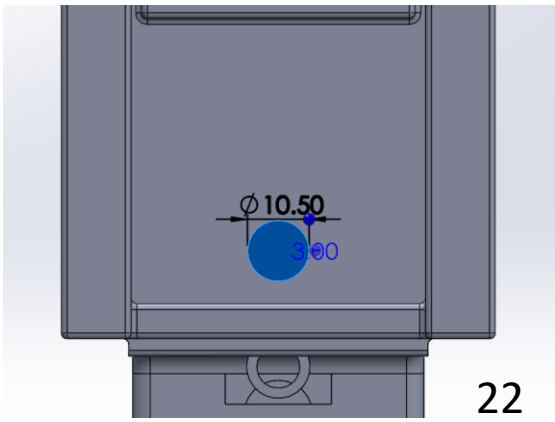

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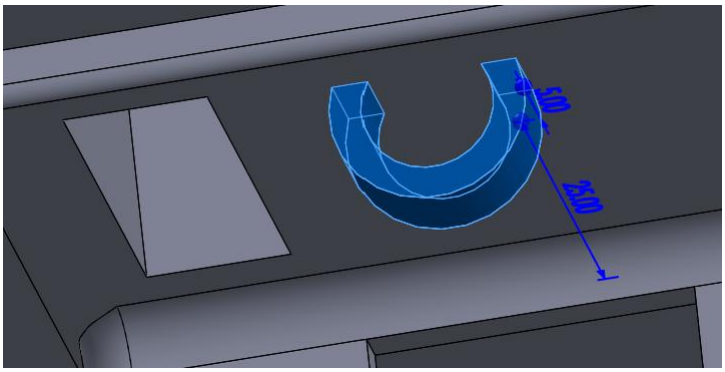

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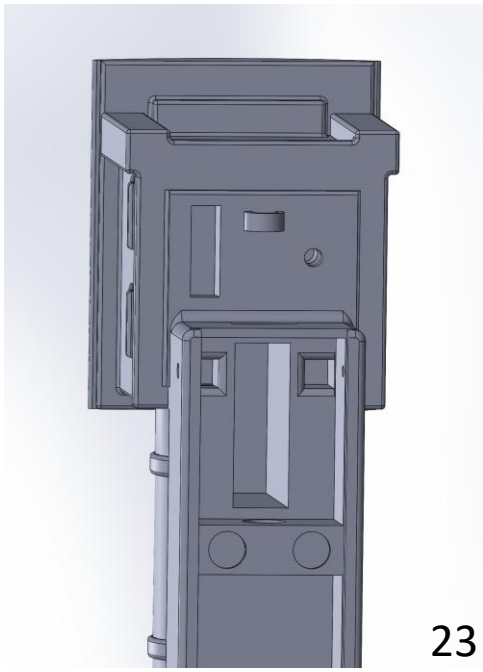

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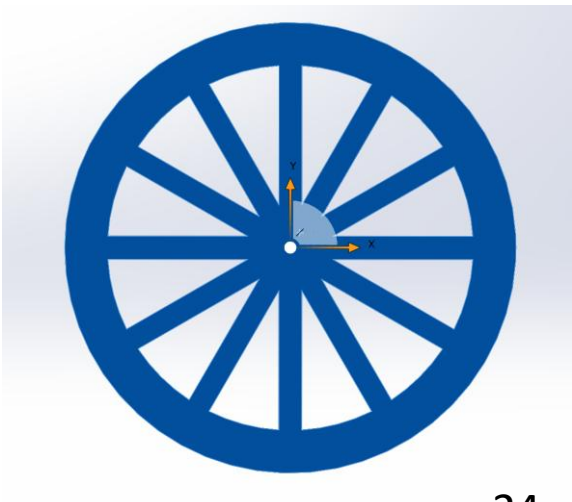

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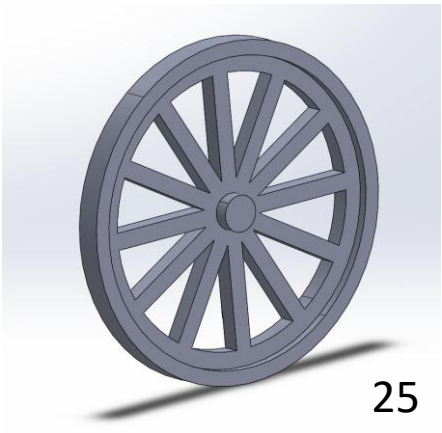

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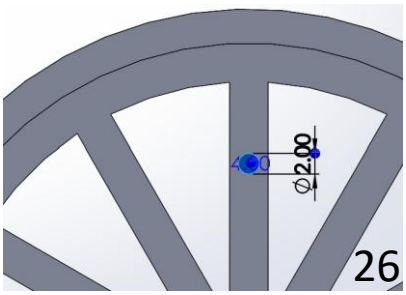

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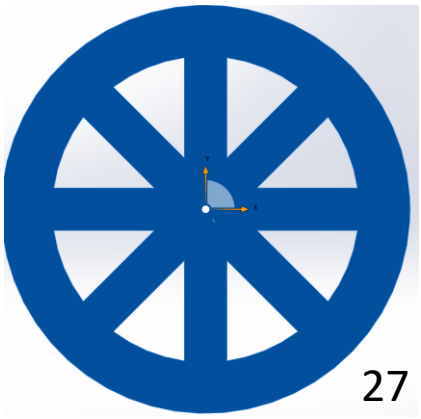

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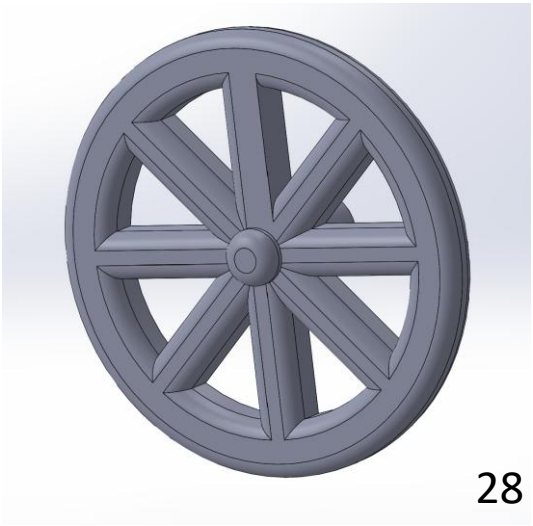

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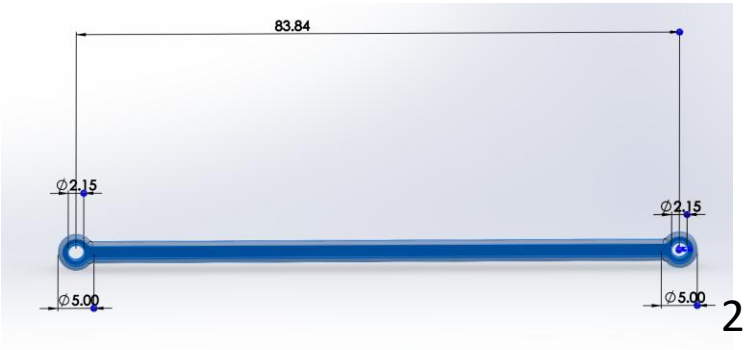

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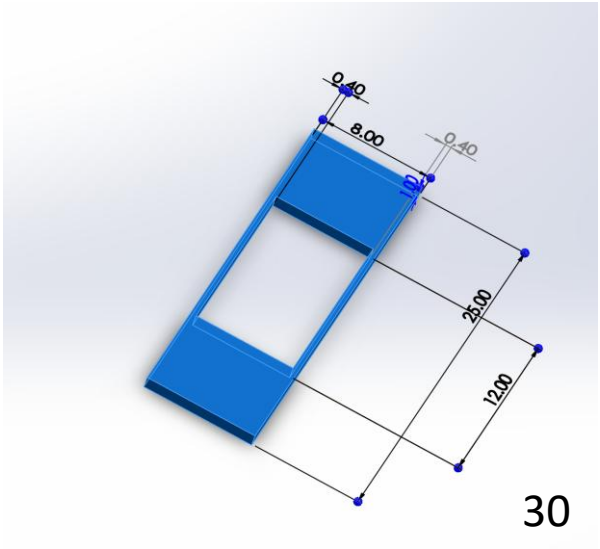

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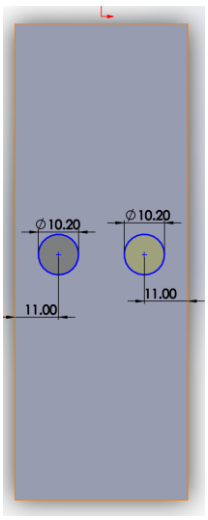

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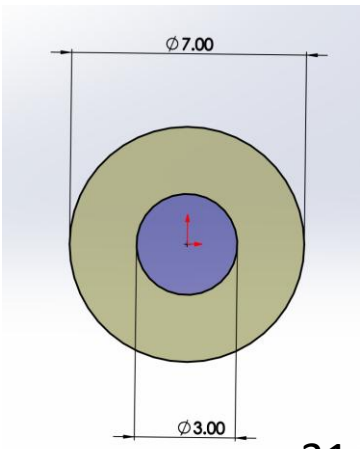

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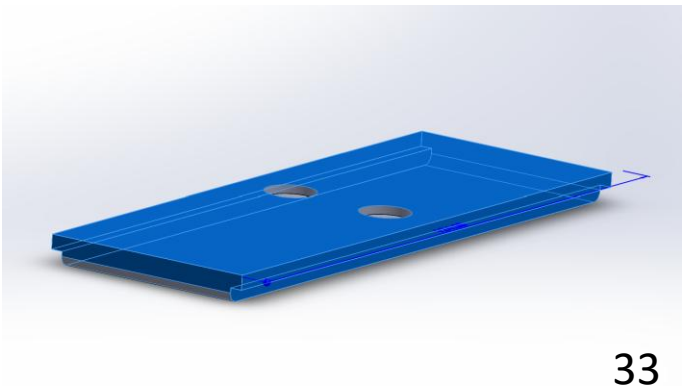

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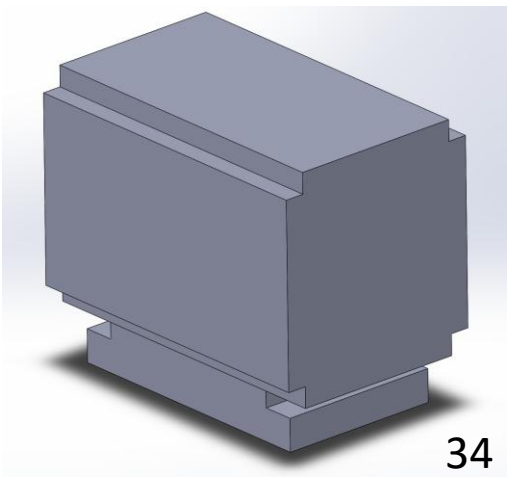

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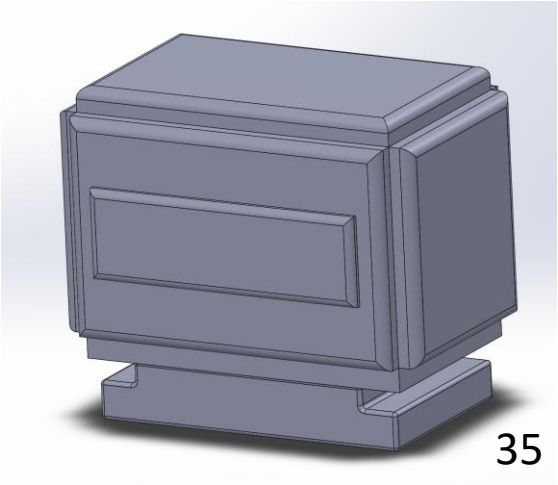

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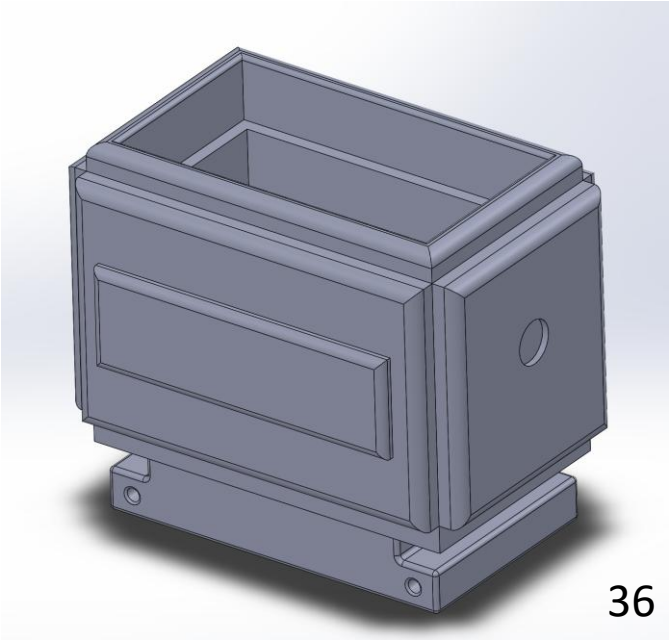

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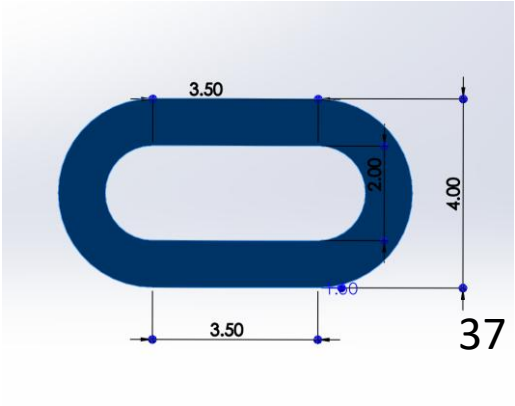

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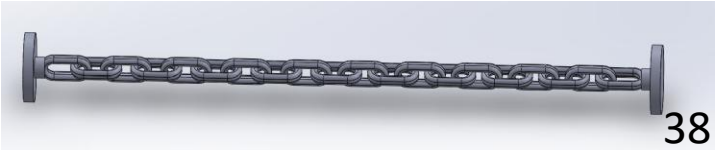

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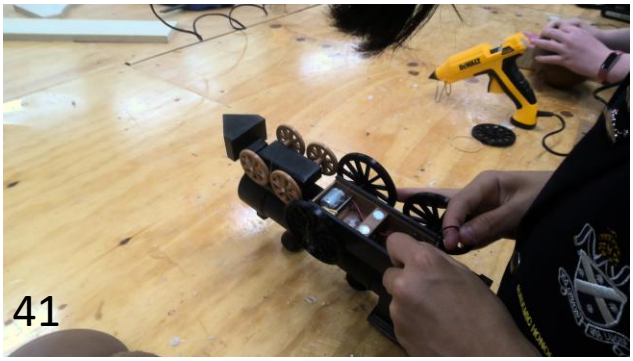

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Your final product

Don't forget to send your website to your teacher.

Explain changes made to the chosen design and plan when making the solution.

Changes Made

Change made to chosen design	Why did you make this change?
I changed the colour of the electric toy	In the Solidworks rendering, I used a variety of metallic colours such as iron, brass and copper. When it was originally printed, the small rings, connectors, chains, carriages and the locomotive were printed in a brown, and the TPU rings and large wheels were printed in black, which was different to my Solidworks design. However, I ended up painting it…
I printed a TPU ring	I was originally going to print the train's wheels in TPU, so that it would have a rubbery texture and it will have enough grip on the ground to move forward. However, when printed in TPU rather than PLA, scaffolding leaves unwanted marks behind, so I ended up printing the wheels in PLA and making a TPU ring that would slide onto the large wheels, giving it the same grip that it would have had it been printed in TPU, while also looking cleaner. This made it so that the final product looked different to the original Solidworks design.
I sanded down the baseplate	For my electric train toy, I ended up having to sand down the baseplate and baseplate holder slightly, because the baseplate slid very stiffly into the main locomotive. I used 180-grit and 400-grit sandpaper to do this.
The top feature broke	In my Solidworks model, my design had a tall section on the top of my train. However, during the sanding process, I accidentally snapped the thin top section. It was too fine to be glued back, so I kept the design without that section, sanding to remove the bump that remained.
I used rubber bands with the motor	When wiring the electronics in the base of my train, The gears used were too small and had the wrong number of teeth. This prevented the motor from being able to turn the axel with the correct torque-speed ratio. To accompany for this, I changed the chosen design to utilise rubber bands to connect the axel to the motor. I did this by twisting the rubber band to quadruple the thickness and connecting either end to the train's wheel axel and the motor axel.

Ctrl Click to go to the design

Ctrl Click to go to the plan

Change made to chosen plan	Why did you make this change?
I printed a TPU ring	I was originally going to print the train's wheels in TPU, so that it would have a rubbery texture and it will have enough grip on the ground to move forward. However, when printed in TPU rather than PLA, scaffolding leaves unwanted marks behind, so I ended up printing the wheels in PLA and making a TPU ring that would slide onto the large wheels, giving it the same grip that it would have had it been printed in TPU, while also looking cleaner. I made the ring by sketching two circles of different diameters and extruding the shape to 4mm. I had to then add this to the logical plan.
I altered the baseplate design	My original baseplate design had the magnet holes perfectly align with the magnet holes in the locomotive. However, when it had printed and I put magnets in, the baseplate self-aligned around 1mm too far forward. So I altered the baseplate design so that the holes were moved 1mm forward, ensuring that the magnets align correctly. I did this by changing the smart dimension that I used for the circles from 58.5mm to 59.5mm.
I did not include a remote control	In my original design, I included a microbit remote control that would have allowed for the train to travel without the need of a switch and could be controlled from a distance. However, there were time constraints that prevented me from finalising the design. So I accommodated for a switch to be the primary stop of electrical flow in my product's circuit.
I used rubber bands with the motor	When wiring the electronics in the base of my train, The gears used were too small and had the wrong number of teeth. This prevented the motor from being able to turn the axel with the correct torque-speed ratio. To accompany for this, I changed the logical plan to utilise rubber bands to connect the axel to the motor. I did this by twisting the rubber band to quadruple the thickness and connecting either end to the train's wheel axel and the motor axel.

Criterion D

You need to design tests, measure the success against the Design Specifications, explain improvements and describe the impact on the target audience.

Carry out testing methods which will produce data (yes/no or numerical answers). It should get feedback on each of your design specifications.

Test Design

Describe your first test design (link to any survey)

Using a Microsoft Form, I will test what toy type my dragster was, its shape, as well as its colour and if it had electrical components. I will create a survey and post it on the class Schoology and ask my peers to complete the form. I decided to do this because I was able to collect many responses quickly, and Microsoft automatically graphs the information, making it easy to read ad interpret.

Describe your second test design

To test if my final product met the design requirement of being under 300g, I will use an electrical scale to measure the total weight of my design in grams. I will record the weight and determine if it is less than the desired amount. I chose this method since it would be the easiest and most straightforward, allowing me to arrive at a precise conclusion with little effort.

Describe your third test.

To see if my final product has met the required target age, I will interview my sister, who is 10 years old (the target age) and ask her what she thinks of my final product. I will include questions relating to its interactivity, use of electrical components and aesthetics. I will do this because this method of collecting data is readily accessible to me and provide relatively accurate results.

Ctrl Click here to read your design specifications on slide 10

Carry out testing methods which will produce data (yes/no or numerical answers). It should get feedback on each of your design specifications.

Test Design

Describe your fourth test design

I will test if my final electric toy met the dimension requirements by using a digital calliper to record the linear length, width and height of my toy. I will then see if the recorded values are smaller or larger than the desired amount. When using the digital calliper, I will make sure that the units are set to mm and the 0mm is correctly set.

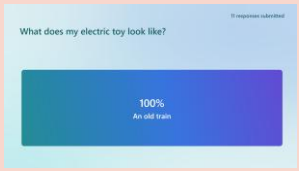
Describe your fifth test design

I will use a drop test to test the durability of my design. To execute this, I will drop my design from a height of 10m onto a hard surface such as concrete. Then I will inspect the damage and determine if my product has met the design specification by interviewing Titus, Mahe and Jaidyn. I chose this method of testing since it would replicate a situation where a child throws the train quite well.

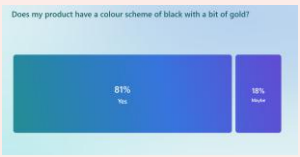
Ctrl Click here to read your design specifications on slide 10

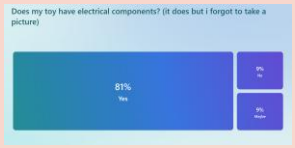
Explains the success of the solution against the design specification.
❖
Add another page if you need to analyse more data.

The Success

Design Specification	Test Result (average/score)	Success
Type of Toy Shape		☐ Yes ☐ No Explain: 100 percent of my respondents said that my electric toy looked like an old train. My design specification was that it looked like an old-fashioned train, so my design specification was met very well.
Dimensions	My final product succeeded in being under the dimension limit. My design specification said that my product must have the dimensions under 350x150x80mm. My final locomotive had the dimensions of 342x147x69mm, which is less than the desired maximum size.	☐ Yes ☐ No Explain: All three of the measured directions were under the desired dimensions of my train, so my locomotive met this specific design criterion.
Target Age	When interviewed, my sister said that she really likes the idea and that while its not very colourful, it is very entertaining and would be fun to play with. Furthermore, when asked if she would play with my locomotive, my interviewee replied positively saying, “Yes. I would definitely play with your toy.”	☐ Yes ☐ No Explain: My sister said mostly positive things about my product, so my final design met this design specification.

Ctrl Click here to read your design specifications on slide 10

Design Specification	Test Result (average/score)	Success
Weight	In my design specifications list and test design, I stated that my train must be under 300 grams to avoid injuries to the child. My product weighed 457 grams, which is above the maximum weight.	☐ Yes ☐ No Explain: Since my final product's weight was above my set amount, my final electric toy did not meet the design specification of being light.
Colour	 81% of the people that I surveyed saud that I had a black and gold colour scheme. The rest said I might have that colour palette.	☐ Yes ☐ No Explain: 81 percent of my respondents said that my electric toy had a colour scheme of black with a bit of gold on it. My design specification stated that my product would have those aesthetics, so this criterion was met relatively well.
Durability	My test was to complete a drop test from a height of 10 metres. After this, my product survived with minor scratches but still functioned. Additionally, nothing broke during the test.	☐ Yes ☐ No Explain: While the product did have some small damages, it would likely still functions after a 10-year-old handles the train.

Design Specification	Test Result (average/score)	Success
Electrical Components	 My respondents stated that my train had motors, wires, a switch and batteries, however it did not contain a microbit or an LED.	☐ Yes ☐ No Explain: 81 percent of my respondents said that my electric toy had electrical components. An additional 9% said that it might have electrical components, and a large majority supported my use of electrical components. Since my design specification said that my finished product should have electrical components, this requirement has been met quite well even though there were some people who said that I did not have electrical components and that I did not utilise an LED as stated in my design specifications.

Describe how the solution could be improved.

Improvements

Improvement	Description
Sanding the final product more and too a finer grit.	One improvement would be to sand my final locomotive more and to a finer grit. I would do this by spending time to hand sand my product with 240, 400 and 1,000 grit sandpaper. When I made the product, I did not have enough time to do this.
Painting the wheels, chain and the carriages.	Another improvement to my final product would be to paint the wheels, chain and carriages. However, when creating the train, I could not find certain types of paint, and I did not have much time, resulting in many parts being their original 3D-printed colour. Next time, I could manage my time better and then use spray paint and acrylic paint to paint those parts.
Utilising a remote control	In my original design, I included a microbit remote control that would have allowed for the train to travel without the need of a switch and could be controlled from a distance. However, there were time constraints that prevented me from finalising the design. One improvement would be to manage my time better to improve the product by including a remote control.
Making the wheels work	I had originally planned for my electric toy to be motorised with turning wheels. However, I encountered many obstacles that hindered my design from working. A lack of time, motor specifications and my gear design prevented the wheels from turning. An improvement would be to use a stronger motor and more relevant gears to make my wheels turn. This would include getting a motor with a higher torque and turning power, as well as custom creating plastic gears in Solidworks and 3D printing them. This will allow my electronics to work and let my train function as desired.

Describe the impact of the solution on the client/target audience.

Impact

How do you think your solution solved the problem for your client?

My solution quite effectively solved my problem for my chosen clients. My target market was 10-year-old children who are tired of standard wooden toy trains and want a more interactive toy but still want to play with trains. I believe that I have met this target audience by creating an interactive train that is quite durable that appeals to these children and their parents. My toy locomotive allowed young children to affordably play with toys that they enjoy. My product included electrical components, good aesthetics and a suitable material, so my product has solved the problem for my clients. My final design solved a large issue in the modern day, that toys are driven by innovation, technological advancements, and changing consumer preferences, by creating an interactive, electric toy that appeals to my target audience.

What impact will your solution have on them?

My solution will have a large impact on these people that may not have access to similar products on the market that are both technologically advanced, durable and affordable. It will allow 10-year-old children to play with things that they like and improve their cognitive and problem-solving capabilities, enhancing their fine motor skills. They will start to recognize shapes and colors, patterns and numbers, as well as a number of different things from an early age, which is extremely beneficial to both the children and their parents. Children who once could not play with such an innovative product will now be impacted positively, because they can occupy themselves with a cheap, good quality product that will entertain my target audience.

Appendix

Word	Definition
Electricity	The flow of electrons in a substance between the valence shells of atoms.
Valency	The number of electrons gained and lost by an atom.
Ion	A charged particle (imbalance of protons and electrons)
Current	The swapping of electrons by ions.
Resistance	Measurement of electric current.
Amperes	Measurement of opposition to the flow of electricity.
Voltage	Current * Resistance
Ohms Law	V = I*R