To: Fluke Toy Corp

From: Nora Atkins, Raine Cheng, Sienna Giuseppi

Subject: Request for Happy Meal Toy Design

Date: March 30th, 2025

Happy Meal Toy Technical Memo

Executive Summary

The goal of this project was to create and document an engaging new toy that is to be placed into McDonald's Happy Meals later this year. The finished toy needed to satisfy a variety of criteria, such as consisting of one unique plastic part per team member, meeting injection molding standards, possessing potential for mass production, and avoiding any potential choking hazards. For the design, the team chose to create a train toy with functional spinning wheels that facilitate consumer play. The toy, as it will arrive in the Happy Meal, is composed of a car top and the frame with wheels attached. The train cars easily attach to one another with a peg-hole system that creates one long train chain. This buildable aspect of the toy incentivizes the consumer to return to McDonald's in order to expand their train's length. The train toy is zoo-inspired, meaning each additional body train car is themed around a different animal, such as pigs or cows. A conductor figurine rides atop the lead engine car. In terms of production, the base toy costs approximately 17 cents for the engine train car and 16 cents for the body train car. Steps were taken to reduce this cost through shelling the train cars to limit the amount of material used. Additional costs involved in the production of this toy include painting, assembly, and the inclusion of a paper map. This adds 7 cents for each part, for a total cost of 24 cents for the engine car and 23 cents for the body car. Team member Raine created the frame of all cars, which included the wheels, axels, and wheel pins to attach the wheels to the frame. Team member Nora created the engine train car. Team member Sienna created the body train car. Both the engine car and body car designs included holes for another peg-hole mechanism that allows the train cars to connect to the frame. Overall, the team believes that including this toy in Happy Meals later this year will excite customers and increase sales for McDonald's Happy Meals.

Approach Description

The team began brainstorming ideas through discussions of popular childrens' movies, tv shows, and cartoons. The team felt that choosing a popular character could entice consumers and increase excitement about the happy meal toy. However, the team realized through discussions with Professor Simmons and TA Emma that many of the character ideas were too simplistic and lacked any functional components that would facilitate play. The team pivoted to consider more functional toys, many of which were inspired by carnival games. All ideas were recorded in a

shared brainstorming document (Appendix A). The team decided that only functional toys, as opposed to character figures, would move on to the next stage of the selection process.

To refine the generated ideas, the team created a Pugh Scoring Matrix (Table 1) which evaluated the top eight generated ideas based on the design criteria of No Choking Hazard, Injection Molding Viability, Functionality, Mass Production Potential, and Creativity. See Appendix B for descriptions of each toy idea.

Design Criteria	Weight	Car/Train		Flower Blooming		Pinwheel		Football Kicker		Potato Head		Mini Golf		Pinball Machine		Bowling	
		Score (1-5)	Weighted Score	Score (1-5)	Weighted Score	Score (1-5)	Weighted Score	Score (1-5)	Weighted Score	Score (1-5)	Weighted Score	Score (1-5)	Weighted Score	Score (1-5)	Weighted Score	Score (1-5)	Weighted Score
No Choking Hazard	30%	5	1.5	5	1.5	5	1.5	2	0.60	1	0.30	1	0.30	3	0.90	1	0.30
Injection Molding Viability	15%	4	0.60	3	0.45	3	0.45	2	0.30	4	0.60	5	0.75	1	0.15	3	0.45
Functionality	20%	5	1.0	2	0.40	4	0.80	5	1.0	5	1.0	5	1.0	5	1.0	5	1.0
Mass Production Potential	15%	5	0.75	4	0.60	4	0.60	3	0.45	3	0.45	4	0.60	1	0.15	3	0.45
Creativity	20%	2	0.40	3	0.60	3	0.60	5	1.0	3	0.60	4	0.80	4	0.80	4	0.80
Total Score		4.25		3.55		3.95		2.35		2.95		3.45		3.00		3.00	
Rank		1		3		2		8		7		4		5		5	

Table 1: Happy Meal Pugh Scoring Matrix

Using the Pugh Scoring Matrix (Table 1), the team decided to move forward with the highest ranked Car/Train toy idea which had a score of 4.25. The Car/Train toy is large enough to avoid a choking hazard, has high injection molding viability, has the ability to be a functional rolling toy, and possesses high mass production potential. The one low-scoring area of this idea was creativity, as the team felt that a train idea is fairly common. To remedy this one flaw, the team decided to create a unique and engaging zoo theme which inspired the design of the engine and body train cars. This decision provided a new, exciting spin on a common idea.

Toy Description, Key Features, and Documentation

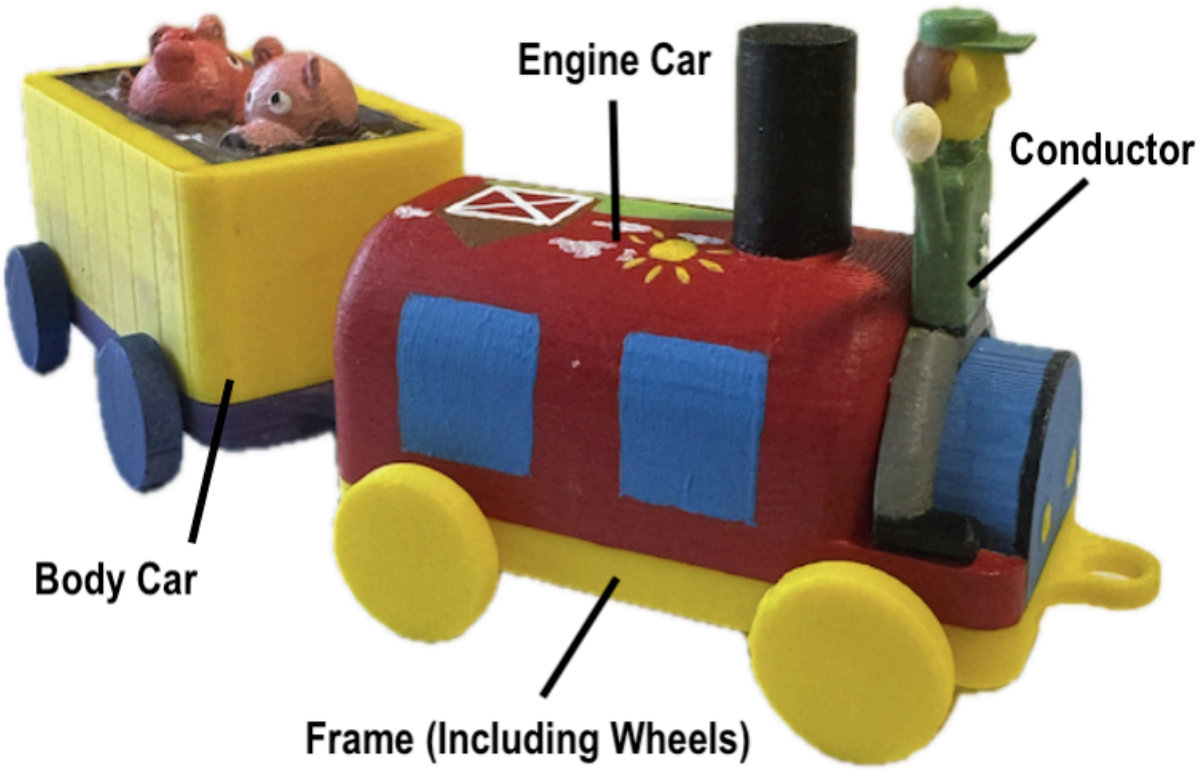


Figure 1: Assembled Happy Zoo Train Toy

The Train Toy is composed of three parts as shown in Figure 1: the car frame, the engine car, and the body train car. Each train car (both engine and body cars) has holes at the bottom that allow it to attach to pegs on the car frames. An important feature of the train is that each train car (engine and body) have the same peg dimensions, allowing all train cars to fit onto different car frames so users can 'mix-and match' different combinations of train frames and cars. This consistent peg-hole system allows the toy to be easily mass producible.

Specifically to the frame, a key feature is the overhanging hole in the front and a pin in the back that allows each assembled train car to connect to another shown in Appendix C. Users can connect each train car they collect, encouraging them to return to McDonalds to lengthen their train. Additionally, the wheels attached to the frame are functional. There are two sets of wheel-axle systems within the train: the front two wheels are connected by an axle and are produced as one piece, and the back wheel system is identical. Both sets of wheels are held into a cavity in the frame and secured by wheel pins that are glued to the bottom of the frame as shown in Figure 2.

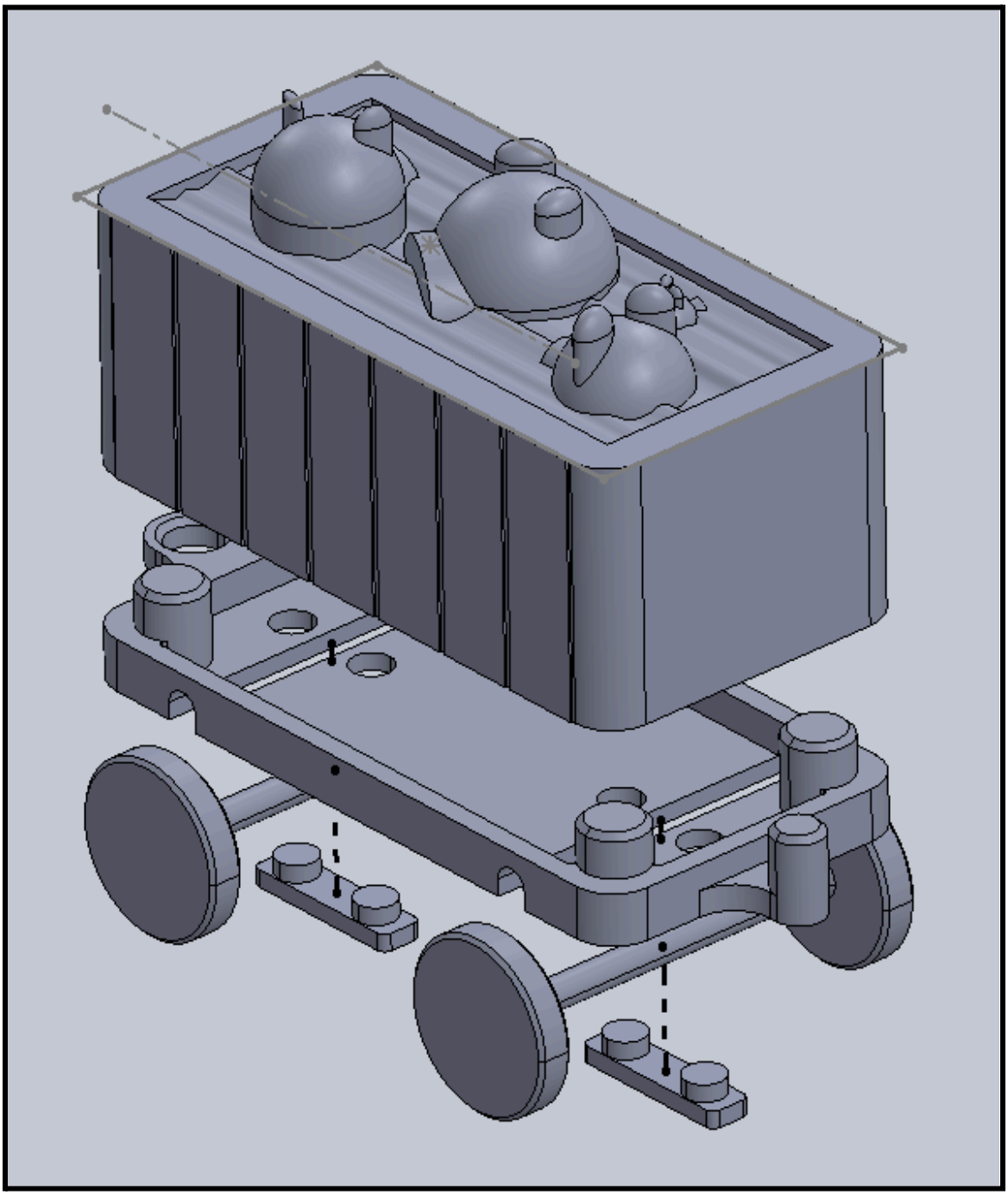


Figure 2: Exploded View Assembly of Train Toy

An important feature of the engine car is the conductor figure that sits atop the train. To facilitate injection molding, this figure had to be 3D-printed separately from the engine car. The engine car is decorated in order to engage the consumer, with windows, the zoo logo, and the zoo name

(The Happy Zoo) all painted on to the car. When making the switch to mass production, stencils for the paint would be used in order to lower cost associated with the design.

An important feature of the body train car is the generic shape of the animals. The same injection molded train body car can be painted to resemble many different animals, lowering the cost of production of this car since only one mold is needed for many different toy variations. The ability to make many different looking toys out of the same mold gives the team the opportunity to make many unique toys that encourage customers to keep returning to collect more. As seen in Appendix item E, the team has provided an example of the train car painted as a 'Pig car' and a 'Tiger car', demonstrating the car's shape's artistic variability.

Finally, a train map shown in Figure 3 is included in all Happy Meal Toys to enhance the user's play experience.

Figure 3: Included Paper Map for Train Toy

Design Documentation

Unless otherwise noted, 0.15mm tolerances were used for all critical to fit (CTF) measurements in this project since printing trial and error demonstrated that this tolerance produced a successful snap fit between parts. Precise dimensions ensured that the train frame and car bodies do not fall apart when being played with, but that the parts could still be separated and swapped by the user if desired. Additionally, this tolerance made it easier to glue in the wheel pins precisely.

The team chose to manufacture the toy with polyethylene (PE plastic) as it is lightweight, durable, and cost-effective. Additionally, PE can be recycled, making the toy more sustainable.

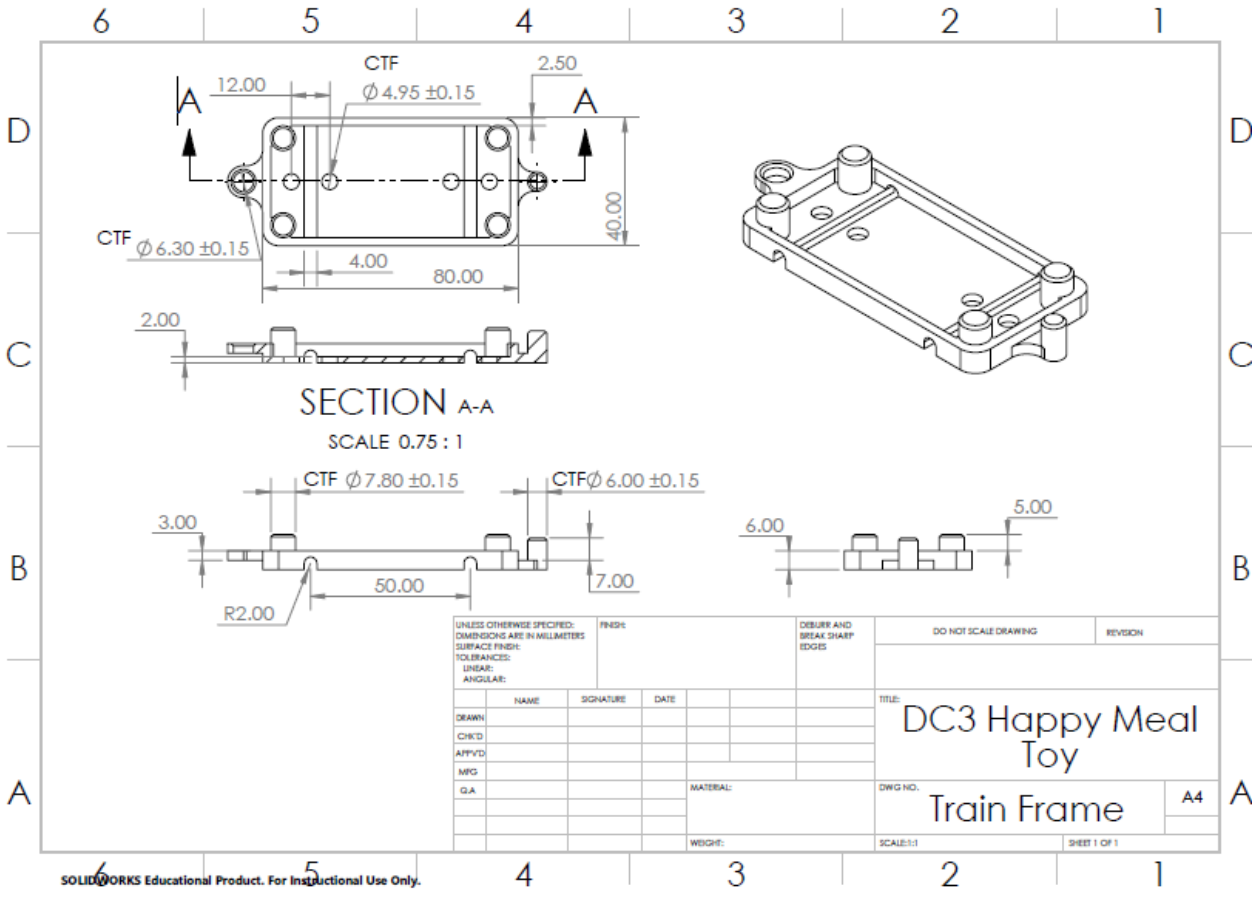


Figure 4: Three View Frame Drawing with Cross-Section

Train Frame:

In the frame as shown in Figure 4, the Critical to Fit (CTF) dimensions include the peg holes on each corner of the frame, the wheel pin holes, and the peg-hole attachment system used to attach each train car.

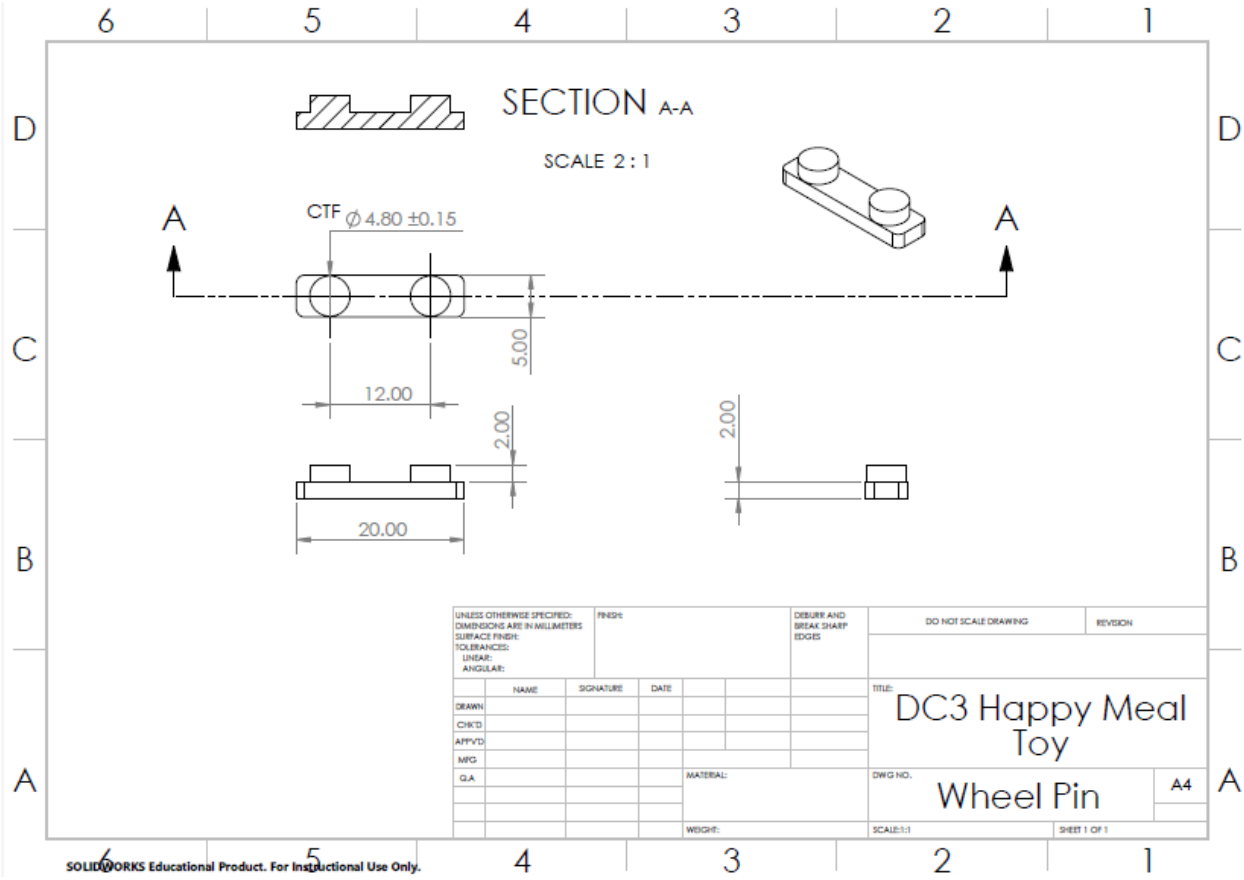


Figure 5: Three View Wheel Pin Drawing with Cross-Section

Wheel Pins:

For the wheel pins as shown in Figure 5, the only CTF dimensions are on the pegs. These are because the wheel pins must interface with the frame to hold the wheel axle securely, but glue was also applied to adhere this part to the frame as it is a choking hazard if not attached permanently.

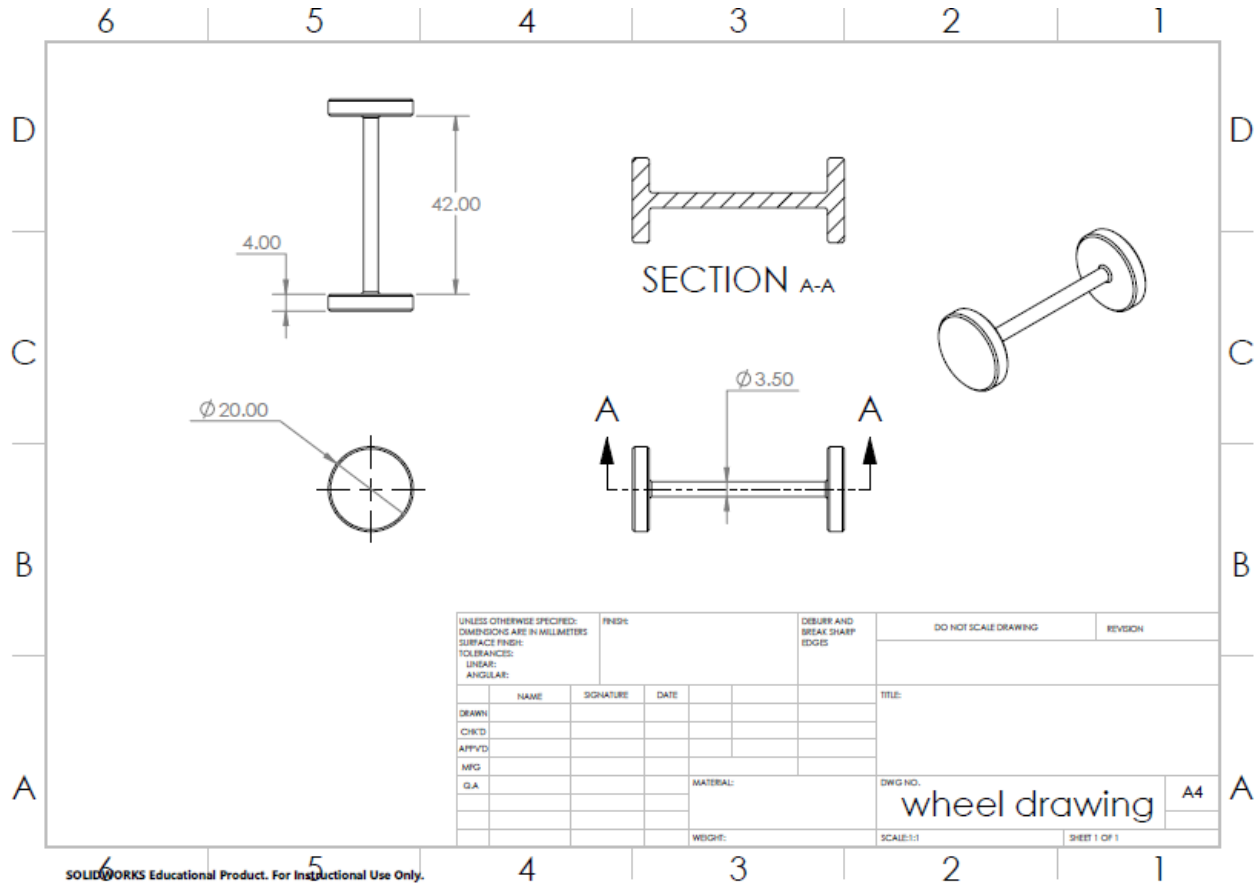


Figure 6: Three View Wheel Drawing with Cross-Section

Wheel:

For the wheels as shown in Figure 6, there are no CTF dimensions. This is because the 3.5mm axle fits into a 4mm large cavity in the frame that gives plenty of ‘wiggle-room’ that allows the wheels to shake and rotate.

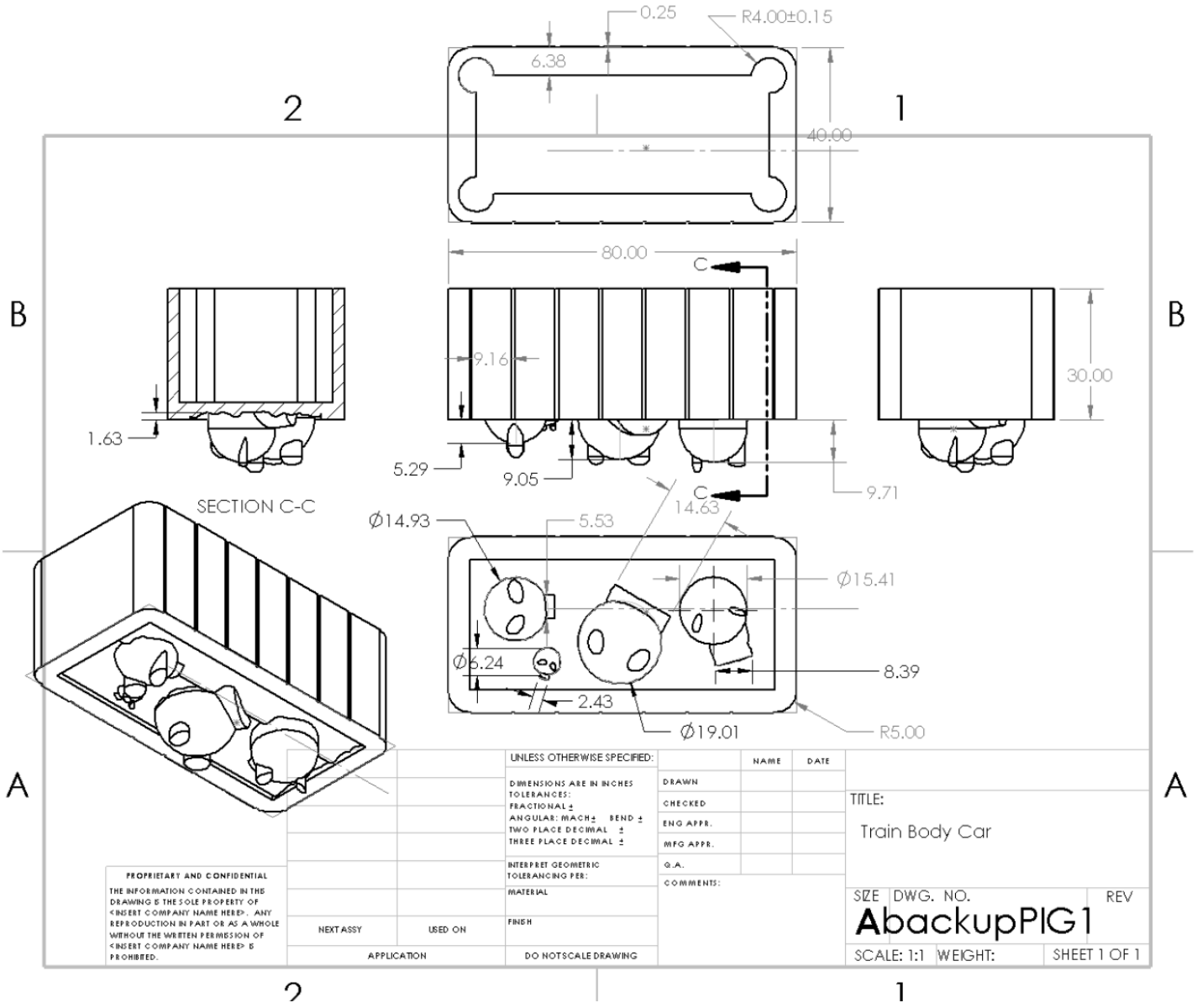


Figure 7: Three View Pig Car Drawing with Cross-Section

Body Car:

For the body car as shown in Figure 7, there are CTF dimensions for the holes inside the shell. This is because the pegs from the frame must fit tightly with the pegs on the frame.

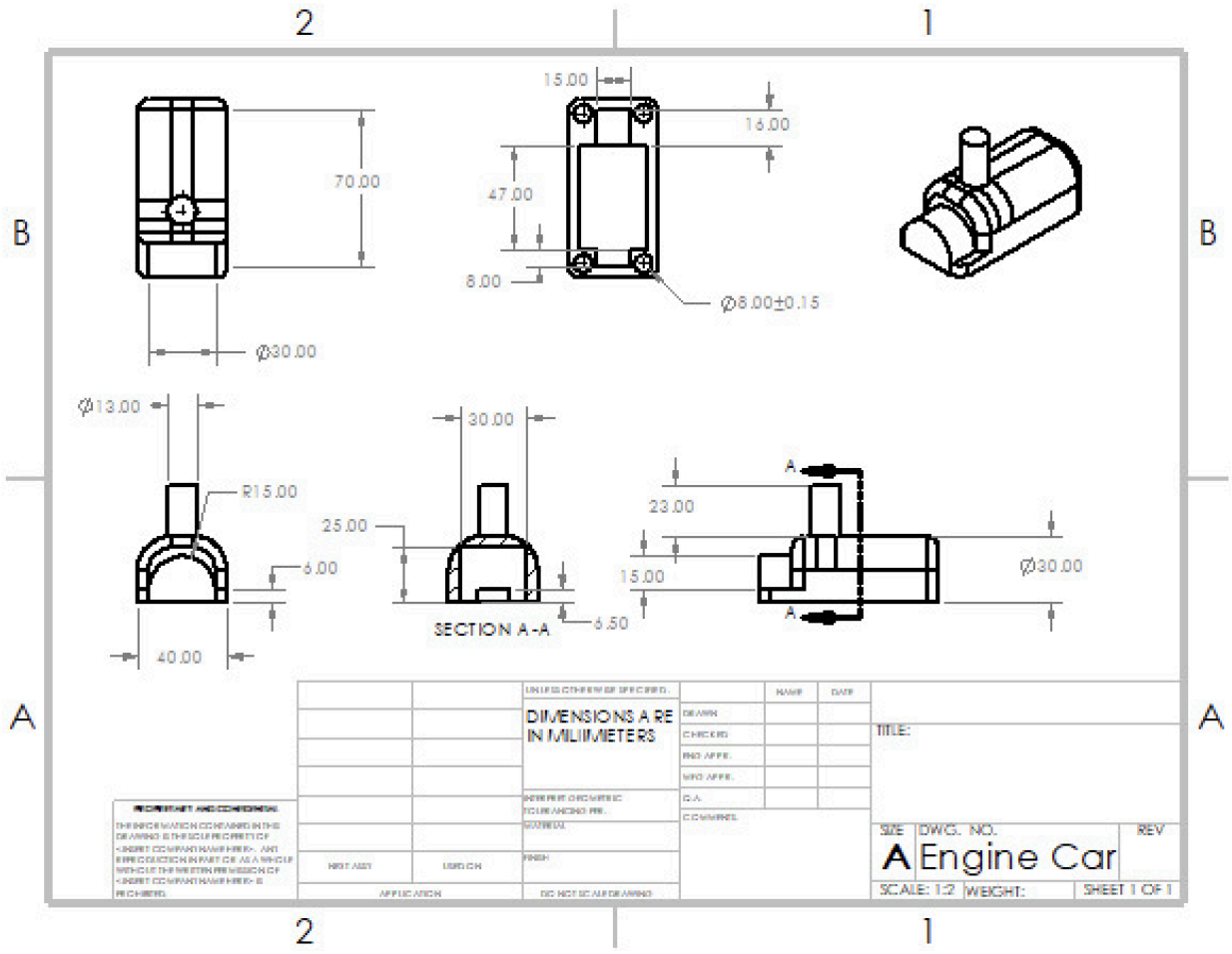


Figure 8: Three View Engine Car Drawing with Cross-Section

Engine Car:

For the engine car as shown in Figure 8, the 8 mm peg holes inside the shell are critical to fit. If the radii of the holes are too small or too large, the pegs will not fit securely into the frame, causing the toy to come apart too easily. Like other parts of the toy, a 0.15 mm tolerance was used to ensure the pegs fit correctly.

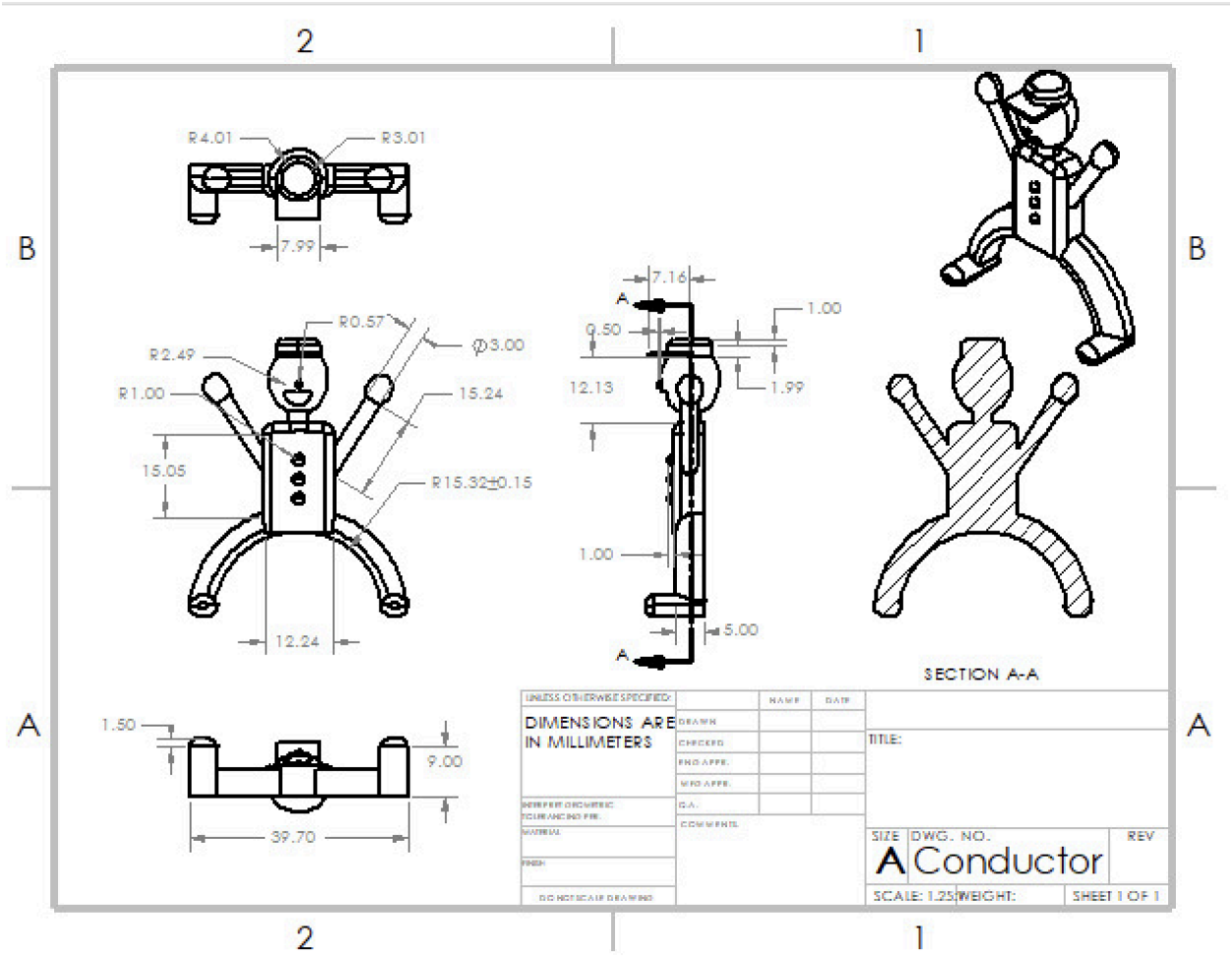


Figure 9: Three View Conductor Drawing with Cross-Section

Conductor Figure:

For the conductor as shown in Figure 9, the 15.32 mm radius of the conductor's legs are critical to fit. The conductors legs need to fit atop the protruding engine car section, giving the appearance that the conductor is "riding" atop the engine car, which has a radius of 15 mm.

Like other parts of the toy, a 0.15 mm tolerance was used for the radii of the conductor leg - engine fit. This tolerance created a buffer that allowed for easy gluing of the conductor to the engine car.

Design for Manufacturability

The team made sure all parts were injection moldable. Holes are all in the direction of the mold to ensure there are no overhangs. In addition, plastic volume of each part was minimized by shelling the car tops and making the frame indented in the inside. Wheel pins were also iterated to be as small as possible both for costs and aesthetics. Moreover, the conductor figure was initially part of the engine car design, but the team moved to having a separate figure that is glued on since that would make both the figure and engine car injection moldable.

Manufacturing Plan

The estimated Toy Production Cost will be $2,266,295 each year. The individual part costs and modeling costs are shown in Table 2 and 3 respectively.

Part	**Part Cost**
Engine Car Top	$0.05
Frame	$0.04
Wheels	$0.02
Wheel Pins	$0.01
Body Car Top	$0.06
Conductor Figure	$0.02

Table 2: Costs for Each Part of Toy

Part	**Molding Cost**
Engine Car Top	$0.028
Frame	$0.035
Wheels	$0.014
Wheel Pins	$0.011
Body Car Top	$0.035
Conductor Figure	$0.020

Table 3: Labor/Machine Production Costs

In total, the assembled engine car (consisting of 2x Wheels, 2x Wheel Pins, 1x Frame, 1x Engine Car Top, and 1x Conductor Figure) is 17 cents and the assembled body car (consisting of 2x Wheels, 2x Wheel Pins, 1x Frame, and 1x Body Car Top) is 16 cents. In addition, 7 cents is added to the overall amount due to painting, assembly, and the cost of the paper map. The price of the map was from online research on the price of colored printers in bulk, with 25000 papers for 5 cents each. The team will produce 10,264,697 parts per year for car tops, frames, and conductor figures. The team will also produce 20,529,394 parts per year for wheels and wheel pins since each frame needs two sets of wheels and wheel pins. The Total Material Cost is $226,670.06 each year using PE plastic which is $0.23 per pound. The conductor figure and engine car will be distributed more sparsely to increase the rarity of obtaining it. The team will be using 1 tool, with a run time of 23.5 hours each day, 7 days a week. Ten cavities per tool will be used for the car tops, frames, and conductor figures while twenty cavities per tool will be used for the wheels and wheel pins There will be 6 injection molding machines, each with their respective mold for the six separate parts. The press sizes vary for each part and are shown in Appendix D.

Post-Injection Molding Processes

Post-Injection Molding, the Train Toy will require painting using stamps. The team plans to paint each train car a bright and engaging color, such as vivid reds, blues, greens, and yellows, in order to catch consumers' eyes. After this base layer of painting, various final details need to be added, such as windows, the zoo logo, the zoo name, the conductor's clothing, and details for the animals. Additionally, different parts will need to be assembled and adhesively joined. The conductor will need to be glued to the engine car. The wheel pins will be glued into the holes at the bottom of the frame to secure the wheels. Finally, each car top will attach to its car frame, then the engine car can be linked to the body train car.

Sustainability Discussion

In order to create a more sustainable product, the team sought to limit material used. This way, less waste is created if the consumer chooses to throw out the toy. To accomplish this, the team shelled the engine and body train cars to remove excess material.

Even greater opportunities to make a more sustainable product arise once the injection molding and mass production stages are reached. Specifically, the team has chosen to create the Train Toy using recycled Polyethylene (PE) plastic. This will once again limit the waste created through the Train Toy manufacturing process and increase the sustainability of the toy.

The team also plans to include a "Please Recycle Me" note that comes with the McDonald's Happy Meal in order to increase the percentage of consumers that choose to recycle the toy instead of throwing it in the garbage.

When determining what sustainability choices to make, the team looked to the sustainability principles of reduce, reuse, and recycle. The team reduced the material used through shelling the engine and body train cars. The principle of reuse guided the team to use recycled ABS plastic to create the toy, and the idea of recycling inspired the team to include a “Please Recycle Me” note within the Happy Meal itself. These strategic choices will ensure the Happy Meal Train Toy avoids creating excess waste and will help McDonald’s move towards a more sustainable future.

Marketing Analysis

The target customers of the Happy Zoo Train Toy are children aged two to ten years old. Before age two, it is unsafe for children to consume Happy Meals alone. Therefore, the toy’s marketing will be geared predominantly towards older toddlers and children. With regards to gender, the target demographic includes both girls and boys. The bright, colorful hues of the toy will catch the eye of any child, regardless of gender. Additionally, the team made the strategic choice to avoid overly gendered colors as to not isolate any specific gender demographic.

Additionally, The Happy Zoo Train Toy is able to be produced and sold worldwide, as trains are an engaging idea of children all over the globe. For example, the TV show Thomas the Train Engine has aired in the UK, Japan, and the United States. This demonstrates the widespread global interest of children in locomotive cartoons and toys. Furthermore, the train toy is parent friendly because it is quiet, not a choking hazard, and requires no electronic components. In addition, the toy keeps kids engaged instead of bothering their parents when they are bored. This is showcased to potential customers and Fluke Toy Corp through the team’s flyer as shown in Figure 10.

Figure 10: Marketing Sheet/Flyer

Conclusions

The team is very proud of the Happy Zoo Train Toy and excited for the upcoming partnership with McDonald's. The Happy Zoo Train Toy has many advantageous features, including functional wheels, mix and match capability, and an engaging zoo theme. Every time a customer comes to McDonald's, they have the opportunity to receive a different animal-themed train car, or even the ultra-rare engine car. This unique feature will keep customers coming back for more. Parents are sure to love this toy, as it promotes fine motor skills in children while being a quiet, non-disruptive toy. None of the pieces are choking hazards, allowing children to have safe, unsupervised play. This toy is also good for the earth, as the team chose to remove excess material through shelling. Further, this toy will be made of PE plastic, which is recyclable. As an engaging additional feature, a paper map will be included in all Happy Meals in order to heighten the user experience. On the back of this map, "Please Recycle Me!" is written as an incentive to limit waste. With all of these carefully selected design choices, the team is sure this toy will bring increased revenue to McDonald's through exciting potential customers.

Appendix

Appendix A: Brainstorming Document

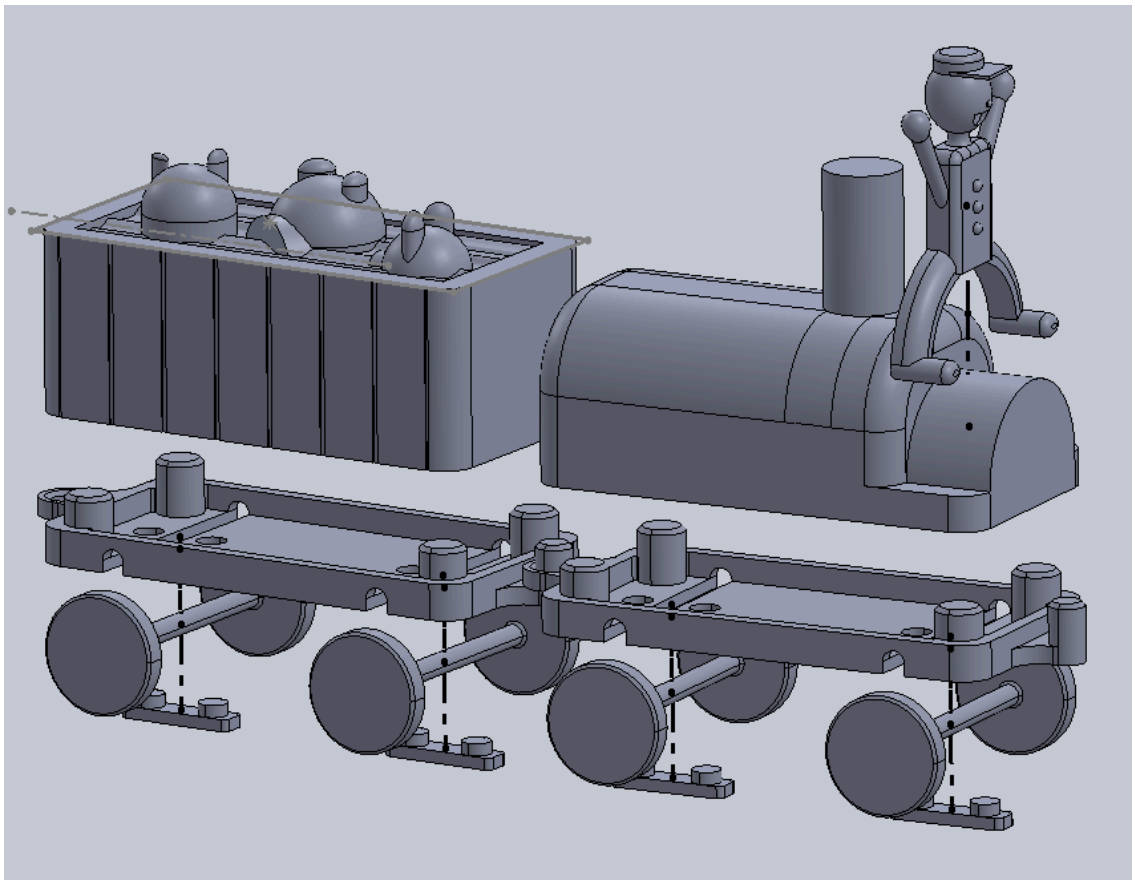
Ideas

- Car/Train
    - Removable shell-> different characters
    - Wind up Car ?
- ~~Moana~~
    - ~~Disney, easily marketable~~
    - ~~Needs to be more interesting~~
- Carnival Games
    - ~~Mini Golf~~
    - Pinball Machine
    - ~~Bowling~~
- ~~Maze~~
    - ~~Cube maze~~
- Football kicker through field goal
    - Table football
- Potato Head Decorated
    - Characters with detachable parts
- Pinwheel
- ~~Jack in the box (needs hinge, release mechanism, spring, danger to kids, hard to mold)~~
    - Collectible characters to use
    - Beyblades
- ~~Magnetic fishing game~~
- ~~Toy parachute soldier that is tossed up and floats down~~
- Flower blooming

Appendix B: Descriptions of Each Toy Design

- Car/Train: Train toy with different car components that can be connected to each other and rearranged
- Flower Blooming: A toy in which the user spins a cube, causing a flower to emerge and “bloom” from the top
- Pinwheel: A toy that is a functional Pinwheel that spins
- Football Kicker: A football player toy that allows users to compete in kicking a paper football the farthest
- Potato Head: A toy potato with many holes and accessories that allow the potato to be customized
- Mini Golf: A toy mini golf course with clubs and holes
- Pinball Machine: A miniature toy pinball machine assembled using clear plastic
- Bowling: A toy bowling set with pins and a ball

Appendix C: Exploded View of Complete Toy Assembly

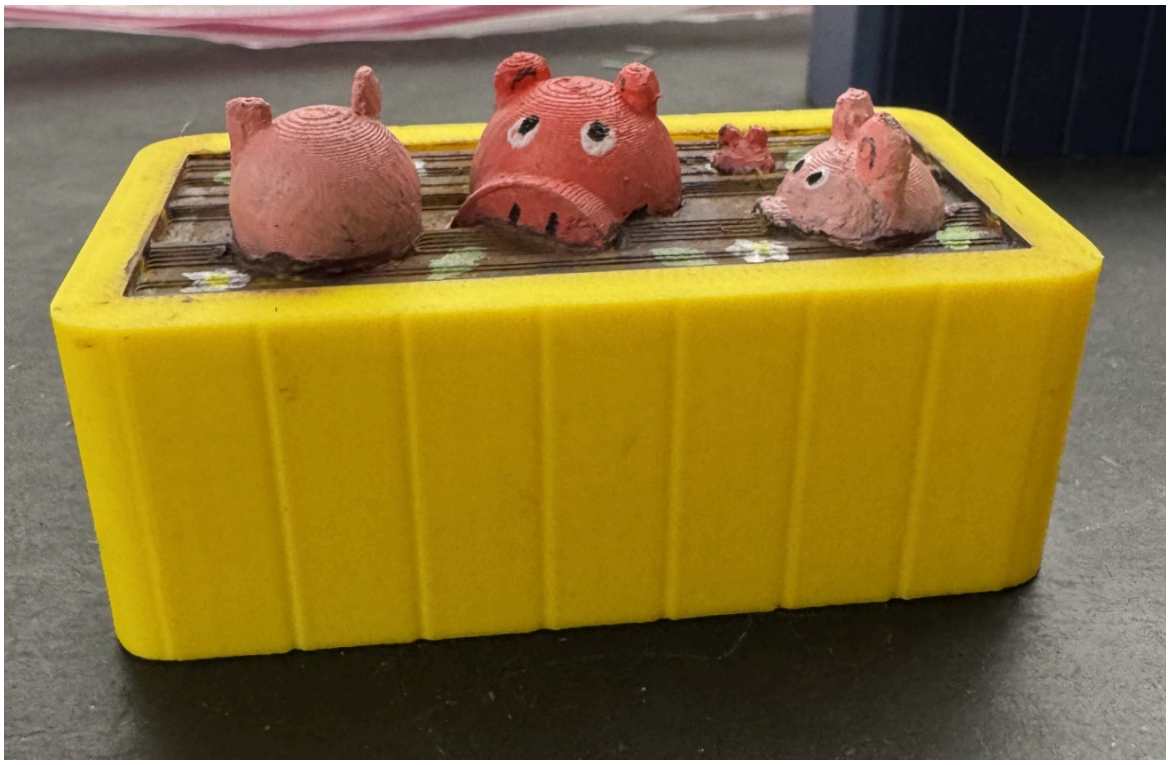


Appendix D: Part Costs Spreadsheet

Plastic Part Cost Estimator
02/27/2024 RGT

		Projected Area	Cavities per Tool	Injection Pressure	Press Size	Attended?	Press Cost	Cycle Time	Yield Rate	Parts / Hour	Molding Cost	Material	Specific Gravity	Part Volume	Part Volume	Part Weight	Raw Material Cost	Part Material Cost	Total Part Cost †	Tools	Run time/day	Working days/week	Parts / year	Total Cost	Part Weight / Year	Scrap Parts	Scrap Cost
	units >	in2	#	tons	tons		$/hr	sec	%	#	$	#		cc	in3	lbs	$/lb	$	$	#	hrs	days	#	$	Lbs		
Part Name																											
1	**train front**	5.0	10	6	298	No	33	30	99.999	1200	$0.028	PE	0.94	46.33	2.83	0.096	$0.23	$0.022	**$0.05**	1	23.5	7	**10,264,697**	$508,952	985,522	102,648	$5,089.57
2	frame	5.6	10	6	336	No	42	30	99.999	1200	$0.035	PE	0.94	10.00	0.61	0.021	$0.23	$0.005	**$0.04**	1	23.5	7	**10,264,697**	$408,193			
3	wheels	2.0	20	6	240	No	33	30	99.999	2400	$0.014	PE	0.94	3.00	0.18	0.006	$0.23	$0.001	**$0.02**	1	23.5	7	**20,529,395**	$311,637			
4	wheel pins	0.8	20	6	96	No	26	30	99.999	2400	$0.011	PE	0.94	0.27	0.02	0.001	$0.23	$0.000	**$0.01**	1	23.5	7	**20,529,395**	$225,046			
5	train cart	5.0	10	6	300	No	42	30	99.999	1200	$0.035	PE	0.94	47.14	2.88	0.098	$0.23	$0.022	**$0.06**	1	23.5	7	**10,264,697**	$589,901			
6	conductor figure	1.0	10	6	61	No	24	30	99.999	1200	$0.020	PE	0.94	3.53	0.22	0.007	$0.23	$0.002	**$0.02**	1	23.5	7	**10,264,697**	$222,567			
	n/a	10	1	6	60	No	24	30	99.999	120	$0.200	Nylon - 6/12	1.08	10.00	0.61	0.024	$1.00	$0.024	**$0.00**	1	23.5	7	**1,026,470**	$0			
																		Total:	**$0.19**					**$2.266.295**			

Appendix E: Pig Body Car compared to Tiger Body Car



Team Reflection

Throughout the project, the team was very effective in completing goals by the team's set deadlines. This was accomplished through regular texting in a designated chat about meetings, ideas, and scheduling conflicts. During the time spent working on the project, over 270 messages were sent in the team group chat. Additionally, the team held meetings once every week on Thursdays for one hour, which provided a time to update one another on progress and goals for the coming week. The team also shared and expanded upon ideas, which helped a lot for brainstorming and key design choices that made the toy unique. The team strove to follow a structured plan which was accomplished through breaking large tasks into smaller logical steps. For example, team member Raine completed the frame of the train toy first which allowed team members Nora and Sienna to create the dimensions of their parts using the frame dimensions. This choice ensured everyone contributed to the toy in meaningful ways and no one was overwhelmed.

The team faced issues with early prototypes not working as intended due to mistakes in the CAD and tolerances. For example, an early iteration of Nora's engine car had the peg holes too close together, causing the frame not to fit. The team solved this issue by bringing their 3D printed parts to the meeting and troubleshooting together to refine their designs. Another challenge faced was making the toy injection moldable. Originally, Nora and Sienna added excess detail to their parts that created overhangs that were not injection moldable. After evaluating the print with TAs and Professor Simmons, Nora and Sienna were able to simplify their designs to satisfy this criteria.

During this project, the team learned the important lesson of starting projects early. The team had their 3D prints finalized before spring break, which allowed them to take the parts home to paint them. This led to a better product, as team members were able to use higher quality paint from home as opposed to the Foundry paint. This choice to stick to a set deadline also decreased team stress and allowed the team to have a lot of fun with this project. Another key takeaway from the DC3 Team Document was the benefit of allowing team members to figure out their projects for themselves. Both Nora and Sienna were less experienced with Solidworks than Raine. However, Raine allowed them the space to troubleshoot and fix their own problems before offering advice. This allowed Sienna and Nora to greatly improve their Solidworks skills during this project, and benefitted the team dynamic.

In future projects, group members will continue to strongly communicate, create structured planning, and hold regular and productive meetings. If a future project involves CAD, the team members will also be sure to check parts through the CAD software before printing in order to obtain a successful print the first time.

Over the course of the project, team members greatly improved their CAD skills. Nora, for example, learned how to create a parallel plane on Solidworks that allowed her to create a much more intricate design. All group members will feel much more confident on any future 3D printing projects and will be able to take on more responsibility without feeling hesitant, as some

group members did in this project. During this project, the team also improved their communication skills. Specifically, the team had to communicate extra during the week of midterms, as the team meeting was moved to an earlier time in order to allow team members to study and prepare for tests. This demonstrated the importance of strong communication within the team that members will bring into their future projects.