Proposal Evaluation Board: The purpose of this memo is to provide a response to your recent request for a design for a cheap, entertaining, safe, and easily manufacturable happy meal toy.

I. Executive Summary

The Fluke Toy Company approached EGR Corp seeking a toy to be put into McDonald’s Happy Meal boxes. EGR Corp then asked our team to develop an enjoyable, economical and safe toy that kids of all ages would enjoy. Before coming up with our idea we had to access the target demographic. We assumed that the target age group that orders happy meals is between 5 and 10 years old. Our group met several times to come up with an idea for a toy that was not only interesting, but interactive. After brainstorming and going through many ideation techniques, we came up with the concept of making a board game. We chose this because it’s interactive, engaging, and also incorporates some of the items on McDonalds menu such as a burger, fries and a drink. The game we designed is called “Build-a-Burger” and the object is to gain enough ingredients to build a complete burger. Players take turns spinning the spinner, which tells them the number of spaces to move their pawns. Each space contains an action, which allows the players to either collect a piece or return one or more. The first player to complete a burger wins the game. All of the game pieces are large enough so that they will not pose a choking hazard to patrons. The projected run time for this toy is a month (average theme for a Happy Meal lasts 4-8 weeks) and in this report includes a cost analysis of producing the plastic parts that go along with the game. Build-A-Burger is a fun and rewarding game and would be a great contender as a new toy for McDonalds to offer.

II. Approach Description
When we first began the process of ideation, our team used a specific brainstorming method. First, we all thought independently about what kind of toys we enjoyed when we were children and what kind of toy we wanted to design. Next, we gathered together for our first meeting in lab and shared the ideas that we individually came up with, gathering notes in a google doc so that we could all add on and contribute. Figure 1 shows the compilation of ideas.

**Figure 1: Initial Idea Brainstorm**

This technique for ideation allowed us to have our thoughts collected and ready, thus immediately beginning our first meeting with many potential ideas which led to instant productivity. After discussing the pros and cons of each idea, we decided to select a toy concept by comparing our top choices in the value analysis matrix shown in Figure 2. After examining the categories of safety, difficulty of design, innovation, and fun for each toy concept, Mini Board Game emerged as the clear favorite.

<table>
<thead>
<tr>
<th>Design Criteria</th>
<th>Mr. Potato Head</th>
<th>March Madness</th>
<th>Car with ramp</th>
<th>Rockem Sockem Robot</th>
<th>Mini Board Game</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>-</td>
<td>N</td>
<td>+</td>
<td>N</td>
<td>+</td>
</tr>
<tr>
<td>Design Difficulty</td>
<td>N</td>
<td>-</td>
<td>N</td>
<td>-</td>
<td>+</td>
</tr>
</tbody>
</table>
Innovative | N | + | - | - | +
---|---|---|---|---|---
Fun | + | + | + | - | +
Total | 0 | 1 | 1 | -1 | 4

**Figure 2: Idea Selection Value Analysis Matrix**

After selecting the concept of a Mini Board Game, we had to refine our idea and figure out the specifics of how it would work. We did so by returning to the google document to brainstorm, and the brainstorm ideas can be found in Figure 3.

![Brainstorm ideas](image)

**Figure 3: Idea Refinement Brainstorm**

The google doc brainstorm allowed us all to edit and observe the same document simultaneously. This enabled us to type out whatever came to mind and share and discuss it with the group. Through our collaborative discussion, we were able to finalize our entire concept and begin work on the CAD designs.

### III. Toy Description and Documentation

The team’s proposed product is a board game, titled Build-A-Burger. The game utilizes the Happy Meal box as a fold-down board for the game. Normally, all four side panels of a Happy Meal box are attached to two adjacent side panels and also the bottom panel. In the box design for the Build-A-Burger game, three of the vertical edges of the box will be heavily perforated, so that when all three are completely separated two panels of the box will fold down
and lay flat. This will give an ideal playing surface for a board game, given the ease of the board set-up and size of the board. The fully set up version of the board game is pictured below in Figure 4. Using the box as a game board avoids the need to include a separate game board, which is both more cost efficient and more environmentally friendly.

![Figure 4: Full Build-A-Burger Layout](image)

Once the box is fully separated and folded down, the Build-a-Burger board has two main panels. The first panel contains the instructions and the spinner board. The instructions, which are shown in Figure 5, consist of set-up and playing instructions.
The spinner board, shown in Figure 5, consists of a large square which contains four smaller, equally-sized squares. Each smaller square has one of the numbers one through four printed on it. The spinner base can then be poked up through a perforated circle in the box, and the spinner can be placed through the peg to complete the layout. The perforated circle will have a diameter of .18 inches, which is .01 inches larger than the diameter of the extruded peg on the spinner base. The peg therefore fits through the hole, as seen in Figure 5. An exploded view of the peg and spinner alone can be seen in Figure 6. The other panel contains the playing board. The layout of the playing board is a rectangular loop with ten different playing squares. The board layout can be seen in Figure 7.
Figure 6 (left) and Figure 7 (right): Spinner Assembly and Board Layout

The base face of the box will be used to house The Kitchen, which is where all the burger components are stored and players can retrieve their parts in order to build their burgers. At the start of the game The Kitchen will hold the two bottom buns, two hamburger patties, and two top buns. The game is played by each player moving their game piece around the board until one of the players has all three Happy Meal hamburger components. The kitchen can be seen in Figure 8.

Figure 8: The Kitchen With All of the Ingredients
The plastic toys that come with Build-a-Burger are separated into two groups: game pieces and kitchen ingredients. The two game pieces are the apple juice box and the box of french fries. Both pieces have their main structure situated on top of a thin, circular base. This allows the piece to be aesthetically pleasing while remaining functional for the board game. Both the juice box and the french fries have the McDonald’s logo cut into the front of the main structure. The juice box has an apple cut into the back, to promote the fact that McDonald’s sells apple juice as part of their Happy Meal menu. Both sides of the apple juice box can be seen in Figure 9. The front of the french fry box has an extruded cut on the upper half to simulate an open box of fries. There are also extruded bosses coming off the french fry box in the shape of individual french fries. These details can be seen on the game piece shown in Figure 10.

Figure 9: Juice Box Game Piece Drawing
Figure 10: French Fries Game Piece Drawing

The patty is a cylindrical disk with two small pegs extruded from either side of the disk. The edges of the disk are filleted to give the patty more resemblance to a true hamburger patty. The hamburger patty is shown in Figures 11 and 14.
Figure 11: Hamburger Patty Piece Drawing

The bottom bun and top bun are also cylindrical disks. The fillet on the top edge of the top bun is very large, to give the bun a rounded look. Likewise, the fillet on the bottom edge of the bottom bun is large enough to give the perception of a rounded bun. The top bun has sesame seed-shaped extrudes coming off of the outside face to enhance the aesthetic appeal and give the burger more resemblance to a true hamburger. Both buns have two circular holes on the inside face which correspond to the pegs coming out of the patty. The depths of the holes are slightly deeper than the height of the pegs so that the faces of the patty can sit flush with the faces of the buns. The buns are shown in drawing form in Figures 12 and 13.

Figure 12: Top Bun Piece Drawing
Figure 13: Bottom Bun Piece Drawing

Figure 14: Cross Section Drawings of Top Bun, Bottom Bun, and Patty
The last two plastic components are the spinner and the spinner base. The circular base of the spinner base is made thick enough to keep the spinner stable, but thin enough to keep the board as close as possible to the table. The spinner is in the shape of an extruded arrow. The bottom edge is shelled out to reduce the weight and amount of material used. Each edge on the spinner has a small fillet to increase the safety of the product. The bottom outside edge of the spinner has a fillet with a slightly larger than the other fillets to reduce the friction of the spinner as it spins across the board. The spinner base can be seen in Figure 15 and the spinner can be seen in Figure 16.

Figure 15: Spinner Base Drawing
Figure 16: Spinner Drawing

For our toy, Critical-to-Fit dimensions include the radius of the pegs in the patty, the radius of the holes in the top and bottom buns. This ensures that the buns and patty will all fit together as demonstrated in Figure 17. Another group of Critical-to-fit dimensions is the radius of the peg of the spinner base and the radius of the hole in the spinner. This ensures that the spinner will fit onto the base and be able to spin.

Figure 17: 3D Assembly Exploded View of Burger Pieces
Our team derived the values of our Critical-to-Fit dimensions using the techniques and charts discussed in lecture [See Appendix C]. First, a basic size was selected for the hole. Then, the allowance is subtracted from the basic size to discover the maximum shaft size. The shaft tolerance is subtracted from the maximum shaft size, giving us the minimum shaft size. And finally, the hole tolerance is added to the basic size to find the maximum hole size.

**Manufacturing Plan**

Each of our parts will be manufactured by the method of injection molding using ABS plastic for the material. We selected ABS plastic because it is mechanically tough, chemically resistant, and visually appealing.

Our plastic parts for Build-A-Burger have been designed so as to ensure a smooth, simple, and cheap manufacturing process. A full set for one Happy Meal includes 10 different plastic parts. Each of these parts has been designed with no undercuts so that they can be manufactured using injection molding. Because the pieces are small, each mold can have 64 cavities, allowing 64 parts to be printed with each injection molding process. This will save both time and money in the manufacturing process. Another design feature is that after the parts are printed, no further assembly is required because they were designed to be assembled by the user, leaving only packaging left. This once again minimizes the time and cost of the manufacturing process.

Our team has prepared an extensive cost analysis which breaks down the various costs associated with producing the plastic parts that are used for the game. Figure 18 shows a breakdown of the yearly machine and material costs of production while Figure 19 shows the specific costs of producing this toy in a five-week time frame given that the demand remains constant. Figure 20 displays the total amount of pieces for each part needed to complete the total amount of Happy Meals. Figure 21 calculates the total cost of each part, including material, labor, and manufacturing costs. All the calculations for these values can be viewed in Appendix A. The plastic parts we used in the calculations were the top bun, bottom bun, burger patty, spinner, spinner base, juice box, and fries.
Based off data from Time Magazine, 220 million happy meals were sold in 2012 in the US alone. This divides down to 21,153,846 Happy Meals sold within a five-week period. The tools used to manufacture our plastic parts can produce enough parts to complete 131,388,126 Happy Meals per a year which boils down to approximately 2,526,695 per a week. Based off calculations from the speed of the tools, it will take ~8.4 weeks to produce the necessary amount of toys to fulfill the normal demand for Happy Meals. In order to keep up with demand, we decided to start production six weeks prior to the initial sale of the toy. By the end of the six weeks of production, ~15,160,170 will have already been manufactured. The total cost for running production for the duration of 8.4 weeks is ~$2,924,880. The cost of the plastic parts contained in one Happy Meal is ~$0.14. All of the relevant information pertaining to total production cost is summarized in Figure 19 and Appendix A. If demand were to increase, our team decided that the best way to keep up with orders would be to increase the number of tools used to manufacture the parts. This would increase our manufacturing costs and subsequently our total costs. For instance, if demand were to double, the total number of tools would double which would double the total costs of production.

The team determined that the most ideal time of year to distribute the game was during the winter because winter weather means kids are more likely to stay inside to play. Distributing the game in January would be particularly advantageous because January sits right between Christmas and Valentine’s Day. This way, McDonald’s could market Christmas-themed toys during Christmas time and Valentine’s Day-themed toys leading up to Valentine’s Day. The specific dates that the team proposes for distribution are December 28th-January 31st. The board game can run for this long of a period because in contrast to non-interactive toys which grow old quickly, a board game can be continually played and enjoyed for a long period of time. Furthermore, if kids want to be able to play with more players, it gives them incentive to come back and get more pieces. One possibility moving forward would be to make more playing pieces so that kids have an incentive to collect them all. Possibilities include an apple piece to represent Happy Meal apple slices and a milk jug for the Happy Meal complimentary milk.

Since the food ingredients in the game are all staples of American food and the instructions are in English, the team recommends that Build-A-Burger only be distributed in the
United States. If the game is successful domestically, then the team recommends that McDonald’s consider expanding the board game idea globally. Expanding the game globally would mean changing the ingredients to fit different global menus. For example, in Greece the game could be themed Build-A-Pizza with different ingredients such as a side salad game piece.

The molding process would consist exclusively of two part molds for each part. As mentioned earlier, each mold will contain 64 cavities. For the top bun, bottom bun, hamburger patty, spinner, and spinner base, the molds will part along a horizontal plane relative to the part orientation. The juice box game piece and the french fries game piece will both part along a vertical plane relative to the part orientation. For a more in-depth picture of the molding process used for each part see Appendix B. The figures in the Appendix B provide a drawing of each molding tool and show the parting line and parting direction of the mold.

The size of mold for each piece of the game is different because the size of each piece is different. These mold sizes can all be seen in Figure 18 below.

The game pieces will vary in terms of what color of plastic they will be produced with. The top and bottom buns will be produced using a golden-yellow-colored plastic and the hamburger patty will be produced using a brown plastic. This gives the hamburger pieces a strong resemblance to an actual hamburger. The french fries game piece will utilize yellow plastic to mimic the color of french fries, and the apple juice game piece will utilize red plastic to mimic the color of an apple. The spinner and spinner base will use light blue plastic so that they stand out from the other game pieces and fit in with the light, vibrant colors used for the game board.

Using colored plastic removes the need to paint any of the parts. Across the market, many board game pieces are single-colored, so the Build-A-Burger game pieces will follow suit. Because of the colored plastic, there is no need for painting or any other post-molding production with the plastic parts. The only other necessary process is for the Happy Meal box to be perforated and for the game board to be printed onto the box.
Figure 18: Plastic Part Calculator

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Material</th>
<th>Purchase Price</th>
<th>Purchase Quantity</th>
<th>Production Volume</th>
<th>Total Material Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top feed</td>
<td>ABS</td>
<td>$0.08</td>
<td>1,000,000</td>
<td>1,313,881,260</td>
<td>$2,546,908</td>
</tr>
<tr>
<td>Bottom feed</td>
<td>ABS</td>
<td>$0.08</td>
<td>1,000,000</td>
<td>1,313,881,260</td>
<td>$2,546,908</td>
</tr>
<tr>
<td>Nut</td>
<td>Nylon</td>
<td>$0.10</td>
<td>500,000</td>
<td>625,000</td>
<td>$62,500</td>
</tr>
<tr>
<td>Bolt</td>
<td>Stainless Steel</td>
<td>$0.05</td>
<td>1,000,000</td>
<td>1,313,881,260</td>
<td>$65,690</td>
</tr>
</tbody>
</table>

Figure 19: Estimated Production Cost

Total Production Cost $2,924,880

Total Material Cost $2,546,908

Labor/Machine Cost $377,972

Cost of Plastic/ Happy Meal $0.14

Production Volume 1,313,881,260 parts/year
<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top bun</td>
<td>42,307,692.31 pieces</td>
</tr>
<tr>
<td>Bottom bun</td>
<td>42,307,692.31 pieces</td>
</tr>
<tr>
<td>Burger patty</td>
<td>42,307,692.31 pieces</td>
</tr>
<tr>
<td>Fries</td>
<td>21,153,846.15 pieces</td>
</tr>
<tr>
<td>Juice Box</td>
<td>21,153,846.15 pieces</td>
</tr>
<tr>
<td>Spinner</td>
<td>21,153,846.15 pieces</td>
</tr>
<tr>
<td>Spinner Base</td>
<td>21,153,846.15 pieces</td>
</tr>
</tbody>
</table>

**Figure 20: Total Parts Needed**

| Part             | Cost/
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Bun</td>
<td>$.014</td>
</tr>
<tr>
<td>Bottom Bun</td>
<td>$.013</td>
</tr>
<tr>
<td>Burger Patty</td>
<td>$.014</td>
</tr>
<tr>
<td>Fries</td>
<td>$.016</td>
</tr>
<tr>
<td>Juice Box</td>
<td>$.022</td>
</tr>
<tr>
<td>Spinner</td>
<td>$.009</td>
</tr>
<tr>
<td>Spinner Base</td>
<td>$.008</td>
</tr>
</tbody>
</table>

**Figure 21: Total Cost/Part (including manufacturing and labor)**

*To see the total cost/part excluding manufacturing and labor, see column titled “Total Part Cost” in Figure 18.*
IV. Marketing Analysis

As a Happy Meal toy, Build-A-Burger’s primary marketing demographic is children. However, the toy can still appeal to a wide range of audiences. Because the board game requires reading and a certain cognitive level, it is designed for kids ages 5+. Younger children, however, will be able to play with and enjoy the game pieces and buildable burger as simple toys and may even be able to participate in the board game with the assistance of a parent. The game can easily appeal to both genders and all ethnicities because the general theme is McDonald’s food which appeals to all McDonald’s customers. Build-A-Burger is also very parent-friendly because it is a two person game, allowing the parent to join in the fun with their kid. The multi-player nature of the game is shown in Figure 22. Our plan is to test the concept first in the US because the game is written with English instructions and centered around the US McDonald’s menu. If it proves to be a successful Happy Meal Toy, however, the specific features of the game, such as the game pieces and squares, can be altered in order to appeal to the demographics of different countries.
Your favorite meal now transforms into your favorite board game!

**Easy, interactive set up!**
Through great innovation, the Happy Meal Box folds down into the game board itself.
This do-it-yourself structure promotes teamwork and tactile skills.

**Fun for the whole family!**
Kids don’t have to have all the fun with Happy Meal Toys. Now moms, dads, or older siblings can join in with this two player game.

**Promotes McDonald’s Food Products!**
With fries and a juice box as character pieces, and two buns and a patty that fit together to build the perfect burger, customers won’t be able to get enough of McDonald’s food.

Interested? Contact Team 3 at agh23@duke.edu

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Figure 22: One Page Takeaway Marketing Sheet
V. Conclusion

The Build-A-Burger game is designed to be a fun, sustainable, cost-effective toy that will fit in nicely with the McDonald’s tradition of adding entertainment to each Happy Meal. Build-A-Burger will be a step in a fresh, new direction because it provides an interactive component which most Happy Meals toys lack. The ease of assembly, ease of game play, and entertainment associated with a multiplayer game will entertain customers in a unique way, which will lead to more repeat customers.

The theme of the game will also make customers more enthusiastic about McDonald’s food and brand. Whether it be with the burger ingredients or with the juice box and french fries game pieces, Build-A-Burger players are constantly handling and being exposed to Happy Meal food products. This brings a newfound familiarity and popularity to all the options that McDonald’s offers. Furthermore, the McDonald’s logo is printed on both the juice box and french fries game pieces, so players are constantly being exposed to the McDonald’s brand. Plus, if players decide they want to bring the game home and play with others, the game pieces provide free advertising that McDonald’s would not otherwise have.

Build-A-Burger has components that both McDonald’s and its customers can enjoy, so McDonald’s should strongly consider including the game in their Happy Meals this upcoming winter season.
Appendix A

Calculations for total cost for each individual part (including manufacturing and labor).

Total cost / part (including manufacturing and labor)

<table>
<thead>
<tr>
<th>Part</th>
<th>Total Cost</th>
<th># parts / year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top bun</td>
<td>$3,772,953</td>
<td>242,770,000</td>
</tr>
<tr>
<td>Bottom bun</td>
<td>$3,424,601</td>
<td>722,776,252</td>
</tr>
<tr>
<td>Burger patty</td>
<td>3,453,275,</td>
<td></td>
</tr>
<tr>
<td>Fries</td>
<td>2,122,501,</td>
<td></td>
</tr>
<tr>
<td>Juice box</td>
<td>3,518,126</td>
<td></td>
</tr>
<tr>
<td>Spinner</td>
<td>1,139,585</td>
<td></td>
</tr>
<tr>
<td>Spinner base</td>
<td>1,082,121</td>
<td></td>
</tr>
</tbody>
</table>

Cost per part = Total Cost / # parts / year
Total Material Cost

Part cost \times \text{parts/year} \times \text{duration of production weeks in a year}

Top horn = \frac{0.01 \times 3,333,333,333 \times 52 \text{ weeks}}{52 \text{ weeks}} = \$20,414,044.72

Bottom horn = \frac{0.02 \times 3,333,333,333 \times 38 \text{ weeks}}{52 \text{ weeks}} = \$12,444,499.72

Horn patty = \frac{0.01 \times 3,333,333,333 \times 33 \text{ weeks}}{52 \text{ weeks}} = \$12,444,499.72

Fires = \frac{0.02 \times 3,333,333,333 \times 33 \text{ weeks}}{52 \text{ weeks}} = \$12,444,499.72

Top box = \frac{0.01 \times 3,333,333,333 \times 33 \text{ weeks}}{52 \text{ weeks}} = \$12,444,499.72

Sprinkler = \frac{0.01 \times 3,333,333,333 \times 33 \text{ weeks}}{52 \text{ weeks}} = \$12,444,499.72

Sprinkler base = \frac{0.01 \times 3,333,333,333 \times 33 \text{ weeks}}{52 \text{ weeks}} = \$12,444,499.72

Calculations for total material cost.
We will start producing 5 weeks prior to when we start selling our toy. In 6 weeks, we can produce 15,000,000 happy meal toys.

Total cost for 36.4 weeks

If we want to double production, we would have to double the labor which would increase the cost by $36,217,460 - $9,217,460 = $27,000,000. This is the cost per a happy meal is 1549

<table>
<thead>
<tr>
<th>Labor/Machine Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost - material cost</td>
</tr>
<tr>
<td>$2,929,850 - $2,849,928 = $77,922</td>
</tr>
</tbody>
</table>

Production volume (parts/year)

Tab bun 762,776,232
Bottom bun 262,776,232
Burger patty 262,776,232
Fries 131,386,126
Juice box 131,386,126
Spinner 131,386,126
Spinner base 131,386,126

Total parts/year = 1,313,814,260 parts/year

Scratch work for the estimated total cost of production and cost per a Happy Meal

Calculations for labor/machine cost and production volume.
Scratch work for the number of plastic parts needed to fulfill demand.
Scratch work for calculating the projected area for each part.
The above drawing shows the mold design and function for the spinner and spinner base. Both pieces have parts that separate along a horizontal plane, as shown by the arrows.
The above drawing shows the molds and mold functions of the hamburger patty, the top bun, and the bottom bun. The arrows in each drawing indicate that the molds separate along a horizontal plane.
The above drawing shows the molds and mold functions for French fries and juice box game pieces. The arrows indicate that the molds for both pieces separate via a vertical plane.
Appendix C

**Basic Hole System**

Apply the *tolerances* to both the hole and the shaft to complete the dimensions; *add* the hole tolerance to the hole lower limit, and *subtract* the shaft tolerance from the shaft upper limit. Do the arithmetic and apply the values.

- **Nominal Size** = 9/16”
- **Basic Size** = 0.5625
- **Allowance** = 0.0004
- **Shaft Tolerance** = 0.0008
- **Hole Tolerance** = 0.0010

Powerpoint Slide on Tolerance Analysis from Lecture

Running and Sliding Fits Chart from Lecture