

## **How DFMA Could've Made Me a Millionaire in College**



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## **Abstract**

How many bags do you leave the grocery store with on average? How many trips does it take you to unload all those bags from your vehicle back into your home? BagBoy was a product idea developed by college students from Bradley University to minimize the number of trips to unload grocery bags & reduce strain on consumer's hands. If they would have had access to DFMA, then they could've had credible manufacturing cost estimates for their prototypes at business competitions. This is the story of one team member who has been introduced to DFMA and now uses it regularly.

## Introduction

How many bags do you leave the grocery store with on average? How many trips does it take you to unload all those bags from your vehicle back into your home? Nowadays, a common problem that people face is carrying grocery bags from their vehicles back into their homes. With stores like Walmart & Target, consumers can purchase a variety of items in larger quantities. The problem with buying in bulk is that the consumer is likely to take multiple trips back and forth between their vehicle and home. If a consumer does not bring all bags in at once, then time and energy are wasted due to multiple trips. If a consumer does carry all bags at once, their hands will most likely be strained from carrying many bags barehanded as seen in *Figure 1*. The solution? BagBoy - an ergonomic grocery bag handle that can carry multiple bags at once to reduce the number of trips and reduce strain on hands. This was a side project outside of school a couple of engineering students from Bradley University worked on. The team competed in four business competitions throughout college but never placed first. The first place prize at one of the competitions was \$10,000 for students to fund their proposed business model. The BagBoy team knew that financials became a weakness at competitions. A tool like DFMA would have been ideal for the entrepreneurial minded engineering students to provide cost estimates for BagBoy, which could have helped in competitions.



Figure 1: Consumer Carrying Multiple Bags at Once

## BagBoy Design & Prototyping

After analyzing the problem, the team designed and created prototypes of BagBoy. The design allowed multiple grocery bags to be distributed to relieve the strain on the consumer's hands. To reduce the number of trips it took the consumer to unload all bags, BagBoy was designed to carry five bags at a time; thus, helping the consumer reduce time spent, energy lost, and strain experienced. The students developed three prototypes for BagBoy. The first two prototypes had a wooden dowel rod for the handle, and a steel rod to handle the weight of all the bags as seen in *Figure 2* and *Figure 3*.

For the first two prototypes, the steel rod was shaped to form divots for weight distribution. The first prototype had the necessary divots, but the steel rod was turned to create a spring for resistance when applying weight. When applying pressure, the prototype would bend significantly. In other words, the

first prototype failed. After calculations were made, it turned out the spring weakened the prototype. For the second prototype, the students got rid of the spring and increased the thickness of the steel. After applying pressure, the second prototype did not bend compared to the first prototype. After pivoting from the first prototype, the second prototype showed a lot of promise and could hold up to 55 pounds. The third prototype was a bigger jump than the first to second as seen in *Figure 4*. The team switched from wood and steel to plastic. The third prototype was 3D printed in one of the engineering labs on campus. The essential features are the same as the first two prototypes with the handle and divots. The third prototype could hold more than the first



Figure 2: Prototype 1



Figure 3: Prototype 2

prototype but not as much as the second. However, the third prototype was much more compact than the first two as seen in *Figure 5*. The compactness of the third prototype made it more versatile allowing consumers to place in pockets/purses. DFMA modeling could've helped the students to gather estimates for the changes made to each prototype with the knowledge of envelope shape, dimensions, process, and materials. These key factors continually changed throughout the prototype stage.

### Statistics and Target Marketing for BagBoy

In March 2016, the team surveyed 50 people at the East Peoria, IL Walmart. The average number of bags that people left the store with were *8.8 bags ~ 9 bags*. The average number of trips people took to unload all grocery bags were *2.5 trips ~ 3 trips*. In fact, *68%* of the people surveyed took more than one trip. On a scale of 1-10, with 10 being the most annoying, people rated this task as a *5.7~ 6 (somewhat annoying)*. After showing the 2nd prototype, *60 percent of people would purchase BagBoy*. *Figures 6 and 7* represent results from the in-person survey. BagBoy would be ideal for people who buy in bulk, specifically families, people who live in urban areas, and people who are eco-friendly. During the survey of 50 people, 33 consisted of families, and *73%* of families would purchase BagBoy. A person that shops for an entire family ends up having a trunkful of groceries, which all need to be unloaded back



Figure 4: Prototype 3



Figure 5: Prototype 3 vs. Prototype 2 in Size



Figure 6: Ranges of Bags People Leave Store With

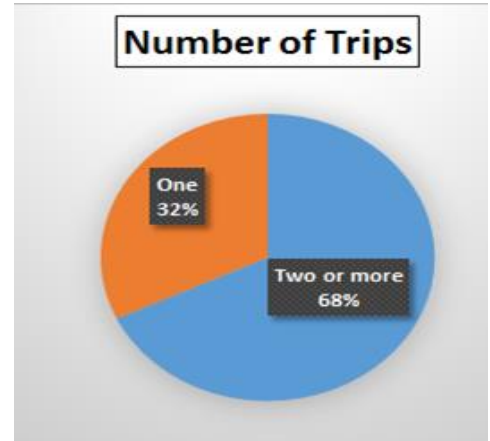
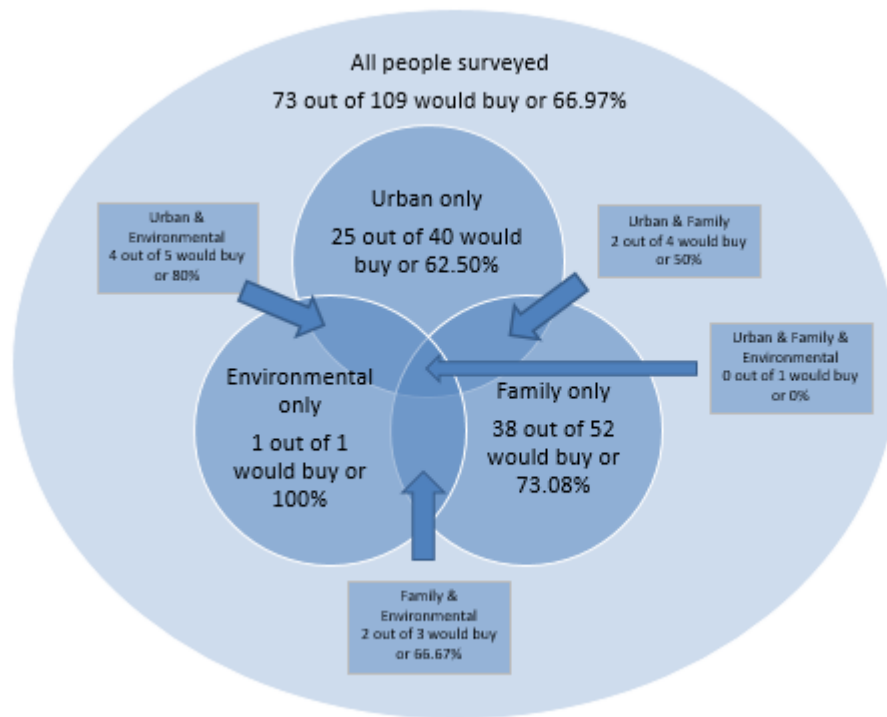


Figure 7: One Trip vs. Multiple Trips

home. Moving on, residents who live in urban areas are accustomed to walking from Point A to Point B due to the city lifestyle. BagBoy would be helpful to these residents by adding comfort to carrying items from the store back home. Lastly, people have become more conscious of negative impacts on Earth. Evidently, people are using reusable bags when shopping. Eco-friendly consumers are bringing multiple bags to the store already, so a consumer could benefit from leaving reusable bags on a BagBoy. Online surveys were conducted as well and the results of in-person and online surveys can be found in *Figure 8*.



**Figure 8: Target Market Data Analysis**

A revenue model was established from the Walmart surveys in East Peoria, IL. After talking with the store manager, a slow day at Walmart would have 2000 people coming in and out, and a busy day would see 4000 people. The team used the slow day number and in a month that Walmart would see 60,000 people. 60% of surveyed Walmart customers would purchase BagBoy after product demonstration...approximately 36,000 packs sold in a month. The team

decided to sell two BagBoys at a time to cover the average of 9 bags that people leave the grocery store with. With the data from the surveys, the team could have established a Life Volume for BagBoy.

## Business Competitions

The team competed in small competitions like Brave Pitch (3 minutes to give pitch), which the team got 2<sup>nd</sup> place as seen in *Figure 9*. However, the students competed in larger scale competitions such as Project Springboard, where the 1<sup>st</sup> place winner received \$10,000 to launch the winning business model. Project Springboard required a presentation, an executive summary, financial documents, and a business canvas model. The team competed in Project Springboard twice, but never won. The group

knew that financials were a key weakness because of the manufacturing costs of BagBoy. The team reached out to start-up companies in the area for estimates, but DFMA could have aided the team for manufacturing costs easily. The estimate cost of BagBoy for business competitions came from material costs for prototyping and from talking to professionals in Peoria.

### Brave Pitch Winners Announced

April 4, 2016

Results from the recent Brave Pitch competition are in. Brave Pitch is an "elevator pitch" competition where students have three minutes to describe a new idea, innovation, or social venture to a panel of judges and the student audience. The best three pitches win cash prizes, and the first place winner also earns an all-expense paid trip to the annual conference of the Collegiate Entrepreneurs' Organization.

There were some great ideas pitched by some very creative students this year. The top three awards went to:

1st: Chelsie Tamms, a Graphic Design major, pitched a card design & custom lettering business that she recently started.

2nd: Paul Majerczyk (Mechanical Engineering) & Ryan John (Industrial Engineering), pitched "Bag Boy", a device to help you carry multiple plastic grocery bags.

3rd: Brian Roskuszka, an Electrical Engineering major, pitched an app that will notify purchasers of recall notices on baby products.



Brian Roskuszka, Chelsie Tamms, Ryan John, Paul Majerczyk

Figure 9: BagBoy Wins 2<sup>nd</sup> Place at Brave Pitch 2016

## DFMA Model for BagBoy

The team graduated from Bradley University in 2017 and decided to part ways with BagBoy. Each team member received a prototype as a token. One team member accepted a position at Kohler and uses DFMA regularly. The following DFMA model will be for the latest prototype, which was the direction the team was heading in.

Instead of using 60% would buy BagBoy at the East Peoria Walmart, the Kohler associate uses 0.1% to be conservative. That's right 0.1% - not even a whole 1%. This leads to 60 *packs sold* in one Walmart. According to CNBC, there are 4,177 Walmart stores in U.S.A. The team felt comfortable extrapolating BagBoy statistics to all Walmarts due to the location of the survey. Peoria is known as a sample city to test

new products in...there is even a saying "Will it play in Peoria". This leads to 6,014,880 *units sold* a year across all Walmarts. At Kohler, life volume is calculated by taking the annual volume and multiplying it by 10 years. For BagBoy's situation, the life volume was calculated using the annual volume and multiplying it by 3 years. Furthermore, BagBoy is made in U.S.A. BagBoy's base part was modeled in DFM with polycarbonate (30% glass filled) as seen in *Figure 10*. A handle grip was modeled as well through a overmolding process. An operation was added to include a logo onto the part. The process steps can be seen in *Figure 11*. The piece part cost came out to around \$0.78. The cost for two BagBoy's would be \$1.55. The price point to stay competitive in the market is set at \$3.00. The gross margin with this DFM model is 48%. The



Figure 10: BagBoy in DFM

- ▲ Polypropylene injection molded part
  - ▲ Injection molding process
    - ▲ Battenfeld BA 600/200 CDC
      - Injection mold
  - Padprint
  - Box parts and tape box
  - (K) Overmold Tooling (Base Part)
  - (K) External Mfr Profit Margin

Figure 11: Process Steps in DFM



gross margin for all Walmarts for 1 year came out to around \$4.4 million. Margin is used because of the money Walmart will take for placing products in stores, legal, insurance, lights, etc. *Table 1* shows the totals from the DFM model.

**Table 1: Totals Chart in DFM Results**

Life volume	Batch size	Cost per part, \$							Initial tooling investment
		Material	Setup	Process	Rejects	Piece part	Tooling	Total	
18,000,000	500,000	0.5001	0.0001	0.2727	0.0017	0.7747	0.0071	0.7818	67,148

The initial tooling investment is one of the startup costs that the college students would have had to include in their financial documents. The earnings from placing first at the larger competitions would have given the team the kickstart needed to pursue BagBoy, and DFMA should cost modeling could have given the team the edge needed.

### Conclusion

DFMA should cost modeling can empower students with entrepreneurial sprits like the BagBoy team. DFMA can provide the data needed to make decisions about innovative ideas and provide costs to use at business competitions for students. BagBoy was a good idea during the team’s college years, but now the power of online shopping is taking over markets. Brick and mortar stores are starting to close, and the BagBoy team is spread throughout the country. BagBoy was an experience the college students would never forget, and it helped land full-time opportunities after graduation. However, the team decided to disband after graduation. The Kohler associate uses the 2<sup>nd</sup> prototype to this day as seen in *Figure 12*.



**Figure 12: Prototype 2 in Action**

## **Bibliography**

Gustafson, Krystina. "Time to Close Wal-Mart Stores? Analysts Think So." *CNBC*, CNBC, 31 Jan. 2014, [www.cnbc.com/2014/01/31/time-to-close-wal-mart-stores-analysts-think-so.html](http://www.cnbc.com/2014/01/31/time-to-close-wal-mart-stores-analysts-think-so.html).