BinderCart

An exploration of the lightweight and collapsible

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Integrative Project 2012-2013

Introduction

In July 2012, when I moved to New York City for an summer internship, I experienced for the first time an issue that thousands of people deal with on a weekly basis. Without the convenience of a car or even a bike, I was left to figure out the maze of public transportation, or walk to where I needed. This would not be an issue if I were only transporting myself, but suddenly a simple errand like grocery shopping became the daunting task of transporting heavy loads for blocks and blocks.

Understanding that I was not the only one who faced this challenge, I began to observe how the natives were accomplishing the chore and noticed two types of carts in predominate use. The first one was an industrial steel cart that was equipped with four robust wheels and could handle up to 77 pounds (Metal). On the street it was referred to as the "granny cart" (Fig. 1), allegedly because it was only the elderly population that used them. It stands three feet tall by 17 inches wide by 14 inches deep ("Metal"). The second was a steel and PVC trolley that was fitted with a large canvas bag (Fig. 2). It utilized only two wheels, and could hold up to 66 pounds. It stands about three feet by 13 inches wide and 10 inches deep ("Shopping").

Figure 1. Metal Shoppping Cart. Alibaba.com

Figure 2. Shopping Trolley. Alibaba.com

I was surprised at how bulky and cumbersome both designs were. Not only were they unaesthetically pleasing but they both took up considerable space when not in use, especially in New York City apartments where every square inch counts. Both carts were only appropriate for planned grocery trips as they were not something that the user could have on them at all times. For impromptu shopping excursions, shoppers had to carry the weight of their purchases using plastic bags, backpacks, and canvas bags. And from what I observed, both existing designs were not being used by anyone under fifty. I was inspired to take on the challenge of creating a lightweight, collapsible grocery transport that allows the user to experience a weight-free shopping commute. Throughout this paper I will use the term "transport" to talk about my product. By "transport," I mean a framework with wheels that is used for carrying groceries.

Precedents

The precedents from which I gathered inspiration included trendy grocery bags on the market today, such as Flip and Tumble (Fig. 3) and designs from the luggage, backpack and portable architecture industries. These types of products were insightful because they deal with the biggest issues I worked on, such as handling weight, collapsibility, comfort and maneuverability. For instance, the Basic House by Martín Azúa (Fig. 4) is an interesting study of how large structures can be condensed to pocketsize without the use of mechanics. The Climbing Up Suitcase (Fig. 5) and the Rolling Bag (Fig. 6) are both compelling solutions for how to navigate obstacles such as stairways and how to create an ultimate ease of maneuverability. The Collapsible Grocery Cart by Jessica Chan in Figure 7 is a successful design for a collapsible framework that is stored in the grocery bag when not in use; however, I felt it could be pushed further in compactness and ease of user assembly. The work I was doing also relates to the rich history of collapsible and reconfigurable products. To familiarize myself with a variety of designs I referred to the book Collapsible: The Genius of Space Saving Design by Per Mollup, which I used to work through quick mock-ups of collapsible frameworks. I took inspiration from many other products that condense or reconfigure for portability, such as baby strollers, laundry baskets, paper lamps, and photography light reflectors that twist to shrink.

Figure 3. 24-7 Bag. Flip and Tumble

Figure 4. Basic House. Martín Azúa

Figure 5. Climbing Up Suitcases. Woo Moonhyung

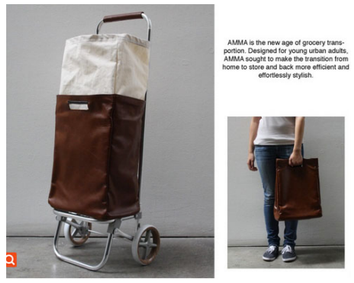

Figure 7. Collapsible Grocery Cart. Jessica Chan

Figure 6. Rolling Bag. Rooz Mousavi

The product on the market today that is most similar to what my design tries to accomplish is The Reisenthel Foldable Trolley (Fig. 8). Not only is extremely collapsible and lightweight, but it gives the user the option of having it on them at all times because it folds into its own

pocket to the size of a standard lap top bag (“Reisenthel”). However, what I believe is unsuccessful about the design is that it includes detachable parts and requires the user to handle the wheels in assembly and disassembly. Not only does this cause issues if a wheel is lost, but also asks the user to continuously handle something being dragged through the elements. To gather how satisfied users were of the product, I researched product reviews online. Overall, most were satisfied, yet one user warned, “Just be aware that it doesn’t have a frame, so you will be holding up most of the weight of your groceries yourself” (Dunhon). This leaves a significant area to improvement for a redesign.

Figure 8. Reisenthel Foldable Trolley.

Design Process

My design process started with face-to-face conversations with cart users to try and understand what are the needs and wants of urban grocery shoppers. In August of 2012 I started taking careful note of all the user behavior I observed on the street. In my conversations with people, I asked them what they found both frustrating and useful about their grocery transport. The main feedback I got was that the wheels on many of these products were hard to turn so the cart didn’t maneuver easily, and that the wheels were not equipped to handle stairs well. People were also dissatisfied with the length of the handle and the difficulty of getting things from the bottom of the taller carts.

When I returned to Ann Arbor the following month, I began to conduct similar interviews. A very slim number of people use the same types of transports in the Ann Arbor area because of the ease of car travel, so I specifically targeted underclassmen on campus without cars. Their biggest frustration with grocery transport is hauling heavy liquids such as milk, juice and detergent for long distances. The majority of people I talked with were using only plastic bags to transport food, even though many of them have a long commute by bus or walking. I was also able to conduct more sophisticated surveys that I sent out by e-mail to capture a larger audience. I learned that underclassmen were split almost evenly into thirds between the use of walking, biking, and busing to get their groceries. I also polled underclassmen to find out how many plastic bags worth of food they usualy carried and found that the majority used two. These results gave me a good direction on what kind of volume my transports need to carry and what sort of commuting means to plan for.

Target Audience

My target audience is those between the ages of 18 and 35 who mainly walk or take public transport for grocery shopping. The transport should hold a weeks worth of groceries for one person. I’m approximating this as the equivalent of 1,152 cubic inches based on the volumetric calculations of a reusable Meijer shopping bag. I am interested in targeting students and young professionals because they are part of my own demographic and I am able to readily understand their needs and lifestyle.

Material Decision

Product design today is highly driven by eco-friendly initiatives and promoted use of recyclable or sustainable materials. Studies even show that “75% of consumers would choose a product with tangible environmental advantages over competitive products” (Chapman 7). Therefore, when I started the project I was very invested in using materials like Tyvek to construct the bag for the transport. Tyvek is a material comprised of non-woven polyethylene fibers and is easily recycled. Yet as I worked with the material, I found that it was not durable enough to handle the weight and that heavier weights of the material were too stiff and inflexible. I began to wonder if easily recycled materials were really more beneficial than something that would last longer. To consult the issue, I referred to a study that compared four different shopping bags types: permanent ripstop nylon bags not intended to be disposed, multi-trip polyethylene bags meant for several trips that will eventually break down, plastic one-trip bags, and paper one-trip bags. The study compared the amount of energy used to make the bag versus how many times it could be used. It also compared the minimum amount of times the permanent ripstop nylon bag had to be used before it broke even with the energy intensity used to manufacture the disposable bags. The results were clear: although the permanent bag would take the most energy to manufacture, it would consistently be the lowest energy intensive option because it could be used continuously. Even with the most durable reusable bag, “a nylon bag used once a week for about two years will reduce the energy intensity per use below that of any of the other bag options” (Fenton 107). The study included the competing factors that the disposable bags could be recycled at a 0, 50, and 75 percent rate. However, the nylon permanent bag was consistently the least energy intensive because of the amount of energy used to collect and recycle the other bags. In summary, “the nylon permanent bag must be used fewer than 120 times to be the least energy intensive” (Fenton 107).

Based on my research, I decided to construct the bag from rip-stop nylon. This material not only makes sense as a low energy intensive option but is also extremely durable, lightweight, and weather and tear resistant. I also decided to construct the framework from aluminum, since it is strong, durable and relatively light compared

with other metals.

Prototyping

The first prototype I created was an experiment with how much Tyvek could compress, with the goal of creating a bag that one could have on them at all times for impromptu shopping trips. I modified a design that I found by Craft Passion (L, Joanne), shown in figure 9. The bag was successful in that it condenses to something small and lightweight that easily functions as a keychain when not in use. This allows the user to have a reusable grocery bag on them at all times with no inconvenience. When expanded, the Tyvek had the volume of 768 cubic inches - about 2/3rds the volume of a Meijer shopping bag. However, I also found that this rendition was not sufficient for handling heavy liquids, bulky items and large fragile items, such as a bag of chips. I also found that the material pinched uncomfortably when under weight stress, much like a plastic bag does.

Figure 10. Nixon

Figure 9. Nixon

After a working through a few other ideas, such as a design for protecting fragile items (Fig 10) I moved from bags to collapsible frameworks in order to build a full scale trolley. The first thing I experimented with was the use of tent poles to create a framework that could easily be assembled and disassembled for the ease of portability (Figure 11). For this exercise, I modified a reusable Meijer bag for the sake of using a product that already had an ideal volume. I fit a rigid support into the bottom of the bag then designed my own hardware out of Delrin to properly hold the wheels in the bottom support and to connect the tent pole framework. I discovered that although the framework packs away neatly, it ultimately demands too much time from the user to put together. This was not in line with the goal of the design, which was to create an intuitive user experience.

Figure 11. Nixon

After that exercise, I went back to researching other products that deploy and collapse with little effort. That led me to the last exploration of the semester - umbrellas. I started sketching umbrellas upside down (Fig 12) to explore the bag form it could create. Figure 13 shows my appropriation of the physical mechanics of the umbrella to create a bag model. After about a month of exploration with the umbrella form, I was running into more mechanical problems than I could design for. I enjoyed the geometry and the idea, but I found I was fighting the design more than working with it, and it was slowing down the overall process far too much. I was encouraged by my professors to work backward. Although it can be a painful process to start over, I found that it was extremely useful and that I was not starting from scratch. I had gained important mechanical knowledge to direct my design in a more practical manner. My new design utilized the form and dimensions of a three-ring binder. To work through this design quickly and overcome design challenges, I used foam core and adhesive to create rapid prototype and test my ideas. What I believe is successful about this design, over the appropriation of the umbrella, is that it has a built-in structure of a bottom and top, has space to house the bag and wheels when collapsed flat, and it directly relates to my target audience because it is a familiar form that is easily carried in a backpack or large purse.

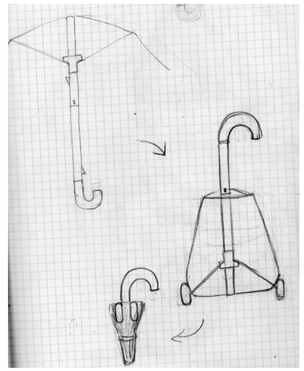

Figure 12. Nixon

Human Factors

Finally, it was important for me to consult human factor and measurements resources while planning out my design. I had learned through my user interviews that the most prominent design flaw in existing grocery transports was the uncomfortable height of the handle. Since I had the opportunity to create my own telescoping handle I consulted the book The Measure of Man and Woman: Human Factors in Design by Alvin R. Tilley for a more appropriate height. Based on averages of knuckle heights for men and women, I decided that a standing

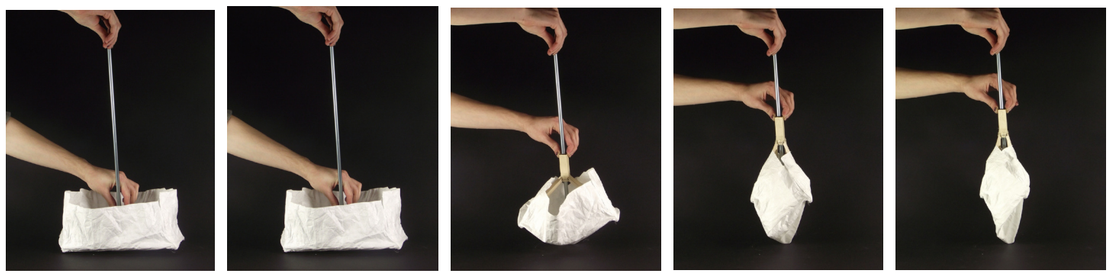

Figure 13. Nixon

Figure 14. Nixon

handle height of 34 inches would provide more universal comfort for the user.

Final Design

My final design is a two-wheeled grocery transport that is easily maneuvered, and holds about 1,152 cubic inches – the equivalent volume of a reusable Meijer bag. When not in use, the transport collapses to the exact dimensions of a three-ring binder, 10 inches by 11.5 inches, and weighs 2.8 pounds. The aluminum top and bottom have been anodized with bright colors to create an eye catching and modern design that would appeal to my target audience. It can easily be carried in a backpack or large purse (Fig 14).

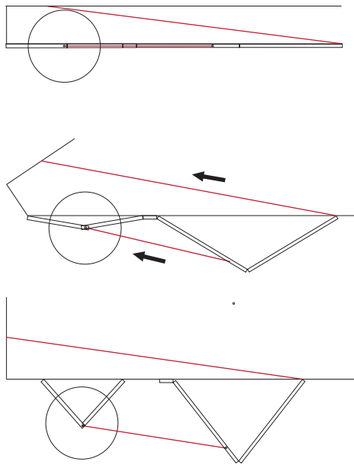

Figure 15. Nixon

The collapsed form reconfigures into a transport with a single motion from the user (Fig 15). This motion is achieved through the connection of the axle and front support to the top of the lid. A flexible hinge attaches a rigid rod to the inside of the lid and top of the front support. When the lid is opened, this rigid rod pulls the front support into a stable triangle shape shown in Figure 16. Simultaneously, the back axle is pushed back through the connection of another rigid bar that travels in a loop through the wheel and through the midpoint of the front support. This action is kept fluid and stable through the use of tracks that the front support and back axle travel along. Once the lid is open, the bag can easily be pulled up to accommodate the groceries. A telescoping handle (Fig 17), attached to the spine and top lid, can then be pulled up to allow the user to pull or push the transport. The same mechanics allow the back axle and front support to collapse flush when the top lid is closed flat. The design creates an intuitive and simple user experience without the handling of separate parts.

Figure 16. Nixon

Figure 17. Nixon

Conclusion

At Aggro Crag: The 2013 Senior Exhibition, I received a lot of positive feedback from people saying they would use this product and wanted to see it available in stores. I also recieved feedback from gallery goers, that I should create another transport that held more groceries. My current design is meant for individual use on a weekly basis, but if I were to expand upon my concept, I would create a series of transports that provided different carrying capacities for couples and familes.

If I were to continue the project I would like to put the design into the hands of five users from my target audience who have diverse lifestyles. I would ask them to use the transport for a couple weeks and record the things they felt could be improved upon. I would then take this data and work on different renditions of the design to try and accommodate my users' needs and lifestyle.

The creation of BinderCart was extremely valuable for me in terms of accumulating new skills and techniques. I gained a deeper understanding of mechanics, physics, manufacturing and the realities of making a functional product. I also learned how to collect user data and use this to create a user-centric design. I gained valuable experience in efficiently working through design problems and rapidly prototyping my ideas. Finally, I learned a multitude of fabrication techniques such as cold metalworking, water-jet cutting, 3D printing, sewing and much more.

Throughout this year-long process, I learned the significance of the term "integrative project." Not only was it an integration of my previous skills, but it was learning new skills quickly, and being able to draw upon the resources of people and facilites availble to me. I learned that good design comes from a collaboration of ideas and diverse perspectives, and cannot be achieved single-handedly.

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