# Final Project Paper - Group 25

## Milk Containers

Caroline Hall-Sherr (A17356827), Kathy Tran (A17710724),
Geovanny Guevara (A17848767), Matthew Odom (A18132823), Kanishka Katragadda (A18021511), Ava Abadian (A18097995)
Wednesday, 3PM Studio
DSGN 1 FA24

## Observations & Interviews

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### Brainstorming:

Our brainstorming process can be followed without much trouble in the **mind map** of Figure 1. Here we began with diverging ideas on what has **errors**. What do we, as students, encounter that errors? What bothers us? Coming up with a list of over a dozen things on the **mind map** and many more in our notes. Some top choices were the glass ketchup bottle that doesn't pour, the plastic fork that breaks into sharp tip shards; that are actually environmentally devastating, bad super glue that glues itself shut, and some bad backpacks. We finally settled on the topic of milk containers. We selected this topic for the widespread use and multiple modality of dispersion. This somewhat concluded our first stage resulting in a topic and some definitive goal for the rest of the project.

From there we initiated another divergent time during which we dissected the components of the milk containment units, with its major modes being glass, plastic and paper. More ideas flowed with notes on cap type, storage, and source. Some **trade offs** we noted right away. Paper bottles create a spout but do not afford sealability, and plastic is detrimental to the environment unless recycled properly. It will be interesting to see where the bottles come from. At this stage we began brainstorming to form the questions for the interview. The resulting eight questions we are using for the interview process focus on **affordances** that may be important to users such as storability, ease of use, and disposal method. This phase of the brainstorming concluded with the creation of the official google form, for use by the group during the interviews to facilitate data collection.

In another stage of **brainstorming** each member suggested a solution to the problem. We recorded the ideas in a sketch and from there we chose a preferred solution path. Some more advanced ideas, like force fields or acoustic levitation of liquids, were canceled due to the group's movement toward a “prefect” recyclable bottle. Once our goal was established, pursuing recyclable cartons, we initiated multiple **brainstorms** for a solution. We analyzed topics like materials, compelling form, and usefulness. Our brainstorm was directed to amplify solutions

resulting in a prototype. Later our prototype milk carton was confirmed as viable by the professor, signifying a relative end to this stage of **brainstorming**.

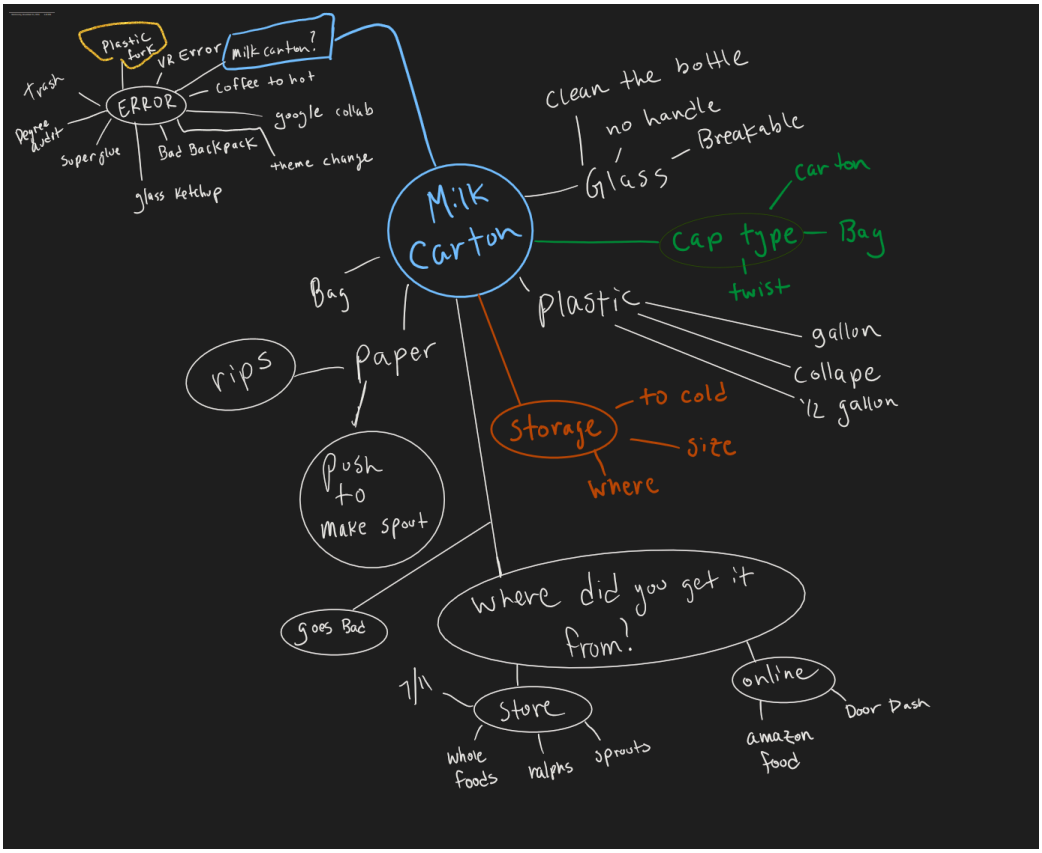


***Figure 1:*** *This is our brainstorming process. We formulated a mind map as a group and this helped us branch out the variety of aspects relating to the milk carton that will help us connect this object design to course concepts.*

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## *Interview Questions & Methodology:*

We conducted a total of 18 interviews and took notes using a google form filled out by the interviewer. We interviewed a population consisting of mostly college students but also conducted interviews with a few older adults. We used the **master-apprentice** model to conduct our interviews: we asked our interviewees ‘why’ and ‘how’ questions which allowed them to explain to us their thought processes behind their actions or decisions without being led by the interviewer. We also gathered **quantitative data** such as how many of our interviewees preferred a particular type of milk container feature. We took our interviewees as the experts on their milk purchasing and use habits and invited them to explain to us why or how they performed certain actions. Our interview questions are outlined below.

**Interview questions**

1. *Do you regularly purchase milk?*

This question is useful in determining if our interviewee is someone who would benefit from a redesign of milk containers. It will reveal whether they have experience with purchasing milk and deciding on what to purchase.

2. *Where do you buy your milk?*

This question will give us some insight into pricing of different milk containers which could be an important **tradeoff** for users. Some variables like delivery are at play. Information like what type of bottles are sold at different locations may come up as a subtopic, for example do convenience stores like 7-11 have glass?

3. *What type of container do you usually purchase? Why?*

This question will allow us to examine which features are the most useful to users. Users will tell us about why they purchase as they do which will showcase which features of the milk containers they currently purchase. This may include information about **affordances**, **signifiers**, **errors**, and **tradeoffs**.

4. *What type of container do you prefer? (glass, plastic, carton)+ Why?*

This question will allow us to examine which features are the most important to users. Since this question does not take practicality into account, this question will illuminate what our redesign should strive to **afford** based on the reasoning behind why users would prefer a certain type of milk container. This question will also give us **quantitative data** on user preference which we will use to inform our redesign.

5. *What size of milk do you usually purchase? (gallon, half gal, quart) Why?*

This question will allow us to determine if users with different milk volume purchasing habits have different needs than users who purchase smaller sizes. We also want to ask this question to tell if certain **affordances** of smaller milk container sizes afford different actions. This will be important to users as some **affordances** are necessary to users of all milk container sizes but current designs may not have appropriate **affordances**.

6. *What cap type do you prefer? Twist cap, pull tab with twist cap, or paper spout? Why?*

This question will contribute to our redesign of the milk carton as we will examine user's responses on what features are actually useful and include that feature or a similar one in our design. This will also illuminate potential **errors** users make when opening milk cartons: perhaps they struggle with a pull tab or always open the paper spout containers improperly. We will pay attention to how people mention ease of use: being able to open your milk carton is perhaps the most essential **affordance** of a milk carton. We want our design to clearly **signify** what users should do when opening their carton and bridge the **gap of execution** as easily as possible

7. *Where do you usually store your milk?*

This question is important for our redesign as users expect their product to have the **affordance** of storability but some milk cartons only afford being stored in certain places. We will use this data to determine where users need their milk cartons to fit in their fridge and design our carton to conform to those requirements.

8. *How do you pick up the milk container?*

This question will allow us to gain insight into what **affordances** of their particular milk containers users actually employ. For example, a milk carton with a handle may be picked up by the body rather than the handle. This question will also illuminate what **signifiers** users pay attention to when deciding how to pick up their milk container. This question will contribute to our redesign of the milk carton as we will examine user's responses on what features are actually useful and include those in our design.

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# *Proof of Data:*

Quantitative Data: Link to Google Sheets

All of our data are collected in a Google Form and Google Sheet attached below where each of us collects data from three interviewees each, having a total of 18 collected results. From these data we collected, we created a Google Sheets that demonstrates our *quantitative* data attached above. In the sheets, the first graph and table represents the type of container interviewees chose, in which the majority of the people preferred plastic, second best was carton, third best was glass. The second graph and table shows the type of cap interviewees preferred: twist cap, twist cap with pull tab, and paper spout. Most people preferred the twist cap. Our third graph and table portrays which size of interviewees preferred: gallon, half gallon, or a quart. The majority chose half gallon. Our fourth graph and table shows where interviewees store their milk: middle or side doors/shelves, in which most of them preferred the side doors/shelves. Lastly, the last graph and table shows which type of milk our interviewees usually purchase.

Proof of Data: Google Forms or Proof of Data: Google Sheets

As for our *qualitative* data, we have formulated our results into a Google Doc attached below. Our *qualitative* data consists of the "Why?" portion of our *quantitative* questions. Why do our interviewees buy a certain milk container? Why do they prefer their chosen choice of container? Why did they choose a certain size? Why did they choose their preferred cap type? And why do they store their milk either in the middle or the side shelves of the fridge? Additionally, we also asked our interviewees where they buy their milk, how often they would

purchase them, and how they handle or hold the milk container. These data supports our **redesign**.

Qualitative Data: Link to Google Docs

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## *Contributions:*

For this final project, each team member contributed fair and evenly. Each of us interviewed three people, a mixture of online calls and in-person interviews using the **master-apprentice model** where we let our interviewees lead us through and collected a total of 18 results. As a whole group, we came up with six different redesigns we each individually think is effective. After, we combined our redesigns together and formulated our final product. Additionally, each member recorded and sent photos and videos from different stores to combine into our final video. We all talked amongst ourselves on each section of this paper such as **brainstorming, methodology, data collection, trends**, **problems**, **trade offs**, **design spaces**, **redesigns, and prototypes**.

We individually assigned each team member to write up on certain sections. Matthew drew and wrote up the brainstorming section, edited the final video that demonstrates the problem, worked on the presentation, worked to beef up the paper and edit the paper. Kathy did the overall layout of this paper, formulated, organized, and explained the *quantitative* and *qualitative* graphs, tables, and data, and wrote up this contribution section. Kanishka worked on the trade offs and design spaces with the tables. Caroline drew and wrote up interviews/methodology, redesign justification, and redesign prototyping. She, along with Geovanny and Ava formulated the layout of the final Google Slide presentation. All of us worked on filling the slides together as a group. Geovanny wrote up redesign tradeoffs and trends and problems with Ava's help and finally, Ava wrote up the conclusion to wrap up everything.

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## *Trends & Problems:*

Through our analysis of the twenty interviews we conducted, several recurring patterns and trends emerged regarding user experiences with milk container designs. These insights reveal both positive features and summon frustrations that users encounter, highlighting opportunities for improvement. By applying core concepts from The *Design of Everyday Things* (DOET) we gained a deeper understanding of why certain design elements succeed or fail. Key trends included environmental concerns, ease of use, ergonomic features, and consistent difficulty users face with paper cartons. Below, we delve into these patterns and their underlying causes, emphasizing the impact on the overall user experience.

1. *Environmental and Sustainability Concerns*

A significant trend across interviews was user concern about the environmental impact of milk containers. Out of the twenty interviewees, twelve expressed their concern about the environment and expressed a preference for paper cartons due to their eco-friendly nature (their **affordance** of sustainable disposal) but admitted they often defaulted to plastic/glass containers as it was more common within their grocery stores. This reveals a fundamental **trade-off**, showing that while sustainability is a priority, it often conflicts with usability. For example, when Interviewee 18 was asked "What type of container do you prefer?" They explained "Cartons, because they are eco-friendly, but most of them are not easy to use, and I personally think there are more options for plastic containers." This statement highlights a key design challenge users face, while users value sustainability, the usability issues with paper cartons act as a significant **physical constraint**. The **physical constraint** lies in the cartons opening mechanism, which requires precise actions that are not natural and often lead to tearing or improper sealing. User's struggle to perform these actions smoothly, unlike plastic containers with twist caps that provide clear **affordances** for gripping and twisting.


***Figure 2:*** *This picture shows the design of milk cartons and how the design can cause a physical constraint.*

Additionally, there's a **gulf of execution** where users have a clear **mental model** of how the spout should open, but the actual design often doesn't align with this expectation, leading to capture **slips** like tearing or spilling. For instance, users apply familiar actions from opening plastic containers like twisting or pulling but these actions don't translate well to paper cartons,

resulting in tearing or spilling. This inconsistency forces users to compromise, often choosing plastic containers for convenience despite their environmental concerns.

2. *Storage and Design Compatibility*

Refrigerator storage patterns significantly influenced user preferences, particularly for those who store milk in the door compartment. Out of all 20 interviews we conducted, 14 of the interviewees reported storing their milk on the refrigerator door. While this may seem like a minor detail, it highlights how users rely on **natural mapping** to organize their refrigerators. This **mapping** can lead to **physical constraints** as well as **logical constraints**. The **physical constraint** arises from the limited space available in the door compartments, which can only **afford** holding certain container sizes and shapes. This creates the problem where if the container is awkwardly shaped or too large, it may not fit causing frustration and requiring the user to rearrange items to store the milk elsewhere. This discrepancy between the container design and available space creates a **gulf of execution**, as users struggle to match their expectations with the fridge's physical limitations.

On the other hand, **logical constraints** emerge when the container design does not align with the user's **mental model** of how items should fit in the refrigerator. In this case, users expect milk containers to be compatible with door space, and any deviation from this expectation creates a **gulf of execution**. For example, containers with irregular shapes or too large to fit in door compartments, forces users to store them in less convenient places. This can disrupt their routine and increase the chances of **action-based** and **description slips**, such as knocking over items, or reaching for the milk from the door as they normally would but instead of it being there it's stored elsewhere.

3. *Sustainable and Practicality*

Users often wanted to use glass or cartons for their containers, but they ended up using plastic because of its practical **affordances** such being easy to use, lightweight, and long-lasting. Despite its reusability and attractive design, glass containers were deemed unsuitable for everyday use due to their weight and fragility, which presented problems. Although cartons were seen as environmentally friendly, there were no obvious **signifiers** for pouring or other actions like opening the carton the right way , so users may rip the packaging or spill the milk if they didn't follow the instructions.

There is a big **gulf of execution** between users' intentions (like picking sustainable options) and the **designs** that are offered. This makes it hard for users to match their actions (like using those containers successfully). Users might need scissors (or something similar) to open the spout on a box, which is a clear sign that the design wasn't easy to find and didn't take **feedback** into account. Also, the fact that there aren't many **affordances** for handling glass containers, like comfortable grips or non-slip surfaces, makes things even harder, leading people to choose less eco-friendly but more useful plastic alternatives.

The **gulf of evaluation** is a problem with the design that makes it hard for users to tell if what they're doing is working or not (for example, filling without spilling or closing the container tightly). Adding clear **signifiers** and easy-to-use **affordances** to environmentally friendly options could help match user tastes with practical usefulness, leading to more consistent adoption of eco-friendly options.

4. *Poor Design and Storage Challenges*

Milk containers are most useful when they can be stored in the fridge, but many designs don't take into account how fridges are usually set up or how people use them, which can be very frustrating. Larger containers, like gallon containers, often have trouble fitting into fridge door spaces or taking up too much shelf space. This makes it necessary for users to move things or make them less accessible. Even though smaller containers can be put in more places, they often don't have features like stable bases or comfortable handles, which makes them harder to lift, pour, and store safely.

This problem comes from not matching up with how users think things should work. For example, milk containers should fit into most fridges without users having to change how they do things. For example, people often think that gallon containers will fit in door pockets, but because many plastic containers are so big, they have to be stored on shelves that are already full. This difference shows a lack of execution because the container's design doesn't allow or explain how it should be used in normal storage situations.

To solve these storage problems, milk containers should have better designs that naturally fit fridge layouts. It would be much easier to use if gallon containers had thinner sides, smaller containers could be stacked, or handles were designed to be easier to hold and place. Manufacturers could create items that fit in with users' settings, decreasing annoyance and increasing happiness, by bridging the **gulf of evaluation** with designs that indicate compatibility with fridge spaces.

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## *Trade Offs:*

Explanation and list of some **trade offs** and **affordances** in the industry today:

Caps: cross reference Sustainability vs Convenience: Twist caps are best for ease of use, but are also environmentally unfriendly. Compared to the trade off with paper, which is biodegrade yet currently has no ability to reseal

Container: cross reference Durability vs Sustainability: Plastic cartons or those with synthetic linings are more robust and resistant to leakage but have higher environmental impact. Glass cartons have a uniquely low durability at times, they can break. Yet glass has some reusability and recyclability

Cost: cross reference Price vs Sustainability: Glass cartons are expensive but are also much more environmentally friendly than the cheaper plastic. Recycling glass has a higher lb in weight requirement per monetary return than other types.

Size: cross reference Price vs Size: Larger cartons hold more milk but also cost more for the higher amount of materials. Yet also buying in quantity can reduce the price point per. For example 1 cubic inch cost 50c if you bought a ½ gallon but 1 cubic inch cost 40c if you bought a gallon although the gallon has a higher total price.

Size: cross reference Size vs Convenience: Larger cartons hold more milk, but are also hard to store in some fridges. Should there be a uniform size bottle? Proprietary shelves seem in place for the 1 gallon size.

Efficiency: cross reference Efficiency vs User Convenience: Tapered or ergonomic designs (e.g., cartons with handles or spouts) are easier to handle but may waste space in packaging or shipping. Some large water bottles are set up "upside down" for dispense, yet milk is not. Is this efficient?

***Figure 3****: an illustration of the* ***trade offs*** *of some different bottle type to consider during our redesign*

Leaks: cross reference Leak Proofing vs Usability: Designs that prioritize easy access may compromise leakproof qualities. Biodegradable materials seem to have the vulnerability of leak. Figure 3 pertains to the interplay of possible leaks in an upside down alignment.

Temperature: cross reference Thermal Insolation vs Material Thickness: Thinner materials are cheaper and lighter but may compromise temperature retention and spoilage prevention. Cost of refrigeration at home and while in transport is true. Can a successful material be cost effective enough to make a difference in the overall finance due less refrigeration?

Size: cross reference Size vs Sustainability: Smaller cartons cater to individual servings but increase material usage per unit volume. Some size may enable reusability which will further sustainability. The value to incentivise recycling is also increased by the size.

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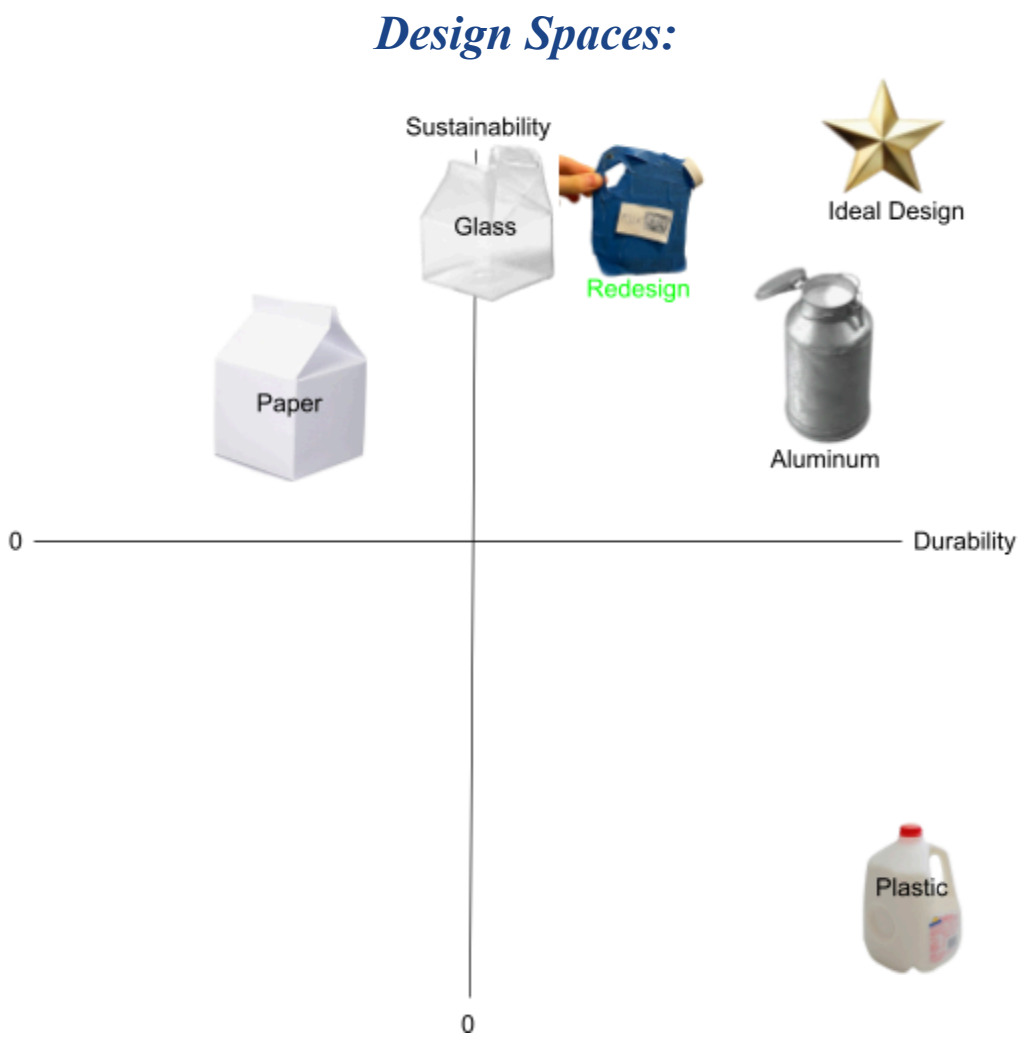


***Figure 4:*** *Design Space of durability x sustainability*

***Table 1:*** *Ranking Milk Containers on Sustainability and Durability*

| Material | Sustainability (0-10) | Durability (0-10) |
|---|---|---|
| Redesign | 9 | 6 |
| Plastic | 2 | 9 |
| Glass | 8 | 5 |
| Aluminum | 7 | 8 |

| | | |
|---|---|---|
| Paper | 6 | 4 |

This design space examines the **tradeoff** between durability and sustainability. Our redesign rates highly in sustainability due to being made from renewable materials, but can suffer from durability issues in certain environments due to being designed to break down. Plastic is very durable, resistant to impact force, water resistant, and environmental conditions, but has very poor sustainability due to the use of fossil fuels, difficulty recycling, and long lasting pollution. Glass is very sustainable due to its infinite recyclability, but is mixed in durability. It is resistant to water and environmental damage, but suffers from high impact damage. Aluminum is also infinitely recyclable like glass, but requires large amounts of energy to produce, bringing it a bit behind glass and the redesign. It is very durable though, able to withstand high impact, corrosion, and moisture easily. Paper is biodegradable and recyclable, but involves deforestation which reduces its sustainability. It is also weak to most forms of damage, particularly moisture, and thus ranks low.

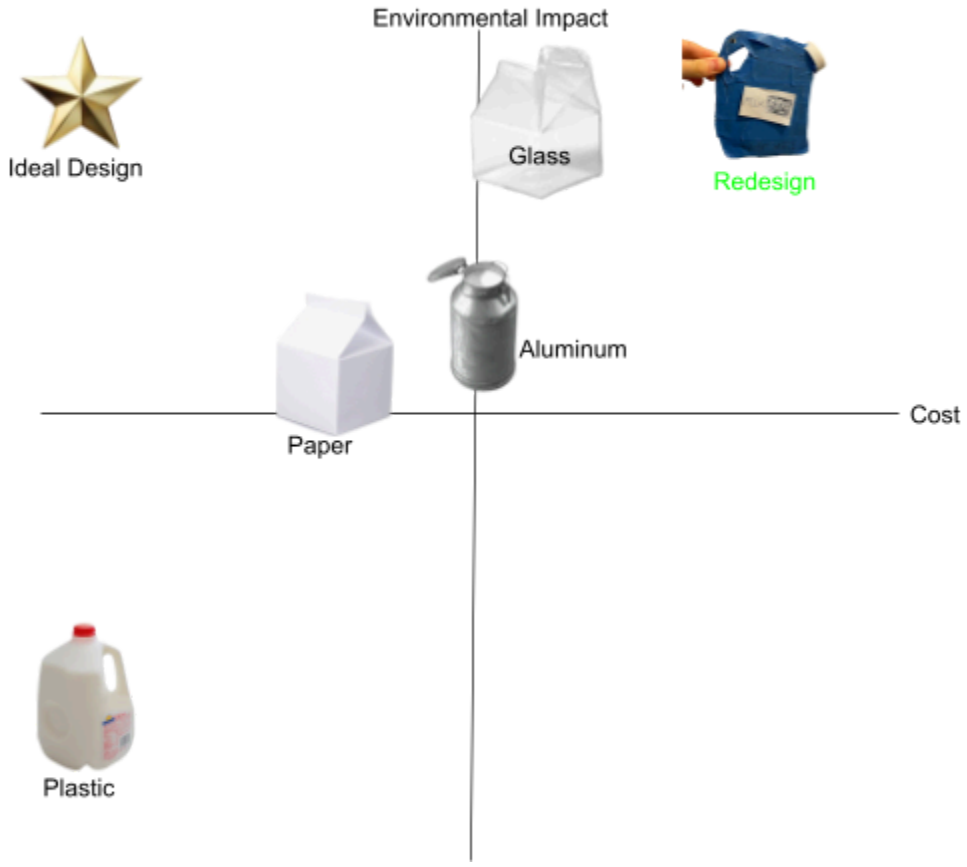


***Figure 5:*** *Design Space of Cost x Environmental Impact*

***Table 2:*** *Ranking Milk Containers on Production Cost and Environmental Impact*

| Material | Production Cost (0-10) | Environmental Impact |
|---|---|---|

| | | (0-10) |
|---|---|---|
| Redesign | 7 | 9 |
| Plastic | 3 | 2 |
| Glass | 6 | 8 |
| Aluminum | 5 | 7 |
| Paper | 4 | 6 |

This design space examines the **tradeoff** between environmental impact and cost. The redesign has very high cost due to its material complexity and specialized manufacturing process, but obviously has little to no adverse impact on the environment. Plastic has low production costs, and is easily mass produced using fossil fuels, but has a large negative impact on the environment from microplastics. Glass is relatively expensive due to energy and transportation costs, but it generally does not affect the environment due to its recyclability. Aluminum has middling costs due to its being expensive to produce but cheap to recycle. Like glass, its recyclability means it has low impact on the environment, though production does impact somewhat. Paper is generally low cost, unless it's treated for special liquid. Its environmental impact is two fold, with little impact coming from the paper itself due to being biodegradable, but high impact due to deforestation.

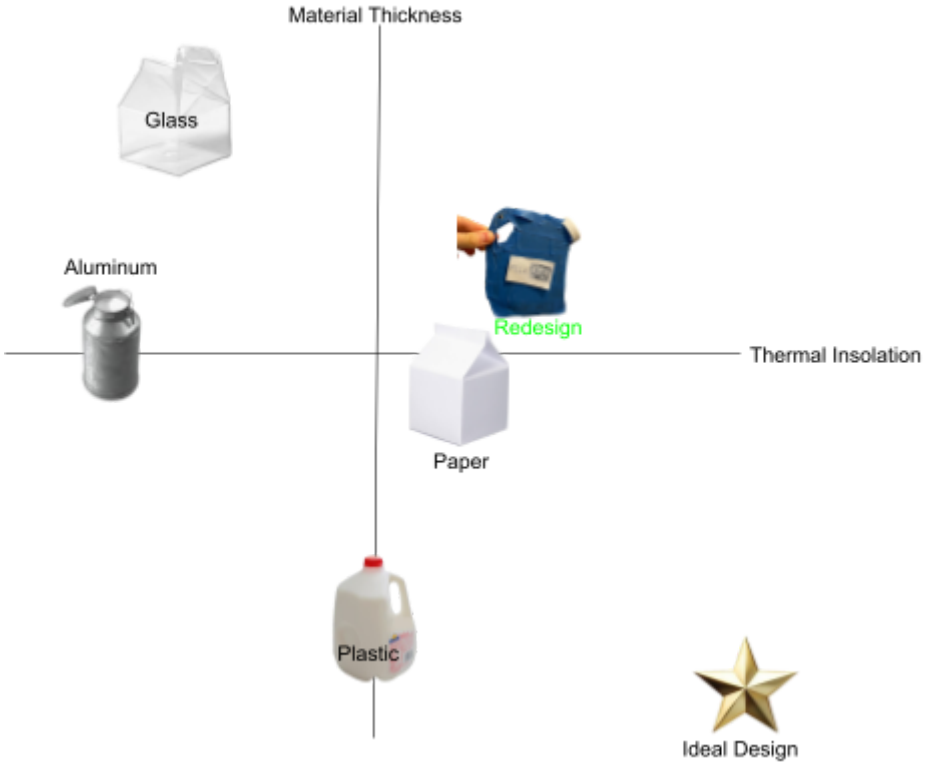


***Figure 6:*** *Design Space of Thermal Insolation x Material Thickness*

***Table 2:*** *Ranking Milk Containers on Production Cost and Environmental Impact*

| Material | Thermal Insulation (0-10) | Material Thickness (0-10) |
|---|---|---|
| Compostable Carton | 7 | 6 |
| Plastic | 5 | 3 |
| Glass | 3 | 8 |
| Aluminum | 2 | 5 |
| Paper | 6 | 4 |

This design space examines the **tradeoff** between thermal insolation and material thickness. The redesign has relatively high thermal insulation due to the biodegradable plastic, but requires being thicker than plastic to maintain enough durability and insolation. Plastic has reasonable insolation, but can suffer due to it being designed to be thinner than other materials to save resources. Plastic is designed to be lightweight and efficient. Glass is a poor insulator which allows heat to transfer easily, but also is required to be thick in order to prevent shattering. Aluminum is a strong heat conductor, which makes it poor at insulating heat. Its thickness is balanced for lightweight design and durability. Paper tends to be quite good at insulating heat because paper fibers trap air, and are generally thin depending on how it is layered.

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## *Redesign Prototyping:*

In our brainstorming process for creating our redesign, we came up with multiple designs that would address the problems our users brought to our attention in our interview process. Using the **double diamond method**, we used our interviews as user research in order to discover the problems users faced when using milk cartons.

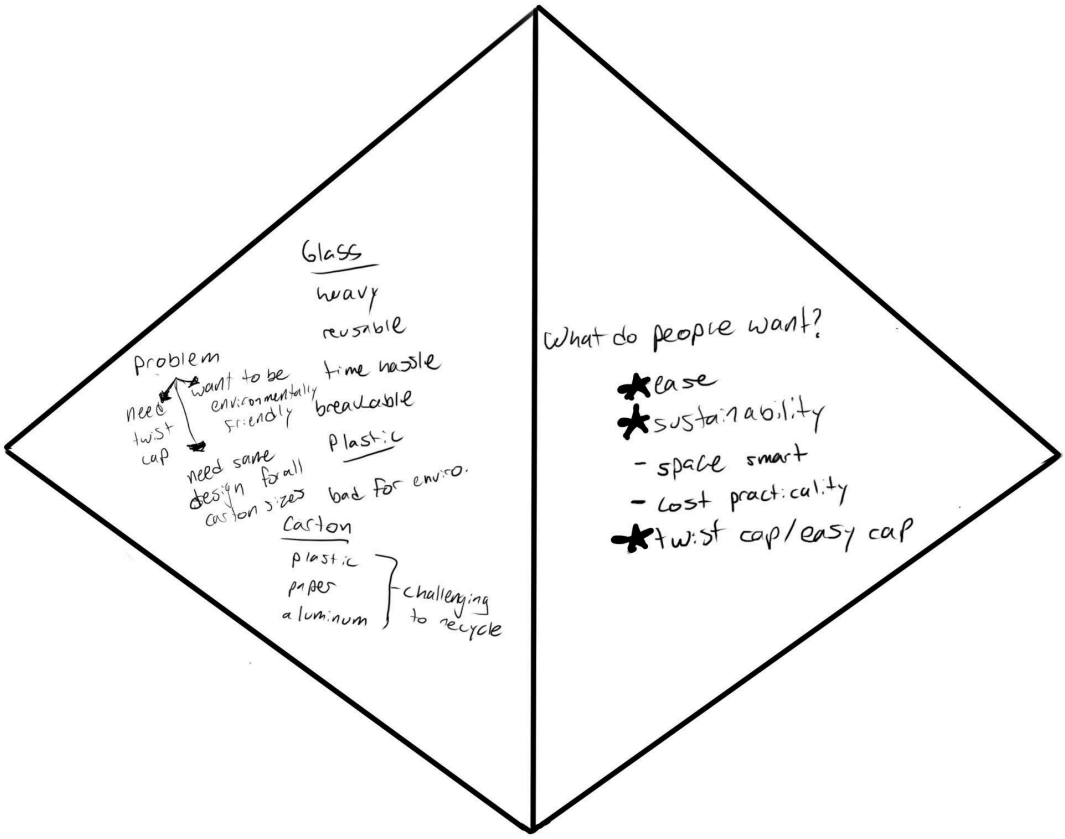


***Figure 7:*** *Image of our first half of the double diamond method*

In our discovery phase of the **double-diamond method**, we found that users tend to purchase a variety of milk cartons but don't necessarily purchase the kind they prefer. Some designs are not available for all sizes of milk cartons and some brands don't sell every kind of carton. Users frequently brought up environmental concerns and the **affordance** or recyclability/sustainable disposal when describing why they chose or preferred certain milk carton designs. Users were also concerned about the ease at which they can use their carton. Overall twist caps were the most popular choice for the spout of the carton as users believed that they **afforded** pourability the best. We also asked users about where they would typically store their milk in the fridge and based on their answers we were able to gauge what shape our redesign should take to best **afford** storability in the fridge.

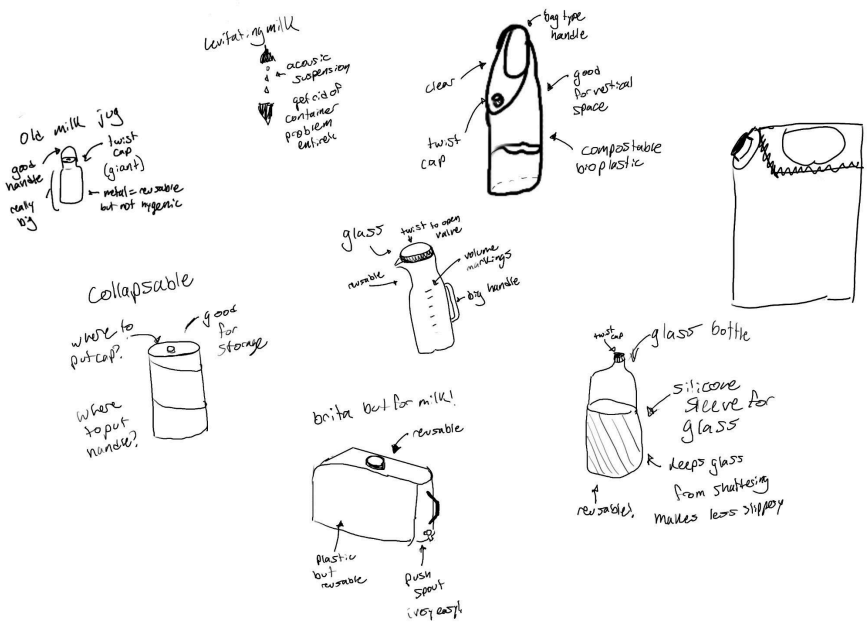


***Figure 8:*** *Image of our designing process. We brainstormed multiple designs.*

After defining the problem and narrowing down the desires of users, we moved onto the development/testing phase of the **double diamond method.** We began by examining the problems we defined before and tried to come up with solutions to those problems. We all contributed our own ideas (as seen in fig. 8) and critiqued them as a group. We pursued two designs in more detail and worked on how we would **signify** the specific **affordances** of our design. Figure 9, shown below, is an example of one of our drafts for a redesign. We made sure to include features that would **afford** and **signify** specific actions like turning the cap (the raised bar on the lid and the arrows with turning direction), picking up the carton (the handle on the back), and pouring milk (the triangular spout).

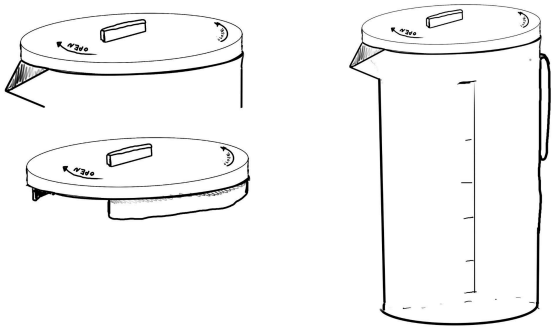


***Figure 9:*** *One of our more detailed sketches for a milk container*

As we moved onto the delivery phase of the diamond, we conducted additional interviews to get more feedback from users on our proposed solution. This process allowed us to refine our design further and see what users actually thought about our solution. Figure 10

shows a sketch of our **prototype** for our redesign. This is the image we showed and explained to users when asking for feedback.

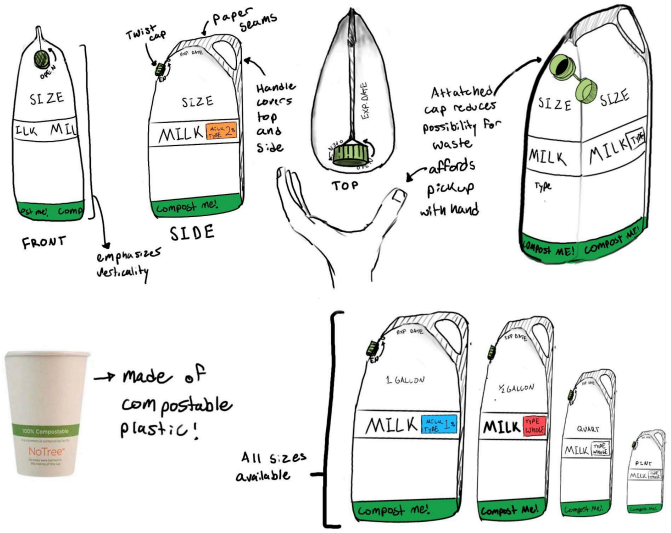


***Figure 9:*** *Redesign Prototype Sketch*

We also constructed a mini-**prototype** from paper and tape to show users what a constructed version of our design might look like as seen in fig. 11 and video 1. We wanted to do this to figure out how the carton **afforded** construction from a single piece of material (except for the cap and bonding materials). We were able to do this by creating a symmetrical image of the carton on each side and folding the bottom edges to overlap as the base of the container.

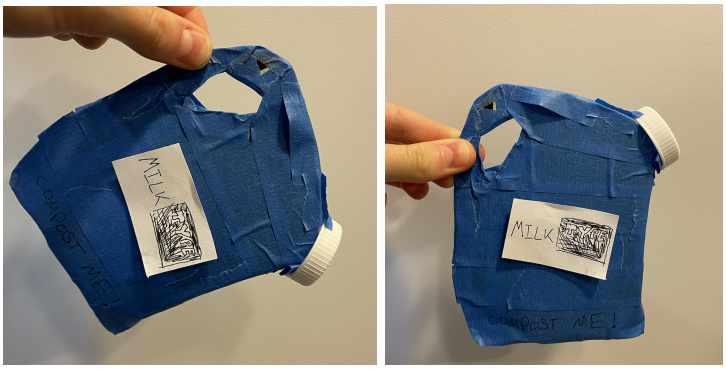


***Figure 11:*** *Prototype Miniature*

*prototype.mov*

***Video 1:*** *Video of our prototype in action*

One interviewee mentioned that “the compostable plastic is definitely a plus” but they wanted “assurance over compost/recycling ability”. This response notified us that we would need additional **signifiers** to tell users about the **affordance** of compostability. This interviewee also mentioned that they were “worried about the pouring angle” from looking at the drawings but

once they watched the video they saw that it was functional. Another interviewee mentioned that they “like the cap being attached so you won't throw away the cap on its own and turtles won't choke on it.” They also gave us some insight on a possible engineering flaw. They said “you couldn't fill (the milk carton) all the way” which they noted as a potential concern about maximizing space in the container. They gave us helpful feedback on fixing the problem and suggested “putting the cap higher.” They also said “it's good that it has a handle” showing us that the **affordance** of pickup via handle is a useful feature to users.

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## *Redesign & Justification:*

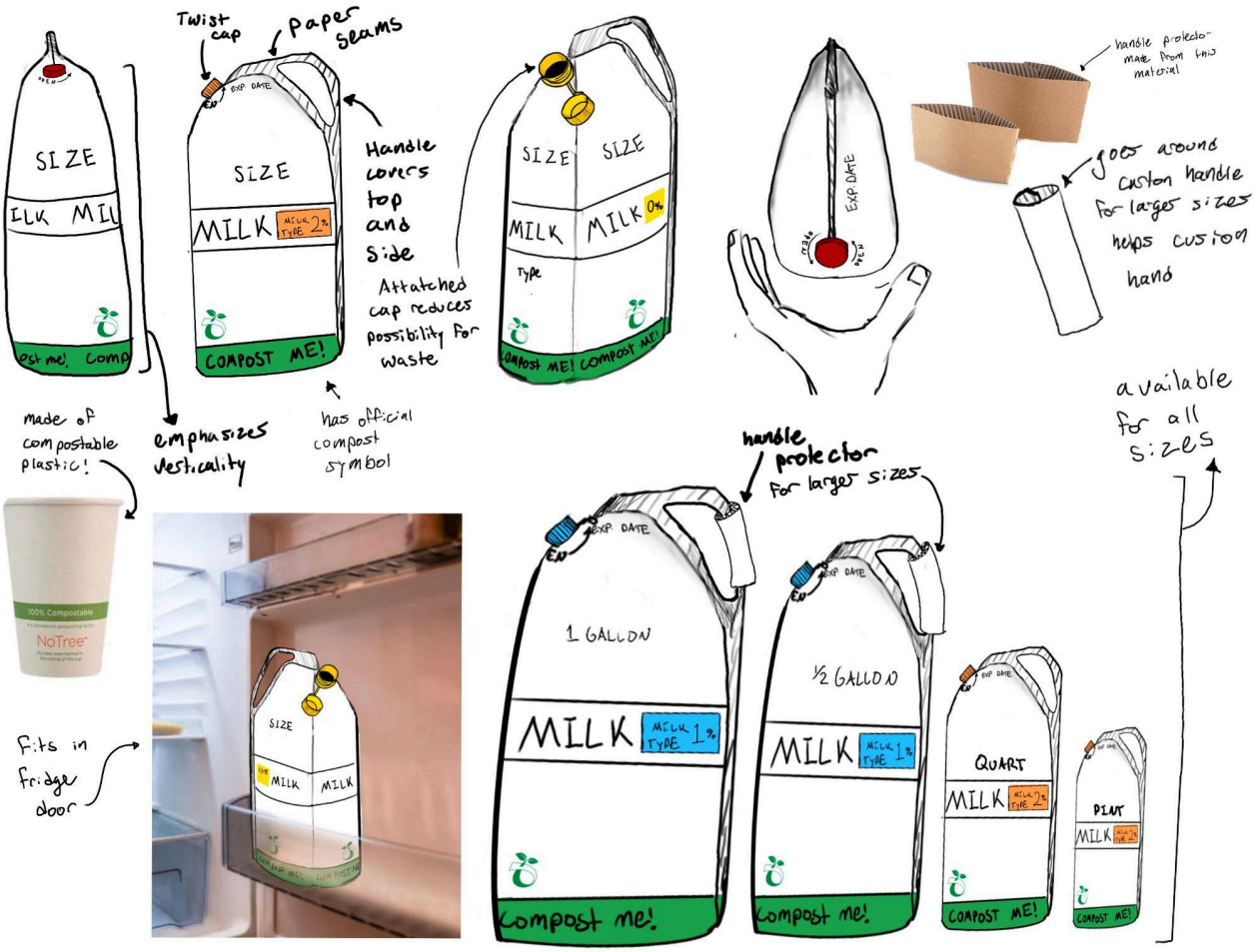


***Figure 12:*** *Final Redesign with multiple views*

After brainstorming, prototyping, and user feedback, we landed on the design shown in figure 12 as our solution to the problems users face.

One of the most common trends in our interviews was the concern over how the carton **affords** disposal. Since most milk cartons do not **afford** reuse, an important feature of the lifecycle of this product and an important **affordance** of the carton is how the user can dispose of the product. Users were concerned with their milk cartons **affording** a sustainable disposal, but were forced to choose other options based on other features they thought were important. Our

carton is made from compostable plastic and paper like the cup shown in the redesign image. This feature gives our redesign the **affordance** of compostability, addressing the concern over environmental impact mentioned in interviews 1, 10, 11, 12, 13, 17, and 19, and in our prototype feedback. The **affordance** of compostability is clearly **signified** with the green bar around the bottom of the container which instructs users on the proper method of disposal for this container, a feature that is lacking on current milk containers. The addition of this feature decreases the **discoverability** of how the carton **affords** disposal, a significant change from the current designs which have more complicated and inaccessible disposal instructions. The compostability **signifier** helps users to bridge the **gulf of execution** when disposing of their carton. Following our prototype interviews, we also chose to include an additional **signifier** of the **affordance** of being compostable (or being disposed of via composting). This comes in the form of the official symbol for compostable materials and provides additional assurance to users that this product can be disposed of in a sustainable way.

Another important feature included in our redesign is the twist cap. 16 out of 18 users overwhelmingly preferred the twist cap (interviewees 1, 2, 3, 4 , 6, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, and 19) as they believed it kept the milk the freshest, was the best at **affording** smooth pouring, and was easy to use. We decided to include ridges on the twist cap (similar to many but not all existing twist caps) to better **afford** grasping the cap and turning it. We also included arrows on the milk carton itself to **signify** to users the direction in which they need to turn the cap to open the container. The location of the twist cap also acts as a **signifier** to the user in the form of a **logical constraint** that the milk should be poured out from that opening. The placement of the cap is also intentional. In our feedback on our prototype, one interviewee mentioned that the location of our previous design might not **afford** being filled all the way. To fix this problem, we changed the location of the cap with the opening more perpendicular to the top of the container, making it easier to fill and maximizing space within the container. We also placed the cap at the front edge of the carton because that location will best **afford** an unobstructed pouring stream and avoid spilling. Another important **signifier** is the color coded caps and labels that tell users what type of milk they are purchasing. This feature is present on some milk cartons, but not all and not usually present on paper cartons. Having a standard system for what color label a specific kind of milk has would be useful to users because, as we learned in our interviews, they tend to purchase the same type of milk.

Another important design is the verticality of the milk carton. Many users (interviews 2, 3, 4, 6, 7, 12, 13, 16, and 17) mentioned that they typically store their milk in the door of the fridge, a very narrow space. In order to **afford** storability in the most typical storage location, our redesign is a container that is taller than it is wide. This shape provides a **signifier** in the form of a **physical constraint** and supports a **natural mapping** of storing a long narrow container in a long narrow space. . As the milk fits in the side door, users are made aware of its **affordance** of being stored in narrow spaces. One of the most important features of our redesign is the handle. As it covers both the top and the side of the container, the container **affords** being picked up from the top and the side. This feature will make the **affordance** of being picked up by the

handle available to the user no matter where they store their milk in the fridge as the carton **affords** being picked up in multiple ways. The handle also acts as a **signifier** (a **physical and logical constraint**) of the container's **affordance** of being picked up by hand due to the fact that the handle is hand sized. Another **affordance** we included in our final redesign is a handle cover (made out of a similar material to paper cup holders) which will allow users to actually use the **affordance** of picking up a carton by the handle for larger volumes of milk. One interviewee mentioned that it would be useful to be able to 'use one hand' for higher volume milk containers so we added this handle cover in order to make holding a heavier carton more comfortable for users and allow the carton to better **afford** being picked up by hand.

While many of the features we included in our redesign are part of existing designs, we believe that the combination of all these features has optimized the milk carton to be the most useful and practical to users as it was designed specifically to address their needs and concerns.

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## *Redesign Tradeoffs:*

Our redesigned milk carton prioritizes environmental sustainability by using compostable plastic, directly addressing user concerns about reducing plastic waste. This eco-friendly approach **affords** sustainable disposal, as the carton can be composted. However, this focus on sustainability introduces a **trade-off** in terms of durability. Unlike traditional plastic containers, the compostable plastic is more prone to wear and tear, which can lead to **action-based slips** during use. For instance, users might apply too much pressure when gripping or pouring, causing the carton to tear or collapse. This disrupts their **mental model** of milk containers being easy to handle, increasing the likelihood of **capture slips**. This **capture slip** could happen where familiar actions from handling plastic containers like firmly gripping could lead to unintended damage or spillage.

Another significant **trade-off** that came with our redesign is the potential for higher production costs associated with using sustainable materials. While compostable plastics are environmentally beneficial, they often require more specialized processes and resources, raising the overall cost. In order to combat this, we focused on optimizing the design for simplicity and efficiency. We created a miniature prototype using a single sheet of cardboard, folded and sealed at the edges and bottom. This miniature prototype, as shown in figure 9 retains essential **affordances**, such as easy holding and sealing, which can help the user create a clear **mental model** of the redesign. After creating our miniature redesign we asked interviewees for feedback on our prototype and their response was "I like the cap being attached so you won't throw away the cap on its own and turtles won't choke on it." Additionally, by adding **signifiers**, such as "compost me," and arrows on the caps to signify where to turn, it reduces the chance of **errors** during use, ultimately balancing sustainability with functionality and cost-effectiveness.

This redesign also aims to accommodate various milk container sizes, introducing both opportunities and challenges. All cartons include handles, which serve as **signifiers** for easy gripping and pouring, enhancing usability and providing clear **feedback**. While all sizes come

with handles, smaller sizes don't necessarily need it as they can be held with one hand. Meaning that while smaller sizes **afford** being held from the middle and the handle, larger sizes only **afford** to be held by the handles. While this may not necessarily be a large **trade-off** it can impact how certain cartons do not have the same ease of handling, increasing the likelihood of **slips** during pouring.

Our redesigned milk carton introduces **trade-offs** between sustainability and usability, while the compostable material reduces environmental impact, it sacrifices durability, and has the possibility of high-cost manufacturing.

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## *Conclusion:*

Problems with storage compatibility, usability, and environmental impact were among the most significant difficulties we found while analyzing milk container designs. Interviews with users showed that they care about sustainability, but they often have to make **trade-offs**. For example, they might choose plastic containers because they are convenient, but they are bad for the environment. Other problems were that paper spouts didn't work right and glass cases were heavy and easily broken. These results shaped how we designed a remake that is user-friendly, useful, and good for our planet.

Concerns about sustainability were taken into account in the final redesign, which uses recyclable plastic and paper materials while keeping important features like easy pouring and secure closing. The twist cap makes it easy to use, the curved handle makes it easier to hold, and the vertical shape makes it perfect for storing in the fridge, especially in the door sections. Directional arrows on the cap and compostability labels are clear **signifiers** that help users interact with the product in a way that is easy to understand and less likely to cause mistakes. Many user concerns have been addressed in the redesign, but there are still **trade-offs.** Compostable materials are better for the earth, but they may not last as long and may cost more to make. Storage compatibility with narrow fridge compartments may also impact flexibility in other situations, so it's important to give this more thought.

To further improve the design and tackle any remaining issues, the following steps would be to conduct ongoing prototyping and testing with various user groups. To make production more cost-effective, working with manufacturers would be helpful. Trials could show how the product would be used in the real world and how it could be expanded. More feedback from users would help guide changes, like making things easier to recycle and using stronger materials.

In conclusion, our new milk bottle strikes a good mix between usefulness, sustainability, and practicality. It also addresses some of the most common user complaints and meets their needs. With more testing and improvement, this idea could make a big difference by providing an eco-friendly and useful alternative to current milk containers.

# *Writing Hub:*

## Writing hub 12/4/2024

https://docs.google.com/document/d/1kRako4xGijNsgYD8HgoNWPNGeWZBf-SmF4AFC56ieFQ/edit?usp=sharing