



UPCYCLING SOFT PLASTICS

By Steven Kinder



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94%
of plastics go
into landfills



SUMMARY

In 2022, the USEPA¹ and Greenpeace USA² updated their reports and concluded that in the United States we only recycle six percent (6%) of all plastics we dispose of into our waste streams. Ninety-four percent (94%) of all plastic waste is going to landfills. At a landfill, about a third of the plastics are incinerated for energy, and the rest are left to decompose, a process that scientists estimate can take several generations to happen. The process of incineration and decomposition of the plastics emit carbon dioxide (CO₂), methane, and benzene, all considered greenhouse gases that contribute to global warming. Over half the plastics sent to landfills are known as soft plastics, these are plastic bags, wrappers, and packaging materials. Recycling soft plastics has been unsuccessful due to a range of issues from the difficulty in identifying and sorting the material, to the lack of economic resale value of the material.

My research into this subject matter has evolved from my experience as a product and furniture designer working with a wide range of plastics and other materials in the design and manufacturing of products I have designed. I'm guided by a belief that many of the materials our society discards daily can be harvested as new material sources

for a variety of applications and creating a circular sustainable solution for the materials. My exposure to plastics and other materials in manufacturing has informed my work and shown there is a design opportunity to improve industries and businesses through upcycling soft plastics. Informed by Human-Centered Design methods and a material exploration process with certain production techniques can yield an improved business case for the reduction of soft plastics pollution and disposal.



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Lifebuoy
100% Eucalyptus Communes

A decorative graphic consisting of three horizontal green lines. The top line is a solid bar. The middle line is a bar with a right-pointing arrow at its end. The bottom line is a solid bar.

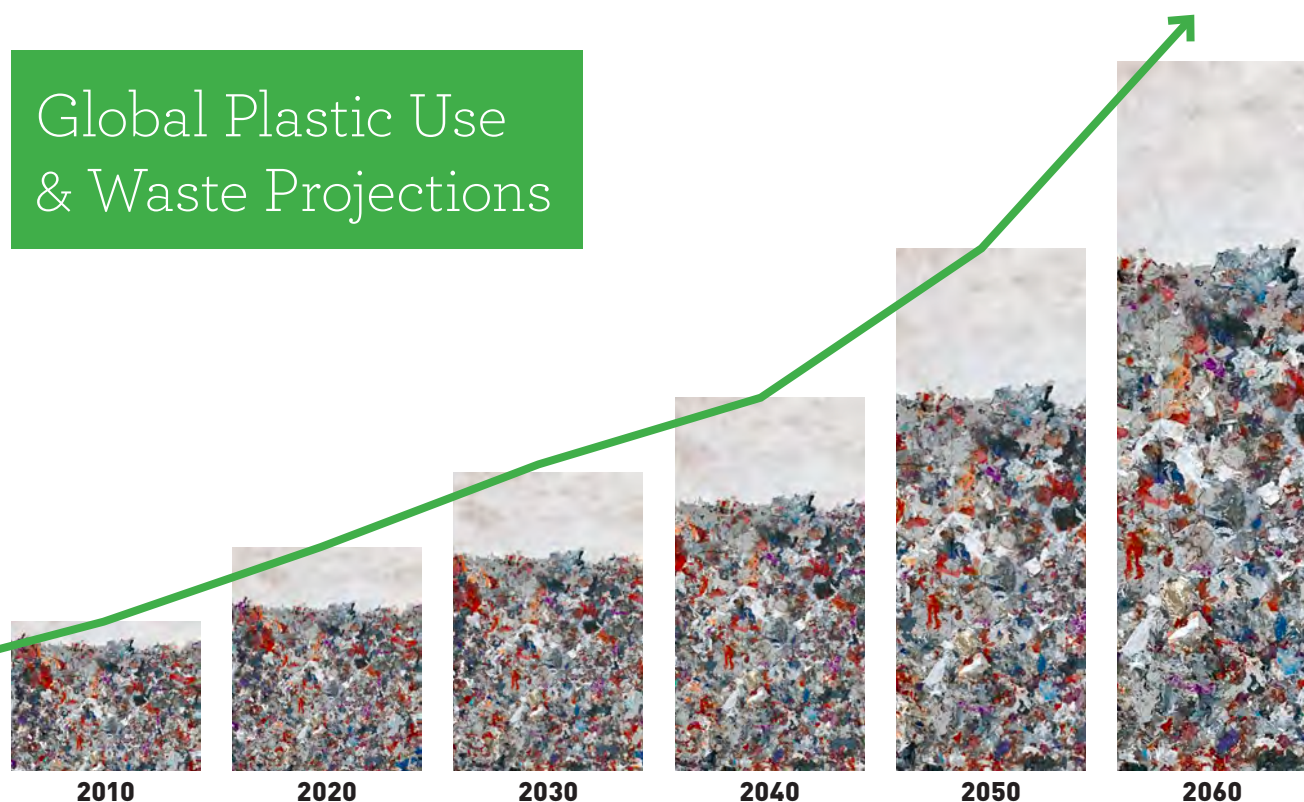
INTRODUCTION

In the US, municipal solid waste (MSW) recycling programs have consistently diverted about 35% of waste from landfills through their recycling and sorting efforts for the last decade³. These items include plastics, glass, metals, and cardboard. However, about one-quarter of recycled items collected contaminate the recycling process and are sent to landfills⁴. The issues of contamination in the recycling programs are materials and items disposed of into the recycling stream by consumers who believe they are going to be recycled but are not recyclable. From my initial research context, I was able to identify how individuals could improve their awareness and

impact of the soft plastic materials they use every day and make better choices for other outcomes available to them through reuse or local recycling at grocery stores that accept some soft plastics.

The objective of my research was to discover, understand, and explore ways soft plastics can be upcycled by businesses and their customers to improve the circularity and sustainability of the business and create circular strategies for the soft plastics materials to keep them from contaminating the recycling streams in the United States. The largest contributor to the contamination of the system is plastic films and wrappers,

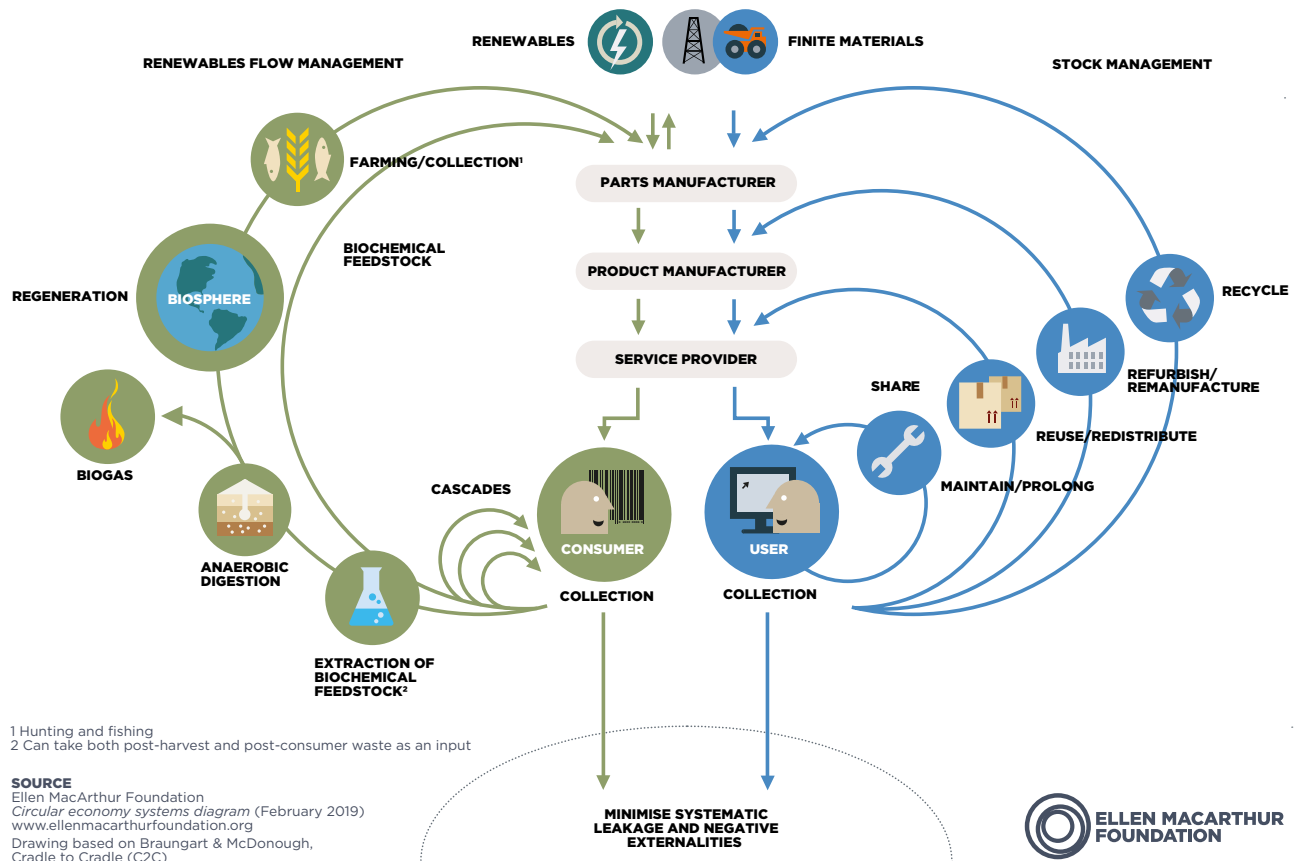
Global Plastic Use & Waste Projections



commonly referred to as soft plastics, because they are not rigid plastic products like water bottles, milk jugs, or detergent containers made from PET and HDPE that can be recycled. These soft plastic items are typically a material known as low-density polyethylene (LDPE), and include food wrappers, single-use bags, and plastic packing materials. A lack of awareness by consumers and misinformation on the issue of recycling these items complicates this problem beyond solely a human-centered issue, due to a fact that many of these soft plastics have no identifier (#1, #2, etc.) that many rigid plastics are labeled with. When soft plastics are not labeled with a material code number, these items cannot be accurately identified and are considered contaminants in the recycling process, making this issue more difficult as the popularity of these plastic films continues to grow.

A report from the Organization for Economic Cooperation and Development (OECD) projects that global plastic use and waste will nearly triple by 2060, resulting in a doubling of global plastic

pollution⁵. The use of soft plastics by our culture will continue to harm our environment and human existence by creating more harmful carbon dioxide (Co2) greenhouse gasses in our atmosphere as the items are incinerated, left to decompose in landfills, or find their way into waterways and oceans. A more qualitative focused, Human-Centered Design approach is possible with the help of sustainable business practices and values many forward-thinking companies can adopt with the concerns of their customers and the greater environmental impact of waste. A Human-Centered Design approach to addressing this situation would benefit a business by better understanding the values and experience of their audiences and customers to make improvements to the way they serve customers. The added value for the business could range from improving internal goals and initiatives to improving profitability and enhancing sustainability goals for the business and customers.



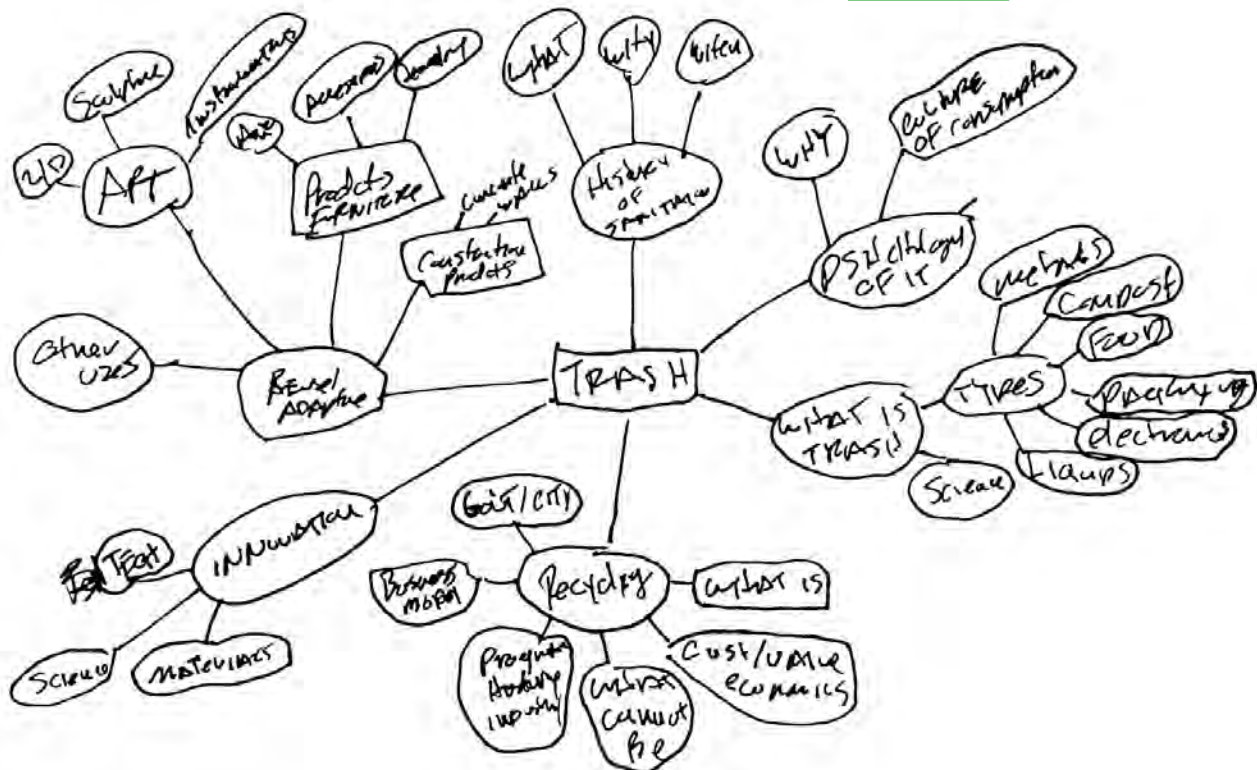
2022 PLASTIC ITEMS: ACCEPTANCE FOR MUNICIPAL COLLECTION BY U.S. MRFs

Plastic Item	Acceptance at U.S. MRFs (375 Total)
PET#1 Bottles and Jugs	375 (100%)
HDPE#2 Bottles and Jugs	375 (100%)
PP#5 Tubs	194 (52%)
Plastic Clamshells	41 (11%)
Plastic Cups	32 (9%)
Plastic Trays	17 (5%)
Plastic Bags	3 (1%)
Styrofoam Food Service	4 (1%)
Plastic Lids and Caps (Loose)	9 (2%)
Plastic Plates	6 (2%)
Plastic Cutlery, Straws and Stirrers	1 (0%)
Plastic Food Wrappers and Pouches	0 (0%)
PP#5 or PS#6 Coffee Pods	1 (0%)

“Butterfly” Circular Concept,
Ellen Macarthur Foundation

Single-use bags, film wrapping, and packaging materials are not recyclable in a majority of recycling facilities (MRF) in the US.

THE RESEARCH QUESTION



How might we upcycle soft plastics to meet a need?

Early primary research was focused on understanding what types of materials going to landfills could potentially be diverted and used as a source for reuse. While the material recovery facilities (MRF) are capable of capturing rigid plastics to be recycled, many are overwhelmed by the contamination of soft plastics they receive and ultimately send to landfills. This discovery led me to refine my guiding research question to be: “How might we upcycle soft plastics to meet a need?”

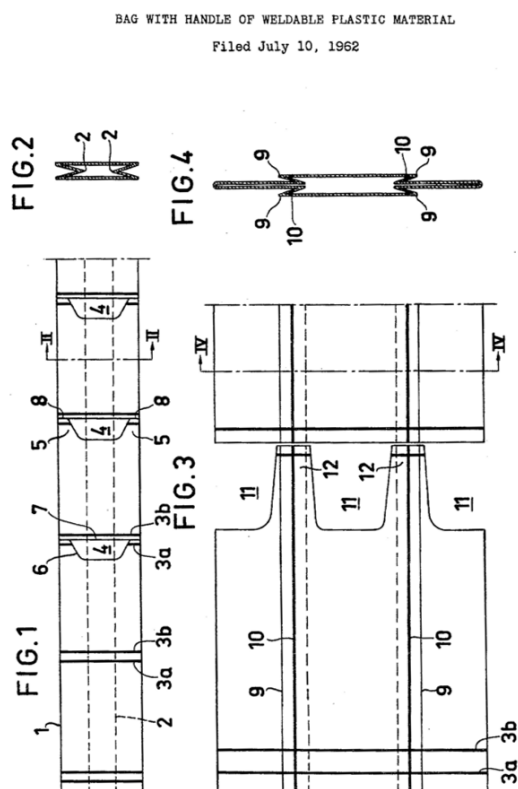
The “need” could be for the context of a business that serves consumers who desire a company to have greater sustainability for what and how the products they package impact the community they serve. If soft plastic materials can be re-adapted or upcycled into other products like small accessories, decor items, or office products; could the materials be beneficial to a business’ operation or serve another application in the business? Is there a cost-benefit, aesthetic or use advantage over other solutions the business may source for an internal operations process to support the business?





America has been an innovator in plastics since 1907 when Leo Baekeland pioneered Bakelite, the first commercially engineered synthetic plastic in Yonkers, New York. Bakelite was used for everything from electrical insulators to automobiles and household products. It would pave the way for synthetic plastics and the chemical industry. By the 1940s, amid WWII, plastics would emerge as an innovation for the manufacturing of products and equipment for our military. New formulas were developed to make armaments and package consumables; these innovations would be foundations for the mass adoption of plastics in the home and office after WWII. The invention of cellophane, a clear film for single use, would be used for a wide range of applications and marketed as a timesaving solution to homemakers for cooking and preserving food. In 1965, a patent would be filed for the single-use “T-shirt” bag, and trillions have been made and disposed of since. The advertising age of the 1960s ushered in plastics with ease and convenience, no need to clean up after you finished, simply throw it away. Single-use plastics took on a cultural identity for a new modern lifestyle of consumption and ease. While those traits remain today, the side effects of mass adoption including pollution and climate change are on a scale early innovators could have never imagined, now requiring innovative ways to address these new problems.





1965 Plastic Bag Patent

Since the 1990s, America's waste and sanitation began to adopt approaches for the processes to sort recyclables from landfill waste items based on the economic value of commodities like paper, cardboard, metals, and glass, whether to be recycled or disposed of in a landfill is driven by the commodities value on the open market and the ability to sort the material effectively at a MRF. This framework varies depending on factors like geographic location and capabilities of recycling providers in a local area. The process of recycling also involves a range of actors who create, consume, pick up, sort/process, recycle and dispose of the waste we create. Consumers who dispose of waste daily through curbside programs, which serve roughly 60% of the US households,² are encouraged to consider recycling in an attempt to reduce the environmental impact waste has.

Municipal waste systems have adopted a single-stream approach to simplify the process for consumers by separating recycled items from landfill items in the residential collection service.



1950's Cellophane Advertisement

Businesses, like consumers, create a large amount of waste through their operations and often see the potential opportunity to build programs in their business to track and improve the impact they can have on the environment. Local and national waste collection providers like Republic Services or Waste Management collect the waste from residential and business customers and are responsible for transferring the waste to the material recovery facility (MRF) or landfill depending on the class of trash. Once delivered to an MRF facility the materials are identified, sorted, and baled into their material class and prepped for sale to a recycling processor.

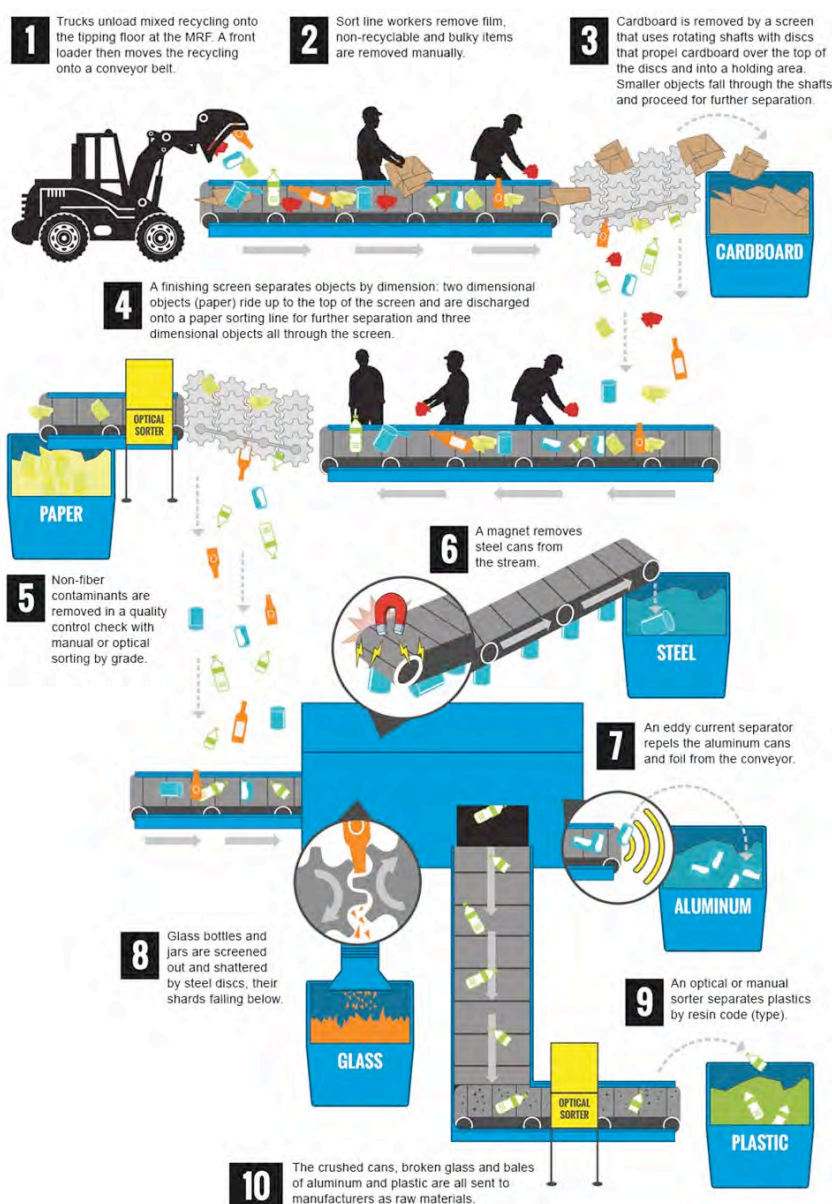
This current single-stream waste model re-captures about one-third of items in waste to be reclaimed and recycled. The statistics on the collection of recycled items at MRFs vary greatly by region but the largest barrier to improving the collection and processing is reducing the contamination that soft plastics materials create when sent to the MRF⁴.



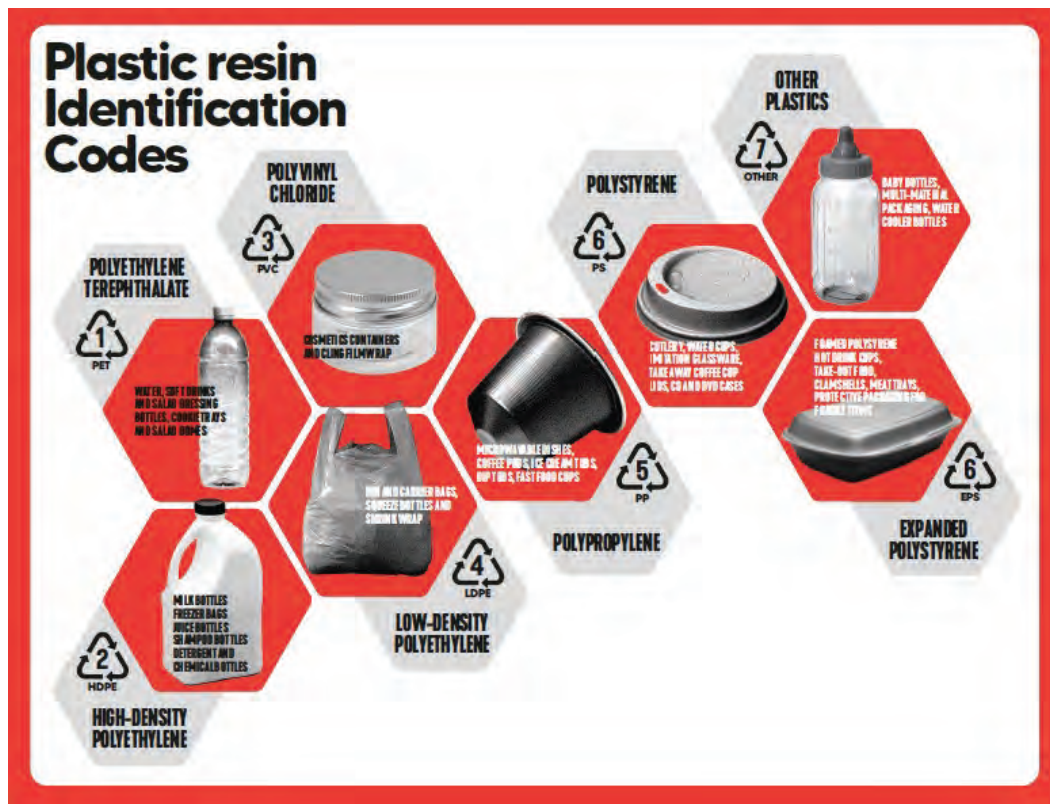
Materials Recovery Diagram

In 2020, the US disposed of 46 million tons of plastic waste. The core issue that exists for all plastics recycling in the US is documented by the United States Environmental Protection Agency (USEPA) report from 2020 that claims only 6% of plastics go into the recycling stream, leaving 94% of non-recyclable plastics to either be incinerated for energy creation or disposed of into landfills¹. Landfills have long been a source of revenue for cities, counties, and businesses, through the surcharge fees for waste disposal. The environmental impact of greenhouse gas emissions is well measured by the USEPA and counters efforts being made in other industries. Diverting soft plastics from landfills could have a beneficial impact on CO₂ and other greenhouse gas emissions that landfills produce from the decomposition of waste and plastics⁶.

The sanitation and recycling industry is challenged to drive innovation around recycling or finding uses for soft plastics because there is no financial motivation due to the costs and complexity to identify, sort and process the materials outweigh the raw material costs to use new virgin material. Therefore we will continue to see this category of



plastics grow because of the ongoing reduction in costs of virgin resins in plastics and the segment continues to grow. Most plastics being sorted for recycling by an MRF are from two primary plastics grades, PET#1 and HDPE #2, and in some cases PP#5, those can be recycled and reused in a typical manufacturing process. A large amount of the plastics going to landfills cannot be reclaimed for manufacturing purposes because of a loss of their original integrity or because of the lack of ability to accurately sort other class types before the baling process at an MRF.



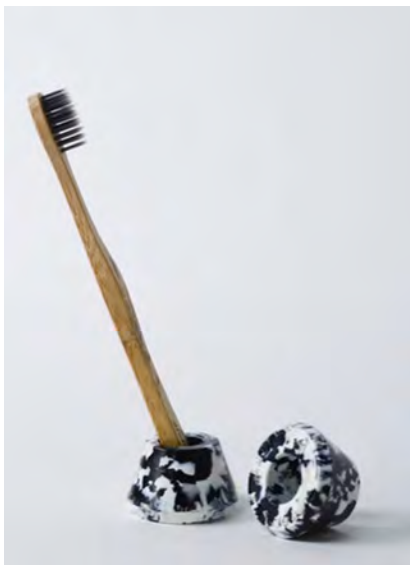
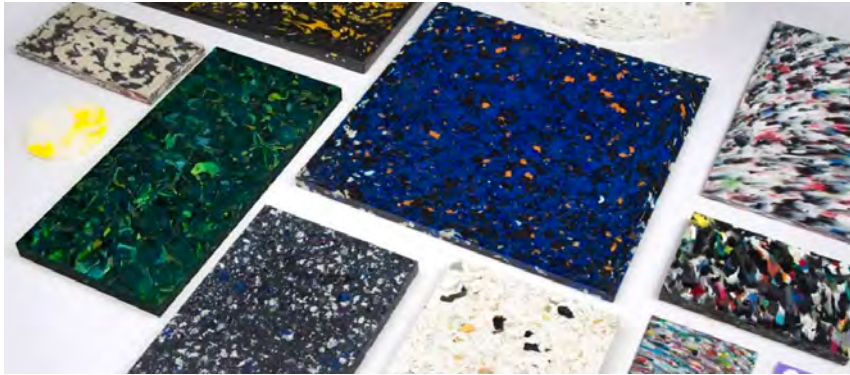
Source: Circular Claims Fall Flat Again, 2022 Update. Greenpeace, Inc.

Although soft plastics are not currently sorted or recycled, they may still have integrity as a viable material with an opportunity to be used but would require new methods and approaches to identify ways they could be applied to manufacturing. In 2013, Dutch designer Dave Hakkens launched his Precious Plastics project as an open-source platform based on simple ways to build machinery to grind, melt and mold plastics on a small scale. Precious Plastics' mission is to reduce the amount of plastic waste through a variety of approaches, mostly based on local collection and awareness of environmental issues⁷. The Precious Plastics movement has grown to several hundred groups around the world sharing information and resources about collecting, processing, and forming reused plastics. Many of the Precious Plastic partners focus solely on the collection of plastic waste

like bottle caps and rigid plastic containers (PET & HDPE) found along shorelines and waterways in their communities, but there has been little effort on the collection and use of LDPE, the main material composition of soft plastics.

Many small businesses have been launched within the Precious Plastics community, collecting plastics to reuse in products they make that are donated or sold to raise awareness and further the impact of plastics recycling in their local community. Multiple examples exist of this approach in Precious Plastics that attempts to recapture plastics polluting the local community or are destined for landfills and are utilized in the creation of items like coasters, plastics tiles, or household items⁷.





#PRECIOUSPLASTICS



Source: Instagram Images @realpreciousplastic

DESIGN PROCESS

While the use and proliferation of soft plastics is happening on a global scale, it is also necessary to understand this issue on a local scale, first-hand in my community. During a site visit to Republic Services' Materials Recovery Facility (MRF) in Plano, Texas, I observed the issue of soft plastics contamination in the recycling system first-hand. The soft plastics were predominantly bags, packaging, and food wrapping that consumers placed into the recycling bins, assuming they belong in the recycling processing system. Soft plastics like these that are not recyclable create unnecessary downtime when they jam up the conveyors and sorting line equipment and require the MRF to stop the systems operations to clean and remove those soft plastic items. Once the soft plastics are removed since they are not recyclable by the MRF, the items are collected, baled, and sent to a local landfill.

A Human-Centered Design approach to this complex problem not only helps explore the viability of upcycling soft plastics as a material for use in making solutions to solve the needs of a business, but also allows for better understanding of a business' and consumers' relationship and behavior to the soft plastic materials.

The Circular Economy model by definition from the Ellen MacArthur Foundation is an approach to building a restorative and regenerative economy through recycling, reuse, and regeneration of our waste streams into renewable sources for our economy, their "Butterfly" diagram provides a visual explanation of this concept⁸. The foundational three principles of the circular economy model are to eliminate waste and pollution, circulate products and materials and regenerate nature.



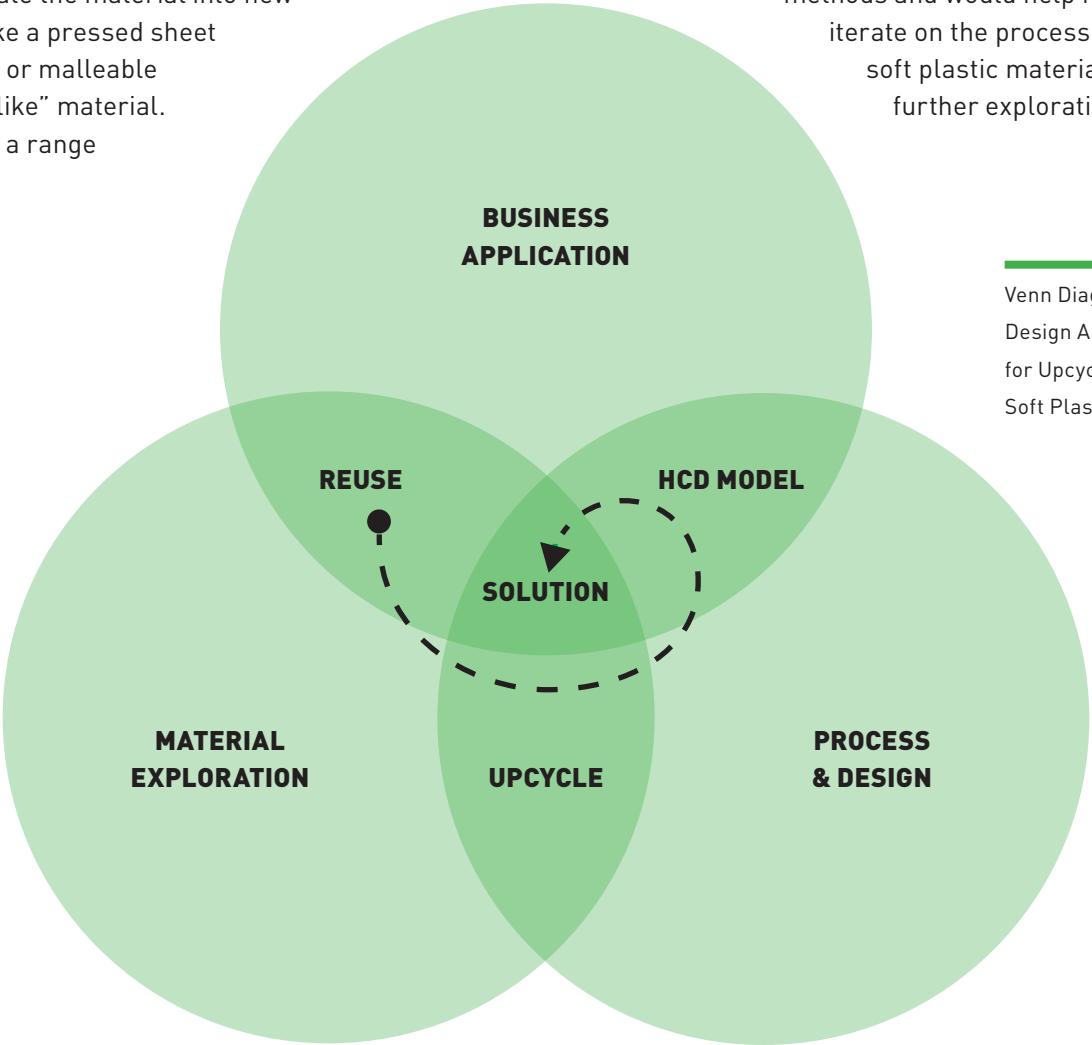
Republic Services Plano Material Recovery Facility(MRF)



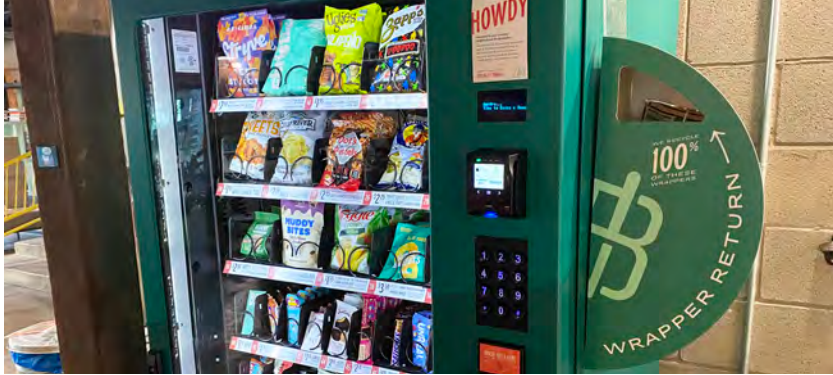
For the research process, there were two major efforts to be explored for the purpose of this opportunity. There was a need to perform a range of qualitative and applied methods to understand the viability of materials and processes to reuse discarded soft plastics. Additionally, deploying Human-Centered Design methods to explore and measure feedback on the desires by businesses and consumers to purchase, use or interact with those products in a way that could serve a longer term need and justify the added resources needed to perform the upcycling efforts.

The early phases of understanding how to modify the material was a blend of experimenting and refining how to compile, shred, heat, and process the plastic films and wrappers with the intent to manipulate the material into new forms like a pressed sheet material or malleable “dough-like” material. I utilized a range

of traditional thermoforming conventions as the context to experiment with the material itself and build my confidence in working with the material. Initial secondary research sources were found through social media outlets where members of the Precious Plastics community often shared their successes and failures for others to learn from. I contacted Precious Plastics members to learn about the machinery and processes they used to inform my ideas for working with the materials. My intention of prototyping small tests with soft plastics was going to be different in scope than most in the Precious Plastic community, because they focus on PET and HDPE, both rigid and more stable when heated and formed. I felt there was value in understanding and validating some aspects of the equipment and techniques learned from their methods and would help me to iterate on the processes with soft plastic materials for further exploration.



Venn Diagram,
Design Approach
for Upcycling
Soft Plastics



Bingo Markets



Creating an Improved Business Application

To apply my research on soft plastics to the context of a business need, I wanted to identify a business that creates or accumulates soft plastic waste through the operations of their business. My intention was to engage in a Human-Centered process to inform how the business might divert their waste and envision new possible ways to upcycle the waste into new solutions to serve the needs of the business. I was introduced to Bingo Markets, a snack vending business through another business relationship I have. Bingo Markets is a Dallas-based vending business focused on providing curated snack offerings for businesses with their vending machines. To better understand the needs of the business and to identify a possible prototype solution to meet those needs, I interviewed Colin Martin, a founder of Bingo. Martin was acutely aware of the negative perception that snack wrapper waste has, since it isn't recyclable, and his customer also operates an office waste reduction program for their location in Dallas, they desire to eliminate single-use plastics from their waste as a business. From this interview, we agreed to explore the opportunity for a Human-Centered Design process to create a circular loop process for food wrappers as source material to create a prototype solution to improve the company's sustainability goals. The combination of the business owners desire to better serve his clients in the space where his vending machines are, plus the available tenants within the space to provide feedback on a more sustainable approach needed created an ideal opportunity to

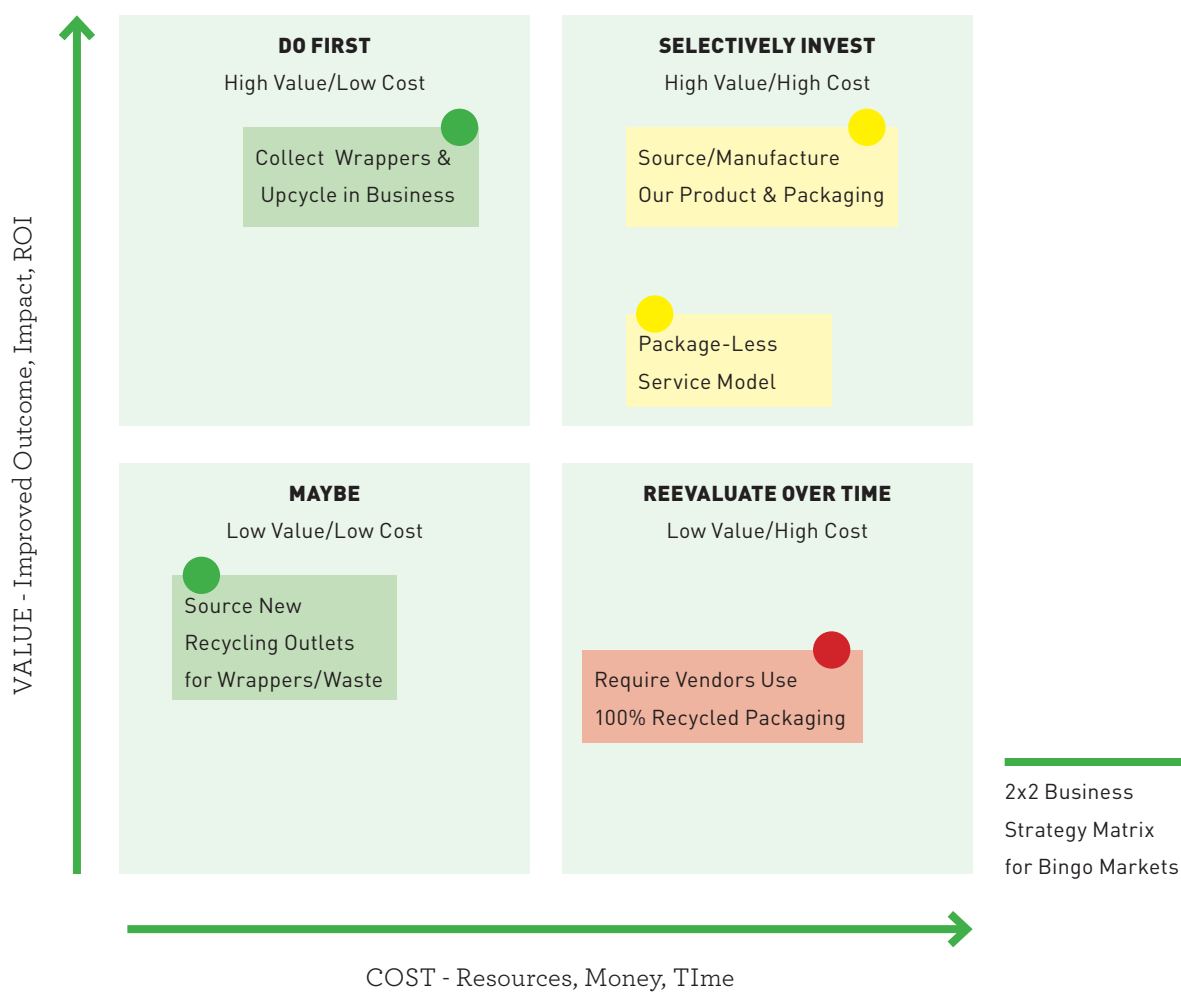
design and prototype a program with the vending company at his customers' site to recapture the soft plastics wrappers and upcycle the items into a usable application for the vending company in a new way to benefit the vending customer.

Case Study Development and Process

To better understand the potential human impact of this opportunity and need, I observed the daily routines of the space and conducted preliminary interviews with Bingo's owner, Colin Martin, and Amy King, of Good Coworking. Amy operates the shared workspace that occupies the office building and the vending machine is located in their space. Talking with Amy about needs in the space and observing the functions of their business and areas in the workspace, it was identified that certain needs were evident. These included simple things to enhance the workplace functionally and aesthetically; like containers for storage, office accessories, plant containers, and coasters for the existing plant pots.

In addition to those needs, the vending company felt it could also be beneficial to use the re-captured wrappers in ways to further the company's marketing or promotional ideas with items made from the wrappers could be used at giveaways to promote their business model as a differentiator to other vending providers. The community at Good Coworking is very sensitive to the creation of waste. In April of 2022, the City of Dallas recognized GCW as

COST & VALUE MATRIX



a Platinum Certified Business for its sustainable and wellness guidelines, which included its handling and reduction of waste for the business. The objective to go one step further and implement a new program to recapture food wrappers and up-cycle them into a viable form to enhance the experience for the users of the business would align with the values and model of the business. While this research has included both a Human-Centered Design process and new material exploration, it has the potential for a larger impact when viewed through the lens of circularity and sustainable supply chain management.

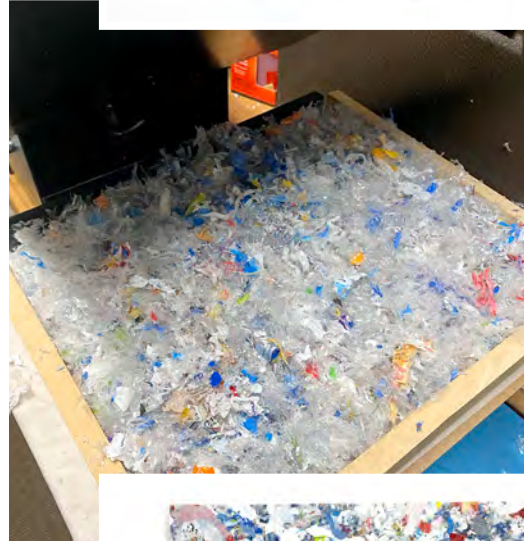
Good Coworking, Dallas



Materials & Process



Top: Shredded snack wrappers and chip bags.
Middle: Shredded materials in heat press.
Bottom: Pressed sheet after heat press process.



Top: Shredded mix of clear LDPE bags and snack wrappers
Middle: Shredded materials in heat press.
Bottom: Pressed sheet after heat press process.

Materials & Process Continued...



Top: Aluminum pot mold being made on CNC lathe.
Middle: Heated plastic pressed into mold.
Bottom: Molded pots with mold.



Top: Early wood mold for coasters.
Middle: Aluminum coaster mold.
Bottom: Finished Molded coasters.



Bingo Coasters made from upcycled snack wrappers.

B!NGO MARKETS



In our initial conversation with Steve, we talked about closing the loop - turning the waste from our business into products with benefit and longevity. We were initially really excited about this process and spent quite a bit of time thinking about what could potentially be made from the material we were providing Steve with. From the beginning, my partner and I have been searching for ways to reduce or recycle our waste and it was exciting to dream about how that could happen. Steve did a great job of tempering expectations, though, knowing that there were a lot of questions that remained about how the material would respond to the molding process.

It was really neat to see the wrapper collection bin that Steve designed. We remained excited about the possibility of genuine products coming out of this process as Steve kept us in the loop about his experimentation with the material.

Steve shared with us some of the products he was able to make with our material - so neat. We talked about the amount of material needed, and the amendments that were necessary in some cases to get the material to come together. The products he came up with can have some genuine utility for the business and will help us to tell a story about our sustainability goals as a business. With some proof of concept under our belt, we feel hopeful about the possibility of this process moving forward and potentially increasing in scale.

Collin Martin
Co-Owner | Bingo Markets

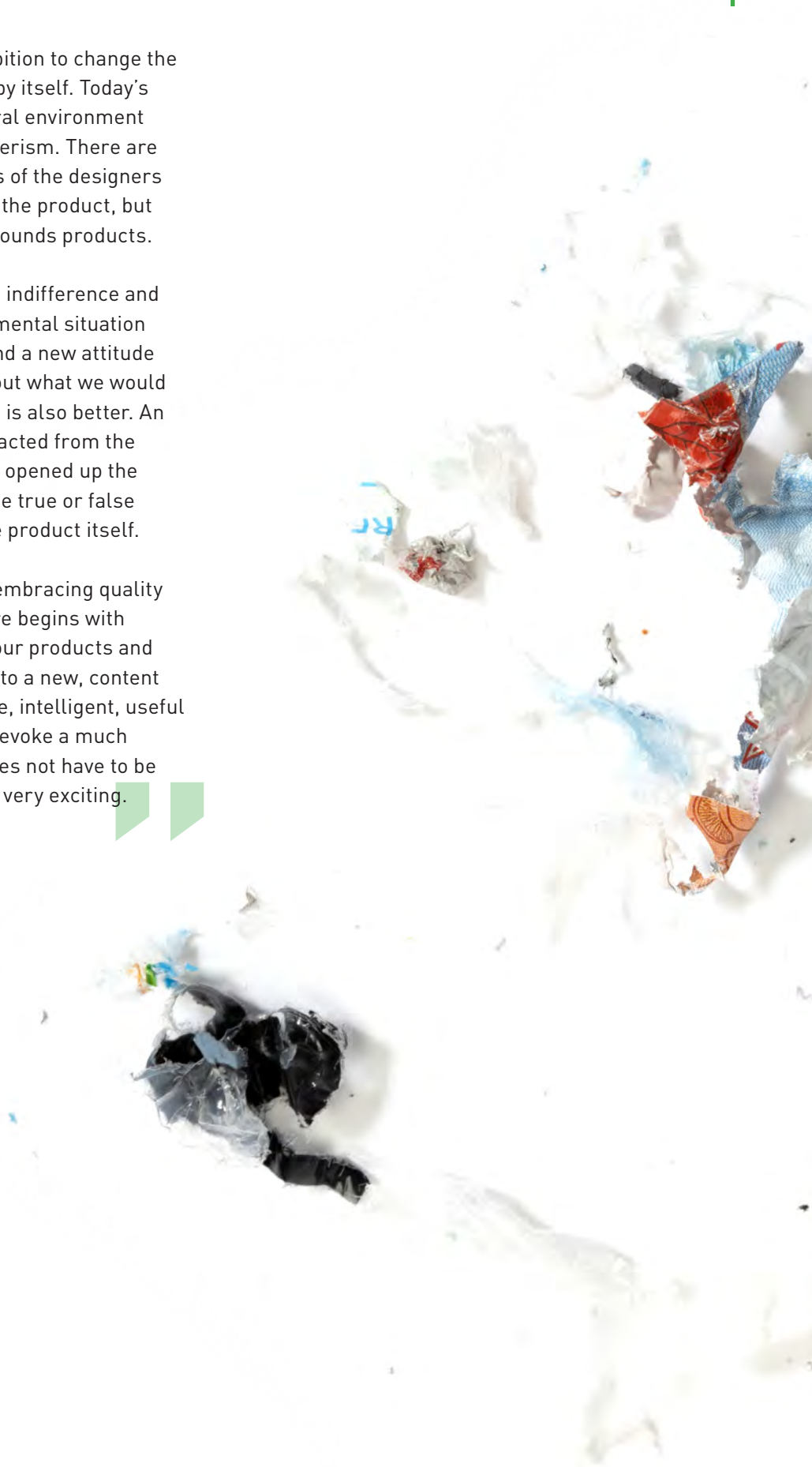



Designers should always have the ambition to change the world for the better; it cannot happen by itself. Today's big challenges are to protect our natural environment and to overcome thought-less consumerism. There are many new challenges on the shoulders of the designers of tomorrow. It is no longer only about the product, but also about the infrastructure that surrounds products.

This will require a design exempt from indifference and arbitrariness. Our precarious environmental situation and an instable global economy demand a new attitude to products. We should think twice about what we would want to produce. Less is only more if it is also better. An excessive hype about brands has distracted from the original, true qualities of products and opened up the market for cheap, fake offers where the true or false label became more important than the product itself.

Designers have to worry about an all-embracing quality of their realized ideas. Design therefore begins with consideration. A new way of handling our products and resources could be liberating, leading to a new, content way of living. Products that are durable, intelligent, useful and conscious of the environment can evoke a much deeper fulfillment. This new design does not have to be boring but quite the contrary, could be very exciting.

Dieter Rams, Tokyo Manifesto, May 2010





Design at it best is a process of making things right. That is, designers, at their best, create things and places that work. But things often do not work. And making things right is not just a generative but a corrective process, a way of righting things, of straightening them out and holding them together coherently.

Ralph Caplan, By Design





Pressed sheet and coasters made from soft plastics.

DESIGN PRINCIPLES

Throughout the research and design process, several key principles began to surface that guided the practice and framework around the subject of upcycling soft plastics. The following principles

contribute to the mindset of understanding what is valuable to be aware of when engaging to design solutions around improving the use of soft plastics.

Awareness of the Issues

Listen or read any content on the topic of recycling in America and it's easy to feel polarized around the negative issues about recycling and plastics primarily impacting our environment and getting worse. Yet we have all benefited in some way through the innovations and advancements these materials have given our society. There are many issues to understand, some driven by **economic motivation, regulatory legislation, social trends,**

misinformation, and local and city governments.

The recycling industry is aware of the slow progress to pivot to more sustainable models and is investing in technology to drive innovation. Addressing the issues with plastics recycling begins with each stakeholder having clarity around being informed on the issues and weighing the many constraints that impact the future outcomes to improve the issue.





Empathy for the Actors

There are many stakeholders when it comes to plastics recycling, it touches almost every aspect of our culture today from the products we use to the spaces we inhabit, **individual consumers, companies, state and local governments, the sanitation industry, and our environment** all play a part in how we address the long term issues with plastics. There are layers of regulations and guidelines for recycling that vary from city to state levels. Greenpeace, the environmental NGO has issued findings in their 2022 report²

highlighting the decline of recycling of plastics across the US due to the increase in production of all plastics, yet industry pod-cast interviews from multiple stakeholders in the recycling industry report a massive increase in investments for recycling efforts and enhanced capabilities that will improve with technology and government support through grants and legislation. Both viewpoints use quantitative data points, but the nature of the context may be varied in ways the data cannot synthesize for a specific region or time period.



Wood prototype
mold for note tray.

Design with Intent

My early research around single stream and recycling issues at the MRF informed me of the issues around soft plastics. My background in product design and exposure to the subject matter of plastics gave me perspective and confidence that designing with plastic materials while it's often an engineering exercise doesn't have to be. The innate characteristic for most types of soft plastics is that they have been thermoformed, which means they can be heated again, and formed into new solutions with intent through the design.

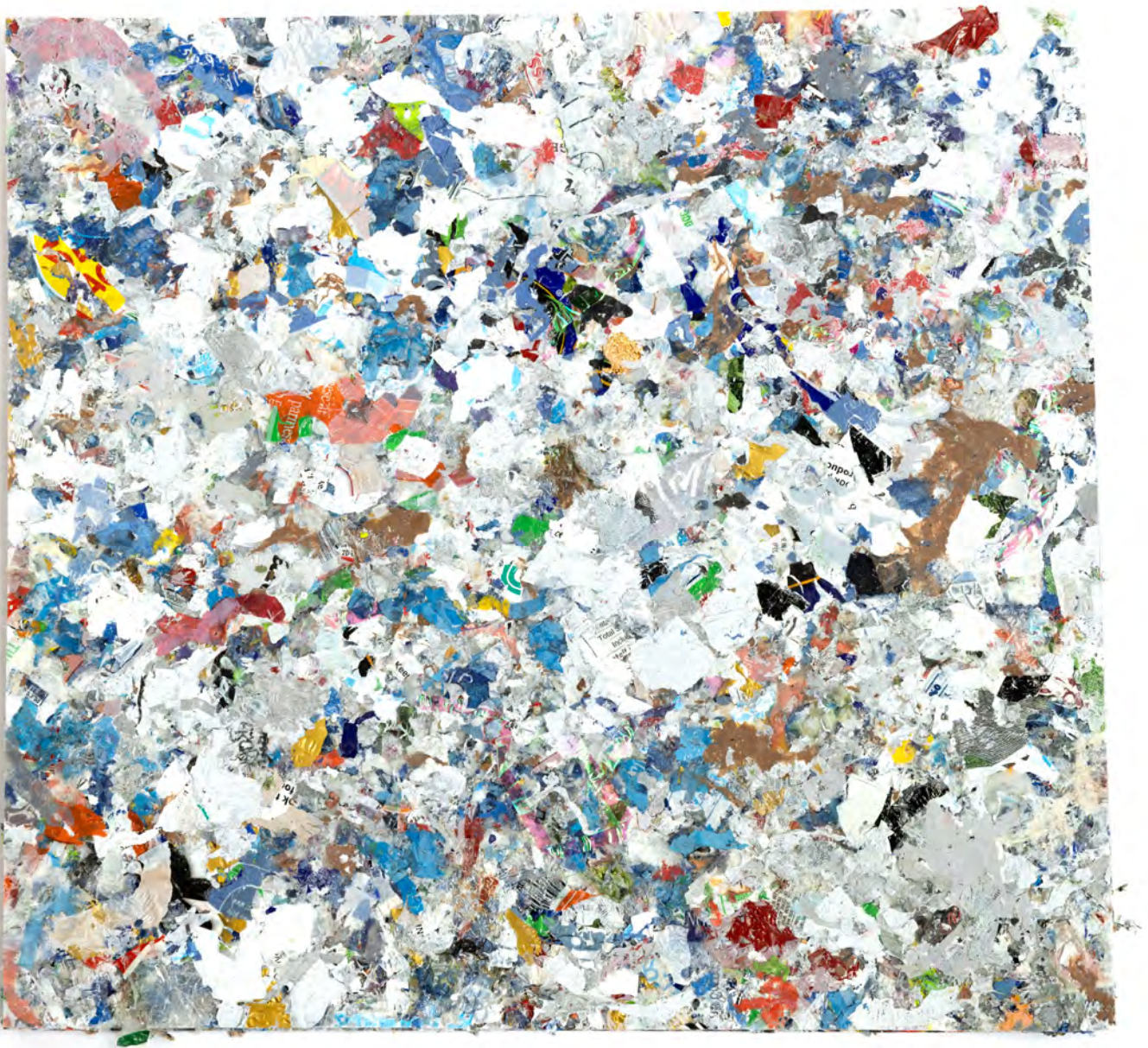
While it is true that working with re-captured plastics in a recycled context may have lost some of their integrity from their original use, making them not as viable to be recycled into the identical prior application. With Upcycling one can reframe with intent to use materials in a new application in which the physical properties and integrity

are no longer critical in an upcycled product. The new use and context can create new value opportunities for the materials in other types of products to serve the world around us. A shortfall in soft plastics being a viable source to create a circular loop solution is the lack of creativity around finding outlets for the materials to be upcycled, it's a design problem. There is an abundance of the material, but a lack of knowledge about what ways it could be used. There are Human-Centered opportunities existing within our local communities, ranging from enhancing municipal construction projects or improving parks and outdoor spaces with furniture made from upcycled soft plastics. If solutions can be researched and tested for certain industries or applications with intent for the outcome it may be easier to define value paths for the material and make soft plastics more valuable for circularity applications for long-term use.

Let the Material Shine

Recycled plastics have a story. From the first samples heat pressed to the molded succulent pots I made to the people I surveyed during my research, all of them found the aesthetic details in the material attractive and interesting on their own. Every single piece can be unique and have its visual appeal through the color or pattern of the recycled plastic

used in the item. The visual fleck persistent on the surface of the item made from recycled content also informs others and raises awareness of their content through the use of those products every day. The two major takeaways were the individual uniqueness of each piece and the visual queue that a “recycled” look promotes awareness for recycling.



Pressed Panel



RATIONALE

Soft plastics and other single-use plastics are destined for the landfill from day one, these plastics are not currently valued for their resale value to be recycled. A large component of unrecyclable plastics in EPA and Greenpeace reports is the packaging and soft plastic film category^{1,2}. Through my work I have been able to upcycle soft plastics in my community into solutions that have long term benefit to a business and their customers. Through prototyping a new strategy with a local business that creates soft plastic waste from the

food products they sell, we are able to divert the materials from the local waste stream and direct them into the manufacturing of new product ideas. The materials used in upcycling can offset the need for the manufacturing of new resins. On a larger scale, the production of new resins has a dramatic environmental impact from carbon emissions from the use of energy in refining the oil to manufacture plastics, including the extraction and the logistics costs to manufacture and transport new plastics.

STEEP

STEEP factors play a critical role in the future success of upcycling soft plastics. These factors directly impact businesses, people

and their communities in which the plastics are put back into new uses long term and can indicate future impacts on a larger scale.

Social

Consumer's desire to use products made from recycled content and recycling has been undermet by a waste industry that can't easily break decades-old habits when it comes to recycling. Plastic consumption is at an all-time high because of the ease of use and manufacture of soft plastics, yet the recycling industry struggles to identify and sort these plastics and has to landfill soft plastics because there is no economic value from them. Upcycling soft plastics presents an alternative to recycling that businesses can implement locally and the social benefits will create greater awareness, improve the waste stream and help identify opportunities in our communities for the use of materials.



Activist in London



Republic Services MRF Plano

Technological

Advancements in technology assist recyclers and consumers to help with the identification and sorting of plastics through the use of sensors and artificial intelligence technology, more investments in technology will increase the collection of these materials. Technology can also be pivotal in the ability to help consumer's process and better understand how to reuse and properly recycle everyday plastics through the creation of digital platforms and tools to support recycling. The recycling industry believes that technological innovations will lead to efficiencies and may have a dramatic impact on costs to the systems in the future, by making it easier to identify, sort and resell soft plastics.

Environmental

Globally, greenhouse gas emissions of carbon dioxide from the manufacturing of plastics, and the decomposition and incineration of discarded plastics in landfills will continue to contribute to global warming and are projected to quadruple by 2060. Soft plastics used by the retail and food industries are raising concerns in Europe and regulators are considering taxes on manufacturers

who continue to use these materials in the future. The USEPA continues to measure the generation, recycling, composting, combustion with energy recovery, and landfilling of plastic materials in municipal solid waste. Upcycling soft plastics can have a positive impact by diverting waste from the waste stream and improving the emissions of greenhouse gasses from landfills.



Soft Plastic Contamination at MRF facility

Economical

The recycling industry desires to invest in ways to increase the economic viability of plastics in the face of a non-existent resale market for soft plastics and films. The pandemic's impact on manufacturing increased the costs dramatically for the creation of new materials from raw natural resources making recycling an increasingly viable alternative. Consumer behavior for proper recycling continues to grow slowly, while the

costs of films and other soft plastic materials continue to decrease from efficiencies gained in production volume and ease of manufacture.

Businesses are listening to their customers and shareholders who want ESG (environmental, social, and governance) issues addressed and surfaced in the face of inequalities and the preference for profits over the planet.

2019



awareness around the issues and alternatives to reduce plastic waste going to landfills. Policymakers are listening to the environmental issue and balancing the economic concerns that businesses typically have over widespread regulation and the availability of stringent recycling guidelines that promote better circularity of waste.



Upcycled molded plant pot.

FUTURE WORK

The prospect for future work on the feasibility of soft plastics as a viable materials source is an opportunity I plan to continue to pursue on several fronts. As more visibility on the topic of soft plastics and their environmental impact continues to grow, this topic will continue to be important and align to my research on the use of soft plastics in applications like 3D printing, product development, furniture design and building materials. While the elimination of this type of plastics is certainly a possibility in some parts of the world, the mass adoption of these materials in the packaging and food industries indicates further continued growth and use of these plastics types due to their ease of use, manufacture, and raw cost.

Based on my exposure to the precious plastics community and interviews with experts in the field of materials and recycling, my future work on the topic of upcycling may continue on several paths. My prior background in business and product design, give me a foundation of relevant experience to act in a consulting capacity to potentially guide and assist an organization on their journey to explore soft plastics as a viable material to utilize in their business, or better build a future framework for how an organization may evolve when thinking about a circular model to integrate into their business.

Another opportunity of interest for future work would be to explore the use of soft plastics in several industries where the circular nature can bring value through product-specific solutions that need to be developed and designed to work within an industry. The applied research portion of my research blended my product design background with the materials and processes to manipulate the materials into usable formats that could be utilized in construction materials, outdoor products, or furniture manufacturing.

In my interview with Purva Chawla, Founder of Materials Driven, I was encouraged to learn that my efforts to explore the LDPE (low-density polyethylene) as a material are very relevant and that the material is abundant and it is one of the most challenging of materials to still recycle and find outlets for to upcycle into new products or materials. More common materials like PET and HDPE, which are more popular to recycle have been popular in the development of new materials and she sees the potential of LDPE as a larger source of the need for new materials development opportunities.



**MATERIAL
DRIVEN**



Expert Interview 11/18/22

Purva Chawla, Co-Founder, Material Driven

What is Material Driven?

We are a Materials consultancy firm, working in architecture, hospitality, consumer goods, packaging and research institutions. We also source with new materials makers and work to make connections and market makers to get their materials to opportunities. We're a Headhunter for materials and solutions.

How do you help your clients or support projects?

Help with improving a space or products they want to improve the goal of sustainability and recycling, we research the materials to meet their criteria. We also help makers who don't have a lot of resources get their materials out there at fairs and exhibits.

On the topic of plastics, what trends are you seeing with plastics being used in new ways?

Seeing more information and clarification around the disclosure of blended Recycled and Virgin plastics, seeing the actual percentage of recycled plastics being displayed on packaging or products. The continued development of bio plastics, lots of new ways to recapture and ways to use recycling technologies with bio plastics.

Do you see more opportunity or demand for the use of reclaimed/recycled/up-cycled plastics?

Yes there is absolutely demand for it in new formats. We're seeing fusions and hybrids to reach forms that are meeting people where their hang-ups and limitations have been before.

How might the LDPE material be beneficial as a source from your experience?

There is so much of it being used, but there hasn't been much of it being recycled or re-used in materials, it's a difficult type to work with, but it's also it's very resilient when modified and can become very robust. The challenge is on the collection side there is no streamlined approach to collection of LDPE.

Could be interesting to better understand what happens when is recycled over and over again.

Are there certain types of products where Soft Plastics/LDPE may be valuable for use?

Outdoor products, furniture, exterior tiles, roofing, consumer goods

I think there is a need for a "dual life" for a product, a sort of a Lego type solution that can be used to construct forms useful to the a community. I like the recent fork from Smile Plastics, Forust, Pretty Plastic in Netherlands, Sustoneable and Ecobirdy furniture.

Are there other waste streams that could blend with this?

There is lots of opportunity to combine a second waste stream into the material because of its properties to bind well with heat. I think there could be an organic waste option that might be explored.

Expert Interview 8/23/22

Team Upcycled

What is Upcycled?

Upcycled Inc. is a waste diversion organization established as a 501(c)3 corporation. We are a verified workspace of the Precious Plastic community Upcycled takes discarded plastics and upcycles them into long-term use products. We create products that can be used to reach our mission of giving plastic a long-term purpose and creating a more environmentally conscious community.

How your entity came to form and identify the niche or need your serving, why did you gravitate to that need Vs others or a more “profit” driven model?

It was a question of impact and scalability. We wanted to make the largest impact that we could; and felt building materials were something that used large amounts of plastic, would serve one function for a life-span, and could build almost anything you could think of. Because our vision was so large, scalability was a concern. We would not have been able to raise funding or succeed in the market as a for-profit. With a non-profit there were more opportunities to grow the idea and impact our community.

Does your team have other professions and support the cause part time or does the non-profit have employees? As you scale how do you think about people?

3 part-time, 11 board members, 50 or so volunteers. People are part of our team. That is what is great about the non-profit; there is no actual ownership so members of the organization are the team.

What local relationships have been big supporters of your initiative and how did you come to make those contacts and relationships?

I do not think the specific organizations interest you, and you are looking for a more general group. If that is the case; local government, other non-profit organizations. There is no straightforward answer on how we built these relationships. Our non-profit partners were built from general interest in the other's work. Local government was pure effort and reaching out. You need to network and meet your community.

Have you needed to fundraise or get donations to operate and get equipment and space to process and fabricate the materials your recycling?

Primarily grants, but yes also fundraisers and donations.

What is the grand vision of what your trying to become or make happen in your community?

Our mission is to put an end to single use plastics.





Upcycled pen blanks and pen. Made by Steven Kinder.



Upcycled portable
charger from GOMI.
www.gomi.design



Early heat pressed coasters. Made by Steven Kinder.



CONCLUSION

With the research question, “How might we upcycle soft plastics to meet a need?”, my early research guided me to understand how materials can be diverted from landfills and led me to the issues around soft plastics recycling and how they contaminate MRFs.

My research aimed to better understand ways in which those materials can be upcycled into solutions that can divert the materials from the waste stream entirely and transform them into solutions that can serve a long-term need, through the process of discovery, defining, and designing the solution with a business case in mind for how we can improve the current reuse or recycling models.

Through applying a Human-Centered Design approach to upcycling soft plastics, I was able to demonstrate how a business like Bingo Markets can create a circular model to upcycle the waste materials they create into valuable solutions to provide value to their customers. This circular approach serves as a solution not only on a large scale but also distills down to individuals and business stakeholders to help close the loop on the disposal of those items into the waste stream by designing better outcomes. I’ve learned that when soft plastics are upcycled into new forms and used in the local community, they create value for businesses and their customers. The results from my work will provide a foundation for my future work with upcycled materials in the design and manufacturing with the materials.

Prototype Upcycled Desk
Accessories made from Soft Plastics,
Designed by Steve Kinder





Steven Kinder

Steven Kinder is a Graduate student in the Masters of Arts in Design and Innovation program at Southern Methodist University. He received his Bachelor in Fine Arts in Industrial Design from The Rhode Island School of Design. As an industrial designer, Steven has led design programs for furniture and products in the contract furniture, real estate, aviation, and consumer product industries. He founded Loftwall, an award winning

manufacturer of design centric workplace privacy solutions and room dividers. He co-founded Good Coworking, a future focused coworking space that blends sustainability, wellness and social impact. His interest in the topic of plastics recycling and reuse evolved from his own experience as a product designer seeing lack of awareness around plastic waste and the use of recycled plastics by designers.



APPENDIX



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