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Plastic Oceans: A New Way in solving Our Plastic Pollution

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Plastic Oceans: A New Way in solving Our Plastic Pollution

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Abstract

By 2050, the world's oceans will have more plastic than fish with potentially catastrophic consequences on sea life and the health of the ocean. Economically, countries with coastal boundaries will be heavily impacted as plastic pollution has already generated a 13 billion dollars in monetary losses. Considering that this is an extreme problem that we are currently facing the current solution is not enough in curbing our plastic pollution. While, recycling programs have been beneficial in reclaiming some plastic our mass consumption of plastic has outpaced the capabilities of recycling efforts. If we are to find a solution in our plastic pollution problem, we must first start at the source of plastic pollution; consumers. One organization in Oahu is doing exactly that, Sustainable Coastlines Hawaii for the past five years has worked within the island chain of Hawaii to educate the public through community based clean-ups and their traveling education station in order to change consumer habits away from plastic and to a more sustainable form of consumerism. The solution that Sustainable Coastlines Hawaii is trying to implement is daunting, as this paper will explore the history of plastic to understand how a product that is dangerous to the environment has become such a staple part of our society. The paper will also utilize Ulrich Beck's "Risk Society" to explain why recycling programs were first seen as a solution to our plastic waste as well as to why we are returning back to the conversation of plastic pollution. Finally this paper explores the dangers plastic pollution has had on the oceans to explain why a model such as Sustainable Coastlines Hawaii is needed in solving our ocean plastic pollution.

Acronyms and Key Words

- Parkesine: the first type of plastic created from Chloroform and Castor Oil
- Bakelite: The first synthetic plastic made from Phenol and Formaldehyde
- Risk Society: A systematic way of dealing with hazards and insecurities induced and introduced by modernization itself.
- HI-5: Hawaii's Deposit Beverage Program to encourage recycling the State has offered a buy back system of 5 cents for every beverage container returned.
- SCH: Sustainable Coastlines Hawaii
- ICRS: International Coral Reef Symposium
- Plastiglomerate: a new rock that is made out of sand, ocean sediment and melted plastic.
- Gyre: formed by surface currents, Gyre systems circulate surface water. There are 5 of them around the world
- Micro Plastic: micro plastic are tiny plastic fragments that are created by photodegradation
- Photodegradation: Similar to biodegradation this process utilizes the Suns UV rays to break down materials but never fully destroying them.

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Introduction

Our stories of the ocean have carried a sense of wonder as tales of giant monsters', mermaids, and pirates have filled our hearts with fear and wonder. These stories are inspired by humanities venture out into the world as the ocean has been our gateway abroad. As we ventured out into this world men women and children sailed the oceans looking for new homes and new adventures. For centuries, Humans have utilized the oceans for food, travel, culture and even leisure, however, while we have continued to use the oceans to our own benefits, humans have created dangers for the ocean. The ocean suffers from from climate change in the form of rising sea level and temperatures and while humans debate if we are the direct link to these issues one issue that is not debatable is the amount of plastic in our oceans. Every year, 8 million tons of plastic from all around the world flows into the ocean every year creating devastating effects to the health of the ocean and sea life. While plastic pollution was first found in the ocean in the 1970's it is now becoming such a problem that it will outnumber fish by 2050. In less than a hundred years, our global plastic consumption will wreak havoc on our oceans potentially destroying one of the largest factors in humanities creation and survival. Thus, now is the time to respond to our plastic pollution problem by creating new solutions that will curb its consumption. One organization, Sustainable Coastlines Hawaii on the island of Oahu has for the past five years worked to achieve this solution. However, with plastic pollution encompassing the globe can a local model as presented by Sustainable Coastlines Hawaii be implemented to solve this problem?

In order to answer this question, this paper will be broken into three parts. The first chapter will unpack the history of plastic from its invention in the 1860's till today. In this chapter, we will unpack how plastic has played an extremely important role throughout history and how its innovations have led to the creation of some of the today's technology. This chapter will also look

at the cultural impact that plastic has made as the perception of plastic in society has consistently evolved as plastic has become more integrated into society. While plastic has become more integrated into society its risk became more apparent as environmentalist began to argue for a change in the 1970's. Theoretically, the reason why the conversation of risk began to happen will be explained by Ulrich Beck's work *Risk Society.* This will also help explain why environmentalist at the time advocated that recycling programs in America and around the World would be essential in curbing plastic pollution from damaging the environment. However, while these recycling programs have been implemented around the world plastic pollution still continues to rise exponentially every year. across the world.

Chapter 2, will explore the case study of Hawaii and the work of Sustainable Coastlines Hawaii. While Hawaii is apart of the United States it suffers from both local and international plastic pollution. This makes the island state important in discussing how to solve plastic pollution on a global scale and this is where the work of Sustainable Coastlines Hawaii is the most important. This part of the paper will also cover the time that I spent working with the organization and will cover the time that was spent working as well as the experiences of this trip. Transitioning away from a solution Chapter 3 will take a look at our current system of recycling and what makes the system so flawed. This chapter will take a look at recycling from two separate perspectives in order to analyze recycling programs. The first section will take a look at the actual process of recycling from the moment it leaves the curb to the end stages of a recycling plant. By unpacking the entire process, we can understand how recycling programs have difficulty recycling plastic as not everything that we consume can be recycled in the first place. The second section will explain the economics of recycling, as often times these programs are constrained by the lack of funds and in recent years have begun to shut down.

Chapter 4, will take a look at the current problems of plastic pollution by looking into the scientific literature currently available. In this chapter, the amount of plastic flowing into the ocean each year will be discussed alongside the dangers that this presents. This includes the consumption of plastic and microplastic in sea life and the consequences they suffer from our plastic waste. Plastic accumulation in Gyre systems around the world creating large areas in the ocean that are covered in plastic will also be discussed to help contextualize the global problem of plastic pollution. Further, the impacts on humans will also be discussed as the dangers of plastic pollution have consequences on economies as plastic damages coastlines and endangers sea life numbers all. The importance of this chapter is showcase the dangers of our current system and how a flawed system of recycling and our over consumption of plastic pollution has led to oceans littered with plastic. Finally, this paper will reiterate the importance of the work Sustainable Coastlines does in order to change our consumer culture.

Chapter 1: The Birth of Plastic

In Today's society, we have become accustomed to having plastic all around us. From forks, straws, and bottles, to our credit cards and cell phones, plastic has become an essential item in our everyday lives. Plastic has become so enriched in or consumer habits that we often disregard the consequences that plastic has on our environment. We know that plastic is essentially immortal and is dangerous for the environment. However, we have disregarded these issues as we have a disillusioned necessity for plastic. As a result, the commodification of plastic has led to an overindulgence within our consumption habits. Plastic is a relatively new invention that has revolutionized the world and impacted human history, however, the commodification of plastic has only been very recent but its impacts have been dangerous. In fact, by delving into the history of plastic we can unpack how plastic has aided scientific discovery, War, and how it has become one of the largest commodified items in history.

During the 1800's throughout North America and Europe ivory had become heavily in demand with manufacturers using ivory for just about everything. Throughout Europe ivory was being used for ornaments, buttons and crucifixes while in America ivory imports were used for piano keys, billiard balls and the handles for six shooters (Beachey, 1967). As a result, the ivory industry went through a huge boom in exports during the first half of the century, "range as low as 40,000 lb a year to as high as 200,000" (Beachey, 1967:28). During the rest of the century, the demand for ivory increased even further as:

> [During} 1859, 488,600 lbs. of ivory worth 146,666 were exported…Although there was a rise in the price of ivory at the time of the Franco-Prussian War from 39 to 68 [pounds] per cwt., ivory exports remained around 400,000 lb., despite the price rise, and continued at this level almost to the end of the century, except for a poor year in 1885, when they dropped to 260,000 lb. In 1890-91 they rose to 950,000 lb., the result of an accumulation of ivory in the interior during the blockade

> of the German East African coast in the previous year. By 1894 the figure of exports was back to 412,920 Ib., and it remained around this mark until the late 1890s, when the effect of game laws and a closer administrative control began to be felt. In 1899 the figure was down to just over 100,000 Ib.; it rose a little at the turn of the century, and then thenceforth continued around the figure of 150,000 Ib. (Beachy, 1967:287).

Ivory imports into Europe and America were high during the 1800's and as a result, the price of ivory was also high further Elephants which were ivory comes from was a finite source. This caused manufacturers to desire a material that was cheaper and more sustainable than ivory that could be used for everything and anything that someone could think of. However, nothing outside of nature was capable of replacing ivory at this time until Alexander Parkes created the first natural plastic.

Revealed at the 1862 Great International Exhibition in London, Parkesine, was the first take on modern plastic and was made from a mixture of chloroform and castor oil (Feinchell 1996). Parkesine was advertised, " In the case are shown a few illustrations… for which Parkesine may be applied, such as medallion, salvers, hollow ware, tubes, buttons… it can be made hard as ivory, transparent or opaque, of any degree of flexibility, and is waterproof. (Feinchell, 1996:17-18). From the description provided Parkesine was advertised to be the plastic replacement for anything you could imagine and cheaper as Parkes claimed the "material can be supplied in any quantity at a cost much below that of India rubber or Gutta Percha"(Feinchell 35). With the claim that Parkesine was better and cheaper than natural resources, manufacturers were attracted. However, Parkes had to deliver on this claim that he could create such a product in mass quantity and this was difficult than imagined.

In order to achieve the claim of being cheaper than rubber or latex, Parkes was forced to use cheaper quality resources. In fact, "Rather than systematically control his processes to ensure

uniformity of product, he constantly and frantically varied them to meet demand, turning out items of uneven finish" (Feinchell, 35). Parkes made the costly error of calling his product cheaper than the rest, as a result the pressure to deliver in bulk was too much causing parkesine to fail.

While Alexander Parkes failed in his endeavors to create a cheap alternative source to ivory, rubber, and latex this would not be the end of plastic. If anything Parkes lit the beginning of plastic by establishing the precedent for other chemist and inventors to create a far better product. With manufacturers still searching for an alternative to natural resources, the pressure was on for anyone to create a solution. Even one prominent billiards supplier, Michael Phelan, suffering from the popularity of billiards and the high cost of billiard balls made an offer of 10,000 dollars to the first person that could create a billiard ball that was cheap but kept the same quality as ivory (Feinchell, 1996). 10,000 dollars in the late 1800's was a lot of money to entice inventors and chemist to create their best creation, but, it was Joh Wesley Hyatt, a printer that would attempt at creating the first billiard balls out of celluloid plastic. Hyatt's billiard balls were the "combination of linen cloth with shellac and ivory dust processed under great pressure and high heat" (Feinchell, 1996:40). However, these new billiard balls did not have the same famous clicking sound when they made contact which Hyatt believed the solution would be to coat the ball in celluloid, however, "A lighted cigar, if applied to the ball, would at once result in a serious flame, even more alarmingly, any violent contact between the balls [would] invariably set off a mild explosion, like a percussion gun cap" (Feinchell 1996:41). With the risk of exploding billiards Hyatt failed in creating an effective replacement losing out on the 10,000 dollars in reward money, however, Hyatt discovered practical uses for celluloid as the next possible plastic to replace natural resources.

Though exploding billiard balls was not a selling point of celluloid plastic Hyatt was able to create the first thermoplastic. Thermoplastic is a mass that can be molded into shape by heat and pressure and retains the shape even when cooled, further, the plastic can be reheated and molded again creating endless possibilities for the material (Feinchell,1996). With billiards, a failed adventure, Hyatt attempted at innovating dentures, however, "Dental plates were a very poor choice because they tasted of camphor…Some dental plates softened, warped, or flaked. They were not nearly as good as dental plates made with hard rubber and never seriously competed with them for the market" (Lokensgard, 2008:6). Hyatt now had failed at replacing both ivory and rubber with his celluloid product, however, celluloid held the capabilities of replacing the horn. Celluloid became heavily used in combs and mirrors which were often made by horn, due to its imitation capabilities between 1890 and 1910 celluloid had almost replaced horn products (Lokensgard, 2008). Even better celluloid was able to be used as film for cameras which no other natural resource was capable of doing with a booming market in cinema and photography this proved beneficial for celluloid. However, while celluloid was becoming a popular resource it still retained the flammable properties as Hyatt's billiard balls.

While celluloid was becoming a popular resource, fires caused by celluloid were becoming common. The Celluloid film that made Hollywood possible was also highly flammable as, "when films jammed in the projector, the intense heat caused the ignition of film, Hundreds of people lost their lives in disastrous theater fires." (Lokensgard, 2008:7). Further one of Hyatt's manufacturing plants suffered from a fire known as the Ferry Street Fire. The fire which occurred on September 8. 1875 ripped through the building destroying the plant and stock in less than 2 hours (Feinchell, 1996). These incidents that went all across the United States increased, creating fears that celluloid products were too dangerous due to their highly flammable characteristic. However, there was no

other alternative to the qualities that celluloid had to offer, as a result, manufacturers continued to pump out celluloid products despite its flammability. By the end of the 1800's manufacturers were making due with celluloid, however, Scientist were working on improving plastic and a synthetic solution was around the corner.

At the turn of the century, inventors were still searching for the perfect product that could replace natural resources. With Parkesine an already failed project, and, celluloid far too explosive and dangerous for any manufacturer, there were hardly any more opportunities for plastic to succeed. Chemist at this point was working with Phenol and Formaldehyde in order to come up with a new synthetic plastic ,however, these experiments tended to fail due to chemist keeping the mixture relatively cool (Feinchell 1996). By 1907 scientist still struggled to create a synthetic plastic until Leo Baekeland, Chemist, and inventor, "had an Epiphany: Rather than trying to lower the violent buildup of gasses by slowing the reaction down, why not speed it up...Baekeland turned the heat up to well over 200 degrees centigrade and instead controlled the volatile reaction by increasing the pressure inside the vessel (Feinchell, 1996:89). By controlling the reaction of phenol and formaldehyde Baekeland was able to create a hard plastic that was able to be reheated, withstand electricity and be molded into anything that you could possibly imagine. Baekeland had finally achieved what years of scientific discovery were searching for, a product that was capable of retaining the quality of ivory without the explosiveness of celluloid. Called Bakelite after its inventor, the first synthetic plastic was set to take the world through a new age of innovation. However, before Bakelite could become a household item it would take over industries and be set off to war.

From Insulation to the War Effort

In 1909, two years after Bakelite's invention, Leo Baekeland announced his invention to the public. As soon as Bakelite was unveiled word spread quickly that, "Anything nature can do, Leo could do better. Rather than simply improving the surface of the material. Baekeland could chemically improve its inner self."(Feinchell, 1996:91). The quality of Bakelite quickly became noticeable as an electric insulator as,

It was more electrically resistant than porcelain or mica; more chemically stable than rubber; more heat resistant than shellac; less liable to shatter than glass or ceramic; it would neither crack, fade, crease, was impervious to ozone, contained no sulfur, could not be weakened by hydrochloric acid nor blemished by alcohol. (Feinchell, 1996:91).

With these properties, Bakelite quickly gained a reputation for quality like no other product on the market thus gaining recognition from manufacturers. It was even capable of replacing the elusive quality of the ivory billiard ball as Hyatt, "In 1912 personally ordered his Albany Billiard Ball Company to stop using celluloid and to substitute Bakelite as its molding material." (Feinchell, 1996:91). Bakelite was slowly becoming a resource giant as its qualities were become more recognized by manufacturers. This recognition even caught the attention of the United States Government during World War One.

During the first Great War, the world clashed together while human innovation explored the newest technology. Military units around the world released the latest innovation in weaponry, tanks, and airplanes to try and gain an advantage over the enemy. With Bakelite being the latest invention it too was incorporated in the battlefield in every element. By 1911 Leo Baekeland had issued international patents to Germany, France, and England (Mumford, 1924). However, at the start of the war, the advantage of Bakelite products was on the side of Germany as English Bakelite factories were run by German Chemist and were closed at the start of the war. Due to this perplex

situation, England relied upon American Bakelite productivity in order to even the advantage that Germany had (Mumford, 1924). With Bakelite in serious demand its creator, Leo Baekeland, was appointed as a member of the U.S Naval Consulting Board and was in charge of the manufacturing effort for the war (Mumford, 1924). However, the ingredients for Bakelite, Phenol, and Formaldehyde, were in extreme demand for fuel and explosives limiting the quantity of Bakelite products. Nonetheless, Baekeland was able to use meta-cresol and para-cresol as replacement ingredients (Mumford, 1924). By working for the war effort many notable innovations and technology implemented Bakelite in some aspect in order to create a military advantage.

One of the most notable uses for Bakelite prior to the war was electrical insulation, this would work perfectly during the war as wireless telephones (or radios as they were called after the war) required Bakelite for its capabilities to withstand heat and electricity. The use of Bakelite in radios was based on, "the need of dependable insulation… [For] clarity and sustained strength of transmitted sounds were to be secured" even after the war, "The Army, Navy, and Signal Corps having tested it out in war, still adhere to Bakelite equipment and in the product of the best makers, it is everywhere. Everything in radio apparatus… is made of Bakelite in one form or another (Mumford, 1924:76). The use of Bakelite in radio was heavily important during the war effort as communicating orders to soldiers on the field literally meant life or death by having a secure connection that could transmit sound through Bakelite insulation proved key in the war effort. Even after the war, the effects of radio continued as the technology was transmitted to civilian use and swept across the United States and the world after the war.

While Bakelite was used for radio insulation, it was also used to manufacture engines. With the United States entry into the war, "The Delco Company delivered to the builders of the Liberty Motor 25,000 sets of ignition equipment… In all of these products, Bakelite played a vital part [as]

the intricate molding which was demanded in the complex duplicate system called for the most perfect and dependable insulation that could be devised, and Bakelite was selected to provide it"(Mumford, 1924:74). The ignition systems that were created using Bakelite were implemented in French battleplanes, "and was made a standard for the Lorraine-Dietrich twelve-cylinder engine…[which] were among the most perfect examples of Bakelite molding that have ever been produced" (Mumford, 1924:74). While Bakelite helped create engines for the French battleplanes that proved effective in design, it was also implemented to solve another problem that battleplanes suffered throughout the war, the wooden propeller.

During the First World War, the battleplane took the design of the Wright Brothers airplane and attached a machine gun to the end of it. Other than the engine most of the plane had little metal or armor and was mostly made out of wood and fabric, including the propeller. This proved dangerous for pilots as the wood propeller often broke due to enemy firing and inclement weather. Set to solve this issue Bakelite plastic was molded into the shape of airplane propeller and mounted onto a plane. In order to ensure its quality, the plastic propeller was tested in controlled environments that a plane would often see on the battlefield. These test took everything in consideration as Bakelite propellers were,

Spun… with a 1,750 horsepower motor, up to 2,500 revolutions per minute… Then there was the sandstorm test. They set the propeller running in a tunnel and… blew sharp sand through the passage at high velocity. It left no damaging trace on the surface of the Bakelite. The wooden propeller it tore to pieces…Planes were apt to get shot. The problem was to make a propeller that would keep going afterward…they fired twenty-seven shots from a machine gun into it, then harnessed it to the power and again sped it 2,500 revolutions. It spun without murmur or deviation. If it had been wood it would have shattered. (Mumford, 1924:78).Proving itself in radio

communications it once again proved itself in the battlefield as planes retrofitted with Bakelite propellers were saved by durability, unlike their wooden counterparts that crumbled and shattered once struck with bullets. By the end of the war Bakelite plastic had proven itself in the battlefield aiding soldiers in and out of battle and now it was time to bring that technology to the civilian consumer.

By 1920 Bakelite had proven to be a reliable plastic that no prior invention could achieve. It was already becoming an established product for electrical wiring, and pool halls as well as the war effort. However, despite its initial success much of the public had no desire for plastic. While scientist pushed for decades to create a substitute product to natural resources that's all the public saw, just another product. The lack of public curiosity for plastic created the necessity for Bakelite to be marketed with allure and intrigue in order for the product to be a success. Luckily the Roaring 20's and a slogan would push Bakelite into the consumer market.

From the Battlefield to the Home

By the end of World War 1, Bakelite had proven its worth by aiding the war effort, back in the states, however, Bakelite had yet to take off as a commercial item. With the war over it was time to transition to civilian products. One of the first items to make its way to the battlefield to the home was the Bakelite propeller. The same design that was used for battle planes would be perfect for the washing machine a product that was becoming in huge demand (Feinchell, 1996). Further, Bakelite would become the signature look of the 1920's as it had the allure of sophistication and swank as synthetic plastic was used in cruise ships (Feinchell, 1996). No longer was plastic seen as a substitution to the old it was now the new product that embodied scientific discovery and style.

Leo Baekeland the father of synthetic plastic further illustrated the tone of Bakelite with the slogan “A Material of a Thousand Uses” (Fenichell, 1996:97). Behind the slogan was years of scientific discovery mixed with the future of plastic. Time magazine further highlighted the marvel of plastic in its magazine as it advertised, “It is used in pipe stems, fountain pens, billiard balls, telephone fixtures, castanets, radiator caps. In liquid form, it is a varnish. Jellied, it is glue. Those familiar with its possibilities claim that in a few years it will be embodied in every mechanical facility of modern civilization” (Feinchell, 1996: 97). These new advertisements highlighted that Bakelite was not a product of substitution but a product of the future. With Bakelite you can smoke from your pipe, brush your teeth, and even comb your hair these products of the mundane everyday life vaulted Bakelite into the home and Bakelite and the plastic industry exploded as in 1914 plastic was a 14-million-dollar industry and by the end of 1928 to a 219-million-dollar industry (TIME, 1930:82). Plastic had finally found its way into the home and by the end of the 1920’s Bakelite was a household name, however, with a patent set to expire in 1927 chemist and inventors were set to explore all of the possibilities a synthetic product had to offer.

With the success of Bakelite becoming a household name other inventors and chemist were searching for a product that would allow them to enter this booming market. This led to several industries exploring new ideas to protect their product or to incorporate plastic into their product. One of the first industries to incorporate plastic into their product was the cigarette industry, a booming industry that pitted companies against each other to offer the best cigarette on the market. One of the largest companies during that time, Lucky Strike, offered a “toasted” cigarette that set the company as number one on the market. As a result, companies such as Camels had to innovate in order to compete. This led to the incorporation of cellophane a clear plastic wrap that promised fresh inviting products.

While Lucky Strike cigarettes may have been toasted, Camel was offering their cigarette as “fresh” wrapped in a new cellophane-package. In order to do this Camel relied on Du Pont whom, “After buying the rights to cellophane…spent the next seven years and as many millions of dollars trying to make cellophane moisture proof instead of just waterproof” (Feinchell, 1996:107). With success, Du Pont was able to create a pack of cigarettes wrapped in cellophane that was capable of keeping moisture out and cigarettes fresh. By creating a seal that kept products fresh and moisture out, Cellophane would begin to be used for a lot more than just cigarettes.

By 1930, Cellophane was the latest trend in plastic not only was it protecting Camel cigarettes freshness but it was now heading to the grocery store. Soon grocery products would be wrapped in cellophane ensuring the product underneath was fresh and safe. With cellophane manufacturers and grocery stores saw a huge boom, “One major manufacturer of canned foods was shocked to discover that if he wrapped a cluster of cans in a cellophane package sales soared...A national grocery store chain reported a 2,100 percent increase in doughnut sales in two weeks after wrapping its doughnuts in cellophane... Packing pies in paper cases with cellophane sunsets caused pie purchases to triple in six months” (Feinchell, 1996:112). The growth of cellophane was caused by customer perception as, “Cellophane projects an atmosphere of hygiene…A new generation of consumers in America was becoming acutely germ conscious. Obsessed with catching cooties Cellophane struck a chord with the new sanitary sensibility” (Feinchell, 1996:113). Plastic offered what others could not, transparent, and impenetrable by air and moisture, Cellophane was the solution to a generation that sought after cleanliness.

With cleanliness in mind advertisers would target this mindset as one advertisement read, “Like two thieves in the night, Dampness and Dryness silently rob many products…Moisture Cellophane stands guard over foods, day and night” and another read, “Dust, dirt and the germs

on inquisitive hands are kept out by Cellophane. It keeps out foreign odors too" (Feinchell, 1996:114). These ads achieved their goal as eventually everything came wrapped in this transparent plastic and by 1940's plastic wrap filled grocery store markets. Cellophane wrapped so many products that Fortune joked, "The original documents of the Constitution and the Declaration of Independence…violin strings, plated silver… baby carriages, golf balls, pickles, clocks and a deluxe edition of the New York Herald Tribune." (Feinchell, 1996:115). While Fortune joked that everything was wrapped in Cellophane, it wasn't wrong, just about anything would end up wrapped in plastic. With the success of Bakelite and Cellophane, it seemed as if the world of plastic was larger than ever expected but war was returning and plastic was once again called to duty.

Back to War

With the Bakelite patent expiring in the late 1920's other chemist and inventors were able to explore the capabilities of synthetic plastic. and much like Bakelite many of these synthetic plastics would be tested in combat as World War 2 raged across Europe and the South Pacific. Prior to the United States entry into the war, Germany was conquering all of Europe and was knocking on the doorsteps of the United Kingdom whom still remained a threat to the German war machine. In an attempt to defeat the United Kingdom, Germany began its blitzkrieg bombardment of the island. Every single day and night the German Luftwaffe bombarded the island with bombs in an attempt to destroy important outpost for the British military.

With bomb runs every day the United Kingdom had no choice but to withstand the assault or face German Victory. However, The United Kingdom was notwithstanding idle, the British military was innovating the latest secret weapon, Airborne Radar. This new air to air radar was capable due to, "polyethylene [which reduced] multition radar station to a six-hundred-pound

airborne gorilla known as the Mark II…It gave British fighter and bombers the means to detect, intercept, and shoot down German bombers at night and during foul-weather attack. Without airborne radar, the Royal Air Force would have been forced to scramble their squadron at the sight of any approaching aircraft. (Feinchell, 1996:202). Polyethylene was a brand new synthetic plastic that carried dielectric properties making it great insulation for high-frequency cables allowing for telecommunications (Feinchell,1996). Polyethylene made it possible for the British Royal Airforce to turn the tides of war against the German Juggernaut effectively ending the blitzkrieg. With plastic saving the Allied powers from losing the war its job was far from over as recent inventions were soon to be tested throughout other military campaigns.

During the war effort, many resources were procured for military use, this meant that most stocks of metals and natural resources were in limited supply. Brass was the most heavily needed items during the war effort this meant that military whistles and bugles had to be made out of another resource. Luckily, plastic came to the rescue as both instruments were soon replaced with plastic versions that were lighter and easier to carry. Soon after replacing brass instruments plastic was being incorporated into helmet liners and ceremonial sword handles (Feinchell, 1996). However, plastic was still a puttering industry during the war effort as one engineer proclaimed, "Cut out the mystery, glamor, and charm that was good sales talk when you had plastics to sell, and few wanted to buy. Bit for the war services, just let plastics grow up and mature… If you have a plastic that's new why not say so …we are listening" (Feinchell, 1996:207). No longer was the glitz and glam needed to sell plastic, the military was willing to expand the industry itself through military contracts to ensure continuous development and sure enough more plastic entered the front. As a result, even more, plastic would enter the war effort in order to aid soldiers on the battlefield.

While many plastics were aiding the war effort through radar, instruments, and helmets other plastics were ensuring that soldiers retained some comforts on the battlefield. Nylon most commonly used in woman's stocking was being procured for soldier's parachutes (Feinchell, 1996). While many women were displeased with the fact that nylon stockings were in limited stock, Nylon was being used as parachutes for soldiers. With nylon allowing soldiers to safely parachute from planes, Vinyl was also aiding in the war effort. With its waterproof qualities similar to cellophane, Vinyl was soon incorporated into raincoats and gun boots, which covered weapons during rain to ensure they would not sink if fallen overboard. Further, while Vinyl was waterproof it was also fireproof which proved effective in upholstery on battleships (Feinchell, 1996). While Vinyl was keeping soldiers dry and ships fireproof, Saran sprayed on planes protected them from sea salt and ocean spray allowing them to stay docked on carriers rather than dismantled (Feinchell, 1996). By now plastic had proven its worth on the battlefield it was protecting soldiers and keeping them dry, it allowed for ships to be fireproof and ships to be easily carried to their destination but Plastic was not done yet as it would be incorporated into the largest weapon mankind ever created.

In order to end the war, the United States used nuclear weapons on Japan the first and last time they were ever used. However, without plastic nuclear weapons may never have been invented. In the 1930's Roy Plunket was searching for the latest synthetic plastic to be used in refrigeration but accidentally created a whole new product when, "Plunkett manufactured 100 pounds of TFE gas, which he stored in metal canisters. Plunkett decided to keep the TFE gas cold to prevent it from expanding and rupturing the canisters…when he [had] mixed TFE with hydrochloric acid… nothing came out…they thought the valve had perhaps clogged…Finally Plunkett… sawed one of the TFS containers in half. Inside, they found a white, waxy solid that was extremely slippery" (Kilby, 2008:1253-1254). What Plunkett didn't know at the time was that

he had just created Polytetrafluoroethylene otherwise known as Teflon. Teflon was like no other plastic as it was a nonconductor of electricity, was immune to bacteria and mold, it could not corrode or dissolve and it was slippery (Feinchell, 1996). With all of these properties, Teflon was incorporated into nuclear weapons, "coating the valves and seals of pipes that held extremely corrosive radioactive material. Scientist working on the Manhattan project succeeded in detonating a nuclear weapon in 1945 (Kilby, 2008:1254). With the war ending due to nuclear weapons plastic had proven itself on the battlefield to be a useful tool of war. While plastic had innovated throughout the war effort to provide soldiers with protection and technology at home it was struggling to gain consumer recognition. However, as soldiers returned home from the war Plastic was able to explode on the market forever revolutionizing the plastic industry.

From the Battlefield to Tupperware Parties and Beyond

From the failed invention of Alexander Parkes to Nuclear weapons plastic had certainly proved to be the man-made resource to replace all natural resources. It had replaced ivory billiard balls, electrical insulation and was consistently called upon to serve the call of duty. Plastic had certainly revolutionized human inventions as it was often incorporated. However, in the consumer market, there was yet to be any reason for plastic to become a booming industry. While it had success in the form of cellophane wrapping and film photography it hardly gained any other traction. Its use during World War II allowed the plastic industry to expand even further but that was for wartime technology, plastic use at home during the war was a far different story

Before the war had ended plastic had an uphill battle to change the perception at home. This perception was caused because, "its domestication occurred unevenly, by fits and starts. For one thing, the category of plastic included so many different materials with such a variety of appearances, textures, characteristics, and uses…throughout the 1940's people remained uncertain

why some materials qualified as plastic but not others" (Meikle,1995:153). While at war plastic was a success, at home, plastic was something that was misunderstood due to the lack of definition and quality of products. Plastic at home was so confusing that even the Walt Disney Company created a cartoon called "The Plastic Inventor". In this cartoon, " Donald Duck molding a plastic airplane…soars and loops through the sky…the plane disintegrates into a gooey mess…As Donald appears headed for catastrophe, the viscous melt forms a parachute and carries him to an undignified landing" (Meikle, 1995:154). This short cartoon showcased that plastic was a confusing material that lacked quality or shape and thus not popular on the market. Further, products that did gain popularity, such as Nylon for woman's stockings were required for the war effort forcing women to use a lower quality of product. All of these issues compounded at home to create a perception of plastic that it was low quality and could not achieve its true intended use. However, the war was ending and the perception of plastic would forever be changed with a party.

By the 1950's a new product was ready to revolutionize the home with the promise of no more spill, messes, or wasted food. Invented in 1942 by Earl Silas Tupper, Tupperware was intended to revolutionize the home; however, sales in local markets were struggling to take off (Clarke, 1999). Throughout the 1940's Tupperware was purchased as gift product rather than a necessity for the home for example, "Red Rooster cheese products, were packed in Tupperware Poker Chip racks" (Clarke, 1999). At this time Tupperware had yet taken off to be a staple home product was seen more as something that one would gift to another person. As a result, sales of Tupperware were not skyrocketing as they should have been and Earl Tupper was searching for a new sales tactic.

Luckily for Tupperware, a new sales tactic would be started by a single mother that would help take Tupperware from a struggling market to a booming industry, "Brownie, Wise, a middle-

aged housewife and impoverished single mother…initiated the Tupperware party. Wise had sold Tupperware as an independent door-to-doors salesperson… Earl Tupper, astonished by her sales figures, demanded her secret...it was… the Tupperware Party" (Clarke, 1999:2). This new sales tactic allowed Tupperware to go directly to the home where Tupperware host would demonstrate and present the product in front of a group of housewives. This new tactic worked so well, "that by the mid-1950's the Tupperware party had become a cultural hallmark of the post-war era" (Clarke, 1999:2). Tupperware had successfully entered the home, parties demonstrated the necessity of plastic containers as high-quality products that stored food with the promise of no spills, messes, and fresh food. Further, as the result of these parties Tupperware became a cultural icon and a must-have in the home.

Tupperware quickly became the epitome of American Suburbia throughout the 1950's and became the image of consumerism and class. With Tupperware parties, housewives were encouraged to, "enjoy the company of your neighbors by inviting them over for a Tupperware Party. A Tupperware party at a bake sale, white elephant sale, a rummage sale or bazaar (Clarke, 1999). No longer was plastic being sold in markets instead it had become a social experience. This social experience increased Tupperware revenue and as result more Tupperware creations. Throughout the 1950's Tupperware plastic would be used from, "Tupperware place card holder, Tupper Styrene Sandwich and Good Guides, Tupper Food Spears… and the ultramodern-looking tea/coffee set...Jell-O molds to flour sifters…and popsicle molds" (Clarke, 1999:38-39). With Tupperware, the image of class could be presented in any situation for any price. As a result, Tupperware continued to boom with Tupperware parties happening all across the country becoming the staple image of American suburbia and by 1997 was a 1.2-billion-dollar industry

worldwide (Clarke, 1999). While Tupperware was revolutionizing the pantry, plastic was entering the home as models predicted that one day we would live in plastic homes.

The Home of the Future

Ten years before Disneyland opened its doors to the public the Walt Disney Company made a short cartoon on the shortcomings of plastic. However, by the end of the 1950's Disney was home to Monsanto's plastic home of the future. Designed by Monsanto and Disney Imagineering the home of the future, "was envisioned as something that could be quickly and inexpensively constructed on nearly any terrain and could withstand most any force of nature."(Thilmany, 2014:3). Before Disney launched the plastic home of the future the ideas of plastic working in the home went further back.

In 1928, the house of the future was first revealed at the ideal home exhibition and illustrated the role of plastics in the home from walls to backsplash varnishing. In 1933 another home of plastic, the Vinylite House was revealed at the Chicago Exhibition which was a completely plastic house (Clarke, 1999). What separates the Disney home of the future and the other two homes was the era of which they were conceived. In the late 1920's and 30's the idea of plastic homes were trumped by the low quality and capability of plastic, but by the 1950's the plastic industry revolutionized and was capable of bringing high-quality products to the home. Further, the 1950's was an age of wonder as people predicted and dreamt of what the world would look like decades to come. To further fuel the wonder of the future Walt Disney created Monsanto's Home of the Future a concept house made out of plastic (Thilmany,2014). In this house, located in Disneyland's Tomorrowland, the kitchen served as the main hub of the household where everything except essential pipelines were made out of plastic (Thilmany, 2014).This look into the future is telling of the society of that time, no longer was plastic cheap but a product that

was so expansive the only thing that could tie it down was the lack of imagination. However, despite the new age of plastic manufacturing, Monsanto's home of the future only lasted ten years in the park. At the end of 1967 the home was set to be demolished but, "According to the Walt Disney Company, the wrecking ball bounced off the plastic walls and [instead] had to be dismantled (Thilmany, 2014:8). The plastic home while short lived and never a reality showcased the scientific advancement of synthetic plastic. No more was plastic a desperate attempt of replacing natural resources instead plastic was the material of the future that had become a cultural icon must have in the American home establishing itself as a stable commodity for decades to come.

From Teflon to Single Use Plastics

While Tupperware had dominated the storage of dinner's leftovers and Disney was predicting homes of plastic, another plastic product was being brought back to aide cooks and housewives with a non-stick material. Teflon, the famous plastic that aided the construction of nuclear weapons was well known for its non-stick use and manufacturers were looking to incorporate this product into civilian markets. By the 1960's, the FDA granted the use of Teflon as a non-stick surface on cookware (Kilby, Jack, Noyce, 2008). Coating pots and pans, Teflon would be marketed as a marvelous solution to burn on messes and ruined cookware as anything cooked on Teflon would slide right off. As a result, cookware sales exploded 40 percent in the United States as people rushed to get non-stick cookware (Kilby, Jack, Noyce, 2008). With the application of Teflon on cookware, it was no longer the product that helped create nuclear weapons but now the reason why eggs slipped right off the pan for morning breakfast. While Teflon was solving baked on messes another plastic was being created to solve an entirely different problem; the bottle.

With plastic becoming a staple product in every market, bottling companies were beginning to wonder how plastic could replace glass bottles. While glass bottles had been used for decades their vulnerability to shattering and cracking made the industry want to search for a durable container to replace glass. In the 1960's bottling companies were researching plastic to be a viable replacement. 15 years later in 1975 Coca-Cola would have success releasing the first plastic bottle (Ashurst, 2010). However, the plastic that Coca-Cola used, Nitrile, was deemed too toxic for human consumption. This led to manufacturers back to searching elsewhere and a solution was found with Polyethylene Terephthalate otherwise known as (PET) (Ashurst, 2010). This new plastic PET bottle would revolutionize the bottling industry and as a result completely replace the glass bottle for beverages. Plastic bottles are lightweight and durable thus quickly filling the shelves as glass bottles became obsolete. In today's market, the United States uses 30 billion plastic bottles every year becoming one of the largest plastic commodities in the world (Schriever, 2013). Plastic was now everywhere it was in the home, in the cupboard, and in our cookware and now filling our grocery stores in bottle form but the plastic was still not done revolutionizing the American market.

One of the largest companies to join the plastic market was Mobil Chemical who in the 1960's was using polyethylene to create a bag and by 1977 succeeded (Laskow, 2014). Soon after plastic bags were seen throughout the United States, but, paper bags still retained a large part of the market. However, plastic is cheaper to make as "plastic bags cost $24, while the same number of paper bags could set retailers back $30" (Laskow, 2014). With cheaper cost, plastic would soon out duel paper in the grocery market as grocery stores began to transition to plastic bags. By the end of the 1990's plastic controlled 80 percent of the market forever ending the question; Paper or Plastic? (Laskow, 2014). With the success of PET plastic, plastic bottles and bags swept through

the country and was beginning to spread across the world as companies transitioned away from natural resources to some form of plastic. By the 1980's, a hundred years of scientific ingenuity and innovation had gone into synthetic plastic and the transition in human development was remarkable. No longer was plastic a figment of the imagination but instead covering the world in Saran wrap, Tupperware, plastic bottles, and cellophane. It had helped win two wars, create the nuclear bomb, and the plastic bag. The plastic industry had become a goliath that was spreading across the world. However, while plastic revolutionized history there was a harsh reality to this amazing product; its immortality.

Environmental Concerns

As plastic began to skyrocket in the market the consequences of plastic were starting to be realized in the early 1970's. No longer was plastic being seen as the marvelous wonder of the future, instead its environmental dangers were beginning to be discovered. Plastic unlike natural materials are non-biodegradable and are immortal to natural processes of breaking down and being absorbed by the earth. Instead plastic can last for decades often time centuries before it can begin any type of biodegradation. What this means is that every piece of plastic that has ever been created still exist today and will still exist decades after many of us have moved on. However, to combat this environmentalist throughout the 1970's reacted, "environmental movements had mobilized to promote a variety of somewhat more ecologically benign forms of waste reduction. Their proposals included a reduction of producer and consumer wastes, as well as the recycling of residual waste "(Gould, 1996:127). Out of this new idea, slogans such as "Think Globally and Act Locally" and "Reuse, Reduce Recycle" would become staple slogans in environmental organizations, networks, and local ads. However why was plastic suddenly deemed a danger for the environment. Especially since for decades, plastic was seen as the material of the future. To

explain this new perception of plastic it is important to unpack Ulrich Beck's *Risk Society* in order to understand the driver behind environmentalist in the 1970's.

Risk Society

How society measures risk, defines how we respond and approach these risk. Ulrich Beck, in his work Risk Society, defines these risk as, "A systematic way of dealing with hazards and insecurities induced and introduced by modernization itself. Risks, as opposed to older dangers, are consequences which relate to the threatening force of modernization and to its globalization of doubt" (Beck, 1992:21). Looking back into the history of plastic this theory of risk society has always played a part in the innovations of plastic. First the desire to create plastic was created due to a perceived risk that ivory and other natural resources were a finite material that would eventually run out. However, with the creation of plastic that could be used over and over again this risk was eliminated from society. Further, plastic is the epitome of modernity as for decades' plastic was advertised and believed to be the material of the future and its innovations allowed it to become anything and everything. However, the perception of plastic began to change in the 1970's as its new perceived risk to the environment was becoming more apparent.

This new danger of plastic could best be explained by looking at our connection to nature and the environment. According to Ulrich Beck,

> A society with all its subsystems of the economy, politics, culture and the family can no longer be understood as autonomous of nature. Environmental problems are not problems of our surroundings, but – in their origins and through their consequences - are thoroughly social problems, problems of people, their history, and their living conditions, their relation to the world and reality, their social, cultural and political situations. (Beck, 1992:81).

The environment has always had a special connection with humans as we are derived from nature, however, as we industrialized we became disconnected with this relationship. Although this modern society has created a disconnection with nature, it still encompasses our lives, thus the decisions and technological advancements that we choose have implications for nature. Ulrich Beck is correct when saying that society is connected to nature and vice versa. The impacts of plastic pollution is the perfect example of this relationship as the creation of plastic and its impacts on the environment are human in design. Synthetic plastic was created by humans, consumed by humans and its pollution is caused by humans. While we are the creators of plastic its solutions, starts with humans and ends with humans creating a boomerang effect. This effect as described by Beck is when the risk catches up to those that generate such risk (Beck, 1992). This boomerang effect caused society to reexamine plastic consumption as the impacts of plastic pollution were becoming more real in society. In response, environmentalist set out to reduce, reuse, and recycle as much plastic as possible however a growing consumption would prove to overwhelm this solution.

Recycling a Plastic Beast.

The plastic of World War II that lined communication and radar systems were now being used to mass produce radios, the cellophane that kept products fresh and clean still remains wrapping produce and pastries, and plastic bottles and bags were sweeping the globe replacing easily breakable glass and paper. Plastic after the 1950's and especially after the 1980's with the invention of the plastic bottle and bag was no longer confined to America but was now expanding faster than ever across the globe. For the next 50 years, the use of plastic would grow across the world as, "There has been a very steep rise in plastics production, especially in Asia. The EU accounts for around 25% of world production; China alone accounts for 15%." (Plastic Waste in

the Environment, 2011:12). With markets growing in the EU and Asia plastic was beginning to become massively consumed. This consumption continues to grow to this day as "In 2013 some 299 million tons of plastics were produced… representing a 4 percent increase over 2012… [of which] between 22 percent and 43 percent of the plastic used worldwide is disposed of in landfills." (World Watch, 2015). Despite the efforts of environmentalist, plastic production and consumption have continued to expand globally as consumption across the planet steadily increased every year.

Globally consumption of single-use plastics has exploded as, "50 billion water bottles [are] consumed every year, about 30 billion of them in the US… [this massive consumption equals to] 1,500 water bottles consumed per second in" (Schriever,2013). Even plastic bags are consumed globally as "between 500 billion and a trillion plastic bags are consumed worldwide each year. Of those, millions end up in the litter stream outside of landfills" (Roach, 2003). Our plastic addiction continues to grow as in 2014 alone, "311 million tonnes [of plastic was produced], the equivalent of more than 900 Empire State Buildings" (New Plastic economy, 2016:10). Looking at history, the turning point for plastic can be pinpointed to the 1950's when plastic gained a sense of mystery. This mystical property of plastic allowed consumers to create a future where everything was made of plastic. Corporations such as Disney and Monsanto leaped to these new ideas as they even predicted what a plastic future would look like.

As plastic continued to be innovated into new products, the fantasies of the 1950's were becoming realities. However, plastic by the 1970's was starting to lose its allusion of mystery as the dangers of plastic was becoming more and more tangible. Environmentalist began to critique the use of plastic and argued that we must recycle in order to protect the environment. Reacting to this new risk to the environment, Environmentalist groups as early the 1970's were proposing recycling as a solution to our plastic pollution problem, "Through the efforts of trade associations

and their coalitions with local and national citizen-worker groups…environmental protection strategy was deflected into a more exclusive focus on postconsumer waste recycling" (Gould, 1996:27). With success, recycling programs would begin to sprout all across the country and eventually the rest of the world as cities adopted new policies to curb plastic pollution. While these recycling programs were created with good intentions to curb the amount of plastic entering the environment the amount of plastic being recycled is are far lower than expected. In 2013, the United States alone, generated 254 million tons of trash of which only 87 million tons were recycled. Of this number, plastic comprised only 13 percent, roughly around 11 million tons (EPA, 2015). Internationally the world produced 299 million tons of plastic in 2013, however, only 22 to 45 percent was recycled and in Europe, only 6.6 million tons was recycled (World Watch, 2015). Despite environmentalist efforts, plastic has become engrained in our consumer culture as every day millions of single-use plastics are used and disposed of creating constraints on recycling programs and polluting our environment. This has become extremely alarming as research in plastic pollution in the ocean shows an alarming trend of growth.

In the 1970's Environmentalist leaped into action and responded with recycling programs all across world creating campaigns that pushed towards reusing our waste rather than throwing it away. However, recycling has proven to be severely flawed as recycling markets suffering from the lack of finances and technological capabilities are constrained as our consumption has grown tremendously since the 1950's recycling This consumption has become even more alarming as our plastic has been flowing into the ocean for decades, only now being recognized as a problem. With tons of plastic flowing into the ocean every year we truly do not know the amount of plastic in our ocean, however, it is suspected that plastic will soon out number fish by the year 2050.

Recently ocean plastic pollution has come to the forefront of environmental conversations and mass media. Reports of ocean plastic pollution show the alarming dangers of what are consumption have created yet the amount of plastic currently in the ocean is unknown. However, we do know that, while the United States is the largest consumer of plastic pollution, consuming 30 billion water bottles each year alone, the rest of the world also contributes to our plastic pollution problem. Around the world, we produce over 275 million metric tons of plastic waste each year (Tibbets, 2015). While the amount of plastic produced continues to grow so too does plastic pollution as in 2010, between 4 million to 12 million metric tons of plastic entered the ocean (Jambeck, 2015). Of the amount of plastic that entered the ocean during that year, 20 countries were responsible for 83 percent of the plastic waste entering the oceans (Tibbets, 2015). While that was just year alone annually plastic pollution pours into the ocean at a steady rate as,

> Each year, at least 8 million tons of plastics leak into the ocean – which is equivalent to dumping the contents of one garbage truck into the ocean every minute. If no action is taken, this is expected to increase to two per minute by 2030 and four per minute by 2050...The best research currently available estimates that there are over 150 million tons of plastics in the ocean today. (New Plastic Economy, 2016:7).

This alarming rate of plastic pollution heading into the ocean every year is caused by our over indulgence in plastic goods. However not one country can be blamed for our ocean pollution as mass consumption isn't a national issue, but, an international issue as many countries around the world contribute and are affected by our ocean plastic pollution.

For decades' plastics has accumulated in oceans all around the world, but where and how did it end up in our oceans? One of the largest contributors to plastic pollution is boats at sea, in the 1970's, "the world's fishing fleet alone dumped into the sea approximately 135,400 tons of

plastic fishing gear and 23,600 tons of synthetic packaging material…merchant ships dumped 639,000 plastic containers each day around the world" (Derraik, 2002:83). In response to the amount of plastic and other pollutants heading into the oceans, the United Nations responded with the Convention on the Law of the Sea. This document was intended to establish that, "States have the obligation to protect and preserve the marine environment" (LOSC, 1982:100). However, despite international agreements illegal dumping is still a problem today and due to the lack of information the amount of plastic that is illegaly dumped could potentially be a lot higher. While ships dumping plastic into the ocean is one problem another key issue is land based pollution that makes its way to sea. In one report, "Over 80% of the annual input comes from land-based sources. The main contributor is larger plastic litter, including everyday items such as drink bottles and other types of plastic packaging." (Plastic in the Marine Environment, 2016:4). Throughout the world land to sea pollution is a reality as in Halifax, Canada, 62 percent of the plastic debris found in the harbor originated from land-based sources (Derraik, 2002) and, the Danube River, located in central Europe, sees 4.2 metric tons of plastic each day into the Black Sea (Tibbets, 2015). For decades we have used the oceans as our trash bins and while intentional dumping is no longer allowed, plastic pollution has continued to flow as our plastic production grows. While estimates show that there are millions of metric tons of plastic in our ocean there still remains zero quantitative data to show how much plastic is truly out there. Due to illegal dumping, waste mismanagement, and consumer carelessness, the amount of plastic could potentially be more catastrophic than believed.

Despite the dangers that environmentalist have presented for decades, the history of plastic reveals that the material has engrained itself into our consumer culture. However, a new conversation about plastic pollution has been sparked due to alarming amounts of plastic pollution

in the ocean. With plastic soon to outnumber fish populations, the dangers of plastic are suddenly being realized as millions of plastic particles float in the ocean. As a result of this new perceived risk, we have once again begun to reevaluate our use of plastic and the risk it has on our environment. With this new danger our society has begun to strive for new solutions to our plastic problem. One area that has struggled with plastic pollution, The Hawaiian Islands, is also home to a solution. In response to this global issue, a local organization has appeared with a new solution that focuses on the consumer and much-needed change in our consumption.

Chapter 2: A Solution to a New found Danger

Plastic Pollution encompasses the globe and fills our oceans. While throughout the past we have attempted at solving plastic pollution with recycling programs, by now it is very noticeable that these programs have failed to curb our plastic pollution. With 8 million tons of plastic entering the ocean every year, a global initiative to clean and curb our plastic pollution would be daunting. Instead, a solution to our plastic pollution problem must be localized in order to find global change. One spot of emphasis is the State of Hawaii which is an extremely important example of the problems of both international and local plastic pollution.

Hawaii's Plastic Problem

Hawaii's allocation in the Pacific Ocean makes the island chain a prime target for microplastic and plastic debris from all around the world. The reason for this is due to the North Pacific Gyre currents that flow clockwise from japan, California and directly into Hawaii. In one study, conducted between 2001 and 2003 that surveyed 9 remote locations throughout the Hawaiian Islands 22 samples collected 736.47 grams of debris (Mcdermid, McMullen, 2004). What this study found was that of the 736.47 grams of debris 72 percent was plastic and 11 percent was preproduction plastic pellets (Mcdermid, McMullen, 2004). While plastic of all sizes was found on the beaches, "data showed 43% of the plastic pieces collected on remote beaches were 1–2.8 mm in size" (Mcdermid, McMullen, and 2004:793). Unlike, Waikiki beach which is filled with tons of people, the beaches that were sampled consisted of some of the most remote beaches in the Hawaiian Islands, from North and Turtle Beach on Midway Atoll to Waipio Valley.

Breaking down the study even further the 9 sampled beaches collected over 19,000 pieces of plastic with the Midway Atoll collected the majority of plastic with over 18,000 pieces

(Mcdermid, McMullen, 2004).With the Midway Atoll collecting the most plastic out of the 9 remote location the impacts it has had on wildlife is clear. During my time with Sustainable Coastlines Hawaii one of the first things that were made clear was the impacts our plastic has had on marine life surrounding the Midway Atoll. Sitting at the table during the ICRS, looking to get people out to the beach cleanup one of the objects on the table was Albatross bolus filled with plastic. The Albatross bolus, or barf, occurs when albatross younglings throw up indigestible material. With mothers feeding their offspring plastic filled lunches, the colors tend to have high concentrations of plastic. As a consequence, many albatrosses die due to ingesting plastic debris from the ocean. This plastic that is being ingested isn't local but rather international and signifies how plastic pollution has become a global problem.

While the Midway Atoll sees some of the highest concentrations of plastic and microplastic in the Hawaiian chain every single island is impacted by microplastics. During my time with Sustainable Coastlines Hawaii, these issues were stressed every single day and were made more apparent when sifting tiny pieces of plastic for hours. However, what was alarming was the fact that despite cleaning efforts, beaches are often littered with plastic and microplastic just days after a beach clean-up. A study in 2010, researching five beaches on the island of Kauai found, "A total of 6082 pieces of plastic were collected…at an average rate of 484 pieces/day. The first day of sampling yielded 1243 plastic particles, and during the following 10 days, approximately 400–600 fragments were deposited on the beach daily…[and] The heaviest accumulation of debris occurs on the eastern side of the island, indicating a strong relationship between the North Pacific Central Gyre, buoyant ocean debris, and local longshore ocean currents" (Cooper, Corcoran, 2010:651). Despite the best efforts to clean beaches, plastic pollution in the ocean has become so severe that

even shortly after, beaches are littered with plastic. Further, the problem becomes even more difficult to solve when plastic waste from the islands floats out to the ocean and back in.

While international plastic pollution comes from all over the world, local plastic has leaked into the ocean and back into the Hawaiian chain. A study in 2012, on the largest island Hawaii, found that local plastic that drifts out to sea often times floats back towards the island chain. In order to conduct the study, researchers asked two questions: How much goes out to sea? And how much comes back? The first part of the study examined waterways in Hilo and found that,

> In 205 days, the two booms captured 29.9 kg of anthropogenic debris, 73.6% of which was plastic by weight. The largest defined category was polyethylene terephthalate (PET, "#1") bottles, which comprised 17% of the total by weight. They were followed by disposable plastic bags (7.5%), footwear (7.3%), glass (7.0%), and polyethylene (PE) packaging (6.2%). A large portion of the total debris was miscellaneous items, including sports equipment, fishing gear, toiletries, household items, and fabrics. (Carson, 2013:79).

According to the study, plastic is some of the most common items that leave the island especially plastic bottles. The amount of plastic that flows out into the ocean depends on the weather as more storms and rain weather pull debris from the islands and out to sea. Once the plastic enters the ocean it flows out into the sea and often time's right straight back towards Hawaii.

The plastic that flows from the Big Island goes back out into the ocean and then back towards Hawaii. The second part of the study examines how much of that plastic can potentially float back to another island. In this part of the study, wood blocks were used and researchers found, "Of the 1547 wood-block drifters released at four locations around the island, 387 (25%) were reported recovered. Of those recovered, 302 (78%) were found within 25 km of the release point. The remaining 85 (22%) were found at distant locations on Hawaii Island or on one of three other

Hawaiian Islands" (Carson, 2013:80). The result of this study showcased that Hilo is capable of polluting the other islands such as Maui in as little as 8 days (Carson, 2013). However, local plastic pollution that washes up on the Eastern Shores still comprises a minuscule amount of plastic as compared to the amount of international plastic that washes along the shores every single day. While the international and local waste washing to shore impacts Hawaii, the state has made attempts to solve its plastic problem

Recycling, HI-5, and The Plastic Bag Ban

Like any other place, Hawaii is vulnerable to local plastic waste. Often times this waste is caused by faults in recycling programs as well as individual negligence. However, while many around the world have created mature recycling programs, Hawaii has only recently started to productively recycle. In 2008, Hawaii had recycled 674,000 tons which is nine times larger than a decade prior (Cooper, 2010). This late start to recycling might have had more severe consequences as trash continues to pile up in the Waimanalo Gulch Landfill, Oahu's only landfill, and on an island in the Pacific space is a limited resource. this landfill is reaching a critical point as it is expected to reach capacity within 15 years and the state has yet to identify another site to create a landfill as many argue about location. (Opala.org, 2016). This has led to serious problems in Hawaii as eventually the landfill will be filled to capacity and without a proper disposing trash becomes more complicated. One solution to this problem is to ship trash back to the Mainland United States, however, over in 2010 permit issues caused the island to abandon this concept leaving 20,000 tons of trash stuck on the island (Cooper,2010). While Hawaii still struggles with a growing landfill, the government has attempted and diverting recyclable waste by creating the HI-5 program, a program that incentives communities to recycle for a reward.

Created in 2005, the Deposit Beverage Program, more notably known as the HI-5 program, was implemented in order to curb plastic waste. The way the program works is, "Consumers are charged a 5¢ refundable deposit, plus a non-refundable container fee on each labeled beverage container. Consumers are refunded their 5¢ deposit when they return the labeled container to a redemption center and the container fee is used by the program to pay recyclers to process and recycle deposit beverage containers" (Deposit Beverage Container Program,2016). Essentially the way the program works is all plastic beverage containers have an extra charge of 5 cents. Since the low cost is small enough people purchasing the product don't see a negative drawback, however, returning the bottle gives the consumer the 5 cents back which many see as a reward. Since its inception in 2005, the program has effectively recycled over 7 billion containers of all types. While the program has made strides in recycling efforts, there have been some drawbacks as well.

While the HI-5 program incentivized recycling by offering a refund it didn't do anything to curb plastic consumption. In 2005, 270,583,281 plastic containers were sold in Hawaii just 5 years later in 2010, 302,711,174 plastic containers were purchased and 10 years later in 2015 after the program started 388,718,999 plastic containers were purchased (Deposit Beverage Container Program,2016). While plastic consumption increased over time recycling of plastic within the program has dropped. In a report to the state legislature in 2013, the office of solid waste management reported that out of the 907 million containers sold 697 million were recycled of which 75 percent of the recycled materials were plastic (Hawaii State Department of Health, 2013). In 2014, over 933 million containers were purchased while only 677 million were recycled of which only 67 percent of the recycled materials were plastic, dropping 8 percent from the previous year (Hawaii State Department of Health, 2015). It is important to note that while plastic

consumption increased since the implementation of the program the correlation does not equal causation. However, the decrease in the plastic recycling can be explained by the lack of funding and human error.

Many recycling programs are funded by the price of oil. When the price of oil goes up the demand for recycled plastic goes up and when it goes down so does the demand for recycled plastics. Thus, the HI-5 program only does as well as the recycling market dictates and unfortunately since the price of oil has gone down this has put constraints on recycling manufacturers in Hawaii. In 2015 alone over 19 redemption centers closed throughout the Hawaiian Islands due to the market creating low revenue (Namata, 2016). Unfortunately, with the closures, the large amounts of plastic that used to be recycled could no longer be reclaimed and left to either enter a landfill or be shipped back to the Main Land or Asia. Thus the once believed solution to Hawaii's plastic pollution problem has stalled due to the market. The struggling market isn't the only danger to the HI-5 program as recycling centers can only process specific plastics. When plastics go unlabeled the identity of the plastic is unknown and often times isn't recycled. This was the case for Hawaii in 2015 when over 1.2 million plastic bottles delivered by Costco were mislabeled and unfortunately could not be recycled (Cruz, 2016). While Costco was responding to last year's Hurricane season this human error caused plastic that could have been properly recycled to be turned away. Despite attempts at controlling the flow of plastic waste the HI-5 program has stalled due to a crumbling market, however, recycling plastic bottles isn't the only local issue that plagues Hawaii, as plastic bags despite being illegal are still in wide use. This is the result of loopholes within the legal code that allow business to still offer plastic bags as the law allows for plastic bags to be offered as long as they are thicker than 2.25 millimeters (Honolulu, HI Ord. 12-8). Essentially, this section of the law defines any bag larger than 2.25

millimeters as reusable, however, many of the plastic bags that are offered are tossed out just after a short use and enter landfills or the environment.

The loopholes in the law allow for businesses to continue to offer plastic bags that are knowingly harmful to the environment. However, this may be against the Hawaii constitution as Article 11 of the Hawaii State Constitution states that, "The State shall protect the environment and natural beauty, the state has the responsibility to protect water resources, and the people have the right to a clean environment" (Hawaii State Constitution). While Hawaii struggles to battle local plastic pollution, international plastic pollution washes alongside the eastern coat of Hawaii constantly. Thus a solution that tackles both local and international pollution is important. One organization, Sustainable Coastlines Hawaii has arisen to the challenge by implementing a new type of solution that focuses on our consumption rather than our recycling.

Sustainable Coastlines Hawaii

Amongst the Locals and Tourist on the beaches of Oahu lies Sustainable Coastlines Hawaii, an organization since 2009 that has worked hard in changing consumer habits away from plastic. Started by Kahi (Who insisted that this paper includes how handsome he is) and a group of friends, Sustainable Coastlines Hawaii was inspired by a New Zealand organization called Sustainable Coastlines. The organization works in two separate facets the first is to educate the public on the issues of plastic pollution on beaches and coastlines of Hawaii by reaching out to the public and school children through their education station, a traveling school made out of a recycled shipping container. The second method is through local beach cleanups that are open to the public and provide entertainment and first-hand experience to learn and see the effects of plastic pollution. While SCH works mainly throughout the island of Oahu, Hawaii's most populated island, the organization does several beach cleanups on each side of the island

throughout the year. While I only spent a brief time with the organization the experiences during that time truly showcased how we have become a plastic society.

During my stay with the organization, my role was to help in every possible way and this first started with preparing a booth for the International Coral Reef Symposium. The ICRS is a conference that occurs every four years where scientists and students come together to showcase their research on coral reefs and the impacts climate change and human activity has had on them. During this time, Sustainable Coastlines Hawaii was represented by myself and another intern and many of times Kahi. Our job during this event was to encourage the scientist and students to come to the big clean up on Saturday as well as explain a large display of plastic findings that we had on the table. Of these findings, there were a large collection of toy soldiers, construction hats, and toothbrushes all found from beach cleanups. While there other important displays that we had were plastic pieces with fish bites, albatross bullous and a piece of plastiglomerate. Of the collection of plastic that was on display, there were a couple of plastic bottles that had noticeable bite marks all around the bottles. These bite marks all come from fish assuming that the plastic bottles were food rather than plastic. The albatross bullous that was on display revealed the stomach contents of a young albatross and unfortunately it was filled with tiny pieces of plastic from all over, including Japan. The plastiglomerate is an interesting material as it is a new rock formation that has begun to be found in the ocean. How this new rock is formed is when plastic melts down and mixes with ocean sediment and then solidifies turning the plastic and sand into stone. All of these items on display were important in showing the dangers that plastic has on the ocean and the impacts it will have on the future if ocean plastic pollution continues to grow.

While the ICRS took up most of our time during the first week we were able to take a break from the ICRS and complete other projects. One of these projects was to sift plastic from a

previous clean-up and ship the plastic to an artist looking to make furniture from recycled ocean plastic. The whole process of sifting plastic starts with shoveling a mixture of sand and plastic onto a sifter, sorting the plastic out of the sand, pouring the sand into a barrel of water. to be rinsed of any remaining natural debris and then finally strained and left to dry on pallets in the hot sun. By the end of the afternoon Kahi, myself and another intern had sifted millions of tiny little pieces of plastic from the sand weighing well over 20 pounds. The plastic that was found at this specific beach clean-up all came from the eastern side of the Oahu. What makes this important is that every piece of microplastic found on the Hawaiian Islands washed ashore from the North Pacific Gyre making this plastic international.

While sifting through plastic took up a day, the rest of the week focused preparing for the big beach clean-up in Waikiki, a popular tourist destination. While setting up for the weekend events I witnessed firsthand our age of convenience. It was an early Friday morning in Kapiolani Park, a small park located right off of Waikiki in Honolulu, where myself and Kahi were preparing for a family movie night for that evening and the beach clean up the following day. The park was filled with the usual crowd on a Friday morning in the middle of summer. Joggers, walkers, and bikers causally came and went enjoying the ocean breeze, a youth group was playing, and tourist that were avoiding the hustle and bustle of Waikiki enjoyed the relatively quiet beach. While we worked to set up a large screen for the movie, Kahi noticed a small group of people practicing yoga a few feet away from where we were. To no surprise, every single person within the group of about fifteen people was carrying plastic water bottles. Kahi being an exuberant person always looking to talk to others pointed out the group to me as we both contemplated if the yoga instructor would help the organization by advocating her students to bring reusable metal bottles the next time they meet.

Once the small crowd diminished the organizer went up to the instructor and had a small five-minute chat. While I continued to work I observed that the instructor was a little apprehensive to Kahi's presence and once the two were finished talking Kahi walked back towards me shaking his head. Curious as to what occurred I had asked what happened to which he replied, "She said she's not going to do anything because these people are too busy to go out of their way". Looking back now I see how strange this encounter really was as the process of purchasing a plastic water bottle is more inconvenient than having a reusable water bottle when the process to purchase a water bottle is more time consuming than filling a reusable water bottle at home still doesn't make sense. However, after exploring the history of plastic consumerism the idea of convenience has always been sold in the form of plastic. The result of this convenience has led to a throw it away society which views plastic as disposable leading to the huge problems we currently have in the environment.

This throw it away society has allowed plastic waste to be thrown away with little afterthought. However, away often leads to here for someone else as plastic traveling worldwide has killed sea life and destroyed coastlines costing 13 billion dollars in loss of revenue from tourism, fishing and the cost of beach clean-ups. With the amount of plastic soon to exceed the amount of fish in the sea we are reaching a tipping point in our plastic consumption that could exasperate the negative impacts on sea life and human consumption and economics. Thus, a solution to our overconsumption of plastic is needed in order to curb plastic pollution.

SCH Solutions

Ulrich Beck *Risk Society* analyses how society views a risk and mitigates the potential fallout from such risk. While recycling has been considered a solution to plastic pollution it has not done enough to be offered as the best solution. Thus a new solution is needed in addressing

societies plastic problem and Sustainable Coastlines Hawaii is offering a new solution. in order to find a suitable solution. Sustainable Coastlines Hawaii argues that the main dangers of plastic pollution is our addiction to plastic, especially single-use plastics. These plastics make up most of our ocean debris and often only used once for a few minutes before being tossed away forever. In order to change our views on plastic SCH offers solutions to change our consumption habits. On their website and on several posters the first thing the organization stresses is to stop purchasing plastic. This means that we as a society should move away from the use of single-use plastics, which make up most of our plastic pollution, and to transition to sustainable consumption habits. These habits are as easy as using cotton fiber bags and steel reusable water bottle instead of their plastic alternatives. By buying less plastic and changing the demand to a more sustainable ecological consumption we as a society identify that the risk of plastic is no longer worth the ease it has brought to society.

The second solution offered by the organization returns us to the 3 R model but with a twist. Instead of 3 R's the traditional reuse, reduce, recycle, Sustainable Coastlines Hawaii adds a fourth R; Refuse. This R is the most important in the chain of R's that we have been taught for decades and is the first step. In this step, refuse means to deny plastic everywhere from restaurants that offer straws to places that offer plastic containers and utensils. By simply refusing plastic in these areas, we can drastically drop our plastic consumption. Especially straws which while convenient are seriously unnecessary at a restaurant that offers glasses. The organization everyday works to educate the public, while not everyone such as the yoga instructor listens many are willing to sit and learn about plastic pollution and this what is most important just being able to listen to the problem is the first step in changing ourselves and society as a whole in terms of our plastic consumption.

SCH initiates these solutions to plastic pollution by involving the community in beach cleanups around Oahu and the neighboring islands. While working with the organization I was able to experience a beach clean-up first hand and saw a large accumulation of people from all walks of life come together for one goal; to clean a beach. Young to old, to families and friends and local and tourist over 500 people had come together to clean the beach. With a lot of people, we were split into three groups in order to cover certain sections of the beach. I and a group of others went to the Ala Wei harbor where the Ala Wei River runs into the ocean. It also happens to be one of the dirtiest points as all of the runoff and waste flows from the Ala Wei and out to sea. The group that I belonged to was a mixture of people some were out learning about plastic pollution, others were spending a Saturday together as an excuse to watch football on Sunday and others were looking for something fun to do on a Saturday morning. Whatever the cause was to join the beach clean-up one thing was clear everyone was there to learn and to have fun. While beforehand the thought of a beach clean-up sounds like a chore seeing a community together to recognize and solve a problem was amazing. This was a community that was recognizing the risk of plastic pollution to our society and addressing it by cleaning it in order to make a difference. During our time cleaning the harbor the usual findings of plastic bags and bottles were plenty a few other noticeable fines were a car tire, bicycle wheels, a lock box, and a plastic toilet seat that at one point was dumped into the river or harbor rather than recycle.

The difference Sustainable Coastlines has made in beach clean-ups is astounding as for the past five years the organization has had 65 cleaning events on Oahu and the surrounding islands. In total these beach clean-ups have garnered 14,778 people with the largest amount ever attending a beach clean-up at 1,073 (Sustainable Coastlines Hawaii). Overall the organization has collected 161,977 pounds of trash and recycled 40,307 pounds while 8,044 pounds has been recycled

through the HI-5 program. Further, the organization has cleaned 32,883 pounds of ocean plastic waste. After a beach cleanup, the plastic gathered is sent to several partners of the organization to where it can be remade into other products. For example, the plastic that I, Kahi and another intern spent hours sifting through were sent to an artist in England to make a table and chair thus reusing ocean plastic.

In five years the organization has cleared over a 150,000 pounds of trash and over 30,000 pounds of ocean plastic, these efforts are tremendous as the organization has been able to clear these plastic items from ever returning back to the ocean. While the organization has been able to clean beaches and unite the community around a common goal it also, more importantly, educates the public about the dangers of plastic pollution.

Alongside the beach cleanups, Sustainable Coastlines Hawaii offers education to the public and young students throughout Hawaii. In order to do this, the organization has created the Education Station, a repurposed shipping container that is filled with educational games and activities. Of the things to do there are baskets filled with sand and plastic debris where students can filter through sand and plastic to see a small sample of what Hawaii's beaches look like. The education station offers an immersion into our plastic pollution problem and educates students and the future generation of the dangers plastic has on the environment and on us. By targeting the youth this can bring up a new generation that sees plastic more as a risk to society rather than the miracle product that it has been advertised as for decades. Sustainable Coastlines offers education and beach clean-ups to tackle ocean plastic pollution. These solutions not only tackle our current problems of waste but also tackle our consumption of plastic by encouraging anyone and everyone to divert away from single-use plastics and adopt more sustainable practices. These solutions,

while have begun in Hawaii our something that can be done everywhere around the world and it is important to look at the model Sustainable Coastlines Hawaii has created.

While my time with the organization was short, Sustainable Coastlines is still working to create change by creating new projects that could help divert waste. Currently the organization is working towards bringing the Ala Wei Trash Wheel to Honolulu. This wheel would be similar to a trash diverting wheel in Baltimore and would be used to divert waste from one of the dirtiest water ways on the island the Ala Wei (Sustainable Coastlines Hawaii). The organization has already raised enough funds for a feasibility project and have conducted meetings with a feasibility team and local government. Further, the organization has been working day and night at the Vans Triple Crown Surf completion and have successfully diverted 66 percent of the waste generated during the event (Sustainable Coastlines Hawaii). While the organization has been working to solve an ever growing problem the need for the model that they have created is terribly important during a time when recycling struggles to keep up with growing plastic consumption

Chapter 3: Recycling

Neighborhoods have participated in recycling programs for decades but our green thumb ends at the curb. Once our trash is taken away by the city every week it is no longer in our minds as to what happens next. What does happen next is that plastic is sorted, sifted, cleaned and then remade. The first stage of plastic recycling is sifting and separating which is required for recycling as not all plastic is the same. During manual separation, plastic can be separated three separate ways the first being its number categories, "1 = PET, 2 = HDPE, 3 = PVC, 4 = LDPE/LLDPE, 5 = PP, 6 = PS and 7 = others" (Manrich, Santos, 2009:8). These number categories are labeled directly on the plastic surface and allow for manual separations to quickly identify the type of plastic being used. The second capability of separating plastic is identifying the packaging product, bottles are often made out of PET (Polyethylene Terephthalate) while plastic bags are often made out of HDPE (High-Density Polyethylene) other common products such as caps and lids are made out of PP(Polypropylene) by simply looking at these products we can sift through based on what plastics control that specific product (Manrich, Santos, 2009). The third form of identification is identifying the physical and chemical properties of plastic by testing several traits, "Transparency:[plastics that are transparent are] PET, PP, PVC, PS [while] opaque plastics are HDPE, PP, High-impact polystyrene (HIPS) LDPE, and PET" (Manrich, Santos, 2009:10) However, these traits as you can see often describe the same plastic which is hard to identify when sorting mass quantities, luckily, items such as plastic bottles are easy to determine as, " Carbonated soft drink bottles are all of PET and the rest can be differentiated by inspecting the base. If the bottle was injection molded…with an injection point at the middle of the base, it is made of PET; if it was an extrusion parison blow-molded, with a weld line across the base, it is PVC."(Manrich, Santos, 2009:12).

While manual separation offers several tactics to be able to separate the different plastics, automatic separation by machine allows a more precise separation.

Similar to manual separation, automatic separation sifts through plastics by categorizing them through density, chemical structure, solubility, surface character and electrostatic and thermomechanical properties. By using density tanks, "Containing aqueous solutions of various densities", plastics of different weight float to the top or sink to the bottom (Manrich, Santos, 2009:13). While using density as one form of filter plastic is effective another tactic is to analysis the chemical structure. This technique takes,

> Plastic residues, whole or ground into flakes…placed on a conveyor belt and scanned continuously by such a device, whose IR radiation source is adjusted to the absorption wavelengths of the plastic in question. Any change in the absorption spectrum discloses the presence of an impurity at a specific point on the belt at that moment, thus defining the exact position and time, moments later, where a jet of compressed air should be activated. The foreign object is blown off the belt, to land on another, below the first, moving at right-angles to it and so effecting the separation. (Manrich, Santos, 2009:14).

Both manual and automatic separation techniques allow for plastic to be separated into similar categories in order to be broken down in recycled, however, before they can be remade plastic must be cleaned of outside containments.

From the manufacturing line to the recycling bin plastic comes in contact with multiple outside sources that change the quality of the material over time. Thus, after the plastic is sorted by type it has to be clean of outside containments before it can be reclaimed. It is also especially important to evaluate the extent of contamination, the contaminating chemicals, and the final reclaimed product in order to properly clean plastic (Manrich,Santos, 2009). After these

evaluations have been meant plastic can be cleaned utilizing cleaning agents (calcium hydroxide and sodium hydroxide) that strip materials such as glue, stickers, and stains from plastic. This stage is important as residues such as glue can decompose to acid compounds and eat away at plastic. (Manrich, Santos, 2009). Overall, "The cleaning step, in most cases, takes between 5 and 20 minutes at temperatures up to 88 °C. Short times do not suffice to remove adhesives, while periods exceeding 20 minutes give a low return, while the use of baths at high temperatures facilitates the removal of glue" (Manrich, Santos, 2009:19). Once the cleaning process is finished and plastic has been sorted and cleaned it can now finally be recycled into a new product.

After the plastic has been sorted and cleaned it can finally be recycled into a new product. In order to do this, there are several ways in which plastic can be broken down and recreated the first way to recycle is through mechanical recycling. Mechanical recycling, "is the process of converting discarded plastic into new products, principally by melting and molding. In this form of recycling, the macromolecular nature of the polymer is not destroyed, so that the degradation reactions that directly affect the physical and chemical properties of the polymer and, at times, its appearance, are minimized and controlled" (Manrich, Santos, 2009:21). Essentially, this process takes plastic melts it back down to liquid form and then reshapes it back into new products to be sold back on the market. During this process plastic runs the risk of destabilizing thus becoming useless, as a result, polymers that are to be mechanically recycled must have high-quality in order to reduce degradation (Manrich, Santos, 2009). This means due to technology constraints that only high-quality plastic can be recycled through this process in order for it to be effective. However, one of the most common plastics, especially in bottles, PET, can be recycled through this process and is one of the most approved plastics by the FDA to be recycled as recycled PET upholds the same quality as virgin PET (Manrich, Santos, 2009). Mechanical recycling focuses on recreating

new products out of recycled products, however, other forms of recycling focus on using chemicals to return plastic back to its original state.

Unlike mechanical recycling, which focuses on retaining the macromolecular compounds of plastic in order to create new plastic, chemical recycling focuses on the destabilizing plastic back to its original compounds. This process consists, "in using depolymerization and decomposition reactions to convert polymers into low-molecular-weight products… A variety of chemical products is generated that can be used as raw materials in several sectors." (Manrich, Santos, 2009:59). There are two types of chemical recycling the first is thermochemical recycling which utilizes high temperatures gauging from 350 degrees Celsius to 1000 degree Celsius to break down plastic. The second process is Solvolysis, this process of intense heat, pressure and added chemicals such as acids or alkalines that break down plastics back down to their original form. These processes create several products but some of the most important products are oil or gas (Manrich, Santos, 2009). Following mechanical, and chemical recycling is energy recycling which focuses on burning plastics to recover energy and turn it into a form of power.

Unlike Mechanical or Chemical recycling, energy recycling is one of the easiest processes of recycling. Energy recycling basically uses high temperatures to incinerate plastic to be used as energy in the form of steam and electric power (Manrich, Santos, 2009). This process was adopted by countries all over the world as, "40% of all MSW was incinerated in France (42%), Sweden (47%), Denmark (48%), Belgium (54%) and Switzerland (59%), and as much as 75% in Luxemburg."(Manrich, Santos, 2009: 65). The process of incinerating plastic waste, alongside other garbage, ensures that landfills do not pile up next to communities as well as providing a source of power. While these recycling efforts attempt to effectively break down plastics to either

create a new product or power, there still remains large flaws that make reclaiming plastic ineffective.

Commodifying Trash

For over 40 years recycling has been pushed as the solution to our plastic consumption problem. We as a society have endorsed these programs by participating every week, yet we know little of what happens after it is taken, instead for years' society has operated on an out of sight out of mind philosophy. In theory, these recycling programs are supposed to limit the amount of plastic heading to landfills by recycling these products and recreating them into new items. However, plastic pollution has steadily increased creating serious environmental impacts especially on our oceans proving that recycling is not effective. There are two major reasons as to why this is so, the first and largest issue is the market for recycled plastics are generally weak and rely on the cost of oil and second constraints on recycling process limit the amount of plastic that can be recycled.

In order to make money off of a material, you have to create a market that is willing to buy and sell your goods. Some markets such as Apple sells itself by name recognition and the idea of revolutionary technology. Other markets such as food sell itself based on the necessity of nutrients and health. However, how does one commodify trash? Especially when the product is recycled plastic that was only meant to be used once. Unfortunately, markets for recycled plastic revolve around the price of the oil. When the price of oil goes down, virgin plastic becomes cheaper than recycled plastic causing demand to go down. Currently recycled plastic is facing this problem as, "At the start of this year [2015], new polyethylene terephthalate [PET], cost 83 cents a pound, according to data compiled by industry publication Plastics News. That was 15% higher than the cost of recycled PET…As of late March, the cost of new PET had fallen to 67 cents a pound, or 7% less than the recycled form, which costs 72 cents a pound."(Davis, 2015). The ups and downs

of the oil market effects the capabilities of recycling plants to sell recycled plastic on the market which in turn affects the operations of recycling plants.

Market inconsistencies put strains on recycling plants to the point of potentially shutting them down. When the cost of oil was high the recycling market was booming as both cities and waste management companies were able to profit off recycled plastics and other recyclables. Cities such as San Antonio made 5.1 million dollars selling its recycled goods in 2011 while Washington D. C made 550,000 dollars and Orange County, North Carolina was making 500,000 dollars a year from selling its recycled plastic (Gelles, 2016). However, currently, the recycling market is a stark contrast to the booming industries of years before. With lowering prices in oil, cities and companies are beginning to struggle. While Washington DC was once making money off of its recyclables it is now paying 1.7 million dollars to Waste Management to accept the recyclables. Even Waste Management, the same company that deals with cities all around the United States, is losing out as it has reduced its recycling facilities from 130 to a 100 and a loss of revenue from 1 billion dollars to 878 million dollars (Gelles, 2016). With an oil market that consistently fluctuates recycled plastic has little advantage over virgin plastic causing many corporations to use new plastic rather than using existing plastic. The weak market has carried over towards recycling programs as many cities and companies struggle, further exasperating issues of recycling.

The fluctuating market is not the only problem of recycling another large issue deals with how we recycle, to begin with. While we have participated in gathering our weekly recyclables to be carried away in a bin, it is the bin that has become a problem. The large blue bins that have lined the streets for years have created a serious problem in the early stages of recycling. Originating in California in the 1990's the blue bin was meant to make recycling easier on the public by giving the public one bin to throw everything into (Gelles, 2016). However, this system

designed to simplify recycling has only made it more complicated as previously mentioned before one of the first steps of recycling plastic is separating and cleaning. By simply placing all of our plastic into one bin along with other recyclables we potentially can contaminate plastic which has serious consequences, “One dirty product, or one with food waste still in it, can contaminate an entire bale, containing thousands of pounds of collected plastics. This can cause thousands of recyclable items to go to a landfill instead of being recycled” (WM.com). With plastic so easily contaminated, the threat goes up even further once we start to compile other products on top of it, making the big blue bin that was created in good nature, ineffective. However, plastic is still making its way from the curb side pick up to the recycling plant to be recycled. However, even if it has passed the sorting and cleaning it still many not be recycled.

Once the plastic is brought into a plant it is sorted and cleaned, one of the methods as discussed earlier separates plastic based on its number code on the bottom of the plastic product. This identification code separates plastic 1 through 7 based on chemical structure. However, these codes often get confused as recyclable although, “the code was not intended to be a guarantee to consumers that a given item bearing the code would be accepted for recycling” (Recycling Plastic: Complications & Limitations, 2009) , and, “The code number on the bottom of your product is not a reliable indicator of whether something can get recycled” (WM.com.). While consumers misinterpret these numbers as recyclable they are instead intended to make the sorting and recycling process easier. For most recycling plants the only important numbers are 1 and 2 (PET and HDPE) mainly because these are the only plastics that can be recycled and processed. However, even PET and HDPE can only be recycled so often as “plastic resin has limited ability to be recycled because its quality degrades every time it is reheated. When we collect and remanufacture plastic, we are only delaying its disposal. The final destination for all plastic is

either in an incinerator [or]…landfill" (Recycling Plastic: Complications & Limitations, 2009). While recycling has good intentions, "only 14% of plastic packaging is collected for recycling. When additional value losses in sorting and reprocessing are factored in, only 5% of material value is retained for a subsequent use. Plastics that do get recycled are mostly recycled into lower-value applications that are not again recyclable after use" (New Plastic economy, 2016:7). The price of oil has also stagnated the recycling market collapsing the worth of recycled plastic. Further, the capabilities of recycling plastic are flawed as only specific types of plastic can be processed and even then only under specific conditions. As a result, millions of tons of plastic is tossed into landfills each year where it flows into the oceans creating a serious impact on ocean ecosystems and the general health of the oceans. By unpacking the dangers of ocean plastic pollution, we can understand why the SCH model is important in tackling global plastic pollution.

Chapter 4: The dangers of plastic what is happening and will continue to happen

While recycling was determined to be a solution to our plastic problem plastic still finds away into the environment every year with tons of plastic flowing in the ocean. Once plastic enters the ocean, it bobbles and floats it's way around the planet. However, it is often not alone as the millions of plastic debris floating in the ocean accumulates across Gyre systems around the world. These gyre systems are, "formed by surface currents that are primarily a combination of Ekman currents driven by local wind and geostrophic currents maintained by the balance between sea level gradients and the Coriolis force. These surface currents are detectable from the paths taken by satellite-tracked drifting buoys of the Global Drifter Program" (Eriksen, 2013:73). Essentially what this means is surface water moves in a giant circle carrying any pollutants, often plastic, across the globe. Across the world there are 5 gyres: The Indian Ocean Gyre, North Atlantic Gyre, South Atlantic Gyre, North Pacific Gyre, and the South Pacific Gyre. Of the 5 gyres, the North Pacific Gyre has one of the largest accumulations of plastic in the world,

> The Gyre, stretches over 10 million square miles. Its center is in the middle of the Pacific Ocean- a remote and virtually uninhabited area…the gyre has become home to garbage drawn from all over the Pacific. The result is two enormous masses of trash. One dubbed the Western Garbage Patch. Is located west of Hawaii and east of Japan. The second mass is the Eastern Garbage Patch… between Hawaii and California. (Dautel, 2009:183).

Amongst the 10 million square miles of ocean the Gyre contains two trash zones that circulate plastic waste throughout the Pacific Ocean. Combined, The Eastern and Western Garbage Patches are double the sizes of the United States. The Patch spans the ocean for thousands of miles, beginning approximately 500 nautical miles off the coast of California, flowing past Hawaii and almost reaching Japan. Although it contains an estimated 100 million tons of garbage, the debris is hard to see because it bobs just below the surface...Slowly degrading items may remain there

for decades; one piece of plastic found in the Patch was from 1944, and some ecologist predict plastic degradation in the ocean could take 500 years or more. (Dautel, 2009:183). This swirling vortex carries plastic pollution all around the Pacific Ocean gathering debris from Japan to the United States and eventually Hawaii. Like much of the evidence presented the true amount of plastic in the Garbage Patch is unknown, however, as plastic pours into the ocean, we can suspect that the patch will continue to grow. Once plastic enters the ocean it also breaks into tiny pieces called micro plastic.

Micro Plastic

While large plastics are easily discernible in the ocean, small tiny plastics are invisible to the naked eye. These tiny pieces of plastic known as Microplastics and defined as, "Particles with a grain size lower than 5 mm, although a recent definition suggests considering fragments smaller than 1 mm", fill our oceans and beaches (Avio, Gorbi, Regoli, 2016:2). The process that creates microplastics is photodegradation and unlike biodegradation, which fully decomposes an object back into the earth, photodegradation uses UV light from the sun in order to break down plastic but never eliminating them. This process occurs primarily when plastic in a marine environment, preferably on a beach, is exposed to UV-B light. The UV-B light and heat begins the degradation process of plastic and once started will continue as long as the plastic is exposed to oxygen. This process is increased the higher the temperature is, a simple 10-degree increase doubles the rate of photodegradation with plastic found on beaches (Andrady, 2011). Unlike plastic on beaches the photodegradation of plastic that enters the ocean is stalled due to relatively cool temperatures. However, plastic over time degrades due to the movement of ocean currents and exposure to the sun (Andrady, 2011). With plastic degrading and becoming smaller and smaller this complicates data as not every single piece of plastic can be physically accounted for. Thus concentrations in

Gyre systems are important in garnering samples and with large amounts of plastic debris these Gyre systems serve as a basis to gauge the population size of ocean plastic pollution. Further, Gyres are important in discussing how plastic travels around the world and has become an international problem. Traveling in Gyre systems micro plastic has encompassed the globe and has recently been discovered in the Arctic Ocean (Avio, Gorbi, Regoli, 2016). The dangers of micro plastics and plastic, in general, is especially noticeable in sea life as these tiny pieces often are confused for food by fish, birds, and other sea creatures. While the damages of plastic have been documented in sea life the economic damages towards humans are now starting to be realized as plastic has littered coastlines all around the world. By exploring the impacts of plastic debris within the ocean and its relevance to humanity we can unpack why change is necessary in order to protect our oceans health.

Impacts on Sea life

Since the first plastic products flowed into the ocean, marine life has been impacted by either being caught or ingesting our plastic. Just over the summer 13, sperm whales washed up off the coast of the North Sea in Germany, of these 13 whales, all of them, according to an autopsy report, had ingested plastic pollution (Hoare, 2016). The digestion of plastic wastes is not uncommon amongst sea creatures and is heavily documented one study off the coast of North Carolina that analyzed the stomach contents of 1033 birds found that over 55 percent contained plastic while a study off the coast of England found that 21 percent of flounder had plastic in their stomach contents (Derraik, 2002). Marine debris has also affected 83 percent of turtle species, 44 percent of bird species and 43 percent of marine mammal species (Derraik, 2002). Further with an increase in plastic pollution, there are predictions that 99 percent of all seabirds will eat plastic by 2050 (Wilcox, 2015). Sea creatures getting caught in plastic debris is not uncommon either as, “In

the 1980s, researchers estimated that there were approximately 100,000 marine mammal deaths per year in the North Pacific related to entanglement in plastic nets and fishing line" (Moore, 2008:133). With plastic soon to outnumber fish in the ocean we can only assume that more sea life will be in danger of confusing plastic as a source of food or being a trap and as plastic continues to flow into the ocean the impact of this waste can be felt by humans.

Human and Economic Dangers

While fish have been consuming plastic since the 1970's, humans have been consuming fish for centuries. Our fish consumption much like our plastic consumption is large as in 2009 America alone consumed 4.8 billion pounds of fish behind only China and Japan in fish consumption (NOAA, 2016). However, it is possible that the fish we have been eating have been transferring plastic toxins to us. One study found, "that fish, exposed to a mixture of polyethylene with chemical pollutants absorbed from the marine environment, bioaccumulate these chemical pollutants and suffer liver toxicity and pathology" (Rochman, 2013:1). These chemicals absorb by fish enter the food system with the potential of transmitting these chemicals into the human diet. While "research cannot quantify the amount, plastic in the ocean does appear to contribute to [persistent, bioaccumulative, and toxic substances] in the human diet."(Seltenrich, 2015:35). With plastic toxins leaching into our food stream we know that we are consuming plastic toxins, yet, it is difficult to ascertain how potentially dangerous ocean plastic contamination is in the human system. This is mainly due in part to the fact that we are surrounded by plastic toxins throughout our daily lives thus making any critical almost impossible. The connection between plastic toxins traveling from fish to the dinner plate are still being explored and while it may be a weak link in connecting plastic pollution to humans other aspects of plastic pollution cost humans billions of dollars.

Throughout the history of plastic, manufacturers struggled to establish itself on the market. Innovation and ingenuity caused the plastic to gradually become the material of the future, becoming a multi-million-dollar product. However, plastic is also causing the industry millions of dollars as, “95% of plastic packaging material value of $80–120 billion annually is lost to the economy after a short first use.” (New Plastic Economy, 2016:12). This cost loss is mainly due to single-use items that can no longer be reused after their initial use. Even for plastic that is recycled, it loses its value as it degrades to lower quality of plastic eventually ending in a landfill. That plastic once after it is finished its intended use impacts human cost again as it impacts the ocean environment. The United Nations Environment Programme (UNEP) reported that “The most significant downstream impacts marine pollution, which has a natural capital cost of at least $13 billion dollars” (Raynaud, 2014:10). This cost factors in the damages to the environment and the loss of sea life, however, it is possible given the unknown amount of plastic in the ocean that this number is significantly higher.

While the oceans continue to be invaded by plastic pollution these consequences will only continue to grow. The dangers of plastic pollution have been well documented for decades yet while environmentalist have attempted to warn society, society continues to consume mass amounts of plastic. However, with plastic pollution gaining new attention, society has once again begun to reexamine the dangers of plastic. Considering that recycling has struggled to keep up with the amount of plastic generated a new solution is necessary in solving our plastic consumption. This is where the model of Sustainable Coastlines Hawaii comes in as the organization focusses on changing our consumption and to eliminate single- use plastics from our daily habits. By addressing this issue society can eliminate the mass consumption of plastics and clean one of the most vital systems on the planet, our oceans.

Conclusion

While this paper has discussed the history of plastic from its invention in the early 1860's, its scientific innovations and its transition to a mass consumed product it is important to note the importance that plastic has played throughout history. Without this product much of the technology that we use and love today would never have been able to be created. However, despite this the dangers of plastic have created a large problem for our oceans. Millions of tons of plastic every year floats into the ocean creating economic dangers for humans as well as destroying sea life populations and ecosystems. This pollutant is not healthy for our environment and the new risk must be addressed. Originally this issue was believed to be solved by recycling, however, by unpacking the issues of recycling we understand how the system has become flawed. However, despite this conclusion on recycling it is important to note that recycling is extremely important in curbing our plastic pollution (Just imagine what the world would look like without recycling). Thus we must not completely do away with recycling but reanalyze what we determine a solution must be.This paper argues that one solution to this problem is by utilizing the model that Sustainable Coastlines Hawaii.

While Sustainable Coastlines Hawaii offers a solution to our plastic pollution problem it is important in discussing the challenges moving forward. These challenges consist of the fact that Sustainable Coastlines Hawaii is working against a global epidemic. This can be heavily seen in the organization itself as many times there was the discussion of how beach clean-ups were only temporary as beaches would once again be covered in plastic. The real solution is not beach clean-ups or recycling but ending our plastic addiction by transitioning to sustainable consumption habits such as bringing your own water bottle or using wooden traveling utensils. However, this is the limitation of this project as while the paper has focused on a local solution taking that model and

implementing a global program of change will be tremendously difficult given our plastic culture. The history of plastic suggests that while our thoughts on plastic has consistently changed, we now live in an age of plastic where everything can and must be made out of plastic. In order to change this mindset that society has we must once again reevaluate the risk that plastic has on our environment and especially the oceans.

While we our currently undergoing that reevaluation process it is important to note that any further research must focus on implementing local models similar to Sustainable Coastlines Hawaii. Because of the difficulty of implementing a global program we must return to the roots of the environmental movements that started it all "Think Globally Act Locally". Currently there are many organizations that are utilizing the same models that Sustainable Coastlines Hawaii offers. The first being the original Sustainable Coastlines, found in New Zealand as well as many other organizations such as Surf Rider which has chapters throughout the United States. Each of these organizations are working to challenge our consumption habits and to encourage society to move away from plastic.

As a society we have the responsibility to make change happen by individually moving away from plastic by doing so we have the power to change the market one person at a time. By encouraging friends and family members to change we tackle plastic consumption and where ever there is an opportunity to create change we as a society must move forward to accomplish that change. This paper encourages anyone that is reading to change your habits by using a sustainable water bottle and utensils and whenever you have an opportunity to go out and clean your local beach wither with an organization or with a bunch of friends it is certainly a fun opportunity with tons of rewards.

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