Fantastic Plastic and Its Dark Side

Summary

Plastic: we love it and hate it. Plastics are fantastic, they not only can replace most other materials, no other material has the flexibility to alter its features and attributes.

You are awakened by a plastic alarm clock, make your coffee in a plastic coffee maker. Cook your breakfast on pans with plastic handles and non-stick surfaces. You use shampoo from a plastic bottle, and brush your teeth with a plastic toothbrush. Your toothpaste has an even chance of having plastic microbeads in it. Then as you dress you will generally have something with plastic fabric on your body for the day. Your drive to work completely surrounded by plastic in your car, and sit at a desk with plastic computers, desk pads, chairs and even furniture.

Yet our use of so much plastic has a down side too. Plastic does not biodegrade for hundreds or thousands of years. Therefore, all the plastic that does not get recycled (which is the vast majority) is filling up our landfills, and littering roadways, beaches and oceans. Environmentalists have found animals with plastic in their stomachs, and additionally plastic contain toxic chemicals and are made with even more toxic chemicals.

Getting rid of plastic will have negative effects on sterile applications for health care, eliminate products that can be made with only plastic, and cause much more food spoilage.

No easy answers are in our near future, but new biomass plastics show some hope if only regulation doesn't get in the way.

Author Biography

Ron Burgess was born and raised in Colorado. He attended the University of Colorado where he carefully manipulated matriculation, receiving two separate undergraduate degrees; a BA in Fine Arts and BS in Business.

While working to meet student expenses he worked at a local college retail specialty shop, where he was fortunate to combine the realities of small business with the theory of academic big business education. This lead to an opportunity to open a retail store one week after graduation. Seven stores were opened over ten years.

In the early 1980's Ron accepted a position with a national retail consulting firm where he was responsible for new product development and training of 120 field consultants. He started his own firm in 1989.

His interests include history, genealogy, woodworking, art and science.

Ron and wife Molly have three grown sons, who together with their wives have created 7 grandchildren, all of whom are local.

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Our days cannot pass without enjoying the benefits of plastic. You listen to the morning news on your television full of plastic parts, microelectronic components set in plastic, the case, backing and even electric cord and the wall socket it is plugged into.

You have your coffee from a plastic travel mug which you place in your car's plastic cup holder. The door handles, dashboard finishing, steering wheel and front bumpers are all plastic. You use your largely plastic computer at work and sit on a chair with plastic components, and vinyl cushions. You quench your thirst from the drinking fountain because you don't want to throw away the plastic bottles, not knowing the water was delivered to the fountain with plastic pipes.

At the cafeteria, your food selections were kept fresh with plastic wrap, which preserves freshness of food, fresh food is handled by workers with sterile disposable gloves, and served in paper containers lined with plastic for durability.

Of course, we forgot to mention your plastic heart valve and stents that have added years to your life, not to mention disposable injection needles, pill bottles, plasma bags and hundreds of medical devises make from plastic. Plastic is fabulous. Its light, flexible, strong, can be made with many characteristics and is not nearly as energy intensive or capital intensive as steel, wood or aluminum.

IF we magically evaporated plastic from our lives, the day would be substantially different than today. We simply cannot get through the day without them.

Author Susan Freinkel, prior to writing her book, "Plastic, a Toxic Love Story", decided to see how plastic influenced her life throughout the day. She decided to go through one day without touching plastic. The absurdity of this experiment became apparent to her in about ten seconds, "the toilet seat was plastic.[1]" She then decided then to write them down and filled her notebook page in just forty-five minutes. The notebook also had a plastic binding, and the no. 2 pencil was coated with yellow paint, which contained acrylic.

Plastic polymers have advanced amazingly in just our lifetimes. Some of you remember before most of the day had plastics. I remember when I got my first plastic toys over 60 years ago, and even in those days, they were far superior in detail and coloration than my metal and rubberized ones. While many did not stand the rough play as long as the cast metal ones, they were usually much more fun to play with.

The plastics industry is a relatively young one[2].

Today we often think of plastic polymers as modern magical materials brought to us in chemist's labs. In reality mankind has run into this interesting material naturally for thousands of years. The ancient Mesoamericans processed a natural rubbery material into balls and other

objects as early as 1600 BC![3] References about natural materials used as adhesives, coatings, and fillers are even referenced in the Old Testament of the Bible[4].

Polymers are substances having molecules with a high number of repeating molecules. Called monomers, they form a sequential chain[5]. There are naturally occurring and synthetic polymers. Naturally occurring polymers are starches, latex, cellulose, and proteins[6].

These very long molecules allow the construction of many interesting materials from fibers, films, adhesives, paints, and tough but light solids that have transformed our modern world.

Ebonite or hard rubber, was first discovered in the early 1800s. This was the first thermosetting material used. Thermosetting is a resin pre-polymer that is in a soft or viscous state that changed into a polymer in the process of curing. This process (curing) is caused by an action of heat or radiation often under pressure. This is called Thermoset.

In 1839, Goodyear invented vulcanized rubber, and Eduard Simon discovered polystyrene. Simon was a German apothecary[7]. Of course, we know the Goodyear name because of the tires that we still buy for our cars.

Charles Goodyear walked in to the Roxbury India Rubber Company, the first American rubber manufacturer in 1834. He was trying to sell a new valve he had devised for rubber life preservers. The company was unable to do business as they were doing badly and not sure they could stay in business. Taking young Goodyear into the storeroom, they stared at rack after rack of rubber goods that had melted into a big mess of foul-smelling glue due to the hot and dry weather. Customers were returning thousands of melted rubber products. This became "rubber fever," and soon demand shifted to a new waterproof gum from Brazil. His valve business was hit hard. Goodyear, returning to Philadelphia was thrown into debtors' prison where he began to work on rubber experiments. Goodyear reasoned that this gooey substance might be mixed with a dry powder to take away the stickiness.

When out of jail again, he continued his experiments. He made up rubber overshoes, but that summer they also sagged into shapeless paste. Continuing his experiments, he tried sulfur and by mistake his rubber was thrown on a hot stove. Instead of charring, it hardened into weatherproof rubber. He realized he could alter the formula and make many different products. It was the first and most versatile of the modern "plastics.[8]"

In the 1850s at the Great Exhibition of London, Alexander Parkes of England discovered a solid residue that was left when photographic solvent evaporated. This residue was a hard, elastic, and waterproof substance. He described it as a horn-like substance. Think of a cow horn and its almost plastic-like quality. He later patented the process of waterproofing woven fabrics using his discovery[9].

The same process was also worked on by the Hyatt brothers, who after some legal battles, called a similar substance cellulose. Today it is called cellulose nitrate[10]. The word "plastic" was introduced in 1925[11]. In the same decade a German chemist with experience in studying natural

compounds proposed that these substances were made up of macromolecules with 10,000 or more atoms[12]. He studied a polymeric structure for rubber which was based on repeating monomers. He eventually was awarded the Nobel Prize for his work. This understanding helped fuel the rapid development that would follow.

Developmental work continued almost unbounded through the first half of the twentieth century. Chemists eventually realized that many natural resins and fibers were polymers. The first synthetic plastic was the introduction of Bakelite, invented by Leo Baekeland in 1907. His company produced laminating varnish, molding material, and casting resin. The molding product sales exceeded laminating material in the 1930s[13]. Some of the first products were motor distributer rotors, radios, and the Ericsson Telephone. Many toys were made from Bakelite replacing cast iron and tin toys in the 1940s and 1950s. They were more durable, didn't scratch, and could be made in colors that were imbedded in the plastic, making paint unnecessary.

During the first half of the twentieth century, at least 15 new classes of polymers were synthesized. The commercial success since then has been substantial.

A range of materials including natural polymers, modified natural polymers, thermosetting plastics and thermoplastics, have been developed. They have a range of unique properties and a wide range of temperature usage. They are chemical and light-resistant. They are strong, tough, and low cost compared to other materials.

Polyethylene was developed by Reginald Gibson and Eric Fawcett in 1933. It was used as a low-density resin (LDPE) by 1935. In 1953, high-density polyethylene (HDPE) was invented[14]. About 25 processes are used today in manufacturing the full range of polyethylene. This is the second most used resin type. It is used to make plastic film, milk jugs, sandwich bags, cling wrap, pipes and insulation for electric cables[15].

PVC (Polyvinyl chloride) was commercially viable in the 1920s. PVC differs in chemical structure because it contains chlorine as well as carbon and hydrogen. This white powder needs a blend of other substances to give it a wide range of attributes. It is used in piping, medical devices, shutters doors, and upholstery and other industrial applications.

PS, Polystyrene, was produced in the 1930s by the well-known BASF German company. It is in two primary forms: A general purpose and high-impact grade. We know about polystyrene cups, and a modified form is also an excellent insulating medium for homes and industrial buildings. It is also used in TVs and other electronic goods.

PET was discovered in 1941. Today we recognize this polyester film in many forms of bottles which are clear and resist Ultra Violet light. It is transparent, lightweight, and resists carbon dioxide permeation[16]. These include the very familiar water bottles and soda bottles today. Also in this year, following Pearl Harbor, the director of the board responsible for provisioning the

military, pushed for substitution of plastic, for aluminum, brass, and other strategic materials[17]. The war pulled the plastic industry out of the lab and into the real world.

Polypropylene was discovered by Giulio Natta in 1954. Commercial production followed in 1957. This is the most widely used plastic and is manufactured around the world. This is because it is a low-cost and versatile material. It can be thermoformed, blown film blow-molded, injection-molded and extruded into a wide range of products such as stackable crates for storage and shipping, small, thin-walled containers (yogurt, margarine tubs, food trays), glass replacement, window frames, water pipes and household goods, such as bowls, combs, toasters, hair dryers, and film wrapping for clothing and many other applications.

Today we have many social benefits of plastics. They are lightweight, sterile, and relatively easy to manufacture. The strength-to-weight ratio assists car manufacturers in pushing up gasoline mileage. Stronger, lighter packaging and bottles are convenient and save millions of dollars in transportation weight. We have many products that would cost much more in wood, metal, glass, or ceramics, saving billions of dollars for consumers.

Perhaps the plastics world came of age in the movie *The Graduate*, where the term "the future is plastics," was uttered to Dustin Hoffman in the 1960's. This phrase has certainly come true. Since then the industry has grown 20 times. In 1979, the production of plastic exceeded that of steel.

Industry Statistics

The plastics manufacturing industry and their suppliers are the third largest in the US, and employs 1.4 million workers. There are 16,000 factories in all 50 states. Together they log a $13.4 Billion trade surplus. The world produced 311 million tons of plastic in 2014[18]. That is a lot of plastic! And this enormous number contributes to the "Dark Side" of Plastics, because 50% of all plastic we consume, is for just one use[19]. That's 185 pounds each year for each one of us[20].

If you ask a friend what they think of their laptop (encased in plastic with lots of internal plastic components), you will likely get a thumbs-up. Ask them about the plastic bag they carried it out of the store in, and they would give you thumbs-down.

The plastic industry is stuck with this bi-polar consumer attitude about the plastic products they produce. People can't really live in a modern society without plastic products, yet many highly resent some of the products produced.

Plastic products can be broken into two categories -- durable vs. disposable.

People love products made from plastic, but not all products. Google “consumer attitudes about plastic products,” and you will get a page filled with Websites about plastic bags, but not much about consumer attitudes about durable plastic products like laptops, chairs, clothing, dishware, medical products, and recycled plastic decking material.

In fact, the anti-plastic bag and disposable plastic attitude is clearly very negative, while few of these same Websites even bring up durable plastics as an issue. Lots of scholarly studies have been done on plastic bags, packaging and throw-away containers like water bottles, but little is found on durable plastic products intended for many years of service.

The concern about shopping bags started all the way back in 1974 in some communities. At that time, it was thought that paper bags were killing all the trees. But a switch to plastic bags in that decade became another cause for the landfill-aware consumer. Of course, the issue reversed course when “renewable” resources were compared with non-renewable resource awareness. Trees, after all, have been farmed specifically for paper usage for nearly a hundred years; old-growth forests are not cut for paper bags. Plastic bags became the darling of the environmentalists, and I switched to plastic in my seven stores in the 1970’s, because my environmentally sensitive customers didn’t want paper anymore. The public concerns about waste in general were well known by the 1990s when academic studies were completed by behavioral marketing research firms. A Purdue study in 1995 concluded that, “Buying and using recycled products can stimulate the market of recycled materials, which is good for the environment. The results of this study suggest that consumers' willingness to buy recycled products can be motivated by emphasizing the importance of environmental issues, positive attitudes toward recycled products, and the feeling of contribution to the environment from the purchase of recycled products.[21]”

“Of course, the inference on recycling is that it can be an asset, after the initial disposal of plastic or paper. But later studies focus on plastic bags as a heinous environmental pollutant because it did not deteriorate quickly enough and was hurting fish, animals, and the environment[22].”

Today, however environmentalists are seemingly more concerned about CO2, so the amount of energy use is also calculated. This calculation puts plastic above paper again, because paper is so energy intensive. None-the-less politics rarely follows logic or pure science, so we now charge for plastic bags in California.

Studies that support or condemn durable plastic product production on the other hand, is difficult to find. However, consumer behavior -- watching what they do instead of what they say -- can provide some information.

Plastics consumption and production alone is a simple test of acceptance. In the last thirty years, it has grown almost 600%, from 50 Metric Tons to just over 300 Metric Tons[23]. Even in Europe, which is sensitive to waste, plastic packaging is nearly 40% of all plastic demand. Consumer and household durable goods were 22.4%[24].

These facts alone explain the consumer demand. If people did not buy plastic products, they would not be produced for long. The issues with plastic appear not to be about usage but about reuse versus disposal.

Packaging is one of the sensitive areas for plastic production. It's really easy to criticize a single use of packaging when it stays around the environment for hundreds of years. A new Microsoft Surface Pro comes in a beautifully designed cardboard box, but a great vinyl (plastic) cover for it is encased in three layers of plastic; a clear plastic box containing another plastic spacer inside, and plastic wrap around the box. They were well designed, but not something you would save. The Surface Pro will be well used for perhaps six to ten years, as will the cover. Then much of that will be recycled. But the plastic wrapping will go directly into the trash, and even though it is in the recycle bin, it will likely not make it back into another plastic product. The consumer asks why it was necessary to encase the product in plastic layers?

But one study indicates that packaging increased the salability of products. In a Mead Westvaco study, "64 percent of those surveyed indicated they purchased a new product because the packaging caught their eye. And 42 percent said they used products more regularly because of packaging. And 36 percent — more than one of every three people surveyed — said they changed brands from a product they previously used because of new packaging[25]."

Packaging can influence buying behavior. In the case mentioned above, the case is easily viewed on all sides due to the clear-plastic boxes. Did the item really get bought because it was visible? It probably did play a part of the decision because it was visible and elegant, creating a perception of superior quality (way beyond its actual price).

How many times do you wish you could look and feel how a piece of hardware will work with your project? Or simply want to see the toy you are about to buy your kid for Christmas? Of course, plastic can be used with paper and cardboard in packaging, but the plastic will outlast the paper in a trash fill about a hundred times.

Retailers will also tell you that plastic clam shell packaging also reduces theft because it is difficult to get the product out of the package without a knife. Seeing the product without removing it from the package is driven by inventory shrinkage as well.

Packaging experts will say that "both plastic and paper have advantages and disadvantages. Paper takes more energy to produce than plastic, but traditional plastic from petroleum isn't biodegrade[26]."

The promise of biopolymer plastic bags is not quite here, but this may lead to plastic bags that people can feel better about. This may also lead to biodegradable packaging, but the truth is that even this option is not a panacea. The consumer is confused about how to make buying decisions due to the complexity of understanding the trade-offs between plastic, paper and other options.

As long as we see plastic on beaches and floating in big circles in the middle of the Pacific Ocean the problem stays in the forefront of the consumer's mind. It is likely they will continue to find fault with plastic as disposables even as they love their durable plastic products.

Marketers of plastics will still need to honestly assess each use of plastic, and truthfully communicate the reasons for the decision to use the material. This is a task that is still lacking for most purveyors of plastic products. As long as this continues, consumers will have doubts about disposable plastics. Transparent, logical thinking about what plastic is used for, is the best way forward for the industry and each of us as consumers.

The environment

All this success and usefulness does come at an environmental price. The simple durability of the material makes plastic a material that lasts and lasts and lasts.

If you mentally go back through a hypothetical day, how many times did you use plastic then throw it away? We buy groceries in plastic bags (that were thrown away until recently in California) We drink water in plastic bottles, (60 million each day[27]), we buy meat, and produce in plastic wrap and Styrofoam plates, we buy butter and cottage cheese, and milk in plastic bottles. We put sandwiches in zip lock bags, and our Amazon shipments come with plastic wrap, Styrofoam peanuts, and finally we use a Styrofoam cup to get our coffee after working out at the Y.

You guessed it, we throw away all of it. Some of you actually put it in the recycling bin! But our recycling of plastic is still abysmal. We recycle only 9.5% of the plastic we use, another 15% was combusted for energy[28]. This leaves 75% as pure waste for landfills.

Naturally as we all know plastic is tough, it is estimated to take 500 to 1000 years to decompose. Of course, no one can verify that! While some plastics continue to break into smaller and smaller pieces, they are still with us. Almost 8 million metric tons of plastic ends up in the world's oceans annually, one report calculates that there will be more plastic in the ocean than fish. (But if you read the Population Bomb in the sixties, you may have some skepticism about long term forecasts.)

We may debate global warming, but few debate the problem with plastic. It's not that we hate plastic, on the contrary, we love it. It is that we throw it away and its useful life is as short as a few days. It is waste pure and simple.

Many plastic industry people don't try to defend this anymore. Yet they know their customers demand plastic products, so they feel they must produce them. And some work hard to increase consumer awareness for recycling. Few want to jeopardize a million US workers either.

So, like previous pollution problems that we have solved, governments get involved to first monitor then legislate fixes.

As you all know California has just done this with plastic bags. But as is often the case, the attempt of big government to regulate, often doesn't really solve a problem. The flimsy T-shirt plastic bags are gone now, and we must pay for different bags at grocery stores. However, many replaced the free bags that broke down in the sun fairly quickly with heaver ones that theoretically are supposed to be used several times. Currently we don't know how many times they are actually reused. But these bags last much longer than the older flimsy free ones. The problem is how many we recycle.

Nearly all plastic of course is an issue we must deal with environmentally, but for now, the single use plastic we discard is the most visible and troublesome problem.

Plastic that is not recycled, can make it into landfills, where without light and the elements, will not biodegrade. If it is discarded, on the ground it can sit on the surface for hundreds of years, or find its way into the water system, washing into lakes and oceans. There, it can break into smaller pieces that wildlife can mistake for food, and their digestive systems do very little better than the environment does. Large animals can pass some of it, but birds and smaller animals can't.

The implication is that this kills the animals, however I have not seen research on this yet. But one can assume it does them very little good. Sea life also gets caught in nets and fishing lines that don't deteriorate rapidly enough to keep them from catching unintended wildlife. Some larger containers are collecting in giant swirls of natural ocean currents. The clarion call by environmentalists is that one the size of Texas is in the northern Pacific Ocean, however at least one experienced mariner who has steamed through this several times, says you can hardly tell it is any more than random flotsam, it is dispersed so greatly.

No one will defend acres of floating plastic, but as usual both sides have different realities, making the consumers decisions largely uninformed.

The flotsam eventually breaks up and falls to the floor of the ocean. Some declare that this will change the ocean balance, and the sedimentary development over Millenia. I doubt that this is untrue, and encased in sediment, I expect geologists of the future to identify us as part of the plastic geological age. On the other land, logic tells me it is in the same place as the oil started! CO2 advocates should be happy to have carbon sealed forever in sediment and out of the air. But so far, I see few who will admit to it.

Recycling is not possible for all types of plastics, but we are not doing a very good job so far with those that are recyclable. Nationally we recycle about a quarter of PET bottles, such as a Coke bottle. (California does better at about 75%). So, from almost seventy-five billion bottles

produced each year nationally, about fifty-seven billion bottles are litter or in a land fill somewhere.

This amounts to enough polyester so that every person in the US could have three knit sweaters. The energy used could light and heat 1.2 million households for a year.

It hasn't always been this way. For most of our history, we produced almost no waste. Few people had the money to be wasteful. Rags were used for paper, or new clothing, broken items were repaired, or sold to peddlers who then sold glass, rags, leather and other materials back to industry. The rest was burned for heat or cooking according to Susan Strasser who wrote Waste and Want.

According to Susan Freinkel "People say plastic is plastic, but a milk bottle is as different from a soda bottle as an aluminum can is from a piece of paper." A PET bottle that has been blow molded into a bottle shape, is different from a cookie tray that was extruded made from PET. If you try to combine them for recycling, you end up with a batch of goop that is unusable.

Just a few PVC pieces in a bale of PET can contaminate the whole bunch, making the value drop or even completely unusable. Processing all plastic is also problematic. Plastic bags and film, get caught in the separating machinery at the recycling plant. Styrofoam has few secondary markets, and only a handful of recycling plants in the country. Each of the seven so called types of plastic have different chemical properties; different melting temperatures, physical properties and secondary markets.

Colors used to pigment plastic can't be removed so like your paint palette, if you mix several darker colors you get a dark brownish color, that limits the final use for recycled material.

Every product and material has its own economic market. Interestingly, the way we recycle plastics today, manufacturers are actually enabled by recycling, because customers are lulled into thinking they are putting their plastic into the recycling ben, justified buying more. Manufacturers are thus relieved from the burden of dealing with the ultimate waste.

Huge government sponsored programs at the local, and state level have their own programs that compete for raw materials. In an effort to "do something" about the problem, overzealous politicians are happy to start another program to fix the problem. On the other hand if the manufacturers had to deal with the problems, they would be incented to solve the issues of collection and recycling themselves using efficient business like solutions. The cost would then shift to the products instead of taxes, potentially changing behavior based on comparative value for each packaging alternative.

Toxicity

The approximately 4% of petroleum that gets cracked into plastics through a combination of temperature and pressure, dissembles and reassembles hydrocarbons in to new arrangements

that lead to monomers. Monomers can be formed into an almost infinite variety of shapes, each with potentially different characteristics.

A ring of six carbon atoms gets you benzene, a base for styrene, which is then used to make polystyrene. A carbon quartet can become ABS (acrylonitrile butadiene styrene) which you will now associate with Legos.

At another temperature three carbons make polypropylene. Higher still, creates ethylene the starting molecule of polyethylene. But the chemist is just getting started. Other chemicals mixed in under repeated steps like butane, isobutene and propylene can further increase the variety of plastics.

Additional chemicals change the characteristics of each of these. Vinyl plastic use in bags and tubing contains a softening chemical called phthalate (pronounced tha-late) is known to block production of testosterone and other hormones. The effects may not show up for years, and perhaps only in offspring. Some accuse new susceptibility to asthma, diabetes, obesity and infertility to the poor phthalate.

Different types of plastics have different chemicals that potentially leach into water or air around us. Most of us, including new babies, carry traces of phthalates and other synthetic substances such as fire retardants, solvents, and waterproofing agents.

Bisphenol A, is the primary component of polycarbonate. It is used for baby bottles, eyeglass lenses, and water bottles. It is also part of another plastic epoxy resins used to line canned foods and drinks. Hot water and detergents can loosen the links in the polymer daisy chain so small quantities of PBA can be leach out. PBA is associated with blocking estrogen receptors on cells. The research is highly controversial because effects at low doses may not show up, and controls are difficult[29].

Chlorine is a dominant part of PVC Poly Vinyl Chloride, that we all are in contact with. It makes PVC very hazardous to make, and it is tougher to get rid of. When incinerated it releases dioxins and furans that are highly carcinogenic compounds.

These few cases are not the only concerns but serve to illustrate some of the later day issues that may be the future of some plastic. Consumer concern has already caused adjustments by manufacturers. PBA free is a newer development which is touted on packaging for those seeking to avoid PBA exposure.

This problem seems as complex as making plastic itself. Some plastic may be toxic, and some is only toxic due to certain conditions. No single rule or behavior will work across all plastics, which in itself erodes consumer confidence.

BIO ALTERNATIVES

All news on the plastic front is not bad. New plastics made from biomass are under development. The first full blown factory that will make certain plastics from plant based polymers will open in 2018 in

Malaysia. The demand for all plastics exists for a renewable source of polymers. While good progress has been made, so far some sacrifices in quality seem inevitable.

However, assuming that plastics made from plants, makes all disposal problems go away is simplistic. It also does not mean that the same bad additives won't be needed to make certain plastics. One thing is clear, it will add to the complexity of disposal.

The state of California has already sued companies using the term bio-degradable for plant based material marketing. So far new plastics made from biomass are not bio-degradable according to California's regulations, but bio-compostable.

This simply means that in order to break down chemically into natural materials, an item must be in a composting site that includes the proper bacteria that will eat particular chemicals. These bacteria do not readily exist in our landfills, which are all sealed with, ironically, plastic to protect ground water leaching.

Certain areas do sell lawn clippings and plant waste to companies that compost, but these facilities are not really set up for millions of pounds of plastic, assuming they would want to include it in a soil enhancing product. So we may end up with biomass, bio-compostable, plastic products that are preserved for the archaeologists of the future in our current landfills anyway.

But people will feel better about it.

The race to develop better degrading plastics has been taken up by most of the very largest plastic producers. Even plastic giant, Legos has started a large research facility to develop better plastics. The first to the market will reap large rewards because consumers will flock to them if quality is good enough.

It's not yet a panacea but it's a small start to tame the Dark Side of Plastics.

Conclusion

Modernity would not exist without plastics, consumers would howl without certain benefits that can only be made using plastic polymers. The cheap cost of plastic (which used to be largely burned off as waste) allowed our natural inventiveness to create many wonderful products at prices that drove alternatives out of business. Our standard of living went up, and in many cases the pressure on natural resources was reduced or eliminated, saving species, and conserving resources for other purposes.

No one wants to go back to 1900 and leave plastic behind. Yet it has become so pervasive in our lives, that is has spread into areas of the economy like a unwanted invasive species in the wrong bio niche.

The very success of plastic has made it seem valueless because of its low price. We rarely consider the downstream issues caused when we throw away single use plastic. They are too numerous to save for other uses.

We all know (consumer, manufacturer and government) that our current habits are unsustainable. Consumer groups work on changing our habits, government tries to regulate but gets tied up by special interest groups and lack of full knowledge. Science and industry is attempting to solve the problems with modern technology.

Ironically any of these groups could solve it alone, customers could stop buying single use applications, manufacturers could stop making them, or take responsibility for them through end use, government could properly and realistically add regulations, but that seems fanciful. Perhaps technology will finally fix the problem if consumers buy new bio plastics and recycle more and government doesn't stifle the bio plastic development before they solve them.

As futile as it may seem, plastic is so valuable for some uses that we cannot go back. Other uses we can do without. Yet other plastics are still unsafe and harm the environment. The chemistry remains very complex, but we invented the stuff, so we can tame it too. In the meanwhile, consider glass and paper where you can, and take the time to recycle mindfully.

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