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Designing Single-Use Plastic Products: Far from the Earthly Paradise

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Abstract

Single-use plastic products design has been one of the cleverest and efficient plastic design achievements of the last decades of the twentieth century. New, simple, inexpensive and innovative solutions based on the flexibility of the technologically advanced plastics found wider applications in the everyday lives of millions of people around the world. Nevertheless, the bliss of these economic, handy products-miracles of the ever-growing global technology soon became a nightmare as all the plastic that has ever been produced has never been totally biodegraded and is still in some form on the planet. Although we use them for a few minutes, they can stay in the environment for hundreds of years. Our dependence on single-use plastics has now become unmanageable, and plastic pollution is everywhere: from our body through the food chain to the more remote beaches and uninhabited islands. This article aims to examine not only the advantages of single-use plastic product design, but also to point out their serious defaults, such as environmental pollution and discuss the possible measures to be taken by several public and state bodies, especially EU, who intend to protect people, economy and the planet itself.

Keywords: single-use plastics; environmental pollution; sea pollution; plastic bags; plastic packaging.

1. Introduction

Plastics are one of the major and perhaps most controversial phenomena in the industrial, social and cultural scene of the twentieth century, as they are carriers of qualities and concepts such as success, triumph, technological development, practicality and functionality, as well as ambiguous value, misleading beauty and cultural spoofing.

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However, their glamorous upsurge at the beginning of the last century led to the unparalleled superiority of a new, revolutionary industrial product that would change the economic and cultural profile of humanity. Of course, this was the result of the overwhelming global mechanization, but above all the need of Western societies to invent inexpensive and functional solutions to the practical problems of everyday life. However, in the turmoil of contradictions that arose in terms of their validity, plastics managed to gain a high position in the list of the globally accepted new typologies only when their economic prospects started to converge with their contribution to the cultural scene [1]. Products of the new developments with specific characteristics such as smooth, clean and transparent forms, sometimes strong and some other times soft colors, shiny and glossy surfaces, rounded, 'fancy' shapes or, on the contrary, 'masculine' geometric volumes, the synthetic items took the place they deserved in the collective memory of consumers right next to traditional materials such as wood, glass, metal and ceramics during the first half of the twentieth century.

However, diversification into consumer tastes, needs and, by extension, purchasing choices, particularly in the second half of the twentieth century, blurred their glow. Post-war consumers in several Western European countries and the U.S.A. seemed to gradually lose interest in this endlessly repetitive functioning system of simplified synthetic objects and to focus, from the field of their materials and primary properties, on the area of *communication functionality* of the products [2].

Nowadays, production, quality and the importance of plastics, mainly of the single-use plastic products, have increased significantly to the point that they exceed even the most optimistic predictions. Affordable, attractive and easy to be massively produced, freed from any sterile ideological and cultural constraints, but also from their monolithic functional value, the single-use plastic products were combined with a wide range of other materials, which not only restored the lost glamour of synthetic objects, but also established them as absolutely necessary.

However, their excessive production on a global scale, their unrealistic use and their limited material and design properties to get biodegraded in the environment after use, rendered them perhaps the most problematic industrial design products for mass use. Every year, the consumption of single-use plastic products is growing, making plastics waste become one of the most important ecological issues which has found no drastic solution so far. It is therefore reasonable to raise questions about their current problematic with regard to the contamination burdening of the environment, an issue that will remain not only on the agenda of international political circles but also on the education and consciousness level of consumers which needs to change rapidly. What are the use benefits of single-use plastics today? What are their effects on environment? [3] What are the measures that can be taken for the protection of environmental pollution from single-use plastic waste?

2. Use and benefits of single-use plastics today

Nowadays, single-use or disposable plastics, that is plastic products which can be used only once before been thrown away or been recycled, have taken an enormous part of our lives in the form of visible or even invisible elements whether they concern industrial applications or simple daily consumption. Thus, they can be found almost anywhere in the world, not only in big cities, but also in nature itself: especially soil and water can be

fatal hosts of these 'miraculous' products, according to the increasing scientific research documenting the human plastic footprint in the planet [4]. As mentioned above, their very important properties, and especially their low production cost and consequently their sales, as well as their enormous versatility for everyday use, make them the most affordable items to buy and consume. For these reasons, they are usually a source of inspiration for many, radical innovations in industrial design so that any new product is tailored to the needs of consumers, related mostly to health and safety.

The products included in the wide range of disposable plastics are widely known and have been used as everyday use objects by all of us: water and soft drink bottles, razors, plastic bags, straws, plastic tablecloths, coffee, tea and water cups and stirrers, but mainly packaging of any kind. Developed, developing or even underdeveloped countries consume more than 150 million tons per year of disposable plastic goods, from which only 10-15% is recyclable. Today, their production seems to move towards Asia as China and India, the two most heavily populated countries in the world have presented an analogous growth in manufacturing sectors, leaving Europe, the U.S.A. and the states emerging from the former Soviet Union far behind [5]. But which categories of these kinds are the most important for the smooth running of everyday life? Which products are directly contracted with the concept of necessity with regard to the coverage of human needs and in which areas? And why does the design of these products provide for their immediate disposability after use?

Packaging is probably the most important sector of this type of plastic products that seems to be related to many categories of product or service design goods as it is an essential factor for their smooth and systemic consumption. Nowadays, packaging can be found in many forms and is both widespread and diverse. Some of its most important characteristics in terms of use are: the protection of the product (from any kind of biological attack or mechanical damage), the attractive presentation of the product or even the information it may bear about the use or the ingredients of the product [6].

Figure 1: Food plastic packaging is one of the most useful forms of single-use plastic products, but also one of the highest environmental hazards.

Food packaging is one of the most notable areas of plastic packaging and constitutes possibly the major area of plastics consumption worldwide. From East to West plastic is vastly used to package, deliver, store or serve foods and drinks. Especially preservation and distribution of food so as to be delivered fresh, tasty and delicious to consumers, is of vital importance [7]. These two basic requirements can be achieved through this type of packaging as it is considered an inactive and chemically resistant material both to foods of any kind and the outside environment. Recent technological advances have rendered it more efficient as its weight has been reduced about thirty percent. On top of that, clear plastic packaging gives the opportunity to consumers to view the goods they purchase and make opening of the packaging an easy task. Some types of food packaging such as plastic food and drink containers and wraps are extensively used as they contribute both to the reduction of waste by reducing the amount of spoiled food that must be thrown away and the decrease of the amount of preservatives added to keep food fresh.

Food packaging is inextricably woven with the crucial concepts of hygiene and health. For example, a plastic water bottle can allow hygienic access to clean drinking water and is less resource intensive to produce than alternative materials. It's easy to forget this as plastic packaging does such a good job protecting us from harmful germs. The new technological achievements in food packaging, as well as in other forms of plastic packaging, have managed to reduce considerably packaging weight in transit and in many cases, the number of trucks needed to transport goods from place to place is also reduced. Consequently, without this type of packaging food waste would increase, more energy would be needed and consumed and more carbon emissions would result [8].

Other types of packaging concerning areas such as the cosmetic and personal care industry (shower gel, shampoo, body lotions, perfumes etc.), the health care (plastic syringes and tubing, intravenous blood and medicine bags, catheters and even contact lenses and eyeglass frames etc.), or the home and garden industrial production goods (furniture, lighting, cooking utensils, garden tools, plant pots etc.) are also of much importance as they contribute to the ideal use of the items from the final recipients. In many of these cases, plastic packaging functions require special skills and knowledge in addition to specific machinery and facilities to produce reliable and effective products [9]. There are many cases when plastic is successfully combined with other types of packaging materials such as cardboard, wood, glass or paper according to the needs of each product in terms of reliability, safety and aesthetics. However, the latest years, packaging designers keeping in mind the several drastic changes in the environmental issues, but also in the consumer ecological attitude, look for ways to use recycled content, design for recyclability where it makes sense, and many times include guidance about recycling on product labeling.

Everyday single-use plastic items such as plastic water bottles, lighters, cups, forks, spoons, knives, plates, straws, flood the lives of millions of people at every corner of the globe. However, plastic bags of any type, size, color, design and quality are the most debatable items of all. Having first won over supermarket and grocery stores and then consumers themselves they managed to be the most notable phenomenon in the modern plastics world for many, positive and negative, reasons [10]. When they first appeared in public were almost totally detested as they were taken cheap, in terms of quality, and unattractive; but the most persuasive factor for their subsequent success in the buyers consciousness was their extremely economical price. Later, however, they

began to be distributed free of charge, which made them an absolutely necessary and useful product in everyday shopping. On top of that they were light, easy to use, flexible and easy to dispose which made them really handy in terms of goods transportation. Today, plastic bags of every use are an icon of convenience culture and are absolutely representative of the achievements and important problems created by global industrial culture, too [11].

3. When blessing becomes a curse

From the above it follows that plastics, especially single-use plastic goods, - have many useful uses which are however directly contracted with multiple and serious environmental issues. Typically, around one million plastic bottles are purchased every minute, and we use up to five trillion disposable plastic bags per year. Overall, 50% of the plastic we use is for single-use. Almost a third of the plastic packaging we use escapes from the collection systems, which means that it ends up polluting the natural environment in several ways. Every year, up to thirteen million tons of plastic come to our oceans, resulting in the slow death of coral reefs and the extinction of other vulnerable marine wildlife. The plastic that ends up in the oceans is enough to cover millions of acres of marine and / or land surface and can remain for up to 1,000 years before gets biodegraded totally. Discarding plastics after use is one of the key reasons that there are so many plastic products in the oceans. Items such as cigarette butts, personal care and cosmetic containers, plastic drinking bottles, food wrappers, plastic grocery bags, plastic lids, plastic bottle caps straws and stirrers, may contain tiny pieces of plastics known as *micro beads* which can stay in the water and eventually find their way into the sea [12].

Plastic can easily enter tap water and it can consequently enter our bodies. What kind of harm can this cause? Scientists are still not sure, but plastics contain many chemicals, many of which are toxic or hormone disrupters. More specifically, when we deal with petroleum based plastic which is definitely not biodegradable, it usually goes into a landfill where it is buried or it gets into the water and finds its way into the sea. This type of plastic breaks down into small, tiny, barely visible particles known as *microplastics* and during this process, known as fragmentation; it can release toxic chemicals, that is some kinds of additives that are used to harden plastic material and give it its final shape, which make their way into our food and water supply. Single-use plastics can have such ‘qualities’ and they can additionally serve as a magnet for other pollutants, including dioxins, metals and pesticides. We can see, therefore, that many times their ‘cost of use’ may be much higher than their production cost, as man and the environment are the main recipients of their dark side [13].

It is estimated that plastic packaging accounts for almost half of the plastic litter in the whole world. As stated before, Asia, the most populated Continent, is primarily responsible for this, while the rest of this waste is generated in the U.S.A. and the European Union which are considered to be the world’s largest producers of *plastic packaging waste* per person. According to *Plastics Europe* plastic production comes in three large categories in Europe [14]**.** In the first category which constitutes the 40 per cent of the total waste and which is possibly the larger of all, we find the single-use disposable items, such as food packaging, agricultural films and disposable consumer goods for 2015. A year earlier, in 2014, in Canada and the U.S.A. the same type of plastics covered the 34 per cent of total plastics waste whereas in China in 2010, the equivalent figure was 33 per cent.[15] But if we have a closer look in specific areas such as waste streams we will find out that plastic

packaging reached a much higher percentage, almost 62, of the total plastic waste in Europe in 2012. All this data make us come to the conclusion that single-use products and especially packaging constitute the biggest part of plastic waste, followed by waste derived from other sources of consumption such as vehicles and electronics.

As regards plastic bags and containers in particular, research suggests that they can be particularly destructive for both the environment and urban life. They can block or pollute waterways by clogging up water or sewer pipes and thus rendering them ideal places for mosquitoes and pests breeding. They can also contribute to the increase and the transmission of vector-borne diseases like malaria. In many cases plastic materials, especially transparent bags, are found to be taken as food by hundreds of species, especially sea creatures such as turtles and dolphins which mistake them for jelly fish and also birds blocking their airways and stomachs and constitute a severe factor for their immature death.

Figure 2: Single-use plastics, especially plastic bags are considered *the biggest source of trash" found near waterways and beaches.*

These items are scientifically proven to contain a high amount of toxic chemicals which can easily pass to the animal tissue, which can be fatal for health after its consumption by humans. Their consumption is literally massive and it is assumed that one to five trillion plastic bags are consumed across the world each year which can be interpreted as follows: five trillion plastic bags is almost ten million plastic bags per minute. If all these plastic bags were tied together, they could be wrapped around the globe seven times every hour [16].

Styrofoam containers, such as coffee or tea cups, food containers or dishware made from polystyrene, a petroleum-based plastic, are full of carcinogenic chemicals like *styrene* and *benzene* [17]. These can be extremely dangerous if ingested, because of their high toxicity that can damage the crucial parts of human organism such as the lungs, the nervous and the reproductive system. And this is quite possible to happen as Styrofoam toxins can easily leach into food and drinks.

All types of packaging applications can also constitute a significant source of rubbish contamination. As much of this stuff is able to stand the solar radiation effects and air oxygen in combination with the effects of heat and moisture under natural conditions for a very long time without being degraded, it can constitute a stable threat for the environment.

There are also cases that plastic waste is not considered totally useless, as it can be used as 'fuel', with all the dangerous effects this may bear. In many poor countries, it can be burned for heating or cooking; however, its disposal through burning can produce harmful, toxic gases such as *furan* and *dioxin* to which ignorant people are exposed with fatal consequences. In general though, atmospheric pollution caused by plastic gas emissions as a result of several human activities, is a quite common phenomenon, which however can have destructive results in both in people's health and environment itself [18].

From an economic point of view, the damage caused by plastic waste is literally enormous. For instance, plastic litter in the Asia-Pacific region alone is particularly harmful for its shipping, fishing and tourism industry as it may cost it over one billion dollars every year. In the European Union countries, cleaning coasts, beaches, and streets from plastic waste may cost more than six hundred thousand dollars [19]. However, the damage caused to the environment, mainly as regards the world's marine ecosystem, is priceless and many times, unfortunately, irreversible.

Recently, the UN underlined that we are undergoing a 'global crisis' that destroys our ecosystem. In spite of the fact that we are aware of the magnitude of the impact of pollution, we do not try to reduce it as much as we need it [20]. However, governments, international conferences, the press and also large international organizations have tried to inform the public and, in many cases, to enforce measures that would help combat this scourge that seems to undermine the future of our planet.

4. Some of the latest measures

Plastic products, especially those of our interest, are a global issue with multiple interpretations, benefits, and national interests. For the EU, this is a single market issue, as more and more Member States or local authorities undertake individual actions to ban various types of single-use plastic products, while more Member States or even local authorities aim to reduce consumption of certain types of such plastics. However, the risk of fragmentation is real and there must be a level playing field.

This action is also an economic opportunity to innovate and replace the most harmful single-use plastics with more innovative products or business models - taking advantage of the EU's leading role in the bio-economy or the introduction of return and re-use programs that create local jobs. This legislation will be able to provide both clarity and the economies of scale required for investment and innovation in the single market. EU citizens are aware of this issue and are also willing to act. According to a recent Eurobarometer survey, 87% of Europeans are concerned about the environmental impact of plastic, 74% are worried about its impact on their health, 94% believe that products should be designed to facilitate recycling, whereas the same percentage believes that industry and retailers should try to reduce plastic packaging.

After many suggestions on the ecological issue solution, with special focus on the single-use plastic products contaminating character, the first results did not take long to show up. Already since the beginning of 2018, the most important and most effective special committee / group of representatives of the European Parliament, the European Council and the European Commission whose meetings deal with solutions to this issue, has been set up. At the same time, a 'diplomatic' fever is in progress, as the directly involved stakeholders, such as the plastic industry of each country and the economic and social players, discuss with governments the attitude they would like to keep. The decisions taken so far by this committee are of particular interest: the ban on the free disposal of the plastic bag, although it appears to be a very simple measure, in other countries has already brought a great reduction of its use. However, this measure has yet to be followed by further steps, such as the gradual increase of its fee and ultimately the final ban of its production, as only then we can have serious results for the protection of the urban and natural environment. After the unprecedented, world-wide suggestions for the plastic bag use in areas such as Australia and the United States Europe, which has already taken steps to ban the plastic bag, some other plastic products will have also be taken into consideration so as either to be banned or to continue being produced, but under certain specifications. Now, let's focus on some of the proposals, adopted by a large majority in the European Parliament:

- By 2021, it is proposed to completely prohibit the purchase of single-use plastic products such as cutlery, dishes, straws, balloon supports, cotton swabs, oxodispersible bags and expanded polystyrene (EPS) fast food packages.

- Member States should draw up a plan to reduce single-use plastics by at least 25% by 2025. The measures should not be 'horizontal', but per product, depending on the estimated impact on the environment.

- Single-use plastic products traders (manufacturers, producers, importers, etc.) should participate proportionally in the cost of cleaning the environment (to date they are involved in the cost of recycling through known systems).

- Single-use plastic packaging with a plastic lid may only be placed on the market if the lid is not detached during use. Such products are already in circulation in some countries, such as France.

- Plastic bottles of beverages, water and soft drinks will only be allowed to circulate on the European market if they contain at least 35% recycled raw material by 2025. The aim is obviously to encourage the re-use and increase of the economic value of materials so that they can contribute to a better recycling.

- Generally, Member States will need to collect 90% of single-use plastic products by 2025 and ensure they are properly recycled.

- Feminine personal hygiene products should not contain hazardous chemicals in their composition.

- Finally, particular emphasis is placed on updating: single-use plastic packaging products should clearly indicate the appropriate - after use - management of the packaging staff, its environmental impact in

case of poor or improper disposal and whether it contains hazardous chemicals such as heavy metals [21].

5. Conclusion

The blessing of single-use plastic products and their multifaceted contribution to the modern life of all societies of the East and the West is indisputable, given the elimination of their 'side effects' in the urban and natural environment and thereby to man himself. However, the weakness of many international bodies and governments so far to eradicate their harmful effects has led to the prevention of major measures, mainly by the European Commission. It should be noted, though, that the measures proposed for single-use plastics are not individual, but complementary to other relevant measures taken primarily against marine pollution, such as the directive on port reception facilities. This wider strategy adopted by the European Commission constitutes a part of the transition towards a more circular economy to protect the planet and the citizens and also to invigorate European industries. According to this directive derelict fishing gear and, generally, ship-generated waste are considered to be a major source of plastic litter for marine pollution. So new measures are put in place in order to ensure that waste generated by ships or collected at sea must always be returned to land, recycled and processed in the ports.

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