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Planned obsolescence or planned resource depletion? A sustainable approach

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A B S T R A C T

Although much research has been done on ways to provide better conditions of environment and cleaner production, little attention has been paid to the impact of the short lifetime of the current products in sustainability and also to the necessity of providing natural resources to supply goods to a human population with a growth rate never seen before. Using literature review, secondary data and field research to illustrate this work with examples, the objective of this paper is to study the necessity of changing the paradigm of planned obsolescence to the one of long-lasting products and to present some suggestions found in the literature review on how to keep them updated under so many changes and innovation to which the products are subject in the present days. The practical implications of this research are to propose two mechanisms of planned obsolescence to complement the theory: **Design for fast consumption**, showing how industry designs products to artificially increase consumption of olive oil, perfumes, sunscreens, moisturizing creams, shampoos and other related products, and alert how a simple design change in toothpaste tubes with a mouth of internal diameter of 8 mm decreased to 5 mm can reduce consumption by 61% if frequency of brushing and length of toothpaste can be maintained; and **Design for restricted technological update,** approaching how industry uses this mechanism to force people to exchange their cellular phones and electronics in general every year; and also to propose solutions for a better benefit for consumers and the environment, and to arouse interest that global developing based on a consumption society is no longer sustainable, so a new and less consumerist society must replace the current one.

1. Introduction

Design is an issue that has received much attention in recent years because of its importance to sustainability (De Medeiros et al., 2018; Rehman and Ryan, 2018; Sonego et al., 2018). Due to the growth of the worldwide awareness of the environmental problems we face today, manufacturers are more concerned about the environmental performance of their products and services (Brundage et al., 2018; Tao et al., 2017; Zhang et al., 2018).

Manufacturing is an important sector of the economy. In 2016 the value added by manufacturing sector in the European Union accounted for 16.08% of its economy, Ireland 34.69%, Korea 29.34%, Czech Republic 27.08%, Hungary 23.90%, Slovenia, 23.34%, Germany 22.91% and in the UK 9.71%. In 2015 the value added by US manufacturing sector accounted for 12.27% of its economy and Japan 20.55% (Organization for Economic Co-operation and Development (OECD), 2017). Directly or indirectly most jobs depend on manufacturing, transforming through physical, chemical or mechanical processes, components, materials or substances, into new products (United States Department of Labor (DOL), 2017; Roosevelt Institute, 2011).

Possibly inspired by the fashion industries that launch new models every season, in order to increase sales, some industrial sectors promote changes in their products, sometimes minuscule,

Abbreviations: DESA, United Nations Department of Economic and Social Affairs, Population Division; DFX, Design for X; DOL, United States Department of Labor; FAO, Food and Agriculture Organization of the United Nations; HYDE, Netherlands Environmental Assessment Agency, History Database of the Global Environment; MAM, Milwaukee Art Museum; OECD, Organization for Economic Co-operation and Development; SUV, Sports Utility Vehicle; UNFPA, United Nations Population Fund.

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to differentiate a products launched in one year from the other year. At the same time these industries design, produce and sell their products so that they can become non-functional or obsolete in a short period of time, reducing the product lifetime, preventing from technological updates and so forcing consumers to buy new ones very frequently (Bakhiyi et al., 2018; Lawlor, 2014; Kozlowski et al., 2018; Maitre-Ekern and Dalhammar, 2016). This practice is referred as "planned obsolescence" (Bridgens et al., 2018; Fishman et al., 1993; Niinimäki and Hassi, 2011). The subject has had such relevance that on June 9th, 2017, the European Parliament adopted a motion to extend the lifetime of products and called on the Member States and the European Commission to take the necessary measures to counter planned obsolescence (European Parliament, 2017).

There are authors who advocate planned obsolescence perceiving it as a tool to recover market share, achieve technological progress, driving innovation, seeing long-lasting products as inductors of slow innovation that can lead to economic stagnation (Blonigen et al., 2017; Fishman et al., 1993). Other authors emphasize the negative economic side-effects of planned obsolescence, such as pollution, increase of waste and depletion of scarce natural resources (Echegaray, 2016; Guiltinan, 2009; Cooper, 2008).

Whilst much research has been done on ways to provide better conditions of environment and cleaner production, little attention has attracted the interest of the academic community to the impact of the short lifetime of the current products on sustainability, and the consequences that this can cause on the necessity of supplying goods to a human population with a huge growth rate, a gap that this research seeks to study.

The objective of this paper is to study the necessity of changing the paradigm of planned obsolescence to one of long-lasting products, present some suggestions found in the literature review on how to keep them updated under so many changes and innovation to which the products are subject in the present days, and to present some examples of products designed with mechanisms of planned obsolescence found in the field research and proposed solutions to keep them functional.

This research is structured in sections. Section 2 presents the method and shows the academic research on this subject. Section 3 provides the literature review on design, sustainable consumption and planned obsolescence. Section 4 presents the discussion about the world population growth, scarcity of raw materials, planned obsolescence, consumer profile in some countries, proposes two mechanisms of planned obsolescence to complement the theory and gives some suggestions found in the literature review to extend the life of some products. Section 5 provides the conclusions, points out the limitations of the present research and gives some suggestions for future research.

2. Method

Based on Scopus database, the research for this paper was made in the first quarter of 2017, using as search engine the terms "planned obsolescence" AND sustainability, the first terms in quotes to reach results that have both words together and using the logical operator AND to provide both terms. These terms were used in the search field: paper title, abstract, keywords, in the period from 1970 to 2017 and in all document types.

The research presented nine papers, five conference papers and two book chapters, resulting in sixteen documents in total, in a period of almost thirty-nine years, shown in Table 1, giving an idea of the scarcity of studies on this subject. However, the literature review did not limit to these sixteen documents, and we used other papers to complement the information presented in these selected papers, identified through Scopus database.

Table 1
Quantity of documents found in Scopus database. Search engine: "planned obsolescence" AND sustainability.

Year	No. of Documents	References	Document Type
2017	1	Cooper (2017)	Book Chapter
2016	2	Echegaray (2016)	Paper
		Wieser (2016)	Paper
2015	2	Engel (2015)	Book Chapter
		Tokić and Tokić (2015)	Conference Paper
2014	5	Lawlor (2014)	Paper
		Çetiner and Gündoğan (2014)	Conference Paper
		Lobos (2014)	Conference Paper
		Madden (2014)	Paper
		Rodrigues et al. (2014)	Conference Paper
2012	2	Nyman et al. (2012)	Conference Paper
		Borenstein (2012)	Paper
2011	1	Miller (2011)	Paper
2009	1	Guiltinan (2009)	Paper
2007	1	Forge (2007)	Paper
1978	1	Hayes (1978)	Paper
Total	16		

The research at Scopus database made at the end of February 2018, using as search engine the term "planned obsolescence" in the search field - paper title, abstract, keywords, in the period from 1971 to 2018 (almost 47 years) -, resulted in 127 documents (95 papers, 12 conference Proceedings, 11 books, 6 book series and 3 trade publications), pointing out a shortage of studies on planned obsolescence, even when the subject is addressed in a general way.

We also used secondary data available in the World Population Policies Database of the United Nations Department of Economic and Social Affairs Population Division (DESA, 2017) of the United Nations Secretariat and in the Greendex 2014 (National Geographic and Globescan, 2014).

In order to illustrate the literature review with examples of products designed for fast obsolescence, we made a field research, visiting: one car dealership, six technical assistance and five general and electronics stores, in a total of twelve professionals interviewed.

The interview with the technical assistance technician of the car dealer took about 1 h—30 min in the morning and 30 min in the afternoon -, and the others took around 30 min each, made in Portuguese with the professionals of those companies in their workplaces. All interviewees had more than two years of experience. The questionnaire had one main question: What products/parts had problems and needed to be fixed in a short period of time after its sales and/or were difficult/expensive to fix? The interviewees did not agree to be recorded, so the answers were written by hand, and the useful ones for this research were presented in Table 3.

For the convenience of the researchers all these companies were located in Sao Paulo, state of Sao Paulo, Brazil. Two of these companies were located in the neighborhood and the others at downtown Sao Paulo. The authors of this paper also provided examples of such products.

We decided to do the interviews instead of analyzing consumer complaint sites to look for examples to illustrate this research because most of the technical complaints in these sites deal with brand new products and we were looking for used products with problems.

From this methodology we could identify two mechanisms of planned obsolescence that we suggest in this paper to complement theory.

3. Literature review

3.1. Design for X

Competition is high at the present days and at the same time that companies are looking to launch innovative products to increase market share or to stay in the market, now companies need to worry not only about production costs, total quality, decline of time for development and launch of new products, but also about an ever increasing number of product requirements (Floriane et al., 2017).

In order to achieve these many requirements, the concept of Design for X (DFX) arose in the eighties, a design approach, gathering different cultures and/or specialists in teamwork, where skills and knowledge are shared in a collaborative and integrated approach, propitiating the enhancement of the design process and/or product, from a peculiar perspective which is represented by "X" (Tichem, 1997; Tomiyama et al., 2009).

There are different understandings of "X" (Tichem, 1997):

- Specific properties, such as: environmental effects, cost, risk, quality, flexibility, lead time, efficiency, etc.
- Phase of a product life cycle, such as: production, assembly, marketing, service, discarding, disassembling/recycling.
- Process and/or sub processes of manufacturing, such as: stamping, machining, etc.

It is also possible to take into account all these understanding of "X" as a whole, when life cycle, manufacturing process and specific properties are considered.

3.2. Ecodesign or design for the environment

Ecodesign or Design for the Environment, also known as: Green Design, Sustainable Design, Environmental Conscious Design, Life Cycle Engineering, Clean Design and Life Cycle Design, is a design approach that takes environmental issues into account in product development and related processes (Almeida et al., 2010). The goal of Ecodesign is to reduce environmental impact to a minimum, reducing the consumption of natural resources and energy, as well as prevention of waste and emissions through the product life cycle, but at the same time keeping essential characteristics of the product, such as cost, quality, performance, etc. (Pigosso et al., 2013; Van Weenen, 1995).

Ecodesign involves two main goals (Van Weenen, 1995):

- Waste prevention – to minimize the generation of waste by the manufacturer and consumers (e.g. designing products with less material to perform identical function, or designing products that are easy to fix or to replace) to extend the life cycle of the product.
- Better material management – applies to the tasks that make easy to recover, recycle and reuse materials and product components, the "design for recycling".

3.3. Design for efficient longevity

"Design for efficient longevity" or "design for longevity" aims to design products which can last longer, the product life service can be easily extended, using the product more intensively and at the same time keeping it efficient along the years (Van Nes and Cramer, 2008, 2005; Van Weenen, 1995). The objective of the product lifetime extension is to preserve natural resources, reduce solid waste management costs and protect the environment (Van Weenen, 1995).

3.4. Sustainable consumption

The Organization for Economic Co-operation and Development (OECD, 2008) states that sustainable consumption considers the social and ethical dimension of the product, the way products are produced, the effects of the production processes, including resources and workers, and their ecological impacts, seeing consumers as the key driving to sustainable production, leading to a sustainable development. Sustainable consumption and production play a key role in sustainable development, which aims to achieve long-term economic growth coherent with social and environmental needs (OECD, 2008).

Linear economy is considered when the end of the life cycle of a product is achieved, and in consequence, it is disposed and considered a waste (Mathews and Tan, 2011; Russell et al., 2005), that is, extract, produce, consume and trash, without any concern to the pollution created at each phase (Sauvéa et al., 2016).

"Closed-loop" economy or circular economy, is regarded when the use of by-products, recycling, or wastes of disposable products is used as resource of raw material to produce new products, converting wastes of an industrial process into inputs to another process (Sauvéa et al., 2016; Mathews and Tan, 2011), when inputs of water, energy, and new raw material consumption reduce and output of waste disposal requirement is declined (Cooper, 2008, 1994). To achieve sustainable consumption it is necessary to change from linear economy to circular economy.

3.5. Planned obsolescence

One of the oldest formal use of the term "planned obsolescence" was reported in a brochure of nineteen pages entitled "Ending the Depression through Planned Obsolescence", written in 1932 by Bernard London, from the University of Wisconsin - Madison (London, 1932), when the economic depression in the USA declined the buying power of the consumers. The American economy was in a recession and the Americans were using their products as long as possible, not buying new ones as they did before the depression and in consequence of the low consumption, industrial production was in decline. To overcome the recession, London (1932) suggested the planned obsolescence.

In a talk at a local advertising club in 1954, in Minneapolis, USA, Brook Stevens defined planned obsolescence as the notion of "instilling in the buyer the desire to own something a little newer, a little better, a little sooner than it is necessary" (Milwaukee Art Museum (MAM), 1999).

The purpose of planned obsolescence is to instigate buyers to replace their buying before it would be really inevitable (Guiltinan, 2009). According to Guiltinan (2009), there are two main obsolescence mechanisms:

3.5.1. Physical obsolescence mechanism

i. **Design for limited repair**. Critical components that are subject to deterioration in service are so expensive to be replaced that it is cheaper to buy a new product. For example, breaking of bearings in some washing machines, which is one of the most common problems, is so expensive and complex to repair that it is worth buying a new washing machine (Poulter, 2015).
ii. **Design for limited functional life** ("death dating") or **Contrived durability**. The product is designed to degenerate quickly, so each component of the product is made to last a short period of time, such as 3 years. One method of limiting

durability is the use of substandard materials in key components, such as plastic material that deteriorates easily, screws undersized that break down after a limited time, and others that weaken the use of a product (Giles, 2006; Orbach, 2004).

iii. **Design aesthetics that lead to reduced satisfaction.** Aesthetic characteristics that deteriorate over time, such as parts that oxidize with use. For example, a quartz wrist watch, whose body and back were made of stainless steel, but the crown, used to adjust the hands and the clock calendar, was made of a material that oxidized before one year of use. This can reduce the satisfaction of using such wrist watch, and at the first time consumer needs to change the watch battery, consumer will probably consider replacing the watch.

3.5.2. *Technological obsolescence mechanism*

i. **Design for fashion or style obsolescence**. The concept of fashion is used in the design of products, so that consumers are convinced to replace their buying for a new one that has some design change. An example is the automotive industry that promotes superficial changes, such as new headlights and friezes in a vehicle to differentiate it from the ones produced in the previous year, but keeping the vehicle with the same basic technical specification (Müeller et al., 2007).

ii. **Design for functional enhancement through adding or upgrading product features**. New products are launched incorporating other technological enhancement or functionalities, such as cellular phones incorporating GPS, digital TV, and other functionalities, or personal computer with more powerful memory, processors, etc., making it attractive to replace the old ones that did not have these new characteristics.

4. Results and discussion

The world population data is presented in Fig. 1 that illustrates the total number of inhabitants from 1900 to 1950 based on the estimates of the Netherlands Environmental Assessment Agency, History Database of the Global Environment (HYDE, 2010), from 1950 to 2015 (DESA, 2017), and the prospects from 2015 to 2100 in three scenarios: high, medium and low fertility (DESA, 2017).

In the 1930's, when London (1932) defended the concept of planned obsolescence, the world population was about 2.08 billion, the USA was in a depression, the market was stagnated and the idea was to force consumers to start buying, so industry could produce more, hire more people to keep production running and in so doing, moving economy, reducing depression.

By the 1950's, five years after the end of the II World War, the world population was about 2.5 billion inhabitants. The population was devoid of products for consumption, so mass production and abundant raw material made it possible to offer products in big quantities. Over the years competition among industries became fierce and planning obsolescence was used to keep companies supplying each time more.

The modern medicine, the reduction of war among nations, and the improvement of living standards have enabled the vast growth of the world population and increased life expectancy, advancing migration and expanding urbanization (United Nations Population Fund (UNFPA), 2017). Observing Fig. 1, the medium fertility scenario projection indicates that by the 2050's the world population will reach 10 billion, an increase of 2.5 billion inhabitants over the present year. That means within almost 30 years the world population increase will represent the same amount of people that inhabited Earth in the 1950's.

One central challenge to attain a sustainable society is waste reduction (OECD, 2011), and in order to attempt to reduce it, government and society are trying to compromise the producer as responsible for the entire life cycle of their products (recycling or ecofriendly waste disposal). Fast obsolescence rises waste generated, pressuring public resources with the increase of garbage collection, costs with purchase and maintenance of waste disposal areas, exposing population to toxic material from non-recycled products, polluting land, water and air (Echegaray, 2016; Çetiner and Gündoğan, 2014; Madden, 2014), lowering consumer experience (Lobos, 2014; Wieser, 2016) and consuming exaggerated natural resources to produce replacement products, pressing the commodities price, thus generating economic volatility and supporting inflation (Tokić and Tokić, 2015; Echegaray, 2016).

In addition to the waste generated by planned obsolescence, which leads to fast obsolescence, our generation is facing natural resources depletion (Rodrigues et al., 2014). The climate change effects provoke water shortages, among others, compromising society, agriculture and industrial production, and the population growth forces the demand for food and agricultural resources (Food and Agriculture Organization of the United Nations (FAO), 2016).

Another challenge is metal shortage, since extraction and consumption of metals has increased in the industrial economy, and the depletion of some metals is a possibility if extraction is not

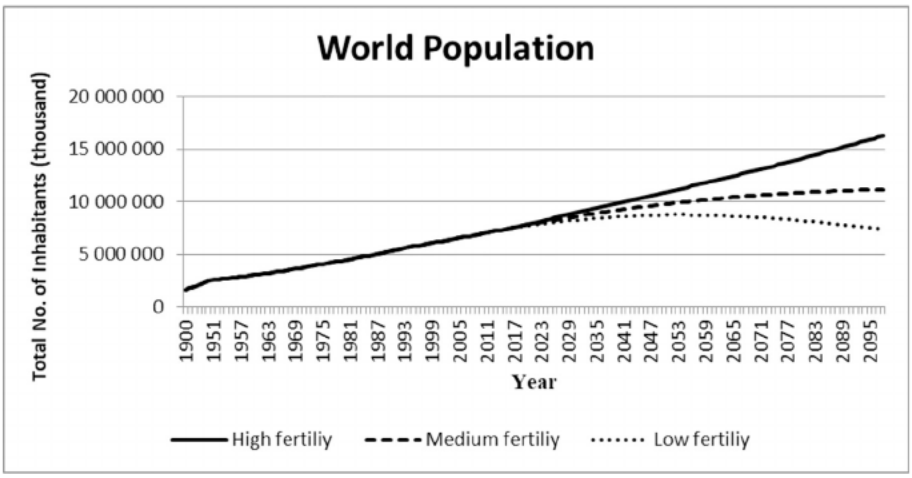

Fig. 1. World population (adapted from DESA, 2017; HYDE, 2010).

decreased (Arvidsson and Sandén, 2017; Henckens et al., 2014; Vivanco et al., 2017).

a) **Antimony**, which is used in the electronics industry to manufacture ammunition, fireworks, lead-acid batteries, semiconductor accessories, and also used to make flame retardant products (Rakshit et al., 2011) should have extraction reduced in 96%, or antimony mineral reserves will be exhausted before the year 2050 (peak year production 2020) (Sverdrup et al., 2017).
b) **Bismuth** that is used for pigments and cosmetics, substitute for lead due to its less toxicity will have its peak production by 2020 (Sverdrup et al., 2017).
c) **Copper** extraction should be reduced in 63% to become sustainable, peak production is expected by 2040 (Sverdrup et al., 2017).
d) **Aluminum** that is crucial to the aerospace industry due to its ability to resist corrosion and to its low density is expected to have its peak production by 2034 (Sverdrup et al., 2017).
e) Other important metals that are under the risk of scarcity are: **gold**, **molybdenum**, **boron**, **zinc,** which peak production is expected by 2025 (Sverdrup et al., 2017) and **rhenium** should also be given high priority to reduce their primary consumption on a world scale (Henckens et al., 2014).

In terms of quality it is possible to substitute some of these metals for others, but it is expected that many of them will become expensive and scarce at almost the same time, so the potential for replacement will be limited (Sverdrup et al., 2017).

New products demand to explore new resources, such as the demand for lithium to produce special batteries for electric vehicles and electronic devices, whose consumption is rising from 30% to almost 60% by 2020, but comes up against the ability to increase production at such rate, what may be a limiting factor for the electric vehicle (Peiró et al., 2013), a cause of concern to an increasing number of analysts.

Defenders of the planned obsolescence state that new appliances are more energy-efficient and use less water than old ones (Hennies and Stamminger, 2016) and that it is necessary to replace buying to keep production running (Blonigen et al., 2017), but this is a paradigm that needs to be changed (Çetiner and Gündoğan, 2014).

Governments are using several legal approaches to repress and criminalize planned obsolescence practices, at the same time forcing manufacturers to provide longer consumer warranties and the accessibility of spare parts for more time (Maitre-Ekern and Dalhammar, 2016; Stamminger et al., 2018).

Consumers in emerging countries show greater concern about the consumption of sustainable products, although this has not yet been translated into consumption of more environmentally friendly products (National Geographic and Globescan, 2014).

Consumers in India, Brazil, Argentina and Mexico are more concerned about sustainability for receiving feedback about their impact on the environment, while German, Swedish and British consumers are the least influenced (National Geographic and Globescan, 2014). Chinese, British, American, South Korean and Indian consumers increase confidence that new technology will be created to solve the environmental problems (National Geographic and Globescan, 2014).

Some designers and engineers think that if they plan their products for manufacturing, use and obsolescence, they can be recycled after they are disposed and the resultant materials reprocessed, making them consider that they are reducing the environment impact, but this is not true. Toxic materials from non-recycled parts/products have to be taken into account and recycling is not total, there are losses. To reduce the environmental impact to a minimum they need to delay obsolescence of their products, if and when possible (Lawlor, 2014).

Design for X, Ecodesign and recycling try to minimize the effect of fast obsolescence, although little attention has been paid to produce long-lasting products and repairable appliances (Echegaray, 2016), that is the focus of "Design for efficient longevity or Design for longevity (Van Nes and Cramer, 2008, 2005; Van Weenen, 1995).

We suggest two other mechanisms of planned obsolescence to be added to the classification made by Guiltinan (2009):

i. **Design for fast consumption**. The product is designed to supply more than the necessary, so it lasts less than expected and consumer needs to buy more frequently. For example regular cigarette lighter designed without flame control that produces a flame bigger than the necessary to light a cigarette or other similar products, wasting the product and so finishing it before expectation. Another example is the internal combustion engine used by the automobile industry that consumes big quantities of liquid fuel (oil derivates such as gasoline or diesel, and/or ethanol from sugar cane or corn, mainly). The concern of the automobile industry in general is with maximum speed and power of the vehicles, not economy of natural resources, stimulating liquid fuel consumption, and so the interests of the industry to supply each time more, beyond what would be necessary if research on these engines were persistently concentrated on liquid fuel economy.
ii. **Design for restricted technological update**. The design of product is made to use: (ii.1) **Restricted software** - When the software developer decides not to provide support, or some sort of blocking prevents the software from updates, they force the product to become obsolete. An example is the cellular phone with operational system based on Windows Phone whose platform was discontinued by Microsoft. Support will be provided for a certain period of time, when it will be no more available, as Microsoft did with past software. It means no more updates to fix security breaches, prevent the cell from locking, or make the software available to run new mobile apps will no longer be provided. Consumer does not have other option than planning to buy a new device, although the cellular phone is still operational. (ii.2) **Restricted hardware and software** – A new software that requires new powerful hardware is launched. Manufacturers prevent technical hardware replacement to upgrade the product, making it obsolete.

There are ways of delaying obsolescence, such as making technologies easier to fix/upgrade, using modular design, remanufacturing them, so the modules that compose the product can be replaced to incorporate innovation, instead of exchanging the whole product (Van Weenen, 1995), create open source software (Nyman et al., 2012), projects that simplify replacing/updating parts rather than replacing the whole product, so that waste can be reduced and long-lasting products can continue functioning, as well as many other ways that innovation in engineering and design and the creation of new technologies can provide (Van Nes and Cramer, 2008, 2005; Lawlor, 2014). A cultural problem that must be overcome is that potential consumers of remanufactured products do not trust that these products can keep high quality standards (Liu et al., 2017) after being upgraded.

People fundamentally want an up to date and well-functioning product that meets their changing needs (Van Nes and Cramer, 2005), so the product design should take this into consideration, to maintain market share rather than design for the planning of obsolescence.

Just to have an idea of the possibility of the economy simply changing the product design, here follows the analysis of the toothpaste tube, one example detected in this study.

India and China developed the toothpaste by 500–300 B.C., but only in the 1800's the modern toothpaste arose, and in 1873 toothpaste mass-production started. Generally toothpaste uses sodium ricinoleate and sodium lauryl sulphate as emulsifying agents and different concentrations of fluoride (from zero to 5000 ppm), among other components (Jardim et al., 2009).

The global toothpaste market is estimated to achieve US$ 17.4 billion by 2024 (Global Industry Analysts, 2017). Table 2 presents the consumption of toothpaste in some countries.

It is available in the market toothpaste tubes with a large mouth of 8 mm of inside diameter to release the product. Supposing that the mouth of the toothpaste could be reduced to 5 mm, thing that would not affect hygiene standards, presuming that people could keep using the same length of toothpaste in their toothbrush and if the habitual frequency of dental brushing was maintained, it would be possible to reduce toothpaste production in 61% with this simple diameter change, and in the same percentage, sodium ricinoleate, sodium lauryl sulphate, fluoride and other components to produce toothpaste could be spared.

$$V = l.\pi r^2 (\text{Volume of a cylinder}) \begin{cases} l = lenght\ of\ the\ toothpast\ in\ the\ toothbrush \\ r = inside\ radius\ of\ the\ mouth\ of\ the\ toothpast\ tube \end{cases}$$

The same principle of design change could be used to reduce excessive consumption of products packaged with large mouth to release the product for consumption. Table 3 illustrates some examples of products designed for planned obsolescence found during the field research and some proposed solutions.

In all these examples, the economy to be generated may also take into account.

1) Raw material and resources related to its extraction and processing; 2) Final product packing; 3) Logistics: (inbound and outbound): reduction in transport costs/pollution/traffic; 4) Family costs saving/time spent on purchases, and 5) Other costs.

An example of design for limited functional life and design for limited repair found in the field research is shown in Fig. 2. A broken plastic holder, practically impossible to be repaired, of a vanity mirror in the sun visor of a Sports Utility Vehicle (SUV) with 3-years use, prevents the adjustable light from being turned on. The entire sun visor must be replaced, as the vanity mirror is not sold separately. Only available from authorized dealers, it was budgeted at almost 2% of the selling price of a new car in January 2017, in Sao Paulo, state of Sao Paulo, Brazil.

5. Conclusion

The planned obsolescence paradigm with the concept of inducing the buyer to replace his buying earlier than necessary, awakening the desire to buy new products that could provide better benefits is no more defensible today, although some authors defend the planned obsolescence so companies can produce more, generate employment, profits, stimulate competition among companies, improve the search to incorporate innovation/new technologies in their products and thus generating progress.

On the other hand, planned obsolescence generating short lifetime of the current products impacts sustainability negatively. World population growth, increase of waste generated, water shortage, natural resources scarcity and climate change, among other factors, are pressuring for a new production paradigm because the planned obsolescence paradigm is compromising sustainability.

Planned obsolescence press consumers to spend more money to have functional products than would be expected, buying more frequently than necessary. It generates social inequalities among the population that can afford to buy new/innovative products and part of the population that has to conform to continue using non-functional or obsolete products.

In the 1950's there were abundant natural resources with industries able to produce considerable quantity of products, but due to the limited number of consumers and the reduced world population compared to our days, industries had to create mechanisms to induce consumption, generating the “consumption society” to keep the industries running and also the economy.

Now in the twenty-first century things have changed, population grows faster than expected, and in 2017 the world population stands by 7.5 billion, or three times the world population in the 1950's. The industries will have to produce each time more to supply a population that is growing in a rate never seen before, and the natural resources required are becoming scarce.

Industry ended up shaping people to accept planned obsolescence as a normal fact, if some mechanisms of planned

Table 2
Toothpaste annual consumption in some countries (adapted from Global Industry Analysts, 2017, DESA, 2017; Seeking Alpha, 2017).

Country	Per capita consumption of toothpaste estimate for 2017 (g/year)	Population (Medium fertility–2017 prospects)	Total consumption per country of toothpaste estimate for 2017 (Ton/year)
USA	690	324,459,000	223,877
Mexico	460	129,163,000	59,145
Russian Federation	400	143,990,000	57,596
Philippines	355	104,918,000	37,246
China	240	1,409,517,000	338,284
India	170	1,339,180,000	227,661
Turkey	130	80,745,000	10,497
Kenya	73	49,700,000	3628

Table 3
Some examples of products designed with mechanisms of planned obsolescence found in the field research and proposed solutions.

Example	Mechanism of planned obsolescence	Problem	Proposed solution	Benefits	Other applications
Toothpaste Tube	Design for fast consumption	Toothpaste tubes with a mouth of Ø int. = 8 mm	Reduce the mouth to Ø int. = 5 mm	Consumption reduction by 61% if frequency of brushing and length of toothpaste can be maintained	Some bottles of olive oil, perfume, sunscreens, moisturizing creams, shampoos, and other similar products
Operation-al system iOS 11 for iPhone and iPad (64-bit)	Design for restricted technological update	iPhone 5, iPhone 5c and iPad 4 (32-bit) can no longer update the operational system to the iOS 11	Design to make it possible to replace the 32-bit processor with the new 64-bit processor and some other related components	Enable the old device to remain updated	Cellular and tablets in general
Emergency lamp	Design for limited repair	Sealed acid battery of 4 V 1.5Ah costs more to be replaced than to by a new emergency lamp, although the flash bulbs are still working	Supply the sealed acid battery at a reasonable price.	Enable the device to remain functional	Devices that use battery in general
Plastic holder	Design for limited functional life and design for limited repair	Broken plastic holders designed to force the replacement of the entire part	Improve the technical specification of the plastic holder	Keep the part functional	Components designed with inferior material or undersized

Fig. 2. Broken plastic holder of a vanity mirror in the sun visor of a SUV, budgeted at almost 2% of the selling price of a new car to be replaced.

obsolescence turn the product non-functional, people accept it naturally. It is now a cultural problem that needs to be altered to preserve the natural resources necessary to keep industries running. In general, people are increasingly adopting a more sustainable consumer behavior, more concerned about the negative effects of global warming, raw material scarcity and more convinced that the cause of climate change is linked to the human activity.

Scientists, engineers and designers have the challenge of delaying obsolescence, for example, creating open source software, as suggested by Nyman et al. (2012), making technologies easier to fix/update, developing projects that make it simple to replace/update parts, rather than replacing the whole product, as proposed by Lawlor (2014).

Entrepreneurs, industry and academy must be made aware of the impact on sustainability of the short lifetime products. It is no more possible trying to live in the twenty-first century based on paradigms created in the twentieth century, when the conditions of life on Earth were different and natural resources were abundant. It is important for the industry to start paying attention to the impact of the short lifetime of the current products on sustainability, starting to think in long-lasting products terms.

People have desires and dreams that change over time, so companies should invest to identify these changes and design their products accordingly, providing innovation and differentiation to attract new consumers and improve market share, but at the same time, allowing the upgrade of the previous products and keeping these used products in good working order. That is the real challenge for designers, marketers, engineers and people in general that deal directly and/or indirectly with research, development, innovation, and launch of products in this new century.

It is time to look back to the twentieth century and think about the paradigm shift proposed by three visionaries - Hayes (1978), Sherif and Rice (1986) -, and change from planned obsolescence to planned improvement, thinking more seriously about Design for efficient longevity.

The contributions of this research were: (1) the two suggested mechanisms of planned obsolescence, found in the field research, in addition to the classification proposed by Guiltinan (2009): **Design for fast consumption,** analyzing how a simple design change in toothpaste tubes with a mouth of internal diameter of 8 mm decreased to 5 mm, can reduce consumption by 61% if frequency of brushing and length of toothpaste can be maintained, and how industry uses this mechanism to design products that artificially increase the consumption of shampoos, moisturizing creams, sunscreens, perfumes, olive oil, and other related products, and **Design for restricted technological update,** approaching how industry uses this mechanism to force people to exchange their cellular phones and electronics in general every year; (2) to open discussion about the excessive consume of liquid fuel in internal combustion engines and possible interest of the liquid fuel industry; (3) to suggest solutions for a better benefit for consumers and the environment, and (4) to arouse interest that global development based on a consumption society is no longer sustainable, so a new and less consumerist society is expected to replace the current one.

The difficulty of finding people who agreed to be interviewed, the visible discomfort of the interviewees to talk about planned obsolescence and the difficulty to collect data about the subject that we faced during the field research to illustrate this work, may be one of the reasons for the scarcity of studies in this area. The possibility of introducing a bias in the interviews under these conditions is a limitation of this research, another one was the location of this multiple study concentrated in Sao Paulo, SP, Brazil, for search convenience.

For future studies we propose research on ways to improve products to keep them updated and innovative throughout their lifetime while preserving sustainability.

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