

Article

US Legal Frameworks: A Path to Product Longevity?

Philip White ^{1,2,*}, Aaron Fellmeth ³, Dallin Robinson ⁴

¹ Industrial Design Program, The Design School, Arizona State University, 1001 S Forest Mall, Tempe, AZ 85004, USA

² School of Sustainability, Arizona State University, Tempe, AZ 85004, USA

³ Sandra Day O'Connor College of Law, Arizona State University, 111 E. Taylor St., Phoenix, AZ 85004, USA

⁴ Sandra Day O'Connor College of Law, Arizona State University, 111 E. Taylor Street, Phoenix, AZ 85004, USA

* Correspondence: Philip White, Email: p.white@asu.edu; Tel.: +11-602-349-6866.

ABSTRACT

Legal actions to increase product lifespans and reduce environmental damage have been explored for many regions around the world. However, little research has focused on the ways that the extant legal system affects product lifespans and product repair in the US market. Our research reviewed the network of statutes and standards on the Federal level and sampled laws from some of the fifty States, noting unique qualities of the US legal system. Literature implied the longstanding acceptance of planned obsolescence and its justification as a profitable business practice. We reviewed the scope of the well-established product warranties in US commerce, noting substantive limitations as well as their untapped potential to support of longer product lifespans. Lawyers who counsel firms that sell consumer products in the US market were surveyed, and the survey results corroborated several initial findings. While the client firms all sold some products with express warranties, most of their products relied on implied warranties, and the respondents unanimously agreed that mandatory regulations would most effectively motivate their firms to develop and sell products with longer lifespans and greater capacity for repair. We suggest a path to product longevity—mandating the labeling of all hardgoods with accurate estimates of average product lifespan and capacity to be repaired. If properly structured, the framework could push industry, government, and product owners to all accept more obligation for the materials and products that we use, while stimulating competition based on product repairability and longevity.

KEYWORDS: planned obsolescence; product lifespan; product regulation; repairability; warranty

Open Access

Received: 03 August 2020

Accepted: 04 July 2021

Published: 22 July 2021

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ABBREVIATIONS

DoJ, Department of Justice; EWSC, extended warranty service contract; FDA, Food & Drug Administration; FTC, Federal Trade Commission; GDP, Gross domestic product; GWP, Gross world Product, MMWA, Magnuson-Moss Warranty Act; PCR, product category rule; SKU, stock keeping unit; UCC, Uniform Commercial Code

INTRODUCTION

The Origins of Planned Obsolescence

Over a century ago, Henry Ford rolled out the Model-T automobile with the moving assembly line, his newly invented and highly efficient manufacturing system. Ford Motor Company soon grew to be the largest and most profitable manufacturing enterprise of its time (Figure 1). Don Norman, in *The Design of Everyday Things*, conveyed an anecdote about Henry Ford [1]. Ford bought broken Ford automobiles to disassemble and then sort failing parts from still-functioning parts. His goal was not to redesign the failing parts so that they would last longer. Instead, Ford's reported goal was to save money by redesigning the functioning parts so that they would fail earlier.



Figure 1. A nascent example of planned obsolescence: the Model-T Ford automobile.

This story reveals an unsettling truth about unregulated commercial markets. Because selling products with shorter lifespans is more profitable than selling products with longer lifespans, businesses will find a way to sell products with shorter lifespans. Product sellers rarely divulge reliable information about product lifespans to potential buyers. A statement of expected lifespan or expected amount of service per product life could be interpreted by a court as an express warranty and treated accordingly. This lack of essential product service information also prevents buyers from accounting for product longevity when making purchase decisions.

In *Made to Break*, Vance Slade noted how manufacturers in unregulated markets carefully design products to malfunction far earlier than is technically required [2]. This practice is known as planned

obsolescence. For example, internal documents from 1939 described how General Electric designed lightbulbs to stop working 33% faster than was necessary, ordering that “no publicity or other announcement will be made of this change” [3]. Although unearthing hard evidence of planned obsolescence such as this is a rare occurrence, our homes, garages, and offices are populated with products that were designed to fail prematurely.

Planned obsolescence increases the economic burden on consumers and puts a growing stress on the Earth’s dwindling natural habitats and the tenuous existence of many thousands of living species in those habitats. Since the 1930s, dominant economic theories have treated increasing per capita consumption of materials and energy as indicative of economic growth that has been, and still is, considered to be desirable. The goal of resource consumption was not to serve basic human needs for food, shelter, education, and healthcare, but instead, to fuel the economic engine. People who buy and use products were no longer identified as people, purchasers, owners, or users, but referred to with a new designation: consumers. Depression-era marketers such as Sheldon & Arens promoted “consumer engineering”, a process where companies use intensive advertising to convince people to buy goods [4]. This program foretold the eventual ubiquity of television advertising, with the US viewer in the year 2000 watching 45 min of commercial ads each day (Figure 2). Over a 75-year lifetime, one could watch ads for the equivalent of more than four continuous years [5].



Figure 2. In 2000, US television viewers watched an average of 45 min of advertising each day. Image © J. Bui.

Mainstream economic theory has not depicted planned obsolescence as a fringe doctrine that is plagued with ethical conflicts. To the contrary, it is a common practice, deserving of attention, if not justification. Economist Jeremy Bulow, in *An Economic Theory of Planned Obsolescence* [6], defined the practice as “designing a product with a purposely frail design, so that it becomes obsolete after a pre-determined period of time upon which it

decrementally functions, suddenly ceases to function, or is perceived as unfashionable”. He instructed, “A monopolist (one dominating company in a market) desires uneconomically short useful lives for their products. An oligopolist (one of many competing companies in a market) can gain by colluding (with competing companies) to reduce durability”. Those with an entrepreneurial perspective, such as Fethke, Jagannathan, and Orbach [7,8], embraced planned obsolescence as valid business practice. In this economic model, a company that manufactures and sells non-perishable goods will secure a degree of higher market demand for its products in the future by:

1. Stimulating sales by adding features and functions, *often regardless of whether users need the features and functions* (authors’ assertion italicized),
2. Designing the goods to be less durable than is possible, given the market and technological constraints,
3. Convincing customers through a variety of means of the necessity to purchase the new goods, and
4. Selling the goods at high prices compared to competitors.

Although dominant economic theory supports the microeconomic benefits of planned obsolescence for product manufacturers, from a macroeconomic perspective, poor product quality wastes resources and is thus inefficient. An ongoing debate addresses the ethical contradiction of supporting planned obsolescence to benefit only manufacturers, who are a subset of the overall economy [9–11]. The economic losses caused by planned obsolescence are further exacerbated by moral hazard and the externalization of the costs of environmental damage and natural resource depletion. In other words, the business firms that benefit from planned obsolescence do not absorb and internalize the costs the practice imposes on the economy as a whole or the natural environment shared by all members of society and all living things, present and future.

Many critics have disparaged planned obsolescence, the promotion of consumption as a goal, and the subsequent waste of finite natural resources. In 1969, biologist Eugene Odum described how human society would be wise to learn to function like a mature ecosystem. As human society moves from functioning like an immature ecosystem with high population growth, to a mature system that is characterized by a diversity of species and stable populations, our economic metabolism must, like a mature ecosystem, develop a “greater capacity to entrap and hold nutrients for cycling within the system” [12].

In lamenting our “Kleenex culture” in 1971, Victor Papanek admonished “That which we throw away we fail to value. When we design and plan things to be discarded, we exercise insufficient care in design, in

considering safety factors, or thinking about worker/user alienation from ephemeral trivia” [13]. In 1994, he projected that the enlightened societies of the future would place “a greater emphasis on quality, permanence and craftsmanship in designed products” [14].

Since 2010, a new production and consumption model, the circular economy, has been gaining momentum. According to Ken Webster, the circular economy “aims to keep products, components, and materials at their highest utility and value, at all times” [15]. In a circular economy, society takes more responsibility for materials and products than in the prevailing global system that ejects greater and greater volumes of solid waste. The ever-growing flow of garbage is moved to landfills in countries that can afford to make space them, and to colossal waste heaps in countries that cannot, with some spilling into the oceans to congeal in massive floating waste patches.



Figure 3. The “great” Pacific garbage patch is primarily composed of plastics that require many thousands of years to decompose. It floats in an expanse several times the area of Texas.

Conny Bakker explained that a “longer product lifespan is a cornerstone of the circular economy, because it slows the speed of the materials and goods flowing through society, thus reducing waste” [16]. Maximizing product lifespans and enabling product repair are core design strategies of the circular economy. These strategies significantly transform the business models that affect how products are produced and used. The process of transforming the economy from linear to circular will require fundamental changes to business practices that require planning, including the co-development of business models with design strategies [17,18].

Industry Governance in the US

Consumer goods produced in the United States are regulated by a network of State and Federal laws, further developed by regulatory

agencies at both levels of government. In addition, product warranties and liability for defects are equally governed by common law developed by judicial decisions. To see how legal reform could help resolve the inefficiencies and inequities of planned obsolescence, it is instructive to understand the legal doctrines governing consumer product guarantees. Guarantee frameworks in modern US commerce can be usefully divided in these categories:

1. *Express contractual warranties* either tied to the product or separately entered into with the seller or a third party.
2. Federal legislation and regulation on product quality standards and *mandatory warranties*.
3. State legislation and regulation of the same nature and *common law implied warranties and related consumer protections*.

Express Contractual Warranties

Express warranties are promises made directly by the manufacturer, reseller, or third party to the purchaser, usually in written form. Because such warranties are voluntary and disclosed prior to or during the sale, they are enforceable under the law of contracts. In general, express warranties guarantee product performance for a defined period, subject to conditions and specific legal remedies, such as repair by the manufacturer or its designated repair service. In practice, consumer product warranties are nearly always much shorter in duration than the period consumers expect the product to function, and they rarely cover the entire cost of repair. For example, the warranty on General Electric compact refrigerators lasts only one year, far less than purchasers expect to use it, and does not cover labor even if the refrigerator fails within that year due to defective materials or construction [19]. Similarly, the Ford automobile “bumper to bumper” warranty lasts three years or 36,000 miles (whichever comes first), far less than the expected life of the automobile [20].

Consumers can purchase extended warranties from the manufacturer, reseller, or a third party warranty service, usually at a considerable additional cost, but as a rule consumers must do so ignorant of the value of the warranty relative to its price, because the seller usually withholds reliable information on the expected product life and average cost of repair or replacement of each product they buy.

The legal effects of express warranties, however, are not under the sole control of manufacturers and sellers. They are regulated by state and federal law, that impose requirements for the clarity and completeness of disclosures in the warranty. Most prominently, the *Magnuson-Moss Warranty Act of 1975* (MMWA) [21] requires any express warranty on a

consumer product costing more than \$15 to be visually conspicuous and written in plain language, and it empowers the Federal Trade Commission (FTC) to publish regulations on the detailed information such written warranties must provide. However, the MMWA explicitly denies the FTC any power to dictate a minimum duration of warranties or to require that products even have a warranty [22]. In its regulations, the FTC narrowly interprets what qualifies as a warranty, excluding general promises about product quality or consumer satisfaction [23]. The MMWA's function, then, is merely to require specified disclosures, such as a clear designation of the product or parts covered and how to obtain warranty service, and prevent specified deceptive or exploitative business practices, such as an unreasonable delay in resolving a legitimate defect complaint. It does not require any minimum product longevity, standard of quality, or product repairability.

Federal Legislation and Regulation of Product Quality

At the Federal level, the main statute controlling product guarantees is the MMWA, but the MMWA does not regulate product quality or longevity directly, nor does it automatically create an implied warranty in consumer products. Such matters are left to State law. The MMWA does limit the ability of a supplier to disclaim implied warranties that exist under State law. However, the *Federal Trade Commission Act* (FTC Act) [24], has potential to protect legitimate consumer expectations about product longevity. Section 45 of the FTC Act prohibits “unfair methods of competition in or affecting commerce”, as well as “unfair or deceptive acts or practices in or affecting commerce”, and it empowers the Federal Trade Commission to prevent individuals and business firms from violating its prohibitions. The FTC thus has legal authority to punish companies that engage in unfair trade practices. Unfair trade practices might include consciously manufacturing products to fail more quickly than is necessary, or products that cannot be readily repaired by the user or a trained technician.

The FTC Act, however, does not authorize courts to hear lawsuits brought by purchasers harmed by such products. The FTC has not investigated and punished planned obsolescence as an unfair trade practice. Despite the early FTC suggesting it might pursue manufacturers who practice planned obsolescence [25], it has never vigorously investigated and fined companies known for intentionally designing products that fail prematurely.

Alternatively, Federal antitrust laws could be used to punish manufacturers who collude to reduce product lifespans. The *Sherman Antitrust Act* makes collusion between competitors in restraint of

commerce a crime [26], and agreements between competitors to reduce product quality and lifespan, whether explicit or implicit, plainly violate the Act. The Sherman Act may be enforced by the FTC and US Department of Justice's Antitrust Division, and it may also be enforced by an individual harmed by the illegal conduct, with the possibility of the individual being awarded triple damages to incentivize enforcement of the Act.

Such cases are rare, however. Collusion must be intentional to violate the Act. Parallel behavior itself violates no antitrust law and, as noted earlier, few manufacturers are so unsophisticated as to document their collusion through a written agreement or other reliable evidence. Although there are indirect ways of showing collusion to inflate product prices (for example, price jumps by one firm closely followed by a similar jump by competitors), collusion in planned obsolescence is much more difficult to prove. It is so difficult to prove that, in the long history of antitrust law, only a handful antitrust cases have addressed the issue, and in none has a court held that collusion occurred in violation of the Act [27,28]. However, if the FTC were given greater political independence and adequate funding, it could develop metrics to detect product quality collusion more reliably.

Product purchasers can independently arrange the extension of a product's lifespan with third-party repairs and upgrades to the product. In general, manufacturers are prohibited by antitrust laws from penalizing consumer repairs by, for example, nullifying the warranty or using contract terms to tie the purchase to the use of the manufacturer's (or an affiliated party's) repair services [29,30]. Even so, purchaser-arranged product repairs often depend on essential information. Buyers at the time of purchase need reliable information on the cost of repairs or upgrades, and they need to know whether they will have access to the required repair parts and qualified repair technicians.

Aside from these practical obstacles, potential legal impediments also suppress the opportunities for purchasers to repair products. Utility patent and design patent law can be used by manufacturers to deter owners from repairing products. The legal issues raised by purchaser repairs to patented products are too complex to discuss in detail here, but, purchasers generally have a right to repair patented products without the manufacturer's consent. However, if the part of the product that fails prematurely is patented, that part can only be replaced with the patent owner's permission.

Further, if a patented product failure requires repairs so extensive that the product is deemed "reconstructed", the patent owner may treat it as an infringement [31]. This scenario only occurs when the entire product or the segment of the product that breaks is covered by a utility patent, but

several million hard good products are covered by utility patents. If the product or part is covered by a utility patent, the line between a permissible repair and infringing reconstruction is not always clear, and purchasers may be deterred from trying to repair, due to the high cost of litigation. Manufacturers are not legally required to disclose patents on their products, much less their product components, and most purchasers are not prepared to research and analyze whether the product, or any of its critical components, are covered by a patent. Moreover, if planned obsolescence incorporates multiple points of failure in a product, an infringing “reconstruction” may be the only way to return the product to functional condition.

State Legislation and Regulation of Product Quality and Common Law Implied Warranties

Each State has adopted some form of legislation and regulations on product quality and warranties. States have jurisdiction primarily over transactions within their borders, so these regulations apply only to goods manufactured or sold within that State. All US States except Louisiana have adopted the implied warranty of merchantability set forth in the *Uniform Commercial Code* (UCC), and Louisiana has a similar concept in its Civil Code. The UCC includes a guarantee (unless disclaimed) that the goods “are fit for the ordinary purposes for which such goods are used” [32]. The UCC’s implied warranty of merchantability originated in a common law doctrine developed by State courts. Both before and after adoption of the UCC, the implied warranty has been interpreted to mean the product is free from material defects at the time of sale, and a buyer may only invoke the implied warranty if the product defect is discovered before the expiration of the State statute of limitations (usually within four years of sale). A warranty only guarantees that the product will function for a defined period if the seller explicitly guarantees that the product will function for that period, in that case it becomes an express warranty.

Some States adopted more specific statutes, but these seldom go beyond the UCC’s protections. For example, California’s *Song-Beverly Consumer Warranty Act* [33] not only establishes strict rules on express warranties but requires that every retail sale of consumer goods in California (other than clothing or consumables) automatically includes implied warranties, including a warranty of merchantability. However, the Song-Beverly’s definition of the warranty of merchantability is not significantly different from the UCC’s definition. Because each State’s jurisdiction is limited, and because the entire United States comprises a single common market, differences between States in their product quality regulatory regimes have as much potential to confuse purchasers and manufacturers as they

have to protect the former and create a predictable regulatory framework for the latter.

Most States have also adopted unfair competition laws (or have common law protections against unfair competition) that empower purchasers to seek compensation for product defects [34]. However, courts in several States have interpreted these statutes narrowly to prevent users from attempting to sue, particularly in cases where products function for some period but do not meet the reasonable expectations of product owners.

For instance, courts commonly hold that a supplier can limit the duration of the implied warranty of merchantability to that of the express warranty. In *Sony Grand WEGA Television* litigation, a California court pre-trial judgment rejected a planned obsolescence claim for high-end televisions costing \$2500 that broke a few months after the express one-year warranty expired. The court dismissed both unfair competition and implied warranty theories. It found that the unfair competition claim was not viable because the manufacturer's assertions of high product quality were "nothing more than mere puffery" upon which purchasers have no right to rely. Further, the one-year express warranty preempted the implied warranty theory [35]. The court held that sellers have a right to misrepresent product quality if their language is sufficiently vague. It also held that when a purchaser buys a product with an express warranty of fixed duration, the purchaser must assume that the product will cease functioning immediately on expiration of that warranty. The purchaser has no right to expect the product to function one day beyond that period. Purchasers have little legal protection against planned obsolescence, even when sellers explicitly advertise that the product will have a long, usable life of an unspecified duration.

Few aggrieved purchasers are eager to pay the cost of a lengthy lawsuit against a wealthy corporation over any purchase, even an expensive appliance or automobile. In many States, purchasers who can prove product defects can recover their direct damages, but they must pay attorneys' fees that usually far exceed the cost of the product. *Class actions* are a uniquely American procedure for collectively mitigating grievances against wealthy entities [36], but few class action attorneys will risk a lawsuit unless the potential damages are immense and the probability of success high. Purchaser claims for damages based on premature failure are not supported by any statute, and no line of case law validates such claims. Consequently, the prospects for successful class action lawsuits based on purchaser claims of planned obsolescence are meager.

Research Purpose

The scale of the United States market is immense, as are its consequent environmental impacts. While the US now holds 4.3% of the global human population, as of 2020, the US Gross Domestic Product (GDP) comprised roughly 21% of the Gross World Product (GWP) [37]. Per capita GWP does not accurately gauge human satisfaction, but total GWP can roughly approximate global environmental burdens. Combining its percentage of the GWP, its importation of consumer goods, and its reckless consumption fossil fuels, the US probably creates the most environmental damage of any nation on the planet. Likewise, its untapped potential for reducing this damage through extending product lifespans and enabling the ability for product repair is immense.

Many researchers have investigated how the legal systems in European and Asian markets could support greater amounts of service over the lifespans of products [38,39]. In comparison, research on the opportunities to increase product lifespans via US product statutes and regulations is sparse.

We organized this research to reveal how existing legal frameworks influence the sale of hard good products in the United States to help us identify approaches with the most potential to support maximum hard goods lifespans and maximum ability to repair products. US law most directly influences the sale of products through a few types of product warranties, so investigation of these guarantee frameworks is critical. Our primary research questions were:

1. What clues can current product warranties give about increasing the amount of service delivered over a product's lifespan or about increasing the capacity of a product to be repaired in the US?
2. What paths of action have the greatest probability of convincing firms that sell hard goods in the US to significantly increase product durability and product repairability?

SURVEY OF LEGAL COUNSEL

We prepared a survey to document current trade practices involving product lifespan and product repairability. A human subjects confidentiality statement was supplied with the survey that guaranteed that each participant's identity would be kept confidential, as would be the name of the employer, the market sector, the brands, and the product names sold by the company. It guaranteed that all identifying printed and digital data would be destroyed after its collection and that no other personal information would be collected, that the participant could choose to not answer any survey question, and that no compensation would be exchanged for participating.

In an iterative process to locate in-house counsel for companies that sold durable goods in the US, we sent the survey to lawyers in 43 companies. The companies sold products in US market sectors, including housewares, home appliances, electronics, sporting/outdoor gear, and toys. The percentages of respondents in each market sector were not recorded to protect the identities of the survey respondents.

Survey Results

Twelve respondents completed and returned the initial survey. The survey had described warranties with language like DiMatteo et al. [40], with the terms “statutory guarantees” to mean “implied warranty”, and “warranties” to mean “express warranties” that come with some products automatically. These terms were not clearly understood by most survey participants, so, we clarified the definitions used in questions 1–7, and resent those questions to the participants. Twelve completed surveys were returned, yielding a 28% response rate. We approached the data qualitatively because this sample size was not large enough to be statistically significant.

The answers to survey questions that were expressed in percentages (Questions 1–9) are reported with mean and deviation values for answers from all the respondents. Responses to ‘check the box’ answers (Questions 10–12) are reported in percentages where the sum for each selected answer was divided by the total respondents in the survey. Questions 11 and 12 allowed the choice of multiple boxes, and the sum for each selected answer is also divided by the twelve respondents.

Guarantee Frameworks

The survey asked each lawyer to focus on their ‘client company’ who sold the greatest number of different kinds of products in the US. For each question, the lawyer estimated the percentage of the total of all the kinds of products that the ‘client company’ sold in the US. The lawyer was then asked to estimate the total number of ‘stock keeping units’ (SKU’s) that their client company was selling. Then she was asked to answer the following questions in terms of the percentage of those SKU’s.

“What percentage of all the products that your client sells have an implied warranty of merchantability?”.

“What percentage of all the products that your client sells have express written warranties?”.

“What percentage of the products with express written warranties guarantee an amount of service or a duration of time that the product will deliver service?”.

“What percentage of the products with express written warranties

guarantee the ability to repair the product or replace components that no longer function?”.

“What percentage of all the products that your client sells offers extended warranty service contracts (EWSCs)?”.

“What percentage of the products with EWSCs guarantee an amount of service or a duration of time that the product will deliver service?”.

“What percentage of the products with EWSC guarantee the ability to repair the product or replace components that no longer function?”.

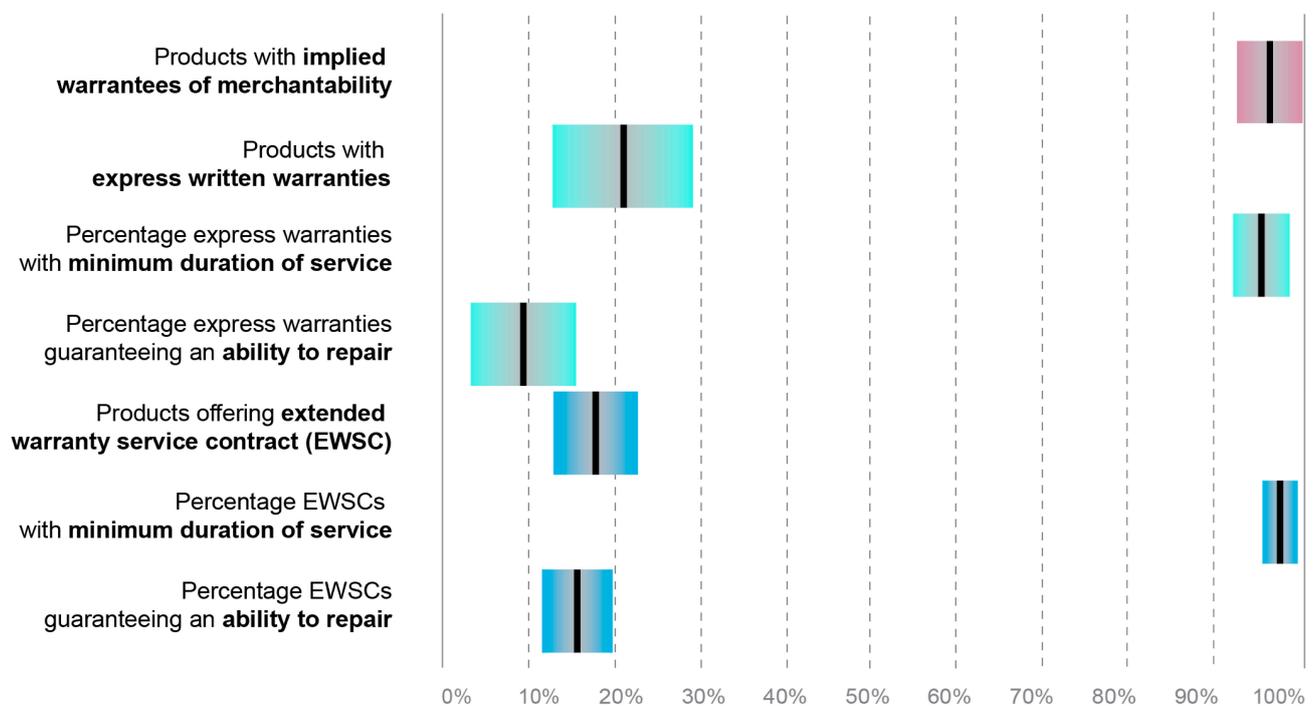


Figure 4. Percentages of product SKU’s with warranties (The black line is the mean, bounded by deviation values).

The collected survey data would be more accurate if we had a larger number of survey responses. On average, 96% of the products had implied warranties of merchantability, while an average of 21% had express written warranties. Of the products that had express warranties, an average of 95% guaranteed an amount of service or an amount of time that the product delivers service, while an average of 9% of the warranties guaranteed the ability to repair the product or replace components that no longer function. 18% of the products, on the average, offered EWSCs. Of the products that offered EWSCs, an average of 97% of the contracts guaranteed an amount of service or time that the product provides service. 16% of those extended service contracts, on the average, ensured the ability to repair the product or replace non-functional components.

The data in Figure 4 indicate that implied warranties of

merchantability, here at 96%, apply to all products except those sold with specific disclaimers. Express written warranties that are regulated by the MMWA, here at 21%, can apply to any product that costs more than \$15, but suppliers do not always perceive an advantage in providing such warranties. Most products with express warranties also had implied warranties. The high percentages of products that guaranteed an amount of service in both express warranties (95%) and extended service contracts (97%) do not mean that these warranties guaranteed a long product lifespan. As noted previously, periods of service stated in most express contracts are usually a small fraction of what buyers expect, while extended service contracts require the buyer to pay for the extra period of service, usually in an amount proportional to the length of the period.

Respondents next estimated the percentage of the non-consumable products that the firm, or the product supplier(s) to the firm, had designed to have desired characteristics. The questions were, “Given the available technology and market structure. What percentage of the products were designed to be repairable, either by a user or by a repair technician?”, and “What percentage of the products were designed to have the longest possible functional lifespan?”.

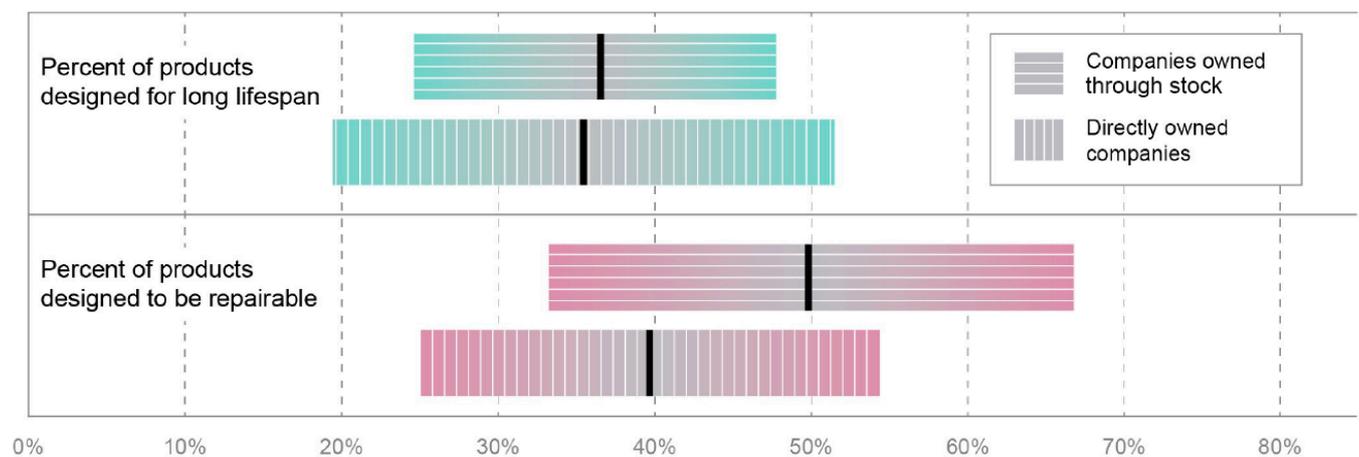


Figure 5. Percentages of products designed for desired qualities (The black line is the mean, bounded by deviation values).

We sorted the responses in Figure 4. According to those that are directly owned (3 firms) and those with publicly traded stocks (9 firms). More of the products were perceived as being designed for repair than were perceived as being designed for a long lifetime, regardless of how the firm was owned. Directly owned firms were perceived to be being nearly as likely to offer longer lasting products as firms with traded stock, as is indicated by the slight difference between their mean values. The more than 10% gap between the mean values of stock-owned and directly-owned firms that offer repairable products imply that privately held companies might be more likely to offer goods that can be repaired. Again,

given the small sample size, these results should not be claimed as a clear snapshot of the market.

Drivers of product lifespan and product repairability

We asked the lawyers to indicate how much the logic of this statement influenced the lifespan of their firm's products: "One microeconomic theory of a durable goods posits that a firm will make non-perishable products to be less durable than they could be, given economic and technological constraints, and sell the products at relatively high prices compared to competitors, to increase a degree of higher market demand for the firm's products in the future". Figure 6 shows that five respondents indicated that the firm was "not influenced at all", four thought that it was "somewhat influenced", one thought that the firm was "moderately influenced", and two thought that the was "heavily influenced".

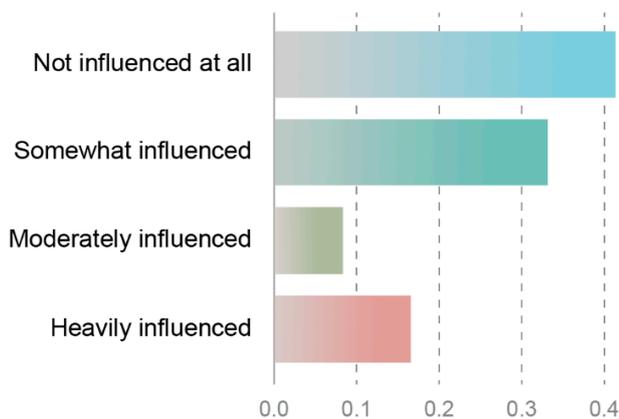


Figure 6. How much product sellers are influenced by the logic of planned obsolescence (percentage of total).

We next asked about actions that would persuade firms to planned obsolescence. Figure 6 shows the responses to: "What would motivate the company to maximize or significantly increase the lifespan of its products?" and Figure 7 shows the responses to: "What would motivate the company to maximize or significantly increase product repairability and the replaceability of product components?". A few (1,2) marked "Voluntary Ecolabels with product repairability requirements such as the EPEAT electronics ecolabel". Some (5,6) marked "Industry standards such as the FTC Green Guides with new product lifespan and repairability requirements". All respondents (12,12) marked "New laws on product lifespan—repairability".

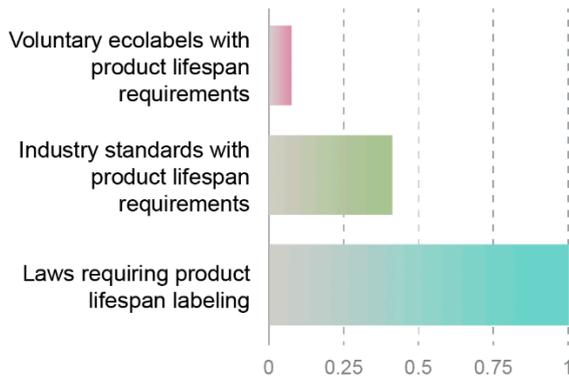


Figure 7. Motivations to significantly increase the product lifespans (percentage of total).

DISCUSSION

Maximized product lifespans and product systems configured for maximum repair capacity are core design strategies for the circular economy. However, they are not a panacea to guide the design of all manufactured systems. This is especially true for products that consume large amounts of energy and digital products employing electronic technologies that become technologically obsolete at a two to five-year frequency. A 60-year old petrol-guzzling automobile and a 40-year old electricity-profligate refrigerator may be exquisite antiques but the most environmentally responsible action for such devices is to replace them with more efficient modern models. Likewise, it makes little sense to design an internet-accessing telephone that can be repaired for forty years if any of its core technologies become technologically obsolete in five years.

However, for manufactured product systems that do not intensively consume power and that have no electronic circuitry (or limit circuitry to a small, easily upgradable subassembly within the larger product) extending product lifespans and enabling product repair are powerful strategies to minimize environmental impacts over the system's lifespan.

Question 1: What clues can current product warranties give about increasing the amount of service delivered over a product's lifespan or about increasing the capacity of a product to be repaired in the US?

As noted, for the survey responses to be statistically significant, we would need more survey respondents. Accordingly, we interpret the survey results with caution. The authors posit that in recognizing that these are not definitive results, we can still gain a relative degree of understanding from them. Figure 4 largely confirms what we might expect about product warranties in the US market. All but a small percentage of products (roughly 97% from the survey) were protected by implied warranties. A minority of products (roughly 21% from the survey) also had express warranties. The extended service contracts are usually

for a period that begins after the express warranty expires, and most products that offered extended warranty service contracts (roughly 18% from the survey) also had express warranties. Although statistically insignificant, these results imply the high degree of integration that product warranties have reached in the US market. Most market barriers to adopting warranties have already been overcome, thus paving an easy 'entry in the market' for those wanting to leverage the potential of warranties in circular business models.

Figure 5 indicates that privately owned firms were somewhat more likely to offer warranties specifying product repairability and longer product lifespans than firms with traded stock. Perhaps this occurs because firms with traded stock are obliged to deliver financial profits four times each year, while privately owned firms can more easily take a long-term approach to profits. This hypothesis could be further explored in future research.

The literature implied that planned obsolescence occurs in all markets where it is not stopped by regulations. The survey results (Figure 6), however, do not confirm this reasoning. An agreement to shield the identity of each lawyer, their business client, and the products that the client sells is a useful research tool. However, an employee can sidestep a candid evaluation of her employers' planned obsolescence behavior if it poses a risk of the employer learning of the critique. The survey invitations were all sent to company email addresses, and more than half of respondents replied from a company email address. Some employers might intercept and read the responses. In these circumstances, asking employees their opinions about such sensitive topics does not deliver objective answers. Because of the reputational sensitivity of a company to accusations of planned obsolescence, we believe that some responses to this question were made with a bias toward protecting their employer. We submit that the influence of planned obsolescence on their firm's product priorities is greater than "some influence" that was reported.

Question 2: What paths of action have the greatest probability of convincing firms that sell hard goods in the US to significantly increase product durability and product repairability?

Few readers are likely surprised by the responses on the motivations for manufacturers to increase product durability and product repairability in the US (Figures 7 and 8). The responses corroborate findings from the literature that voluntary ecolabels can be useful in supporting long product lifespans and product repair, and industry standards are even more supportive. But of the proposed methods, the one that most motivated companies to sell products with long lifespans and capacity for repair was mandatory legislation. A law that inspires

companies to abandon planned obsolescence would create an even playing field that financially incentivizes firms to compete based on the longevity and repairability of their products. Is it possible to create a law that would establish that financial motivation?

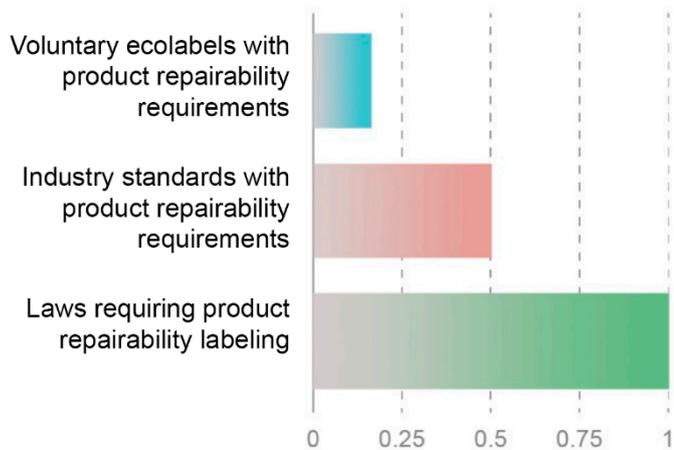


Figure 8. Motivations to significantly increase product repairability and component replaceability (percentage of total).

Law Reform and Planned Obsolescence

The incentives for manufacturers to design products that fail too early could be removed by various means. An extensive discussion of all possibilities would require a book-length treatment. Here, we examine some of the more direct paths to deterring planned obsolescence. One path is a carbon tax covering the embedded carbon (from materials extraction and processing, manufacturing, transport, and end-of-life treatment of the discarded product). The carbon footprint for electricity consumption during use should be taxed on the electricity supplier, not the product manufacturer. Ultimately, the owner of the product will bear most of the total carbon tax burdens. Depending on the rate, the tax could press the manufacturer to improve product longevity and raise product prices accordingly. Or the government could empower an agency to monitor product longevity and offer tax incentives to manufacturers that produce longer-lasting products. Another path, such as the recently enacted Swedish tax law [41], could deduct some or all costs of product repair from a product owner's income when calculating taxes. This approach could indirectly incentivize firms to sell products with a greater capacity for repair, with the costs of the repair shifted from tax deduction itemizing product owners to society as a whole.

Another potential path to reducing the environmental damage and macroeconomic inefficiencies of planned obsolescence would be to adopt a federal excise tax on the importation or sale of products with unnecessarily short lifespans. Excise taxes impose costs on, and therefore

provide disincentives to, activities considered socially harmful like the consumption of alcoholic beverages, or activities that impose externalities on the environment, such as the burning of fossil fuels. An obstacle to such a tax is the difficulty of determining an appropriate product lifespan for every consumer product on the market. Consumer goods have highly variable characteristics and expected lifespans, and the variety of products sold in the US is tremendous. The *Harmonized Tariff Schedule* of the United States lists over 5000 unique product classes [42]. Legislation establishing a general rule about product longevity for such a wide variety of products would not be feasible. Efforts to characterize the durability of a subset of product types is a more feasible task. For instance, the intensive research conducted by Catherine Rose to estimate the lifespans of common household appliances succeeded within the scope of a relatively modest research program [43].

The approach taken by legislators in Finland [44] and The Netherlands has been to authorize an agency to identify product categories with extended service warranties that are purchased in large volumes (automobiles, cellphones, home appliances, etc.) and establish minimal lifespan values for these categories. Such a list of product categories would significantly reduce the onus of identifying product lifespans by limiting regulation to a relatively small number of product classes, but it would not address the full scope of the problem.

Product labeling legislation offers a more practical path. A solution to information asymmetries that create inefficiencies in the market is to remedy those asymmetries directly by requiring manufacturers to disclose to consumers accurate and comprehensible information about the product to assist informed decisions. Regulation of this kind is already in use for some products, such as disclosures required by the Food & Drug Administration (FDA) of ingredients and nutritional information on the packaging of processed foods [45], and of the expiration date of pharmaceuticals [46,47].

One way to regulate labeling would be to obligate manufacturers to gather statistics on the average product lifespan of products and to disclose them to consumers through product labeling prior to purchase. A statute might require product sellers to disclose information about the monthly or annual cost of the product (i.e., product cost plus expected average repair costs over the product life divided by the average product life in months or years). In theory, such disclosures would allow purchasers to accurately compare products on a price per unit service basis. This would remove most of the incentive for manufacturers to plan obsolescence by providing an easily ascertained basis for cross-product price comparisons.

Further, manufacturers who are required to accurately disclose expected product lifespan (or service per product life) to purchasers will have a new incentive to make products repairable under warranty (unless replacement is more economical for them), because requiring the disclosure to be accurate means that the FTC could penalize companies whose products last less than represented and are not repaired by the manufacturer and/or consumers could obtain a refund or financial damages.

A disadvantage of such disclosures is that not all purchasers will understand them or have the time to include the lifespan information in their purchase decisions. Ample scholarly literature has analyzed the tendency of information overload to negate the benefits of providing complex information [48–50]. Strategies that a Federal statute might adopt to present such information in the manner most useful to consumers require further consideration and development.

A similar path could legally require all suppliers that sell a type of product in the US to collectively define a set of essential physical parameters for that product type and the primary function(s) that it delivers. These parameters could be used by trusted third-party evaluators (such as Underwriters Laboratories) to conduct physical assessments of product longevity and repairability. This is analogous to the process for making a *product category rule* (PCR). ISO established a detailed protocol for establishing a PCR [51]. In this approach, transfer of much of the onerous workload of categorizing and maintaining product type classifications from the government to private industry could make such a system more viable than an enormous government program, if proper oversight and safeguards are built into the program, like frequent reporting by stakeholder groups, and having the agency define the longevity standards. Such a program would need to exercise extra vigilance to ensure that the industry collaboration was not used as an opportunity for anticompetitive collusion.

CONCLUSIONS

The most useful findings of this study include:

- Product sellers rarely provide reliable information about product longevity for two reasons. Firstly, stating an expected lifetime or expected amount of service over the product's life establishes what could be interpreted as an express warranty for which the firm could be held financially responsible. Secondly, and frequently overlooked, preventing buyers from knowing how much service the product delivers also prevents buyers from factoring the product lifespan in their purchase decision. Undisclosed service per lifetime information

make it easy to sell products with a predetermined and premature lifespan.

- Companies profit by selling products that become prematurely obsolete. Planned obsolescence occurs in all markets where it is not stopped by government regulation.
- The extant range of warranties offers US businesses a robust, time-tested platform for expanding product lifetimes and product repair.
- Mandatory legislation would create the strongest motivation for firms that sell products in the US to maximize product lifespans and ensure product repairability, both of which support the circular economy, and if applied at scale, will significantly reduce damage to our stressed natural environment.

Two promising paths for reform that support longer product lifespans and increased product repairability in the US include:

- Congress could adopt legislation requiring the labeling of consumer products that provides accurate estimates of average product lifespan, and/or amount of service over the life of the product, possibly including the disclosure of information about the monthly or annual cost of using the product based on expected lifespan, repair and upgrade schedules and costs, that, if properly implemented, would spur competition in creating durable products.
- With support from Congress, the FTC and the DoJ could develop reliable metrics of implicit product quality collusion and increase enforcement of antitrust law and purchaser protection regulations to deter such collusion among competitors.

More objective ways of identifying planned obsolescence than feedback from company lawyers are needed, but large laboratories, timelines, and budgets are needed to identify product lifetimes through physically testing. Qualitative interviews with company lawyers or business managers could collect insights on how the company would likely react to potential regulatory intervention for expanding product lifespans. Such efforts might reveal a more nuanced depiction of the importance of premature obsolescence in product planning.

Further research could explore contiguous topics on policies and strategies for businesses, design teams, policy makers, and citizens to build the circular economy. A potentially rich area of investigation is the existing products already have lifetime warranties. By better understanding the physical characteristics, market sectors, and business models of these products, we can find opportunities to expand the use of lifetime warranties in larger hardgoods markets.

AUTHOR CONTRIBUTIONS

White, Fellmeth and Robbins planned the statute review and data collection for the study. White developed and administered the questionnaire. White, Fellmeth and Robbins wrote the paper after analyzing the reference literature and the collated questionnaire data.

CONFLICTS OF INTEREST

The authors declare that no conflicts of interest have occurred in this research.

ACKNOWLEDGMENTS

We are indebted to the Industrial Designers Society of America (IDSA) and members of the IDSA Ecological Design Section for assistance in identifying lawyers for firms that sell products in the US. We also thank Darian McCollum and Mark Carty for text review.

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How to cite this article:

White P, Fellmeth A, Robinson D. US Legal Frameworks: A Path to Product Longevity? *J Sustain Res.* 2021;3(3):e210016. <https://doi.org/10.20900/jsr20210016>