How Plastics Came to Pollute the Technical Literature: Evidence from US Patents on Facemasks

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Abstract

Today, we know a great deal about how plastics invade the oceans, but we know less about how these same pollutants begin to colonize the world upstream, even before the manufacturing process, when inventors draft their patents. This paper addresses this gap through a textometric study of the corpus of US facemask patents over a century. Patents are highly constrained by specific laws and rules: they must focus on utility, and only on utility, thus preventing moral concerns such as care for the planet from being part of the patenting process. They must also be generic, which prevents them from focusing on specific materials. Despite these limitations, the empirical analysis of our corpus reveals the linguistic tricks and cultural patterns that have allowed plastics, but also health and environmental concerns, to circulate in patents. The use of certain rhetorical devices, such as "preferably" and "or any other suitable material(s)," helps to mention specific materials while preserving the genericity of patents; in addition, the reference to market-based components contributes to externalize environmental and health considerations. As the analysis shows, most of these patterns contribute to deepening the production of ignorance in contemporary societies, although recent developments offer a glimmer of hope: the reference to external pressures for sustainability, or the transformation of the concept of sustainability into a material property, has helped to transform ethical concerns into useful facts, thus facilitating the replacement of plastics with more sustainable materials in the patent literature.

Keywords: Patents, Plastics, Ignorance, Matters of Concern, Health, Environment

Introduction

The Covid-19 crisis was not only a major disruption in the normal course of human history; it was also, in some respects, a return to the past. After decades of environmental progress, including a growing awareness of the threat posed by the proliferation of plastic materials in the environment, the need to fight the virus and the means to do so led to an impressive comeback of plastic-based solutions. During the pandemic, plastic gloves, shields, packaging of all kinds, and Plexiglas windows proliferated at an unprecedented rate. In a speech published on September 10, 2020, on *Plastic News*, a web journal of the plastics lobby, the CEO of the Plastics Industry Association proclaimed, "Plastic saves lives" (Radoszewski, 2020). Plastic has certainly helped to save lives, but in doing so it has also contributed to the introduction of the following paradox: if plastic saves lives, it also kills the planet and thus endangers the long-term conditions of human existence (de

Sousa, 2021) – in other words, plastic saves some of us and kills everyone at (not exactly) the same time.

In this paper, I would like to address this paradox by examining what is probably its most material and symbolic embodiment: the sanitary mask. This device, now largely made of plastic, was one of the main tools designed to contain the pandemic. The mask is a weapon against toxicity, but this weapon is made with toxic materials: although some chemists claim that plastics are not toxic per se, their construction contains several toxic substances (Liboiron, 2016). Moreover, plastic masks may end up invading and contaminating the land of other entities (air, rivers, oceans…), and as such they are part of pollution as a new form of colonialism (Liboiron, 2021). As such, the mask is what Plato called a *pharmakon*: it is both a remedy and a poison (Derrida, 1972). The mask epitomizes the fate of modern objects: its short-term usefulness obscures its long-term hazardousness, along a technological version of the "whatever it takes" rhetoric. The present usefulness of plastic masks conceals their future danger: on the one hand, polypropylene – the most common plastic component used in masks – is recognized as the safest plastic for the human body (Kumar, 2021), with the best filtering properties compared to other materials (Wang et al., 2023), so that it is likely to be difficult to replace; on the other hand, the same material becomes harmful to wildlife when burned (Purohit and Orzel, 1988) or dispersed in the form of microplastics (Hwang et al., 2019: 684; Jeyavani et al., 2022). In other words, polypropylene masks are subject to a 'Gremlin effect': just as the well-known creatures looked harmless, cute and friendly when used properly, but turned into terrifying monsters when exposed to light, wetted, or fed after midnight, health-protective polypropylene masks become a threat to all living entities, including ourselves, once released and degraded in the environment. This tragic metamorphosis is all the more common because people often perceive these masks not as plastic but as objects made of paper (Cochoy et al., 2022), and thus tend to use them without any sense of guilt and to release them more easily into the environment – during the Covid-19 pandemic, plastic face masks became a new item of waste polluting the oceans (Parker, 2021; Peng et al., 2021).

Therefore, I propose to investigate how plastics have been involved in the scientific and technical development of facemasks since the early 20th century. This study helps us understand why plastics were so easily incorporated into facemasks, and why the associated health and environmental concerns were overlooked in the patent literature. I conduct this research based on this latter corpus. In contrast to myriad studies conducted in law and economics that look at patents from afar, as black-box type of assets used in economic strategies and legal battles (for reviews of the literature, see Pénin, 2017 and Cochoy, 2021), I will join the few STS studies that take the content of patents seriously, as a repository of technology but also social history. Focusing on patents is important, because these documents contribute to shape techno-economic agencements, for instance by introducing new technologies and approaches in market organizations, bringing new consumer habits, and so on (Parthasarathy, 2017). Suggestive and recent examples include Jungnickel's studies of how patents on clothing inventions such as convertible cycling skirts helped women overcome the restrictions imposed on their sex (Jungnickel, 2023a, 2023b). In this vein, my own case will examine the extent to which patents may not only "hold social and technical stories" (Jungnickel, 2023a: 14), but also convey material and moral elements that both fuel and shape the latter.

The research is grounded in the perspectives of science and technology studies and scientometrics, based on a tradition initiated by Michel Callon and his colleagues (Callon 1986; Callon et al., 1991) and methods I have adopted on similar topics (Cochoy, 2021; Cochoy, 2022). I draw on contemporary work on the sociology of plastics (Hawkins, 2019; 2021) and its alternatives (Cochoy et al., 2022). I also draw on a body on research focusing on the various epistemic, economic, political and sociological processes that tend to produce ignorance even in the most scientific oriented settings (Frickel and Vincent, 2007; Heimer, 2012; McGoey, 2012; Dedieu, 2022; Knudsen et al., 2023). After describing the data and methods on which this study is based, I present the legal and professional rules as well as some specific rhetorical patterns that frame patent writing. As the study shows, patents are highly constrained by specific laws and rules: they must focus on utility, and only on utility, thus preventing moral concerns such as care for the planet from being part of the patenting process. They must also be generic, which prevents them from focusing on specific materials. These rules promote the unconscious, discreet and continuous proliferation of plastics in face mask patents, as well as the ignorance of their health and environmental impacts, at the risk of eliminating safer and more sustainable alternatives (Strasser and Schlich, 2020). The research reveals new patterns behind the production of ignorance, and thus new challenges that need to be addressed at the theoretical, technological and political levels, if we really want to move towards a healthier and more sustainable society.

Data collection and methods

A lot of work is being done to trace the presence of plastics in rivers and oceans (e.g., Ter Halle and Ghiglione, 2021), but such efforts take a downstream approach that neglects an upstream problem about which we don't know much: plastic components collected in outdoor spaces are hard to trace, both chronologically and spatially. If plastics are a threat, would it not make sense to address their proliferation both upstream and downstream? Would it not be appropriate to address the source of the problem rather than just its consequences? Hence the following questions: Where are the plastics in the environment coming from? Since when? How do plastics end up in everyday objects? Who decides to use them? For what reasons? How does the technological embodiment of plastic evolve over time?

In their comprehensive history of facemasks, Strasser and Schlich (2020) recall that surgical masks have long been made of fabric, and that the filtration performance of such fabric masks was as good as that of contemporary polypropylene models. However, I would like to complement this historical statement with a more systematic and precise examination. For example, talking about cloth and fabric could be confusing, because several fabrics are in fact made of synthetic materials. A long-term collection of patents seems to be a good way to deal with this issue, since patents focus on the design of technical objects and thus provide innumerable details about their construction.

Thanks to the Google patent search engine and ad hoc scraping software, I have built up a collection of patents related to face masks. I focus on simple filtering face masks that can be used in both medical and general settings, without an external oxygen supply, to protect the wearer from various types of contaminants – germs and viruses, as during the Covid-19 crisis, but also gases or dust, as all sorts of masks have been used by laypeople for sanitary purposes. To this end, and based on preliminary research in the scientific literature, I focused on US patents: this state-based corpus provides greater homogeneity, is based on a single legal framework and patenting process, and avoids language problems that arise when looking at patents from an international perspective. I then retrieved all US patents with one or more of the following expressions in the title: cloth mask; disposable mask; dust mask; fabric mask; face covering; face(-)mask; face protection; face shield; face mask; homemade mask; medical mask; ppe[2] mask; protection mask; protective mask; respirator mask; respiratory mask; sanitary mask; disposable mask. I further reviewed the list of 1,837 patents obtained by this process to eliminate those items that did not fit our research objective – i.e., according to the above definition, I excluded shields and visors and masks with self-contained oxygen supply. I kept some gas masks, but only those that were not labeled as such in the title. I excluded masks for extreme cold, automobile or train driving, aviation use, oxygen supply, facial care masks, recreational use, mechanical face protection in sports or industry, firefighter masks, and animal masks. I also excluded mask accessories and mask manufacturing methods. According to these various inclusive and exclusive criteria, I ended up with a population of 615 patents covering the period from 1912 to 2022. This corresponds to a corpus of 3,604,498 words (i.e. an average of 5,861 words per patent). In the following pages, the reference year is the priority year, i.e. the year from which the patentees can legally claim their priority. For each patent, the scraping process retrieves the full PDF, as well as the description, claims, and citations given and received (in raw text format). It also provides rich metadata: patent title, assignee and inventor names, priority, filing, publication, and grant dates. I then enriched this metadata with additional information, such as the number of claims, the number of citations given and received, and several indexes measuring the number of words related to plastic and natural components, as well as the number of terms related to disposability and sustainability (see below).[1]

On patent writing

A "factural" rhetoric

However, before studying the content of patents and tracing the presence of plastics in them, it is important to know what such texts are, what they are about, what they have to say, and what matters they cannot deal with. Bruno Latour (2004; 2005; 2008) proposed to complement the classical notion of 'matters of fact' with the twin notion of 'matters of concern.' He did so to emphasize that contemporary 'things' are entities that combine objective and moral dimensions:

> where matters-of-facts have failed, let's try what I have called matters-of-concern. (…) For too long, objects have been wrongly portrayed as matters-of-fact. This is unfair to them, unfair to science, unfair to objectivity, unfair to experience. They are much more interesting, variegated, uncertain, complicated, far reaching, heterogeneous, risky, historical, local, material, and networky than the pathetic version offered for too long by philosophers. (…) "Facts are facts"? Yes, but they are also a lot of other things *in addition.* (Latour, 2005: 19-21).

A face mask, for example, is both a physical object – a matter of fact – and something that involves moral issues – the sense of caring for others, the preoccupation with its polluting character, and so on, i.e., matters of concern. According to Latour indeed, "a matter of concern is what happens to a matter of fact when you add to it its whole scenography, much like you would do by shifting your attention from the stage to the whole machinery of a theatre" (Latour, 2008: 38). Latour's matters of concern can (should?) even be extended to 'matters of care' (de Bellacasa, 2017), for at least two reasons: first, as Bellacasa explains, the notion of care implies a commitment to action; second, in my particular case, masks are obviously oriented to care, provided that we do not restrict the notion to health care, or rather, that we do not limit health care to the human body, but also apply it to the well-being of the whole planet.

The problem with patents on facemasks, however, is that patents are texts that, given their legal and technical characteristics, avoid 'matters of fact,' 'matters of concern' and 'matters of care.' Patents are not really about introducing (arti)facts; they are rather about presenting innovations publicly. As such, a patent is more about disclosing the idea behind a technology, than exhibiting this technology per se (Biagioli, 2006). What a patent protects is a concept, not a manufactured good. The particular application of such concept and the means employed to materialize it have therefore better to remain vague. In other words, a patent deals with the following dilemma: it has to be specific enough to differentiate the invention it presents from previous patents and avoid litigation, yet broad enough to secure its industrial and commercial application, and prevent it from future competition. Such writing style protects the patentee, because varied material applications may still refer to the idea behind a single patent. It also increases the chances of having the patent implemented: a manufacturer will prefer to rely on patents that provide some freedom about the means to industrialize them. In other words and as surprising as it may seem for an institution about technology, patents are not so much about matters of fact, but about technological ideas. Just like Cori Hayden's generic drugs (Hayden, 2022), a patented solution has to be the same and not the same: is has to be both faithful to a given patent and a specific application of this same patent. Therefore, it is largely against the interest of patents to describe what materials should be employed to apply them, although it is not strictly prohibited for patentees to do so (and it may be best for them to do so, since suggesting appropriate means ensures the practicability of the proposed solution).

If patents are not really about matters of fact – except of course for patents aimed at describing particular materials –, neither are they about matters of concern or matters of care (Cochoy, 2021). In the United States, there has long been a legal debate about whether patent examiners or courts should reject or invalidate patents based on moral or ethical considerations. If in the early 19th century a "moral utility doctrine" (Enerson, 2004: 690) prohibited patents that conflicted "with the sound morals of society" (Enerson, 2004: 685) such as slot machines, this doctrine has since been abandoned. As Enerson puts it: "moral and ethical concerns should not be considered in determining the usefulness of an invention in the United States (…) courts and patent examiners should ask only whether a particular invention may be useful to the public, not whether the public should use such an invention" (Enerson, 2004: 688). As Enerson concludes, citing Schapira (1997: 171-172), "most patent attorneys in the United States believe that the 'American view' is that 'morality (...) should have nothing to do with patents.'" As a result, contemporary concerns such as environmental protection do not fall within the scope of patents (except, of course, for patents specifically directed to devices for cleaning or protecting natural environments). In 2024, US patenting institutions still view patents as morally neutral, as mere technical devices designed only to stimulate the market, at the risk of ignoring their obvious political character in terms of underlying ethical worldviews, social impacts, and other multiple 'distributive implications' (Parthasarathy, 2017).

In fact, patent writing is highly constrained by patent law and institutions. To be patented, an innovation must be shown to be novel, non-obvious, and useful (Seymore, 2014). Patents cover the novelty aspect by showing the contribution of the innovation to the prior art. They thus refer to each other by allusion or direct citation. Non-obviousness means that a 'person of ordinary skill in the art' (PHOSITA) would not know how to solve the problem addressed by the invention. Last but not least, as mentioned above, the usefulness of the patent refers to a classical, selfish and narrow sense of usefulness: the patent should prove its ability to fulfill a local and particular function, and thus its immediate use; whether the patent is useful or harmful to society or the environment as a whole on the long run is outside the scope of patents. According to this logic, a novel mask can be patented because it filters germs better, even if the chosen solution obviously endangers the planet.

For all these reasons, the content of patents is neither real nor abstract; we could say that patents are *factural*, i.e. they are both factual/instrumental – they address material problems – and cultural: they present ideas for solving these problems, but also convey or raise concerns about their subject matter. This factural dimension is tightly constrained by patent law and the rules of patent offices (Myers, 1995). Based on these laws and rules, patents must focus on presenting plans and special arrangements that help perform a particular action. However, they are not concerned with describing the precise means of doing so (e.g., materials) or discussing the morality of that action (e.g., concerns). Thus, when considering how materials or moral concerns are addressed (or not) in patents, it is paramount to keep these constraints in mind. As we will see, in part because of the above constraints, such entities are rarely presented, and when they are, they appear in a particular way that I propose to discover. In other words, it is not enough to obtain statistics on the occurrence of materials in patents; these statistics should be closely related to the patent culture and, more importantly, to how such materials (matters of fact) and cultural dimensions (matters of concern/care) have evolved together in the patent genre as well as in society at large.

In this respect, the patent institution could be described as another framework that contributes to the production of ignorance. For example, Frickel and Vincent showed that standardized pollution assessment methods were unable to determine whether Hurricane Katrina had polluted Louisiana or not (Frickel and Vincent, 2007). François Dedieu showed how ignoring farmers' fraudulent use of pesticides helps the French food safety agency keep its assessment procedures unquestioned and thus protect its reputation (Dedieu, 2022). Similarly, following the rules of patent writing is the best way for patent writers to get their applications patented and avoid embarrassing debates. On the one hand, these constraints explain the longstanding and overwhelming disregard (or ignorance) of mask patents for material and moral concerns. However and as we shall see, these constraints are not absolute, but can be overcome by various means, the first of which are of a rhetorical nature.

Preferably [X]…

In the case of mask patents, I have to solve the following puzzle: how can specific materials or concerns penetrate a kind of discourse that tends to favor the adoption of generic and moral-free formulations? If I cannot immediately address the case of concerns, I can provide an answer for materials. To promote some materials in their texts, patent attorneys and engineers rely on two specific and ubiquitous rhetorical figures.

The first figure consists in coupling the mention of a specific use of materials with the adverb "preferably." Our corpus contains 1,256 different adverbs, used 109,126 times. In this list, "preferably" ranks 7th, just after very vague and frequent adverbs like "wherein," "not," "as," "also," "herein," "so," and even before such common adverbs as "about" and "only." It appears in more than half of the patents (52%). It is used 2,383 times, which is 2.1% of the total number of adverb occurrences. Even more interestingly, this figure places "preferably" at roughly the same level as "generally," which is used 2,311 times. This equivalence epitomizes the tension between specificity – indicated by "preferably" – and genericity – embodied by "generally." Preferably is thus a way of suggesting the use of a particular material, but also of presenting it as just one solution over several others, and thus respecting the generic nature of patents. See the examples below:

> A yolk 60 is typically placed on top of the face piece 10. The yolk is made of a semi-rigid material, preferably plastic. (US5592937A); Facial protection layer is (sic.) prevents dryness, and is preferably non-woven material. (US20170209719A1); Respirator face piece 10 preferably comprises three stiffening elements 20, 30, and 40, respectively, made of a lightweight material, preferably a moldable plastic, and more preferably polypropylene or glass filled polypropylene, which are held together by a thermoplastic rubber 50, preferably one that has polypropylene in it such as kraton, starflex or sanoprene. (US5592937A); On the outer surface, and attached thereto in any suitable manner is a non-porous sheet 22 of impervious material preferably polyethylene film. (US3170461A)

… (or) any other (suitable) material

A similar and complementary way to be specific while still respecting the generic nature of patents is to accompany the mention of a preferred material (presented as a pure option: see the use of "can be" or "may be") with a clause like "(or) any (other) suitable material(s)." Searching such clauses in the corpus with TXM[3] yields 124 matches spread over 63 patents, i.e. more than 10% of the entire collection, of which Table 1 gives examples:

Table 1. Pivot table for "or any other suitable material.

id	Left context	Pivot	Right context
US20210106853A1	the material M2 may be polybutylene terephthalate	or any other suitable material	). The different materials M1, M2 of the facepiece 12
US20220105369A1	The hook may be made out of plastic, metal, composites,	or any other suitable material	. The hook may extend from the third strap portion 140
US20220117335A1	The tubular members 310 and 312 may be made of plastic	or any other suitable material	. The tubular members 310 and 312 may be hollowed for passing
US20220312867A1	the valve-connected member 118 ca be manufactured of fabric, flexible plastic	or any other suitable material	as is known in the art which allows the exhaled air to
US20210352978A1	hard plastics, fiber reinforced plastics, carbon fiber, fiber glass, resins, polymers or	any other suitable materials	including combinations of materials

Zooming in on the full version of the last item of this list illustrates well the logic of which "any other suitable material" is a part:

> the elements that comprise the device 100 may be made from or may comprise durable materials such as aluminum, steel, other metals and metal alloys, wood, hard rubbers, hard plastics, fiber reinforced plastics, carbon fiber, fiberglass, resins, polymers or any other suitable materials including combinations of materials. (US20210352978A1)

This list shows the extreme caution of the patent's author in providing details about the material construction of his innovation, and all the tricks he uses to be specific and generic at the same time. Not only is everything presented as optional, but the optional character concerns both the proposed materials ("such as") and their full or partial use ("may be made of or may comprise"). The list addresses specific materials, but its length compensates for this specificity: no less than 12 items are listed. Moreover, most of these elements are themselves of a generic nature and presented in the plural, so that they offer a subsequent choice within the choice itself: the manufacturer can choose between wood or hard rubbers, but he will also be free to decide which wood or which rubber to use. The materials are listed without regard to their natural or synthetic character: "wood" comes between "metal alloys," "hard rubbers" and "hard plastics." What matters is not the specific nature of the materials, except that they are all equally capable of belonging to the generic category of "durable materials," in the sense of solid, long-lasting (in French, durable also means "sustainable," which is of course irrelevant here: all materials are considered equal, provided they perform the same function). Last but not least, despite the impressive care taken to mitigate all possible differences between the listed materials, the author ends with the formula "or any other suitable materials," followed by a precision: "including combinations of materials."

We now understand how materials are addressed in patents and how they can penetrate this literature: materials enter patents provided they perform a certain function, and only that, are generic in nature, and are considered as one option among many equivalent others. "Preferably" pushes a solution while making it optional; "or any other suitable material" softens the suggestion of particular materials by pointing to alternative solutions. All in all, these two tropes are about nudging manufacturers: according to the generic nature of patents, it leaves the choice of materials completely open ("or any suitable material") while still recommending certain solutions ("preferably"). With this rhetoric in mind, it becomes possible to understand, measure, and analyze how plastics have been incorporated into the patent literature.

Plastics as one material among many, and materials as one theme among several others

We will be able to better evaluate the presence of plastics in patents if we get a larger view of their place among all the other aspects that patents are about. To get such a view, I propose to first subject the vocabulary of my corpus to a descending hierarchical classification using the Iramuteq software.[4] This method divides the whole corpus into text segments (identified by punctuation). It then builds a presence/absence table that crosses the text segments with the entire vocabulary of the corpus. The goal of this table is to bring together text segments that tend to contain the same words[5] into sets called "classes." A word's membership to a given class is established according to its independence, as measured by a Chi-square test. Using this procedure, the software is able to identify the different topics covered in the corpus and the words that are most associated with each topic.

As can be seen in the caption on the left, seven classes emerge from the classification. This analysis provides no surprises, but rather a synthetic view of what mask patents are all about.[6] Facemask patents are technical documents that describe the purpose and field of an invention (class 5: "scope," "description," "understand," drawing…") and provide detailed information about its technical construction (class 4: "fold," "edge," "pleat," "bottom," "line…"). An interesting feature of facemask patents is that they cover a cyborg-like aspect: these inventions are about finding the technical means to closely articulate a technical device and a human body. Thus, facemask patents focus on

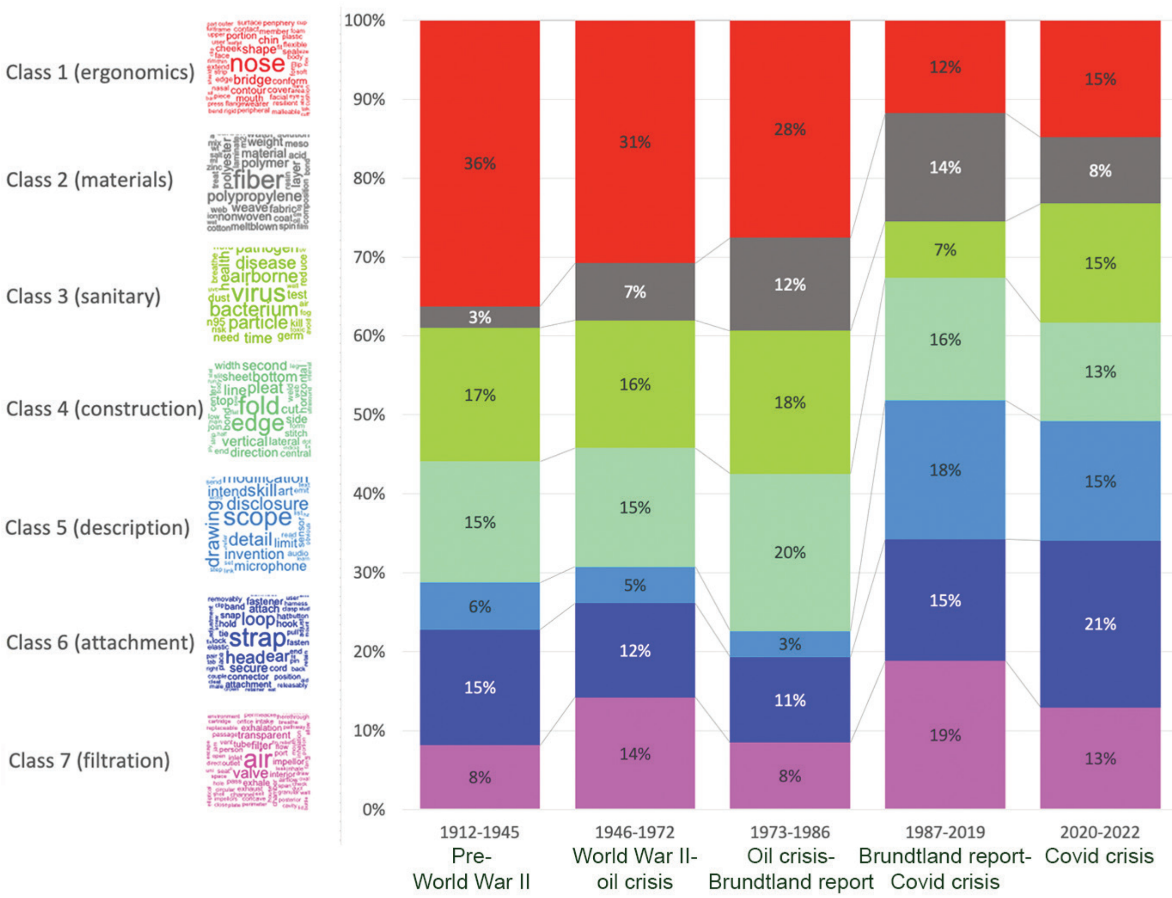

Figure 1. Reinert classification of the corpus.

ergonomic issues (class 1: "nose," "bridge," "shape," "chin," "contour") and especially on the best way to attach the mask to the user's face (class 6: "strap," "loop," "ear," "secure," "attach"…). A key concern is obviously the hygiene performance of the device in terms of combating various substances (class 3: "virus," "bacterium," "airborne," "particle, "disease," "pathogen"…) and thus its functional filtration devices (class 7: "air, valve," "filter," "transparent, "exhale"…). Here, the concern for health is clearly oriented toward a sense of care, even if it is limited to the human body. Of course, the materials used to achieve these different objectives are present (class 2: "fiber," polypropylene," "polymer," "material," "weave," "polyester"…), but the share of this class is rather discreet: it represents 11.2% of the total, a rate which is only slightly higher than the share of the "description" class (10.9%), but far behind other classes such as sanitary aspects (16.3%) and ergonomics (18%). This modest position of materials in patents on masks confirms that such patents tend to avoid being too specific in terms of manufacturing. However, it can be noted that words related to plastics (polypropylene, polymer, polyester, non-woven...) are among the 10 most representative terms of class 2, whereas other materials such as "carbon" or "cotton" appear only in 18th and 23rd place respectively.

The right part of the figure shows how the share of the seven classes has evolved over the history of mask patents. For better clarity, I made the calculation for five different periods related to events that affected the plastics industry: before World War II, after World War II until the oil crisis, from the oil crisis to the Brundtland Report, which popularized the idea of sustainable development (Borowy, 2013), after the Brundtland Report, and finally the Covid-19 period. As can be seen, the main evolution concerns ergonomic aspects, which tended to decrease, probably due to the emergence of a standard design for facemasks. The share of descriptive aspects increased, mostly due to the increasing average length of patents over the years (roughly from a few pages in the early

20th century to often ten or more pages today). Most other aspects have not changed significantly, reflecting the persistence of the underlying problem: a mask is a mask, and a patent on a mask has to address issues of construction, attachment, and filtration, no matter when. However, materials are an exception: until the Covid-19 crisis, the share of materials increased continuously, from 3% to 14%. This evolution shows a tendency for patents to show a greater concern for materials over time, despite the need for patents to have a generic character that requires/favors technical vagueness. The development of plastic materials after the war certainly explains this shift, but I still have to check which materials have been put forward and why in the most recent periods, notably after the oil crisis, the sustainability turn and the Covid-19 pandemic.

Presence and evolution of materials and concerns in mask patents

In order to document these aspects, I propose to track the presence of key materials and concerns and to follow their evolution. To this end, I have constructed two pairs of indices, one contrasting natural vs. plastic components and another contrasting disposability vs. sustainability concerns (i.e. health preoccupations related to caring for the planet). The idea is to compile the occurrences of words related to each term and study the chronological evolution of the resulting indexes, as well as their level in specific patents. For this purpose, I used the TXM software, a powerful textometric tool designed to track specific items in a given corpus (Heiden, 2010). With TXM, it is possible to count specific words or linguistic structures (e.g., the combination of any adjective with a given word) and to specify the results according to the underlying metadata (e.g., the publication date of the documents that make up the corpus under study).

The first pair of indexes focuses on materials and contrasts natural components (excluding metals and minerals) with plastics. I constructed the plastics index based on the tables of thermoplastics and thermosets provided by Encyclopedia Britannica:[7] acrylonitrile-butadiene-styrene; cellulose diacetate; epoxies; polyethylene; phenol formaldehyde; polyacetal; polycaprolactam; polycarbonate; polyester; polyetheretherketone; polyethylene terephthalate; polymethyl methacrylate; polyphenylene sulfide; polypropylene; polystyrene; polytetrafluoroethylene; polyurethane; polyvinyl chloride; urea and melamine formaldehyde. I supplemented this list with more general terms, such as plastic(s) and nonwoven(s), on the assumption that almost all contemporary nonwoven textiles are synthetic, and commercial or common names for synthetic fibers, such as acetate, acrylic, elastane, lycra, lyocell, nylon, polyamide, rayon, spandex, and viscose.[8]

For the natural fiber index, two lists were combined: a list of vegetal fibers (bamboo; banana; barley; coconut; cotton; flax; hemp; jute; kenaf; linen; palf; pineapple; ramie; rattan; rice; straw; vine; wheat; wood) and a list of animal components (alpaca; cashmere; chitin; chitosan; collagen; keratin; leather; mohair; silk; wool).[9] To these lists, I added the more general terms of "natural fiber(s)," "natural rubber(s)" and "natural adhesive(s)" found in the patents. I did not approach the opposition between synthetic and natural materials with the presence of "cloth" or "fabric" elements, because these words say nothing about the nature of these textiles.

The second pair focuses on concerns contrasting disposability and sustainability. I found these terms not by examining an external list, but by counting the number of "*able" adjectives present in our corpus, i.e. words that end with the suffix "able" and are related to disposability and sustainability, respectively: flushable and disposable for disposability; autoclavable, biodegradable, cleanable, compostable, durable, launderable, machine-dryable, machine-washable, microwavable, non-disposable, reusable/recyclable, recyclable, rinseable, sanitizeable, sterilizable, sustainable, and washable for sustainability. As can be seen, if the concept of sustainability is a recent one, other related terms are much older and thus help to trace the concerns that have become associated with sustainability over the long period.

Thanks to the TXM software, I counted the occurrences of each word for each category per five-year periods and compiled the results. The level of each category is summarized with an index that gives the number of occurrences per year per thousand words for each five-year period (this ratio helps to neutralize the varying size of patents as well as the uneven number of patents per period). The graphs below show the corresponding results.

Natural material vs. plastics

Unsurprisingly, natural elements came first and exclusively: one had to wait until after World War II to see plastics included significantly in facemask patents. Prior to that time, only materials based on vegetal or animal sources were available and cited in patent texts. This was a very modest presence: during this period, 41 words represented natural elements out of a total of 54,853 words, a rate of 0.7‰. Cellulose and cotton accounted for 78% of this total, meaning that the choice of materials was limited and thus not really an issue, all the more so as patent texts were short during this period – with an average of 1,714 words per patent before the Second World War, in sharp contrast to the average of 6,090 words of the subsequent period. Patents thus focused on design issues and tended to avoid material details, as the patent logic described above implies.

A single tiny exception to the discreet hegemony of natural materials occurred: in 1934, just one plastic-related word, "acetate," appeared in just one patent. Paradoxically, this patent (US2038310A) and this word deserve attention despite their exceptional character. The patent presents a simple "surgical mask" whose purpose was very similar to today's devices, since it was "not only protect[ing] the operating working field from contamination, by nose and throat discharges or perspiration during an operation, but also, in certain circumstances, (…) protect[ing] the operation against similar discharges by the patient" (US2038310A). In its description, this patent alludes to possible components, along with the careful rhetoric aimed at suggesting the use of some components without making them mandatory that I described above:

> In the illustrated embodiment of the present invention, there is shown a face mask or shield 5 which may be made of any desirable or suitable fabric or cloth, and which, to meet the exigencies of certain circumstances, may be made of a cellulose derivative, such as cellulose xanthate, nitrate or acetate (US2038310A).

Interestingly, the patent refers to available materials such as "fabric" or "cloth" – i.e., materials made of natural fibers at the time – but it also alludes to the possibility of relying on "a cellulose derivative, such as cellulose xanthate, nitrate or acetate." These materials played a key role in the transition from natural to synthetic materials. In particular, acetate cellulose, also known as "rayon," is one of

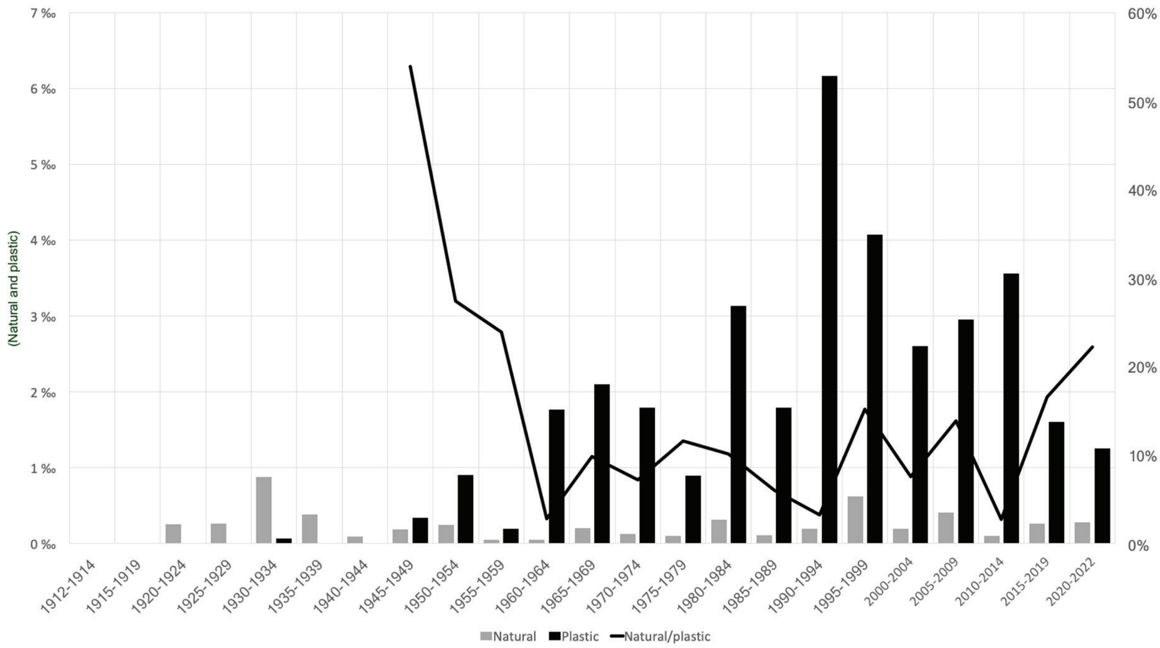

Figure 2. Natural vs. plastic components.

the very first synthetic fibers invented in human history. It was first developed in 1895, but it was not until 1924 that it was converted into a fiber and marketed by the US company Celanese (Kaufman, 1993). Significantly, this product was derived from natural cellulose extracted from cotton and wood pulp and then transformed with various solvents and additives, and even today, it is very difficult to distinguish rayon from cellulose in samples (Cai et al., 2019). In his detailed paper on the history of rayon, George B. Kaufman (1993) describes it as a "semi-synthetic" fiber, given the partly natural and partly synthetic character of this material based on vegetal sources and chemical components and processes. It is noteworthy that Kaufman concludes his review with a paragraph entitled "Ecological and Pollution Considerations" –just a few years after the Brundtland Report brought sustainability concerns to the forefront. In this paragraph, Kaufman, while lamenting the large amount of water needed to make rayon, also points out that no solvent is lost in the manufacturing process and lists the following benefits:

> Since rayon is made from trees, no petroleum is used in manufacturing the polymer, and much of the energy used for separation and purification of cellulose is derived from pulping by-products as energy sources. These last two factors give rayon a favorable position compared to completely synthetic fibers with regard to the total energy required for fiber production. (Kaufman, 1993: 892).

Rayon clearly served as a transition from natural to synthetic products. The latter began to emerge in the interwar period: Polyvinyl chloride was invented in 1927, polystyrene and nylon in 1938, and polyethylene in 1942. However, one had to wait until after the Second World War to see the boom of the plastics industry: between 1950 and 1970, the production of oil-based plastics increased twentyfold to more than 25 million tons, of which 8 million tons were produced in the United States alone (Chalmin, 2019). Throughout these developments, the plastics industry never stopped pushing its products (Mah, 2022), and these efforts obviously contaminated the patent literature. The flow of plastics entered our corpus with a slight delay indeed, along a growing trend that peaked in 1994, with a ratio of 10.6 plastic-related words per 1000 words, i.e. more than 1%! However, the most "plasticized" patent was granted in 2010, as shown by its abstract:

> The purpose of the invention is to provide a surgical mask with sufficient antibacterial properties, by uniformly manifesting on the surface of nanofibers a functional material with antibacterial and antiviral properties. The problem is solved by a mask with a functional material which comprises a nanofiber containing at least one base polymer selected from a group consisting of PVA, polylactic acid, fibroin, chitosan, chitin, nylon 6, nylon 6,6, nylon 9T, nylon 610, polyamide, polystyrene, polyacrylonitrile, polyethylene terephthalate, polyvinyl chloride, polyurethane, polyester, zein, collagen and methoxymethylated nylon, and at least one functional substance selected from a group consisting of catechin polyphenols, persimmon tannin polyphenols, grape seed polyphenols, soybean polyphenols, lemon peel polyphenols, coffee polyphenols, phenylcarboxylic acid, ellagic acid and coumalin, and having a diameter of 1 nm to 2000 nm. (US20130291878A1)

This patent contains a very high number of plastic-related words (282), with a rate as high as 16‰.[10] In a sense, this focus on materials is surprising, as it seems to contradict the generic aspect of patents inherent to the patent institution (see above). However, when we read the patent, we understand that if this particular patent abandons the dominant avoidance of materials in patent writing, it is because in this case plastics are precisely the resources whose combination guarantees the claimed function, i.e. the provision of "a surgical mask with sufficient antibacterial properties." In the patent, materials are presented as the means to achieve the desired function. In this respect, all materials suitable for this purpose are acceptable: the patent cites plastics because they are presented as necessary to achieve the targeted objective. However, it is important to note that plastics are not cited exclusively. Let us look at the very long list of materials mentioned. In this list, natural elements such as "chitosan," "chitin," "zein," "collagen" are jumbled with synthetic plastics, without any sense of hierarchy or preference, i.e., the cited synthetic or natural materials represent equivalent solutions to perform the function in question. In addition, the list recommends the use of polyphenols, a type of molecule extracted from various plants, as the mention of "persimmon tannin," "grape seed," "soybean," "lemon peel," and "coffee" shows well.

In fact, the patent manages to cite materials while fully respecting the logic of patenting. It does so by adopting a subtle strategy consisting in being specific as a way of not being so. In fact, a closer look at the list shows that only two *types* of materials are recommended, and then detailed with two long lists of possible solutions, so that the ways to industrialize the patent remain open: "The problem is solved by a mask with a functional material which comprises a nanofiber containing at least *one base polymer* selected from a group consisting of [set of examples No. 1] and at least *one functional substance* selected from a group consisting of [set of examples No. 2]." Suggesting a "base polymer" – i.e., a general category of material that includes many specific sub-units - is clearly another way of being specific without being so. More importantly, the emphasis is exclusively on utility, as required by the patent genre: materials are cited for their ability to perform the targeted function, and this only: "The problem is solved by a mask with a *functional material* comprising a nanofiber containing at least (...)." This is done without any consideration of the source or the side effects of the chosen materials. This patent illustrates well how plastics came to be included in patents: they were introduced "under cover," as technical means for a given purpose, rather than as entities deserving examination in themselves.

In general, if face mask patents have long ignored the environmental and health hazards associated with plastics, it is because they have considered them as solutions available on the market, be they generic products widely produced by the chemical industry (polypropylene, polyester, polyethylene, etc.) or branded products proposed by large companies (nylon, lycra, etc.). Significantly, the expression "available from" followed by the mention of a specific company appears no less than 100 times in the entire corpus – see for example: "The microporous membrane is made by extruding a mixture of polytetrafluoroethylene (PTFE) (commercially available from du Pont under the name TEFLON ®)" (US20090211581A1). It is as if mask designers follow the implicit assumption that everything that is commercialized is legal and approved. The patent writer, as a mere user of commercial components, thus considers them, if not risk-free, at least free of concerns he or she has to worry about. Indeed, the process of invention is not just about creating things from scratch; it is largely about buying and combining external parts (Cochoy, 2016). This market side of invention distributes responsibilities among different actors. If the fragmentation of standards and regulations dilutes the assessment of hazards in the cases of informed consent procedures (Heimer, 2012), pharmaceuticals (McGoey, 2012) or pesticides (Dedieu, 2022), the externalization of concerns associated with commercial components largely contributes to further deepening the production of ignorance.

Now, if patents are largely indifferent to the nature of materials beyond their functional character, how can we explain that plastics have come to dominate natural components in facemask patents, when some natural elements seem to have the same functional properties as their synthetic counterparts (Strasser and Schlich, 2020)? Looking at Figure 2, we get the impression that the level of natural elements remained stable while plastics invaded the scene: even if the chosen indices are not really comparable, the rate of plastic-related words is significantly higher than that of natural ones, and more importantly, it experienced a clear increase from 1945 to the mid-1990s, even if it slowed down slightly during the oil crisis. More precisely, before the Second World War, only one patent mentioned only one plastic material. By contrast, 61% of the patents with a priority year between 1945 and 1972 mentioned at least one plastic component; this rate increased to 85% for the period 1973-1986 and decreased only slightly thereafter, with 82% between 1987 and 2019 and 76% for the Covid-19 crisis. Nevertheless, the facts that plastic-related words decreased after the 2010-2014 periods and that a quarter of recent patents do not mention plastics seem to be encouraging developments… even if one may wonder if such a decrease is not due to manufacturing routines: when solutions

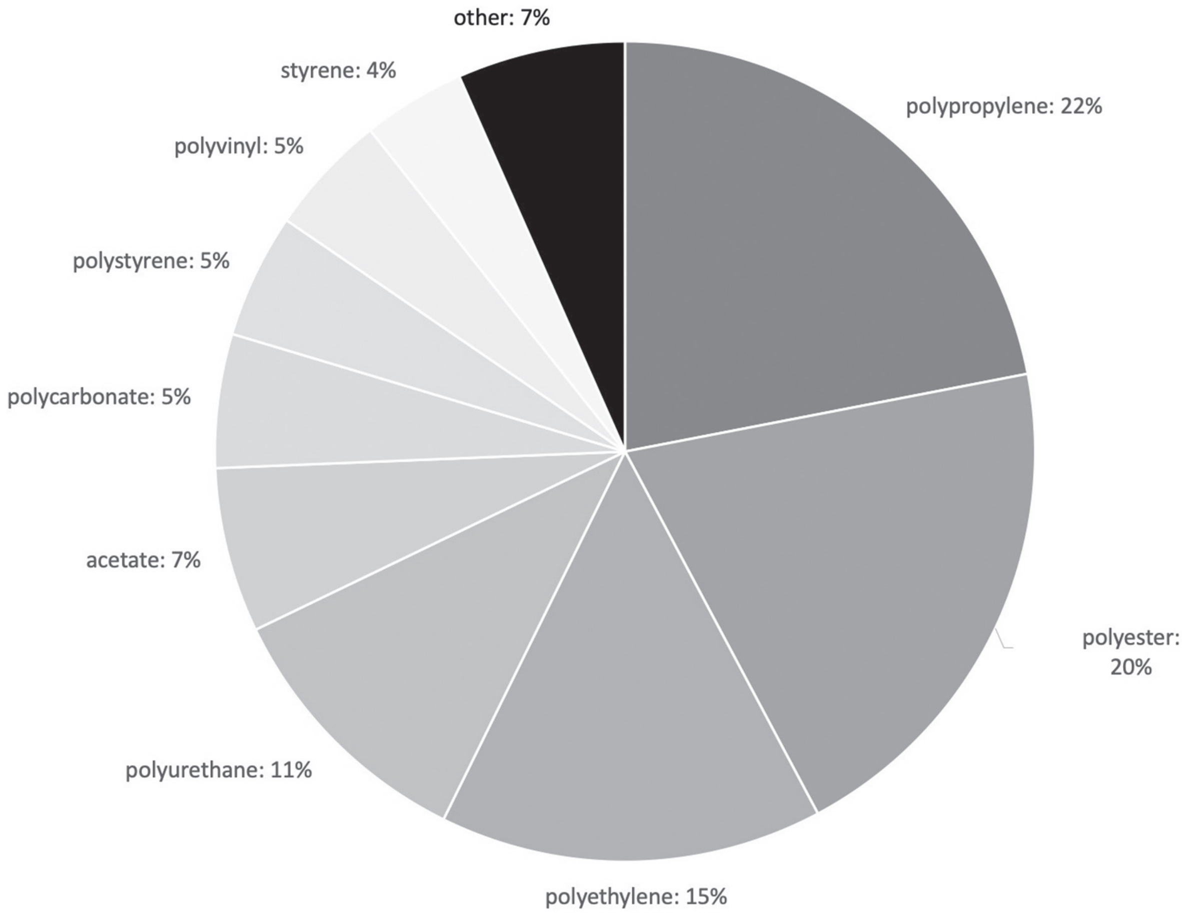

Figure 3. Plastics present in facemask patents.

become standard, there is less need to invoke them. Overall, the mask patents became full of plastics… and full of all kinds of plastics, as the pie chart below shows (Figure 3), even if polypropylene, polyester and polyethylene clearly dominated the corpus in the end, with the three of them representing 57% of the total.

To understand the evolution of the natural and plastic components, a better solution is to look not at these components per se, but at their respective shares. To this end, I have calculated the natural/plastic ratio for each five-year period: see the black curve in Figure 2 and the right axis. If the ratio itself is to be taken with caution (because they deal with different issues, the natural and plastic indices are not fully comparable), the evolution of this ratio is significant. Over time, we see that the share of natural components experienced a sharp decline from 1945 to the 1960s, and then remained at a low level until the 1960s. This corresponds to the plastic age. However, as indicated by the dotted polynomial trend curve, it seems that the recent tendency is more favorable for natural components, even if their comeback is not as fast as their previous decline. In other words, it is possible that the contemporary concern/care for the environment is penetrating the patent world, despite its institutional negligence for moral and ethical reasons.

Disposability vs. sustainability

A similar approach can be used to trace the evolution of value concerns such as disposability and sustainability. Disposability is rather a characteristic that reflects a lack of concern, a sense of carelessness, an immediate preference for convenience and practicality, and a disregard for the long-term consequences of such actions. The preference for disposability is a distinctive feature of late twentieth-century presentism (Hartog, 2015; Hawkins, 2018). As such, disposability is intimately linked to plastic, a material of which 49% goes into single-use items (Ogunola et al., 2018) and 40% is consumed by the packaging industry (Plasticseurope, 2020).

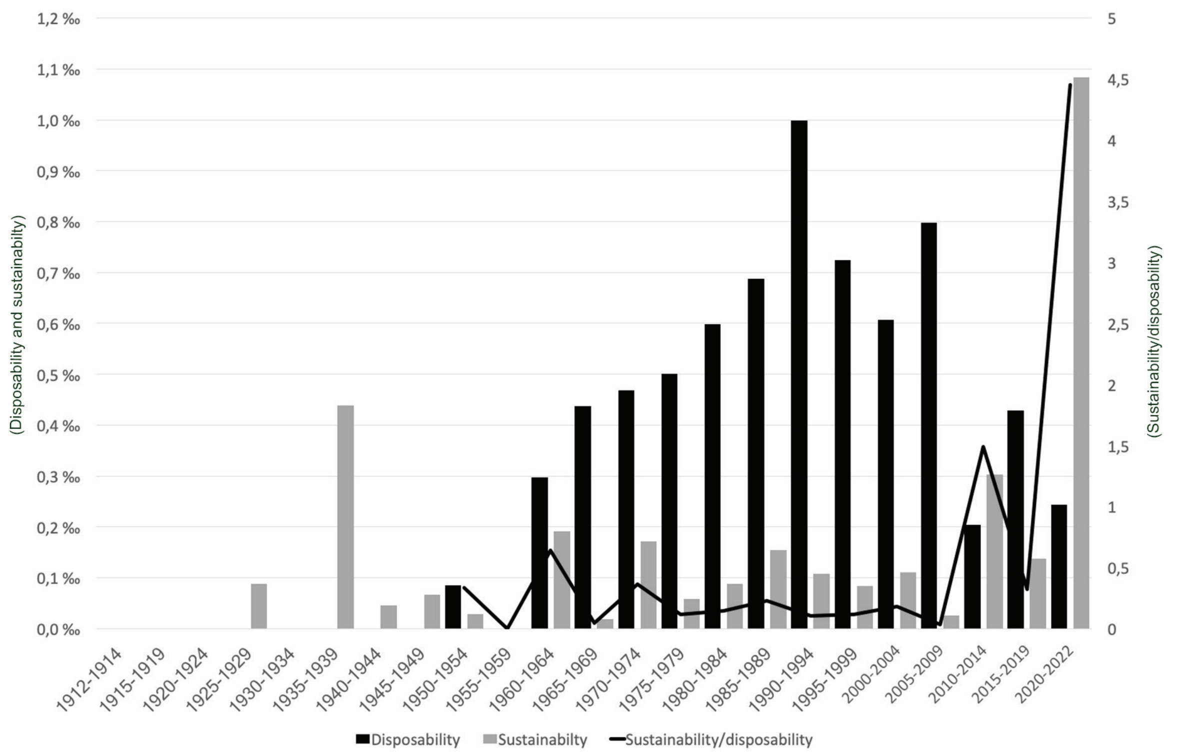

Figure 4. Disposability vs. sustainability.

To say that something is disposable is triple hypocritical. Firstly, it means that the disposable could be used otherwise, whereas in fact the object must be disposed of, since disposable goods are generally designed for single use only. Secondly, the claim of disposability is meaningless, since everything is disposable in some sense, so that one might wonder whether the adjective "disposable" has not long since become an (unintentional?) euphemism for plastic and, as far as patents are concerned, a way of presenting the material content of an invention without having to be specific and without violating the generic requirement of patent writing. Thirdly indeed, disposable qualifies objects that are mostly made of plastic and should therefore not be disposed of. Instead, disposable and (bio-)degradable should be synonymous, whereas in most situations it is exactly the opposite that applies.

Significantly, the plastic and disposable index curves have the same profile; in fact, these two curves are statistically correlated (r = 0.86). The terms "disposable/flushable" appear in 37% of the total collection of facemask patents. In addition, "disposable" appears in the title of 34 patents. In contrast, "reusable" appears in 20% of the patents and in the title of only 15 patents. It should be noted that the oldest occurrence of "reusable" is

id	Year	Left context	Pivot	Right context
US20150075532A1	2012	corporations are being driven to produce more	sustainable	and environmentally safe products through government regulations, by institutional investors
		hospitals and healthcare industries may be made from	sustainable	, environmentally friendly bioplastic resins and may be safely disposed without further
		tubing made from bioplastic resins. Environment and	sustainability	have become increasingly important factors in the design and specification of medical
US20210164138A1	2018	biodegradability which is of key importance for the	sustainable	use in disposable or single-use products such as hygiene articles
US20200323292A1	2019	inorganic antibacterial agents, the high efficiency and	sustainability	of the organic antibacterial agent, the safety and heat resistance of
US10912959B1	2020	adjustable face sizing, and made of	sustainable	, renewable, eco-friendly bioplastic material. 2.
US20210299489A1	2020	More specifically, there is a need for	sustainable	, re-usable, and breathable face masks
		transmission of viruses and pathogens, but is	sustainable	, re-usable, light-weight, and more breathable than the prior art
US20210316170A1	2020	provides an additional benefit in that it is	sustainable	and not quickly disposed of as environmental waste
		use and disposable, which is not environmentally	sustainable	. An embodiment of the face shield may be designed to be
US20220110378A1	2020	der Waals forces. The materials may comprise	sustainable	recycled materials. The face mask device is configured to fit over
		the invention 's mask devices will comprise	sustainable	, non-toxic alternative chemistries for water repellency purposes
		feel for the user, all in a	sustainable	configuration.
US20230014391A1	2020	made from biodegradable materials, recyclable materials,	sustainable	materials, and the like
US20220015474A1	2020	production, mild virucidal conditions, reusability and	sustainability	make HLIG a promising daily-use tool amid the pandemic.
US20220142268A1	2020	flexibility, breathability, washability, and	sustainability	, and does not incorporate the downsides of molded structures
US20220110378A1	2020	and preferably a renewable, recycled, or	sustainably	sourced synthetic fabric or biodegradable fabric
US20220240605A1	2021	of antiviral cellulosic fibers is poor and not	sustainable	. Therefore, biocidal masks based on cellulosic fibers often include

Table 2. Pivot table of "sustainab*" words.

from 1995, and that the use of this term is mostly concentrated in the most recent patents, as shown by an average date of 2016.

The late emergence of reusability is confirmed by the rise of sustainability-related notions of which reusability is just one particular component. After occupying a marginal position until the mid 2000s, with a rate always lower than 0.2 ‰, except before World War I (due to a 1937 patent, US2149067A, which presented at length "A washable and sterilizable surgical mask"), sustainability made a significant entry from the 2010s, to the point where it overtook disposability during the Covid-19 crisis.

In parallel, the presence of disposability declined in the recent period, possibly partly because it has become controversial, partly because it is now a routine, taken for granted and implicit feature of such goods. This evolution is evidenced with the profile of the sustainability/disposability ratio which was above 1 in 2010-2014 and jumped to 4 after the pandemic (see the black curve in Figure 4).

It is possible to get a better idea of such stakes by looking at the appearance of the words "sustainab*" and "toxic*" in patent texts. Developments related to sustainability (in the strict and contemporary sense of the word) have appeared only recently, long after the 1987 Brundtland Report that introduced the term, and only in a very limited set of 12 patents. The first mention dates from 2012 (US20150075532A1); the next ones appear in 11 patents that received their priority in 2018 and subsequent years. There are 18 mentions in these patents (see Table 2). This presence should not be overestimated. Not only are sustainability terms rare and recent, but they are also limited to the patent description and are therefore absent from the claims. To date, no facemask patent has been issued with "sustainable" in the title.

The way in which "sustainab*" words appear in patent texts reveals the processes by which social

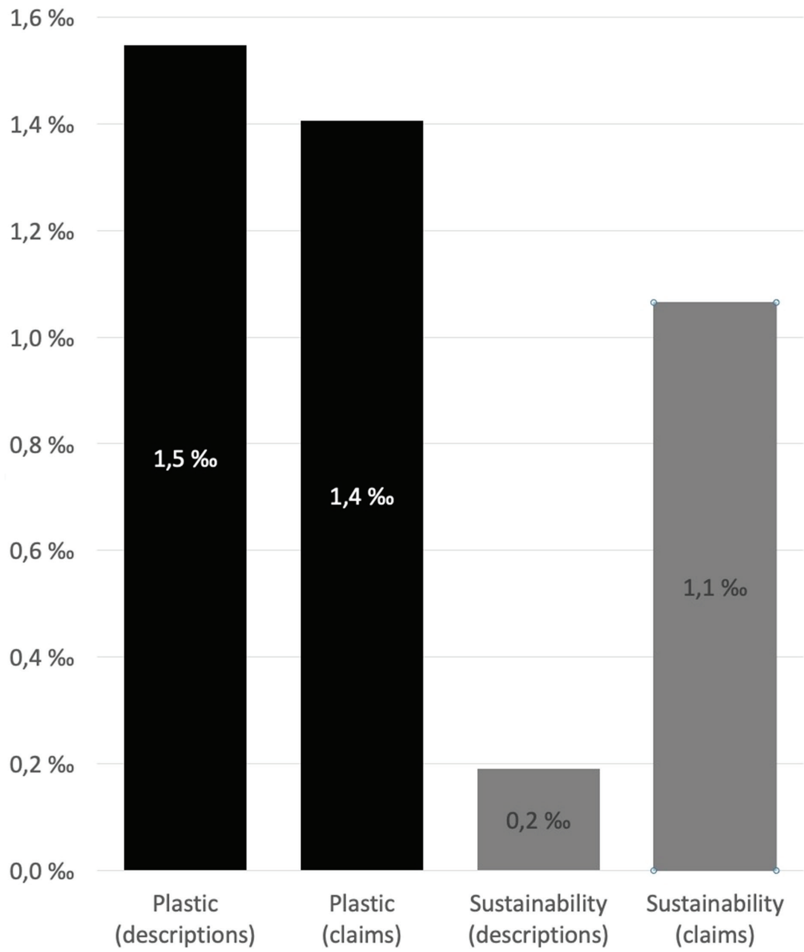

Figure 5. Plastic and sustainability in descriptions and claims.

and moral concerns are (or could be) incorporated into patent literature. Initially, such a shift seems to rely on direct references to external social developments. The 2012 patent alludes to pressures for sustainability coming from "government regulations" and "institutional actors." "Corporations are being driven to produce more sustainable and environmentally safe products": implicitly, if such pressure exists, responding to it falls within the scope of patent texts that are simply about producing useful objects. Sustainability is transformed from a morally remote concern – i.e., a concern irrelevant to patent writing – into a useful, material, and local property – a caring feature – that helps to solve contemporary needs. It is all the more significant that the most common form of "sustainab*" terms is not sustainability itself, but the adjective "sustainable." If we consider "sustainably sourced" as the equivalent of "sustainable," we count 14 occurrences of the adjective in 18 "sustainab*" words, i.e. 78% of the total. In its adjectival form, the concept of sustainability is transformed into a material, mechanical property, just like other similar qualities, such as "renewable," "reusable," "breathable," or "lightweight," with which it is often associated. In fact, sustainability is more often used as an objective property than as a concept: it appears as a twin to other similar properties such as "reusability," "flexibility," "breathability," and "washability." Incidentally, making sustainab* words part of longer lists of similar words is a third way of shifting sustainability from a moral concern to an objective property, or rather of hybridizing the two: with such lists, the moral concern becomes useful, and useful properties acquire some morality.

By the way, the shift towards sustainability is accompanied by the introduction of new materials, including "bioplastic resins" and "bioplastic material." Plastics are still there, but they are not the same. It should be noted, however, that bioplastics appear in only two patents: the US20150075532A1 patent (priority year: 2012) and the US10912959B1 patent (priority year: 2020), two patents that clearly allude to sustainability. The question remains whether this drop of sustainability in an ocean of classic plastics can lead to a more significant evolution.

To answer this question, it is possible to contrast the presence or absence of the four terms discussed so far (natural and plastic components, disposability and sustainability in the broad sense) in descriptions in claims (see Figure 5). Recently, the now familiar notion of "greenwashing," i.e. the promotion of corporate efforts to achieve sustainability goals far beyond what is actually done, has been supplemented by the twin notion of "greenhushing," i.e. a symmetric strategy consisting of silencing corporate sustainable practices, along the hypothesis that publicizing such efforts could attract the attention of activists at the risk of additional pressure and bad reputation (South Pole, 2022). Such caution is likely encouraged by the fact that the realization of sustainability policies, far from being obvious, relies on multiple and therefore controversial configuration practices (Lippert, 2015). It appears that facemask patents are not immune to greenwashing. Above, we signaled that sustainability concerns are quite rare in patents, although some clever rhetorical techniques have helped to introduce such concerns that were a priori illegitimate in this literature. However, Fig. 5 shows that, apart from their overall rarity, sustainability-related terms appear much more frequently in the claims than in the descriptions (5.5 times more), i.e. in the part of the patents that deals with their public objectives rather than their technical construction. As far as plastics are concerned, it seems that facemask patents also reveal the presence of another figure that we could call 'blackhushing,' if we take black as the color of oil, that is, plastic (Hawkins, 2011). As we have seen, facemask patents have increasingly incorporated plastics as part of their construction over the years. However, these materials are somewhat more present in the descriptions than in the claims, as if patent writers found it preferable not to insist too much on such components. However, this 'blackhushing effect' is very modest, which shows once again how little the patent institution cares about materials and their possible effects beyond their functional efficacy.

Toxicity

A final way to approach the attitude of facemask patents in terms of sustainability concerns is to focus on how they deal with toxicity issues. As noted in the introduction to this paper, facemasks are ambivalent in this regard: their purpose is to combat toxic substances such as dust, germs, vapors, gases, or viruses, but they often present themselves as toxic commodities, at least to the environment. As far as toxicity is concerned, a mask is a double pharmakon: it is a remedy against external toxicity, but it is also a poison because of its own internal toxicity. It is possible to assess the importance of these two opposing dimensions by looking at how the adjective “toxic” appears in the text of the patents. In the corpus, this adjective is cited 129 times. It seems that 89.2% of these citations refer to the external toxicity (the remedy side), while only 10.8% of them refer to the toxicity of the mask itself (the poison side). These rare mentions are made in only 8 patents, and apart from US4141703A – a 1976 patent that states that “it is made of materials that are not toxic to the skin” – and US20100239625A1 – a 2007 patent that examines possible legal biocides, even if some of them are toxic – the remaining six patents were all published between 2018 and 2021. The patent that is most concerned with the toxicity of facemasks is US10912959B1, a 2020 patent. This patent has several objectives:

> The invention relates generally to respirator oxygen masks, and more specifically to a reusable respirator oxygen masks with openings for speaking, eating, and drinking purposes, while still protecting the user by filtering air through the mask. Furthermore, a respirator oxygen mask having an exhale inhale breathable filter, adjustable face sizing, and made of sustainable, renewable, eco-friendly bioplastic material (US10912959B1).

Sustainability comes across as one objective among others, as if the author thought that concern/care for the environment (providing a “reusable respirator oxygen mask”… “made of sustainable, renewable, eco-friendly bioplastic material”) would be all the more acceptable if it were combined with more traditional functional objectives (“openings for speaking, eating and drinking”; “protecting the user by filtering air through the mask”). More interestingly, the choice of sustainability is clearly linked to a criticism of the toxicity of previous plastic-based solutions:

> Currently, traditional cloth masks have fibers that are made from petroleum polymers which are toxic to humans. While other masks, such as oxygen masks or dust and bacteria filtering masks are made from toxic petroleum base polymers such as PET or PETE (polyethylene terephthalate). PVC is also another typical component of respirator masks, but it is also toxic to the user’s health and environment. (US10912959B1).

This patent clearly demonstrates that patenting can now address the ‘factural’ dimension of materials, acknowledging their functional usefulness (matters of fact) but also their moral dangerousness (matters of concern), and thus propose a more acceptable solution (matters of care as possible action). It does so by stating that previously irrelevant moral considerations can be transformed into utilitarian concerns, as the patent genre demands. However, it should also be remembered that this is just one patent among hundreds of similar documents that still rely on the narrowest myopic approach of patent writing. It thus remains to be seen whether the factural concern for sustainable products can spread in the patent literature.

Conclusion

My project was to investigate how matters of fact (plastics) and matters of concern/care (disposability and sustainability) are embedded in patents despite (and within) patent law and genre. To this end, I conducted a comprehensive textometric analysis of the presence of plastic materials and plastic-related concerns in mask patents.

I first recalled that patent writing is highly constrained by specific laws and rules. Patent law excludes moral considerations from patent writing; similarly, the patent institution requires patents to be novel, useful, and non-obvious, and thus leads them to insist on their generic functional character and to remain vague and open as to what specific materials can be employed to fulfill their usefulness objective. In this respect, the patent law and the patent institution can be described as another system involved in the production of strategic (McGoey, 2012) or organized ignorance (Knudsen et al., 2023).

Despite these constraints however, the empirical analysis of our corpus of 615 facemask patents shows how material and cultural considerations have nevertheless circulated in patents. The use of certain rhetorical devices, such as "preferably" and "or any other suitable material(s)," helps to mention specific materials while preserving the genericity of patents; in addition, the reference to market-based components contributes to the externalization of environmental and health considerations. However, more recently, the reference to external pressures for sustainability, or the transformation of the concept of sustainability into a material property, has helped to turn ethical concerns into caring actions and useful facts.

As the empirical material shows, this evolution is slow. The proliferation of plastics in the patent literature clearly preceded and outweighed the late and modest rise of concern and care for the body and the planet. Moreover, the statistical decline of plastics at the patent level does not imply their decline at the industrial level: on the one hand, patents tend to allude less to materials like plastics that are considered obvious, standard solutions; on the other hand, patents leave manufacturers free to use whatever materials they wish.

Nevertheless, and hopefully, despite the patent institution and despite industrial routines, patents prove to be slowly and modestly permeable to societal concerns, especially when such concerns can be transformed into functional goals and health care for both human and non-human entities. In this respect, patents can become *factural*: they can combine factual and cultural dimensions. The extent to which cultural values will take precedence over factual dimensions remains to be seen. Whether the contamination of concerns will reduce the contamination of plastics will depend on social pressure and on the ability of engineers and other actors to channel that pressure into useful inventions. At the very least, we now know that the patent literature's imperviousness to concerns is not as absolute as the patent law and institution make it out to be, and that some patent writers know how to cross the boundaries that surround their practice and care for our world at large.

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Notes

1. The full dataset is available here: https://doi.org/10.34847/nkl.51fd3r6s (accessed 1.7.2024).
2. Abbreviation for "personal protective equipment."
3. I used the query: "([word="any"] [ ] {0,2} [word="suitable"] [enlemma="material"]) within s," which returns all matches of sentences (within s) that contain the words "any" and "suitable" separated by 0 to 2 words, and followed by the lemma "material" (that returns the singular and plural forms of this word).
4. http://iramuteq.org/documentation/fichiers/IRaMuTeQ%20Tutorial%20translated%20to%20English_17.03.2016.pdf (accessed 1.7.2024).
5. Technically speaking, the analysis focuses not exactly on words but on forms, i.e. the underlying lemmas behind each particular word related to it (a lemma is the common heading behind the related words, for instance, "be" is the lemma of been, being, are, were; similarly, plastic is the lemma of plastic and plastics, etc.
6. The examples listed below are the most representative words for each class, listed in the order of their Chi-square value (link to the class). In the word clouds, the font size is proportional to this value. In our presentation, we refer to the words with the highest Chi-square.
7. https://www.britannica.com/science/plastic (accessed 1.7.2024).
8. https://www.loveyourclothes.org.uk/guides/fabric-focus-synthetic-fabrics (accessed 1.2.2024).
9. https://en.wikipedia.org/wiki/Natural_fiber (accessed 1.7.2024).
10. Patents with higher rates may be observed, with a maximum of 19.3‰ for US20060266364A1.