misc.

mikahla dawson

Misc.

By Mikahla Dawson

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THE JUNK DRAWER

Or at least, that's where this all started. I did some introspective research, and sifted through the darkest corners of my junk drawers, and realized that a wealth of treasure, and trash, was available at my fingertips. I am not alone in my minor hoarding of small, pointless objects. In fact, many artists, designers, and sculptors would argue that harboring anything (especially in many modules, like bottle caps) is the best way to get featured in a modern eco-friendly art book!

What I'm reffering to, somewhat tongue in cheek, is the new trend of "upcycling." You've heard about it on pinterest, buzzfeed, and from your artsy aunt, but you might not realize that there is a large body of art work that falls under that specific category as well. The true definition of upcycle, "reuse (discarded objects or material) in such a way as to create a product of a higher quality or value than the original," feels loosely defined when examining the art that emerges from this trend. In contrast, however, some of the work produced is stunning. Even so, some of what you are about to see may be indescernable from standard junk drawer trash, and to drive that point home, Intermised throughout this work is exactly that: trash, art, and everything inbetween.

This book, which is formatted a little strangely, has a few key features that you should note before proceeding to avoid confusion. First, all of the images in this book are credited to the original artist in the back of the book, with thumbnail images and page numbers. If you are interested to know who created that image or the contents of it, see the index. Second, this book is divided into four main sections: Wood, Metal, Paper, and Plactics/Etc. Each of these sections has a new accompanying text from an outside author, mostly excerpts from non-fiction books. These texts are each credited at the start of the section on the main title page in the body text. Lastly, you will notice pull quotes throughout the book. Those pullquotes are the voice of, arguably, the most anti-upcycle, anti-hoarding, tidying expert in the world, Mary Kondo. Her voice really emphasizes the other side of the coin, and the vast public opinion of people who harbor bits of metal or so on.

I'm not suggesting an opion on this subject, I'm just presenting a fw sides of the story, and I leave it to you to make your informed decision. My main goal is just to evoke deeper thought about what we, as a society, keep, throw away, deem as art, and deem as trash. How do we, as a society, diffrentiate between an artist and a hoarder? What about between brokenitems and things worth fixing?

WOOD

We all know the issue, the trees are dying. Deforestation. Ozone depletion aided by deforestation due to the increasing CO2 levels. I won't cram that down your throat. Instead, Alongside the most classic material in discussion, excerpts from *Stuff: The Secret Life of Everyday Things* by John C. Ryan and Alan Thein Durning pose questions about North American consumption, and the next step.

In this book I have delved into our material world in an attempt to show that although the materials around us might seem like blobs of differently colored matter, they are in fact much more than that: they are complex expressions of human needs and sires. And in order to create these materials - in order to satisfy our need for things like shelter and clothes, our desire for chocolate and the cinema-we have had to do something quite remarkable: we have had to master the complexity of their inner structure.

This way of understanding the world is called materials science, and it is thousands of years old. It is no less significant, no less human, than music, art, film, or literature, or the other sciences, but it is less well known. In this final chapter I want to explore the language of materials science more fully, because it offers a unifying concept that encompasses all materials, not just the ones we have considered in detail in this book.

This unifying concept is that although a material may look and feel monolithic, although it may appear to be uniform throughout, this is an illusion: materials are, in fact, composed of many different entities that combine to form the whole, and these different entities reveal themselves at different scales. Structurally, any material is like a Russian doll: it is made up of many nested structures, almost all of which are invisible to our eyes, each one smaller and fitting exactly into the one before. It is this hierarchical architecture that gives materials their complex identities - and, in a very literal sense, it also gives us our identities too.

One of the most fundamental of these material structures is the atom, but it is not the only structure of importance. At the larger scales there are dislocations, crystals, fibers, scaffolds, gels, and foams, to name a few that have been featured in this book.

Taken in isolation, these structures are like characters in a story, each contributing something to its overall shape. Sometimes one character dominates the story, but it is only when they are put back together that they explain fully why materials behave the way they do. As we have seen, the reason why a stainless steel spoon doesn't taste of anything is because the chromium atoms within its crystals react with oxygen in the air to form an invisible protective layer of chromium oxide on the surface.

If you scratch its surface, this protective layer grows back more quickly molecular explanations are satisfying, but in this case they only account for one aspect of the material: its tastelessness. A full understanding of why stainless steel behaves the way it does requires you

to consider all of the structures of which it is composed. When you start to look at materials in this way, you soon realize that all materials have a common set of structures within them. (To take the simplest of examples, all materials are made of atoms.) And before long, you'll find

"The question of what you want to own is actually the question of how you want to live your life."

that metals have much in common with plastics, which in turn have much in common with skin, chocolate, and other materials.

In order to visualize this connection between all materials, we need a map of this Russian doll-like material architecture: not a normal map that shows the variety of terrain on a single scale, but a map that shows terrain on a variety of scales: the inner space of materials. Let's start with the primary ingredients: the atoms. These are approximately ten billion times smaller than us, and so structures at the atomic scale are obviously invisible to our eyes.

On Earth, ninety-four different types of atoms naturally exist, but eight of these elements make up 98.8 percent of the mass of the Earth: iron, oxygen, silicon, magnesium, sulfur, nickel, calcium, and aluminum. The rest are technically trace elements, including carbon. We have the technology to transform some of the common ones into the rare ones, but this requires a nuclear reactor, which costs even more money than mining and results in radioactive waste. This is essentially why gold is still valuable in the twenty-first century. If gathered together, all the gold ever mined would fit inside a large town house.

Nevertheless, the rarity of certain types of atoms on the planet, such as neodymium or platinum, which are so technologically useful, may not ultimately be a problem, because a material is not defined by its atomic ingredients alone. As we noW know, the difference between hard transparent diamond and soft black graphite is not to do with their atoms: in both cases, they are made of exactly the same pure element, carbon.

It is by changing how they are arranged, by altering them from a cubic structure into layers of hexagonal sheets, that the radical differences in their material properties are brought about. These structures are not arbitrary - you cannot create any structure - but are governed by the rules of quantum mechanics, which treat atoms not as singular particles but as an expression of many waves of probability. (This is why it makes sense to refer to the atoms themselves as structures, as well as their formation when they bond with one another.) Some of these quantum structures create electrons that can move, and this results in a material that can conduct electricity. Graphite has such a structure, and so conducts eles:tricity. Exactly the same If atoms in a diamond but in a different structure do not allow the electrons to move so easily within the crystal, and so diamonds do not conduct electricity. It is also why they are transparent. This apparent alchemy illustrates that even with a very restricted set of atomic ingredients you can create materials with wildly different material properties. Our bodies are very good examples of this:

we are mostly made of carbon, hydrogen, oxygen, and nitrogen, and yet through subtle rearrangements of the molecular structure of these ingredients, and the sprinkling of a few minerals such as calcium and potassium, an immense diversity of biomaterials results, from hair, to bone, to skin. It is hard to overestimate the philosophical as well as the technological importance of this dictum of materials science: that knowing the basic chemical composition is not enough to understand materiality. It is, after all, what makes the modern world possible. To make any material, then, we need to bond atoms together. If you assemble a hundred or so of them, you have what is called a nanostructure. Nano means a "billionth," and this world of the nanoscale features things that are roughly a billion times smaller than us. This is the scale of macromolecules, where tens and hundreds of atoms get together to form much larger structures. These include the proteins and fats in our bodies. They also include the molecules at the heart of plastics, such as the cellulose nitrate used to make celluloid, or the lignin that is removed from wood to make paper. Holes in the structure at this scale create a fine foam, such as that of aerogel. These are all structures that feature in this book under different guises. What unites them is that they express their characteristics at the nanoscale, and it is manipulations at this scale that will affect their properties. Humans have been controlling the nanoscale for thousands of

"I recommend you dispose of anything that does not fall into one of three categories: currently in use, needed for a limited period of time, or must be kept indefinitely."

years but only indirectly, using chemistry or using metallurgy in a hearth. When a blacksmith hits a piece of metal he or she is changing the shape of the metal crystals within it by "nucleating" nanoscale dislocations - in other words, by causing the transfer of atoms from one side of the crystal to the other at the speed of sound. We don't see these nanoscale mechanisms, of course. At our scale we simply see the metal changing shape. Which is why we perceive the metal to be monolithic and slab-like: all the intricate mechanics of crystals have been beyond our comprehension until very recently. The reason why nanotechnology is such a buzzword today is that we now have microscopes and tools for directly manipulating structures at this scale and so creating a vastly larger array of such nanostructures. It is now possible to create structures at this scale that will collect light and store it as electricity, to create light sources, and even to create nanoparticles that can sense smells. The possibilities seem limitless, but what is more interesting is that many of the structures at this scale self-assemble. That means that the materials are able to organize them-

"Storage experts are hoarders"

"The process of assessing how you feel about the things you own, identifying those that have fulfilled their purpose, expressing your gratitude, and bidding them farewell, is really about examining your inner self, a rite of passage to a new life."

selves. This might seem spooky but is perfectly in line with the existing laws of physics. The crucial difference between the car motor and a nano-motor is that in the case of the nano-version the physical forces that dominate at that scale, such as electrostatic and surface tension forces, which can pull things together, are very strong, while gravitational forces are very weak. At the scale of a car, by far the strongest force is the gravitational force of the Earth, which pulls the various bits of the motor apart. The result is that nano-machines can be designed to assemble themselves using electrostatic and surface tension forces (and heal themselves in the same way). Much of this molecular machinery already exists inside cells, which is how they can assemble themselves, whereas at the human scale we need things like muscles and glue.

METAL

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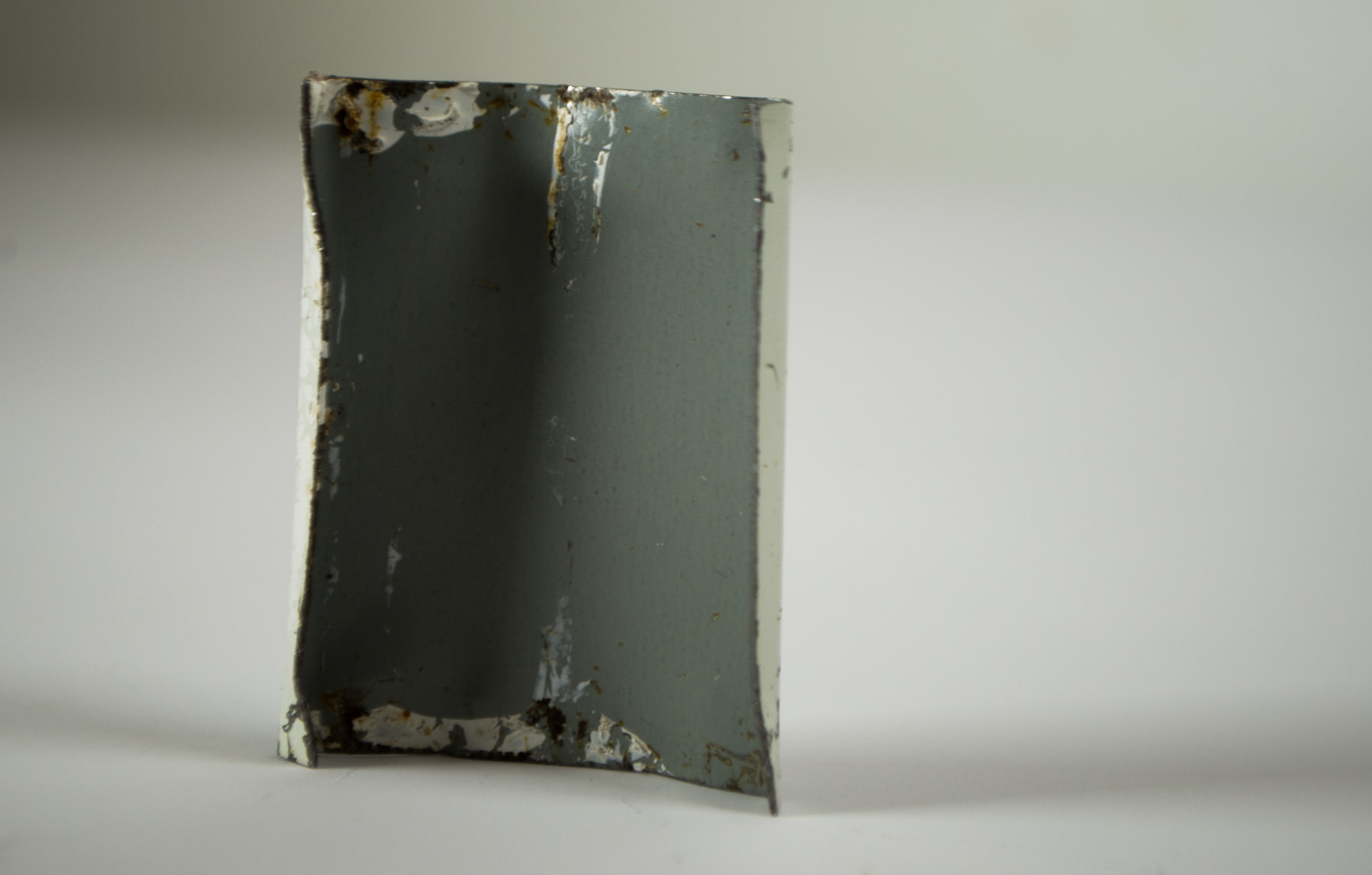
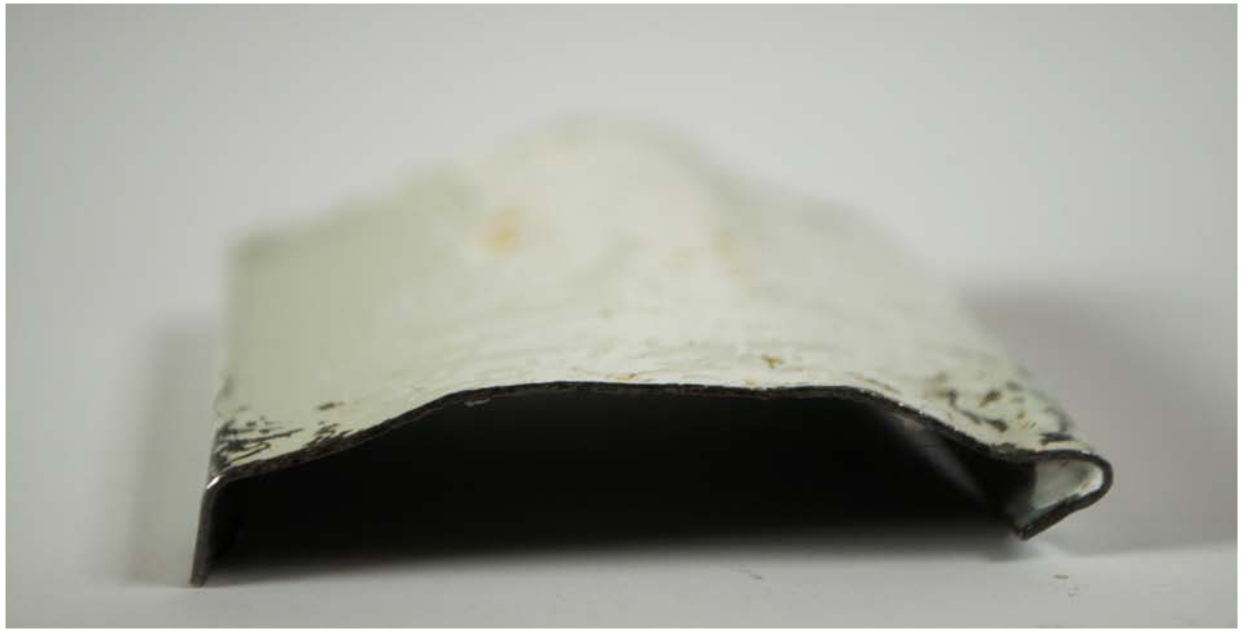




My name is Dana, and I ... am a consumer. Today, as soon as I got out of bed, I started consuming. I had a coffee. I ate breakfast. I read a newspaper. I put on my clothes. I commuted to work .. All day long I went about my ordinary business, consuming stuff and unwittingly affecting places and people around the world.

This book follows 'a day in the life of a fictional, typical North Ameri- , can-a middle-class resident of Seattle. It is a day in which nothing terribly unusual or dramatic happens. Or so it seems. 'I don't usually think of myself as a consumer. Though I don't spend much time worrying about the environment, I don't have a wasteful lifestyle either. I 'recycle. I have a compost bin in my garden. I've even biked to work before. North Americans/have grown more concerned and knowledgeable about the environment in recent years. And many environmental problems—urban smog, water pollution, lead in our air—are less pronounced than they were just a couple of decades ago.

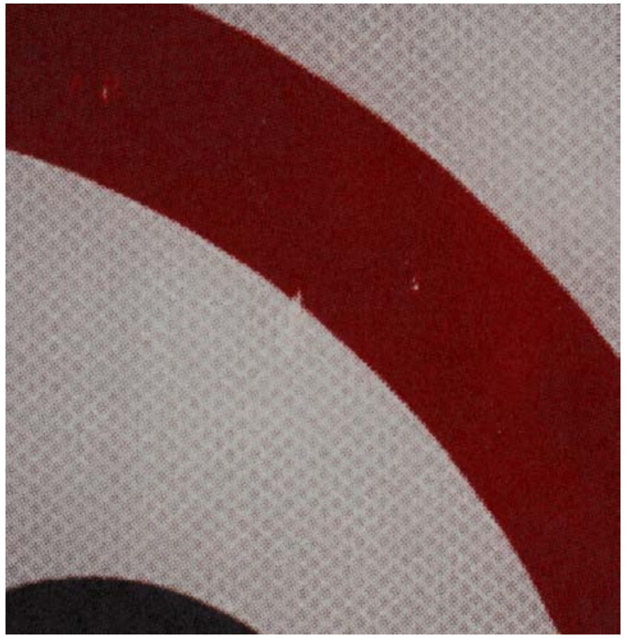
But cleaning out my basement recently got me thinking. Though, it felt good to throw out all that junk, my back was sore for a week afterward. Wading through all the objects of my life was a chore. Making them in the first place must have been one too. Americans throw out about four pounds of garbage each in their daily trash. It's not much in the grand scheme of things. Though they see only a fraction of it, Americans consume 120 pounds-nearly their average body weight-every day in natural resources extracted from farms, forests, rangelands, and mines.

There I was, piling old paint cans into a cardboard box when something caught my eye. It was a sticker that had fallen off the back of who-knows-what stowed in the basement. It said, "Made in Taiwan." I'd seen thousands of such stickers in my life without ever giving them a second thought. Taiwan. Taiwan. Not just a word · on a sticker. It's an island. A country. A real place with real people across an ocean from me . Suddenly, the overloaded shelves around me looked different .

I was stripped of the illusion that stuff comes from stores and is carted "away" by garbage trucks: everything on those shelves came from a real place on the Earth and will go to some other place when I'm done with it. Everything had a history-a trail of causes and effects-and a future. Everything had a life, of sorts. If you tried very hard, you could put a "Made in __ " sticker on each car wax bottle, speaker component, or old magazine on those shelves. Consumption on the North American scale—our own body weight each day—is possible only because of chains

"People who cannot stay tidy can be categorized into just three types: the "can't-throw-it-away" type, the "can't-put-it-back" type, and the "first-two-combined" type."


WARNING: Do not



of production that reach all over the planet. Most of the production, and most of its impacts, are hidden from view-in rural hinterlands, fenced-off industrial sites, and far-off nations.

Thinking about all the consequences of my consumption gets me down sometimes. A friend of mine teases me about how I used to go on shopping trips but now I go on guilt trips instead. She's only kidding, but I know what she means. It's no fun to bite into some hot, salty fries and find yourself thinking about farmworkers children with blue baby syndrome. I often resent this newfound awareness of things' secret lives. I tell myself, "If I'm some sort of global eco-villain, it's not my fault. I'm just trying to get along. It's the whole system that's cockeyed. What am I supposed to do? Stop drinking coffee? Bury my car? Join the Peace Corps?"

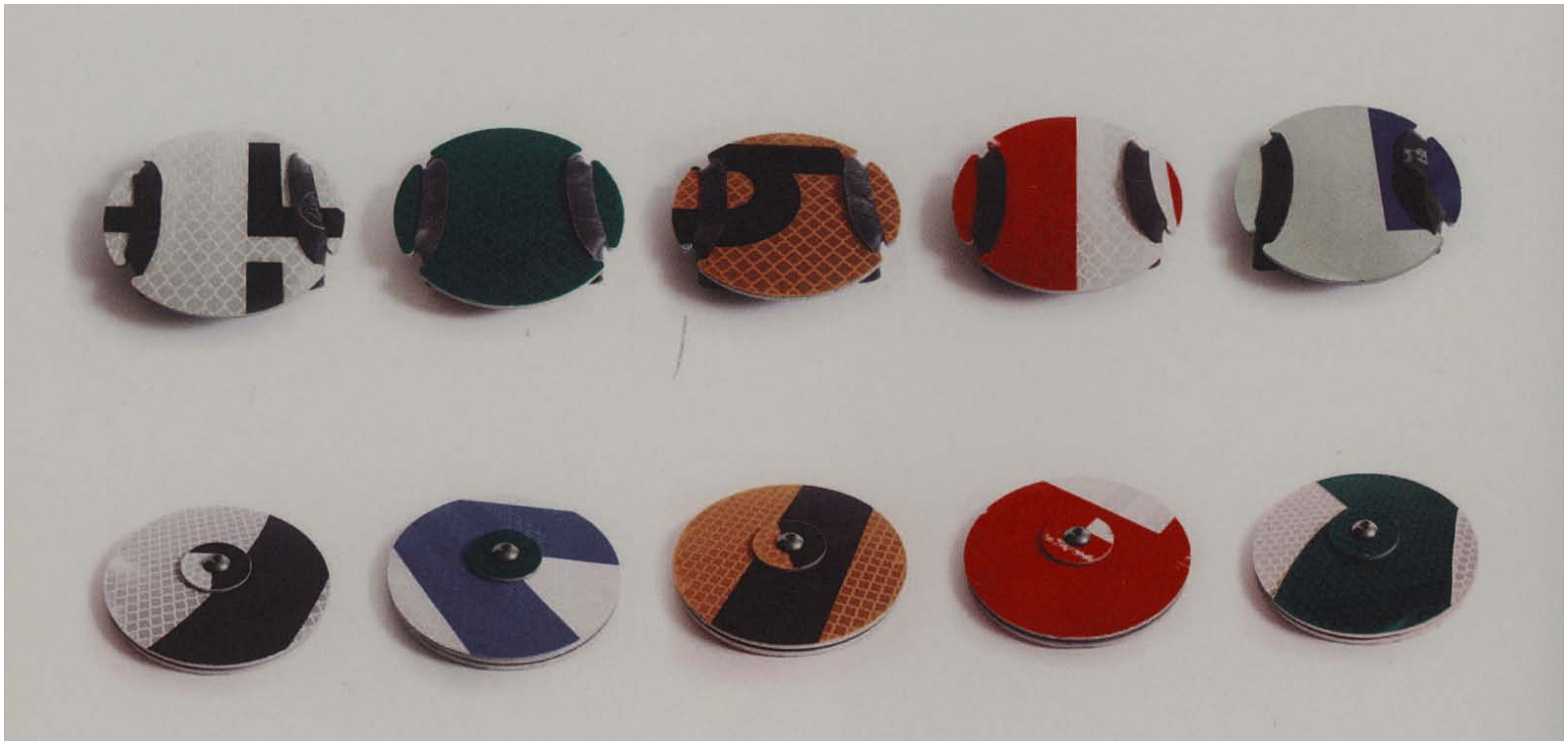
Confronting resource consumption is North Americans' principal environmental challenge, although few realize this fact because the impacts of consumption are mostly invisible to the consumer. The United States, with less than 5 percent of world population, consumes 24 percent of the world's energy and similar shares of other commodities (see table). A team of researchers at the University of British Columbia recently estimated that the typical North American consumes resources each year equivalent to the renewable yield from 72 acres of farmland/forestland. For all the world's people to consume at that rate is a mathematical impossibility. It would require four Earths' worth of productive land. In other words, we're three planets short.

We're at least nine planets-or atmospheres-short of safely absorbing the greenhouse gases that would result if all the world's people pumped Pollution aloft at the North American rate. To keep from getting overwhelmed, I try to focus on all the ways things are better than they used to be. My newspaper was half recycled, for example, and my fries were frozen without ozone eating CFCs. And I focus on all the possibilities for further progress: shade-grown coffee, paperless publishing, refillable bottles. Mostly, I try to remember that flesh-and-blood people like me preside over every step in the production, distribution, and disposal of everything I use. If all of them were constantly on the lookout for cleaner, Earth-friendly alternatives, surely I could have, my coffee and read the comics without suffering through the side order of guilt. And so could everyone else.

"Tidying is just a tool, not the final destination. The true goal should be to establish the lifestyle you want most once your house has been put in order."

Unfortunately, our high-consumption way of life is now the international vision of progress. The world longs to live the American dream, with steaks on the grill and two cars in the' garage. Yet consumption on the North American scale-our own body weight per day cannot last and expanding it to all the world's people is only a fantasy. Until there is a shift toward lower resource consumption and higher quality of life here, there is little prospect of arresting ecological decline worldwide. I can't 'change the world by myself, but everything I do-like biking to work today-makes a difference. Besides, I love bicycling. It gets my heart pumping and gives me a more intimate view of my neighborhood and my City.

Broadly speaking, three factors determine how much a society consumes: population, per capita consumption, and the array of technologies it uses. Environmentalists have long debated which factor deserves the most attention, just as they have debated whether individual, corporate, or government behavior is most responsible for our global predicament. These debates, to some degree, are moot: the gap between how our economy operates and how a sustainable economy operates is so wide that we need progress on all fronts to achieve sustainability. Slowing population growth is essential. So is speeding the spread of resource-efficient technologies, from laptops to clotheslines. And so is reducing individual consumption-through less materialistic lifestyles as well as



improvements in efficiency.

My commute to, work takes me across the old Fremont drawbridge over Seattle's Ship Canal. From my bike today-riding on the sidewalk-I saw a sign down at water level that I never noticed before from my car. It told boaters, "No Wake." Strictly speaking, that's an impossible command.

Any object moving through water will leave some wake, no matter how small. But as I continued my ride, I got to thinking about the idea. In our personal lives, we can seek to align our behavior with our values. We can live more simp/~ at once reducing environmental impacts, saving mone~ and leading by example. In our public lives- In our workplaces and in our democracy-we can advocate for dramatic reforms in the systems that shape our consumption patterns. We can, for example, advocate the elimination of perverse taxpayer subsidies such as those· that make aluminum too cheap and undammed rivers too rare. And we can promote an overhaul of the tax system.

If governments taxed pollution and resource depletion, rather than paychecks and savings, prices would help unveil the secret lives of everyday things. Environmentally harmful goods would cost more and benign goods would cost less. The power of the marketplace would help

propel the unstuffing of North American life. If a boat isn't too large and doesn't move too fast, its wake won't disturb other boats or ducks in the water, or erode the shore.

Just like boats, people—myself included—will always make waves in the world. When you get right down to it, consumption is inescapable. Any biologist can tell you that life itself is a process of consuming energy and matter and producing waste. Yet consuming too much isn't inevitable.

If there aren't too many of us and we don't consume too fast, we won't leave any wakes beyond the capacity of the Earth to absorb them. The time is ripe for confronting consumption. Not only are ecological problems like climate change more pressing than ever, consumerism has lost some of its allure in its North American epicenter. A majority of Americans already feel that their quality of life is suffering because of overemphasis on work and material gain. Encroachment of work and shopping on leisure time has millions of people searching for ways to restore balance in their lives-through lifestyles that trade money for time, commercialism for community, and things for joy. These people—downshifters or practitioners of voluntary simplicity—may one day attract the majority to their way of life by demonstrating that less stuff can mean more happiness. A North America that prospers without overusing the Earth—O sustainable North America—is entirely possible. All the pieces of the puzzle-from bike and transit-friendly cities to sustainable farms to low-impact lifestyles-exist, scattered all over the continent. All that remains is for us to do the work. of putting the pieces together. On my way home from work, riding my bike on the opposite sidewalk, I saw a second-and more realistic-sign along the Ship Canal. This, I decided, was a sign worth paying attention to. It said, "Watch Your Wake. Wish Everyone Did!"

Some goods clearly have worse impacts than others. Of the items portrayed in Stuff, the car does by far the greatest damage on a daily basis. For most readers, reducing car use should be a top priority. Yet ranking goods by their impacts-in effect comparing apples, oranges, and shoes-is not easy. Unraveling the life cycles of items produced in a global economy can be nearly impossible. Beyond that, some questions have no answers: which is worse, endangering

Canada's salmon or polluting Taiwan's air? Remembering to choose A over B is· less important than looking in a new way at the items you might buy or use. Imagine their secret lives first. With this step alone, you will probably consume less across the board. Just as the impacts of consumption are hidden and often surprising, the solutions can be surprising as well. Using a low-flow showerhead is a good way to save water, but eating less beef thereby saving the water used to grow cattle feed-would cut deepest of all into the 37.5 gallons of water consumed per person per day in the United States. Nationwide, farms ·use about three times as much water for irrigation as homes use for all purposes. One of the best ways to reduce material consumption is to focus on the nonmaterial things often lacking in our lives. We sometimes consume for lack of something better to do. Feeling lonely or dissatisfied, we shop. Lacking community, we travel. Concentrating on friend-ship and community may make us happier while, almost without our I noticing, it trims our consumption. Is it only a coincidence that "conversation" and "conservation" are spelled with the same letters?

"In Japan, people believe that things like cleaning your room & keeping your bathroom spick-and-span bring good luck, but if your house's too cluttered, the effect of polishing the toilet bowl will be limited."


MENU

PAPER

Paper is a wonderfully disposable material. Many of us perhaps take it forgranted.From precious paper to paper trash, we all “harbor” a little paper in our lives, in one place or another. In *Stuff Matters: Exploring the Marvelous Materials That Shape Our Man-Made World,* Mark Miodownik explores the place of this curious material in our society today, and looks at some of the properties that make this pulp-based material such a great canvas for information.

Paper is so much part of our everyday lives that we may easily forget that for much of history it was rare and expensive. We wake up in the morning with paper decorating our walls, either in the form of posters and prints or as wallpaper itself. We head to the bathroom for our morning ablution and there make use of toilet paper, an item which, if absent, quickly foments a personal crisis.

We head to the kitchen, where paper in the form of colored cardboard provides not just the containers for our breakfast cereals but the soundboard for them too, as they rattle their happy morning song. Our fruit juice, similarly, is contained by waxed cardboard, as is the milk. Tea leaves are encapsulated in a paper tea bag, so they can be immersed in and easily retrieved from hot water, and coffee is filtered through paper. After breakfast we may head off to face the world, but we rarely do so without taking paper with us in the form of money, notes, books, and magazines. Even if we don't leave the house with paper we quickly accrue it: we are issued paper in the form of transport tickets, we pick up a newspaper, or we buy a snack and are handed a paper receipt as a record of the purchase. Most people's work involves plenty of paperwork: despite talk of a paperless office, this has never transpired, nor does it look likely to, such is our trust in this material as a store of information. Lunch involves paper napkins, without which personal standards of hygiene would slip dramatically.

Shops are full of paper labels, without which we wouldn't know what we were buying or how much it cost. Our purchases are often contained within paper bags for their journey home. Once home we occasionally cover them in some wrapping paper as a birthday present accompanied by a paper birthday card contained in a paper envelope. Taking photos of the party, we may even print them out on photographic paper and in doing so create our material memories. Before bed we read books, blow our noses, and take one last trip to the bathroom, to convene intimately with the toilet paper again before we surrender to dreams (or perhaps nightmares of a world without paper).

So what is this stuff to which we are now so accustomed? Although note paper seems to be flat, smooth, continuous stuff, this is a deception: it is a mound of tiny thin fibers that resembles a bale of hay. We cannot feel its complex structure because it has been engineered at a microscopic scale that is beyond our sense of touch. We see it as smooth for the same reasons of scale that make the Earth seem perfectly round from space, while up close it has a bountiful supply of hills, valleys, and mountains.

Most paper starts out life as a tree. A tree's core strength derives from a microscopically small fiber called cellulose, which is bound together by an organic glue called lignin. This is an extremely hard and resilient composite structure that can last hundreds of years. Extracting the fibers of cellulose from the lignin is not easy. It is like trying to remove chewing gum from hair. Delignification of wood, as the process is called, involves crunching up the wood into tiny pieces and boiling them at high temperatures and pressures with a chemical cocktail that breaks down the bonds within the lignin and frees up the cellulose fibers. Once achieved, what is left is a tangle of fibers called wood pulp: in effect, liquid wood – at a microscopic scale it resembles spaghetti in a rather watery sauce. Laying this on to a flat surface and allowing it to dry yields paper. This basic type of paper is raw and brown.

Making it white, sleek, and shiny requires a chemical bleach and the addition of a fine white powder such as calcium carbonate in the form of chalk dust. Other coatings are then added to stop any ink that is laid on top of the paper from being sucked too far into the cellulose mesh, which is what causes ink to bleed. Ideally the ink should penetrate a small amount into the surface of the note paper and then dry almost instantly, depositing its cargo of colored molecules, which sit there embedded in the cellulose mesh, creating a permanent mark on the paper.

It is easy to underestimate the importance of note paper: it is a two-thousand -Year-old technology, the sophistication of which is necessarily hidden from us so that, rather than being intimidated by its microscopic genius, we see only a blank page, allowing us to record on its surface whatever we choose. My grandfather's tales from when he lived in Germany at the outbreak of the Second World War absorbed me as a child, but now that he is gone, the documents he left behind must tell the stories for themselves. There is nothing quite like holding a real piece of history in your hand, such as this letter that he wrote to the British Home Office in an attempt to extract my father from Belgium, fearing a German invasion.

Paper yellows with age for two reasons. If it is made from cheap, low-grade mechanical pulp, it will still contain some lignin. Lignin reacts with oxygen in the presence of light to create chromophores (meaning, literally, "color-carriers»), which turn the paper yellow as they increase in concentration. This type of paper is used for cheap and disposable paper products, and is why newspapers yellow quickly in light. It used to be fairly common to increase the textural quality of paper by coating it with aluminum sulfate, a chemical compound that is used primarily to purify water, but what wasn't appreciated at the time was that this treatment creates acidic conditions. This causes the cellulose fibers to react with hydrogen ions, which results in another form of yellowing. It also decreases the strength of the paper. Large numbers of books from the nineteenth and twentieth centuries were printed on this so-called acid paper and can now be easily identified in book shops and libraries by their bright yellow appearance.

Even non-acid paper is susceptible to this aging, just at a slower rate. The aging process also results in the formation of a wide range of volatile (meaning that they evaporate easily) organic molecules, which are responsible for the smell of old paper and books. Libraries are now actively researching the chemistry of book smell to see if they can use it to help them monitor and preserve large collections of books. Although it is a smell of decay, to many it is nevertheless perceived to be a pleasant one. The yellowing and disintegration of paper are disturbing, and yet, like all antiques, paper gains an authenticity and power from its patina of age.

The sensual impressions of old paper allow you to enter the past much more readily, providing a portal to that world.

My grandfather's attempt to petition the British Home Office on behalf of his son was a success. And this was the result: my father's German identification card, which was stamped by the immigration office on his way out of Brussels on December 4, 1939. My father was nine years old at the time, and in the photo he appears oblivious to the danger of his situation. The Germans invaded in May 1940. It is hard to overestimate the effect of photographic paper on human culture.

It provided a way for identification to be standardized and verified and, in this sense, has been accepted as the final arbiter of what we look like and, by extension, who we actually are. The almost fascistic authority of the photograph originates from its (apparently) unbiased nature; which is the result of the way the image is captured. And that lies with the paper itself: since the chemicals in it record the dark and light patches of your face automatically, by simply reacting with the light reflected from it, the image itself is seen to be impartial.

The black-and-white photo of my dad started out as a white piece of paper coated in a fine gel containing silver bromide and silver chloride molecules. In 1939, when the light bouncing off my dad entered the camera lens and fell onto the photographic paper, it transformed the silver bromide and chloride molecules into little crystals of silver metal, which appear as specks of gray on the paper. If the paper had been removed from the camera at this point, the image of my dad would have been lost. This is because all the white areas where there was no image would be flooded with light, causing them instantly to react as well and creating a completely black photo.

To prevent this, the photo was "fixed" in a darkroom with a chemical that washed away the unreacted silver halides from the paper. This left only the silver crystals embedded in the layer of gel on the surface of the paper. Once dried and processed it was the image of my dad that enabled him, rather than some other boy, to escape the concentration camps. My dad is still here to tell the tale, but one day there will only be the photograph to remind us of this moment in time - a material fact of history that contributes to our collective memory.

Of course, photograph- are not really unbiased, but then neither are memories. The transition from an oral culture, in which knowledge was handed down through stories, songs, and apprenticeships, to a literate one, based on the written word, was held back for centuries by the lack of suitable writing material. Stone and clay tablets were used, but they were prone to fracture and were bulky and heavy to transport. Wood suffers from splitting and is susceptible to decay. Wall paintings are static and space is limited. The invention of paper, said to be one of the four great

"My clients always sound so so happy, and the results show that tidying has changed their way of thinking & their approach to life. In fact, it has changed their future. Why? This question's addressed in detail throughout the book, but basically, when you put your house in order, you put your affairs and your past in order, too."

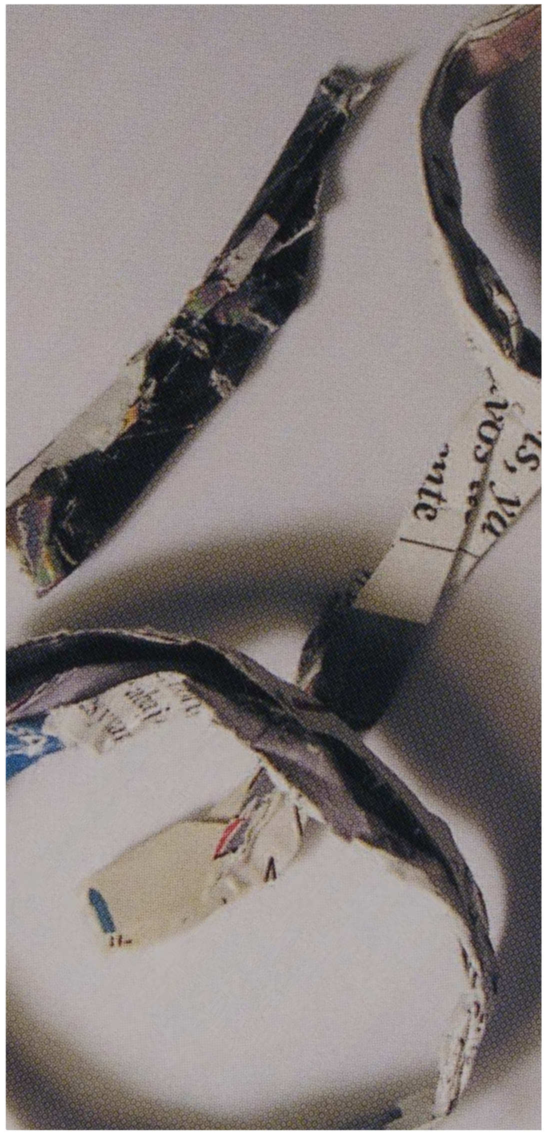
inventions of the Chinese, solved these problems, but it wasn't until the Romans replaced the scroll with the codex - or, as we call it now, the book - that the material reached its full potential. That was two thousand years ago, and it is still a dominant form of the written word.

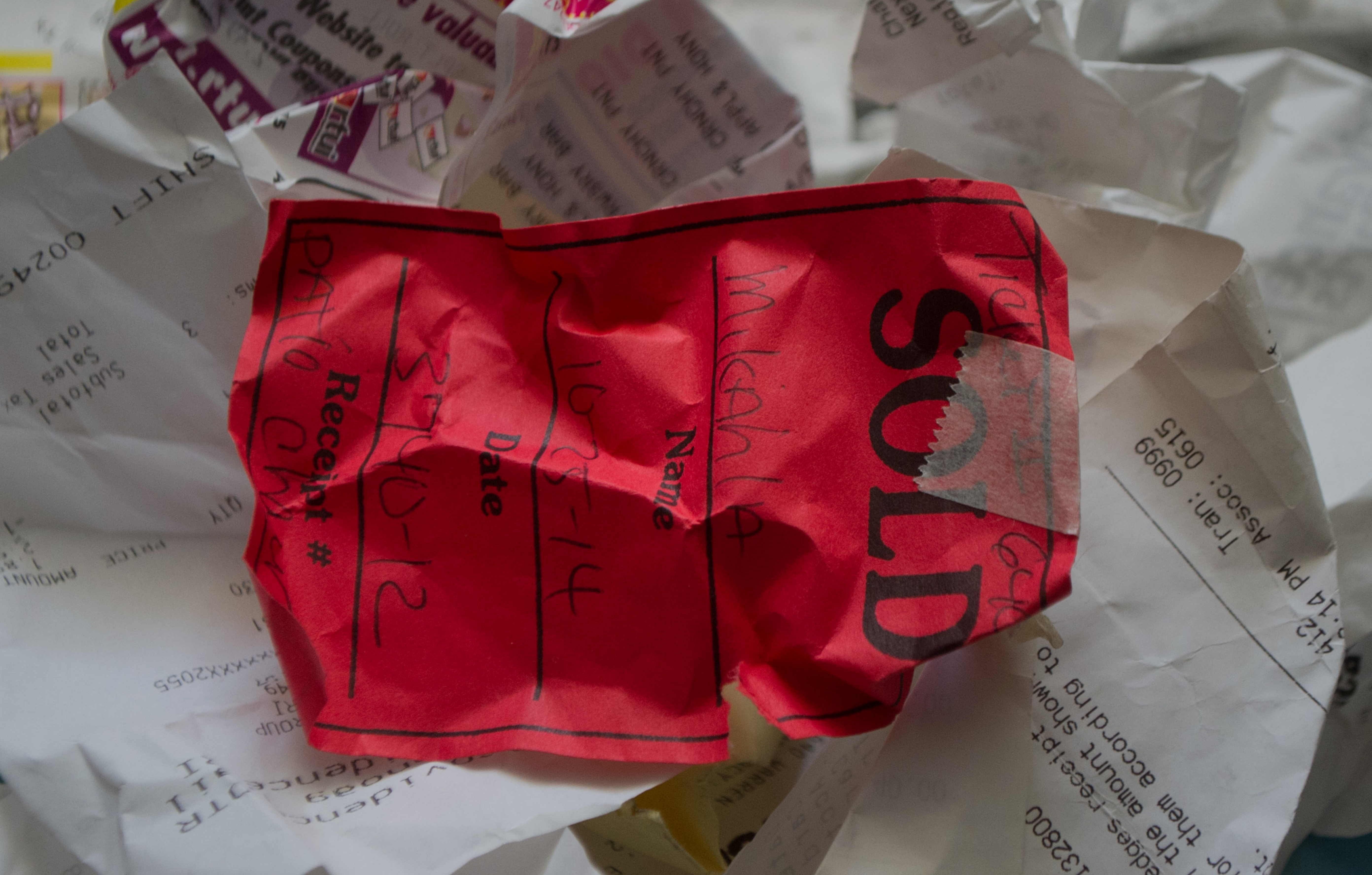
That paper, a much softer material than either stone or wood, won out as the guardian of the written word is a remarkable materials story. It is the thinness of paper that proves to be one of its great advantages, allowing it the flexibility to survive continuous handling, but when stacked together in book form becoming stiff and strong - essentially a re-formed block of wood. With the use of hard covers to hold it all together, the book is a fortress for words for thousands of years.

The genius of this so-called codex format - a stack of papers bound to a single spine and sandwiched between covers ~ and the reason why it usurped the scroll, is that it allows for text on both sides of the paper and yet still provides a continuous reading experience.

Other cultures achieved something similar with the concertina format - forming a stack by repeatedly folding one continuous sheet of paper in on itself-but the advantage of the codex, with its individual pages, is that many scribes could work on the same book at the same time, and after the invention of the printing press many copies of the same book could be created at the same time. As- biology had already discovered, the speedy copying of information is the most effective way of preserving it. The Bible is said to be one of the first books created in this new format, one that suited preachers of Christianity

"Tidying never lies."

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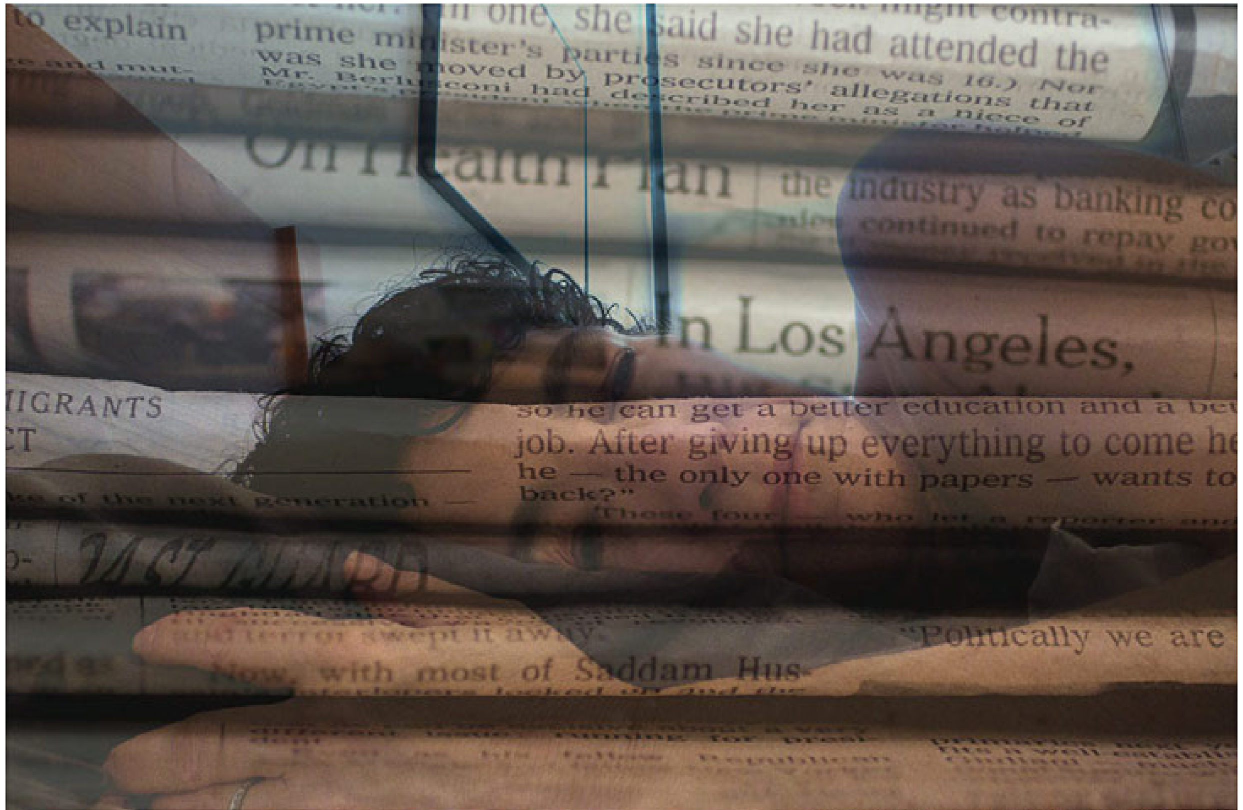


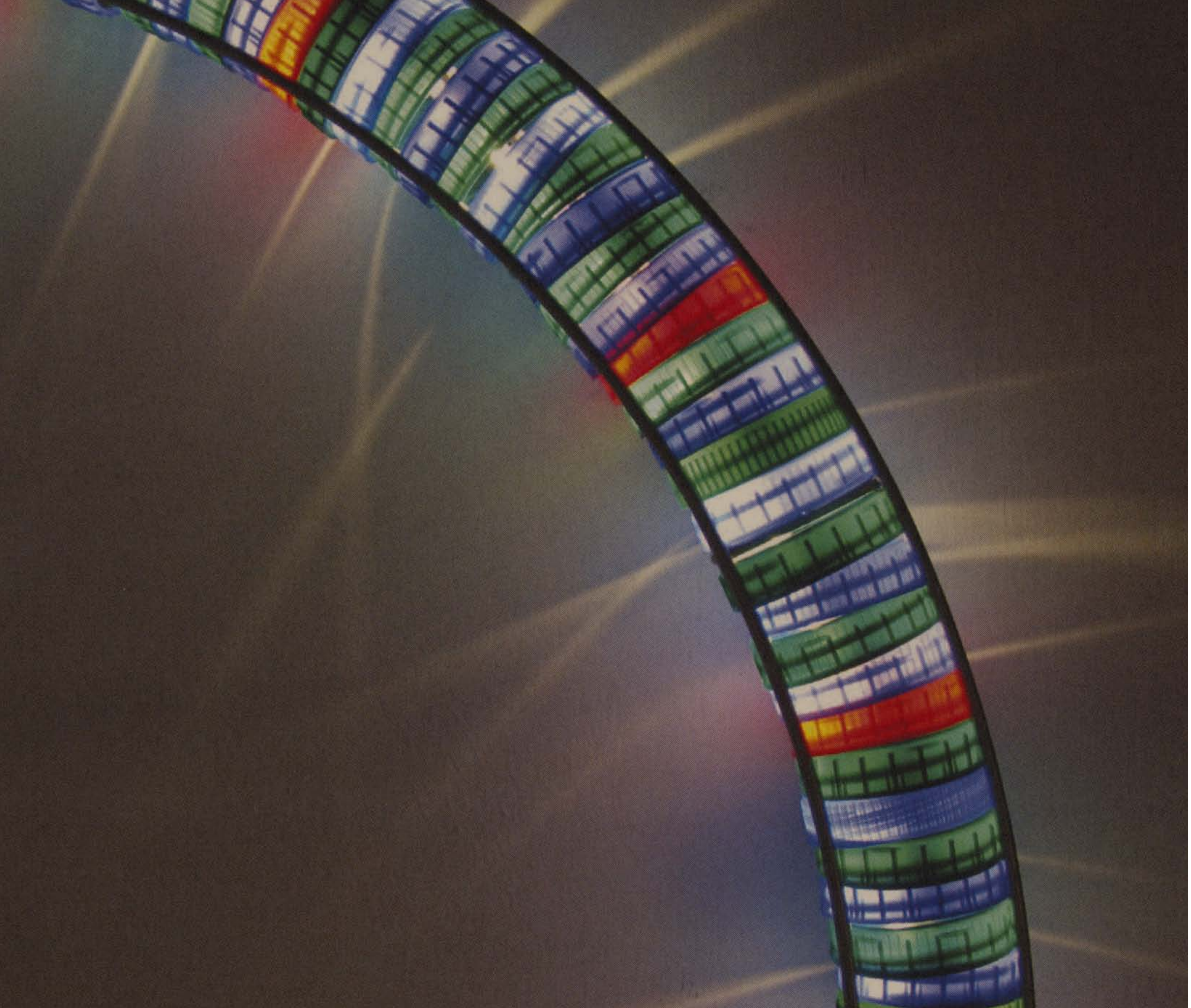
because it allowed them to locate the text relevant to their purpose using page numbers instead of laboriously searching through a whole scroll. This form of "random access memory" prefigured the digital age and may yet outlast it.

Paper is not only useful for preserving information. In its role as a wrapping material, paper also does a good job of obscuring it. What would birthdays be like without this material, which performs the role of building excitement and anticipation better than all others? I have received presents wrapped in cloth, or hidden in a cupboard, but nothing has the magic of wrapping paper. A present really isn't a present unless it is wrapped in paper. It is the paper that, by concealing and revealing an object, ritualizes the act of giving and receiving, turning that object into a gift. This is not just a cultural association. The material has fundamental properties that make it ideal for this role.

Paper's mechanical properties lend themselves to folding and bending. The cellulose fibers of which it is made can be partially snapped in the area of maximum bend, allowing a permanent crease to form, while sufficient fibers remain intact for the material not to crack and fall apart. Indeed, in this state it pretty much maintains its ability to resist being pulled apart, but it can also be torn easily and accurately along the crease if a point of weakness - a small, initial tear - is opened up. This winning combination of mechanical properties allows it to assume the shape of any object through creasing and folding - hence the art of origami. There are very few materials as good: metal foils can hold a crease, but control of the crease is somewhat more difficult. Plastic sheeting doesn't tend to hold a crease at all, unless it is very soft, in which case it lacks the rigidity (and formality) required of a good wrapping material.

So it is its ability to hold a crease while remaining stiff that makes paper uniquely suited to this purpose. Wrapping a present with paper gives it a crispness and pristineness that emphasize the newness and value of the present inside. Paper is strong enough to protect the present when it is sent through the mail~ but so weak that even a baby can rip it open. That moment of ,o. pening transports the object inside from obscurity to celebrity in a few seconds. The unwrapping of a present is akin to the act of birth; a new life for the object begins.

This is a receipt from a trip to the shop Marks & Spencer three days before my son Lazlo was born in 2011. Lazlo's mum, Ruby, had a difficult pregnancy. This was partly because she developed a craving for beer, which she would not allow herself to drink, but insisted instead that I do it for her. Some days the cravings would get so bad that, as the M&S receipt shows, I would have to drink three bottles of beer per night, with Ruby following every sip with a sometimes longing but mostly accusing gaze. Lazlo had almost been born two weeks earlier, but in a turn of events that none of us can satisfactorily explain, he refused to emerge. After twenty-four hours we were sent home from hospital and advised that Ruby's eating hot curries might encourage Lazlo to leave the womb. Two weeks later we had got a little tired of the nightly curries that I was sent out to retrieve.



PLASTICS/ETC.

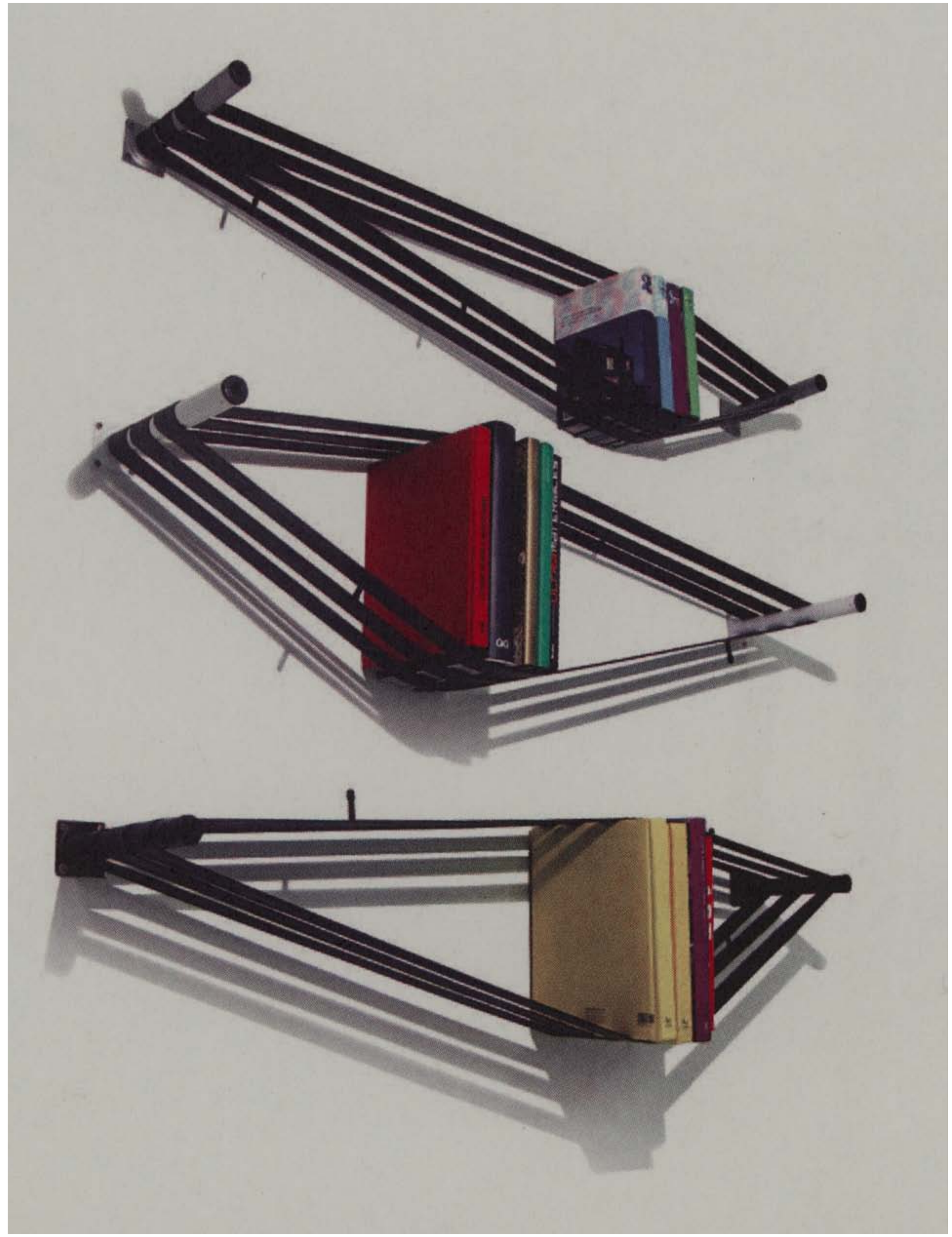
This section is comprised of our strictly man made materials. I don't mean man processed, I mean created, start to finisvh. Plastics, artificial compounds, anything comprised start to finish in a lab somewhere. Most of the materials mentioned in the following pages were modern 20th century advents. The acompanying text is an excerpt from a scientific Journal, titled *Plastics recycling: challenges and opportunities, wr.* by Jefferson Hopewell, Robert Dvorak, and Edward Kosior and published in 2010. It examines the full recycling process currently in place for plastics, and touches on the subject of reducing, reusing, and upcycling.

Plastics are inexpensive, lightweight and durable materials, which can readily be moulded into a var- iety of products that find use in a wide range of applications. As a consequence, the production of plastics has increased markedly over the last 60 years. However, current levels of their usage and disposal generate several environmental problems. Around 4 per cent of world oil and gas pro- duction, a non-renewable resource, is used as feedstock for plastics and a further 3–4% is expended to provide energy for their manufacture. A major portion of plastic produced each year is used to make disposable items of packaging or other short-lived products that are discarded within a year of manufacture. These two observations alone indicate that our current use of plastics is not sustainable. In addition, because of the durability of the polymers involved, substantial quantities of discarded end-of-life plastics are accumulating as debris in landfills and in natural habitats worldwide.

Recycling is one of the most important actions currently available to reduce these impacts and represents one of the most dynamic areas in the plastics industry today. Recycling provides oppor- tunities to reduce oil usage, carbon dioxide emissions and the quantities of waste requiring disposal. Here, we briefly set recycling into context against other waste-reduction strategies, namely reduction in material use through downgauging or product reuse, the use of alternative biodegradable materials and energy recovery as fuel.

While plastics have been recycled since the 1970s, the quantities that are recycled vary geographi- cally, according to plastic type and application. Recycling of packaging materials has seen rapid expansion over the last decades in a number of countries. Advances in technologies and systems for the collection, sorting and reprocessing of recyclable plastics are creating new opportunities for recycling, and with the combined actions of the public, industry and governments it may be possible to divert the majority of plastic waste from landfills to recycling over the next decades.

The plastics industry has developed considerably since the invention of various routes for the production of polymers from petrochemical sources. Plastics have substantial benefits in terms of their low weight,



durability and lower cost relative to many other material types (Andrady & Neal 2009; Thompson et al. 2009a). Worldwide polymer production was estimated to be 260 million metric tonnes per annum in the year 2007 for all polymers including thermoplastics, thermoset plastics, adhesives and coatings, but not synthetic fibres (PlasticsEurope 2008b). This indicates a historical growth rate of about 9 per cent p.a. Thermoplastic resins constitute around two-thirds of this production and their usage is growing at about 5 per cent p.a. globally (Andrady 2003).

Today, plastics are almost completely derived from petrochemicals produced from fossil oil and gas.

Around 4 per cent of annual petroleum production is converted directly into plastics from petrochemical feedstock (British Plastics Federation 2008). As the man- ufacture of plastics also requires energy, its production is responsible for the consumption of a similar additional quantity of fossil fuels. However, it can also be argued that use of lightweight plastics can reduce usage of fossil fuels, for example in transport applications when plastics replace heavier conventional materials such as steel (Andrady & Neal 2009; Thompson et al. 2009b).

Approximately 50 per cent of plastics are used for single-use disposable applications, such as packaging, agricultural films and disposable consumer items, between 20 and 25% for long-term infrastructure such as pipes, cable coatings and structural materials, and the remainder for durable consumer applications with intermediate lifespan, such as in electronic goods, furniture, vehicles, etc. Post-consumer plastic waste generation across the European Union (EU) was 24.6 million tonnes in 2007 (PlasticsEurope 2008b). Table 1 presents a breakdown of plastics consumption in the UK during the year 2000, and con- tributions to waste generation (Waste Watch 2003).

This confirms that packaging is the main source of waste plastics, but it is clear that other sources such as waste electronic and electrical equipment (WEEE) and end-of-life vehicles (ELV) are becoming significant sources of waste plastics.

Because plastics have only been mass-produced for around 60 years, their longevity in the environment is not known with certainty. Most types of plastics are not biodegradable (Andrady 1994), and are in fact extremely durable, and therefore the majority of polymers manufac- tured today will persist for at least decades, and probably for centuries if not millennia. Even degradable plastics may persist for a considerable time depending on local environmental factors, as rates of degradation depend on physical factors, such as levels of ultraviolet light exposure, oxygen and temperature (Swift & Wiles 2004), while biodegradable plastics require the presence of suitable micro-organisms. Therefore, degradation rates vary considerably between landfills, terrestrial and marine environments (Kyrikou & Briassoulis 2007). Even when a plastic item degrades under the influence of weathering, it first breaks down into smaller pieces of plastic debris, but the polymer itself may not necessarily fully degrade in a meaningful timeframe. As a consequence, substantial quantities of end-of-life plastics are accumulating in land- fills and as debris in the natural environment, resulting in both waste-management issues and environmental damage (see Barnes et al. 2009; Gregory 2009; Oehlmann et al. 2009; Ryan et al. 2009; Teuten et al. 2009; Thompson et al. 2009b).

Recycling is clearly a waste-management strategy, but it can also be seen as one current example of implementing the concept of industrial ecology, whereas in a natural ecosystem there are no wastes but only

“Never, ever ball up your socks.”

products (Frosch & Gallopoulos 1989; McDonough & Braungart 2002). Recycling of plastics is one method for reducing environmental impact and resource depletion. Fundamentally, high levels of recycling, as with reduction in use, reuse and repair or re-manufacturing can allow for a given level of product service with lower material inputs than would otherwise be required. Recycling can therefore decrease energy and material usage per unit of output and so yield improved eco-efficiency (WBCSD 2000). Although, it should be noted that the ability to maintain whatever residual level of material input, plus the energy inputs and the effects of external impacts on ecosystems will decide the ultimate sustainability of the overall system.

In this paper, we will review the current systems and technology for plastics recycling, life-cycle evidence for the eco-efficiency of plastics recycling, and briefly consider related economic and public interest issues. We will focus on production and disposal of packaging as this is the largest single source of waste plastics in Europe and represents an area of considerable recent expansion in recycling initiatives.

Even within the EU there are a wide range of waste- management prioritizations for the total municipal solid waste stream (MSW), from those heavily weighted towards landfill, to those weighted towards incineration (figure 1)—recycling performance also varies considerably. The average amount of MSW generated in the EU is 520 kg per person per year and projected to increase to 680 kg per person per year by 2020 (EEA 2008). In the UK, total use of plastics in both domestic and commercial packaging is about 40kg per person per year, hence it forms approximately 7 – 8% by weight, but a larger proportion by volume of the MSW stream (Waste Watch 2003).

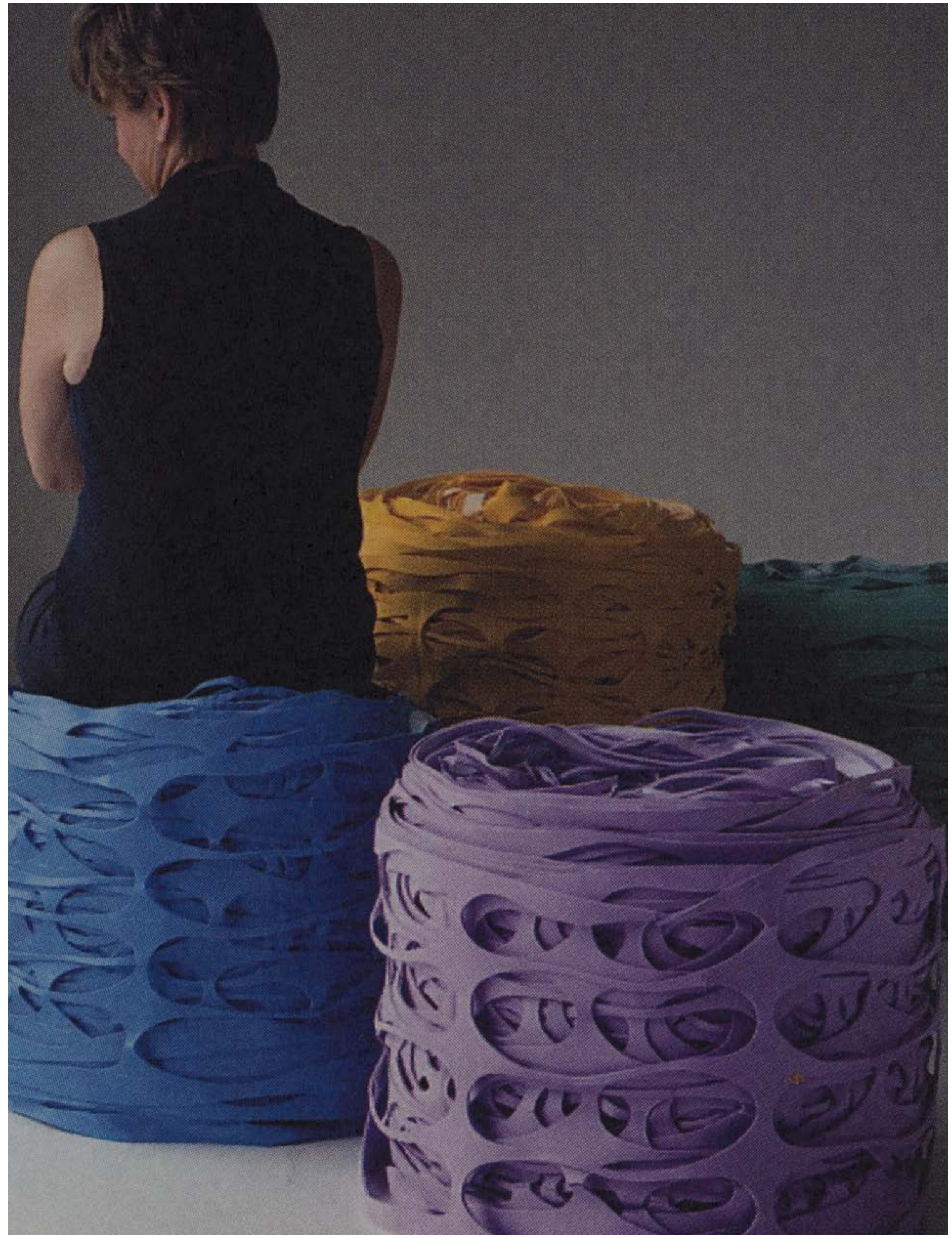
Broadly speaking, waste plastics are recovered when they are diverted from landfills or littering. Plastic packaging is particularly noticeable as litter because of the lightweight nature of both flexible and rigid plastics. The amount of material going into the waste-management system can, in the first case, be reduced by actions that decrease the use of materials in products (e.g. substitution of heavy packaging formats with lighter ones, or downgauging of packaging). Designing products to enable reusing, repairing or re-manufacturing will result in fewer products entering the waste stream.

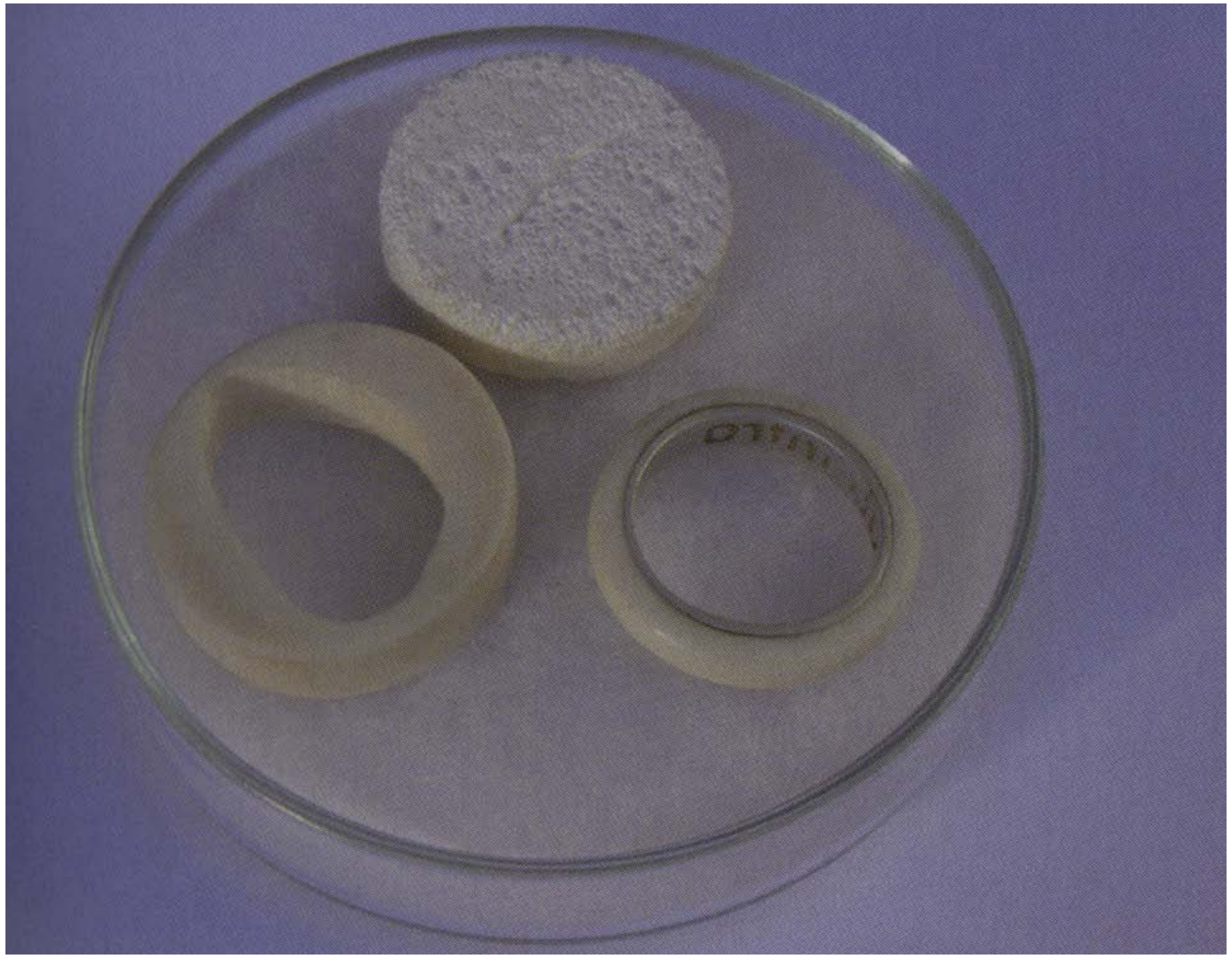
Once material enters the waste stream, recycling is the process of using recovered material to manufacture a new product. For organic materials like plastics, the concept of recovery can also be expanded to include energy recovery, where the calorific value of the material is utilized by controlled combustion as a fuel, although this results in a lesser overall environ- mental performance than material recovery as it does not reduce the demand for new (virgin) material. This thinking is the basis of the 4Rs strategy in waste management parlance—in the order of decreasing environmental desirability—reduce, reuse, recycle (materials) and recover (energy), with landfill as the least desirable management strategy.

It is also quite possible for the same polymer to cascade through multiple stages—e.g. manufacture into a re-usable container, which once entering the waste stream is collected and recycled into a durable application that when becoming waste in its turn, is recovered for energy.

Landfill is the conventional approach to waste man- agement, but space for landfills is becoming scarce in some countries. A well-managed landfill site results in limited immediate environmental harm beyond

“Evaluate the things in your life.”



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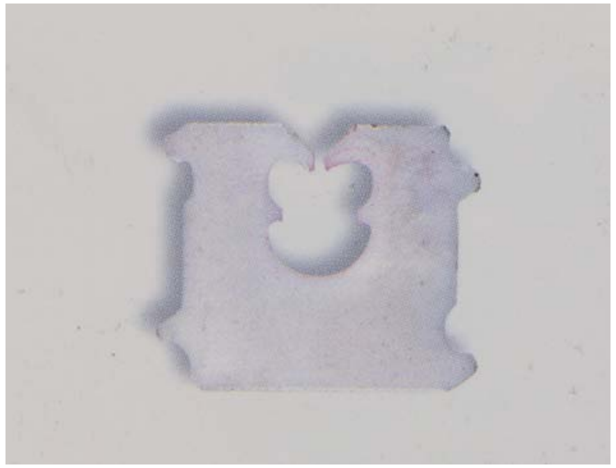


the impacts of collection and transport, although there are long-term risks of contamination of soils and groundwater by some additives and breakdown by- products in plastics, which can become persistent organic pollutants (Oehlmann et al. 2009; Teuten et al. 2009). A major drawback to landfills from a sus- tainability aspect is that none of the material resources used to produce the plastic is recovered—the material flow is linear rather than cyclic. In the UK, a landfill tax has been applied, which is currently set to escalate each year until 2010 in order to increase the incentive to divert wastes from landfill to recovery actions such as recycling (DEFRA 2007).

Incineration reduces the need for landfill of plastics waste, however, there are concerns that hazardous sub- stances may be released into the atmosphere in the process. For example, PVC and halogenated addi- tives are typically present in mixed plastic waste leading to the risk of dioxins, other polychlorinated biphenyls and furans being released into the environment (Gilpin et al. 2003). As a consequence primarily of this perceived pollution risk, incineration of plastic is less prevalent than landfill and mechanical recycling as a waste-management strategy. Japan and some European countries such as Denmark and Sweden are notable exceptions, with extensive incinerator infrastructure in place for dealing with MSW, including plastics. Incineration can be used with recovery of some of the energy content in the plastic. The useful energy recovered can vary considerably depending on whether it is used for electricity genera- tion, combined heat and power, or as solid refuse fuel for co-fuelling of blast furnaces or cement kilns. Liquefaction to diesel fuel or gasification through pyrolysis is also possible (Arvanitoyannis & Bosnea 2001) and interest in this approach to produce diesel fuel is increasing, presum- ably owing to rising oil prices. Energy-recovery processes may be the most suit- able way for dealing with highly mixed plastic such as some electronic and electrical wastes and automotive shredder residue.

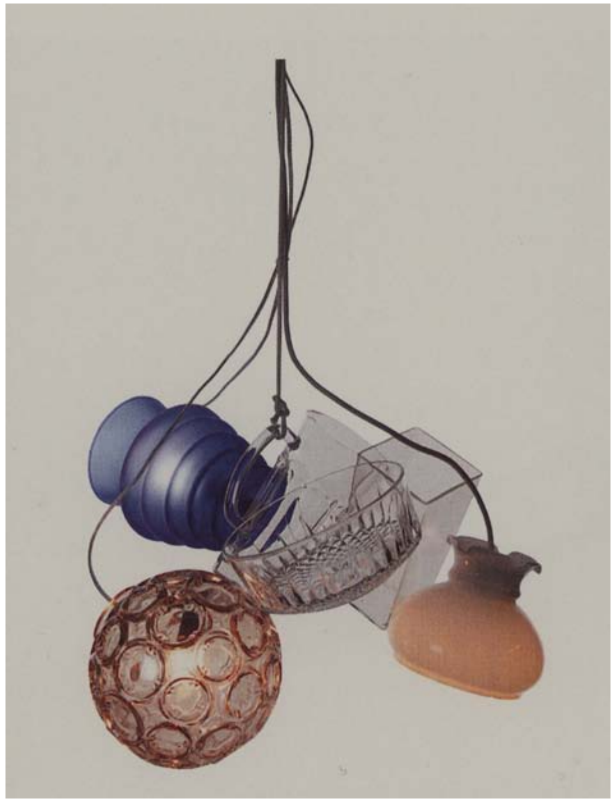
Forty years ago, re-use of post-consumer packaging in the form of glass bottles and jars was common. Limitations to the broader application of rigid container re-use are at least partially logistical, where distribu- tionand collection points are distant from centralized

product-filling factories and would result in considerable back- haul distances. In addition, the wide range of containers and packs for branding and marketing pur- poses makes direct take-back and refilling less feasible. Take-back and refilling schemes do exist in several European countries (Institute for Local Self-Reliance 2002), including PET bottles as well as glass, but they are elsewhere generally considered a niche activity for local businesses rather than a realistic large-scale strategy to reduce packaging waste. There is considerable scope for re-use of plastics used for the transport of goods, and for potential re-use or re-manufac- ture from some plastic components in high- value consumer goods such as vehicles and electronic equipment.

This is evident in an industrial scale with re-use of containers and pallets in haulage (see Thompson et al. 2009b). Some shift away from single- use plastic carrier bags to reusable bags has also been observed, both because of voluntary behaviour change programmes, as in Australia (Department of Environment and Heritage (Australia) 2008) and as a consequence of legislation, such as the plastic bag levy in Ireland (Department of Environment Heritage and Local Government (Ireland) 2007), or the recent banning of lightweight carrier bags, for example in Bangladesh and China.

Effective recycling of mixed plastics waste is the next major chal- lenge for the plastics recycling sector. The advantage is the ability to recycle a larger proportion of the plastic waste stream by expanding post- consumer collection of plastic packaging to cover a wider variety

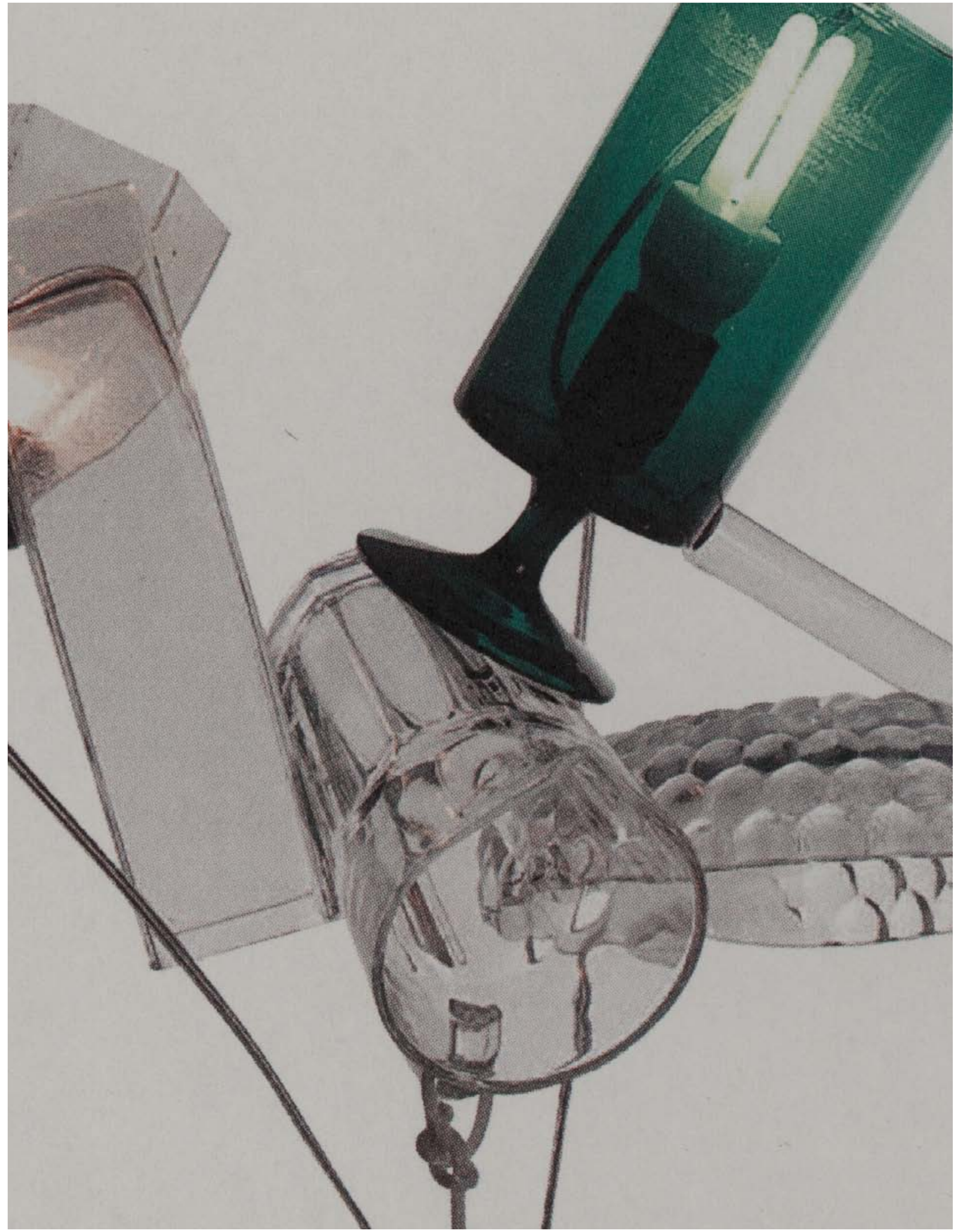
“It must be avoided.”

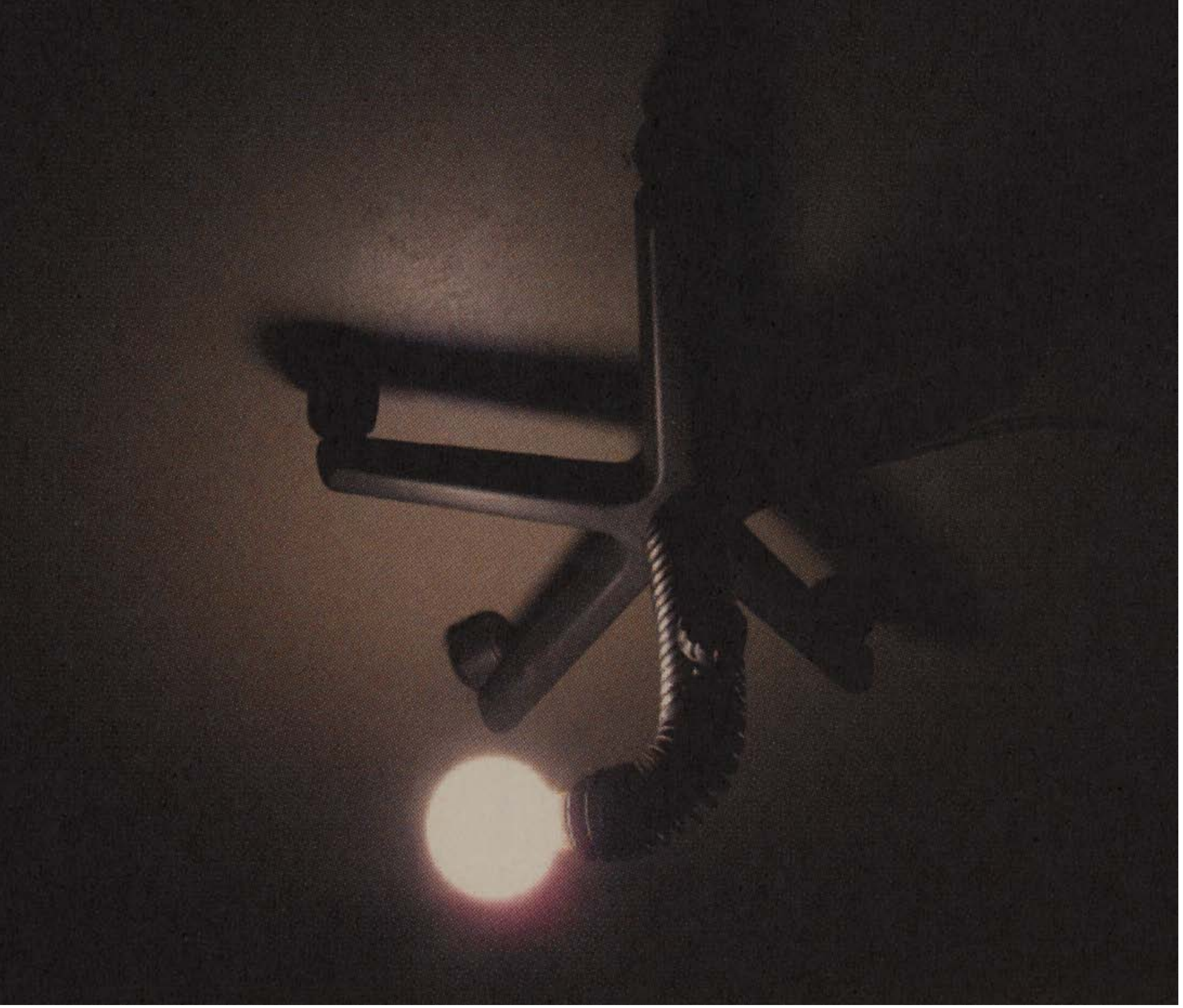


of materials and pack types. Product design for recycling has strong potential to assist in such recycling efforts. A study carried out in the UK found that the amount of packaging in a regular shop- ping basket that, even if collected, cannot be effectively recycled, ranged from 21 to 40% (Local Government Association (UK) 2007). Hence, wider implementation of policies to promote the use of environmental design principles by industry could have a large impact on recycling performance, increasing the proportion of packaging that can economically be collected and diverted from landfill (see Shaxson et al. 2009). The same logic applies to durable consumer goods designing for disassembly, recycling and specifications for use of recycled resins are key actions to increase recycling.

Most post-consumer collection schemes are for rigid packaging as flexible packaging tends to be problematic during the collection and sorting stages. Most current, material recovery facilities have difficulty handling flex- ible plastic packaging because of the different handling characteristics of rigid packaging. The low weight-to- volume ratio of films and plastic bags also makes it less economically viable to invest in the necessary col- lection and sorting facilities. However, plastic films are currently recycled from sources including secondary packaging such as shrink-wrap of pallets and boxes and some agricultural films, so this is feasible under the right conditions. Approaches to increasing the re- cycling of films and flexible packaging could include separate collection, or investment in extra sorting and processing facilities at recovery facilities for handling mixed plastic wastes. In order to have successful recy- cling of mixed plastics, high-performance sorting of the input materials needs to be performed to ensure that plastic types are separated to high levels of purity; there is, however, a need for the further develop-

"Can you truthfully say that you treasure something buried so deeply in a closet or drawer that you have forgotten its existence? If things had feelings, they would certainly not be happy."





ment of endmarkets for each polymer recyclate stream.

The effectiveness of post-consumer packaging recy- cling could be dramatically increased if the diversity of materials were to be rationalized to a subset of current usage. For example, if rigid plastic containers ranging from bottles, jars to trays were all PET, HDPE and PP, without clear PVC or PS, which are problematic to sort from co-mingled recyclables, then all rigid plastic packaging could be collected and sorted to make recycled resins with minimal cross-contamination. The losses of rejected material and the value of the recycled resins would be enhanced. In addition, labels and adhesive materials should be selected to maximize recy- cling performance. Improvements in sorting/separation within recycling plants give further potential for both higher recycling volumes, and better eco-efficiency by decreasing waste fractions, energy and water use (see §3). The goals should be to maximize both the volume and quality of recycled resins. Two key economic drivers influence the viability of thermoplastics recycling.

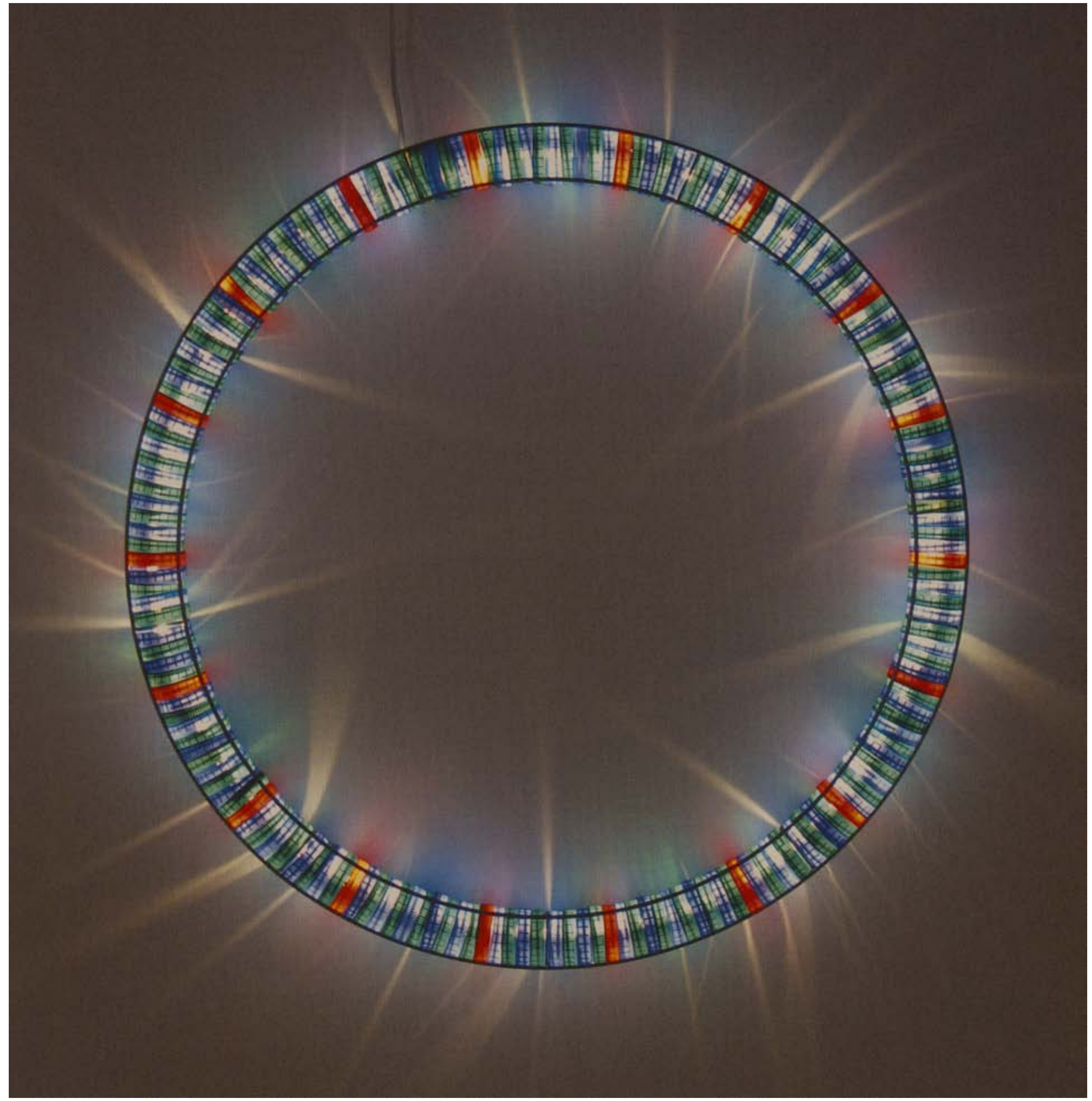
These are the price of the recycled polymer compared with virgin polymer and the cost of recycling compared with alternative forms of acceptable disposal. There are additional issues associated with variations in the quantity and quality of supply compared with virgin plastics. Lack of infor- mation about the availability of recycled plastics, its quality and suitability for specific applications, can also act as a disincentive to use recycled material. Historically, the primary methods of waste disposal have been by landfill or incineration. Costs of landfill vary considerably

“A messy room equals a messy mind.”

among regions according to the underlying geology and land-use patterns and can influ- ence the viability of recycling as an alternative disposal route. In Japan, for example, the excavation that is necessary for landfill is expensive because of the hard nature of the underlying volcanic bedrock; while in the Netherlands it is costly because of permeability from the sea. High disposal costs are an economic incentive towards either recycling or energy recovery. Collection of used plastics from households is more economical in suburbs where the population density is sufficiently high to achieve economies of scale.

The most efficient collection scheme can vary with locality, type of dwellings (houses or large multi-apartment buildings) and the type of sorting facilities available. In rural areas ‘bring schemes’ where the public deliver their own waste for recycling, for example when they visit a nearby town, are considered more cost-effective than kerbside collec- tion. Many local authorities and some supermarkets in the UK operate ‘bring banks’, or even reverse-vending machines. These latter methods can be a good source of relatively pure recycl- ables, but are ineffective in providing high collection rates of post-consumer waste.

In the UK, dramatic increases in collection of the plastic bottle waste stream was only apparent after the relatively recent implementa- tion of kerbside recycling.The price of virgin plastic is influenced by the price of oil, which is the principle feedstock for plastic pro- duction. As the quality of recovered plastic is typically lower than that of virgin plastics, the price of virgin plastic sets the ceiling for prices of recovered



"To truly cherish the things that are important to you, you must first discard those that outlived their purpose."

plastic. The price of oil has increased significantly in the last few years, from a range of around USD 25 per barrel to a price band between USD 50–150 since 2005. Hence, although higher oil prices also increase the cost of collection and reprocessing to some extent, recycling has become relatively more financially attractive.

Technological advances in recycling can improve the economics in two main ways—by decreasing the cost of recycling (productivity/ efficiency improve- ments) and by closing the gap between the value of recycled resin and virgin resin. The latter point is particularly enhanced by technologies for turning recovered plastic into food grade polymer by removing contamination—supporting closed-loop recycling. This technology has been proven for rPET from clear bottles (WRAP 2008b), and more recently rHDPE from milk bottles (WRAP 2006).

So, while over a decade ago recycling of plastics without subsidies was mostly only viable from post- industrial waste, or in locations where the cost of alternative forms of disposal were high, it is increas- ingly now viable on a much broader geographic scale, and for post-consumer waste.

Terminology for plastics recycling is complex and sometimes confusing because of the wide range of recy- cling and recovery activities (table 2). These include four categories: primary (mechanical reprocessing into a product with equivalent properties), secondary (mechanical reprocessing into products requiring lower properties), tertiary (recovery of chemical constituents) and quaternary (recovery of energy). Primary recycling is often referred to as closed-loop recycling, and secondary recy-

cling as downgrading. Tertiary recycling is either described as chemical or feedstock recycling and applies when the polymer is de-polymerized to its chemical constituents (Fisher 2003). Quaternary recycling is energy recovery, energy from waste or valorization. Biodegradable plastics can also be composted, and this is a further example of tertiary recycling, and is also described as organic or biological recycling (see Song et al. 2009).

It is possible in theory to closed-loop recycle most thermoplastics, however, plastic packaging frequently uses a wide variety of different polymers and other materials such as metals, paper, pigments, inks and adhesives that increases the difficulty. Closed-loop recycling is most practical when the polymer constitu- ent can be (i) effectively separated from sources of contamination and (ii) stabilized against degradation during reprocessing and subsequent use. Ideally, the plastic waste stream for reprocessing would also con- sist of a narrow range of polymer grades to reduce the difficulty of replacing virgin resin directly. For example, all PET bottles are made from similar grades of PET suitable for both the bottle manufactur- ing process and reprocessing to polyester fibre, while HDPE used for blow moulding bottles is less-suited

to injection moulding applications. As a result, the only parts of the post-consumer plastic waste stream that have routinely been recycled in a strictly closed- loop fashion are clear PET bottles and recently in the UK, HDPE milk bottles. Pre-consumer plastic waste such as industrial packaging is currently recycled to a greater extent than post-consumer packaging, as it is relatively pure and available from a smaller number of sources of relatively higher volume. The volumes of post-consumer waste are, however, up to five times larger than those generated in commerce and industry (Patel et al. 2000) and so in order to achieve high overall recycling rates, post-consumer as well as post-industrial waste need to be collected and recycled.

In some instances recovered plastic that is not suitable for recy- cling into the prior application is used to make a new plastic product displacing all, or a proportion of virgin polymer resin—this can also be considered as primary recycling. Examples are plastic crates and bins manufactured from HDPE recovered from milk bottles, and PET fibre from recovered PET packaging. Downgrading is a term sometimes used for recycling when recovered plastic is put into an application that would not typically use virgin polymer—e.g. 'plastic lumber' as an alternative to higher cost/shorter lifetime timber, this is secondary recycling (ASTM Standard D5033).

Chemical or feedstock recycling has the advantage of recovering the petrochemical constituents of the poly- mer, which can then be used to re-manufacture plastic or to make other synthetic chemicals. However, while technically feasible it has generally been found to be uneconomic without significant subsidies because of the low price of petrochemical feedstock compared with the plant and process costs incurred to produce monomers from waste plastic (Patel et al. 2000). This is not surprising as it is effectively reversing the energy- intensive polymerization previously carried out during plastic manufacture.

Feedstock recycling of polyolefins through thermal- cracking has been performed in the UK through a facility initially built by BP and in Germany by BASF. However, the latter plant was closed in 1999 (Aguado et al. 2007). Chemical recycling of PET has been more successful, as de-polymerization under milder conditions is possible. PET resin can be broken down by glycolysis, methanolysis or hydrolysis, for example to make unsaturated polyester resins (Sinha et al. 2008). It can also be converted back into PET, either after de-polymerization, or by simply re-feeding the PET flake into the polymerization reac- tor, this can also remove volatile contaminants as the reaction occurs under high temperature and vacuum (Uhde Inventa-Fischer 2007).

There is increasing public awareness on the need for sustainable production and consumption. This has encouraged local authorities to organize collection of recyclables, encouraged some manufacturers to develop products with recycled content, and other businesses to supply this public demand. Marketing studies of consumer preferences indicate that there is a significant, but not overwhelming proportion of people who value environmental values in their pur- chasing patterns. For such customers, confirmation of recycled content and suitability for recycling of the packaging can be a positive attribute, while exag- gerated claims for recyclability (where the recyclability is potential, rather than actual) can reduce consumer confidence. It has been noted that participating in recycling schemes is an environmental behaviour that has wide participa- tion among the general population and was 57 per cent in the UK in a 2006 survey (WRAP 2008d), and 80 per cent in an Australiansurvey where kerbside collection had been in place for longer (NEPC 2001).

Some governments use policy to encourage post- consumer recycling, such as the EU Directive on packaging and packaging waste (94/62/ EC). This subsequently led Germany to set-up legislation for extended producer responsibility that resulted in the die Gru¨ ne Punkt (Green Dot) scheme to implement recovery and recycling of packaging. In the UK, producer responsibility was enacted through a scheme for generating and trading packaging recovery notes, plus more recently a landfill levy to fund a range of waste reduction activities. As a consequence of all the above trends, the market value of recycled polymer and hence the viability of recycling have increased markedly over the last few years.

In summary, recycling is one strategy for end-of-life waste manage- ment of plastic products. It makes increasing sense economically as well as environmen- tally and recent trends demonstrate a substantial increase in the rate of recovery and recycling of plastic wastes. These trends are likely to continue, but some significant challenges still exist from both tech- nologi- cal factors and from economic or social behaviour issues relating to the collection of recyclable wastes, and substitution for virgin material.

Recycling of a wider range of post-consumer plastic packaging, together with waste plastics from consumer goods and ELVs will further enable improvement in recovery rates of plastic waste and diversion from landfills. Coupled with efforts to increase the use and specification of recycled grades as replacement of virgin plastic, recycling of waste plastics is an effective way to improve the environmental performance of the polymer industry.

"What things will bring you joy if you keep them as part of your life?."

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By Mikahla Dawson

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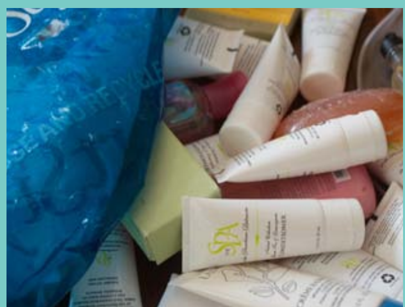

By Mikahla Dawson

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Replex Table
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Colours
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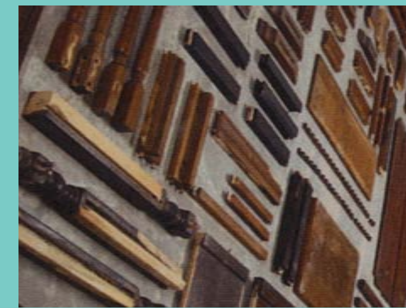

Replex Table
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Bow Bins
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Favela Chair
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Bio Jewellery
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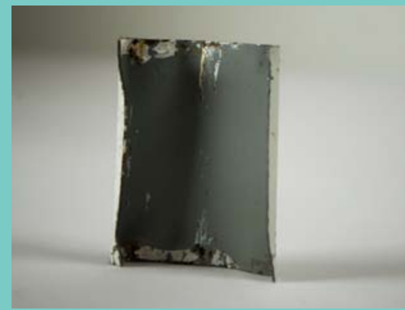

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Sign Stool
By Trent Jansen Studio
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Cycle Sign
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Bullet Rings
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The Found Alphabet
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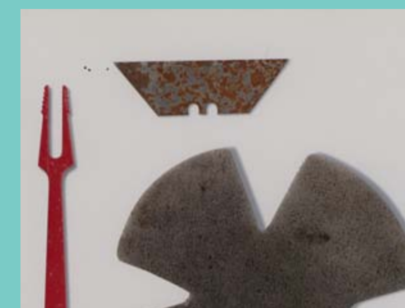

The Found Alphabet
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Bi-Re-Cycle Jewellery
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The DreyFuss Special
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Instilling Inference
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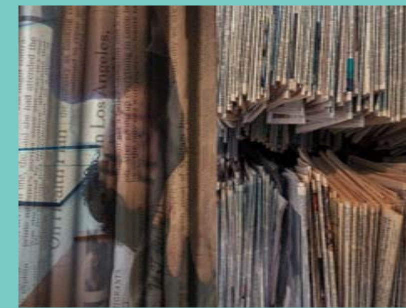

Instilling Inference
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Instilling Inference
By Laura Wexler

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glo
By Draigo Design
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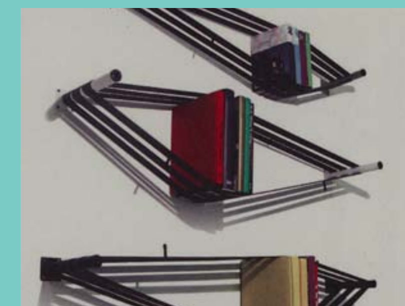

Elasticshelf
By SystemDesignStudio
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Invisible Chandelier
By Castor
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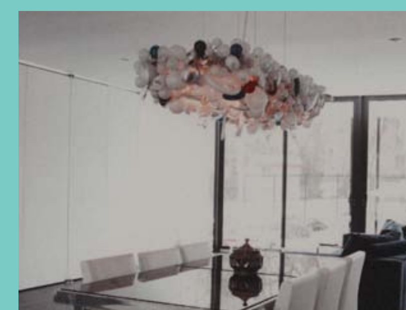

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Latex Roll Pouf
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Latex Roll Pouf
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Pipe line Bookcase
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Tide
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Tide
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Multi Vase Lighting
By Atelier Remy & Veenhuizen
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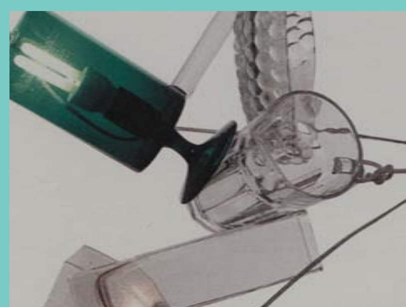

Multi Vase Lighting
By Atelier Remy & Veenhuizen
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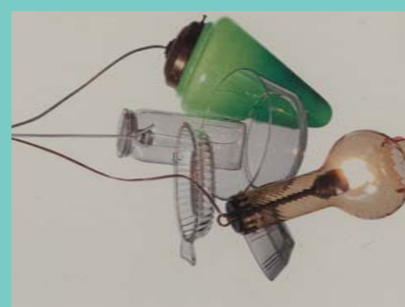

Multi Vase Lighting
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Nine Inch Nails
By G. Delvecchio and A. Magnani for Resign
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Nine Inch Nails
By G. Delvecchio and A. Magnani for Resign
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glo
By Draigo Design
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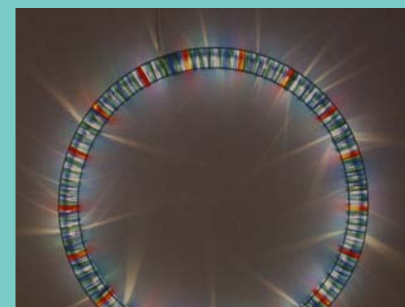

glo
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Warbowl
By Dominic Wilcox/Mosley Meets Wilcox
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Warbowl
By Dominic Wilcox/Mosley Meets Wilcox
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Heiniken Bottle
By Heikiken, Netherlands
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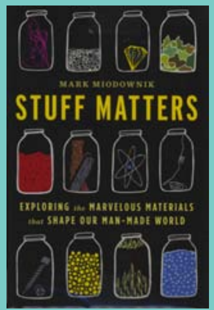
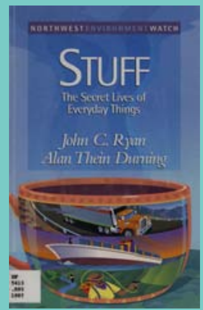


Stuff Matters
By Mark Miodownik



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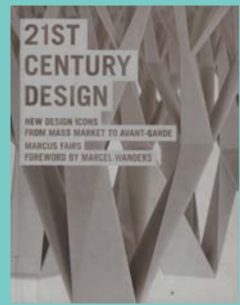

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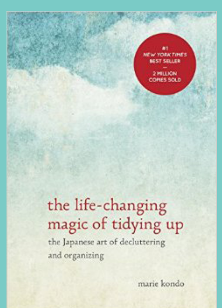

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