PLASTICS IN LIFE AND ENVIRONMENT

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Ministry of Environment, Forest and Climate Change

Government of India

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डॉ. हर्ष वर्धन
Dr. Harsh Vardhan

सत्यमेव जयते

भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्री
GOVERNMENT OF INDIA
MINISTER OF ENVIRONMENT, FOREST & CLIMATE CHANGE

MESSAGE

Every year, the global community celebrates the World Environment Day as a reaffirmation of its commitment to live in harmony with Nature. India has a long history and tradition of harmonious co-existence between man and nature. This is part of our heritage and manifests in our lifestyles and traditional practices. We represent a culture that calls our planet Mother Earth. The reference to Mother Earth has several connotations, but the most crucial aspect is of mutual affection and care. Environmental sustainability, which involved both intra-generational and inter-generational equity, has been the approach of Indians for very long and continue to thrive even today.

Modern life, with its trappings of enhanced aspirations has its own impacts on the environment. The seeming contradiction between growing economic prosperity and sustainability of life on Mother Earth has been a cornerstone of discussions on sustainable development starting from the Rio Summit in 1992. Plastics are symptomatic of this contradiction. It is one of the most versatile and relatively cheap material invented by mankind. Today, the world is living in a "plastic age" to the extent that life without plastic seems unimaginable. It is estimated that nearly half of all plastic ever manufactured has been manufactured since 2000. The world production of plastics has increased exponentially from 2.3 million tons in 1950 to 335 million tons in 2016 and is expected to triple by 2050 while consuming 20 percent of the global annual crude oil. Many plastic products are designed for single use without planning for the potential after-use pathways.

Plastic waste represents a single-use throw away culture. It is estimated that 40 percent of plastics produced in the world is for packaging, used just once and then discarded. In good old days, we used banana leaves to pack our food. Now we use plastic sheets which are non bio-degradable. The throw-away culture is suffocating Mother Earth. If we don't change the way we produce and use plastics, there will be more plastic than fish in our oceans by 2050. It is a proven fact that plastic waste is adversely impacting ecosystems and human beings.

As the host of this year's World Environment Day, I am happy to present this book to the global audience who are eager to learn and take action. This book covers the journey of Plastics, their evolution, diversification and how plastics penetrated our everyday existence. The book tells the story of plastics in an engaging manner while presenting technical details in easy to understand graphics. I hope children will find this publication informative and useful especially the comic strip.

Plastic waste and pollution have entered our homes and ecosystem. It is not a problem for which we don't know the solution. We know how to pick up garbage. We know how to dispose or recycle waste. It's a matter of putting institutions and systems in place and ensure that they work. These efforts will also help us in achieving Sustainable Development Goals especially 12 on 'Sustainable Consumption and Production' and 14 on 'Life Below Water'. Let's join hands to beat plastic pollution today to save our own and our children's existence on planet Earth.

I congratulate all those who were involved in this assignment, in particular, Shri C K Mishra, Secretary; Shri A K Jain, Additional Secretary; and Dr J R Bhatt, Scientist-G for undertaking this invaluable initiative in a timely manner. As the host of this year's World Environment Day, this book is our gift to the people all over the world who are eager to act if they have the requisite awareness. I firmly believe that the need to beat plastic pollution is urgent. I urge the international community to come together and take time-bound responsibilities to save the environment.

Harsh

Dr Harsh Vardhan

सत्यमेव जयते

डॉ. महेश शर्मा
Dr. Mahesh Sharma

संस्कृति राज्य मंत्री (स्वतंत्र प्रभार)
पर्यावरण, वन एवं जलवायु परिवर्तन राज्य मंत्री
भारत सरकार
MINISTER OF STATE (I/C) OF CULTURE
MINISTER OF STATE FOR
ENVIRONMENT, FOREST AND CLIMATE CHANGE
GOVERNMENT OF INDIA

FOREWORD

With rising prosperity of millions of people around the globe, there is a concomitant increase in the pressures on planetary boundaries. There is a near consensus in the global community that sustainable prosperity on the planet is impossible without taking care of the environment and ecosystems. The global celebrations of the World Environment Day are a resounding response of the people that they are committed to sustainable development. As the host of the 44th World Environment Day celebrations, we would like all nations to join hands and rally around the theme of this year "Beat Plastic Pollution".

Worldwide the use of plastics has increased tremendously over the last few decades. In the last decade alone, the world produced more plastic worldwide than in the previous four decades. Due to plastic's versatility, light weight and relatively inexpensive production, the use of single use plastic items has become widespread. Unmanaged plastic waste has become a challenge for all countries as it is contaminating our soil, air and water. Plastics are non-biodegradable, they do not vanish from the face of the Earth. For example, it may take more than 500 years for a plastic bag in a landfill to completely break down.

It is with great pleasure that I am presenting you this book on the occasion of World Environment Day 2018. The book begins with the history of plastics, goes on to provide an overview of importance of plastics in our lives, and highlights the need to beat plastic pollution. I strongly believe that the messages and facts presented in this book will compel readers to act and contribute in saving the environment by following the principle of refuse, reduce, reuse and recycle. At the same time, we must join hands to tackle this challenge at the global level. Plastic waste is crossing national borders through our water ways and oceans. This trans-boundary challenge needs global efforts.

Dr Mahesh Sharma

सी.के.मिश्रा
C.K.Mishra

सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

PREFACE

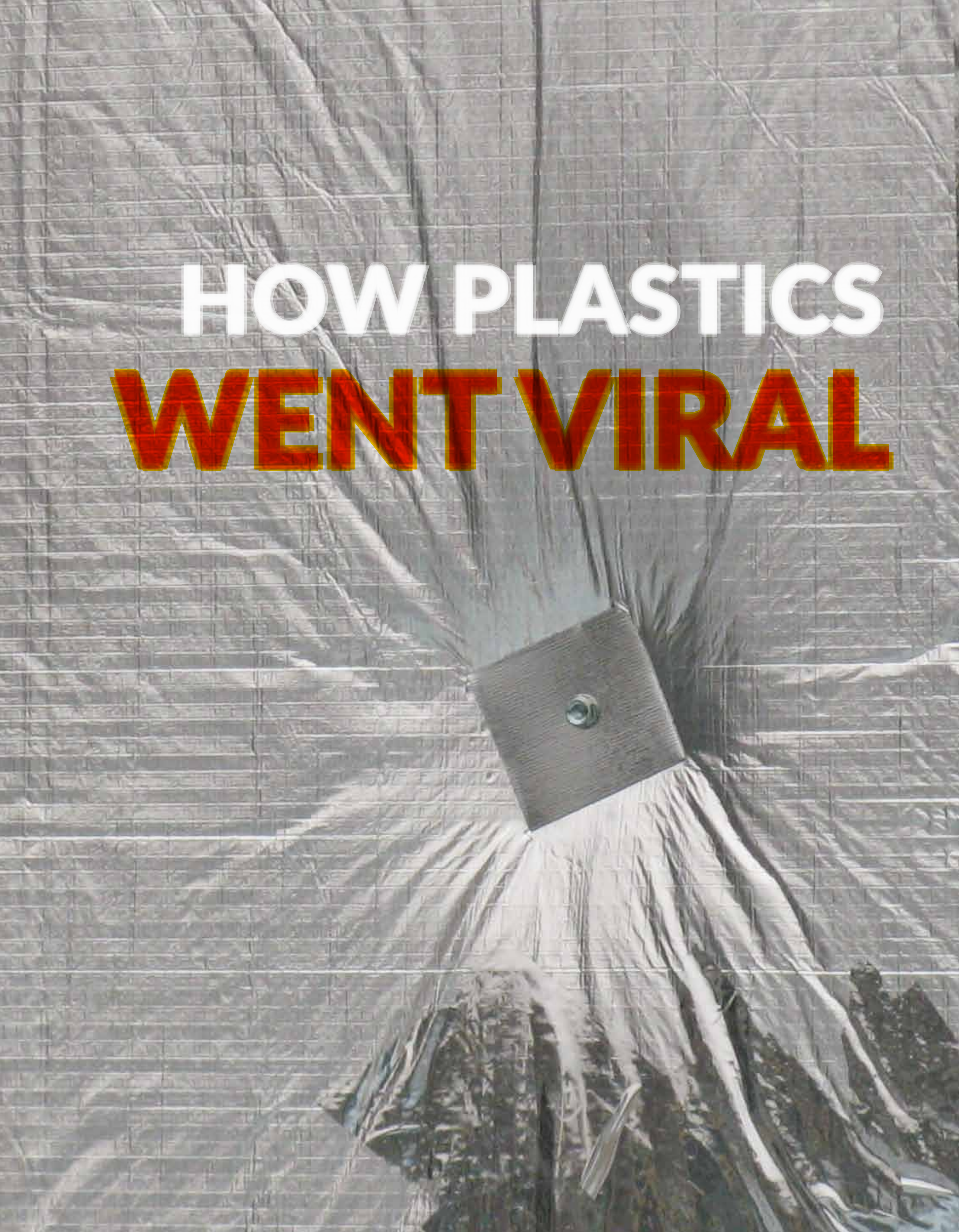
Plastics are an integral part of modern life. They are almost omnipresent – in our homes and offices, in our modes of transport, in our clothes, in our gadgets as well as packaging for what we eat. A part of this omnipresence is driven by the versatility of the material. Plastics have chemical and physical properties that allow them to be shaped for multiple uses. This book presents the technical story of plastics in a non-technical language for people all around the world. In an engaging narrative, the book talks about the history of plastics as well as the widespread use in our daily lives. It also presents the sectors in which plastics have become the essential material without which it is impossible to imagine the product or the service. In line with the theme of the World Environment Day, the book highlights the environmental costs of plastics. From a solid waste management challenge for cities and rural areas alike, plastics have also emerged as a challenge for our oceans and rivers. The book ends by highlighting the key messages for individuals and organisations on how to deal with plastics in a holistic manner.

I congratulate all those who were involved in this assignment, in particular, Shri A K Jain, Additional Secretary and Dr J R Bhatt, Scientist-G for identifying and conceptualising this book and leading it to fruition in a short period of time. I would also like to acknowledge the support received from GIZ for this initiative.

For those of you reading the book, I would encourage you to share it with your friends, colleagues and families. 'Plastics in Life and Environment' tells us that every individual is capable of contributing significantly to 'Beat Plastic Pollution'. Join this endeavour for the benefit of our planet as well as our future generations.

C K Mishra

HOW PLASTICS WENT VIRAL



THE AGE OF PLASTICS

Organic chemistry's sovereignty over Earth is still not complete

The Age of Plastics began with laboratory hypotheticals gone wrong — 'discovered by accident' is the appropriate phrase. Chemist-inventor Alexander Parkes announced, at an exhibition in England in 1862, the dawn of a new synthetic age, convinced his compound Parkesine had inaugurated it. Chemist-inventor and wannabe-entrepreneur Daniel Spill staked his reputation and money on his discovery he called Xylonite, then went bankrupt.

In 1907 Leo Baekeland used coal tar to create phenol, which he developed into the very first synthetically derived plastic from fossil fuels. Baekeland used the plastic for radio and telephone casings and electrical insulators because of its non-conductive and heat-resistant properties. No accident here. Everybody — that is to say, everybody in the organic chemistry-industrial complex of the first 40 years of the twentieth century — had, by now, fully realised. Everybody was agog, alert and secretive about the next best synthetic thing.

Stockings off, in this context, to DuPont company-employed chemist Wallace Hume Carothers who, after five years of research, finally hit the polymer jackpot: Nylon, the first commercially successful synthetic thermoplastic polymer. Another DuPont chemist Roy Plunkett stumbled upon Teflon. 'Discovered by accident', to be sure, but times had changed. Maverick inventor-chemists did not exist anymore. Bankruptcy was forbidden. Opportunity was a polymer-to-profit deadline. Let us remember, here, IG Farben's Professor Otto Bayer, searching for a substitute for natural rubber and accidentally synthesising polyurethane in 1937, on the cusp of World War II.

Is it possible those poised to earnestly inaugurate the Age of Plastics didn't know what they were on the verge of? To what extent was nylon's commercial success a wake-up call? Was it a wake-up call or a competitive barb? Is it possible that all the laboratory work — initially unorganised, then company-organised — was a conscious attempt to replace natural polymers with synthetic polymers? Was the organic chemistry-industrial complex poised to create a new market? Had they already had a taste of it?

We will never know.

HOW PLASTICS WENT VIRAL

What we do know is that the second world war (WWII) came as a rude interruption. DuPont, for instance, had to stop making lingerie and begin making parachutes. When the war got over, it immediately switched back. And there was no looking back, for DuPont and all the other manufacturers.

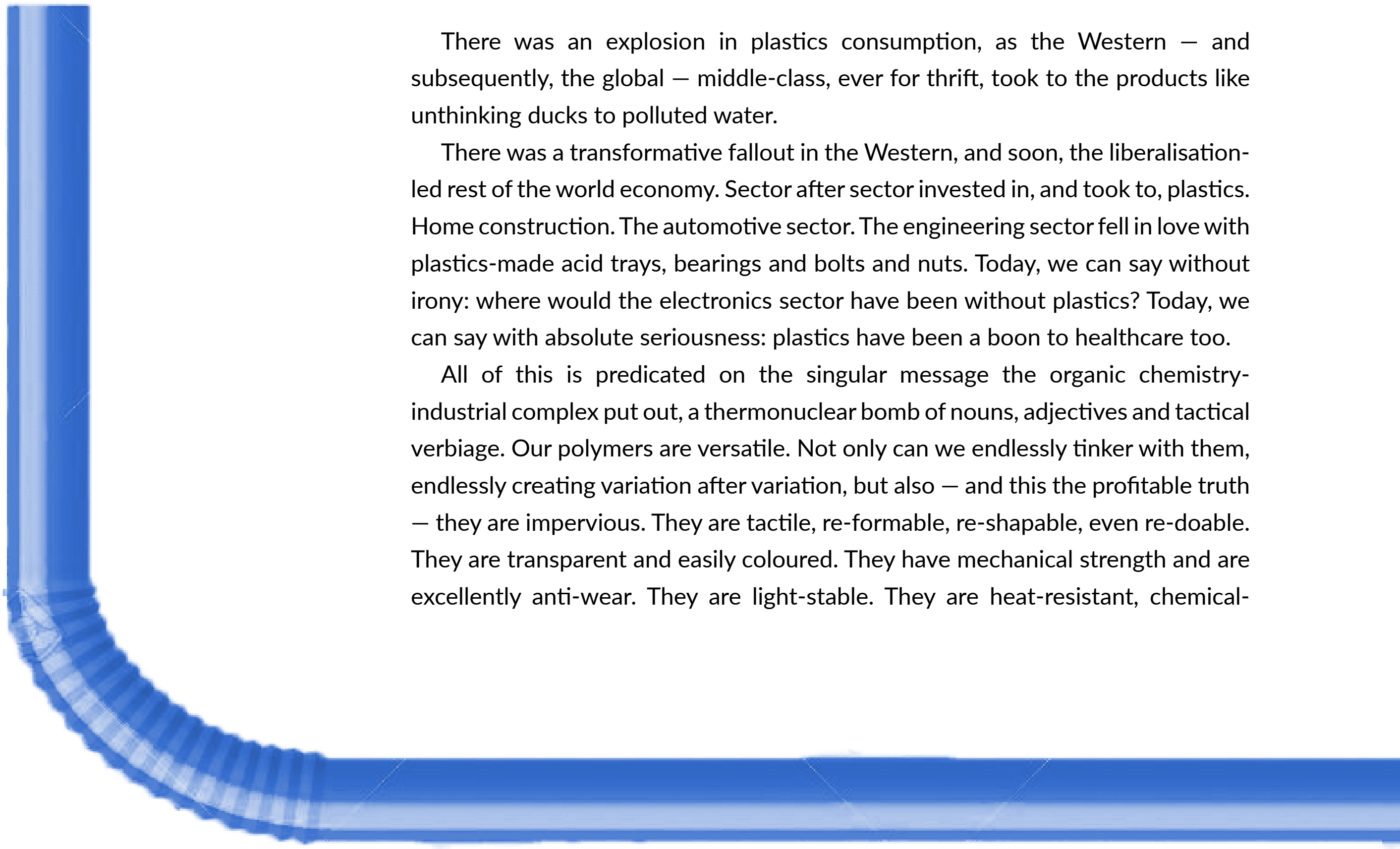
There are at least three reasons the Age of Plastics announced itself, in polymeric splendour, when it did so:

- A shortfall in rubber and other natural materials during WWII spurred demand for synthetic products in this time.
- After WWII, a surplus of synthetics and fossil fuel caused companies to create new markets for plastic products.
- Increased production led to reduced costs, making synthetic plastics more competitive than natural materials.

While working at DuPont, Earl Tupper refined an inflexible polyethylene waste product into lightweight, non-breakable containers. In 1948 Tupper released Tupperware branded products and fostered the growth of his products through branded Tupperware parties. Tupper exemplifies what may be called the second phase of the Age of Plastic: irrepressible expansion.

There was a burst in polymer production: in 1948 itself, ABS (acrylonitrile Butadiene Styrene) was synthesized. Two years later, polypropylene and polyester. In 1953, American chemist Daniel Fox invented a new kind of polycarbonate thermoplastic resin. In 1954, styrene (better known as Styrofoam) was accidentally invented by Ray McIntire. In 1965, chemist Stephanie Kwolek developed Kevlar.

There was a cloudburst in material production: thermos flasks, buckets, pots, pans, condiment containers, bowls and strainers, graters and squeezers, dishwashers, golf club heads, drainpipes, bullet-resisting protective wear, go-go boots, pantyhose and the bikini. The list is endless.



There was an explosion in plastics consumption, as the Western — and subsequently, the global — middle-class, ever for thrift, took to the products like unthinking ducks to polluted water.

There was a transformative fallout in the Western, and soon, the liberalisation-led rest of the world economy. Sector after sector invested in, and took to, plastics. Home construction. The automotive sector. The engineering sector fell in love with plastics-made acid trays, bearings and bolts and nuts. Today, we can say without irony: where would the electronics sector have been without plastics? Today, we can say with absolute seriousness: plastics have been a boon to healthcare too.

All of this is predicated on the singular message the organic chemistry-industrial complex put out, a thermonuclear bomb of nouns, adjectives and tactical verbiage. Our polymers are versatile. Not only can we endlessly tinker with them, endlessly creating variation after variation, but also — and this the profitable truth — they are impervious. They are tactile, re-formable, re-shapable, even re-doable. They are transparent and easily coloured. They have mechanical strength and are excellently anti-wear. They are light-stable. They are heat-resistant, chemical-resistant, ambient temperature-resistant, rot-resistant, eminently pliable but rock-solid, climate-resistant, condition-resistant, context-resistant, even life-resistant.

All of this is predicated on the subliminal messages the organic chemistry-industrial complex put out. Plastics are cheap. Trust us, plastics are safe.

It is a mystery how all of human civilization, so enamoured by availability, adsorbed these messages, like oily plastics microparticles attracting persistent organic pollutants to themselves.

The primary characteristic of the second phase of the Age of Plastics is exclusion. No ceramic, no rubber, no natural polymers. The intent exhibited before WWII now became a material force that could no longer be reckoned with. Excepting steel and cement, it was now plastics or nothing. No alternative was acceptable any more. Again, it is a mystery how all of human civilisation bent their collective knees to this imperious, industrial move.

Another characteristic of the second phase of the Age of Plastics: In terms of production, and sheer consumption, plastics were rapidly outgrowing all human-made materials used. Plastics were re-writing economic history. Re-shaping social spaces. Kindling a new ethic and attitude towards bought products.

This is true: World production of plastics strongly expanded, from 1.7 million tonnes in 1950 to 299 million tonnes in 2013. This is true, too: Global production of plastics was 322 million tonnes in 2015 and 335 million tonnes in 2016.

BOOMTIME

At some point of time, the organic chemistry-industrial complex had an 'a-ha' moment. So far, all the plastics products put out into the market shared at least one quality: they were re-usable. Production of such products could not stop; markets would have to be found. But that wasn't enough. Something else had to be done.

The 'a-ha' moment: plastics for one-time use. Single-use plastics.

So came in coffee stirrers and single-serve coffee pods, PET bottles for water and carbonated drinks, meal trays, cling wraps, produce bags and plastic bags.

Mysteriously, single-use plastics fitted in very well among people all over the world. Single-use plastics are also called disposable plastics, or on-the-go plastics. The products meshed with an attitude of disposability. Quotidian existence was perceived as being on-the-go, so what could be wrong with a use-and-throw styrofoam cup?

Thus began the third phase of the Age of Plastics, a time we are still living in. An incredibly successful production, marketing and profit gambit. An all-out assault of short-term convenience on the eager senses of a willing, worldwide population.

EVERYTHING IS PACKAGED

Plastics production increased from 15 million tonnes in the 1960s to 311 million tonnes in 2014 and it is expected to triple by 2050, when it would account for 20 percent of global annual oil consumption. Plastics use has increased twenty-fold in the past half-century and is expected to double again in just the next 20 years.

A primary reason the figures seem buoyant or alarming is plastics packaging, the vanguard of single-use plastics. Plastic packaging is and will remain the largest application — currently, packaging represents 26 percent of the total volume of plastics used. The perception that propels the marketability, spread and socio-cultural acceptance of single-use plastics is also the mantra of plastics packaging: it not only delivers direct economic benefits, but can also contribute to increased levels of resource productivity—for instance, plastics packaging can reduce food waste by extending shelf life and can reduce fuel consumption for transportation by bringing packaging weight down.

Many plastics are designed for single use without planning for the potential after-use pathways

AN ACHIEVEMENT

A unique achievement of the Age of Plastics is that it has re-defined the nature of garbage, or trash.

If those interested in refuse around the turn of the twentieth century had turned their attention away from the garbage in the streets and concentrated instead on the generation of trash, they might have perceived a host of new developments. Urbanisation and population growth meant that more people lived with less storage space. And mass production literally meant more stuff.

New kinds of household trash and new cultural attitudes emblematic of twentieth-century market expansion and creation were firmly established. There were literally new kinds of garbage, created in support of market growth.

Disposable products, designed to be thrown away after brief use, constituted another new kind of trash. Such products were manifestations of a new concept of disposability. Chewing gum was disposable food. The safety razor, first advertised in 1903, introduced the concept of the disposable part to the consumer: the razor blade, to be thrown away when dull, supplanted the straight razor, which could be re-sharpened hundreds of times. The fountain pen, with replenishable ink is now forgotten. Its successor, the ballpoint pen, is assigned to the bin at the first sign of exhausted ink.

The Age of Plastics has solidified this tendency.

Trash may also be understood as an issue pertaining to the normal functioning of both the household and the economy. The economic proposition is straightforward: once large numbers of people have attained a certain standard of living, the growth of markets in new products depends on the continuous disposal of old things. Disposal, in other words, may be understood as part of the larger process that encompasses production, distribution, purchase, and use, and trash as a product of that process, not merely a by-product.

The Age of Plastics, so far, has managed to rent this process asunder.

Disposal has become a stand-alone act, to which every individual has a right. A throwaway ethic, first noticed in the American middle-class, has now become global. In the process, it has seeped into the realm of common sense: It makes perfect sense, today, to simply use and throw. And not bother about the effects.

Unfortunately, there are consequences. As a normal household process, disposal may involve the literal, spatial interface between the private and the public. Some time after they are purchased and brought home, parts of food, clothing, appliances, cleaning products, and other household goods (the parts that are not literally consumed) are removed beyond the borders of the household.

Non-trash belongs in the house; trash gets put outside. Marginal categories get stored in marginal places — attics, basements, and outbuildings — eventually to be used, sold, or given away.

But once in the alley or in the dump, household refuse becomes both public matter, available for others to claim or reclaim, and a public matter, the topic of public debate, a problem to be solved by public means.

MOULDING THE ECONOMY

Ronald Geyer et. al. concluded in a 2017 study: 8,300 million tonnes of virgin plastics have been produced till date (of the study). Of this, around nine percent have been recycled and 12 percent incinerated. 79 percent have found their way into landfills or the natural environment.

This explains why the oceans are reeling under 4.8-12.7 million tonnes of trash. Most of it is single-use plastics. Here's the proof: International beach clean-up data from the Ocean Conservancy shows that plastic drinks bottles, food wrappers, plastic bottle caps, straws and stirrers, plastic bags and plastic lids are amongst the top ten most common items collected. All of these are single-use plastics.

Profit drives the single-use plastics explosion. Industry is celebrating. The planet is not

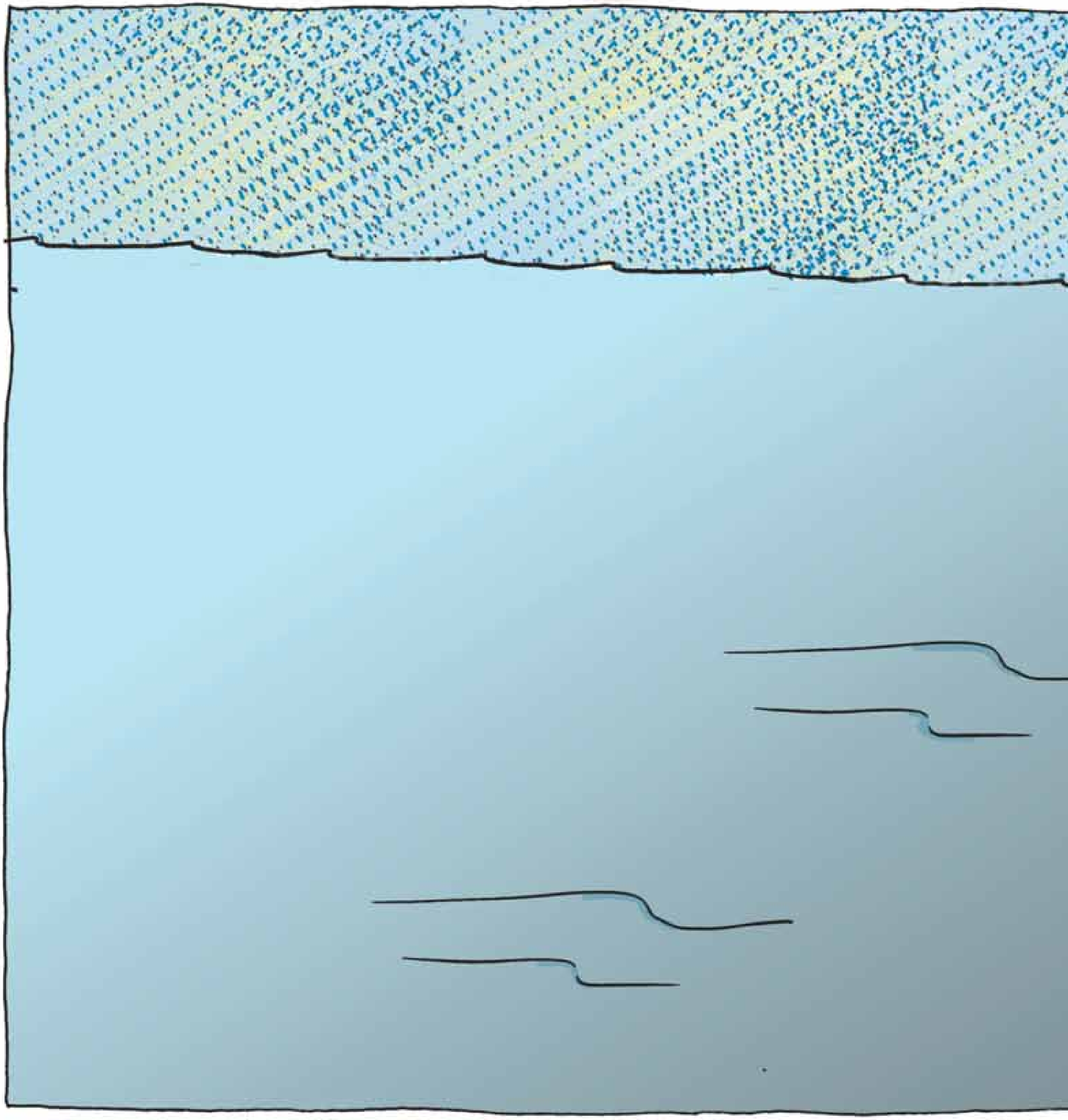
And they are an economic burden. Although the perceived value of single-use plastics items is low, US $80-120 billion of material value from plastic packaging alone is lost to the economy each year. Sectors such as tourism, fishing and shipping are commonly impacted by marine litter, and there is an economic burden on local authorities through clean-up costs.

While delivering many benefits, the current plastics economy also has important drawbacks. Today, 95 percent of plastic packaging material value, or US $80–120 billion annually, is lost to the economy after a short first use. More than 40 years after the launch of the first universal recycling symbol, only 14 percent of plastic packaging is collected for recycling. When additional value losses in sorting and reprocessing are factored in, only five percent of material value is retained for a subsequent use. Plastics that do get recycled are mostly recycled into lower-value applications that are not again recyclable after use. The recycling rate for plastics in general is even lower than for plastic packaging, and both are far below the global recycling rates for paper (58 percent) and iron and steel (70–90 percent).

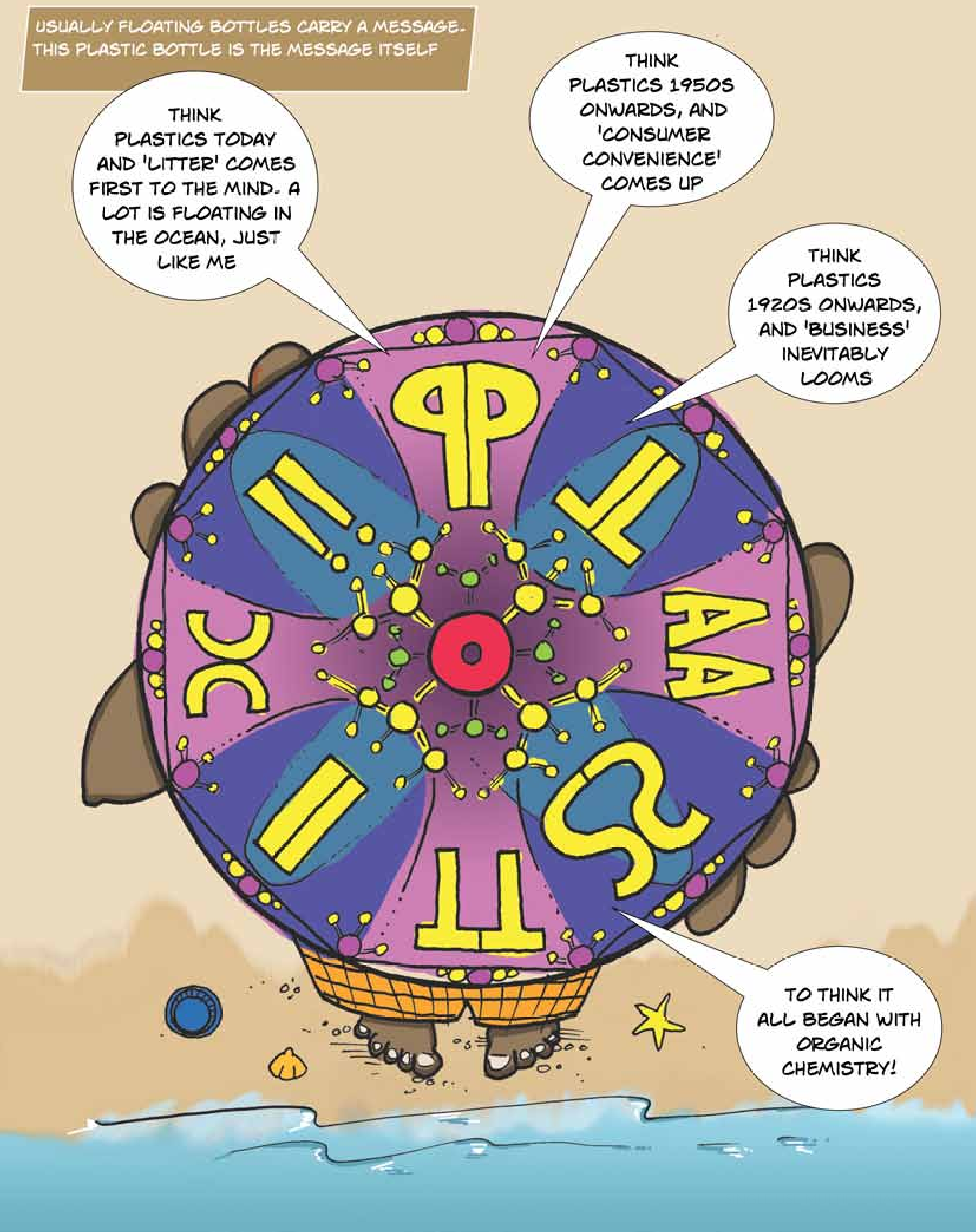
In addition, plastic packaging is almost exclusively single-use, especially in business-to-consumer applications. It generates significant negative externalities, conservatively valued by UNEP at US $40 billion and expected to increase with strong volume growth in a business-as-usual scenario. Each year, at least eight million tonnes of plastics leak into the ocean. Estimates suggest plastic packaging represents the major share of this leakage. The best research currently available estimates that there are over 150 million tonnes of plastics in the ocean today. In a business-as-usual scenario, the ocean is expected to contain 1 tonne of plastic for every 3 tonnes of fish by 2025, and by 2050, more plastics than fish.

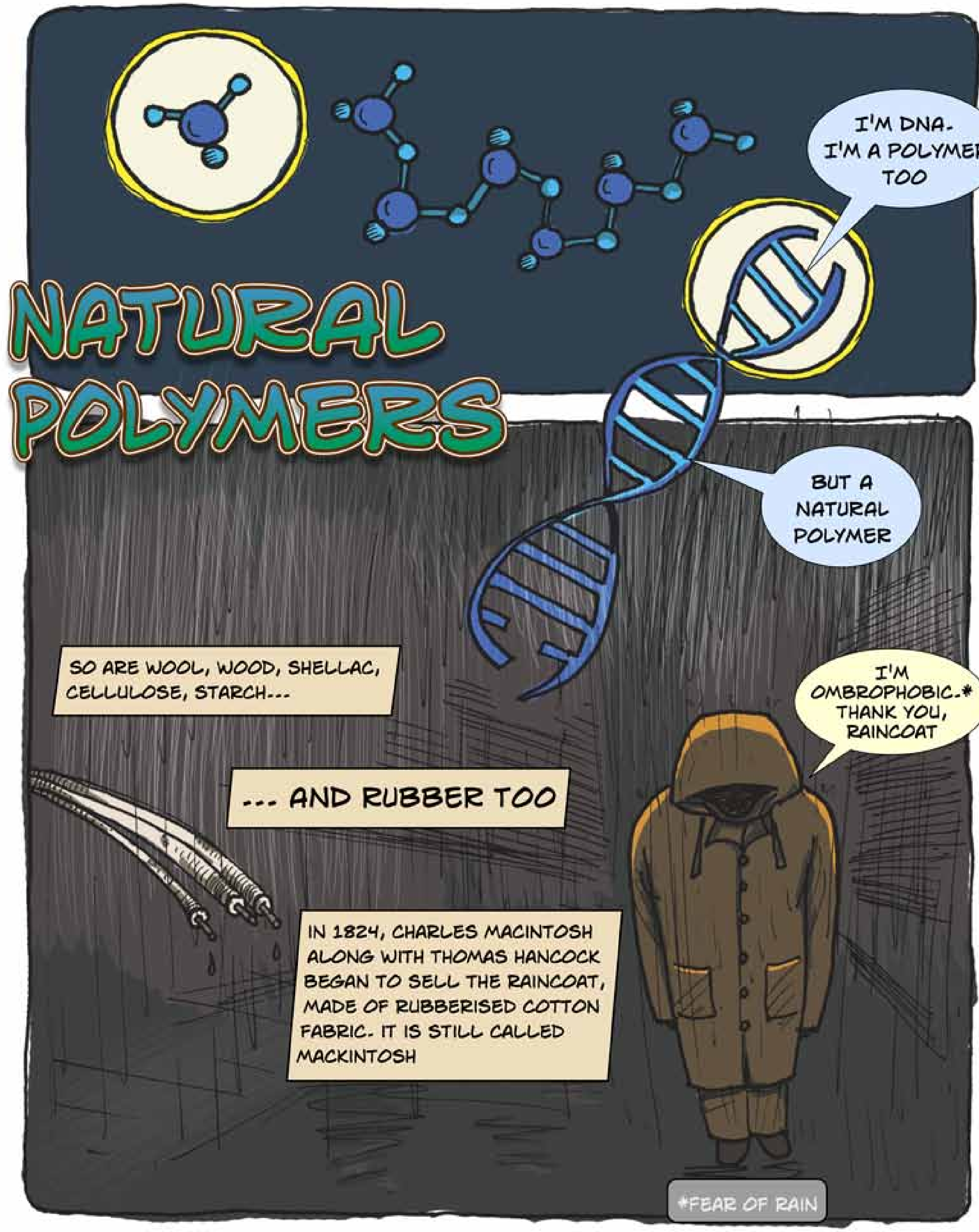
This is the real mystery: then and now, the end-of-life management of polymer resins, synthetic fibres and additives still eludes humanity. Will organic chemistry's sovereignty over Earth ever end?

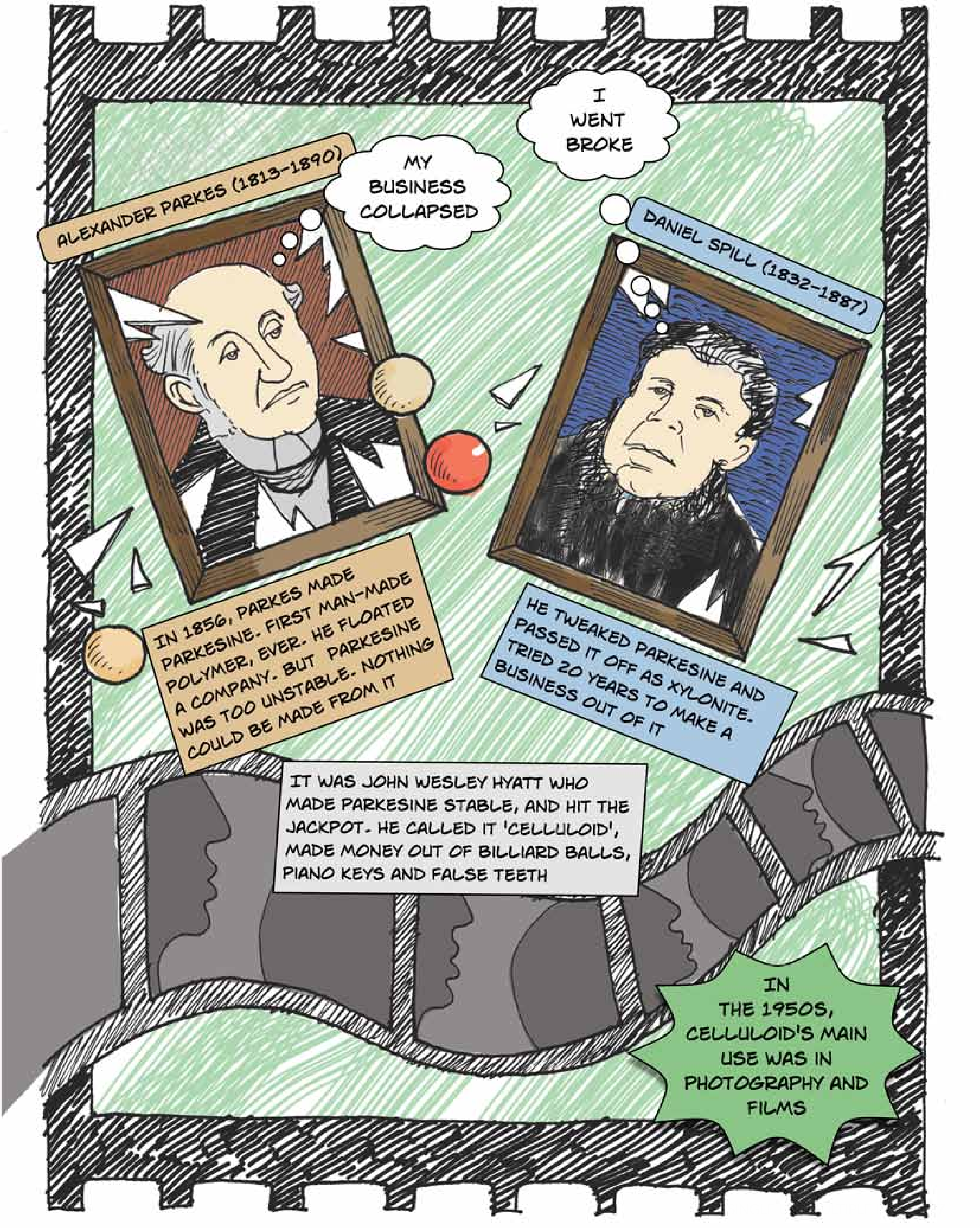
PLASTIC TIMES




POLYMERIA ISLAND, SOUTH PACIFIC.
3,500 KM FROM NEAREST MODERN CIVILIZATION
7-YEAR-OLD
PRONEKUTA SPOTTED
SOMETHING STRANGE
WOW!
WHAT A WILLY
WILLY!*
*ABORIGINAL WORD
MEANING 'DUST DEVIL'

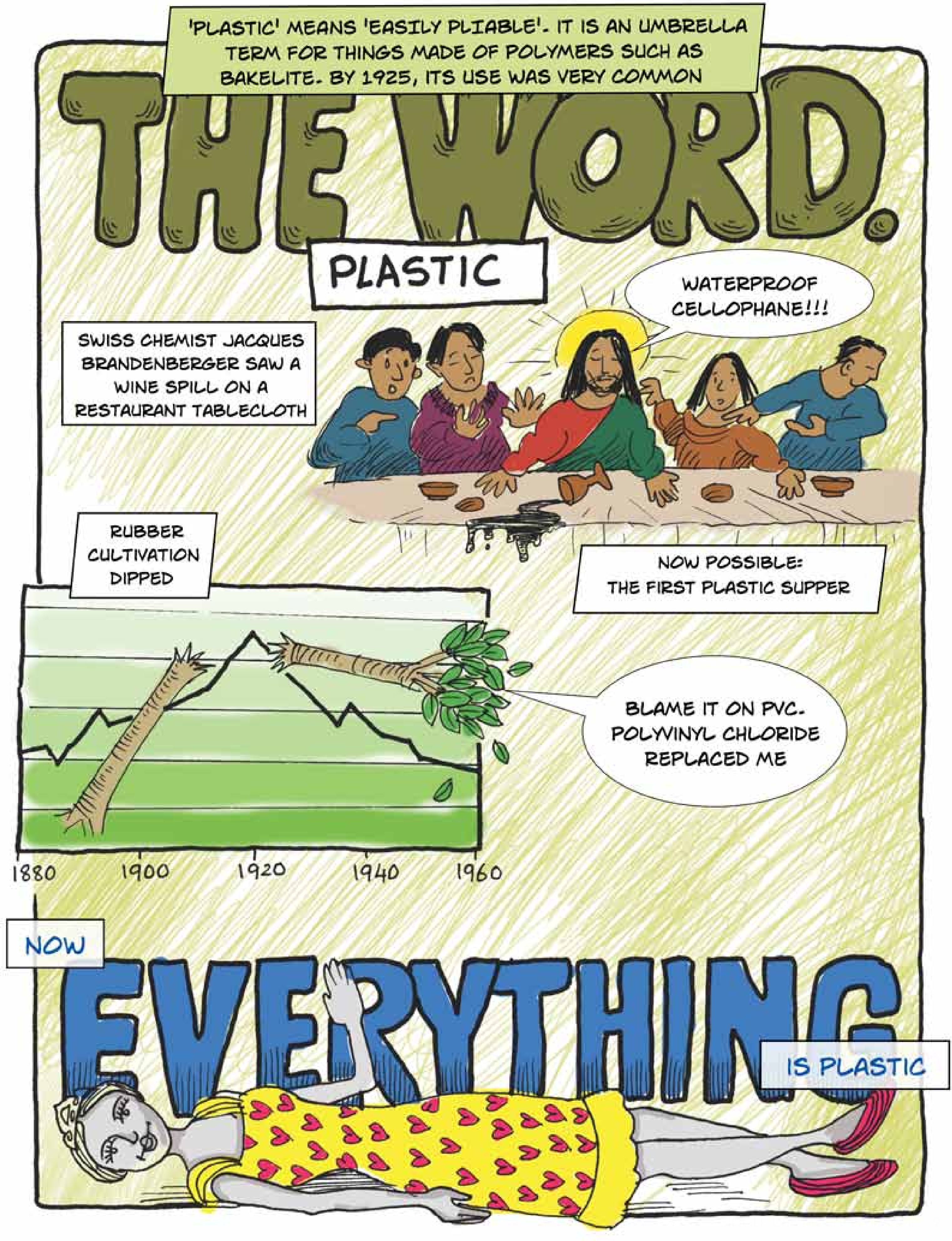

USUALLY FLOATING BOTTLES CARRY A MESSAGE. THIS PLASTIC BOTTLE IS THE MESSAGE ITSELF
THINK PLASTICS TODAY AND 'LITTER' COMES FIRST TO THE MIND. A LOT IS FLOATING IN THE OCEAN, JUST LIKE ME
THINK PLASTICS 1950S ONWARDS, AND 'CONSUMER CONVENIENCE' COMES UP
THINK PLASTICS 1920S ONWARDS, AND 'BUSINESS' INEVITABLY LOOMS
TO THINK IT ALL BEGAN WITH ORGANIC CHEMISTRY!


NATURAL POLYMERS
I'M DNA. I'M A POLYMER TOO
BUT A NATURAL POLYMER
SO ARE WOOL, WOOD, SHELLAC, CELLULOSE, STARCH...
... AND RUBBER TOO
I'M OMBROPHOBIC.* THANK YOU, RAINCOAT
IN 1824, CHARLES MACINTOSH ALONG WITH THOMAS HANCOCK BEGAN TO SELL THE RAINCOAT, MADE OF RUBBERISED COTTON FABRIC. IT IS STILL CALLED MACKINTOSH
*FEAR OF RAIN

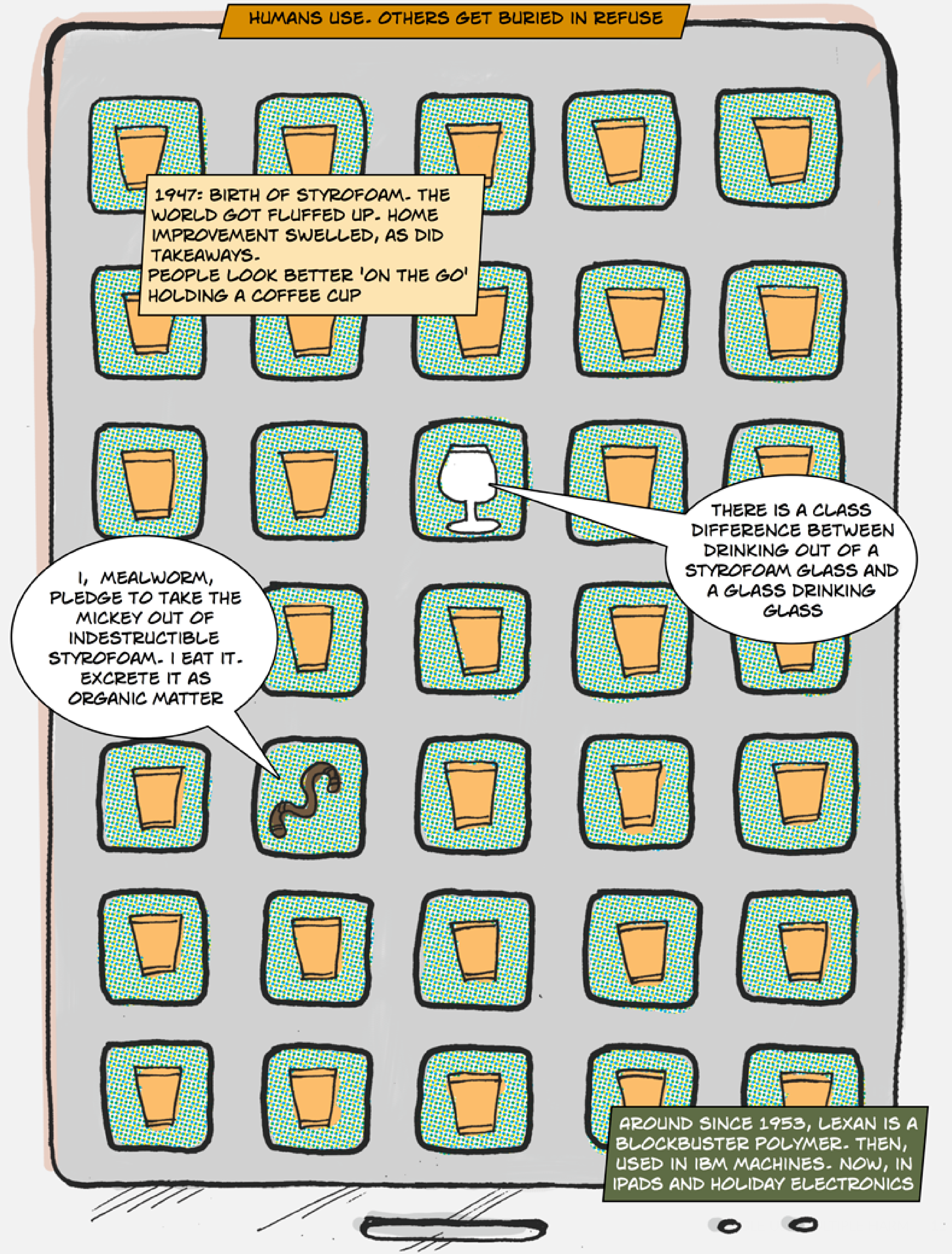


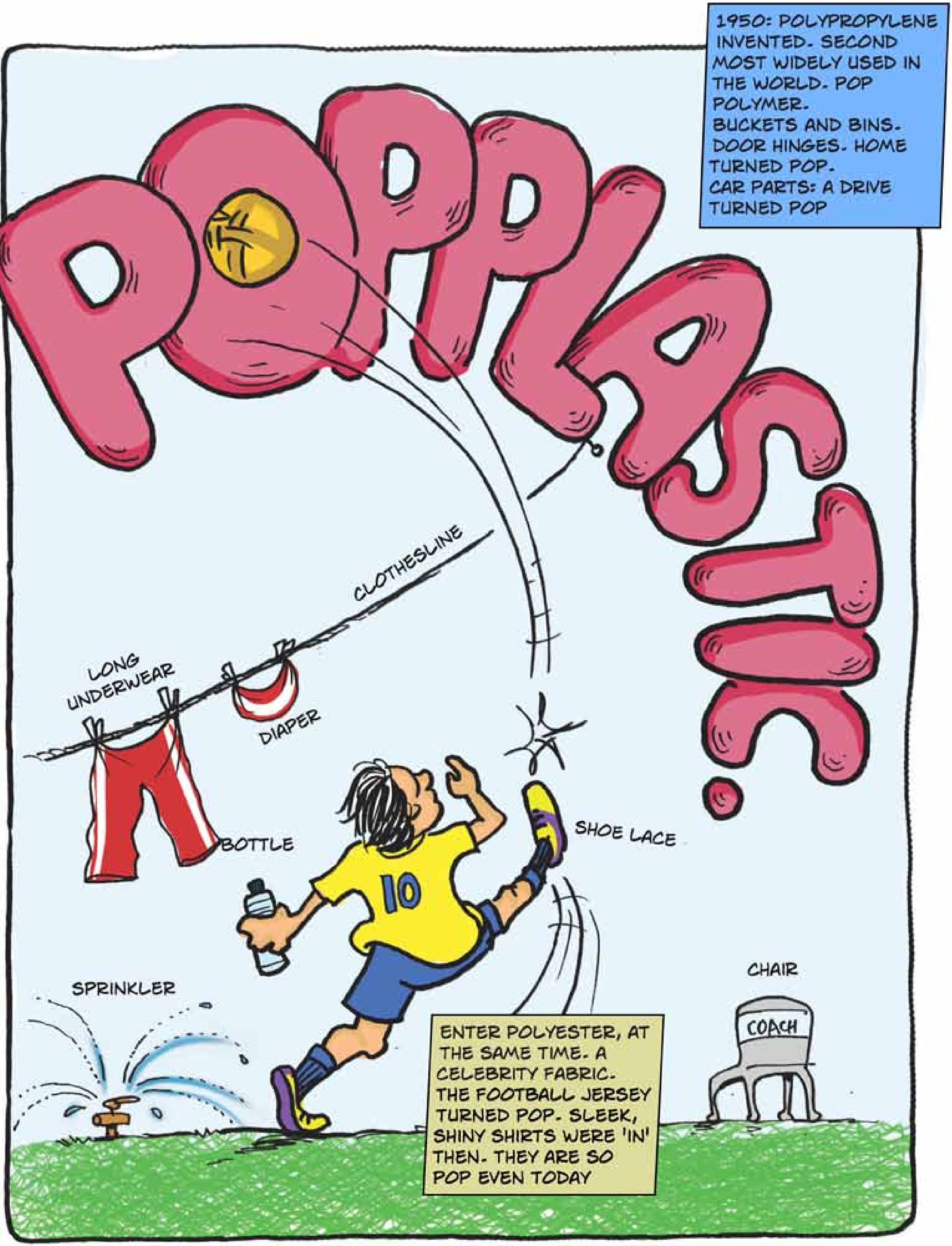
ALEXANDER PARKES (1813-1890)
MY BUSINESS COLLAPSED
I WENT BROKE
DANIEL SPILL (1832-1887)
IN 1856, PARKES MADE PARKESINE. FIRST MAN-MADE POLYMER, EVER. HE FLOATED A COMPANY. BUT PARKESINE WAS TOO UNSTABLE. NOTHING COULD BE MADE FROM IT
HE TWEAKED PARKESINE AND PASSED IT OFF AS XYLONITE. TRIED 20 YEARS TO MAKE A BUSINESS OUT OF IT
IT WAS JOHN WESLEY HYATT WHO MADE PARKESINE STABLE, AND HIT THE JACKPOT. HE CALLED IT 'CELLULOID', MADE MONEY OUT OF BILLIARD BALLS, PIANO KEYS AND FALSE TEETH
IN THE 1950S, CELLULOID'S MAIN USE WAS IN PHOTOGRAPHY AND FILMS

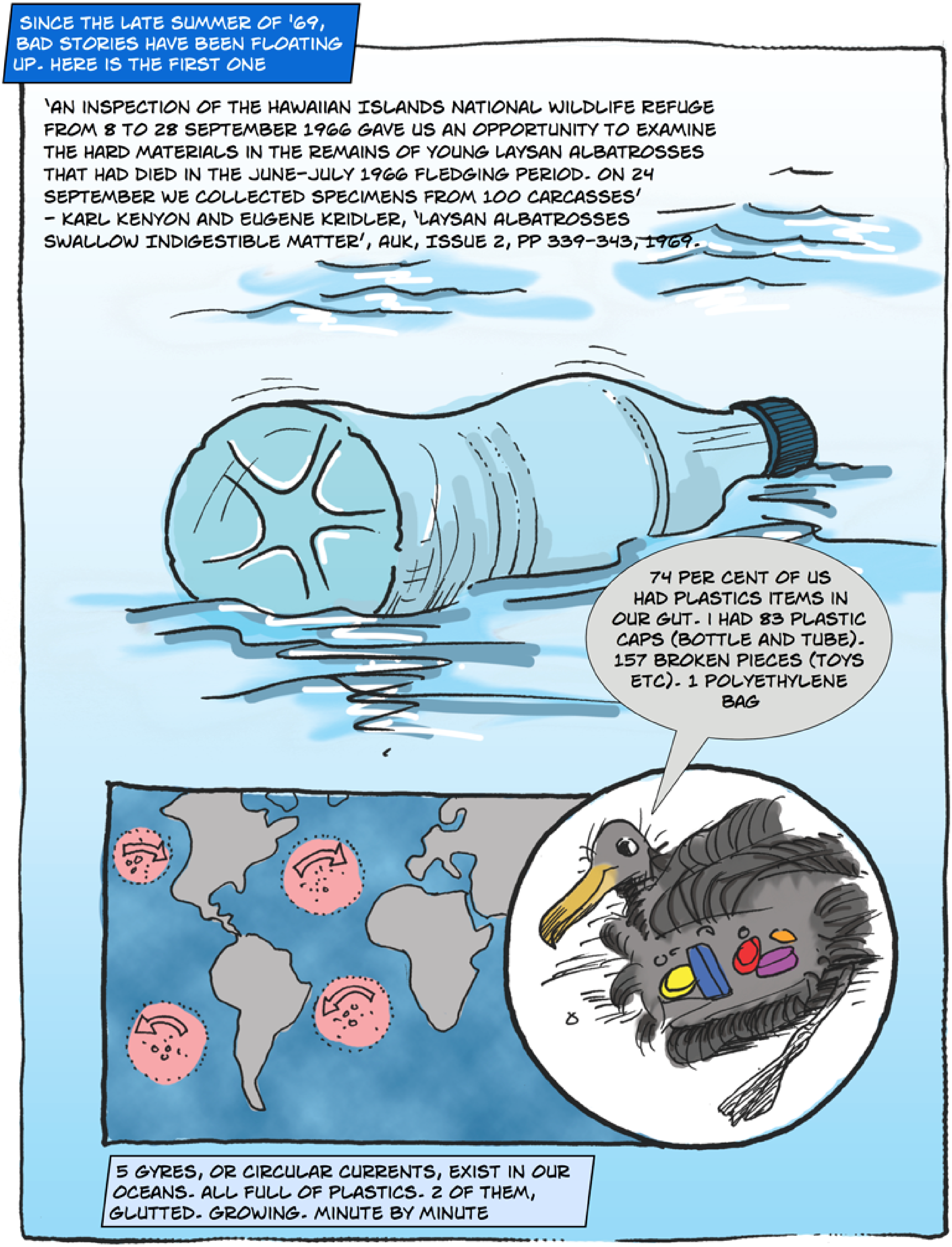

OFF
ON
1920S ON, MOST ELECTRICAL SWITCHES, PHONES AND WIRE INSULATIONS WERE MADE OF BAKELITE. RADIOS, TOO.
BAKELITE IS THE FIRST MAN-MADE SYNTHETIC PLASTIC. MADE BY CHEMIST LEO BAEKELAND. HIS INVENTION MADE POSSIBLE A BOOM IN ELECTRIFICATION AND LONG-DISTANCE COMMUNICATION IN USA

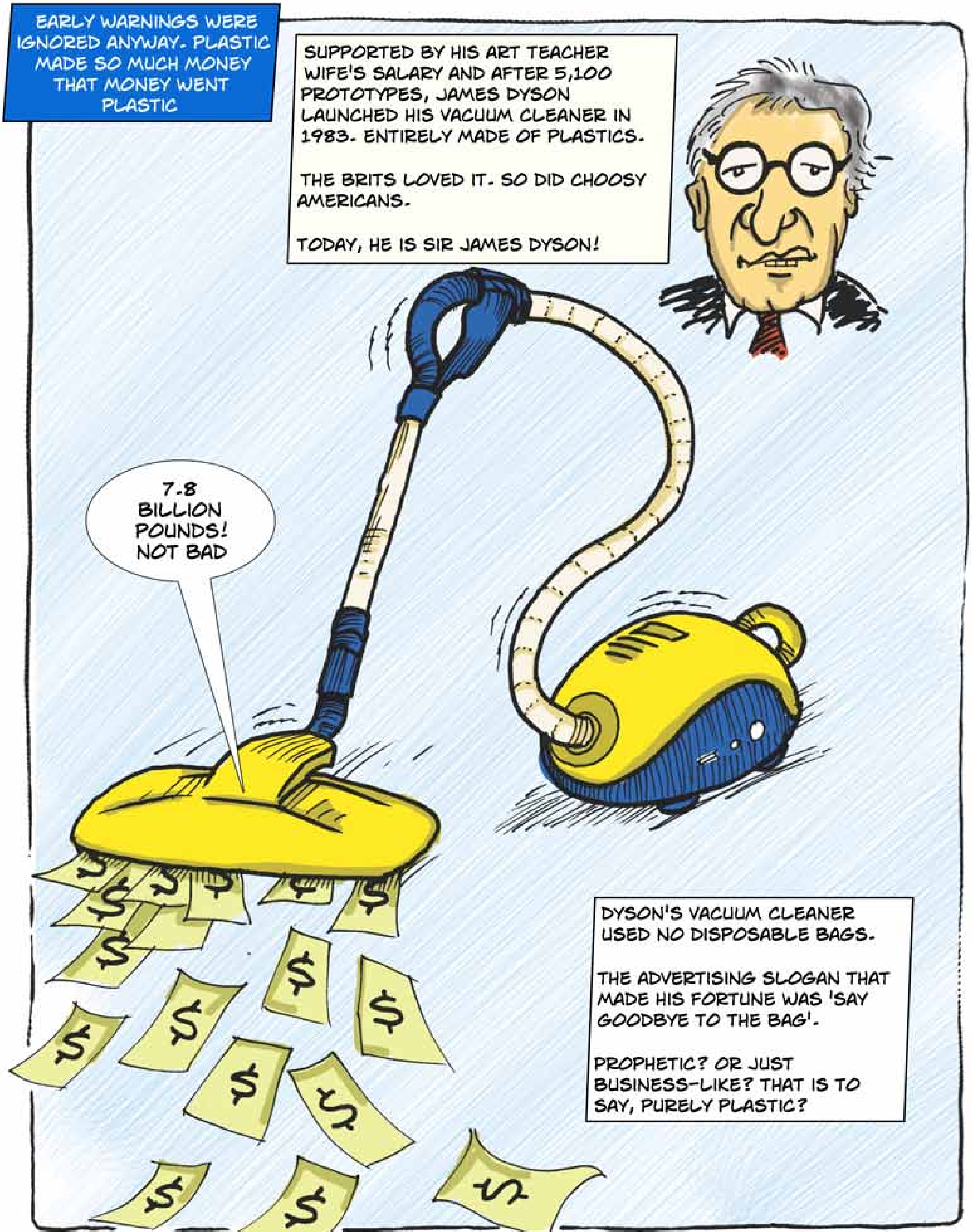

'PLASTIC' MEANS 'EASILY PLIABLE'. IT IS AN UMBRELLA TERM FOR THINGS MADE OF POLYMERS SUCH AS BAKELITE. BY 1925, ITS USE WAS VERY COMMON
THE WORD.
PLASTIC
SWISS CHEMIST JACQUES BRANDENBERGER SAW A WINE SPILL ON A RESTAURANT TABLECLOTH
WATERPROOF CELLOPHANE!!!
NOW POSSIBLE: THE FIRST PLASTIC SUPPER
RUBBER CULTIVATION DIPPED
BLAME IT ON PVC. POLYVINYL CHLORIDE REPLACED ME
1880
1900
1920
1940
1960
NOW
EVERYTHING
IS PLASTIC

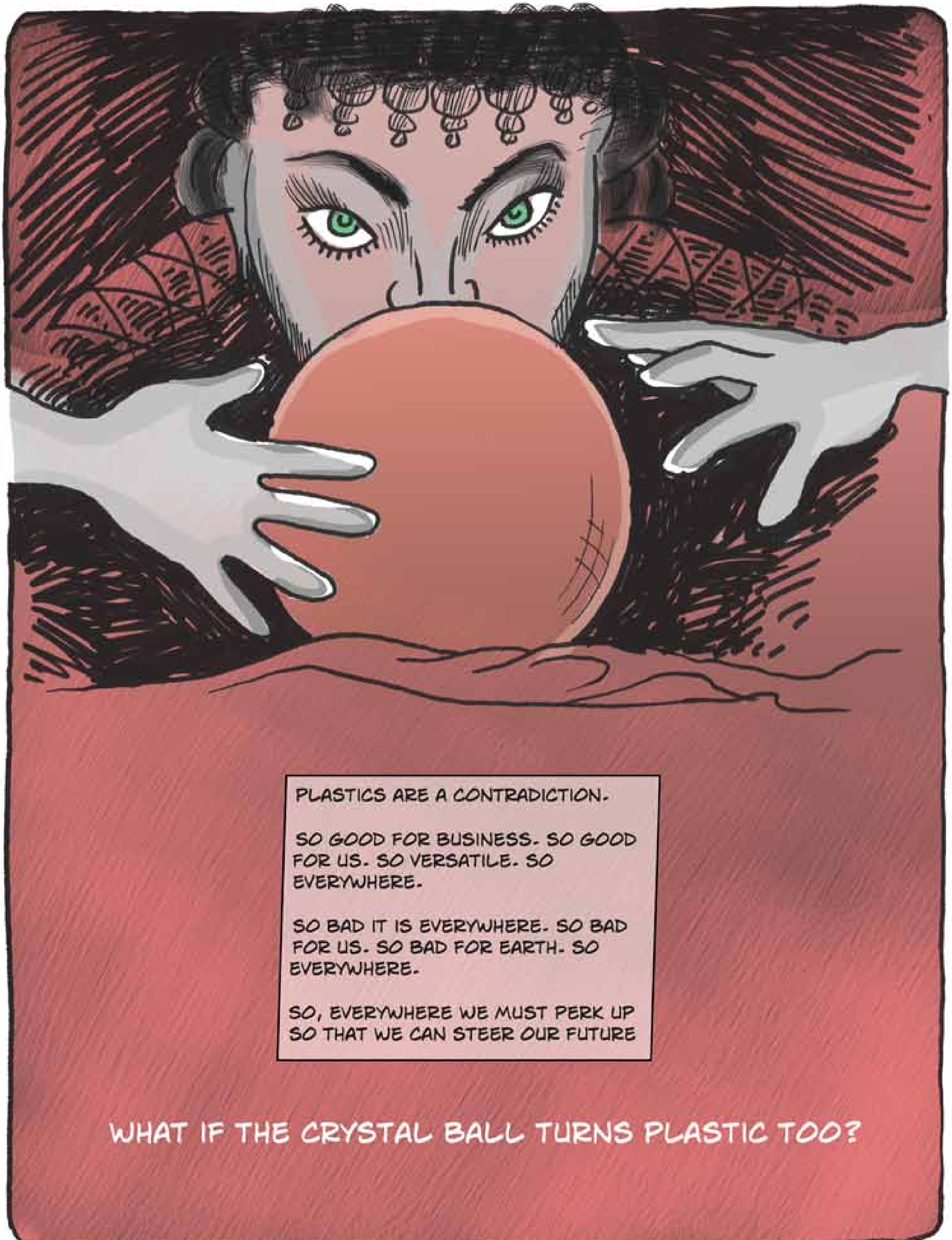

...AND MORE
DISCOVERED BY ACCIDENT. MADE MARKETABLE BY DESIGN. ONE WAY OR OTHER, POLYMERS HAD TO PERFORM. FOR PROFIT.
E.G.: POLYETHYLENE. WORLD'S MOST WIDELY USED POLYMER. TOOK TIME TO MAKE IT MARKET-VIABLE. THEN CAME THE PLASTIC BAG, PLASTIC BOTTLE AND CONTAINER EXPLOSION
PLASTIC
TEFLON WAS ANOTHER LAB ACCIDENT. BUT IT LED TO 'THE HAPPY PAN', FIRST MARKETED 1961. SURELY GOT ONE?
NOTHING STICKS TO ME
COMPANIES REALISED PLASTIC POLYMERS WERE MULTI-USABLE. TAKE NYLON.
FIRST APPEARED AS TOOTHBRUSH BRISTLES. FOLLOWED BY STOCKINGS. 'NYLONS'. WOMEN STILL FLAUNT IT.
IN WWII, ALL NYLON PRODUCTION WAS DIVERTED TO MAKING PARACHUTES. WWII WAS A BOON FOR NYLON AND OTHER PLASTICS. USA PLASTICS PRODUCTION INCREASED 300 PER CENT
S-T-R-E-T-C-H-A-S-A-N-A
NYLON YOGA

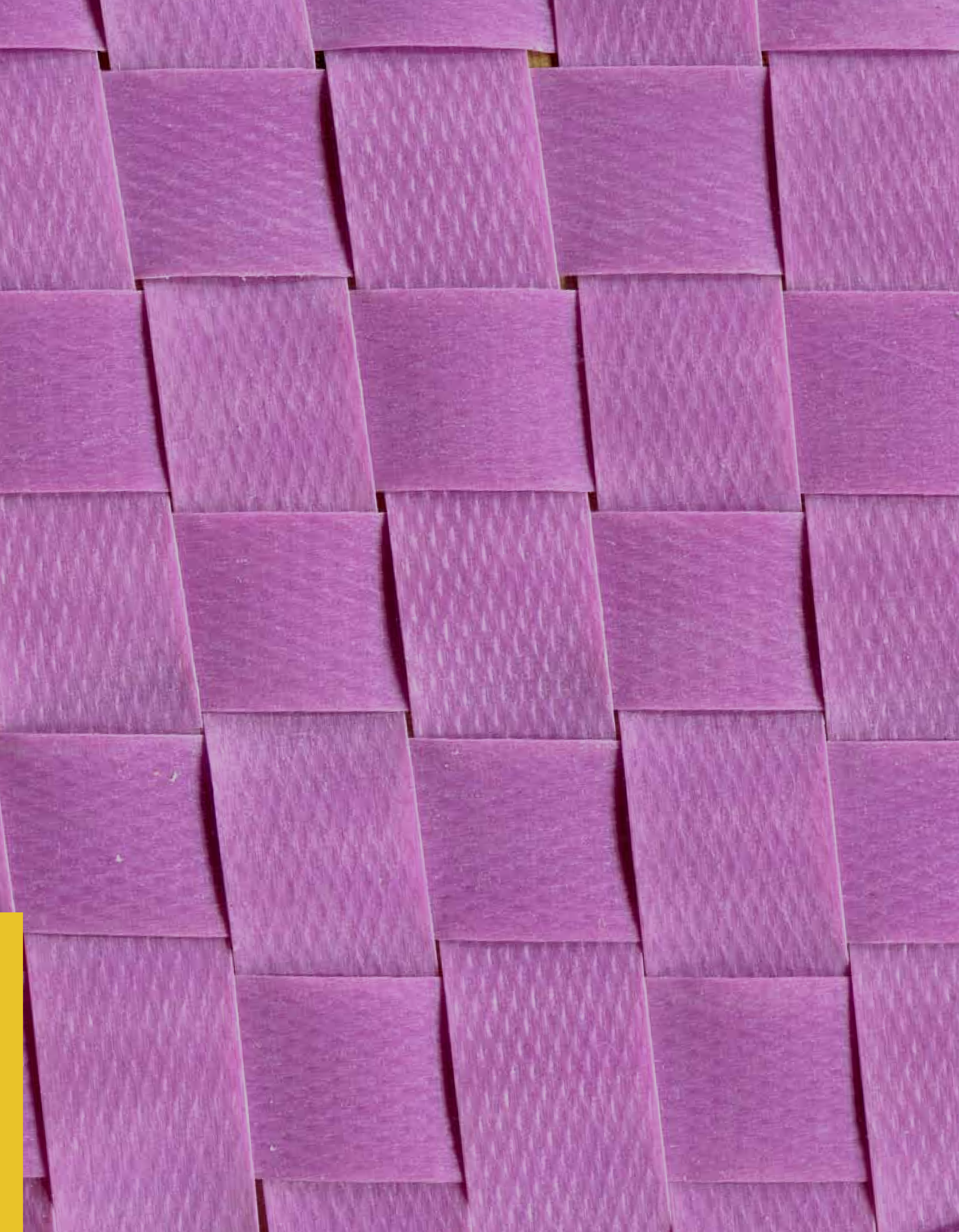

HUMANS USE. OTHERS GET BURIED IN REFUSE
1947: BIRTH OF STYROFOAM. THE WORLD GOT FLUFFED UP. HOME IMPROVEMENT SWELLED, AS DID TAKEAWAYS.
PEOPLE LOOK BETTER 'ON THE GO' HOLDING A COFFEE CUP
THERE IS A CLASS DIFFERENCE BETWEEN DRINKING OUT OF A STYROFOAM GLASS AND A GLASS DRINKING GLASS
I, MEALWORM, PLEDGE TO TAKE THE MICKEY OUT OF INDESTRUCTIBLE STYROFOAM. I EAT IT. EXCRETE IT AS ORGANIC MATTER
AROUND SINCE 1953, LEXAN IS A BLOCKBUSTER POLYMER. THEN, USED IN IBM MACHINES. NOW, IN IPADS AND HOLIDAY ELECTRONICS


1950: POLYPROPYLENE INVENTED. SECOND MOST WIDELY USED IN THE WORLD. POP POLYMER.
BUCKETS AND BINS. DOOR HINGES. HOME TURNED POP.
CAR PARTS: A DRIVE TURNED POP
POPPLASTIC!
CLOTHESLINE
LONG UNDERWEAR
DIAPER
BOTTLE
SHOE LACE
10
SPRINKLER
CHAIR
COACH
ENTER POLYESTER, AT THE SAME TIME. A CELEBRITY FABRIC. THE FOOTBALL JERSEY TURNED POP. SLEEK, SHINY SHIRTS WERE 'IN' THEN. THEY ARE SO POP EVEN TODAY


SINCE THE LATE SUMMER OF '69, BAD STORIES HAVE BEEN FLOATING UP. HERE IS THE FIRST ONE
'AN INSPECTION OF THE HAWAIIAN ISLANDS NATIONAL WILDLIFE REFUGE FROM 8 TO 28 SEPTEMBER 1966 GAVE US AN OPPORTUNITY TO EXAMINE THE HARD MATERIALS IN THE REMAINS OF YOUNG LAYSAN ALBATROSSES THAT HAD DIED IN THE JUNE–JULY 1966 FLEDGING PERIOD. ON 24 SEPTEMBER WE COLLECTED SPECIMENS FROM 100 CARCASSES' – KARL KENYON AND EUGENE KRIDLER, 'LAYSAN ALBATROSSES SWALLOW INDIGESTIBLE MATTER', AUK, ISSUE 2, PP 339–343, 1969.
74 PER CENT OF US HAD PLASTICS ITEMS IN OUR GUT. I HAD 83 PLASTIC CAPS (BOTTLE AND TUBE). 157 BROKEN PIECES (TOYS ETC). 1 POLYETHYLENE BAG
5 GYRES, OR CIRCULAR CURRENTS, EXIST IN OUR OCEANS. ALL FULL OF PLASTICS. 2 OF THEM, GLUTTED. GROWING. MINUTE BY MINUTE


EARLY WARNINGS WERE IGNORED ANYWAY. PLASTIC MADE SO MUCH MONEY THAT MONEY WENT PLASTIC
SUPPORTED BY HIS ART TEACHER WIFE'S SALARY AND AFTER 5,100 PROTOTYPES, JAMES DYSON LAUNCHED HIS VACUUM CLEANER IN 1983. ENTIRELY MADE OF PLASTICS.
THE BRITS LOVED IT. SO DID CHOOSY AMERICANS.
TODAY, HE IS SIR JAMES DYSON!
7.8 BILLION POUNDS! NOT BAD
DYSON'S VACUUM CLEANER USED NO DISPOSABLE BAGS.
THE ADVERTISING SLOGAN THAT MADE HIS FORTUNE WAS 'SAY GOODBYE TO THE BAG'.
PROPHETIC? OR JUST BUSINESS-LIKE? THAT IS TO SAY, PURELY PLASTIC?


PLASTICS ARE A CONTRADICTION.
SO GOOD FOR BUSINESS. SO GOOD FOR US. SO VERSATILE. SO EVERYWHERE.
SO BAD IT IS EVERYWHERE. SO BAD FOR US. SO BAD FOR EARTH. SO EVERYWHERE.
SO, EVERYWHERE WE MUST PERK UP SO THAT WE CAN STEER OUR FUTURE
WHAT IF THE CRYSTAL BALL TURNS PLASTIC TOO?



PLASTIC FANTASTIC

01 FASHION

SLIPPERY CATWALK

'Plastics is so over.
So why do some fashion houses still treat it as cool?'
At a time the world is trying to uncouple itself from plastics?

— 'Lucy Siegle, The Guardian', March 4, 2018

Whatever the designer dreams up, plastics can deliver. What helped put the stretch in skinny jeans and socks, give dress clothes their shimmer and keep outerwear lightweight and water-resistant?

1. Horn-rimmed eyeglasses rose in popularity, only when tortoise shell ones were replaced by moulded plastics.
2. In the 1970s, platform shoes went hand in hand with the disco era. Often featuring more than four inches of thick, stacked plastic bases, these shoes were sported on dance floors by both men and women and loved for their appeal.

NADIIA KOROL/SHUTTERSTOCK.COM

MIISHA/SHUTTERSTOCK.COM

3. Everything was big in the 1980s, even aerobic fashion. Any aerobic outfit of the 1980s was founded on plastic spandex. Sneakers, too, were everywhere. The plastic in the thick cushioned soles allowed them to be engineered for sportsmanship as well as style. High-tops burst onto the scene, and athletes like Michael Jordan began endorsing top-of-the-line sneakers.

4. Take the humble hair comb. The famous glitz and glamour of old Art Deco Hollywood poured into 1930s fashion and accessories, most notably the Art Deco hair comb. Some were made of expensive gems and metals, many were made of plastics, making them a classic trend that could be worn by all economic classes.

02 HEALTH CARE

STOCK UP/SHUTTERSTOCK.COM

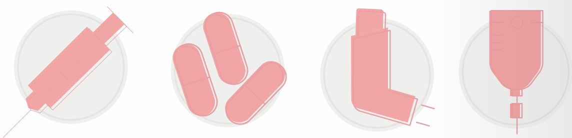
This noble profession has been ennobled by the plastics products to replace—item-for-item medical implants, devices and supports—that were earlier made with metals, glass and ceramics.

Plastic fibres and resins used in medical applications include polyvinyl chloride (PVC), polypropylene (PP), polyethylene (PE), polystyrene (PS), nylon and polyethylene terephthalate (PET). The most widely used is PVC followed by PE, PP, PS and PET.

HELP IS HERE

Medical applications include hypodermic syringes, catheters, repairing diseased arteries via a flexible plastic prosthesis. People with severely impaired hearing can now have plastic implants inserted that allow them to hear again.

It is such a contradiction. Plastics medical equipment has really helped the healthcare sector. On the other hand, such equipment is 100 percent single-use plastics. What are we to do?



03 AGRICULTURE

FECUND FARM

The ever-growing use of plastics in agriculture — called plasticulture — has helped farmers increase crop production, improve food quality and reduce the ecological footprint of their activity.

Not only do plastics allow for vegetables and fruits (even exotic ones, such as broccoli and avocado) to be grown in all seasons, but these products are usually of better quality than those grown in an open field. We forgot to mention exotic, marketable herbs: wouldn't you like to cultivate parsley, sage, rosemary and thyme? Not to mention oregano!

A wide range of plastics are used in agriculture, including polyolefin, polyethylene, polypropylene, ethylene-vinyl accetate copolymer, poly-vinyl chloride and, less so, polycarbonates and poly-methyl-methacrylate.

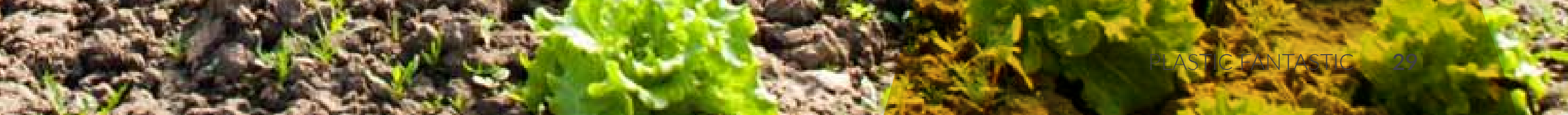
The names don't matter. The function does.

Water can be saved. Crops can even be planted in arid areas. Plastic irrigation pipes prevent waste of water and nutrients, rainwater can be retained in reservoirs lined with plastics, and the use of pesticides can be reduced by keeping crops in a closed space such as a greenhouse or, for mulching, under a plastic film. A silage, made of plastic film and used to store grain and straw in the winter, is a useful application. Silages are time-resistant and the content can be stored for years. Then there are the walk-in tunnels and low tunnel covers. Terrific, for you can grow asparagus and watermelons anywhere.

The raw materials for tunnel covers are usually low density polyethylene (LDPE) and ethylene-vinyl acetate (EVA) or ethylene-butyl acrylate copolymers. For mulching, linear low density polyethylene is used. The names really don’t matter. Really, the function does.

At the end of their life cycle, agricultural plastics such as greenhouse covers can be recycled. Once retrieved from fields, plastics are usually washed to eliminate sand, herbicides and pesticides, before being grinded and extruded into pellets. The material can then be used again.

THROW, AND REPLACE. CARRY ON AND GROW.



04 CONSTRUCTION

HOME, SWEETER HOME

MARIA ARKHIPOVA © 123RF.COM

THIS IS STRICTLY FOR THE HOUSE-PROUD.

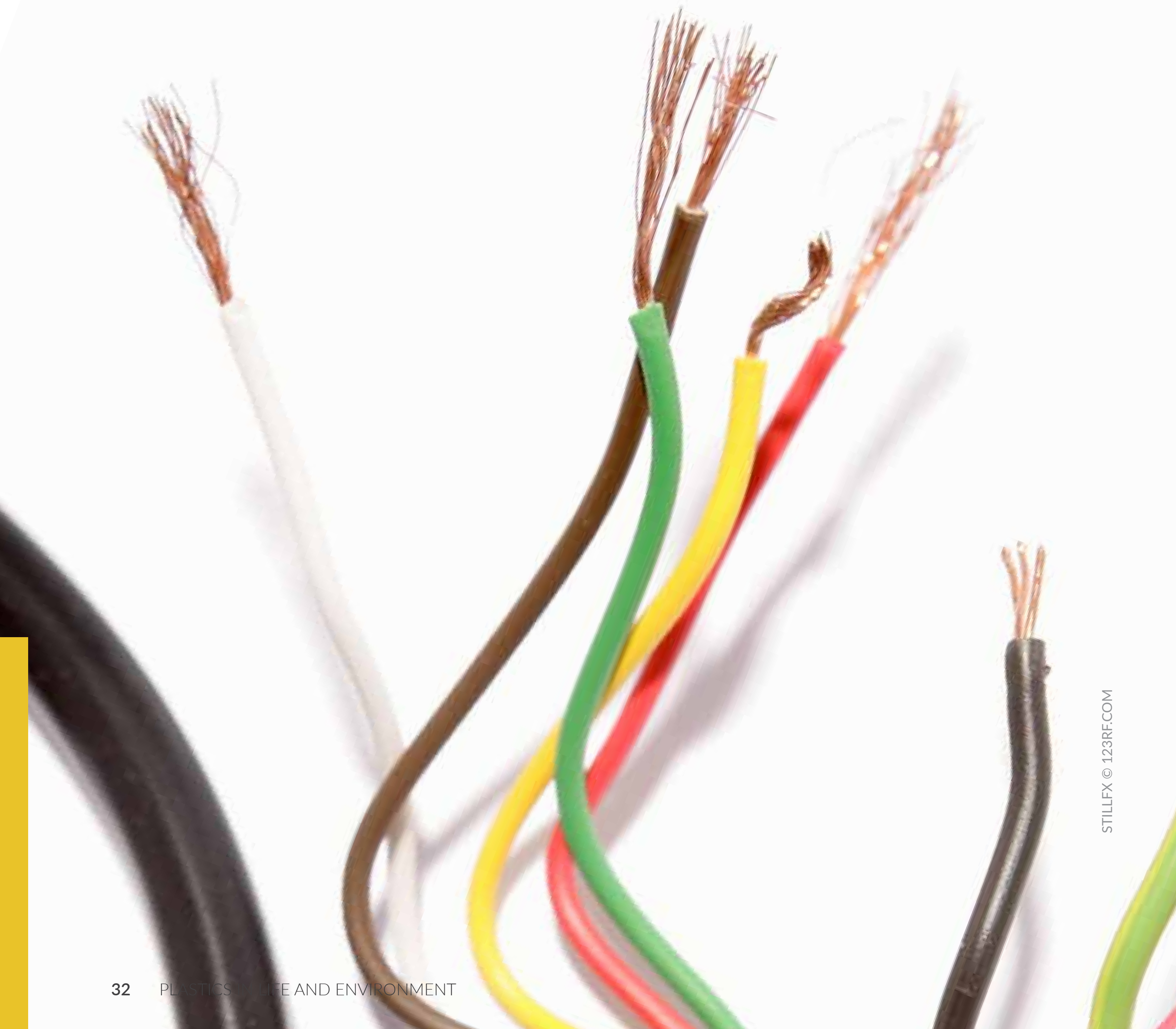
For flooring less prone to wear and tear, and to sound-proof the house, use PVC and Polyethylene materials. The roof is crucial. Use two layers of different materials. To take care of damage and look stylish, use coloured thermoplastic olefin or vinyl as the upper layer. To keep the interior cooler, use polyurethane foam as the inner layer.
Insulation has a one-stop solution: Polyurethane spray.
For walls, use a pre-fab composite wall board. Rigid polyurethane foam sandwiched between thin layers of oriented strand board. Easy to transfer, a good support for columns.

WANT TO RENOVATE? EASY: REMOVE AND REPLACE.

Polycarbonated windows, that use fibreglass and vinyl, are the best. Fibreglass is extremely strong. Vinyl is cheap and durable. Note: compared to a regular glass window, a polycarbonated window is more burglar-proof.
For incredibly strong doors, use those with a stiff polyurethane foam core sandwiched by a fibre-reinforced plastic coating.
Must use only PVC piping. For outside and inside.
Got it? Live in peace.

05 ELECTRICALS

THE PERFECT



STILLFX © 123RF.COM

SHIELD

Shock and fire. Two hazards nobody wants at home or in the work place. The solution is safe and secure sheathing.

They tried knob-and-tube wiring in America. Became too expensive to install. They tried metal sheathing in the UK. Too corrosive. They tried wrapping copper and aluminium wires with layers of paper and a lead outer cover. They tried rubber, in one, two or three layers. Just didn't work.

Then came wiring's eureka moment, Circa 1950. PVC insulation and jackets for residential wiring. PVC/HDPE tubing for conduits. PVC wire troughs to use for trunking if many circuits are required. Single conductors with a thinner PVC sheathing and a thin nylon jacket.

Between switches, among circuit boards. Underground or above. Extension wires, power wires or lamp chords. In-, on- or behind the wall.

YOU ARE INSULATED

06 AUTOMOBILES

0-90 kmph in 3.6 seconds

PLASTIC MAKES YOU FASTER

A car buyer is a demanding fellow. He wants ergonomics and comfort. Safety innovation. The car must have a long life. It must be fuel-efficient and environment-friendly. There must be plug-in innovations for navigation, speech recognition and mobile internet devices. Above all, a well-styled vehicle, inside and outside. But the car can't be heavy.

The car buyer's demands are heavy. But we know the kind of car he wants. A light vehicle.

Every 10 percent reduction in vehicle weight results in 4.1 percent boost in mileage.

We have what he wants. A light vehicle fitted with plastic parts. Now switch the sweet engine on, and go attack the asphalt.

ALEXANDER SOROKOPUD © 123RF.COM

07 TEXTILES

THE FABRICS **OF OUR LIVES**

Plastics are used in equipment throughout the manufacturing process for textiles. For instance, conversion of fibre into yarn, fabric and then textiles.

Not that long ago, people stuck to wool, cashmere, cotton, silk, linen and hemp.
Natural fibres.
But look at your clothing labels today. You are likely to find materials like rayon, polyester, acrylic, acetate and nylon. And your shirts and slacks may be treated to be wrinkle-free or stain-resistant.

Technological advances in fabrics have made our lives simpler.

Chemically treated natural and synthetic fabrics are a source of toxins that adversely affect our health and the health of the planet. So what?

HERE'S A SHORT LIST OF FABRICS TO AVOID

1. Polyester is the worst fabric you can buy. It is made from synthetic polymers that are made from esters of dihydric alcohol and terepthalic acid. So what?

2. Acrylic fabrics are polycrylonitriles and may cause cancer, according to the US-EPA. So what?

3. Rayon is recycled wood pulp that must be treated with chemicals like caustic soda, ammonia, acetone and sulphuric acid to survive regular washing and wearing. So what?

4. Acetate and triacetate are made from wood fibres called cellulose and undergo extensive chemical processing to produce the finished product. So what?

5. Nylon is made from petroleum and is often given a permanent chemical finish that can be harmful. So what?

6. Anything static resistant, stain resistant, permanent press, wrinkle-free, stain proof or moth repellant. Many of the stain resistant and wrinkle-free fabrics are treated with perfluorinated chemicals (PFCs), like Teflon.

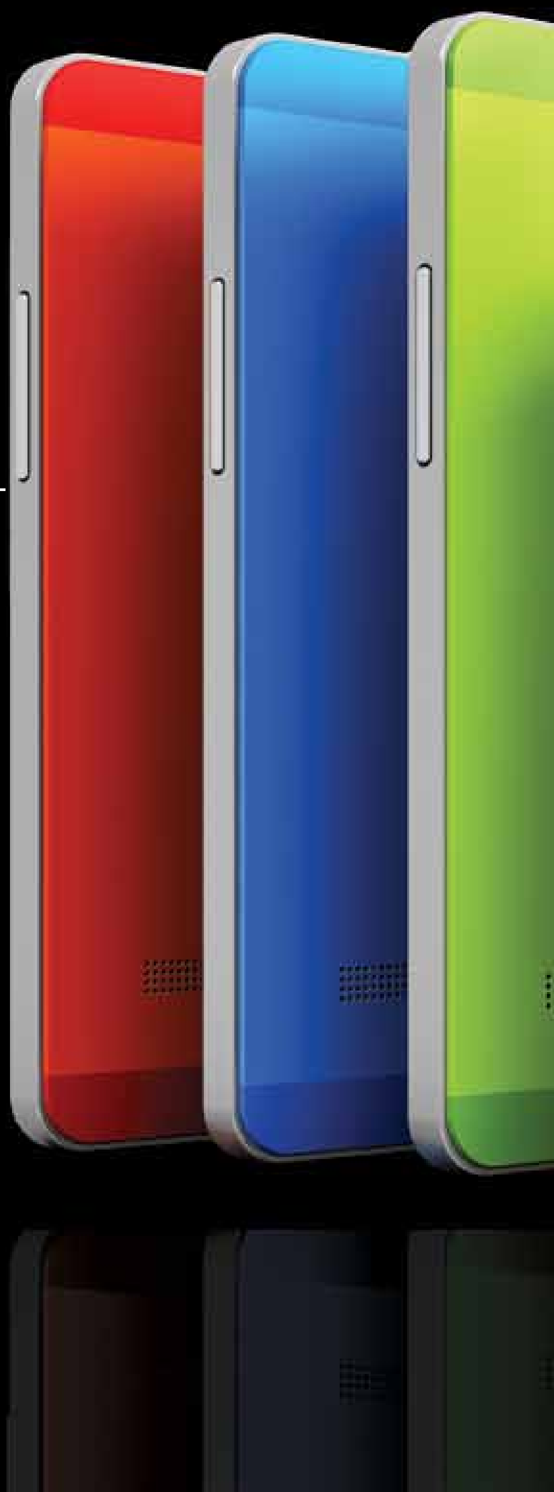
So what? These are the fabrics of our lives

LUKAS JONAITIS/SHUTTERSTOCK.COM

08 Electronics

PING TO YOO TOO

Netflixing? Surfing on your cellphone?
Thank ABS-ASA-SAN, Polypropylene,
Polystyrene, polycarbonates and Polyurethane.



Asia-Pacific was the fastest growing market for electronics goods using plastics in 2016 and is expected to grow at a Compound Annual Growth Rate of 6.2 percent from 2017 to 2025. The presence of consumer electronics makers and users across China, India, Japan, Korea and Taiwan has resulted in a high demand for plastics.

The same industry in Brazil, Argentina, Venezuela and Peru is expected to grow at a Compound Annual Growth Rate of 5.8 percent from 2017 to 2025.

You have tried and tested brown goods. Modern VCRs, CD players, DVD systems, Personal Computers and TV sets today are stylish, thanks to the design freedom granted by plastics.

The global electronics & consumer goods plastics market size was estimated at US $32.78 billion in 2016.

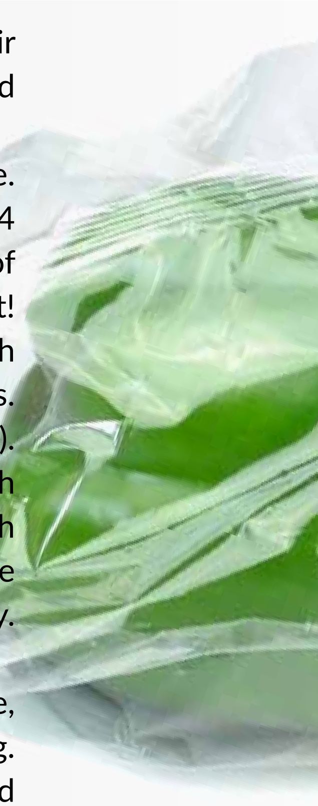
Favourable demographics. Growing middle-class affluence. Rapidly transforming lifestyles. These are positive and promising global cues for the plastics-using electronics industry.

SCANRAIL © 123RF.COM

A POSITIVE AND PROMISING FUTURE BECKONS

09 Packaging

PS: EAT



Packaging plastics are the world's best multi-tasker. But their aim is just one: to protect the valuable customer, his things and his needs, always.

Plastics are THE best for packaging. Energy-efficient to make. So light and usable. Just a kilogram of plastics can deliver 54 litres of a beverage. You'd need 1.3 kg of aluminum, 3.6 kg of steel, or over 18 kg of glass to bring home the same amount! Think bottles for milk, water, juice, cosmetics, shampoo, dish and laundry detergents. Bags for shopping. Cereal box liners. Think longer shelf life. Think HDPE (High-density polyethylene). Caress dry cleaning bags, bags for bread, frozen foods, fresh produce, and domestic garbage. Caress shrink wrap and stretch film. Or, coatings for paper milk cartons and hot and cold beverage cups. Container lids. Squeezable bottles of mustard and honey. Caress LDPE (Low-density polyethylene): be caressed.

Hold in your hand plastic bottles for soft drinks, water, juice, sports drinks, beer, mouthwash, ketchup and salad dressing. Hold comfortably food jars for peanut butter, jelly, jam and pickles. Ovenable film and microwavable food trays. Hold PET. This PET will take hold of you.

Where would food service be without PS? Cups, plates, bowls, cutlery, hinged takeout containers (for clamshells or biryani), meat and poultry trays, and rigid food containers for, say, yoghurt. Foamed or non-foamed, PS makes it possible. PS: eat heartily.

HEARTILY

EASE, CLING WRAPPED

MISTAC © 123RF.COM

Packaging plastics are THE best.

Made only for your convenience. Hassle-free: use and just throw.

10 AVIATION

BIGGEST BIRDS 2.0

The biggest bird in the sky has developed a yen for plastics.

In aviation, composite materials (plastics + something else) are being widely developed and used. Combining materials can generate superior results by exploiting the best characteristics of each material; for example, metal and plastic are often combined to give increased sturdiness and strength at a very light weight.

An excellent example of where plastics are making a difference is the Boeing Dreamliner. Another is the Airbus A380. Both show marked improvements in both passenger comfort and environmental performance, enabled by the use of high performance plastics. Roughly half of the Dreamliner and 25 percent of the A380 consist of glass-, carbon- or quartz-reinforced resins, so-called plastic composites.

Advanced composite components in planes make for a significant improvement in the ecological impact of flying. The new composites are flexible enough to withstand sustained vibration.

FLY LIGHT

Rigid and strong enough to support structures and cargo. Light enough to provide optimal operation and fuel savings.

They are also resistant to corrosion, chemicals, smoke and fire — the core of safe and optimal aerospace applications.

The Dreamliner, for example, will be 20 percent lighter than a comparable plane of this size, reducing fuel consumption and greenhouse gas emissions by 20 percent. And the A380, says Airbus, will use less than 3 litres fuel per passenger per 100 km.

VLADFOTO/SHUTTERSTOCK.COM

11 SPORTS

GGOOOAAAALLL!

Perhaps you don't need plastics in sumo wrestling, but try and think of any other sports.

Remember the tennis racket Rod Laver used? Now remember the rackets Rafael Nadal used to win French Open titles. 10-0 to you too, plastics. Remember the Adidas ball of the 2010 football World Cup. Eight 3-D spherically moulded EVA and TPU panels thermally bonded together. Stable flight and a perfect grip in any weather condition.

UK-based Zotefoams could never have developed the world's lightest footwear without plastics. It developed a special foam for midsoles and insoles for trainers and football boots five times lighter than before. Now athletes can run faster due to the better energy return from their shoes. Plastics have set free the field of sports equipment design.

Plastics-made sportswear is waterproof and can be designed to minimise the wind resistance of an athlete's body. Ah, Usain Bolt. Ah, Michael Phelps. They can also be easily coloured and decorated to ease recognition by spectators and sports officials.

Plastics products facilitate the safe enjoyment of major sporting events. Comfortable, ergonomically optimal seats, to hold, say, a swinging 60,000 football fans. An overarching roof to protect spectators from the elements. Drinks and meals at half-time, or tea break

ALL CAN BE MADE POSSIBLE BY PLASTICS.

RUN WITH IT

© ADIDAS

12 CONSUMER AND HOUSEHOLD GOODS

A VILE BREAK-IN

ALEXANDRE ZVEIGER © 123RF.COM

COBALT © 123RF.COM

DENYS BELMAS © 123RF.COM

Yesterday a gang of six broke into the house of the Sharma family. They were away on vacation to Ibiza, Spain. The heinous thieves used the ground-floor glass windows and tore down the blinds, despite the fact that blinds use a tilt mechanism that adopts POM on account of its mechanical strength and excellent anti-wear properties. They created mayhem.

Here is an incomplete list of the items stolen:

- 3 lighting stands, which use plastics headed by PMMA (for design freedom), and including PC and PS (transparent and easily colored, light stable, and durable). They even took the PBT-made base and the PVC-sheathed cord.
- 2 TVs, mainly made of PP, PS and ABS (large components). Engineering plastics headed by POM play an active role in internal mechanical components. Rapidly growing liquid crystal displays (LCDs) use Plastics in their orientation films, PVA in their polarisation films and MMA in their light-guide panels.
- 1 dishwasher, made of PP (compact design) and POM (proper sealing)
- 1 microwave oven, which uses PP, PET and AS (heat resistance and transparency).
- 1 each toaster and rice-cooker molded from (highly heat-resistant) PF.

Further, following household items were desecrated:

- 2 ACs, found hanging half out of their cabinets made of PP, PS and ABS.
- All the sofas were slashed, the urethane foam spilling, the PVC leather cover lacerated.
- 3 frypans, 2 kettles and sundry pots, made of PF plastic, littered the kitchen.
- 1 refrigerator, door broken, its PS and PP inner lining torn.
- 3 water taps, made of POM (mechanical parts) and plated ABS and PP, left open.
- Pudding, margarine, yoghurt, ice-cream containers, made of PS and PP, smashed.
- 3 lunchboxes and spoons made of PP, PS, PC and PE strewn around.

[This advertorial is sponsored by Ubiquitous Security Pvt Ltd]

PRECOCIOUS POLYMERS

PLASTICS 101

Plastic is a word that originally meant 'pliable and easily shaped'. Now it has become a name for a category of materials called polymers. The word polymer means 'of many parts', and polymers are long chains of molecules. Polymers abound in nature. Cellulose, the material that makes up the cell walls of plants, is a very common natural polymer. But the term 'plastic' is used for human-made, synthetic polymers.

Synthetic polymers are made up of long chains of atoms, arranged in repeating units, often much longer than those found in nature. It is the length of these chains, and the patterns in which they are arrayed, that make polymers strong, lightweight and flexible. Very, very durable.

AT THE REFINERY

Crude oil contains the hydrocarbons that make up plastics monomers (one molecule; the building block of polymers). The hydrocarbon raw materials are obtained from the 'cracking process' used to refine oil and natural gas. Once various hydrocarbons are obtained from cracking, they are chemically processed to make hydrocarbon monomers and other carbon monomers (like ethylene, propylene, styrene, vinyl chloride) used in plastics. All this happens in refineries.

Producing and refining monomers uses a lot of energy. Much of this energy is generated at the production site (refineries) by burning some of the feedstock of natural gas or crude oil. Therefore, producing plastics uses nonrenewable resources.

For example, producing one kg of ethylene consumes at least 20 megajoules (MJ) of energy. 20 MJ would run a 100-watt light bulb for 56 hours. It is a question of resource-use choice.

AT THE RESIN PRODUCER

Next, the monomers are sent to resin producers. They carry out polymerisation reactions in large polymerisation plants. The reactions produce polymer resins, which are collected and further processed. Processing includes the use of chemical compounds called additives (heat

From manufacture through popular use to post-use, the shadow of hazard looms over plastics

stabilizers, UV stabilizers, plasticizers, processing aids, impact modifiers, thermal modifiers, fillers, flame retardants, biocides, blowing agents and smoke suppressors, and, optionally, pigments). These chemicals enhance the qualities of the polymers. The final polymer resins are usually in the form of powders, liquids or pellets or beads.

The powder, liquids and pellets are then transported, across land and across the seas, to plastics manufacturing plants.

Mysteriously, pellets have been found in all the oceans of the world. How did these pesky pellets miss the manufacturing plant? The best guess is an accident that causes pellets containers to spill from a truck and burst open, or a storm at sea that dislodges a pellets container from a ship and hurls it into water. Nobody really knows.

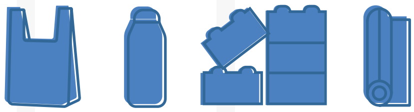
AT THE MANUFACTURING PLANT

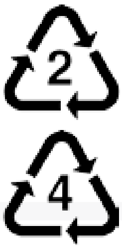
Plastics processing is divided into two main classes. Thermoplastic materials are polymers that can be repeatedly softened and reshaped by applying heat and pressure. Thermoset materials undergo a chemical reaction that results in a permanent product that cannot be softened or re-shaped.

Using one of these classes of processing, the resins are formed into various products such as PVC fabrics, steering wheels, bumpers, light lenses, fuel tanks, water tanks, furniture, fixtures, foams, insulation, adhesives and sealants. Food and condiment containers, water and juice bottles, plates, pails, jugs, mugs.

Plastics processing is a hot process. It involves the conversion of resin to a soft state through heat and pressure. Several methods are used to form resin into the final product. The main methods are injection moulding, extrusion, blow moulding, calendering and compression moulding.

POLYETHYLENE (PE)





TYPICAL USES: Packaging. Plastic bags, bottles, containers.

Commonly known as polythene. Discovered by accident in 1898 by German chemist Hans Von Pechmann, PE's industrially applicable synthesis was found by Eric Fawcett and Reginald Gibson at the Imperial Chemical Industries works, England, in 1933. Again, by accident. The breakthrough came when, in 1951 and 1953, chemical engineers came up with additives that enabled commercial production.

PE is synthetic plastic number one. The annual global production is around 80 million tonnes.

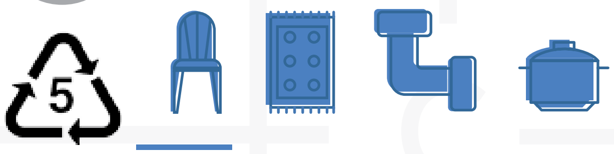
POLYVINYL CHLORIDE (PVC)

TYPICAL USES: Food packaging, plastic wrap, containers for toiletries, cosmetics, crib bumpers, floor tiles, pacifiers, shower curtains, toys, water pipes, garden hoses, auto upholstery, inflatable swimming pools and medical equipment such as urine collectors, catheters and heart-lung bypass sets, and tubing for giving and taking blood.

This polymer is also called vinyl. It is the world's third most-produced synthetic, or human-made, polymer. 57 percent of its mass is chlorine. It takes two forms: rigid and flexible. The hard form is used to make pipes, flooring, doors and windows, as well as bottles and bank cards. The more pliable form is used for vinyl records, plumbing, electrical wire insulation and so on. Both forms rely on additives, that can leak into the environment when a PVC-based product beings to degrade.

When degrading and breaking up into smaller particles, PVC-based products have a tendency to act like sponges for persistent organic pollutants. Caught in a landfill fire or when incinerated, PVC-based products emit dioxins that are carcinogenic in nature.

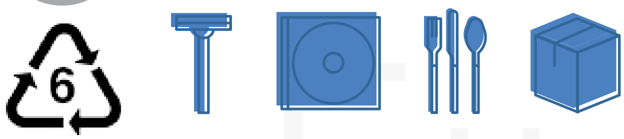
POLYPROPYLENE (PP)



TYPICAL USES: Hinges, plastic pails, car batteries, wastebaskets, pharmacy prescription bottles, cooler containers, dishes and pitchers, laboratory equipment, car parts, medical devices and in packaging and textiles.

First created by Phillips Petroleum chemical engineers J Paul Hogan and Robert Banks in 1951. Further refinement by others made possible large-scale production in 1954. PP is the world's second most-produced synthetic (human-made) polymer. In 2013, the global market for polypropylene was about 55 million tonnes. For its manufacturers, PP is expected to rake in revenue worth more than US $145 billion. For external uses, PP is typically made using UV-retardant additives. This is because PP's molecular structure begins to break up at temperatures above 100˚C.

POLYSTYRENE (PS)

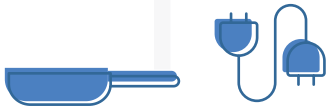


TYPICAL USES: Food containers for meats, fish, cheeses, yogurt, foam and rigid plates, bakery containers, foam packaging, CD cases, disposable cutlery, building insulation, ice buckets, paints, serving trays, throw-away hot drink cups and toys.

Commonly known by its trade name, Styrofoam. PS synthesis requires benzene, a known carcinogen, to form the monomer styrene, itself reasonably understood to be a human carcinogen. Apart from low cost, low strength foam, PS can be made as a clear, glassy, hard polymer. Properties: versatility, easily formed.

Recyclable but most polystyrene foam ends up in landfills because it is expensive to transport a product that is virtually air

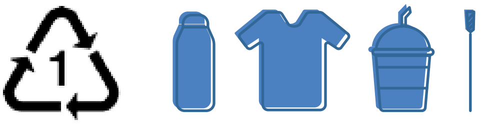
POLYTETRAFLUOROETHYLENE (PTFE)



TYPICAL USES: Non-stick coating for pans and other cookware.

This polymer is better known as Teflon. PTFE is a fluorocarbon solid, as it is a high-molecular-weight compound consisting wholly of carbon and fluorine. Accidentally discovered in 1938 by chemist Roy Plunkett while working for the company DuPont in New Jersey, USA. By 1948, DuPont was producing over two million pounds (900 tonnes) of Teflon brand PTFE per year. An early use was in the Manhattan Project as a material to coat valves and seals in pipes. In 1954, the wife of French engineer Marc Grégoire urged him to try the material he had been using on fishing tackle on her cooking pans. He subsequently created the first Teflon-coated, non-stick pans.

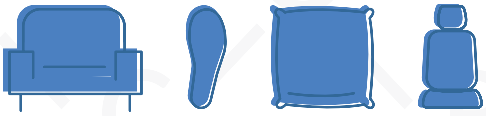
POLYETHYLENE TEREPHTHALATE (PET)



TYPICAL USES: Bottles (water, soft drink, juice, beer, wine, mouthwash, salad dressing); jam jars; oven-ready and microwaveable meal trays; and detergent and cleaner containers. Also used in liquid crystal displays, insulating tapes.
PET fabric (polyester) is commonly used in textiles, padding and insulation (for pillows, comforters and upholstery), and carpets, tyre reinforcements, conveyor belts and tarpaulins, drinking glasses, coffee stirrers, chewing gum.

PET is the most well-known in the polyester family of synthetic polymers. It initially gained widespread use as a wrinkle-free fibre, commonly called 'polyester'; most PET production is still geared to textile-making. It has also become synonymous with food and drink packaging. This is because PET has a strong ability to create a liquid and gas barrier (so, oxygen cannot get in to spoil food, and carbon dioxide that makes drinks fizzy cannot get out).
PET bottle use has spiralled out of control. Humans use one million PET bottles a minute, worldwide. Such demand, is equivalent to about 20,000 bottles being bought every second. Demand will grow 20 percent more by 2021.

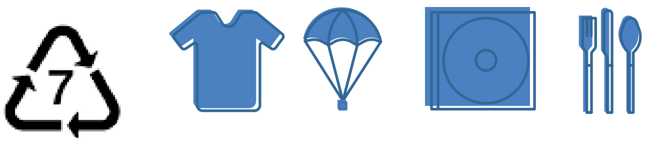
POLYURETHANE (PU, PUR)



TYPICAL USES: Cushions, mattresses, pillows, car and truck seats, upholstery fabrics in commercial and domestic furniture, foams inside refrigerators and freezers, and between walls of houses. Brassiere cups. Mouldings, including door frames, columns, balusters and window headers.

Otto Bayer and his coworkers at IG Farben company first synthesized polyurethane in Leverkusen, Germany, in 1937. Polyurethane formulations cover an extremely wide range of stiffness, hardness, and densities. This dictates the nature of the product it is used to make.

POLYAMIDES (NYLON)



TYPICAL USES: Many food containers for meats, fish, cheeses, yogurt, foam and clear clamshell containers, foam and rigid plates, clear bakery containers, packaging peanuts, foam packaging, audio cassette housings, CD cases, disposable cutlery, building insulation, flotation devices, ice buckets, wall tiles, paints, serving trays, throw-away hot drink cups, and toys.

Nylon is how polyamides are better known. First synthesized in 1935 by Wallace Hume Carothers after five years of research, Nylon was the first commercially successful synthetic thermoplastic polymer. As one of the largest engineering polymer families, the global demand of nylon resins and compounds was valued at roughly US $20.5 billion in 2013. The market is expected to reach US $30 billion by 2020, at an average annual growth of 5.5 percent.

Nylon is a thermoplastic silky material. It has always been linked to fashion, celebrities and culture

AN OPEN DEBATE

The use of plastic products has seen a steady rise over the past 50 years. And from time to time, a debate breaks out: how safe are these products for the people that use them? How exposed are humans?

The axis of the debate is a word: leaching. It is said that chemicals used to make plastics products somehow manage to find their way into the material the product contains, thus contaminating the material.

The focus of the debate is water or juices in bottles; milk and milk powder in cartons; meat, fruits and vegetables wrapped in film; nylon- and rayon-based fabrics or clothing, and so on. In short, food and other everyday life objects, such as floor lining, insulation, carpets, doors and windows.

Animal studies provide conclusive evidence of exposure to chemicals leached from plastics in-use products. But they are not enough. And human trials cannot be done

A SUB-DEBATE

Studies in Canada, France, Egypt and Taiwan have pointed out the dangers workers face in plastics processing, whether it is pellet-making, resin making or end-product manufacturing. Findings range from eye and skin irritation and influenza-like fevers that come and go suddenly to increased risk of breast cancer, among both men and women workers, due to consistent exposure to emissions and resin dust emanating when plastics are processed. As of now, the findings are consistent but the state of the research is too meagre to reach conclusions with certainty. For instance, while scientists are aware that such exposure is not to a single chemical compound, but a mixture, they are unable to pinpoint the many-sided nature of the exposure and its true effects. Here, too, lack of human trials is a big obstacle.

TWO KNOWN 'VILLAINS'

Additives are a focal point of the debate. When scientists talk about chemicals 'leaching' from a plastic wrap into the food it is wrapped around, or from a milk carton into milk, or from a PET bottle into the water it contains, what they mean is the leakage of additives from the finished, marketed and used product.

Says a report of the World Economic Forum, "The 150 million tonnes of plastics currently in the ocean include roughly 23 million tonnes of additives, of which some raise concern. While the speed at which these additives leach out of the plastic into the environment is still subject of debate, estimates suggest that about 225,000 tonnes of such additives could be released into the ocean. This number could increase to 1.2 million tonnes per year by 2050!"

There is scientific consensus that phthalates — perhaps the most widely used set of chemical compounds in making plastics products — cause endocrine disruption, asthma, growth and reproductive effects. Effects also include birth defects, hormonal changes, declining sperm counts, infertility, endometriosis and immune system impairment. Most of the consensus is based on animal trials. However, lack of human trials — a no-no in most countries — clouds the consensus.

Then there is the monomer bisphenol A (BPA). The primary concerns regarding BPA is that it has estrogenic activity (EA). In other words, it mimics the hormone estrogen in the body. Chemicals with EA have been linked to all kinds of health problems. These include early puberty in females, reduced sperm counts, altered functions of reproductive organs, obesity, altered sex-specific behaviours, as well as increased rates of some breast and ovarian cancers in women and testicular and prostate cancers in men.

BPA has been controversial enough for regulators (in Canada, in the EU and in many US states) to ban its use as an additive in baby bottles for children under age three. Nevertheless, it continues to be used in other products.

In sum, the jury is still out on how and to what extent plastics products are unsafe for humans.


SINGLE
USE
MULTIPLE
HARM

POLYMER GLUT

Earth's oceans are full of plastics debris. Researchers found that 4.8 to 12.7 million tonnes of plastics entered the oceans in 2010. All plastics are used on land. How did it swamp the oceans?

Oceans receive land-based plastics debris: flying from street litter into a stormwater drain, dumped into a sewage drain, flowing into a river and then to the seas. Or, people come for a picnic on a beach and leave behind bottles, meal trays, beach toys and more, which get carried out to sea by tides.

Oceans receive sea-based plastics debris: Fishing lines, nets and ropes, floats and bait packaging material, those lost accidentally or dumped deliberately. Garbage from boats, cruise boats and ships, such as food and beverage packaging, bottles of water or toiletries.

Oceans also receive plastics pellets and plastics resin beads or nurdles (these are raw materials for making plastics products, sent from a petroleum or a natural gas refinery to a plastics manufacturer).

The highly buoyant nature of most plastics ensures these travel along with ocean currents for thousands of miles. Plastics are a trans-boundary pollutant.

ALDARINHO/SHUTTERSTOCK.COM

OMNIPRESENT

RICH CAREY/SHUTTERSTOCK.COM

Plastics products are not bio-degradable. But under stress, say heat or sunlight, they keep disintegrating over time into smaller and smaller particles. They can reach a size >5mm, becoming microparticles. They keep breaking up, even becoming nanoparticles.

In a marine environment, the physical forces that cause such disintegration are winds, waves and ultraviolet radiation (from sunlight).

In all this, the chemicals used to make them persist, even in microparticle and nanoparticle forms. Also, these particles, because of their chemical content, attract persistant organic pollutants (pesticide residue, for example). Since such residues exist in the ocean, a plastic product, breaking up, becomes even more toxic.

Species living there are affected.

For example, in the north-eastern Pacific and close to the coast of British Columbia (Canada), concentrations of microplastics in seawater sampled from a depth of 4.5 metres ranged from 8 to 9,180 items per cubic metre. Microplastics were also detected in deep sea sediments, e.g. in the northeast North Atlantic and southwest Indian Ocean and in the Mediterranean Sea at water depths between 300 metres and 3,500 metres below sea level.

Seabirds and fish mistake these toxic globules for food and gobble them up. As do sea turtles.

Over 90 percent of seabirds' stomachs contain plastics. A study of six species of fish in the North Pacific gyre found that 35 percent had at least two kinds of plastic particles in their gut. Most of the ingested plastics were fragments (94 percent) and had a size of 1.0–2.8 mm.

At least 267 species worldwide, including 44 percent of all seabirds, 43 percent of all marine mammals, 86 percent of all turtles as well as fish species were affected by marine debris.

Even plankton, one of the tiniest creatures in our oceans, are eating microplastics and absorbing their toxins. The substance displaces nutritive algae that creatures up the food chain require.

Millions of tonnes of plastics reach the oceans, yet researchers are finding only between 6,350 and 245,000 tonnes floating on the surface — a mere fraction of the total. This discrepancy is the subject of ongoing research. Says the co-author of the 2015 study Kara Lavender Law: 'Right now, we're mainly measuring plastic that floats. There is a lot of plastic sitting on the bottom of the ocean.'

A TALE OF TWO GYRES

At the centre of the Pacific Ocean in a windless, fishless oceanic desert twice the size of Texas, a swirling mass of plastic waste converges into a gyre containing an estimated six pounds of plastics trash for every pound of plankton. It is called the Great Pacific Garbage Patch. In 1997, Charles J. Moore was returning home after competing in the Transpacific Yacht Race. He came upon this enormous stretch of floating debris.

In 2015, a mega-expedition — 30 vessels simultaneously — crossed the Great Pacific Garbage Patch and collected 1.2 million plastic samples. Researchers say the problem is getting worse. They found about 16 times more waste than previously thought floating there. The mass of waste spans 1.6 million sq. km, about three times the size of France.

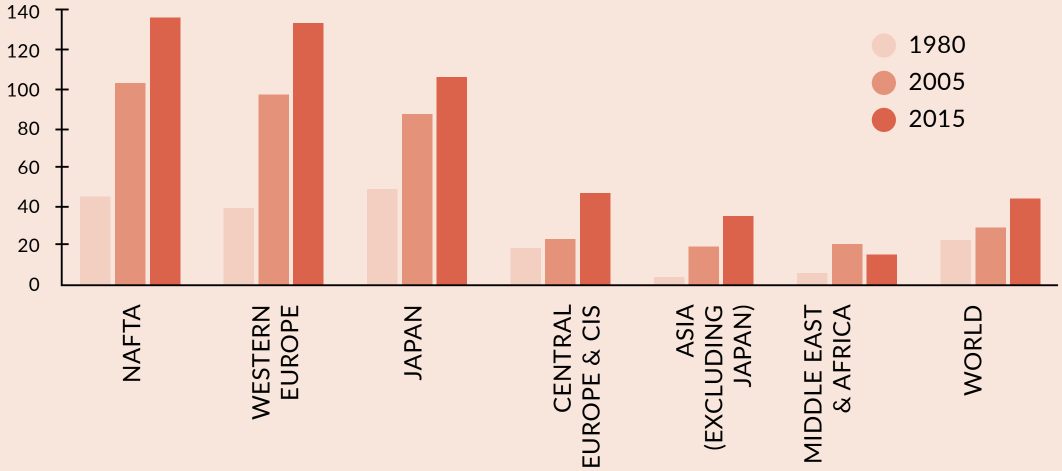
Billions of bits of plastic are also accumulating in a massive garbage patch in the Atlantic Ocean. Tiny pieces of trash, each less than a tenth the weight of a paper clip, make up most of the debris. Plastics can circulate in this part of the Atlantic Ocean for years, posing health risks to fish, seabirds, and other marine animals that accidentally eat the litter. In some places, researchers found more than 200,000 bits of trash per sq. km.

NO PLASTIC WASTE IN MY BACKYARD

How are rivers in the not-Western world so choked? How are five Asian countries held most responsible for plastics in the oceans?

Global Consumption of Plastics Material by Region

(1980-2015) (in kg/ per person) *Source: Plastics Insight*

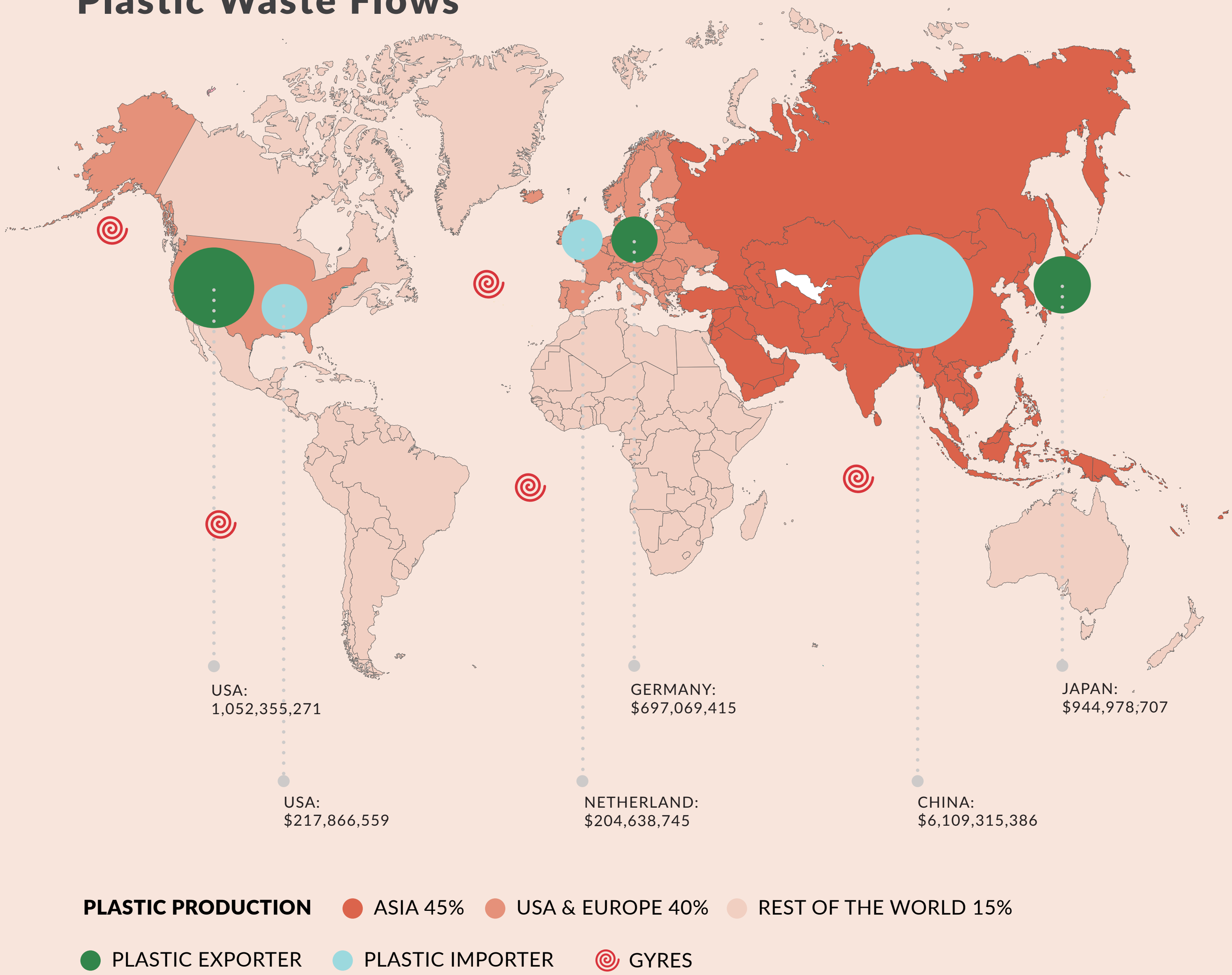


Five Worst Marine-littering Countries

As much as 95 percent of the plastic waste that enters oceans via rivers is carried by just 10 waterways, according to a study by Helmholtz-Centre for Environmental Research. Two are in Africa; eight in Asia.

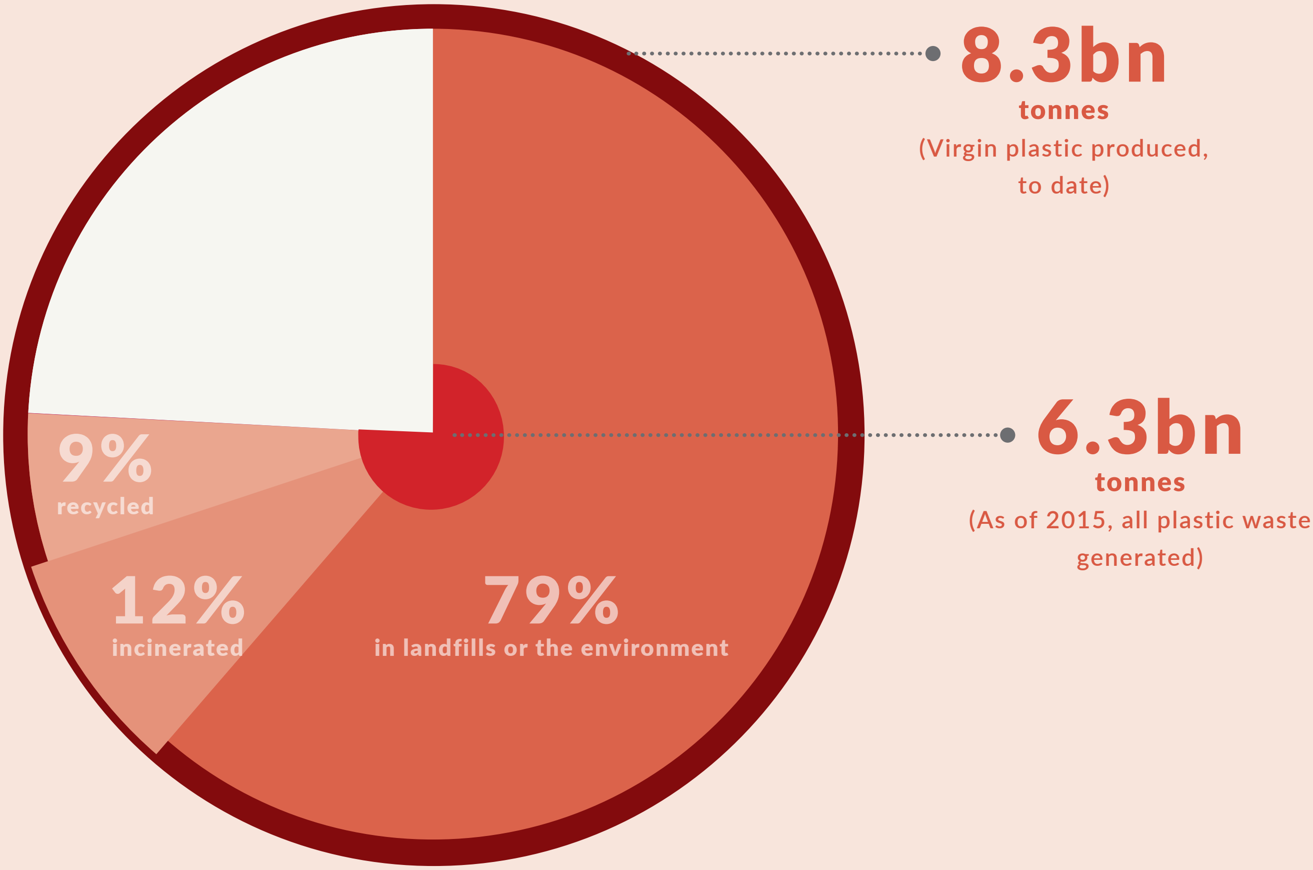
This is very puzzling. Per capita consumption in Asia and Africa is far lower than that in the western world: The NAFTA region rules, at 139 kg per person per annum. Western Europe follows, at 136 kg. Africa's consumption is just 16 kg per person.

Plastic Waste Flows



The Western world has efficient systems to collect post-use plastics. They do that, and export a considerable portion to Asian countries. Is it possible the trash that flows down these rivers are not home-used, but trash from outside? They collect, minimally segregate and export it off their shore. China, enraged by the mixed plastics its biggest clients USA and the EU were sending, called for a ban on importing plastics scrap. It is now in place. The Western world said: what are we going to do?

A WORLD LAID WASTE



There is a plastics waste skew between the North and the South. The North is externalising its plastic waste. The South internalises it.

Given challenging regulatory regimes, informal arrangements, trash leaks. Asia faces a double burden: take care of plastics trash internally generated; at the same time, assuage the conscience of the West. What a way to manage plastics waste, globally.

Especially if most of the sent stuff is single-use plastics.

8 REASONS TO REFUSE SINGLE USE PLASTICS

Since the late 1970s, single-use plastics have become the vanguard of plastics production. The global growth of the packaging segment of plastics production is proof. The emergence of supermarkets, first in the West and then in the Rest, was a primary incentive. Today, single-use plastics have cling-wrapped, meal-trayed the world. It is now a throwaway pandemic.

The time has come to say: NO. If not now, then when?

HERE TO STAY FOREVER

Single-use plastic items are not like a fallen leaf. They are not-bio-degradable. They do not vanish from the face of the Earth. For example, it takes 500, or more, years for a plastic bag in a landfill to completely break down.

TOXIC FOOTPRINT

Thrown away, single-use plastics items begin to break down into smaller particles, becoming tinier over time, becoming microplastics (less than 5mm) and even more miniscule. Whatever the size, the chemical ingredients used to make the items remain in these particles. These ingredients are toxic. Thus, microplastics become carriers of the chemicals. They can roll, fly, float…litter streets, block storm drains… make their way, via rivers, to the ocean…go anywhere. And take the toxic chemicals with them.

Moreover, microplastics are known to act as sponges, attracting and absorbing persistent organic pollutants. They may be tiny, but they sure pack a poisonous punch!

A WASTE OF ENERGY

The raw material used to make single-use plastics items is petroleum or natural gas. Both are finite resources, and finite sources of energy.

For example, 14 plastics bags are the equivalent of fuel used to drive 1.2 kilometres.

The Pacific Institute estimates that producing bottles US consumers needed in 2006 needed the equivalent of 17 million barrels of oil.

So when these items are thrown away, they represent sheer energy loss.

BAD ECONOMICS

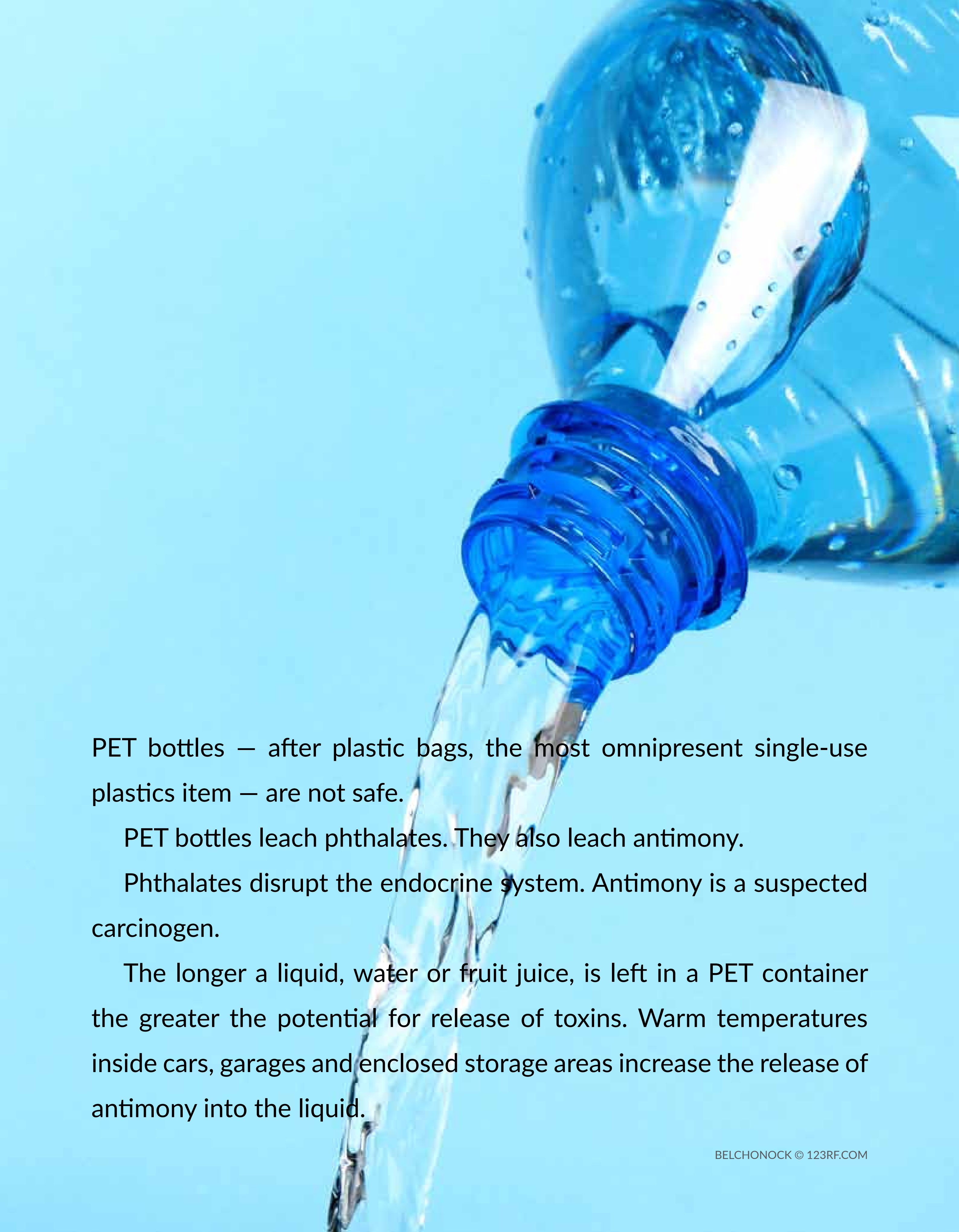
Plastics have turned out to be the greatest engine for economic growth, making cheap mass production possible, seemingly delivering a better quality of life. A careful look debunks such mythology. Total plastic production doubled in the last 50 years, but the next doubling will occur in just the next 20 years. More than 90 percent of all plastics use oil as feedstock, currently 5 percent of total oil consumption. Current growth trend shows the industry will use 20 percent of total oil consumption by 2050. For energy economists, unacceptable.

The crisis turns acute for single-use plastics, largely used for packaging, almost 26 percent of plastics produced. 95 percent of packaging plastic, after a ridiculously short use, gets lost to the economy, a loss valued at US $80-120 billion annually. That's bad economics.

It gets worse. 32 percent of single-use plastics escapes the collection system, clogs urban infrastructure and ends up in the oceans, disrupting a valuable natural production system. UNEP has modestly valued these externalities at US $40 billion annually. The World Economic Forum suggests this hidden cost surpasses plastics packaging industry's profit.

JIRI VACLAVEK © 123RF.COM

FRESHLY EXPOSED



PET bottles — after plastic bags, the most omnipresent single-use plastics item — are not safe.

PET bottles leach phthalates. They also leach antimony.

Phthalates disrupt the endocrine system. Antimony is a suspected carcinogen.

The longer a liquid, water or fruit juice, is left in a PET container the greater the potential for release of toxins. Warm temperatures inside cars, garages and enclosed storage areas increase the release of antimony into the liquid.

BELCHONOCK © 123RF.COM

OCEAN OF DEBRIS

In 2014, the Ocean Conservancy carried out an International Coastal Cleanup, combing beaches. Their data shows that plastic drinks bottles, food wrappers, bottle caps, straws and stirrers, plastic bags and plastic lids are amongst the top ten most common items collected. All single-use plastics.

In 2015, 1,024,470 plastic bottles were collected in beach clean-ups across the globe.

Winds, waves and ultraviolet radiation disintegrate larger plastics. Microplastics are now the scourge of the oceans.

At least 267 species worldwide, including 44 percent of all seabirds, 43 percent of all marine mammals, 86 percent of all turtles as well as fish species are affected by marine litter.

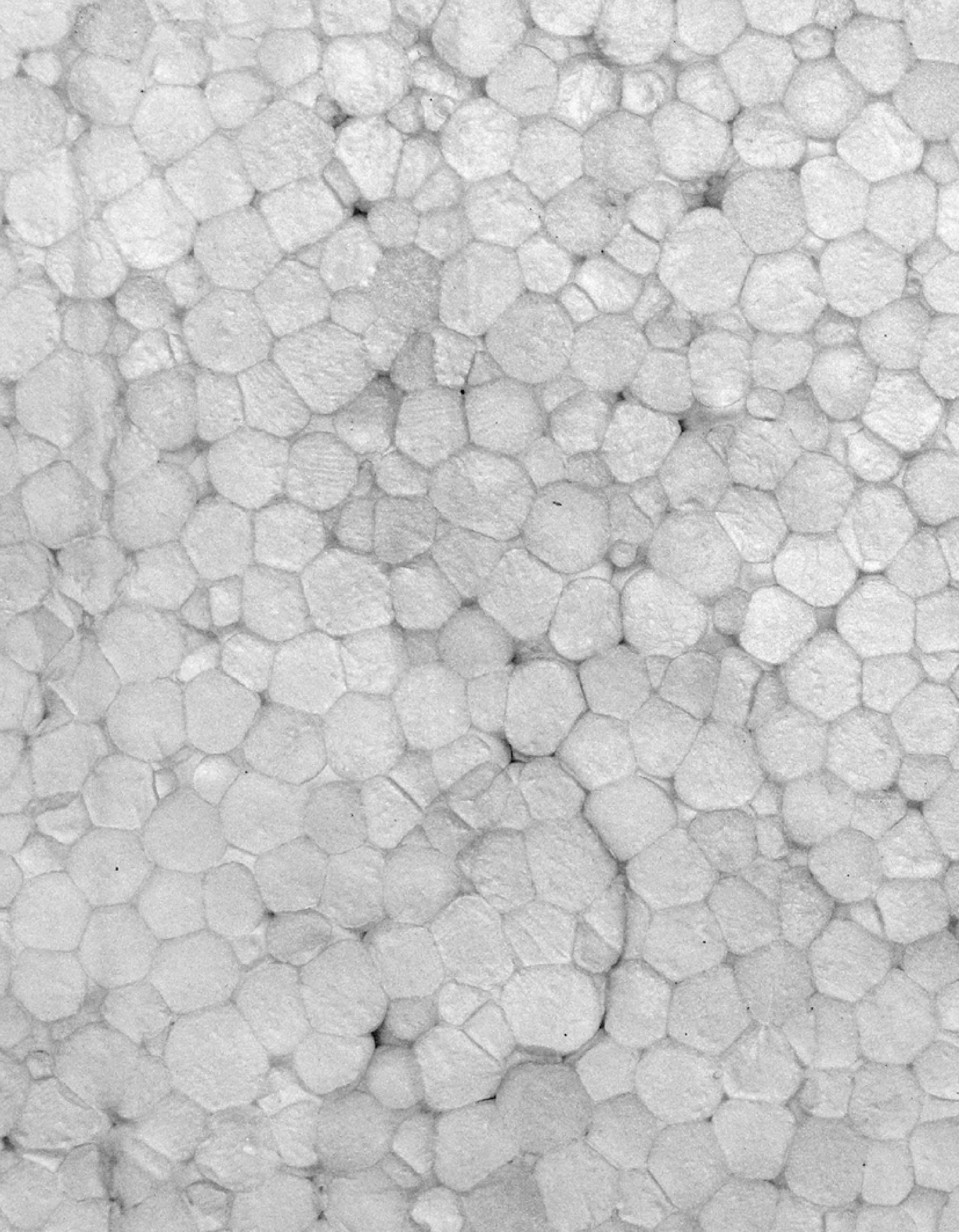
RICHARD WHITCOMBE © 123RF.COM


PAUL HAKIMATA © 123RF.COM


LESS THAN 1%
OF ALL
SINGLE USE PLASTICS
ITEMS ARE
RECYCLED

Single-use plastic items are a good reminder of a use-and-throw way of life. A just-junk-it style of living, in a world of short-term convenience.

THROWAWAY
WORLD



PLASTICS

A POST-PLASTICS ODYSSEY

Let us agree, at the outset, that it is not possible to ban all plastics. There are areas where plastics are indispensable, such as the medical industry. Sure, we are surrounded by door hinges, hypodermic syringes, shower curtains, urine collectors, jam jars, meal trays, ice buckets, wall tiles, toys, pacifiers, tongs, pails, bins, bottles and mouldings. Irremediably, we are moulded.

Or, are we? The industry's agenda is very simple. Another variation, another resin, another application, another barrel of crude oil, more pellets or nurdles, another product, another avenue of profit. The 'ban plastics' slogan, just by comparison, is too vague. Sincere, civil, morally appropriate, but just vague.

The 'say no to plastics' slogan is somewhat better, for it has an actionable intent. It is, indeed, possible to live without many of the plastics objects we are immured in. Yes, it will require an effort to revert to a glass bottle, or a stainless steel container, but it's very doable. Yet, this approach is designed keeping middle-class individuals, neighbourhoods and communities in mind. What about someone who can't afford aluminium water bottles, or if given one, might be more interested in selling it than using it? More importantly, it's too focused on use (reducing it) in the present and future, whereas the real crisis has to do with historical post-use. The approach is necessary, but not sufficient.

It is possible the problem with plastics begins with their very production. The products we see, and avidly buy, every day. People, ever since the 1950s, have taken to plastics like ducks to water. If we talk about the 'plastics problem', we must understand the nature of consumer choice. Plastics are accepted in human society because all of us, first in the West, and then in the Rest, gladly bought containers. That was just the beginning. Was it a bad choice? No. It just happened. Is it a good choice? We still don't know.

Plastics may or may not be used now and in the future, but the past cannot be avoided, or wished away. For the plastics problem is no longer restricted to a household, neighbourhood, town or city or country: it is a globalised menace. For the time has far gone to be light-weight, like the plastics that surround us. Like the plastics polymers, we must be durable. And versatile.

The way to a cleaner future cannot be paved with plastic intention

VIKENTIY ELIZAROV/SHUTTERSTOCK.COM

A RE-THINK, TO BEGIN WITH

It has now become clear that producing and using plastic — especially in single-use form, such as packaging material — and taking away market share from more recyclable and reusable packaging is a bad idea from an ecological point-of-view. So why is the plastic packaging business growing?

One big reason, says the 1996 Berkeley Plastics Task Force report, is that popular misconceptions about plastics production and reprocessing contribute to the growth of the organic chemistry-industrial complex. Here are some such misconceptions:

Misconception # 1: Plastics that go into a curbside recycling bin get recycled.

Not necessarily. Many plastics are unrecyclable, and the recyclable ones must be separated out. The rest go to waste.

For instance, collecting single-use plastics such as PET bottles, coffee cups and stirrers and plastic packaging at curbside fosters the (false) belief that, like aluminum and glass, the recovered material is converted into new packaging. In fact, most recovered plastic packaging is not made into packaging again but into new secondary products such as textiles, parking lot bumpers, or plastic lumber—all unrecyclable products. This does not reduce the use of virgin materials in plastic packaging: manufacturers in the organic chemistry-industrial complex prefer the pellets and nurdles the petrochemical refineries send them.

So there must be a way for municipalities to explain the truth about curbside recycling. And people to realize that merely junking single-use plastics does not make the problem go away. The crucial question here is: How is the collected material to be handled after being picked up? A neighbourhood or community may adopt a collection programmes, only to find there is no reasonable market for the collected material, or that they must incur additional costs to clean and separate it to market specifications. Please be clear: 'Recycled' in such cases merely means 'collected', not reprocessed or converted into useful products.

Misconception # 2: Curbside collection will reduce the amount of plastic landfilled.

Not necessarily. If establishing collection makes single-use plastics products such as packaging seem more environmental-friendly, people may feel comfortable buying more. Curbside plastic collection programmes, intended to reduce municipal plastic waste, might backfire if total use rises faster than collection. Since only a fraction of certain types of plastic can realistically be captured by a curbside programme, the net impact of initiating curbside collection could be an increase in the amount of plastics landfilled. Furthermore, since most plastics reprocessing leads to secondary products that are not themselves recycled, this material is only temporarily diverted from landfills.

Reject all symbolism. Know that the chasing arrows symbol is a lie

Misconception # 3: A chasing arrows symbol means a plastic container is recyclable.

The arrows are meaningless.

Every plastic container is marked with the chasing arrows symbol. Many believe the symbol indicates the container is composed of recycled material. Actually, the only information in the symbol is the number inside the arrows, which indicates the general class of resin used to make the container.

The organic chemistry-industrial complex adopted this symbol in 1988 to identify the resins, at a time when legislatures were discussing bans on plastic containers (packaging). They say the symbol never intended the chasing arrows to indicate recyclability or identify recycled content, but only to be a catchy graphic to point out the number inside that identifies the type of resin. In short, the symbol is misleading

Misconception # 4: Packaging resins are made from petroleum refineries' waste.

No. People believe the raw materials for single-use products such as packaging plastics come from an otherwise useless industrial waste stream. They believe that if these plastics were not made, the raw materials would be anyway dumped into the environment as a hazardous waste. But actually, most packaging plastics are made from the same natural gas used in homes to heat water and cook.

Misconception # 5: Using plastics, especially single-use plastics, conserves energy.

Energy use studies that compare various packaging materials often do not account for the large amount of energy required to synthesize plastic resin. Most of the energy and environmental costs of plastics are hidden because they are incurred in the plastics factory.

Misconception # 6: Our choice is limited to recycling or wasting.

No. Many people take plastic packaging as a given and narrow the issue down to the simple question of how best to dispose of it. In the resulting turmoil, obvious alternatives may be overlooked, such as reducing or eliminating our consumption of plastic packaging. Simple, effective source-reduction strategies for individuals and households are: (a) using refillable containers; (b) buying in bulk; (c) selecting products that use little or no packaging; and (d) choosing packaging materials that can be recycled and are made from recycled materials such as glass, metal, and paper.

We have to stop believing in the efficacy of plastics, other than healthcare

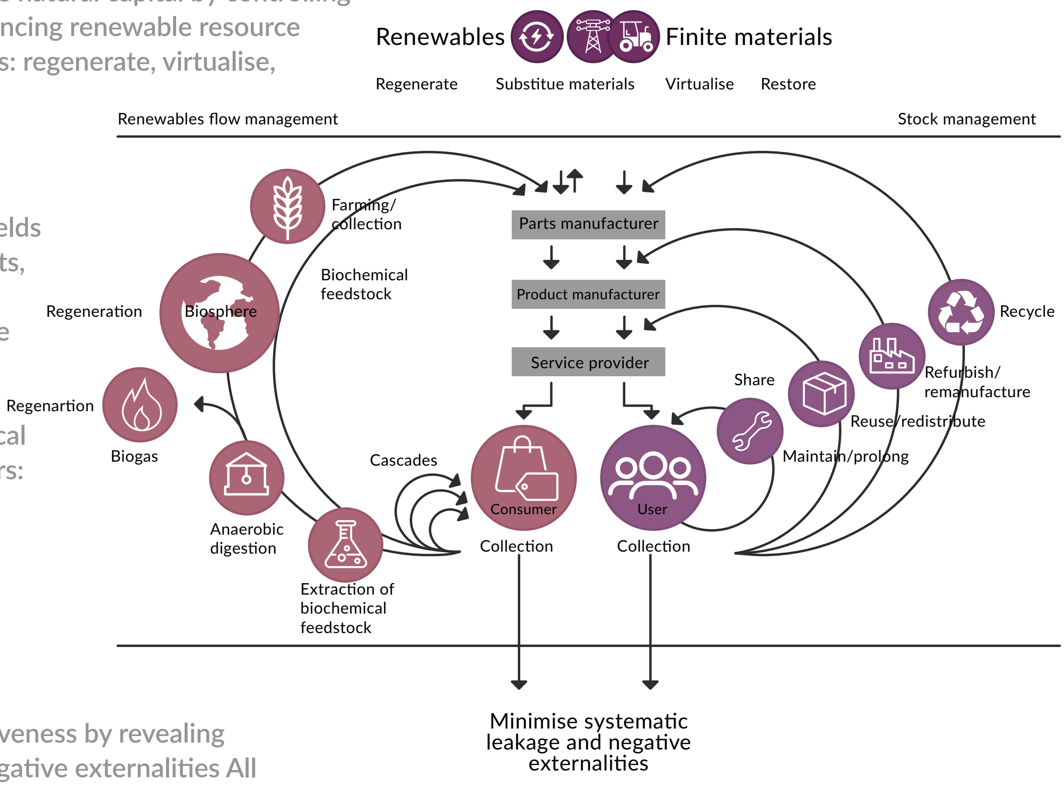
OUTLINING A CIRCULAR ECONOMY

PRINCIPLE 1

Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows ReSOLVE levers: regenerate, virtualise, exchange

PRINCIPLE 2

Optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles ReSOLVE levers: regenerate, share, optimise, loop



PRINCIPLE 3

Foster system effectiveness by revealing and designing out negative externalities All ReSOLVE levers

Source:
Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment

The time has come to hold the organic chemistry-industrial complex accountable for the material they sell. Via legislative demand. Till that doesn't happen, the conflict of interest between the convenience of throwaway containers and responsibility for long-lasting waste and environmental damage will remain.

RE-THINK

To the effective slogan 'reduce, reuse, recycle', we would like to add a proviso. First, re-think. Walk, don't run.

The International Bureau of Re-cycling, a global recycling trade association, defines 'waste' as 'the Seventh Resource'. (After water, air, oil, gas, coal and minerals) 'Waste' suggests not only useless consumption — squandering, extravagance, and indulgence — but dissipation, destruction, and death; the bureau gives it a positive connotation. Piquant. This must be done. Proviso: this might take us up the alley of re-cycling as the primary solution. Wait. Again, absolutely necessary but still not sufficient.

We invite the organic chemistry-industrial complex to take responsibility. In two ways. First, take Extended Producer Responsibility (a well-known but squeamishly applied environmental/waste management strategy designed to promote the integration of environmental costs associated with goods and products throughout their life cycle into the market price). Second, give your chemical engineers a new task: find a way or ways to disintegrate or destroy plastics such that the world doesn't choke on dioxins.

Here's a good example. An international team of scientists, reports The Guardian, have created a mutant enzyme that breaks down PET (drinks) bottles. The breakthrough could enable, for the first time, the full recycling of PET bottles.

To re-do our common future, the world must re-do its economic practices

The new research was spurred by the discovery in 2016 of the first bacterium that had naturally evolved to eat plastic at a waste dump in Japan. The scientists have now revealed the detailed structure of the crucial enzyme the microbe produced. The international team then tweaked the enzyme to see how it had evolved, but tests showed they had inadvertently made the molecule even better at breaking down the PET polymer used to make soft drink bottles. 'What actually turned out was we improved the enzyme, which was a bit of a shock,' said Prof John McGeehan, at the University of Portsmouth, UK, who led the research. 'It's great and a real finding.'

Surely the organic chemistry-industrial complex could pitch in and bolster such research? They have the money. Why not, for our children's sake, make an effort? Behind the stubbornness of a polymer lay a science focused on making it durable. Now that scientific intent has come full circle. It's time for a re-direction. Time for science, as it was in the early days of the history of plastics-making and like the products they came up with, to become versatile again.

It is also time to put a searchlight on post-use management. The ethic and practice of 'reuse' and 'recycle' aren't enough. For instance, if we don't have authentic data on single-use plastics — a scourge on land and in the oceans — how can we even begin to tackle this hydra-headed monster?

Finally, let us re-think the many rigmaroles that make our sincerity fall flat on its well-rounded face — the hesitant and incomplete legislation (regulation) that provides the organic-chemistry-industrial complex total immunity; well-meant programmes sans implementation; surveys and surveillance on plastics that cannot even stop plastic bags from littering streets.

It is doable. All we have to do is re-think the nature of the economy we would like our children to live in. This linear input-profit-output economy we live in cannot resolve the plastics problem. As long as it exists, so will the Age of Plastics. That's untenable, from a human civilizational perspective. The real imperative, then, is to jettison the heavy, toxic baggage of the present and shift to a Circular Economy.

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