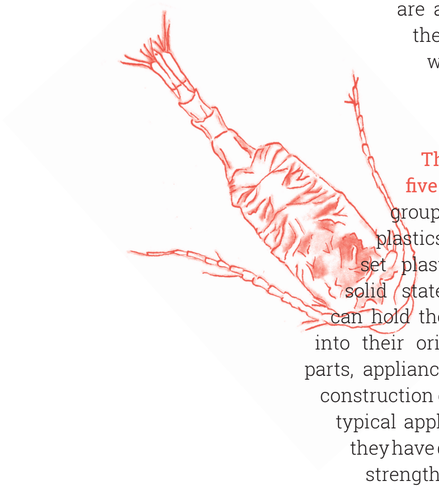
Millions of years ago, algae and zooplankton were buried under layers of sediment on the bottom of oceans and lakes. Over time, heat and pressure transformed these fossilised plants and animals into crude oil, natural gas and coal. **Extracted from the earth, these "fossil fuels" form the base materials of most plastics.** Plastics are a family of substances, from the Greek word "plastikos", a word which means able to be shaped or moulded.



There are around forty-five different plastics, broadly grouped into two types: thermoset plastics and thermoplastics. Thermoset plastics remain in a permanent solid state once they're hardened; they can hold their shape & can't be melted down into their original form. Automotive, aerospace parts, appliances, electric housings & components, construction equipment panels and insulators are typical applications of thermoset plastics, as they have good chemical & thermal stability, strength, hardness and mouldability. They're cost-effective but they can't be recycled & they are viewed as a bit old-fashioned now.

In 1846, the Swiss chemist Charles Schonbein accidentally discovered a polymer when he spilled a mixture of nitric and sulfuric acid on cotton, triggering a chemical reaction. The resultant polymer, nitrocellulose, led to the invention of celluloid in 1869. Chemist John Wesley Hyatt was inspired by a New York firm's offer of $10,000 to anyone who could find a substitute for ivory. The growing popularity of billiards had put a strain on the supply of natural ivory obtained through the slaughter of wild elephants. By treating cellulose, derived from cotton fibre, with camphor, Hyatt discovered a plastic that could be crafted into a variety of shapes. **Celluloid was praised as the saviour of the elephant and the tortoise.** Plastics were promoted as protecting the natural world from the destructive forces of human need.

In 1931, Reverend Julius Aloysius Nieuwland, a Belgian Holy Cross priest and professor of chemistry, developed a synthetic rubber called neoprene. The DuPont Corporation purchased the patent from Nieuwland, developing the material for a wide range of uses, including gaskets, hoses and adhesives. Today it is used in many domestic products, including laptop sleeves, tablet holders, mouse pads, remote controls, wetsuits & cycling chamois. Neoprene is a type of thermoset plastic.

Teflon was invented by accident in 1938 by American chemist Roy J. Plunkett who was working with refrigeration gases. On checking a frozen canister, he and his colleagues discovered that the sample had polymerised spontaneously into a waxy solid to form polytetrafluoroethylene. In 1945 DuPont registered it with the trademark Teflon. It is used in aerospace, communications, electronics, industrial processes and non-stick cookware, nail polish & stain repellents for fabrics. **Plunkett was inducted into the Plastics Hall of Fame in 1973.** His invention changed the way we cook, clean, groom & floss.

The first fully synthetic plastic was invented in 1907 when Belgian chemist Leo Hendrick Baekeland accidentally created Bakelite $(C_6H_6O.C\text{-}H_2)_x$. Baekeland was attempting to create a replacement for shellac, an expensive lacquer made from the shell of the lac beetle. Rather than a shellac-like material, he inadvertently created a polymer by combining formaldehyde with phenol, a waste product of coal, & heating the mixture. The resulting material did not melt under heat and stress. Bakelite's chemical name is polyoxybenzylmethylenglycolanhydride. **The invention of Bakelite heralded the age of plastics.** It was cheap, non-flammable and versatile. Bakelite was used for everything, from electrical & mechanical parts, to telephones, clocks, buttons and jewellery.

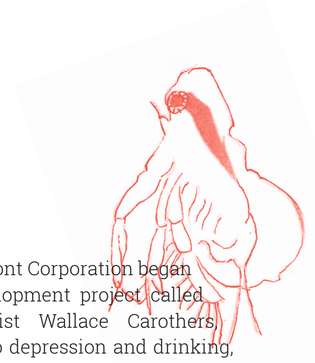
Thermoplastics can be re-melted to their original form when heated. They make up the majority of plastics that come and go in our daily lives. The funny triangles with numbers in the middle signify the type of plastic. No. 1 is PET or polyethylene tetraphthalate, a plastic used to make stuff like re-usable drink bottles & cups, salad dressing bottles, medicine jars, combs, carry bags. No. 2 is HDPE or high-density polyethylene, used to make things like milk bottles, rubbish bags, shampoo & conditioner bottles, detergent & bleach containers. No. 3, PVC or polyvinyl chloride, is a rigid plastic used for stuff like plumbing pipes and flooring, cladding, electrical cabling, blood bags, raincoats. **No. 4, LDPE or low-density polyethylene is a soft flexible plastic made into cling wrap, shopping bags, six-pack rings, squeezable condiment bottles, Ziploc bags, frozen food bags & bubble wrap.** No. 5, PP or polypropylene is a hard plastic used for takeaway containers and some yoghurt and ice-cream tubs. No. 6, PS or polystyrene is still floating around in bean-bag fill & some takeaway containers and packing foam & food boxes. No. 7 is all other plastics, including nylon & acrylic. Most thermoplastics can be either recycled or repurposed.

In 1957 chemists Alfred Fielding & Marc Chavannes were trying to create a textured wallpaper that would appeal to the Beat Generation. They put two pieces of plastic shower curtain together through a heat-sealing machine, resulting in a sheet of film with trapped air bubbles. Their bubbly wallpaper was unsuccessful; they imagined hundreds of uses for their product, branded Bubble Wrap, until they decided to market it as packaging material. Around that time, IBM had introduced an early computer and needed a safe shipping method. Previously, balled-up newsprint was used to protect goods, but it didn't offer much protection and the ink rubbed off onto the products. Bubble Wrap evolved into different shapes and sizes, becoming a widely-used packaging material for many industries. It is used extensively in art galleries & museums. Bubble Wrap is made mostly from low-density polyethylene (LDPE).

To make plastic, crude oil and natural gas are sent to refineries, where they are converted into the building blocks of plastic: ethane (C_2H_6) from crude oil and propane (C_3H_8) from natural gas. Ethane and propane are then sent to a "cracker" plant to be broken down into smaller molecules: ethane into ethylene (C_2H_4); propane into propylene $(C_3H_6)_n$. A catalyst is introduced, linking all the molecules together to form polymers called resins. Polymerisation converts ethylene into polyethylene $(C_2H_4)_n$ and propylene into polypropylene $(C_3H_6)_n$.

The long-chain chemical structure of polymers allows plastic to be molded and shaped easily under heat and pressure. **The resins are melted, cooled down and chopped up into pre-production plastic pellets called "nurdles".** In the manufacture of nurdles, additives such as plasticisers, flame retardants, pigments, light & heat stablilisers are introduced to give specific properties to different plastics. Manufacturers use heat to mould the nurdles into different types of plastic products through processes including extrusion, injection moulding, rotation moulding, vacuum forming & blow moulding.

In 1965, while searching for strong but lightweight plastics to use in car tyres, DuPont researcher Stephanie Kwolek accidentally discovered what would become known as Kevlar. Not only was it stronger than nylon, Kevlar was five times stronger than steel by weight. Kevlar is used in more than 200 applications, including boats, bridge cables, tennis racquets, mobile phones, skis, bullet-proof vests, parachute lines, aeroplanes, ropes, car tyres, canoes, fire fighter boots, hockey sticks & armoured cars. **Kwolek did not profit from her invention, as she signed over the Kevlar patent to DuPont.**



In 1927, DuPont Corporation began a secret development project called Fiber66. Chemist Wallace Carothers, who was prone to depression and drinking, led the research into new fibres. Carothers and his team discovered nylon and other polymers including polyamides and polyesters. Nylon was strong and flexible and was first used in toothbrushes, but DuPont's real target was women's stockings. Twelve years later in 1939 DuPont introduced nylon at the World Fair in New York City. They had spent so much money developing and refining nylon, they spared little expense to promote nylon. An unprecedented stampede descended on hosiery counters on Nylon Day in 1940. Crowds waited for hours and customers could only buy one pair of stockings. **Sales assistants were warned not to sell a second pair, "not even if your grandmother wants it."** About four million pairs of nylon stockings sold within two days. Over the following months, "nylon mania" raged on.