**Chapter 17**

**Plastics we Can’t Live Without**

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ABSTRACT …………

Since the commercial production of plastics first began, our use of this durable and convenient material has increased as well as our dependence and addiction that penetrates to the heart of modern society and its infrastructures. This chapter explores the nature and extent of that reliance through the lens of Maslow’s hierarchy of needs to consider which areas of our plastic use is really necessary rather than just convenient or desirable. Safety and physiological hygiene factors are discussed to establish a basis for prioritisation coupled with consideration of key design parameters to establish whether these plastics can be: a) avoided by using a different product or activity; b) reduced through design; c) replaced by another material. The role of plastics in areas of priority including food production, medicine and health and electronics are discussed along with the challenges of finding appropriate alternatives to help break our plastic addiction without causing serious negative consequences for society.

KEY WORDS ………..

Plastic addiction; sustainable; design; hygiene factors; dependence; circularity

17.**1 Introduction**

Plastics are everywhere in our environment and they are the subject of serious public concern. Deeply moving images of the interaction of plastics in nature with our wildlife and environment have led to a wave of strong public opinion and laws and legislation being reviewed globally to drastically reduce our dependence on this material, especially single use plastic. Public action groups are campaigning to convert their towns to be “Plastic free”. It is clear that our addiction to plastic has got out of hand and we need to withdraw from our unhealthy dependence, but it is also clear that while we have developed many unnecessary plastic products that can be avoided, and others that can be made of more sustainable materials, we have also come to depend on plastics that we can neither avoid or replace as they are making such an important contribution to the quality of millions of people.

Our dependence on modern plastics began back in 1907 with the production of Bakelite, a synthetic material made using chemicals derived from fossil fuels. Since then our reliance on this material has grown and penetrated almost every aspect of modern living. Plastic is used in the manufacture of a vast array of goods, including obvious items, such as toys, straws, packaging, disposable nappies, casings for electrical devices as well as less obvious items such as teabags and fabrics. Driven by the fact that plastics are relatively cheap and easy to mass manufacture, by 2017, global production reached 350 million tonnes and made a major contribution to economies, contributing around 1.5 million jobs in Europe alone [1]. By enabling the production of structures that are lightweight and can come in a virtually unlimited range of shapes and sizes this material has enabled both innovation in product design and a massive proliferation of affordable goods, whether we needed them, or not. This has led us to a situation where we are rethinking our relationship with plastic.

A major consideration in this rethink is the relatively short useful lifetime of many of these products, in comparison to the long lifetime of the material in the environment [2] (sometimes running into centuries) and subsequent breakdown to micro-plastics [3]. This is coupled with a lack of adequate disposal and recycling systems and poses a serious problem and negative impact on the environment [4]. This impact has raised serious questions about our consumption of plastic and whether we should phase out certain products completely, especially single use plastics and those products that offer little value and benefit compared to the harm that they do in the environment. It also raises controversial debates about: the depth and nature of our dependence; who should be responsible for driving change; and which of the many plastics that we now take for granted can we really do without.

During 2018, governments and businesses around the world acted to reduce use of some items with bans on cosmetics containing microbeads and plastic straws, together with bans and charges for single-use plastic bags [5]. Much of the media and public focus has been on tackling avoidable plastic use and environmental impact. However, despite their undoubted environmental impact, a number of plastics have enabled significant developments in energy infrastructure, medicine, health services, transport, and food production. The benefits to society through improved standards of living have meant that we have fast come to depend on this material at the heart of many of our most vital services and practices. This chapter will explore some of the plastics that have become vital in maintaining the shape of our societies and their role in our modern lives.

**17.2 When we came to depend on plastics**

Before synthetic plastics were developed from fossil fuel, polymeric materials were made from natural compounds. They have been used by humans from as early as 1200 BC, when the Olmec people created rubber from latex and vine extract. Over time we discovered how to produce more and more sophisticated polymers from natural ingredients. For example, shellac is a resin secreted by the female lac insect, *Kerria lacca*. This early plastic has been used for at least 3000 years [6] and even in recent times it has been used: as a protective coating for electronics; as a varnish for furniture; and predominantly, before the use of modern vinyl, in the production of records. There was an estimated 18 000 tonnes of shellac used in record manufacture in Europe between 1931 and 1928 [7]. However, shellac is not as durable as modern plastics as it susceptible to damage from water and solvents.

Another important precursor to synthetic plastics was celluloid, derived from cellulose. The first celluloid was “Parkesine” which was invented in 1856. This solid, versatile material, which was tough and could hold its shape, set the scene for a wave of similar materials that were used to make a range of everyday items, such as piano keys, combs, jewellery boxes, handles, spectacle frames and cinematic film. The latter giving a media for a vast and popular film industry. Another early plastic that shaped modern life and our relationship with plastic is the natural rubber, gutta percha, from the *Palaquium gutta* tree. This thermoplastic material was used from the mid-1800s enabling telecom wires to be laid at the bottom of the ocean and for electronic wires to be insulated.

Around the same time in 1845, vulcanised rubber was patented. Natural rubber was stabilised through the addition of sulphur and made a more rigid, less sticky material, ideal for tyre production. This innovation was fundamental to the design of vehicles enabling huge improvements in our transport infrastructure and a fast-growing automotive industry. It also enabled production of strong and stable rubber seals, drive belts and components that played a vital role in industrialisation and technology development in the 21st century. [8]

Natural resources, although enabling some vital initial developments of engineering and technology in the 1800s, were not able to sustain the massive growth in manufacturing, telecommunications, electronics and medicine that was to come. As demand for new products in larger volumes grew, so did the need for more synthetic materials.

Synthetic modern plastic production really took off during the Second World War with an urgent need for new, abundant materials to make aircraft, boats, vehicles, equipment and footwear for soldiers [9]. As there was a shortage of natural rubber [10] and the need for new synthetic materials drove the search for alternatives from oil and coal tar sources. Development of these new synthetic production routes paved the way for a post-war proliferation of affordable, lightweight plastic that quickly became engrained in our everyday domestic lives and infrastructures, modern life would be unrecognisable without it.

Our dependency on plastic today is so entangled with our daily lives and activities that our quality of life would not be the same without it. It ripples through production of everyday goods to the provision of vital services. Our relationship with plastic has infiltrated our lives to a much deeper role than that of simply adding convenience or maintaining acceptable comfort levels. We would find it difficult or impossible now to do without plastic in many areas. Our rate of consumption of some plastic goods would be difficult to maintain using alternative materials. For example, the soles of modern shoes are often made of durable synthetic material. Before our reliance on plastics, the soles of shoes were made from natural materials such as leather, rope or wood. If we switched to non-plastics for all of the 22 billion pairs of shoes manufactured every year [11] we would need to find an abundant suitable substitute material that would be as durable and would fit with current manufacturing processes. Similarly, elasticated fabrics provide us with comfortable underwear and swimwear that would be difficult to produce from natural fabrics such as wool, cotton and hemp. Modern fabric production replacing cotton and silk is another major contributor to our plastic use that would be difficult to supply solely from natural means and with demand ever increasing, it is a source of plastic use that is not showing signs of slowing down. One such synthetic fabric is polyester, used in modern clothing, bedding and furnishings. Production of polyester fibre has risen from a production of 3.37 million tonnes in 1975 to a staggering 53.7 million tonnes [12]. Much of this production of synthetic textiles feeds a growing appetite for “fast fashion” [13] where low-cost fashionable clothes are purchased, worn and discarded, sometimes only after a single-use. A radical shift away from single-use to longer life-cycles is needed to improve the sustainability of textiles, requiring a change to behaviour and lifestyle, but to move away completely from all synthetic-polymer based clothing without changing consumption demand would be impractical. The demand for materials would put a huge strain on natural resources, particularly through increased water and fertiliser use, both resources that are under threat [14], [15].

**17.3 Essential applications for modern plastics**

Depending on our personal perspective, our individual view of what we can and can’t do without will vary. Maslow’s hierarchy of needs model is a useful tool to consider and prioritise those plastics that satisfy our most critical needs (Figure 17.1.). The various hygiene factors: self-actualisation; esteem; social; safety, and; physiological, give us lens through which we can view our relationship and consider which plastics we only really *want*, and those we actually *need*.

The physiological factors are those that address vital food production and supply, water services, shelter and energy infrastructure requirements. Plastics that fall into this category are the pipelines supplying water to billions of people for drinking and agriculture, materials for producing and transporting food and the fabric of buildings. Safety factors include those areas that preserve life, including those that give us security of supply of resources and services, such as transport networks, health and medicine, cleanliness and quality of food and water. Plastics that are used here include materials used to make vehicles, syringes, catheters and some packaging for preserving sterile conditions. The other factors: self-actualisation; esteem; social, although important to maintaining a comfortable standard of living, and maintaining longer-term well-being, are lower in priority for immediate basic survival needs. It is these areas too, that have a strong bearing on our social interactions and status that we have also, albeit to a lesser extent, come to depend on to maintain a standard of living and operation of society that would be affected without plastics.

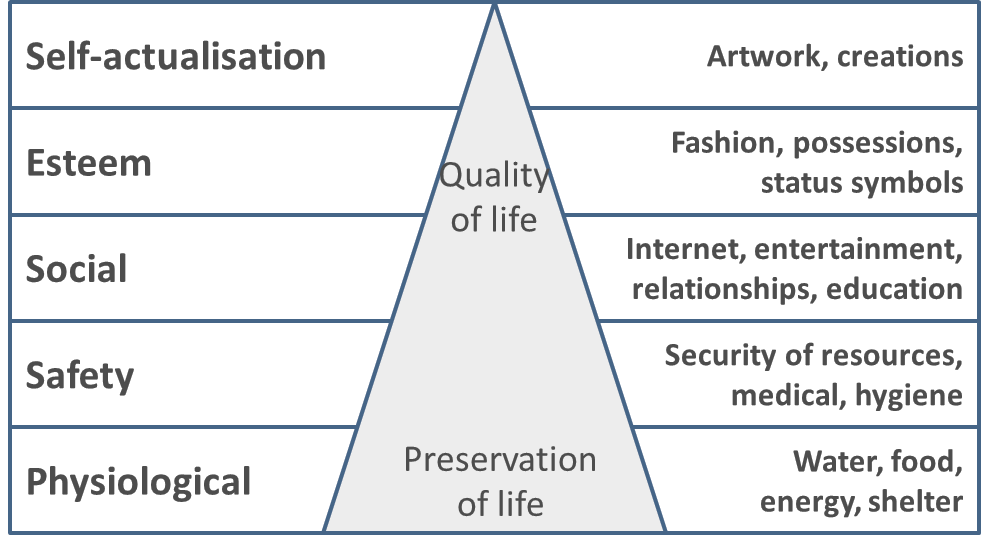


Figure 17.1. Prioritisation diagram of goods and services based on Maslow’s hierarchy of needs [16].

This model is however a very simplistic view and only useful if it is coupled with the consideration of whether the role and impact of a given plastic is one that could be:

1. avoided by using a different product or activity
2. reduced through design
3. replaced by another material

These three design dimensions more thoroughly examine the extent to which viable alternatives can be applied. Using the hierarchy model shown in Figure 17.1 alone is not sufficient. Using only this approach, it could be argued that the use of single-use cellophane wrapping for tomatoes grown in Spain to the UK in August is a vital use, as it is for essential food supply. Instead, if you consider which alternatives are available through design by avoiding, reducing or replacing material (table 17.1) it becomes apparent that the wrapping is not all that essential for the end-user but only desirable. It is also apparent that the majority of the benefits of the packaging are for the supplier rather than the end user. Some alternatives result in higher costs of production, this could then be passed onto the end user.

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| --- | --- | --- |
| Activity | Alternative | Impact |
| 1. avoid | * Don’t import and only use UK grown tomatoes in the growing season * Use containers that are returned to the grower for re-use * Don’t wrap in plastic at all * Don’t have tomatoes at all | * The tomatoes may not grow as well if the weather is poor * Higher cost through additional time needed for unpacking/packing and transport costs * Cost of damaged goods and shorter shelf-life * Less consumer choice |
| 1. reduce | * Use thinner materials to use less plastic | * Packaging may not be as robust |
| 1. replace | * Use biodegradable/recyclable plastic, paper, cardboard or re-usable plastic | * May be a higher cost or unintended negative impact of using alternatives |

Table 17.1. Impacts of avoiding, reducing and replacing plastic in packaging of tomatoes

Examining the design possibilities in this way is a useful way to consider and evaluate our dependencies and explore whether we really *need* a plastic product or dimension that would on the surface, appear to be indispensable. For example, many sports items associated with safety used in martial arts such as boxing gloves and safety mats are made of synthetic polymers. These items seem critical but when the design is challenged, for this application, the use of alternative materials could be switched for biomaterials and natural packing and gels could be a viable alternative. There is an urgent need to consider the design of more plastics goods to improve them and to identify those that we can do without, for example in the field of single-use plastics.

It is also important not to generalise too much when considering the relative importance of plastics. For example, the use of single-use plastics in particular has become a focus of intense and well-founded public concern. There have been successful initiatives to cut the use of this class of plastics, especially plastic bags, packaging and plastic straws in response to public demand. “Single-use” has fast-become a negative term when used synonymously with plastic in the view of the general public. Are we to accept that all single-use plastics are bad? There are, of course, several exceptions. A number of these plastics are considered necessary in vital and often pressured sectors such as the emergency services and hospitals. The convenience of instant, sterile, stable and lightweight materials can be invaluable in saving time in emergencies and preventing infection. Most are currently irreplaceable by available alternatives such as natural latex, wood, metal and biomaterials. If we use the example of sterile tubing used in catheters and apply the principles of: avoid, reduce, replace scenario (Table17. 2) we find that the negative impact is much more serious than in our previous example in Table 17.1, resulting in poorer care and a direct risk to human health.

|  |  |  |  |
| --- | --- | --- | --- |
| Activity | Alternative | Impact | Severity of impact |
| 1. avoid | * Don’t use catheters for patients | * Poorer patient care resulting in poor outcomes for patients * Higher cost through poorer patient outcomes | * High * High |
| 1. reduce | * Use thinner materials to use less plastic | * Tubing may not perform as well resulting in poorer patient outcomes | * High |
| 1. replace | * Use biodegradable/recyclable plastic or re-usable plastic | * Higher cost and time associated with sterilisation for reuse * Higher risk of transfer of infection | * Med * High |

Table 17.2. Impacts of avoiding, reducing and replacing plastic in plastic catheter tubing

There is no doubt that certain plastics play more important roles in our lives than others and this impact can be direct on the end-user or indirect giving benefits along various upstream parts of the supply chain. Important plastics are the ones that meet our physiological and safety hygiene factors. Of these important plastics the ones that we need, i.e., can’t do without, are the ones that have applications that can’t be avoided without serious detrimental impact to our lives and wellbeing and can’t be made out of something other than plastic on a scale large enough to satisfy the needs of a modern society. There are many examples of these in use in the areas of: medicine and health; electronics; utility services; food provision, and; transport.

**17.4 Medicine and Health**

Modern low-cost, disposable, synthetic polymer-based materials have revolutionised medical care and surgical practice [17] The low-cost and versatility of plastic has helped provide a range of medical devices [18] and innovations that have improved health and outcomes for patients undergoing routine and life-saving treatment. Single-use plastics in particular, in the context of healthcare and medicine, have played a vital role in the prevention and control of the spread of disease. For example, latex gloves, bags for intravenous fluids and tubing for dialysis and catheters are all relatively inexpensive, disposable items that provide sterile conditions. In particular the properties and relatively low cost of polyethylene terephthalate (PET) make the production of these plastics possible at a scale needed for a growing global population and modern healthcare provision. Use of polythene packaging to maintain sterile conditions means that resources can be stored, distributed and used where and when needed without concerns of contamination.

The versatility of plastic has opened up the possibilities for new products tailored for very specific uses. Plastics can be adapted in terms of shape and texture and the surface can even be tailored to a given porosity or can be doped to provide antibacterial properties. One way that such innovation has been used, is in the treatment of burns and wounds. Non-stick dressings have been developed to cater for specific types of injury and provide conditions to promote the rate of healing. For example, to really promote healing, dressings need to be breathable and still be able to absorb fluids. They need to provide thermal insulation and mechanical support to protect the wound as it heals and they should not stick to the wound [19]. Modern antibacterial polymer dressings for burns [20] and wounds [21] provide these optimal conditions, replacing the use of simple linen and gauze dressings that would often stick to wounds and cause irritation and on removal, considerable pain as newly healed skin would tear, increasing the risk of scarring and re-opening up the site to potential infection.

The threat of infection from a rising number of dangerous viruses and bacteria that are becoming more resistant to treatment has driven and underpinned the need for safer, cleaner treatments. These new approaches have included the introduction of a number of single-use plastic products that are now standard. They have been especially important in keeping patients and medical staff safe during treatments and surgical procedures that involve contact with bodily fluids, which carry a high risk. Since the mid 1980s several major threats emerged that drove the need for disposable treatments. For example, disposable syringes became commonplace in the 80’s as a major tool in the fight to stop the spread of human immunodeficiency virus (HIV) and hepatitis B from unsterilized needles.

In 1986, the first case of bovine spongiform encephalopathy (BSE) was recorded in the UK. This disease, dubbed “Mad Cow Disease” hit the headlines in the UK and caused widespread concern when humans developed the related condition, variant Creutzfeldt–Jakob disease (vCJD). It caused even greater concern when people realised that there was a risk of infection from contaminated surgical implements [22] and that it could be spread through blood products [23]. These spongiform encephalopathies (TSEs) are caused by misfolded proteins, called prions. These resilient pathogens are virtually indestructible by conventional sterilisation [24] and although new methods of sterilising medical equipment are being explored [25], it is clear that where practical, disposable goods are for now, a safer option, especially for routine, lower cost items. Lightweight, sterile plastic containers are now commonplace. They save time and prevent infection taking the place of more traditional glass and metal materials that were previously used, sterilised and re-used.

A major and important single-use plastic that has come to be important to our health is the condom. It is usually made of natural latex, polyurethane or more recently polyisoprene, a far cry from the first condoms that were fashioned from animal intestine. This barrier method of contraception is considered so important for the prevention of disease and birth control that it is listed on the WHO model list of essential medicines (EML). It is a highly popular method of protection across the globe. It’s estimated that we buy between 6 and 9 billion every year [26] but UNAIDS point out that the use needs to be higher [27]. There are still too many people with no access to condoms while these preventable diseases prevail especially in Sub Saharan Africa where there is an annual estimated shortage of around 3.3 billion condoms being supplied. This is an area that is disproportionately affected by HIV, that could be tackled more effectively with more use of condoms. It’s estimated that in 2017 around 1.8 million people contracted HIV and 36.9 million people were living with the disease [28]. Since the HIV crisis it’s estimated that condoms have prevented 50 million cases of HIV [29]. Condoms are an important tool in prevention of this disease and also other sexually transmitted diseases such as chlamydia, gonorrhoea, syphilis. The World Health Organisation estimate that there are around 1 million new cases of these preventable diseases every single day [30] and in 2012 there were an estimated 80 million unplanned births due to lack of access to sufficient contraception. The condom is not necessarily single use, as the female condom, developing in popularity and more commonly made from durable polyurethane, can potentially be washed and re-used.

**17.5 Electronics**

One major part of our dependence on plastics is our growing dependence on electronic goods. We are embracing technology in an increasingly bigger part of our everyday lives spanning household appliances, cars, mobile phones, computing devices and toys. The development of smaller, more affordable and efficient electronics has transformed modern living into a more online existence with more of our services being conducted online and more of our everyday items having electronic features and becoming “smart” with remote control features and links to online applications where we can record, monitor and broadcast our use to others. More and more of our everyday activities are becoming digitised, e.g., shopping online and our social practices becoming “facilitated” online. Our online habit is supported by our growing ownership of devices, from a global average of 2.3 connected devices each in 2015 to 3.5 in 2021 [31]. Unsurprisingly our associated use of energy is spiralling upwards too [32].

Relatively recent advances in smart technology and our appetite for online services have resulted in us decluttering and replacing our physical goods, for example, photographs, vinyl records, DVDs and CDs with streamed music and digital media. The hardware necessary for the infrastructure, both in the data centres and the devices has been instrumental. Plastic is the ideal material for this application. No other material has the right various material properties so well-matched with the needs of electronics development for versatile design, durability and safety (Table 17.3).

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| **Plastic property** | **Pros** | **Cons** |
| Poor electrical insulators | Safety through of insulation of wiring and provision of non-conductive switches and casings | None |
| Poor heat conductors | Thermal insulation properties and widespread use in casing and handles of heat-producing appliances prevent burns.  Extremes in temperature within (hot and cold) can be isolated.  Thermal performance can be improved through insulation, e.g. in a freezer. | Poor heat dissipation can cause uneven heat distribution, changes to rigidity, material expansion and warping, e.g. in circuit boards |
| Easily doped with flame retardants | Improves safety of components through fire-prevention | Makes recycling and disposal difficult and many retardants are toxic, e.g. brominated materials |
| Durable | Provides long service use | Persists in the environment, potentially for centuries |
| Versatile physical properties | A wide range of properties and shapes possible, e.g. flexible films, tough crack-resistant casings, insulating layers, wide possibility of colour and texture | A fit-for-purpose recycling/disposal system for a large range of non-standard types can be difficult |
| Low cost | Provides more economically viable production of goods | Perceptions of low value can result in shorter period of use before replacement or upgrade |

Table 17. 3. Pros and cons of plastics for electronics production

Modern advanced plastics have enabled not only increased production but enabled the miniaturisation of devices, bringing down manufacturing and transport costs. The low costs of production have underpinned a fast product turnover. With a fast pace of design innovation and the role out of new more fashionable, more compact devices with more features, especially in mobile phones which have become more advanced with high quality screens, cameras and satellite navigation that are a far cry from the simple earlier models (Figure 17.2), it has become cheaper and more convenient to upgrade rather than repair [33] so older devices lose their appeal and their perceived value. They quickly become worthless and are discarded, significantly add to waste streams [34] or end up in drawers in our homes [35]. This faster turnaround has been reinforced with quickly evolving, non-compatible vital components in some cases resulting in a culture of planned obsolescence [36] resulting in increasingly short product lifecycles [37] and e-waste becoming the world’s fastest growing waste stream [38]. The material properties, low cost and versatility of plastic has underpinned this astonishing electronic revolution.



Figure 17.2. Motorola MR30 released in 1994

Advances in technical plastics for very specific applications have enabled the development of tailored components. Printed circuit boards (PCBs) are a good example (Figure 17.3). They are made using plastics and resins to produce non-conductive substrates and layers that support circuits (Table17. 4). The most common PCB substrate is FR-4, made with a woven fibreglass layer impregnated with resin. Automated production of these boards, incorporation of flame retardants in materials (FR1 to FR6) and cheaper composite epoxy materials (CEMs) have provided us with more reliable, safer goods.

|  |  |  |
| --- | --- | --- |
| **Component** | **Common Materials** | **Description** |
| Flame retardant printed circuit boards (PCB) | FR-1 to FR-6 | Flame resistant laminate materials. The most common is FR-4, made with a woven fibreglass layer impregnated with resin |
| Printed circuit boards (PCB) | CEM-1 to CEM-6 | CEMs or composite epoxy materials are made with woven non-woven glass and epoxy resin. |
| Casings | Polycarbonate, polyurethane | Hard thermoset plastic. Poor conductor. |
| Wiring | Polyethylene | Good electrical resistance |
| Thermal resistance | ABS | Ability to withstand higher temperatures. |

Table 17.4. Common materials used in electronics manufacture

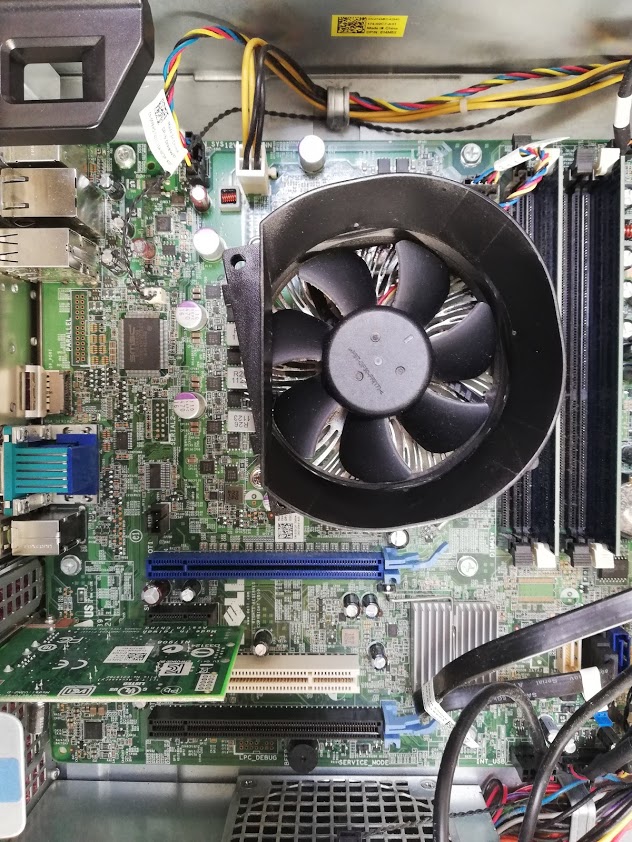


Figure 17.3. Inside a desktop PC showing plastic use in PCBs, fan and wiring

Electronics are still evolving to have more advanced uses but also to have less environmental impact using less energy, less toxic materials and flame retardants and more biodegradable components. One such development is in the area of “transient electronics” which are designed to biodegrade in-situ. These have applications in environmental monitoring where the device can be deployed and then abandoned for example in difficult to access areas, like volcanoes. Another area is in medicine in monitoring and in short-term activities, such as temporary stents or targeted drug delivery in the body. For example, during surgery a device can be inserted that aids recovery, then it doesn’t need to be removed. Advanced developments in smart technology and control coupled with the ability to produce thin film polymers that are absorbed into their immediate environment or degraded are still being researched [39][40] and if they are successful, these new short-lived devices will mean less material use in manufacture, less e-waste related plastic and smaller, less disruptive monitoring and treatments. These devices could well become a future branch of plastics we may come to depend on to meet needs while addressing waste issues.

**17.6 Provision of vital supplies in cities**

The world population stands at around 7.6 billion people and it is predicted to rise to 9.8 billion people by 2050 [41]. There are 8.8 million people living in the bustling city of London which covers 1572 km2 . This seems a lot until you consider that there are 8.5 million in Dhaka, Bangladesh, one of the most densely populated cities in the world, which is just 306.4 km2. The numbers of people moving to cities is rising. Around half of the world’s growing population already live in cities and it is predicted that by 2050 this urbanisation will continue to a level of around 68% [42]. The logistics of ensuring that those people have vital supplies is a huge challenge, especially with increased pressure on finite resources of fertilisers and pressures on land and water due to shifting climate and extreme unstable weather patterns.

Meanwhile, against this tide of resource shortages, consumption and waste levels remain too high. Globally, a third of all the food that we produce goes to waste, either along the supply chain route as spoiled goods or rejected quality food, or as domestic food waste [43]. This is not a cost we can afford. Spoiled food due to damage in transport is avoidable with the proper protective containers and some packaging helps preserve the food. Whether this is a plastic we can do without comes back to the questions “is the plastic avoidable/reduceable/replaceable?” The answers to that vary depending on access to resources. If we live in an urban environment with no access to local producers then we have no alternative but to buy from commercial outlets, so from a consumer perspective, it is very difficult to live without this kind of packaging without causing more food waste. The alternatives are only possible through the supply chain, by sourcing as locally as possible to shorten transportation time, reducing packaging as far as possible or increase its strength to be more robust and re-usable.

Similar complexities exist with bottled water in some parts of the world. In the UK, safe, fresh drinking water is available in abundance. In locations with no access to safe municipal drinking water supply, and no natural water available, the consumer often has to buy water. If that water is sold in plastic bottles then the consumer has little choice. There is choice, however, further up the supply chain and options for change are becoming more attractive as the pricing and logistics of the packaging changes. PET plastic bottles are generally highly recyclable and in Europe, businesses have to change their approach to recycle 90% of all drinks bottle by 2029 and to include 25% recycled content in them by 2025 [44]. This may change the dynamics of the business model and give companies a strong incentive to examine the “replace” option in the use of this plastic. For now, at least, much of the plastic used to preserve fragile and fresh food during transport, e.g., fish and fruit, is still something we need.

**17.7 Will we always need plastic?**   
  
We cannot continue to use all of the plastics that we are currently using in the same way. It is clear that we cannot deal with the volume that is pouring into our waste stream. The reputation of this material is being harmed by constant abuse and misuse and the assumption that this material is cheap to manufacture and cheap to buy, without considering the full life-cycle costs. We all need to value this material properly and make some difficult choices about the plastics we don’t need and make changes to adjust to life without them so that the stream of overproduced plastic waste can be stemmed.

Used for the things we really need, plastic is a great choice of material. It has enabled our technological development, shaped our vehicles and transport, improved our health and given us a means to feed ourselves. Used for the things that matter, that we truly need, in a circular way, there is no reason why this awesome material should not continue to help make our lives better.

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