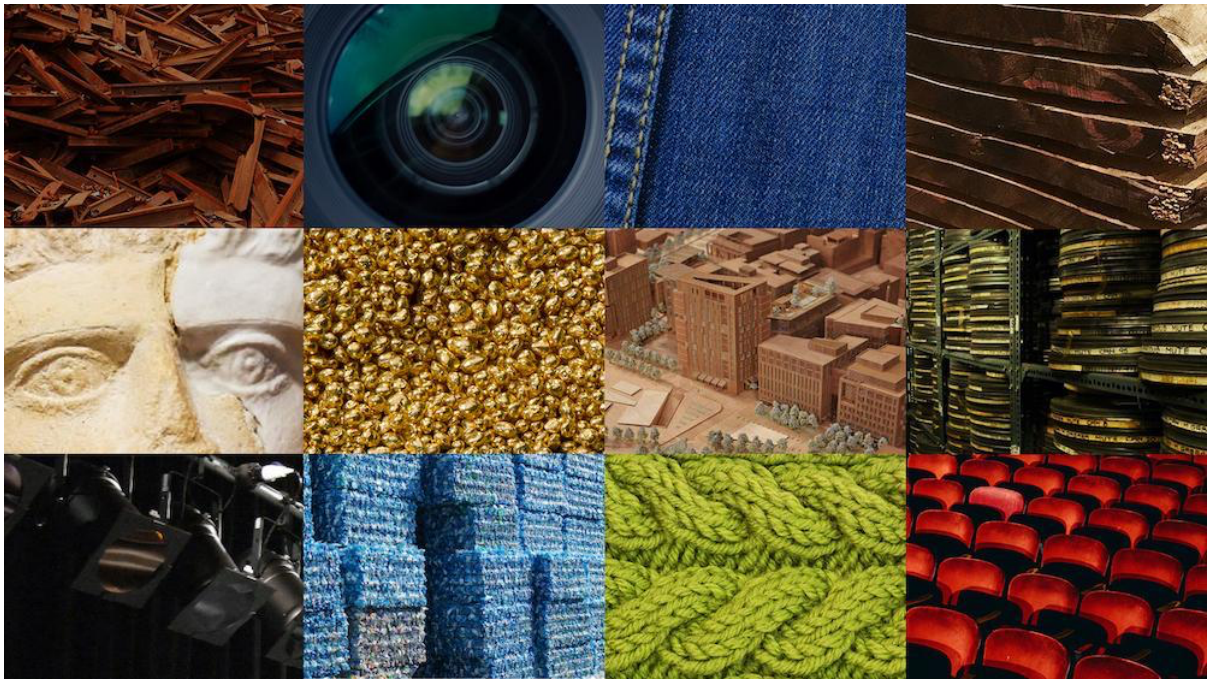

Sustainable Materials in the Creative Industries

A scoping report for the AHRC

Redacted Version: created 14 July 2022

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Sustainable Materials in the Creative Industries REDACTED VERSION

Index

The SMICI report was originally written for the Arts and Humanities Research Council as a summary of the scoping research undertaken by the *Sustainable Materials in the Creative Industries* project team. The original version contained funding priority recommendations to the AHRC, following the call brief.
This redacted version was created for wider dissemination to support subsequent research, with the approval of the AHRC, on the 14th July 2022. the redacted version has some text removed and consequently has different chapter and page numbering.

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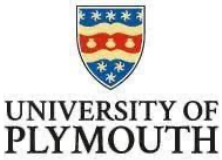

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Chapter 1: Executive Summary

Peter Oakley

Over the past two decades sustainability has developed from a peripheral concern to a pressing mainstream issue. The diverse outputs of the creative industries, from physical artworks and hard luxury goods to performances and films, all entail multiple entanglements with material sustainability. These can be as direct as the supply chains for materials that products are made from, but may also involve the procurement, use, reuse and disposal of the less obvious tools, equipment, and secondary materials essential to creative producers. The level of responses to the need for more material sustainability across the creative sector have varied dramatically depending on the sector, and in some cases, specific disciplines. In addition, the impact or transferability of many of the more successful localised or specialist initiatives has not been widely recognised or broadcast.

This report contains the results of a twelve-month scoping study of current sustainable practice around materials across the creative industries. The project team has explored current and immanent sustainable practice around the sourcing, use, disposal, reuse, recycling, and upcycling of materials, to help understand the creative sector's ongoing responses and its current and potential contribution to the development of a circular economy. It provides a snapshot of practice and perceptions around material sustainability in the creative industries, identifying existing trends and showcasing cutting-edge developments, as well as flagging sector-wide and discipline specific barriers that will have to be negotiated or addressed to achieve widespread sustainably orientated practice.

Having recognised that there will be some commonalities but that different creative disciplines have different prerogatives and operate under specific pressures, the scoping has taken a predominantly discipline-led approach, followed by a team review to identify and clarify points of cross-over. The report has five core chapters, each covering a sector of the creative industries: Crafts and Applied Arts; Design; Fashion, Textiles and Accessories; Film and Photography; and Performing Arts. It also has chapters examining two cross-sector aspects: firstly, electronic and electrical equipment; and secondly, carbon calculation tools, as well as a further chapter identifying and unpacking other cross-cutting issues. In addition, the report presents thirteen case studies of initiatives or innovations in the creative industries relating to sustainability.

Chapter 2: Sustainability across the Creative Industries

Peter Oakley, Ita Jansen, Jules Findley, Roberta Mock

This report contains the results of a twelve-month scoping study of current sustainable practice around materials across the creative industries in the UK, with excursions abroad where these were found to be especially informative. The project team has explored current and immanent sustainable practices around the sourcing, use, disposal, reuse, recycling, and upcycling of materials, to help understand the creative industries' ongoing responses and its current and potential contribution to the development of a circular economy. The report therefore provides a snapshot of practice and perceptions around material sustainability across the creative industries, identifying existing trends and showcasing cutting-edge developments, as well as flagging sector-wide and discipline specific barriers that will have to be negotiated or addressed to achieve widespread sustainably orientated practice.

Having recognised that there will be some commonalities but that different creative disciplines have different prerogatives and operate under specific pressures, the scoping has taken a predominantly discipline-led approach, followed by a team review to identify and clarify points of cross-over. The report has six core chapters, each covering a sector of the creative industries: Crafts and Applied Arts; Design; Fashion, Textiles, and Accessories; Film and Photography; Fine Art; and Performing Arts. It also has chapters examining two key cross-sector aspects. The first, electronic and electrical equipment (chapter 10) was identified in the project proposal. The second, carbon calculation tools (chapter 11) emerged as an important influence on perspectives around material selection and disposal during the lifetime of the project. The report also includes a chapter (chapter 3) identifying and unpacking further cross-cutting issues revealed during a project team workshop held in November 2021. In addition, the report presents thirteen subsidiary case studies of initiatives or innovations in the creative industries relating to sustainability. Each of these case studies relates to one of the five sectors outlined below.

Defining the Sectors Covered in the Disciplinary Chapters (4-9)

Crafts and Applied Arts

The term crafts and applied arts covers a range of specialist material disciplines, typically with a long history of practice and associated heritage. Most are heavily reliant on manual making techniques. In many cases the craft discipline has an industrial equivalent, e.g. furniture design, ceramics and textiles. However, due to the difference in scale of operation, the techniques employed, and to some extent, the exact materials used and the ethos of the practitioner, there are evident and fundamental differences in practice with regards to materials sourcing, use and disposal.

The individual craft and applied art disciplines that were examined are:

- Blacksmithing
- Bookbinding
- Ceramics (studio)
- Clock and Watchmaking
- Furniture Making
- Glass (studio)
- Jewellery
- Leatherworking (bespoke)
- Metalworking (base metals)

- Musical Instrument Making
- Restoration (Fine Art)
- Restoration (furniture and textiles)
- Silversmithing & Goldsmithing
- Textiles (studio)
- Woodworking

Note on Conservation and Restoration
Most of the list above aligns with the Crafts Council's definition of craft, which considering the overall project scope of focusing on the creative industries, is to be expected. The most obvious difference is the inclusion of restoration and conservation practitioners, whose activities turned out to have much in common in terms of needs and decisions over sourcing materials and making processes. The other main area within museums and galleries, curation, has been allocated to design.

Note on Jewellery
All jewellery and watchmaking practice within the Crafts and Applied Arts section of the report, rather than the other options: Design or Fashion, Textiles, and Accessories. Whilst globally jewellery and watch manufacturing includes a significant tranche of large companies, the industry is different in the UK; most jewellery manufacturing businesses are categorised as SMEs (Department for International Trade 2020; OECD 2005). In addition, manual or semi-manual processes are still in evidence in many of the larger UK jewellery manufacturers. This stands in contrast to disciplines such as ceramics and furniture production, where almost total automation exists at the industrial scale and differentiation by the types of materials used is also evident.

Design

Design as a profession operates in terms of product specialisms, such as: exhibition design, furniture design, product design, and packaging design. However, design consultancies and design-led manufacturers typically work across multiple cognate areas, especially when there is a commonality of materials or context across their product range.

The more intangible design specialisms, such as digital graphics, games design, animation, and virtual or augmented reality production are not identified or discussed directly in this chapter. The digital tools used in these creative specialisms are covered in the chapter on electronic and electrical equipment (see chapter 10) and the lens-based equipment addressed in the chapter on film and photography (see chapter 9) and, in both cases, there are also associated case studies.

Note on Architecture
For the purposes of this report, architects have not been treated as designers. This has been decided on the basis that the materials their finished products – buildings – are constructed from, such as brick, concrete, and steel, all fall under other research councils' remits. However, the practice of model making within architectural studios, which can be thought of as the materiality of the creative process itself, is included. This activity also bears a close relationship to the creation of product prototypes for manufacturing and the two are often undertaken in the same workspaces or studios.

Note on Museum Curation
Due to similarities in perspectives, museum curation relating to presentation and display practice and exhibition development and realisation has been subsumed into exhibition design. Consequently, museum practice around materials has been split in line with the scoping findings as conservation and restoration aligned better with other craft and applied arts.

Fashion, Textiles, and Accessories

Fashion includes womenswear, menswear, childrenswear and babieswear in a variety of different market sectors, luxury, mid-market including prêt-à-porter, or ready to wear, sportswear, urban wear, lingerie, and the lower end of the markets together with fast fashion. The garment industry also includes corporate clothing, workwear, apparel, and accessories. The different categories of clothing together with the different sectors already make a complex composite of markets with global sourcing of fabrics and trims, as well as global areas of manufacturing that makes for a broad range of countries of manufacture, communication, and shipping at various stages of completion of garments.

Textiles is comprised of raw natural fibres such as cotton, hemp, linen, wool and cashmere, mohair, silk, down, with synthetic materials such as acrylics, polyesters, viscose, rayons, lyocell, nylon, polyamides, polypropylenes and other mixtures of fibres. There are market sectors in textiles with fabrics appealing to each market sector aimed at fashion at all levels and interiors and medical textiles. Although carpets are not necessarily considered as textiles, as they are materials sometimes made of wool or various mixes of polyesters and polypropylene, they are included in this section.

Accessories encompass a range of items, such as shoes, bags, belts, hats, fashion jewellery and masks, each available from a variety of materials: plastics, rubber, wood, textiles, leather, among others. Accessories exist in all social contexts (sportswear, casual wear, workwear, etc.) and at all market sectors from luxury to lower levels of markets, including fast fashion.

Note on Jewellery

As noted previously, for the purposes of the report, fine jewellery (made from precious metals and gemstones) is covered in the crafts and applied arts section. Though globally many leading fashion houses produce their own jewellery and watch ranges, in the UK this is a relatively insignificant aspect of the fashion manufacturing sector.

Note on Leatherworking

In terms of the UK, there is also an overlap in terms of bespoke craft production of leather footwear and bags, with scale of production, reliance on branding, and means of distribution and retail being the defining differences. Consequently, large-scale production appears in the Fashion, Textiles and Accessories section, whilst small bespoke production is covered in Crafts and Applied Arts.

Film and Photography

Film and Photography refers in this report to different practices using both analogue and/or digital camera equipment to make either still photographs or audio-visual productions, whether these are commercial, fictional, documentary, or experimental in approach. Both film and photography have been shifting in the last fifteen years from analogue equipment and materials to a predominant use of digital equipment and materials.

Many professional photographers are sole traders or operate as a small enterprise. They can be hired or commissioned for services ranging from portraits to food photography, fashion shoots, or event photography. Similarly, most film practitioners are also sole traders and are hired for a specific department in the context of a specific project.

Film production is inherently interdisciplinary and involves a variety of different practitioners. Each genre of film production will have its own specificities. For example, documentary and fictional drama differ in the sense that the departments commonly found in fictional drama

production: Art Department, Costume, Make-Up, and Special Effects, are not required for documentary production.

The different specialisms in fictional film production, typically referred to as departments within the industry, are as follows:

- Film Producing
- Film Directing
- Cinematography Department
- Sound Department
- Art Department
- Costume Department
- Editing
- Special Effects
- Post Production

Fine Art

Fine art covers a field of traditional creative practices: drawing, painting, print, and sculpture, which each relies on an established platform of materials with coherent supply chains, exclusive distribution networks and a sense of self-identity as a unique practice.

Note on Contemporary Art

Though this was initially anticipated to be a more inclusive sector, in researching this area the difficulty became distinguishing between contemporary art practice and other creative industries e.g. differentiating between screen-based fine art and film, or textile art and studio textiles. Consequently, taking account of the focus of the research being relationships to materials, it became apparent that restricting this chapter to the more traditional modes of fine art production and treating contemporary art practice using alternative media within the other sectors as applicable was the most practical solution.

Performing Arts

This chapter benchmarks current practices, initiatives and attitudes related to the sustainable use of materials in the Performing Arts, which include theatre, dance, opera, circus, performance/live art, immersive/participatory performance and/or installation, performance poetry, stand-up comedy, cabaret, sound walks, and music of all forms played by bands, choirs, orchestra and DJs.

The chapter is organised via three inter-related cross-disciplinary sections:

- *Production* – This refers to the making of a show, event, or performance, as well as the material and operational elements that support and enable its specific presentation and the creation of its inner world.
- *Venues and Environments* – This section focuses on the places and spaces in which the processes of development, presentation and reception of live performance occur, whether these are purpose-built, multi-use or appropriated. These may include buildings (such as theatres, concert halls, art centres, exhibition halls, stadia, studios, workshops, galleries, and homes), as well as outdoor sites and festivals. This section also considers the operational infrastructures of these environments that enable, arise from, and maintain these performance processes.
- *Performance* – While the word “performance” might be used to describe the meta-disciplinary framework that includes generic forms and practices from theatre, dance and music to rituals and parades, it is used in this chapter to describe the confluence

> of elements in a live moment of interchange between processes of presentation and reception. Our primary, but not exclusive, focus is on people – that is, on performers, technicians, and audiences coming together at a specific time to experience something and make cultural meaning, emotion and/or entertainment with and through all material elements of production. It therefore also includes touring, transport and travel to participate in a performance, as well as its subject matter, messaging and thematic/visual/narrative content.

The nature and extent to which each of these categorisations relate to the sustainability of materials in industry and practitioner concerns and activity is discipline specific. In theatre, dance and opera, for instance, it tends to be focused on production whereas, in the live events and music industry (which includes festivals, exhibitions, conferences, music arenas, and indoor sporting events, although the latter is outside of our scope), it is primarily linked to performance and venue or environment.

Note on Recording Formats

This chapter does not cover sound and music recording formats in this chapter. Similarly, performances made primarily for screen and/or camera are the purview of the "Film and Photography" chapter, rather than this one. However, there is a crossover in terms of hybrid, remote and multi-media performances and/or AV elements of live productions or shows.

Note on Instrument Making

Sustainability challenges and solutions related to musical instrument-making are discussed in the Crafts and Applied Arts chapter and the Case Study on Urban Forestry.

Chapter 3: Cross-Cutting Issues

Peter Oakley

Introduction

Many of the issues around sustainability and adopting a circular economy model faced by the Creative Industries are unique to specific sectors (see chapters 4-9). However, during the review session the project team held in November 2021 some common issues emerged, beyond the universal use of electronic and electrical equipment (see chapter 10) and the use of Carbon Calculation Tools (see chapter 11). These cross-cutting issues were of two types. The first were situations identical to more than one creative discipline. The second were superficially different but had underlying similarities. The list of notable cross-cutting issues we identified during the session are described below.

Current Conventions of Practice

Dominant conventions of practice are highly varied, ranging from specific processes and individual tools to the expected approach to entire projects. What they have in common is a tendency to obstruct shifts towards more sustainable practices and behaviours. They are also often so embedded in their respective creative industry that they are treated by participants as essential rather than conventional. Even questioning their necessity in discussions with practitioners can prove problematic.

Many conventions of practice are concerning from a sustainability perspective. In the performing arts, there is an apparent need for a constant supply of low-cost single-use materials to create audience engaging moments during performance finales e.g. balloons, confetti and glitter (see chapter 9). In the crafts, there is the issue of lumber devouring wood firings (see chapter 4). The fast fashion approach is well established in international fashion supply chains and fashion retailing in the UK, despite the amount of unnecessary waste it generates at every stage of production, use and disposal (see chapter 6), and much of the film industry is still wedded to the practice of junking the sets after a production ends (see chapter 8).

It is notable that one of these conventions - the annual international round of fashion shows - has come under increasing pressure over the past decade. The COVID-19 pandemic has brought to a crisis point an industry model that has been strained for years. Several ongoing debates have arisen over the future of fashion shows. Should they still be divided based on gender? (see Sanders, 2020; Thawley, 2020) Or should the conventional catwalk be jettisoned in favour of more esoteric performance events? (De Klerk 2021). But these questions sidestep the underlying issue: traditional fashion shows consume huge amounts of resources for very little long-term tangible benefit. The necessary outlay can financially ruin a less established designer, remains a substantial outlay for established fashion houses, and the show schedules operate at such a pace and to such exacting scrutiny that success at any cost becomes the imperative. A cornucopia of materials, including fabrics, garments, and entire sets, are used once for the benefit of an elite audience then discarded. In some senses, the fashion show system in the early 21st century bears an uncanny relationship to the sacrificial economies of the Pacific Northwest and Oceania, where the public destruction of goods as spectacle became a means of gaining social status within the community (Mauss 2001).

However, the restrictions on travel brought about by the COVID-19 pandemic has provided a space for virtual alternatives to the physical fashion show to develop over the past two years. These are becoming established and gaining industry acceptance. The ongoing uncertainties caused by the successive waves of COVID-19 has meant that over the past two years, fashion houses have not been able to depend on the attendance of the essential elite audience needed to make their physical show a success. Due to this uncertain situation, the excessive

expenditure such shows demand now make them a much riskier venture, even for established maisons.

A more critical disruption has recently occurred in the watch industry. For decades the leading event of the watch industry was the Baselworld trade show held in Switzerland each February. The show, which began as a Swiss industry showcase in the interwar years, became pan-European in the 1970's, and global in the 1980s. At its height around the turn of the century, the show covered 160,000 square metres and attracted around 100,000 visitors (The Loupe 2016). Baselworld had become so central to the global watch industry that any brand with aspirations to join the ranks of *haute horologie* had to have a stand. The same pressure to demonstrate industry status led the most celebrated watchmakers to rent large spaces on the central avenue and erect imposing two- or three-storey high stands to annually reconfirm their elevated position in the horology hierarchy (ILoboYou 2015).

The Rolex stand at Baselworld in 2017.

Despite its apparently unassailable status at the start of the millennium, Baselworld's dominance collapsed over three years. During the height of the show's popularity, visitors and exhibitors often complained of being treated as cash cows by the city's hospitality sector and the exhibition organisers (see Koh 2021; Robinson 2020). In 2013, Basel's exhibition hall was modernised and remodelled as a piece of signature architecture. The work was undertaken on the assumption that subsequent watch industry shows would underwrite the cost, and as a result the price of exhibiting at the show was substantially raised. But over the subsequent five years the luxury watch industry suffered increasing uncertainties and declining profits. In 2018, 600 of the regular exhibitors decided not to show. The following year the Swatch Group, which controls around half of the notable Swiss watch brands, also pulled out, citing rising costs and declining benefits; it was reported that Swatch had been spending around $50 million a year to exhibit its brands at Baselworld (Naas 2018). Following the crash in exhibitor numbers and loss of many high-profile brands, the viability of Baselworld 2020 was already uncertain before the Covid pandemic struck and the show was cancelled. Basel has now not seen a watch show for two years and the touted 2022 show has also recently been called off. Some of the leading Swiss manufacturers are now holding smaller shows in Geneva for their core clientele. Leading industry insiders believe there will never be another Baselworld (Koh 2021).

What these fundamental shifts in the fashion and watch industries demonstrate is that even industry-wide conventions that appear to be unassailable may collapse if their raison-d'etre becomes undermined. In both cases, the excessive expenditure and material profligacy

thought necessary to underpin the international fashion shows allure and Baselworld's appeal eventually turned out to be substantial weaknesses.

Education
Each sector identified specific educational needs which fell under broad headings: general practitioner education in sustainability and the creative economy; technical skills for sustainability management; and materials of presenting sustainability and circular economy narratives.

General Practitioner Education in Sustainability and the Creative Economy
Due to the recent emergence of material sustainability issues and the circular economy principles as topics of social and political importance, these did not feature in the educational curricula of many creative industry practitioners, either at school or at higher education level. There is, therefore, a clear need for continued professional development opportunities that will address these areas. This is particularly acute in those sectors where sole traders or SMEs are the predominant business arrangements, as such entities do not have the resources to provide such specialist training for their employees.

Technical Skills for Sustainability Management
There is also an evident and acute need for individuals whose skill sets encompass knowledge of the technical issues and analytical and reporting tools relating to sustainability, including: knowledge of material sourcing and associated recording processes to ensure transparency and meet certification requirements; experience of using carbon calculation tools and an understanding of how they operate; and expertise in the deconstruction and dissolution processes and systems needed for end-of-life disposal.

Narrative Skills and Resources for Sustainability Promotion
Creative practitioners are often well placed to be influential advocates for sustainable practices and circular economy principles, either within the organisations they are employed by or through interactions with clients, customers, or audiences for their products. However, without sufficient narrative skills to inform and influence or the material resources to enhance their knowledge (e.g. reports of recent developments) this opportunity is lost. The current production of such resources is ad-hoc and often in the hands of advocacy or campaign groups with specific and often competing agendas.

Transport
In constructing the proposal for the Sustainable Materials in the Creative industries project, it was decided not to include energy consumption, in order that the focus could be exclusively on materials. However, in practice, the dividing line between the two is not hard and fast. In many contexts the two interact, with decisions made about one having direct, if sometimes unanticipated, impacts on the other (see chapter 11).
One such point of connection is transport. In every sector of the creative industries, the transport of raw materials, goods, equipment and sets, or audiences features in some way, bringing with it issues around energy use and the practitioner’s carbon footprint (see chapter 11).

Transporting Materials and Goods
In the sectors of design, crafts, and fashion, transport becomes an issue in the context of the movement of raw materials, intermediate and finished products, and waste. Here the cargoes are fixed. It is the mode of transport and the distances covered that are variable and can be judged in terms of sustainability.
As evident from the examples discussed above, for design, craft and fashion, trade shows bring another set of considerations. In these situations, there is an element of choice over what should be transported, but this is constrained by the industry's current conventions and

the need to present a sophisticated image to clients. Competition within the industry can engender a one-upmanship that leads to material excess.
In the film industry the genre of the film defines the demands made in terms of the types and numbers of cameras, lighting, and sound rigs, as well as the types of costumes needed. At one end of the scale is the Hollywood blockbuster, at the other are lean independent productions that have a minimal material and carbon footprint (see case studies4,7, and 9).
The performing arts have a similar divergence, in this case around the types of sets, costumes and lighting and sound rigs. But the type of performance makes a difference. The breadth of options a contemporary performance company has far exceeds that of a traditional ballet or opera company on tour. The existence of this range of options entails complicated decisions. What materials are suitable for the staging or set? Lightweighting will reduce the carbon footprint but may result in a less robust stage with a shorter lifespan. Here the circular economy imperatives of extending object use and reducing carbon emissions come into direct conflict at the point of material selection.
Transport considerations are also evident at International Art Fairs. The value and nature of the works being shipped to and from the fair's venue imposes a particular strain. Many fairs also require the transport of robust temporary structures and subsidiary equipment needed to provide the infrastructure necessary for a comfortable visitor experience. Despite the recognition that the International Art Fair and Biennale model is inherently unsustainable in its current form, there is far more rhetoric than action in this arena (Gerlis 2019; Tanninen-Mattila, M., 2021).

Transporting People
For the performing arts, the size of audiences features heavily in the sustainability debate. The Green Theatre Book places great emphasis on this issue (see chapter 9 and case study 12).
Commercial trade shows for design and craft products also entail the transport of attendees, sometimes in significant numbers. Baselworld attracted around 100,000 people per year (The Loupe 2016). In 2019, *Ambiente*, the annual consumer goods show held in Frankfurt, had 136,000 visitors arriving from 166 countries (Messe Frankfurt 2019). Spring Fair, the UK's biggest housewares and gift show, held at the NEC in Birmingham, has drawn between 60,000 and 70,000 trade visitors every year over the past two decades. Notably, trade show venues tend to be sited at major travel interchanges, providing more sustainable travel options for their audiences.

Regulatory Change
The impact of formal or self-adopted regulation is another cross-cutting theme, but this time one that is encouraging the adoption of more sustainable practices. In some cases, this has come through government legislation, in others because of adherence to voluntary certification schemes or codes of practice.
The jewellery industry has examples of both types. The US Dodd-Frank Act and EU Non-Conflict Minerals Legislation regulates gold sourcing in terms of these acts and laws, designed to eliminate conflict minerals from international supply chains. At the same time jewellers can choose to become Fairtrade gold or Fairmined gold licensees to support sustainable ASGM communities (see Case Study 1) or become members of the Responsible Jewellery Council, which involves an RJC Code of Practice certification.
One of the hottest topics in the UK's packaging industry is the UK government’s imposition of Extended Producer Responsibility legislation, which will be finalised and implemented over the next two years. EPR is an instrument intended to instigate a more circular economy and is identified as fundamental in Stahel's theoretical model and promoted in the Ellen MacArthur literature. The legislation is having a profound impact on packaging designers in terms of the new demands it places on the packaging industry. In this scenario, the industry appears largely reactive (and at times obstinately uncooperative), though notably some of the larger packaging manufacturers have already reconfigured their practice to tackle the issues the legislation is

anticipated to address. For international companies, the existence of similar EU legislation also in development has helped in this process.
In contrast the performing arts has been far more proactive in developing its own set of working criteria, materialised in the form of the Theatre Green Book (https://theatregreenbook.com/). In a sharp contrast to the packaging industry's confused response to the EPR legislation, there is an evident sense of ownership and forwards thinking regarding what sustainable practice might be from the performing arts industry. The Theatre Green Book initiative has a significant overlap with the aims of the charity Julie's Bicycle, which focuses on carbon reduction in the performing arts sector. Though ostensibly voluntary, Julie's Bicycle's carbon calculation tool (chapter 11) has also gained a measure of formal recognition and practical clout through its promotion by the UK's Arts Council as the preferred option for applications to their calls.

Jellyfish Theater by Kaltwasser and Kobberling, 2010. The first theatre building in London made entirely of recycled materials. The building was used to present a programme of performances about sustainability issues (see Akt II, 2021). Photography by Brian Benson.

The ubiquity of regulatory frameworks, either legislative, voluntary, or located in a grey area somewhere between the two, makes them an important aspect of the sustainability landscape in the creative industries. The responses of individual practitioners to these instruments, negative as well as positive, and the motivations behind these responses, are very poorly understood.

Communities of Sustainable Practice
Perhaps one of the most heartening aspects of the research was finding established and active communities of sustainable practice. These differed from industry associations, whose membership might, but did not necessarily have an interest in improving the sustainability of their actions. For communities of sustainable practice an active and applied interest in the topic was foundational to the assembly and functioning of the group as an entity. That said, the structures of these entities varied. As an ad hoc attempt at categorisation, these have been grouped into four types, based on the relationships between most of their membership

and its core stewards: formal associations; formal initiatives with loosely affiliated adherents; acephalous advocacy groups; and informal support groups.

Formal Associations

The first category is perhaps the most easily recognised: formal associations. These have a hierarchical structure, often with paid staff in senior management and core administration positions. The more junior members of the group may be there from personal interest or work requirements, with some cross-over between the two (e.g., personal career development). The association's relationship with commercial companies is either close, or even entwined; some associations were set up by coalitions of companies with a mutual interest. An association's leaders are often seconded or retired from one of the group's affiliate companies and movement between corresponding roles in the affiliated companies and the association itself is part of a relatively common career path for those at all management levels. This proximity is frequently criticized by more alternative-minded sustainability and social justice campaigners as inevitably compromising, due to the employee's individual's supposed internalisation of the commercially based agenda of their current or previous employer.

Examples of formal associations include Fashion for Good; Global Fashion Agenda; the Responsible Jewellery Council, the Sustainable Production Alliance; Sustainable Packaging Coalition and Sustainable Production Alliance.

Formal Initiatives with Loosely Affiliated Adherents

Less hierarchical, but with a still recognisable core, are initiatives with loosely affiliated adherents. These tend to assemble around a successful and formal programme of action that acts as the centre of gravity. The wider group does not have a formalised structure towards the core or each other. Perhaps the best visualisation is of a cartwheel with a variable number of spokes, each of which represents one of the affiliated adherents. Such groups prove unstable if the hub loses coherence or impetus, but the hub, whilst not relying on any one affiliate, needs a critical mass of adherents to operate.

Initiatives with loosely affiliated adherents include the Precious Plastics network (Case Study 6) and Fairtrade licensee jewellers (Case Study 1).

Advocacy Groups

In contrast to the previous two communities, advocacy groups coalesce around the pursuit of a single ideal or campaign for a specific aspect of social justice. Whilst they develop a coherent group identity, they often do not have any established management structure. The operational tasks are frequently undertaken on a volunteer basis, and major decisions tend to be reached by consensus. This informality is a double-edged sword. On one hand it allows for new members to assimilate easily and take on responsibilities as far as they are able. On the other, it restricts collaborative opportunities with more formalised organisations. This is partially due to legal restrictions, but even when these are not exclusionary, the difficulties of joint working when the partners have such different structures also plays a part.

Examples of advocacy groups are Fashion Revolution (see Chapter 6), Fair Luxury (Case Study 1), and the network that created the Green Theatre Book (Case Study 12).

Informal Support Groups

The last category covers informal support groups relating to sustainable practice. Unlike advocacy groups, these are not built around a specific issue, but a particular practice, and are open-ended in terms of intention. They are therefore like other support groups or active networks. The network can be based around in-person meetings, virtual interactions, or a mixture of both. The rise of online social group platforms such as facebook, Instagram and LinkedIn is a fundamental part of the phenomenon. Membership is at the discretion of all the current group members, in terms of whether they individually choose to engage with potential new members. Such networks are notoriously hard to gather information on due to their lack of profile and records (online contact platforms often being the best record when these have

an archive). In some cases, the reluctance of their members to consider the network an entity worth discussing or reflecting on is an additional obstacle.
Examples of informal support groups include London's urban forestry network of sawmill owners and furniture makers described in the Urban Forestry case study (Case Study 13).

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Chapter 4: Crafts and Applied Arts

Peter Oakley and Rebecca Lardeur

Description of Scope
The term crafts and applied arts covers a range of specialist material disciplines, typically with a long history of practice and associated heritage. Most are heavily reliant on manual making techniques. In many cases the craft discipline has an industrial equivalent, e.g. furniture design, ceramics and textiles. However, due to the difference in scale of operation, the techniques employed, and to some extent, the exact materials used and the ethos of the practitioner, there are evident and fundamental differences in practice with regards to materials sourcing, use and disposal.

The individual craft and applied art disciplines that were examined are:

- Blacksmithing
- Bookbinding
- Ceramics (studio)
- Clock and Watchmaking
- Furniture Making
- Glass (studio)
- Jewellery
- Leatherworking (bespoke)
- Metalworking (base metals)
- Musical Instrument Making
- Restoration (Fine Art)
- Restoration (furniture and textiles)
- Silversmithing & Goldsmithing
- Textiles (studio)
- Woodworking

Most professional craft and applied arts practitioners operate as sole traders or small or medium side enterprises, with a tendency to be on the smaller end of the SME scale. There is also a significant leisure or hobby constituency for most crafts. In addition, the boundary between professional and amateur is extremely blurred. Notably, the appearance of online selling platforms such as Etsy has facilitated opportunities for craft and applied arts makers to generate a second or supplementary income whilst remaining in employment elsewhere.
The report structure has included all jewellery and watchmaking practice within this section of the report. Whilst globally, jewellery and watch manufacturing includes large companies, the industry is smaller in the UK; most jewellery manufacturing businesses are categorised as SMEs (Department for International Trade 2020; OECD 2005). In addition, manual or semi-manual processes are still in evidence in many jewellery manufacturers. This stands in contrast to disciplines such as ceramics and furniture production, where almost total automation exists at the industrial scale and the use of different types of materials is also very evident.

Use of Electronic and Electrical Equipment across the Crafts and Applied Arts
Despite the supposed continued predominance of manual techniques across these disciplines, in many contexts craftworkers do make use of electrical tools and equipment. Most crafts encompass a range of related processes, some of which are dependent on electricity and electronics and others which are entirely manually operated e.g. a bench jeweller may use just hand tools or choose to employ an electrical pendant drill; studio ceramics can be

practiced using either electrical or wood-fired kilns and in either case the firing temperature can be managed by taking readings from electrical thermocouples or from direct observations of pyrometric cones; a furniture maker may use manual saws and an electric circular saw at different times when making the same piece of furniture. In other situations, the construction process is manual whilst the material preparation uses electrically powered equipment e.g. leather skivers or clay pugmills. Professional practitioners running a business often make use of electrical equipment to undertake tasks that would be exhausting or too time consuming to do manually on a regular basis.
In a similar manner to other creative industry professionals, contemporary craft and applied arts practitioners make extensive use of digital technology for a range of purposes connected to their business but not to making *per se*. These include promoting work to clients, customers, and retailers; selling work; making or receiving payments connected to running the business; extending their making skills and business management skills through training; and wider networking. Consequently, desk computers, laptops and mobile phones have become business necessities rather than personal luxuries.

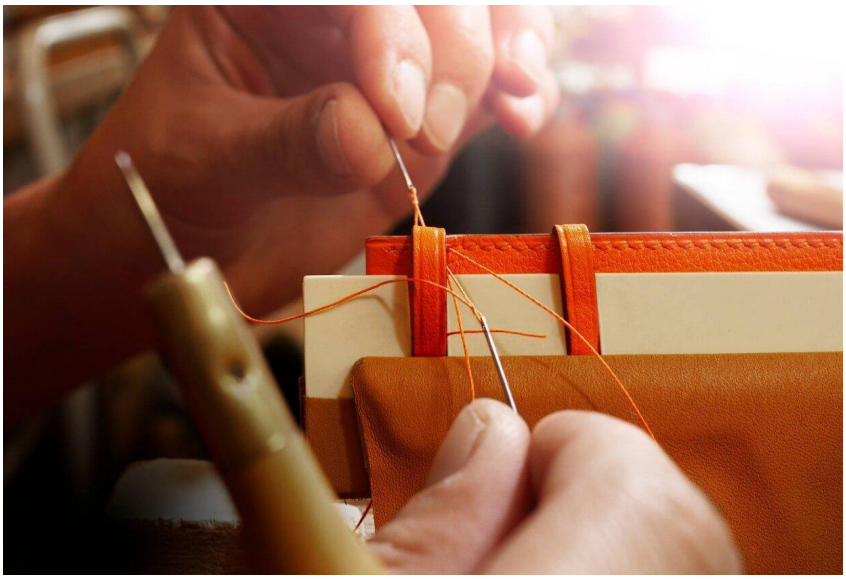
Craft and Applied Arts defined
In contrast to the definitions used for other sectors, the term ‘Crafts and Applied Arts’ will be considered contentious by some of the practitioners being represented. This is due to perceived implications of hierarchies being imposed and the discipline’s consequent relative social status. For some makers, ‘crafts’ carries connotations of being backwards looking, connecting to a type of ‘play history’, allied to historical re-enactments. They feel his underlying association damages their credibility. ‘Applied Arts’ has different issues. The term is relational to the ‘Fine Arts’ and suffers from perceptions of subordination, somehow contaminated and denigrated by these activities' connection to trade and commercial products. Both terms are also ‘conceptually leaky’ in that their constituent disciplines have never been fixed and have undergone notable shifts over time (Adamson 2007, 2018; Pye 1968; Sennet 2008).
There have been past attempts to re-designate individual practises through new appellations. Most of these now either only have limited currency or have fallen from use entirely. For example, at different times over the past 70 years ceramics practitioners have employed the following: potters, studio potters, ceramicists, designer-makers, artist-makers, artist-craftsmen [sic] and ceramic artists, depending on how they see their practice and which other creative activities they want to be associated with.
The situation is complicated by the varying positions of government funded institutions, charities, and foundations. The Crafts Council (https://www.craftscouncil.org.uk) was set up by the government as a non-departmental public body in 1983 and became a subsidiary organisation of the Arts Council in 1999. Its original defined focus was supporting the "artist craftsman" [sic]. Today the Crafts Council’s efforts are mostly directed towards advocating that the crafts are contemporary artistic endeavours of social and economic relevance (e.g. Crafts Council 2021; Morris Hargreaves McIntyre, 2020). Conversely, the Heritage Crafts Association (https://heritagecrafts.org.uk/) claims: "In the UK traditional crafts are not recognised as either arts nor heritage so fall outside the remit of all current support and promotion bodies". As both these organisations support London Craft Week (https://www.londoncraftweek.com), the resulting event consists of a heterogenous mix of participants that extends beyond either organisation’s definition.
The lack of precision in the term craft presents ethical and practical issues when it comes to collecting and analysing data. A practitioner’s self-identification may lead them to be mis-categorised as a fine or contemporary artist or a designer working in one of the industrial specialisms where this professional title is typically employed. Individuals undertaking activities they term a craft but which sit outside the creative industries definition may erroneously be included. The potential for error is greater in anonymous data provision contexts, such as in the online survey. In face-to-face engagements and textual research, the researcher has had to make an individual judgement call on the practice being described.
The terms employed in this report are intended to encompass the series of disciplines listed above, without making any judgement as to their cultural or social value or status relative to

other creative sectors. Notably, most of this list aligns with the Crafts Council's definition, which considering the overall project scope of focusing on the creative industries, is to be expected. The most obvious difference is the inclusion of restoration and conservation practitioners, whose activities turned out to have much in common in terms of needs and decisions over sourcing materials and making processes.

Is craft inherently sustainable?

The ideology of independence and self-reliance that was evident in the mid to late twentieth century as a fundamental aspect of creative craft practices (see Albers 1966; Leach 1945) has diminished as an overt driver of behaviour amongst craftworkers. This is in part due to a critical re-evaluation of its viability in practice, including the actual circumstances of this position's strongest advocates (Adamson 2018; De Waal 2013).

Over the past two decades there has also been an element of 'reclaiming turf' by larger companies operating in the hard luxury goods sector (e.g. jewellery, leather accessories). This has been part of a wider shift from their previous reliance on individual brand identities as an abstraction. Increasingly, companies have shifted to emphasising a connection to their brand's heritage and, through this, to the value of craftsmanship [sic] as a justification of their companies' position in the market. Exceptional craft skills are seen as a means of realising the maison's creative director's unique vision. Here the craftworker is seen as an integral element of a larger organisational structure but with very limited autonomy (for examples, see: LVMH 2021; Kering 2021; Martin Roll 2021).



One of a gallery of images on the Journal Haute Horologerie website describing the construction of a Hermès watchstrap © Hermès

But there is still some element of anti-industrial romanticism – an undertow of a desire to escape the madding crowd or the rat-race – surfacing in these and many other contemporary craft businesses' promotional strategies, and this can interact with, or partially rely on, avowedly sustainable approaches to working. Often this is implied through imagery or elliptical narrative statements, rather than claimed clearly and directly. Therefore, in assessing this promotional material, one needs to be careful not to take too much on face value. The use of circular economy principles as benchmarks has been useful in this regard. Applying these criteria has thrown doubt on the veracity of some of the approaches as sustainable from a holistic viewpoint, even when the subject obviously meets individual aspects.

However, the typical size of craft operations in the UK and the requirement of managing a small enterprise means that craft and applied arts practitioners tend to become knowledgeable about the circumstances of production and experts in a wide range of skills that relate directly and indirectly to the discipline they practice. This sits in contrast to the acute specialisation of

employees that occurs in larger businesses. The overall grasp that craft practitioners running their own business possess – which covers material properties and sourcing, the nature of their product range (including its overall material composition and long-term durability), and the possibility and practicality of offering ongoing maintenance, servicing, or repair options to customers – puts them in the ideal position to make holistic assessments regarding their products' current sustainability and how it might be improved. Unlike specialists working in a large company, practitioner-owners also have the direct authority to implement the changes they believe are needed to become more sustainable. In addition, many craft and applied arts practitioners teach their skills to novices, either as informal apprentices or through short courses in specific techniques, as an element of their business model. They can therefore pass on sustainable principles as part of this process.

Sustainability issues relevant to Crafts and Applied Arts

Craft and applied arts practitioners typically work in SME contexts that tend to specialise in utilising one type of material and a small number of associated manual-focused processes and technologies. Their products are typically hard goods that are sold onto customers. These products are usually discretionary purchases with a price premium to more prosaic alternatives. Many fall into the luxury goods bracket.

Consequently, the key issues for craft and applied arts coalesce around:

- Practitioners 'locked in' to working with unsustainable materials
- The lack of leverage the practitioner has over essential material supply chains
- Practitioners 'locked in' to employing unsustainable making processes
- The sourcing of a limited range of very specialist materials, usually of high quality with distinct aesthetic and functional properties
- The dominance of the 'goods for sale' model - linked to the linear economy.
- The lack of resources available to support extended producer responsibility

Positive aspects are:

- Their products are typically well-made from appropriate and high-quality materials and therefore comparatively durable.
- Craft and applied arts practitioners have a high level of expertise around the nature of their specialist material.
- Some craft practitioners have developed alternative, more sustainable supply chains for specific materials
- Direct and profound engagement with customers that facilitates explanation and transmission of sustainable practice where it exists.
- The widespread existence of craft object maintenance, servicing and repairs.

Practitioners 'locked in' to working with unsustainable materials

Some materials used in the crafts are, by their very nature, limited resources. Metals and clay must be mined where they are found as deposits. In some cases, the only supplies available to craftspeople are entwined with large-scale extraction operations. These have assumed their current form through successive restructures of supply chains by multinationals making decisions based on the locations of international supplies and global markets, leveraging economies of scale and socio-political opportunities to enter or corner new markets. Such is the case with china clay, cobalt and steel.

For example, though the UK has extensive china clay reserves and mines, these are managed by international conglomerates and the clay that is extracted is immediately exported in industrial quantities. In 2018 overall UK production of china clay amounted to 0.9 million tonnes and entailed the production of mineral wastes eight times that amount, with only about 15% of the waste material being repurposed (Wardell Armstrong LLP 2021). Meanwhile most ceramicists in the UK are now buying and importing prepared clay bodies from craft suppliers

based abroad, entailing the carbon cost of international shipping. This may also involve the unwitting re-import of exported UK raw clays that had been used to prepare the clay body. In the immediate aftermath of Brexit, the international nature of these supply chains briefly became apparent as supplies of clay to UK craftworkers were severely disrupted.
Equally, the international market for cotton and the lack of transparency in supply chains makes it very possible a craft weaver working in the UK is using cotton grown in Central Asia that has contributed to the excessive and ongoing water depletion in that region (Environmental Justice Foundation 2005, 2012; Satke 2021).
In cases where more responsible extraction options exist (e.g. digging local clay rather than purchasing mass-produced clay bodies), the more sustainable approach may involve additional costs, time, resources, and extended expertise that are formidable barriers to their adoption. The decline in use of local mineral deposits in the UK since the mid-twentieth century, which has accelerated since the 1970s due to de-industrialisation, alongside the growth in the gentrification or fetishization of rural landscapes, places additional barriers in the face of those wanting to exploit such resources. Examples of objections to extraction projects, even on a small scale, include the ongoing controversy over the Scotgold gold mine at Cononish, near Tyndrum, on the edge of the Loch Lomond and Trossachs National Park (see Kempe 2017, 2021; The Scotsman 2010).
Perhaps the most extreme example of an unsustainable craft material is lead crystal, traditionally used by craft glassblowers and cutters in the UK. This aesthetically beguiling material is highly polluting in terms of the lead fumes given off by the molten glass during production. But it has recently been identified as also toxic in general use due to lead leaching. This makes it highly unsuitable for drinking vessels, including wine glasses and whisky tumblers. Lead crystal is even more unsuitable for long-term storage of acidic alcoholic drinks such as wine; despite their visual appeal, lead crystal decanters are a definite health hazard (Schwarcz 2019). In such situations, there needs to be a determined change in material selection. Alternative options are available, including some which also help resolve the issue of currently dysfunctional waste 'management'. The Upcycled Glass Project is proposing repurposing architectural glass waste, which currently goes direct to landfill, as a raw material in an innovative recipe for glass cullet for glassblowing (Hankey 2021).

The lack of leverage the practitioner has over supply chains
Many contemporary supply chains which developed during the twentieth and twenty-first centuries incorporate a severe imbalance between large material suppliers and the numerous small craft businesses they serve. This disparity can be exacerbated by the suppliers also having much larger industrial downstream clients or with companies supplying the material to diverse markets that are competing with craft production as buyers.
Perhaps the most extreme version of this situation is the global gold supply chain, where sole trader and SME jewellers in the UK and elsewhere are competing with larger jewellery

manufacturing companies overseas, and all are competing with the much larger gold investment market, which purchases gold bullion as a store of wealth, and the growing use of gold in the electronics sector (see chapter 12 electronic and electrical equipment) and a range of other advanced applications, including nanotechnology (see Letcher and Scott 2012).
However, the same issue is evident in the case of cobalt, used as a glaze colourant in studio ceramics, a glass colourant in studio glassworking, and a pigment in fine art paint manufacturing (see chapter 10 Fine Art). Cobalt is also an essential material in the production of many electronic devices and other technological applications (see chapter 12 electronic and electrical equipment).
For some materials this issue may not affect all practitioners. If there is a disparity within the discipline, it tends to be those craft practitioners who are using more generic materials, which are also those sought by industrial manufacturers, that have been the most disadvantaged. This is evident in the supply of metals, clay bodies, leather, and wood. That said, the more specialised a material the more costly it tends to be, a situation that then determines the market for the finished crafted products. However, in some specific cases craft practitioners have developed alternative supply chains that evade competition whilst restraining costs (see below).

Practitioners 'locked in' to employing unsustainable making processes
As noted earlier, some craft processes are extremely profligate in terms of secondary material use. As an example, the amount of wood needed for one ceramic wood kiln firing is usually measured in the Imperial measure of cords ($3.62m^3$), with 1.5 cords being a reasonable amount for a typical production firing in an average wood-fired kiln. The source and quality of the wood being burnt are key variables in determining the sustainability of the process in specific situations. Ceramicists' continued adherence to the practice is based on a mixture of tradition and the unique glaze aesthetic of the results, which is due to the ash drawn into the kiln chamber from the firebox. The same surface effect is not attainable by using electric or gas kilns.

Left: a cord of wood. Right: a wood fired pot.

If the wood collection for wood firings is an integrated part of a forestry management plan there is a potentially valid claim to its sustainability. However, this is rarely demonstrated. There have also been claims made that burning 'waste' wood should be seen as sustainable, though the examples given, such as using pallets, are easily criticized as contrary to circular economy principles, as the pallets could be reused, rather than incinerated.
A more promising avenue has been the use of waste vegetable oil as the fuel for firing kilns, an approach that has been successfully employed for two decades (Harrison 2013). However, though used vegetable oil was a classic waste material two decades ago, its potential as a

fuel in other contexts has since been recognised (including as a feedstock for biodiesel). Consequently, there is now a potential issue with future supplies.
It may be that the most long-term viable approach is for ceramicists to use the most efficient kiln possible in terms of insulation heat retention and for the heat source to be the most sustainable possible e.g. electricity generated from sustainable sources.

The sourcing of a limited range of very specialist materials, usually of high quality with distinct aesthetic and functional properties
Craft goods are often discretionary purchases, with the quality of the materials employed being an important customer consideration.
A good example is the case of leather products, where the quality of the hide and the tanning process contribute significantly to the final look and feel of the finished article. There are two main types of tanning: vegetable tanning and chrome tanning. The latter is the more recent industrialised process, making use of chromium salts to preserve the leather. Vegetable tanning, which makes use of the tannins found in tree bark, is considered more environmentally friendly but is also more expensive as it is more time-consuming and costly in terms of raw materials. The UK is home to a small number of vegetable tanners, including J. & F.J Baker (https://www.jfjbaker.co.uk/) the only remaining oak bark tanner in the UK, and Thomas Ware of Bristol (https://thomasware.co.uk/). these companies supply high-end shoemakers and other leatherworkers.
A similar reliance is found in bespoke furniture making, with the type and seasoning of wood being fundamental to the final look and feel of the finished piece (see urban forestry case study).

The dominance of the 'goods for sale' model, linked to the linear economy
Historically, craft workers have had a variety of relationships with the users of their products. This has included arrangements of exclusive patronage (sometimes even with an aspect of coercion or incarceration). In the British Isles, the establishment of the craftsman as a supplier to the open market was well established by the time of the industrial revolution, and craft wares ended up competing with industrially produced goods. Consequently, craft has only retained a foothold in niches where aesthetics or bespoke production is an evident and valued aspect. Craft practitioners have adapted to the linear economy both in terms of the type of objects they sell and the methods they use to attract customers and make sales. Whilst the growth on online sales platforms such as Etsy have opened new markets, virtual seller-buyer relations are constructed along the same lines as in-person sales. One could even claim that the digitally mediated nature of the contact means online sales have become even more de-personalised, with constructed narratives and visual facades built on stereotypes replacing the last vestiges of personal engagement.

The lack of resources available to support extended producer responsibility
If the need to fit into the linear economy model makes large demands on small craft businesses, the demands of extended producer responsibility may exceed even that. The resources necessary to assume continued ownership are often beyond the financial means of craftworkers operating alone or in small groups. Whether is this a viable model in the form currently promoted in the circular economy literature is a moot point; it is telling that in *The Circular Economy: A User's Guide,* Stahel equates point of sale with the factory gate, not the studio door or gallery shelf (see Stahel 2019, p47). However, as covered later in this chapter, a few crafts include arrangements that bear a marked similarity to EPR, and it would be useful to understand how and why they operate successfully.

Craft products are typically well-made from appropriate and high-quality materials and therefore comparatively durable
In terms of supporting extended use, the material selection that goes into craft practice tends to support the extended lifespan of the resulting goods. The high level of conservatism in process found in most crafts is linked to this feature, as is the lack of rampant experimentation

in form and surface. Both are in part due to the best solution having been determined by previous generations of practitioners. Craft is therefore materially and conceptually the opposite of the notion of fast fashion and the faddish short-termism in ownership that fast fashion promotes.

Craft and applied arts practitioners have a high level of expertise around the nature of their specialist material

This apparently unremarkable fact has profound implications for extending use, effective repair and refurbishment, and the responsible disposal and recycling of goods. Experienced craftworkers can determine the future lifespan of products, the most effective methods of repair, and have the practical ability to follow through on this knowledge.

Some craft practitioners have developed alternative, more sustainable supply chains for specific materials

This has been a growing feature of recent craft practice. Though it is tempting to presume a direct linkage to the self-reliance and anti-industrial ideology of 20th century studio crafts, this might be a misleading interpretation. Many practitioners are conceptualising their approach to material extraction, harvesting or processing more in terms of acting in a more sustainable and responsible manner as global citizens, rather than embarking on a romantic quest to evade the modern world or undertake a spiritual journey.

In these situations, the claim to sustainability can be made through different criteria. In the case of the Thorody Flax Project (https://www.crowdfunder.co.uk/thorodyflaxproject), the intention is to re-establish a once thriving local industry - flax growing and linen production - in Southwest England. The project is based on enhancing the local ecology and agricultural diversification, as well as reducing the carbon cost of transporting the harvested flax to northern France for processing and weaving.

It is perhaps worth noting environmental sustainability is not the only benefit the project will bring. As well as offering new employment opportunities, in a post-Brexit context the channel-hopping of raw materials which the current flax-linen supply chain relies upon will become more difficult to successfully manage.

For other crafts, there are different drivers. The rise of urban forestry is a counterbalance to the waste of a difficult-to-source product: high quality specialist woods. The drift towards standardisation of feedstock and large-scale extraction amongst large sawmill operations has led to their rejection of involvement in the sensitive extraction of trees from urban sites. The waste of resources that this flight to volume and standard product by large operations entailed - urban trees had to be chipped, rather than extracted to be cut into lumber - has led to committed individuals setting up small extraction and sawmill operations (see case study: urban forestry)

ABOUT

OUR AIM IS TO GROW 1 ACRE OF FLAX AS A PRECURSOR TO ESTABLISHING A MORE SUBSTANTIAL COMMERCIAL FLAX GROWING SOCIAL ENTERPRISE THAT IS ENVIRONMENTALLY RESPONSIBLE. INITIALLY THE AMOUNTS OF FLAX FIBRE FROM 1 ACRE WOULD BE SUITABLE FOR HAND PROCESSING AND WEAVING. EVENTUALLY WE AIM TO DEVELOP AN INTEGRATED 'GROW, PROCESS, SPIN, WEAVE AND SELL' SOCIAL ENTERPRISE INVOLVING LOCAL SMALL FARMERS AND CREATIVE ENTERPRISES IN PLYMOUTH AND CORNWALL LINKING THE CITY TO THE SURROUNDING COUNTRYSIDE AND VICE VERSA AND PROVIDING SUSTAINABLE AND LONGTERM EMPLOYMENT AND TRAINING OPPORTUNITIES IN THESE AREAS.

The Thorody Flax project crowdfunder page

Direct and profound engagement with customers that could facilitate explanation and transmission of sustainable practice where it exists

In some cases, craftworkers are very successful ambassadors for their own products. Examples include the successful shoemakers CarréDucker https://www.carreducker.com/ and the woodworker Gareth Neal https://www.garethneal.co.uk/.

However, it is not inevitable that a craft practitioner possesses the ability to communicate their insights about the sustainability of their products to potential owners or can explain why users should or should have selected a particular object made from a particular material in a particular way in the first place. It is also currently not a substantial aspect of craft training, or most craft related HE courses; these tend to focus more on the making process itself.

In conducting research for the SMICI project it has been noticeable that in the online world this role is often taken by third-party influencers. These include the journalist Simon Crompton, whose Permanent Style website (https://www.permanentstyle.com/) and newsletters tirelessly and effectively promotes craft makers relating to men's fashion. Similarly, the broadcaster, journalist, and curator Corinne Julius champions UK crafts through media articles for a diverse range of publications and exhibitions, including the 2017 show Silver Speaks: Idea to Object held at the Victoria and Albert Museum. However, to date these promoters have not focused on craft's sustainability credentials where these are evident.

Crafts magazine, published by the Crafts Council, has made efforts to engage with the sustainability agenda, recently devoting an entire issue to the subject of restore, repair, renew. However, the extent to which Crafts or similar lifestyle publications can present a critical viewpoint or initiate direct debate around the issues associated with adopting circular economy principles is limited by their format, circulation and core audience.

A FINE BALANCE

For a new wave of craft businesses, social and environmental values have equal weight to profit. ***Debika Ray*** *speaks to four companies that are rethinking what success means today*

OTTER SURFBOARDS

Crafts Magazine Issue 291 Restore, Repair, Renew pp 58-59.

The possibility of offering servicing and repairs – in many craft contexts these are already well-established services

As the development of repair and refurbishment is identified as a key element of a circular economy, it is interesting to note that in some craft disciplines this is already part of established practice, whereas in others it is almost entirely absent.

In the craft jewellery sector and in leatherworking, specifically cordwainery, repair and renovation are often part of the ongoing after service offered to clients. In recent years this has even extended to jewellers' advertising to design new pieces that incorporate old (usually inherited) gemstones. It is perhaps worth noting this activity is also not new. It was traditionally practised by high-end jewellers for their established clientele, but not couched in terms of sustainability, but offered more as a discrete service. This was because the rationale was usually keeping up with the latest fashion when one could not afford to purchase new diamonds.

Ceramics are difficult to repair in terms of individual items. But for dining sets the long-term production of specific ranges facilitates continuity of use of a set when individual items are broken. This is an important aspect of the high-end casual dining trend in the hospitality industry, where characterful craft ceramics are used to help create an informal but highly aesthetic ambience.

Repair is also a significant element of the clock and watch trades and bookbinding. It is the raison-d'etre of the entire restoration sector.

Sustainable Practice in Crafts and Applied Arts

The current situation offers a very mixed picture, between and within craft disciplines in the UK. Proactive individuals have been responsible for impressive innovative developments, and the craft disciplines appear to have much more potential to contribute to a circular economy. Yet most craft practitioners lack sufficient access to knowledge about supply chains, material certification options, and cutting-edge developments around sustainable practice. They also lack the financial resources to implement changes or experiment with new, more sustainable materials. Lastly there is a concern around the expectations of their current client base, and a general lack of the promotional skills needed to advocate for a change in customers' attitudes.

Glossary

ARM	Association for Responsible Mining https://www.responsiblemines.org/en/
ASGM	Artisanal and Small-Scale Gold Mining
Craft Council	https://www.craftscouncil.org.uk/about/our-work
FSC	Forestry Stewardship Council https://fsc.org/en
HCA	Heritage Crafts Association https://heritagecrafts.org.uk/mission-and-aims/
Kering	Kering S.A. Luxury Conglomerate. https://www.kering.com/en/group/discover-kering/
LVMH	Louis Vuitton Moet Hennessey, often shortened to Louis Vuitton. Luxury Conglomerate. https://www.lvmh.com/group/
SME	Small or Medium-sized Enterprise https://stats.oecd.org/glossary/detail.asp?ID=3123
Richemont	COMPAGNIE FINANCIERE RICHEMONT SA Luxury Conglomerate. https://www.richemont.com/en/home/about-us/what-we-do/
RJC	Responsible Jewellery Council https://www.responsiblejewellery.com/

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Chapter 5: Design

Peter Oakley and Rebecca Lardeur

Defining Design

Design as a profession operates in terms of product specialisms, such as: exhibition design, furniture design, product design, and packaging design. However, design consultancies and design-led manufacturers may work across multiple cognate areas, especially when there is a commonality of materials or context across their product range e.g. Liqui's (Liqui Design, 2021) product range covers both exhibitions and furniture.

For the purposes of this report, architects have not been treated as designers. This has been decided on the basis that the materials their finished products – buildings – are constructed from, such as brick, concrete, and steel, fall under other research councils' remits. However, the practice of model making within architectural studios, which can be thought of as the materiality of the creative process itself, is included. This activity also bears a close relationship to the creation of product prototypes for manufacturing and the two are often undertaken in the same workspaces or studios.

The more intangible design specialisms, such as digital graphics, games design, animation, and virtual or augmented reality production are not identified or discussed directly in this chapter. The digital tools used in these creative specialisms are covered in the chapter on electronic and electrical equipment (see chapter 11) and the lens-based equipment addressed in the chapter on film and photography (see chapter 9).

Design and the Circular Economy

Almost uniquely amongst the creative industries, design is assigned a specific set of tasks in circular economy theory. Design is charged with extending objects' lifespans, enabling repair, refurbishment, and reconditioning, as well as facilitating final disassembly (see Ellen MacArthur foundation 2021; Stahel 2019; also See also case studies 2 and 3).
In actuality, design has a more extended role. The support infrastructure for more sustainable goods and services, such as electric vehicles, require a design input (Royal College of Art, 2021) as do waste recovery and sorting systems.
In addition, depending on the nature of the product, a designer may have an input in or even completely control, the material selection for parts or even all of a product. This has a fundamental impact on how sustainable that product is going to be from a material sourcing perspective (including issues of extraction or harvesting as well as processing and transportation), as well as influencing the product's longevity and the end-of-life material recovery.
Design also has a role in upcycling materials, as recovered materials may impose additional restrictions on manufacturing - which will need to be taken into account in the design - when compared with their virgin counterparts (see Case Studies 6 and 10).
However, the circular economy theory does tend to treat design as an abstraction, rather than situating it as a skill set possessed by an individual or a profession, with all the social implications that entail.

Design as a Practice

In almost all contexts, designers operate in relation to a manufacturing or service industry. They are either directly employed within a company and integrated into its hierarchy of employees or retained on a temporary or semi-permanent consultancy basis to contribute to

individual projects. This type of relationship has strong similarities to the roles a creative director or commissioned fashion designer has within the fashion industry (see chapter 6) and some commonalities with the creative management in the performing arts and film industries (see chapters 7 and 9). There are also a small number of designer-makers who engage with the manufacture as well as conceptualisation of products and some small companies whose heavy focus on aesthetics means they can be considered as design-led. This end of the design spectrum has a closer relationship to craft practice (see chapter 6). When designers choose to work in larger organisations, they work within its hierarchy and their perspective and vision is moderated by the sourcing, production, marketing (and possibly retail) managers, as well as the finance, legal and corporate responsibility directors and the CEO. At the same time as the larger corporation gives opportunities in terms of the number and range of products, it diminishes the designer's overall influence on the nature of the goods being produced.

Almost all designers work with materials, even if vicariously. Consequently, they develop a direct understanding of material properties and the principles of material science, though this may be tacit and empirical rather than explicit and theoretical. The design perspective always encompasses aesthetics in some form, whether it is the pursuit of spectacular beauty or the elegance of expressed functionalism. But once design becomes purely concerned with functionality, it tips over into engineering.

Over the past three decades, there has been a profound shift in theoretical and educational design practice towards the social role of design, with a rejection of the notion of design as simply the provision of a new look or style to generic goods. This evolution opens more of a space for the inclusion of sustainable material sourcing and manufacturing and the realisation of circular economy principles. Despite this shift, within more commercially driven contexts, the designer is still employed primarily to exploit visual and haptic appeal to differentiate products and make them more appealing to potential consumers.

Design also has its own cross-cutting infrastructure, including material libraries and materials testing laboratories, which provide a universal service to the sector. As repositories of knowledge and material insight, these low-profile entities have the potential to facilitate and promote more sustainable manufacturing.

Materials Libraries

Designers use materials libraries to support their decision making during the creative process and follow the latest trends in the field. Samples of materials are often requested from the library or the supplier and help a haptic-informed design choice. By nature, the libraries' influence on the end product makes them a key to sustainable materials expansion. Materials libraries might solely focus on sustainability or offer a range of sustainability options in their database.

For example, the Thai Creative and Design Centre presents its materials based on the manufacturer's location, promoting local factories (Thai Creative and Design Centre, 2021). The Materiom library, experts in bioplastics, invites collaborators and makers to scroll through materials by ingredients or process (Materiom, 2021). The Rematerialise Eco Smart library is organised by type, process, character, and application (Kingston University, 2002).

Categorisation of each library varies, with examples primarily focused on recycled and recyclable materials, bio-based materials, sourcing transparency or carbon impact of materials. The clarity of how 'sustainable' came to be defined is not always shared with the user. When the definition is left unclear, the variability allows for abuse in the accuracy of sustainability principles. It implies different priorities for each of which the designer might not be aware of.

In the case of recycled materials, the amount of recycled and virgin materials mixed to produce new materials might not be clear, neither for its source location. For bio-based materials, the accuracy of its compostable abilities might mislead to dispose incorrectly of the object as the UK does not have sufficient industrial composting facilities (Powersystems UK,

2019). Sourcing information might not be shared alongside water and electricity usage information. The carbon impact of materials categories will allow a loose understanding of sustainability principles (see chapter 11).

Architectural Models and Production Prototypes

Architecture studios mainly discuss sustainability from the perspective of the building materials and less through the view of the physical models. The most common materials found in model-making are glue and foam board, resulting in a low capacity for recycling and disassembly. Architects in the UK started a support group (UK Architects Declare Climate and Biodiversity Emergency, 2021). No support or advice for model-making appears – although support for building materials and sharing resources is provided. This understanding of model-making as part of the architectural practice contrasts with the increasing emphasis on using sustainable materials in the actual buildings being constructed.

Wood and paper are sometimes used in architectural models, but it should be noted that these materials are more complex to work with than foam, requiring expert knowledge; hence these options of paper and wood-based products become less desirable for most practitioners. Office conversations seem to emphasise recycled materials for model-making, but as long as glue is used, the recycling process will be challenging.

Architecture modelling has grown exponentially in the last few decades (Fairbrass, 2016), both for rendering and visualising aesthetic opportunities. Softwares have allowed for new automated types of carbon calculations and anticipating waste for construction (Cousins, 2021) and made model-making a luxury product to some extent. It is possible to 3D print a model from these digital files, but 3D printing at the scale required is too expensive for most practitioners. For more information on sustainability and 3D printing, please see below under Product Design.

Exhibition Design

Museums

Museum exhibition design primarily focuses on carbon footprint from an administrative perspective, often presented alongside an environmentally-focused curation programme. The practice of publishing carbon footprint reports is growing alongside commitments to reduce carbon footprints (Cascone, 2019), with the Tate and V&A starting as early as 2007 (Loiseau, 2019), and the Science Musem Group announcing an ambitious net-zero emissions pledge by 2033 (Lister-Fell, 2021). However, the majority of these museums likely omit materials of their exhibitions in their carbon calculations, such as seen in the Tate Carbon Footprint report released in collaboration with Julie's Bicycle (Tate, 2021). This is due to what is considered a responsibility of scope. For more information, please see chapter 11.

When museums show direct interest in material selection, it is mostly led by a health and safety perspective where non-toxic volatile organic compounds are desired in paints and other finishes products (Hammond, C., 2021).

The materials for exhibition design are then predominantly selected by exhibition design practitioners and studios, who are more likely to consider the circular economy principles within their practice. The design studio Formafantasma designed an exhibition for the Rijksmuseum that re-used glass from previous shows; used a non-toxic fabric, reducing the need for paint, to be donated to schools as post-use; and selected materials, such as steel, that can be recycled indefinitely (Block, 2020). Cooper Hewitt published a Green Exhibition Design article, which also focused on reducing the number of materials and using recycled

and recyclable materials (Shelly, 2009). This focus on the ability and advocating for the re-use of materials is prevalent.

Carbon calculations priorities and material sustainability are likely to conflict. This has happened recently with the case of the Serpentine's Pavilion 2021. Aecom, Serpentine Gallery's construction consultant, claimed the new pavilion was carbon-negative justified by the wood used in its construction. The wood panels have been estimated to have sequestred a quantity of carbon large enough during growth that it compensated for the manufacturing process (Ravenscroft, 2021). Many critiqued the complexities of oversimplified materials, the use of a considerable amount of concrete and questioned the accuracy of wood as a sustainable product (Hurst and Waite, 2021) and accusations of using misleading data (Smith, 2021). The allegations forced Aecom to justify their work on Dezeen (Fairs, 2021), with Serpentine's Gallery removing any mention of 'carbon-negative' as a term on their website.

Commercial

As seen in trade shows and fairs, commercial exhibition design is often used as a branding mechanism to enhance how a brand is perceived. Unlike museums focused on public-facing customers, commercial exhibition design focuses on business-facing customers. It is more likely to follow external certification to validate their activities, especially ISO, and take shipping for carbon emissions reports. This is especially true when large corporations are involved, as they are more likely to report their emissions through the GHG protocol (please see chapter 11).

By nature, trade shows and fairs are temporary events where structures are being built with materials disregarded post-event. Single-use designs have been prevalent in this context (McClernon, 2014).

Overall, the understanding of sustainable materials in this field has strongly emphasised 'reduce, repurpose and recycle', alongside lightweight materials for transport optimisation.

Reducing waste also generated savings in flat packing the design and reducing transport costs, ordering less material, although prices increased in waste management.

Material sourcing refers to the condition and location of raw extraction, manufacture and supplier. Suppliers and companies from medium to large scale are highly likely to have a sourcing policy in place. This might be focused on their supplier's location, of which the chain of supply from the raw extraction is not mentioned. Transparency allowing traceability of all stages of manufacture would be beneficial to ensure sustainable materials.

Companies are also likely to promote renewable energy within their production methods to reach sustainability goals (Liqui Design, 2021). This aligns with quantifying carbon emissions.

The ability to re-use exhibition stands is desirable but rarely achieved. Conversations and advice are shared around this (Tecna UK, 2021).

Ecobooth launched a circular booth in 2019 with PA consulting. The booth was built by repurposing plastic waste and won Gold in the Sustainable category at the 2018 World Exhibition Stand Awards. They have re-used the booth at over 10 events globally (Ecobooth, 2019).

Furniture Design

Furniture design, both for commercial and the home interior is investigated in this section through high-end manufacturers and mass-production companies such as Ikea. Wood is a prevalent material for furniture and has been claimed as a sustainable material originating from renewable sources: trees. For textiles and upholstery, please see chapter 6.

Wood sourcing

Wood furniture at mass scale is likely to use certifications to ensure sustainability in their practice. For this, the FSC certification is often seen as the most robust certification for sustainable forestry and used to ensure sustainable furniture, which has been challenged on several counts (WWF 2020). Yale Environment 360 reported, “a number of recent logging industry scandals suggest that the FSC label has at times served merely to “greenwash” or “launder” trafficking in illegal timber” (Conniff 2018). The Yale report gives three examples of mismanagement and fraud from China, Peru, and Romania.

More recently, an investigation led by Greenpeace linked FSC certifications and the furniture manufacturer Ikea to a massive deforestation event in a protected forest in Russia (Earthsight 2021).

By 2006 the number of cases of mismanagement by the FSC led to the setting up of a watchdog website, fsc-watch.com, that exposes FSC misconduct. The site acts as a clearinghouse for findings of investigations into the FSC. Such as the Channel 4 2021 report that unearthed proof (Thomson 2021) of the FSC lobbying the EU to weaken forestry biomass rules.

The UK has ‘The Timber and Timber Products (Placing on the Market) Regulations 2013’ to control illegal logging, carried out by the Government’s Office for Product Safety and Standards. A recent example of this regulation put into action is in 2021, with the company India Jane being fined £5,000 for ‘breaching regulations prohibiting the placing on the UK market of illegally harvested timber’ (Institute of Materials, Minerals & Mining, 2021).

Swoon considered a mass-production company, advertises their mango wood as sustainable due to their harvesting methods and low need for finishing treatments. If a mango wood does not produce enough mango fruits, it will become furniture. Unlike museums focusing on carbon emissions, including transport, in their emissions reporting, Swoon does not mention the heavyweight of wood and the implications of transport emissions in their definition of sustainability.

Non-VOC certifications

As furniture is also meant for indoor use, certifications exist to ensure control over chemical emissions, aimed to reduce indoor air pollution and the risk of chemical exposure, such as the UL GREENGUARD Certification Program (UL, 2021). USM, for example, has applied this since 2007 (Bilski, 2007). This is due to chemicals in paint or finishes releasing particles indoors and causing worries to customers (Menghi, Ceccacci, Papetti, Marconi, and Germani, 2018).

Packaging Design

Packaging design uses different materials such as plastics, cardboard and metal. Materials are interchangeable, with plastic and wood, aluminium cans and PET bottles.

In the case of plastics vs wood-based products (e.g. paper and cardboard), there is tension and complexity between renewable and finite resources, environmental contamination, water usage, carbon calculations from energy and transport and recycling potential, altogether making decisions unstable. Plastics imply a continued dependence on crude oil, with 90% of plastic produced in the EU originating from virgin fossil fuels, while only 9% is made from recycled materials (Devitt, 2020). Wood’s impact varies based on the situation of its extraction – if the harvest is derived from a sustainable and well-managed forest or a deforestation area. Trees are host to many biodiversities lives that are hard to quantify, with one mature tree producing enough material to create only an average of 150 large

cardboard boxes. The carbon cost of manufacturing also adds a layer of complexity, with plastic manufacturing alone estimated to be the 5th most significant greenhouse gas emitter in the world if it were a country. In contrast, wood-based manufacturing is more likely to use renewable energy sources such as biomass, biogas, and hydroelectricity. Another complex layer is the carbon calculations of transport, which take the weight as a significant source of emissions, of which plastics are lighter than wood-based products. Finally, at the end of life, both materials present challenges. Plastics and wood cannot be recycled indefinitely, as quality is reduced. It is estimated that 91% of all plastics have never been recycled (Swiftpak, 2021). The recycling abilities of the UK also puts a certain added level of restrictions on wood and plastics, as recycling rates are calculated on the amount of waste sent for recycling and, essentially, not the amount of waste that is recycled (Plank, 2020). As the UK sends most of its waste abroad, the true recycling capacity of UK waste is currently impossible to calculate.

There are established commodity markets for waste packaging materials, such as bales of cardboard, aluminium cans, steel cans. However, spot price instability in commodity market prices undermines recycling systems, especially if they have been set up for social benefit but are justified on the grounds of commercial viability. This is a challenging problem, especially in the US (Karidis, 2016). In the UK, local councils' rapid expansion of cardboard collection systems in response to government recycling targets depressed the commodity price of used cardboard, making the schemes financially unviable. The recent rise in online retail during the pandemic led to a shortage of cardboard boxes (Wood, 2021), partially due to the rise in demand but also caused by a drop in recycled cardboard feedstock due to shifts in use patterns (Staub, C., 2020). Recycling cardboard brings many benefits, such as reducing landfill pressure, reducing carbon emissions, saving energy and trees, and creating new jobs (SL Recycling, 2021). As recycled cardboard can reduce grade, it is important to ensure quality control steps (DSSmith Recycling Services, 2021).

The UK government launched a consultation on introducing Extended Producer Responsibility (EPR) for packaging from March to June 2021 (GOV.UK, 2021). The concept of EPR was formulated in a report by Thomas Lindhqvist for the Swedish government in 1990 (Wikipedia, 2021). It proposes that packaging producers pay the total cost of managing packaging after its use. It seeks to encourage manufacturers to reduce material use and source recycled and recyclable materials, limiting the amount of hard to recycle packaging placed on the market. The UK government sought views on the scheme design, governance, implementation timelines and how the scheme will be enforced. Results of the consultation are expected to be published shortly.

Product Design

Product designers are commercially-led, similar to exhibition design, as they respond to precise client briefs. Design consultancies have limited control over the end decision.

Small-batch design-led companies and start-ups might have more disruptive potential than mass-produced products. This can be illustrated by the example of Precious Plastics upcycling waste plastics; please see chapter 19.

Product design companies are likely to use 3D printing to streamline manufacturing, especially in the proof of concept and prototyping stages (Columbus, 2019). 3D printing, additive manufacturing, is often understood as more sustainable than subtractive manufacturing, as less material is wasted (Auerbach, 2021).

It is possible to recycle any filaments used in the production process, hence participating in the circular economy. MIT and others have developed machines to directly recycle and reproduce filaments within the studio (Filabot, 2021). It should be noted that currently, it is

understood filaments cannot be recycled indefinitely as it loses quality in each printing process (Zhao, Rao, Gu, Sharmin and Fu, 2018).

There is a strong and established interest in the filament industry to rely on bio-source for plastics (PLA) to reduce reliance on fossil fuels by-products, with an estimated 95% of 3D printer users using PLA (Toor, 2019). PLA is not suitable for home composting, and a PLA bottle could take up to 1,000 years to degrade in a natural environment and should still be disposed of responsibly. The advantages of PLA plastics are less toxicity compared to their fossil fuel counterparts and captured carbon during its growth, as PLA can be sourced from wheat, seashells, coffee, corn, etc. (Sensiba, 2021).

Metal 3D printing shows potential also to reduce material consumption and optimise manufacturing processes but is currently expensive and only suitable for luxury and high-end products. It has been noted metal 3D printing consumes a lot of energy, making renewable energy sources key to this process (Fredriksson, 2019).

3D printing has the potential to support a repair economy with its ability to intrinsic parts to complex machines, with the Ellen MacArthur Foundation acting as an advocate (Iles, 2021).

Product & Packaging Design for Medical Applications

Medical applications add exceptional circumstances to the manufacture of packaging as it is subject to specific health concerns, such as biohazards, storing pharmaceuticals, and contamination. These demands are much more extreme than food packaging as human health often predominates the argument. This is seen particularly clearly with the covid pandemic and the use of single-use plastics, with littering of single-use face masks and gloves becoming a visible side-effect of their increased use.

Single-use is preferred for health security as it reduces the risks mentioned above. Traditionally glass was used in healthcare, and after each use went through a cleaning process, and single-use plastics removed this cleaning step and simplified the workload of workers.

For example, blister packs are very complicated objects with metal and plastic layered as composites. This makes recycling extremely complex, with separating steps costly and time-consuming. Individually, they represent minimal amounts, but large volumes of material appear in aggregate. This is similar to electronics; please refer to chapter 13.

Recommendations to the AHRC

The design sector is engaged with numerous materials and therefore comes into contact with many different legislative regimes and voluntary programmes and codes of practice. Research that engages with these laws, regulations and guidance, examining their aims, sector scope, development, and impacts, providing it includes engagement with the sector and those constructing such regulatory systems, will therefore be highly beneficial to the design sector.

There is an obvious opportunity for research that addresses the impact of imminent extended producer responsibility legislation on packaging. As this legislation will be in development and implementation over the next two years it will provide an unparalleled opportunity to observe the development of a new paradigm.

For those design specialisms that are completely dependent on electronic equipment, such as games design, website design and digital animation, as well as other design specialisms where computers are frequently used, there is a need for more detailed information on the reuse, refurbishment and disposal of electronic equipment.

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Chapter 6: Fashion, Textiles and Accessories

Jules Findley & Rebecca Lardeur

In 2017, the government requested a report to be written called, ‘Fixing Fashion: clothing consumption and sustainability’ published in 2019 (Environmental Audit Committee, 2019). The reality of fashion and textile practices were uncovered, examined through the fast fashion sector, the lack of sustainable practices in order to obtain a cheaper cost of our clothes, the environmental impact of our clothes, the waste of our clothes, the lack of circular opportunities and the fibres that make fashion and textiles challenging to the closed loop circular economy. It was clear from this report that things had to change.

In 2021, there have been a number of initiatives that have been launched to help the fashion and textile industry especially in the run up to COP26.

All bagged up: Clothing being sent to East London Textiles Recycling Centre © Jules Findley

FASHION

Description of Scope in Fashion

The fashion industry comprises of womenswear, menswear, childrenswear and babieswear in a variety of different market sectors, luxury, mid-market including prêt-à-porter, or ready to wear, sportswear, urban wear, lingerie and the lower end of the markets together with fast fashion. The garment industry also includes corporate clothing, workwear, apparel and accessories. The different categories of clothing together with the different sectors already make a complex composite of markets with global sourcing of fabrics and trims, as well as global areas of manufacturing makes for a broad range of countries of manufacture, communication and shipping at various stages of completion of garments.

Data published by United Nations Environment Programme [UNEP] and the Ellen MacArthur Foundation conclude that the fashion, accessories and textiles industry is responsible for 10% of all global emissions realised being the third highest, and is set to surge more than 50% by 2030 unless something can be done. Global consumption in 2019 at 62 million metric tons is set to grow to 102 million tons in less than 10 years. The Ellen MacArthur Foundation is an international charity, which is trying to tackle some of the largest environmental and circular problems on the planet including fashion and textiles. In response to supporting the circular fashion economy and help shift the current fashion linear model, Ellen MacArthur Foundation recently published, 'Circular Design for Fashion' (2021), co-created with many organisations and brands, to help innovative thinkers rethink and design fashion systems into a more resilient, less polluting, with less waste and where the natural can be regenerated through circular systems. Aimed at everyone interested in design for fashion, recycling and circular thinking, the illustrated book emphasises the iterative nature of the circular model, consequences of the current linear model and the opportunities of regeneration, repurposing and reusing waste. (Ellen MacArthur Foundation, 2021)

The sustainability challenges relevant to the Fashion Industry

- Cheap manufacturing in clothing in the fast fashion industry
- Unsustainable practices by not paying garment workers a Living Wage
- Polythene packaging and anti-mould chemicals being used in the Fashion and Accessories Industries in Transporting Goods into UK
- Deadstock in Fashion, Textiles and Accessories at all levels of markets being burned or going to landfill
- Increasing returns market post pandemic
- Low levels of repair so clothes are discarded
- Low recyclability of fibres and fabrics in the overall FTA industry
- Greenwashing by companies claiming to be using recycled fibres but actually using a very low percentage
- Washing of micro plastics into the ocean

Cheap manufacturing in clothing in the fast fashion industry

The UK is one of the worst countries for consuming fashion products. After COP26, the reliance on fossil fuels has got to change and it is no less wanted in the fashion industry by either eco-conscious consumers or professionals, which are growing. Over production is one of the issues and the pressure on producing for seasons fuels the production chain. Hubbub

hubbub.org, is an organisation concerned with over consumption and the environment, cite an example of their research, over Halloween around 39 million families dress up for the occasion 90% of outfits are bought new every year, and out of that around 7 million Halloween costumes are thrown away every year. The equivalent amount of plastic would be 83 million plastic bottles, or to 2,000 tonnes of plastic waste. (Hubbub, 2019)

The fashion, textiles and accessories industry (FTA), are significantly complex areas and have many challenges. Currently, the fashion business has low recycling statistics and a large carbon footprint due to a global industry. Clothing can be cut in one country, sewn in another, and finished in another country before being transported to the UK. According to the UKFT, which supports the fashion and textiles industry in the UK, in industry performance and statistics the fashion and textiles industry spent over £74 billion on fashion, fashion accessories, household textiles and carpets in 2018. Fashion clothing sales made up the most of the spend at £53 billion, up by £17billion in the ten years since 2008, when it was worth £36 billion.

Unsustainable practices by not paying garment workers a Living Wage

The fashion and textile industries are heavily criticised for not complying with the SDG 8, which focuses on decent work and a fair wage. Eco-Age an agency for business strategy, makes the case for sustainable practice through fair pay in a report made in 2019 about fair wages in the garment industry published in 2019. (O'Driscoll, 2019). Referring to the Clean Clothes Campaign report of 2019, '*Tailored Wages 2019: The state of pay in the global garment industry'* revealed that out of twenty top clothing brands covering luxury, sportswear, fast fashion, and online retail, none were able to demonstrate wages that escaped the poverty trap in Asia, Africa, Central America or Easter Europe by the reporting time in June 2019. (Bryher, 2019). From this report 85% of brands they worked with paid wages to support garment workers basic needs, however no brand was paying a living wage. Clean Clothes Campaign reported that over five years research in their investigations, nothing had evolved. The United Nations in a report in 2011, describes the basics of a living wage. (United Nations DESA, 2011).

There is confusion in the fashion and textile industry over the universally agreed figures for a living wage; around the world, some have set a living wage such as the Asia Floor Wage, set by garment workers, other governments disagree with what a living wage is, such as in Bangladesh and Myanmar; this confusion allows for garment workers to be treated unfairly in employment, even if inadvertently. Collective bargaining has been successful in Vietnam and India at regional levels. In Italy, unions have been successful in negotiating collective bargaining agreements however the country has a high density of illegal practices, Clean Clothes Campaign report on the fact that in Italy there are a plethora of small hidden away workshops, where sub-contraction is rife and where luxury brands do not disclose their supplier lists. (Bryher, 2019, p17). This puts pressure back onto brands to act ethically, using the Fair Wage Method (https://fair-wage.com/12-dimensions/). Fashion Checker list brands that do not pay a living wage, (https://fashionchecker.org/).

Poor employment practices are especially true particularly in cotton growing areas apart from other sectors of the textile industry. Most of the world's cotton is grown in India, Pakistan, Brazil, US, Turkey and China, where employment is cheap, however sourcing responsible cotton is a move forward to changing attitudes to human conditions as well as better care of the environment. The organisation Cotton Up based in London, supports sustainable cotton organisations such as Fairtrade, United States Cotton Trade Protocol (USCTP), Cotton Made

in Africa (CMIA), the Better Cotton Initiative (BCI), and other sustainable organisations such as Anthesis. Anthesis works with companies that are using the Global Supplier Code of Conduct which determines working practices with human rights of workers, ethical practices in pay, conflicts of interest, and other ethical working practices in labour, which deny human slavery and exploitation, originates from Global Ethics and Compliance. (Anthesis Group, 2021).

Polythene packaging and anti-mould chemicals being used in the Fashion, Textiles and Accessories Industries in Transporting Goods into UK

Every garment, every accessory and every textile product is wrapped in a polythene bag when leaving the factory. Hundreds of billions of polythene bags are packed up with every shipment and container load imported into the UK. Although most of the plastic is now LDPE, low dosage polyethylene, which is technically recyclable according to a report written in 2019 by Fashion for Good on Polybags in the Fashion Industry, (Holding and Gendell, 2019).

Only a minority of brands are recycling their single use poly bags, many thousands go into the bin for landfill. In the report, it asks (to considers the idea of brands to focus on innovative methods of collection, addressing recyclability of current bags as well as looking at inks and labels and future innovation of recyclability methods. (Holding and Gendell, 2019, p5). Compostable plastics may be developing but are not at scale yet and innovative ideas could be manifested for reusable packaging. The main type of plastic used in fashion industry bags is polyethylene terephthalate (PET) but there are other PET plastics used in buttons and hangers. The challenge is with e-commerce increasing is that companies with aspirations for zero waste goals have to deal with single use plastics with no sufficient recycling in the UK. There is insufficient information or innovative solutions in this recycling plastics, it remains a concern for areas of climate change and the environment. (Holding and Gendell, 2019).

Deadstock in Fashion, Textiles and Accessories at all levels of markets being burned or going to landfill

In a report written by Sharecloth (2018), made an infographic for over production of garments in the fashion industry. The report estimates 30% of all clothes made in 2018 globally were never sold. It revealed a disconnect between producers and consumers with many of the clothes ending up in landfill after very little wear. In England, $45 billion worth of unworn clothes were unworn residing in UK wardrobes in 2018. By 2030, Sharecloth predict a $52 billion decline in the profits of the clothing industry due to overproduction, scarce resources, and higher labour costs. (See climate change impact on cotton producing countries in Textiles).

The Ellen MacArthur Foundation highlights the missed opportunities in a report *'A new textiles economy: Redesigning fashion's future'* 2021, where current practice currently eliminates $500billion worth of potential opportunity to capture different ways clothes are being sold and used. The current linear system in Fashion, Textiles and Accessories is dated and needs to be re-designed and re-aligned, through the circular economy model the Ellen MacArthur Foundation recommends an industry where clothes, fabrics and fibres re-enter the circular economy after use and never end up in landfill in order to limit waste and resource use and eliminate pollution contaminants. (Ellen MacArthur Foundation, 2021)

Brands can no longer hide their over production, however with more accurate trend production and cutting tools will help the supply chain in fashion. Over supply as deadstock in accessories and textiles is also a threatening problem in the fashion industry. Post

pandemic, as the world fashion production came to a halt together with it came the cost of over production, to a change of values in the consumer, as recorded by Stephanie Benedetto from Queen of Raw, a US deadstock market place in an article by Forbes, April 2021, (Mellor, 2021)

Increasing returns market, post pandemic

Post pandemic and according to the Centre of Retail Research spending online has increased by 57%, and with this the amount of clothing and footwear returns, as stores were shut together with their changing rooms (Retail Research, 2019). Women are happy to try on things at home but often choose two or three sizes and return two or more items. 'Bracketing' where clothes are purchased on line are returned on purpose due to colour, size, fit, accounts for 30-40% of returns to the seller, according to Eco-Age, (Bennet, 2021). This unsustainable practice, where the customer thinks that items returned will be resold, is predicted to rise to a £5.6billion market by 2023, after surveying 10,000 customers (Global Data, 2018). Most consumers do not realise that most of the returns are not resold when returned, but end up in the bin and landfill. These returns have major consequences, all the waste of fabric materials, plastics included in packing and wrapping items, the energy and cost consumed in making the products and the carbon footprint transporting products to and from supplier to consumer including the costs of fabric manufacture, fashion making and transportation from fabric manufacturer to garment manufacturer to the supplier.

There are many companies releasing digital trying on facilities both on their websites and in digital apps. Not only will it help reduce the amount of returns, but it allows customers to experiment and control their experience with clothing. Customers have stayed on a website for on average nearly three times longer than previous browsing times, (Berjikian, 2020)

Low levels of repair so clothes are discarded

There are several reasons why clothes are no longer repaired in the way they used to be done two generations ago, (Martin, 2021). One of the reasons is down to clothes and textiles being so cheap that people do not see the need to repair garments, as it might be cheaper to buy new rather than invest the time and equipment into repairing.

Lack of time is given as an excuse for lack of repair; modern work hours for most leave people with little or no time to repair items. Lack of sewing and material knowledge, as children are no longer taught how to sew or make textiles either at school or by their parents. As a consequence, there is a lack of confidence in repairing items due to lack of sewing and cutting skills. There used to be a stigma attached to repaired clothing which was associated with being poor and a negative attitude to repairing items due to being a chore, which may have been a contributor to repairing items falling out of fashion (Martin, 2021). Finally, currently there is little respect for clothing and products anymore. People do not value fashion and textiles in the way they used to due to the cheapness of clothing, and the fact that clothing is so readily available, like a never-ending supply. The relationship between the fabric and repair through caring for the fabric and clothing has diminished, and this idea of care and respect for products needs to be brought back into society.

Professor Jonathan Chapman, whose research examines the throwaway society, calls for the 'decoupling of economic activity from mindless material consumption' so that products can be made to last (Chapman, 2021). In the fashion, textiles and accessory industries, a re-education programme is critical in schools to promote respect for fibres and fabrics together with learning about the ethical practices of people who make clothes and the promotion of

sewing and making skills in schools. There are some practitioners who are already pioneering this, please see recommendations.
(See Accessories, shoes)

'Greenwashing' by companies making claims on recycling that are not true
For example, signatories to the UN Fashion Charter have promised to reduce their global carbon pollution by 30% in the next 6 years. While this commitment deserves credit, it also doesn't reach the 40% reduction needed to align with the UN Paris Climate Agreement's pathway to 1.5 degrees of warming – which is the level of action needed to avert the worst consequences of climate change. Other companies are also relying on carbon offsets to claim "carbon neutrality." Offsets alone do little to actually mitigate the climate crisis and instead can provide a front for greenwashing.

Making decisions as a consumer in today's world, means having to learn to understand poor labelling and make increasingly tougher purchase decisions based on mis-information and greenwashing. Average consumers lack the curiosity, time and inclination to inform themselves in what to look for in responsible labelling. From research carried out in 2019, by the Centre for Retail Research, 26% of consumers were not interested in 'doing the right thing' although there are some out of that category that made the odd purchasing decisions based on ethics, only 11% were fully committed and a further 27% were quite committed, with 36% being an occasional green shopper. 62% of shoppers are making conscious ethical purchasing decisions. A call for better information and labelling is much needed as many consumers do not fully understand the consequences of their poor purchase decisions on the environment or contributing to climate change. This is very true in fast fashion and textiles, shoe sales and the material choices therein. (Retail Research, 2019)
One example of green washing is when companies report they are designing products using reused polyester (among other things), and then use virgin polyester or a very small proportion of recycled polyester – these companies are storing up mistrust with their customers. Consumers are savvy and although in the short term the brand may have made profits through increased sales, once the brand is found out that their marketing is not true, it can take a long time for brands to recover from poor practice, as well as industry word of mouth for that brand to recover. 'Greenwashing' made popular in relation to brands and consumers in 1986, by Jay Westerveld, an environmentalist. If brands are caught greenwashing, it is difficult for them to recover trust from their consumers, (Watson, 2016).

Washing of Micro Plastics into the Ocean
There are14 million tons of plastic, which are washed into the ocean every year. Plastic debris makes up 80% of the waste from the edge of the beach to the sediments at the bottom, (IUCN, 2021). However, 0.5 tons of plastic micro fibres are washed into the oceans every year and this this very concerning (The World Bank, 2019), 35% of micro plastics are from synthetic fibres being washed in our washing machines (Common Objective, 2021), the equivalent to 50 billion plastic bottles, inevitably this is increasing. Micro plastics are in tap water, beer, salt, they are throughout the food chain and as humans we are ingesting micro plastics, (IUCN, 2021). It is confirmed that harm is being made to human cells by micro plastics, results from a study carried out at Hull York Medical School, UK. The ultimate solution is to stop the loss of plastic waste. Carrington, D. ed., (2021).

With huge pressures over the costs of manufacturing clothing from competition, manufacturing fashion and apparel over the past thirty years has increasingly been sourced abroad due to lower costs of employment and manufacturing, Examining the labels of clothing and the origin of manufacture demonstrates a global industry with consequences for the fashion industry over ethical practices. For example, in paying fair wages, as well as conditions in the workplace in these countries, working in poor conditions, leads clothing companies to review their ethics in this ruthlessly competitive industry at the lower end in the fashion market, especially in fast fashion.
GenZ in the UK (those born between approximately 1997 – 2010), have never known a life without the internet, a smart phone or fast fashion. When the GenZ child grew out of a Nintendo DS lite and into the first generation of iPads or tablets, the age of social media had arrived. Cutting their teeth on Facebook, GenZ together with late Millenials (born 1981 – 1996), grew into Instagram, and are now adept content creators.
The fast fashion sector is most often supported by GenZ. This is set to grow by 7% to $38billion by 2023, (Fast Fashion Global Market Report 2021: COVID-19 Growth and Change to 2030, 2021). A study by Forbes says that 62% of GenZ are willing to support sustainable fashion (Olu, 2021), however many purchases are influenced by social media Influencers, who go on a fashion purchasing splurge from fast fashion brands and broadcast them to their thousands of followers through reels on Instagram and Tiktok (Francis and Hoefel, 2018).

The second-hand clothing market is set to soar, according to current figures, (Eley, 2021), the second-hand market is worth $24bn U.S. dollars; predictions from the Financial Times say that the market is expected to rise to beyond $50 bn dollars by 2023. In May 2021, Etsy an online platform which allows small creative businesses to sell products bought out the app De-pop (a social media platform for users to realise cash in second hand clothing), for $1.6m. Gucci owner, Kering has a 5% share in Vestiare, the French second-hand on-line store. Covid-19 first lockdown from March 2021, fuelled a wardrobe and house declutter on extraordinary proportions in the UK as many had the time to go through their homes and clear out.

TEXTILES

Description of Scope in Textiles
The textiles industry comprises of raw natural fibres such as cotton, hemp, linen, wool and cashmere, mohair, silk, down, with synthetic materials such as acrylics, polyesters, viscose, rayon’s, lyocell, nylon, polyamides, polypropylenes and other mixtures of fibres. There are market sectors in textiles with fabrics appealing to each market sector aimed at fashion at all levels and interiors and medical textiles. Although carpets are not necessarily considered as textiles, as they are materials sometimes made of wool or various mixes of polyesters and polypropylenes, they are included in this section.

The sustainability challenges relevant to the Textiles Industry

- Chemicals in fibre and textile fabric preparation, fabric finishes as well as dyestuffs
- Fibre preparation for spinning in weaving and knitting
- Low recyclability of fibres and fabrics in the overall FTA industry
- Climate change in agriculture and farming
- Exports and carbon issues

Chemicals in fibre and textile fabric preparation as well as dyestuffs

Around 8,000 synthetic chemicals are used in the production of fashion, textiles and accessories, mainly used in raw materials as recorded in textiles. These hidden chemicals which contain known carcinogens and hormone disruptors, are not recorded on manufacture labels in clothing or textiles, (Plell, 2019).

There are consequences to sourcing cheaper fabrics and manufacturing from countries where employment is cheaper There are two issues, first of all the hidden chemicals in dyed garments as a threat to human health, and second, the concerns for environmental health. In the dyeing fibres, fabrics and yarns, there are many hazardous chemicals used in both the preparation of fibres, fabrics and the dyestuffs used both on fibres and fabrics apart from the use and damage to precious resources of clean water. Washing, scouring using detergents, bases, solvents are used to remove fats and grease off natural fibres, bleaching, mercerising, sizing and desizing are used on woven fabrics to prevent shrinkage.

Viscose, rayons and lyocell use chemicals as they are resource intensive fibres some produced from wood pulp. Polyesters, polyamides, poly acrylic and aramide are made from monomers which are sourced from fossil oils, polymerised into different fibres. Chemicals are used in lubricants, to spinning fibres for knitwear and wovens to strengthen fibres. Many chemicals from textiles enter freshwaters and contaminate rivers and seas due to printed silk screens being washed off, or when textiles with dyestuffs are rinsed, the effluent water is not sufficiently purified before being discarded into rivers. There are increasing concerns of harm to human health, (Rajshekhar, M., 2016), in an article about one example in the destruction of the river in Tirupur. 20% of global water pollution is a result of textile dyeing and treatment (Chauhan, P., 2021). Pollution of this nature together with other polluting industries are found in many of China's rivers, (World Bank, 2007) as well as other rivers around the world.

There are heavy metal ions used in the mordants of the chemical dyes used in the textile industry which are very damaging to human and environmental health, (Velusamy et al., 2021) AZO dyes are most often used on cottons, 60-70% in all cases, according to when the fabric is in contact with the skin, other chemicals are released, onto the skin from the dyed garment. Sweat reacts with the fabrics onto the skin, the skin being a permeable membrane, can absorb these chemicals, (Common Objective, 2021). In report by KEMI, a Swedish Chemical Agency, found that 30% of chemicals used for textile manufacturing and dyeing remain confidential. (KEMI, 2016). Digital printing on textiles using pigments uses less water than dye based printing methods and produces much less waste. Scaling up is more difficult as the textile printing business is very competitive on price and this is part of an iterative problem of changing the industry. There are new more sustainable dyes emerging with Huntsman one of the largest textile dyers, and a global provider of dye brands such as Avitera and Terasil dyes since 2017, which use less water and energy. Terasil is used on polyester fabrics, microfibers and elastane blends, (Textile News, Apparel News, RMG News, Fashion Trends, 2017).

Colorifix, a British company that started up in 2016, with finance from Fashion for Good accelerator funding, has created a dying technique using scientific engineering, DNA sequencing, and using nature's colour inspiration, are mixed to create a synthetic colour without the use of hazardous chemicals. Colorifix worked with Pangaia based in London and US, (a materials science company with sustainable concerns), in using materials initially using two colours, blue and pink. Colorifix add the colour bacteria into the fabric which when heated up the bacteria releases the colour as the micro-organisms burst. The colour chemically attaches to the fabric fibres, then washed as the bacteria residue is rinsed off but the colour remains on the fabric. The process eliminates the environmental impact with

chemicals associated with textile dyeing, and reduces the platform of water, electricity and CO_2's. The micro-organisms are fuelled by simple sugars, yeast and plant bi-products, without the need for petrochemicals.
There are concerns that it is impossible to have full circularity in the fashion industry at the moment without looking at harmful chemicals in the process of recycling as the recycling of heavy dyestuffs and antimicrobial finishes as well as chemical finishes to give softer finishes to garments cannot be properly recycled. (Cernansky, 2021).
Textiles is an integrated global industry; it affects consumers and professionals as sourcing, manufacture and the end products originate from all of these different areas, from all areas of manufacturing to all products from sofa covers to accessories, they are all imported into the UK. Many waste effluent problems from dyestuffs still exist due to some factories building discrete pipes that disperse waste at night rather than cleaning up their act. A more consistent and transparent supply chain would help detect the companies that are unethical in coming clean. There are organisations such as ZDHC that help with reducing hazardous dyes or Oritain Global**,** which will help companies have fully traceable and ethical supply chains.

Fibre preparation for spinning in weaving and knitting

Cotton
Cotton accounts for 31% of all globally produced textiles including towels, bedsheets, sofa covers, cushions, curtains, tea towels and shirts, all are made from cotton, (Chapter 10. Cotton, 2019). Producing cotton from raw materials is process and chemical heavy in raw materials. Cotton production is reliant on the use of nitrogen and phosphorous-based fertilisers, as well as pesticides and insecticides during growth which are designed to protect the crop from boll weevil insects and mealybugs. The scale of reduction of chemicals is not consistent across countries and although somewhat reduced from decades ago the reduction of chemicals and substitution of less hazardous chemicals is not near enough.
Cotton is a material that has been mis-represented in the use of data. The mis-use of information in the fashion industry is an issue, it has a silent, derogatory effect on the material itself, and this trickles into u the industry and to consumers. Transformers Foundation have released a report about the mis-information from data being used especially with cotton in the fashion industry. (Transformers Foundation. (n.d.). 2021).
Accurate information on cotton data from the International Cotton Advisory Committee (ICAC) reports generally cotton uses approximately 1,931 litres of irrigation water (blue water – water mainly derived from irrigation), in order to produce 1 kilogram of lint. Globally, cotton uses 6,003 litres of rainwater (green water, water mainly derived from rainwater), on average, to produce 1 kilogram of lint. Approximately 1 kg of lint is sufficient to make one tee-shirt or one pair of jeans is the more accurate statistic derived from primary sources.
Prior to dyeing cotton, the fabrics are scoured using chlorinated solvents such as trichlorethane (TCE), nonylphenol ethoxylates (NPE's) among others. Looking at unbleached cotton, the little bits of natural cotton are visible, which are unseen once the fabric is scoured, bleached and dyed. These chemicals are banned in the EU due to threats to human health.

Climate Change and Growing Cotton
According to Cotton 2040, (Cotton 2040, 2020). 50% of cotton growing countries face high or very high exposure to climate risk. 75% of cotton regions will experience increased heat stress by 2040. 40% will experience shorter growing seasons by 2040. There are 350m people that rely on cotton growing and producing cotton for their livelihoods. CottonUP is a tool which helps

source more responsible cotton, one of the most positive solutions for sourcing responsible cotton supply is in increasing soil health, erosion control, and protecting the biodiversity and ecosystems. (Cotton UP, 2018). CottonUP claims that the United Nations Sustainable Development Goals (UN SDGs) 6, 8 and 12 are upheld through sustainable practices in clean water, better employment, eliminating exploitative practices and sustainable supply chain.
GOTS Global Organic Textiles Standard is the leading standard of organic textiles and fibres. It applies to cottons, silks and wool fibres. For the GOTS label to be used then a minimum of 70% of organic fibres should be used, a product with the label 'organic' must have a minimum of 95% organic fibres used. They have comprehensive resources from first fibre processing stages, spinning, weaving and knitting, wet processing, manufacturing, to the customer. https://global-standard.org/

Denim

Denim first documented as being worn in England as early as 1695, and is made with a typically dyed blue warp thread, with originally an ecru (unbleached) weft thread woven as a twill type of weave. Originally denim was sold unwashed, a stiff, hardwearing, rigid fabric, which took time, years even, to 'wear in'. During the 1970's, denim became softer through pre-washing, the resulting fabric was more wearable and the washing allowed the fabric to shrink prior to wearing and the first wash, making sizing easier to navigate.
Recently, as denim is now made of cotton (and in the last twenty years, elastane for stretch), it is sold washed, often with other finishes, stone washing, rips, fraying, and peached finishes. Denim finishes can be harmful and there are plenty of incidences where finishes such as stone washing and peaching (which gives the surface a soft, used, slightly brushed, peachy effect), have been made using unethical processes. Many garment workers (not just in denim, but in other textile manufacturing, such as in fibre preparation and in knitwear) do not use protective equipment whilst working with garments. The fibres that come off the garments are ingested into the lungs of garment workers, (Lai and Christiani, 2013).
Denim has been associated with poor employment practice and heavy use of water resources, not only in the growing of unsustainable cotton, but also in the use of huge amounts of water to grow the cotton and wash the denim. Reference to BBC and Stacey Dooley's documentary 'Fashion's Dirty Secrets' aired 2019, and the devastating Aral Sea, which was once the largest sources of freshwater, reduced to dust through making cheap jeans. (BBC, 2018)
Established denim companies such as Wrangler have been working with cotton farmers, buying products from regenerative sources, where farmers can demonstrate soil health and are using regenerative agricultural systems. (Versteeg, 2021)
Saitex, originally a Vietnam based sustainable denim company, with its parent company in Malaysia, have opened up a denim facility in Vernon, LA, South Carolina, US. Saitex is a pioneer in sustainable denim production, working with brands developing cleaner manufacturing and makers that deliver on their sustainability goals. Saitex work with brands such as Ralph Lauren, Madewell, Filson, Edwin USA, Outerknown and Atelier and Repairs. Sanjeev Bahl from Saitex forecast the desire for more local manufacturing in the US as the main reason to have more local supply in a country that traditionally uses denim, with faster and shorter supply chains delivering speed to market using sustainable processes. The new facility at Vernon will produce 3,000 pairs of jeans a day. (Sherman, 2021)
An example of good practice in making denim jeans in the UK is The Huit Denim Company who concentrate on making sustainable denim jeans for men and women in the UK, with short runs making sustainable products to the best practice. The company is situated in Cardigan in Wales, where there was a skillset of 400 people that used to make around 35,000 jeans a

week for forty years before the jeans company shut down. Huit Denim Co. make a mere 200 jeans a week which are not usually pre-washed and recommend six months of wear before washing. Like Patagonia offering a repair service on their jackets, The Huit Denim Co. offer repairs on their purchased pure denim jeans. (Huit Denim, 2021)

Wool including cashmere

The challenges of Wool in the UK

British farmers have been burning or composting their fleeces according to an article in (Eccles, 2020). A year later, reports from a farmer burning 1000 fleeces when it costs the farmer £1.50 to sheer each sheep. (Davidson, 2021).

The value of a wool fleece has been steadily falling and has now fallen to 33p per kilo due to the pandemic and wool not being sold to China and Japan as they were closed. 25% of British wool is sold to China and 25% of wool is sold to Europe and Japan. Five years ago, fleece would have fetched 87p per kilo. Since then consumers have switched to synthetic carpets, furnishings and clothing. British wool is used in carpet in cruise ships, hotels and airports also partially shut by the pandemic. There are innovation ideas that fleeces could be used for insulation in housing are coming but at present the costs are not feasible. (Davidson, 2021).

It is illegal to burn fleeces on an open fire, (Farmer Network, 2020). Wool is an animal by product or an ABP and the legal way to dispose fleeces is to incinerate, or send them to landfill, after processing or composting, or applying them to land as fertiliser, or in some cases using them as fuel in combustion. There are strict rules for incineration ABP. Wool, has been under-utilised for a long time, and in order to help reduce fleece wastage of over hundreds of thousands of tons, John Lewis in collaboration with Waitrose have recently launched a new mattress range, which uses 100% traceable sustainable fleeces of wool from sheep producers who supply Waitrose. Customers would be happy to pay more for British wool, 41% saying they would pay up to 5-10% more and 30% would be happy to pay 10 -20% more. (Farming UK Team, 2021)

The International Wool Textile Organisation promotes wool; explains how existing wool is recycled through closed loop production, open loop production and reengineering. (IWTO, 2021). Wool has carbon storing potential, natural resource for insulation which can be used in building and can be used to help fight climate change. (Taylor, 2021).

Wool and Climate Change

Wool and sheep are associated with greenhouse gases connected with climate change, that come directly from grazing sheep but these can be mitigated through regenerative agriculture, (Gosnell, Charnley and Stanley, 2020). The more concerning problem is that NY fashion brand Another Tomorrow, have found that sheep wool is already deteriorating in some rural parts of Australia due to scorching heat and drought. (Godin, 2021)

Cashmere fur is a luxury, silky yarn, and originates from specially bred goats in Mongolia, Southwest China, Iran, Tibet, Northern India and Afghanistan. It is a natural fabric and like wool, cotton, silk, hemp and linen is biodegradable, (Rauturier, 2019) As the temperatures rise the goats shed their coats. The fur is collected by hand and put into bales. Cashmere takes four goats to make a sweater. Stella McCartney proudly uses a transparent supply chain. In Mongolia, the goat herds have increased from 2.3 million goats in 1994, to 30 million goats in fifteen years, (www.stellamccartney.com, n.d.).

There is concern over the lifestyle of the goat herders as the prices of cashmere has gone down, in response to this the goat herders have increased their herds. This has increased

pressure on feeding goats and maintaining them. 70% of the fertile terrain has been overgrazed and the surface of the green pastures have become damaged by their hooves, and are now rapidly becoming desserts. (Ng and Berger, 2017). Some of the goats are treated very cruelly by some herders who lost patience if the goats are past their prime in shedding their fur and they are killed and left to die on dirty floors. The poor pastures that have become desserts have turned into some of the world's dust storms on record and that poses a damage to human health, (PETA UK, n.d.).
Rather than using virgin cashmere Stella McCartney uses certified recycled cashmere from Re-Verso, an Italian company made up of Green Line and Nuova Fratelli Boretti together with various partners that have a circular model. (Re-Verso™, n.d.). There are other UK companies such as LondonW11 that collect unwanted cashmere items for free around London and send them to Italy to reuse recycled cashmere in Prato, Italy, (London W11., 2020). It is better to buy second hand cashmere than new.

Hemp, Flax and Linen
There is not much difference between hemp fibres and flax fibres. Without a microscope or chemical examination, the fibres can only be distinguished by the direction in which they twist when wetted. Hemp turns counter clockwise and flax clockwise but they tend to have similar characteristics. Hemp and linen are both strong fibres, hemp stronger than linen, and the lifetime of hemp is the longest of all natural fibres and is resistant to rot, mould and saltwater. It is resistant to ultraviolet light and does not fade or decompose in sunlight. (Hempalaya, n.d.). Both hemp and linen are breathable and absorb moisture, hemp slightly more than linen at around 12%. They are resistant to moths and are biodegradable. Hemp fibres are longer than linen at approximately 1- 2m whilst linen fibres are up to 1m in length.
Hemp is environmentally sound plant, does not need pesticide or fertilisers, and it grows quickly. It produces 250% more fibre than cotton and 600% more fibre than flax per hectre. (cfda.com, n.d.). See chapter on Crafts and Applied Arts for more detail on Hemp and the Thorody Flax Project p8.

Leather
Leather manufacturing and processing can be very hazardous to human health. The waste from dyes if the effluent is not treated can be hazardous to living beings if it goes into rivers and seas. Leather waste which can include residue animal skin can absorb dyes and treatments to skin including chlorides, sulphates, hydrocarbons, amines, aldehydes,
and heavy metals including chromium, and arsenic used in tanning processing among others. Leather waste can include trimmings, shavings, splits, and animal skin residue. If the wastes from leather are not treated properly and disposed of ethically, then damage to groundwater, soil, human health as well as odour and emissions such as GHG which can be poisonous, (Leather Panel, n.d.).
Good practice leather companies think about sustainability in developing their products such as Authenticae, such as Billy Tannery.
(See Case Study Leather: Billy Tannery)
(See Leather Products in Accessories)

There are many new materials that are being created using waste resources to create new fabrics, two examples of leather alternatives are mentioned here:

1. Using waste leaves from the pineapple, Dr Carmen Hijosa resolved to make a new fabric which has the same properties as leather re-using waste and developing an

upmarket alternative to leather materials. Piñatex textile is a non-biodegradeble leather alternative made from the cellulose fibres extracted from pineapple leaves. It contains PLA (polylactic acid), a bioplastic material which can biodegrade and is eco-friendly, (All3DP, 2021).

2. Bolt Technology have design 'Mylo', which is a leather like fabric as a high quality alternative to synthetic and animal leathers made from mushrooms. Certified bio-based made predominantly from renewable ingredients makes for a sustainable alternative for leather and is being used by designers such as Stella McCartney, adidas, lululemon and kering in collections. The fabric is grown and is certified vegan. Mycelium used to grow Mylo take two weeks to grow using mulch, air and water, grown vertically. (Mylo™ Unleather | Sustainable Vegan Mycelium Leather, 2021)

Synthetics fabrics: Acrylics, Viscose, Nylon, Polyesters, PVC and plastic

Synthetic fibres are man-made materials that originate from chemicals, often with superior properties to natural fibres hence their popularity. Materials that are considered synthetic in textiles are polyester, polyamide, polypropylene, rayon, acrylic, spandex, acetate, lyocell, microfibre and nylon, as well as plastics. Most of these fabrics are by-products of crude oil, petro chemicals and are made from either inorganic products or a mixture of organic ones and chemicals. Synthetic fibres developed in the 1930's, acrylic was developed in 1893 by Dupont as it had similar properties to wool. Wearing synthetic fabrics and fibres became very popular in the 1950's – 1970's, as they allowed for mass production and cheaper prices (KeyColour, 2017). It was seen as a revolution in the field and grew rapidly in popularity alongside other types of plastics in furniture, design and food containers.

Similar to plastics, in general research plastics-based products comes with a cost to both human health and the environment (Alexander, 2020). The first is to human health by close contact and sweat for the wearer, with chemicals released against the skin (similar to AZO dyes, above); and in environmental health due to the manufacturing process and each wash load releasing micro-plastics into rivers and seas. This is also true for plastic drink containers and bottles leaching plastics into the liquids which humans ingest. (Belluz and Radhika Viswanathan, 2018).

Synthetics and Climate Change

One man-made fabric that seems to stand out with lower human-health risks, is rayon. Polyester, acrylic, and viscose fabrics have a damaging effect (such as endocrinal disruptors and potential cancer risks) that are still not fully understood. (Grebleski,2019) Acrylics are energy intensive and come out worst in fibres for CO_2's used for finishing as does polypropylene and polyester. Natural fibres such as wool and silk come out best, followed by cotton. (Breton, et al, 2006).

One of the reasons why clothing can be difficult to recycle is because there are high volumes of non-renewable sources, including clothes made with petroleum sources (polyesters, polyamides etc.), knowingly made as clothing most likely to be dumped in landfill or incinerated.

The Ellen MacArthur Foundation recommends the ban of polyesters, acrylics and nylon altogether. (Ellen MacArthur Foundation). Acrylic continues to have a negative impact on the environment during its entire lifetime and each time an acrylic garment is washed, it releases tiny fibres which are micro plastics, that get washed into the sea. (It's a Stitch Up)

In September 2016, Edwin Keh, CEO of The Hong Kong Research Institute of Textiles and Apparel (HKRITA), together with the H&M Foundation to form a Closed-Loop Apparel

Recycling Eco-System Program, this meant finding at least one technology to recycle clothes from textile mixes (blends) into new fabrics and yarns over a four year period. After one year HKRITA together with Ehime University and Shinshu University in Japan, successfully developed a hydrothermal (chemical) process, using heat, water and less than 5% biodegradable green chemical, in order to fully separate polyester and cotton blends. The fibre-to-fibre recycling method is cost effective, there's no secondary environmental pollution. (Persson, 2017). This is an important breakthrough and the project can be scaled up. This is one of various projects that are being developed by HKRITA.

Carpets

Greenwashing in the carpet industry is high as currently only 2% of carpets are reused or recycled. Approximately 130,000 tonnes of carpet are annually disposed of - there are some carpets which are shredded for equestrian purposes such as arenas, but the rest either goes to landfill or burnt, (Zero Waste Europe, 2019). Immediate action is needed by carpet manufacturers towards the carpet recycling as they are 100% recyclable so that consumers public authorities, municipalities, and retailers are informed clearly that carpets can be recyclable and not the 95-97% that go to landfill or be incinerated, (Goldsteinresearch.com, 2021).

Exports and carbon issues

More brands and companies are starting to measure their carbon footprint and sustainability audits. There are huge carbon issues with global transportation in the fashion, textiles and accessories industries particularly in transportation through shipping and air freight. Many goods are imported into the UK from all over the world. Stand.earth, an international not for profit environmental organisation point out in their report, '*A Roadmap for Fossil Free Fashion'*, (Stand.earth, 2020) on decarbonising the fashion industry, one of the major barriers for decarbonisation is 85% of Shipping Executives identify lack of customer demand.

In the report, addressed are several "wrong turns" the fashion industry should avoid, such as:

- Do not pursue greenwashing initiatives like renewable energy credits and carbon offsets.
- Do not support false "clean" energy transitions from coal to fracked gas or coal to biomass.
- Do not rely on false "clean" shipping proposals such as scrubbers & LNG.
- Do not increase the amount of materials sourced from fossil fuels like fracked gas and coal.

Carbon Offsetting is just one of several wrong turns listed in the report. Others include switching to gas ("coal to renewables, not coal to gas," the report says), planting trees while carrying on emitting as usual ("tree-washing"), and relying on the "scrubber loophole" for shipping, which allows brands to keep using highly toxic High Fuel Oil by installing a scrubber, which removes the sulphur from the exhaust – but then dumps it in the ocean instead." The report recommends phasing out polyester fabrics and other plastic fabrics, manufacturing greener and longer lasting fabrics, sharing capital costs, blocking out coal investment, demand clean energy policies, in manufacturing and greener shipping. Leaving behind the take-make-waste linear business model, from fast fashion, (Stand.earth, 2020).

A Roadmap for Fossil Free Fashion highlights the addition of new coal power plants being planned in Vietnam, China Turkey and Bangladesh and links the fashion industry to the connection of rapidly expanding polyester use together with the explosion of fracking in the U.S. Stand.earth in its report, '*Filthy Fashion Scorecard'* (2019), ranked out of 45 brands which ones made sustainability commitments. They issued a warning that the FTA industry needs

to pay attention to climate change, and urged the industry to make shifts and changes in order to stay within the UN Paris Agreement.
Stand.earth note in 2019, 24 textiles, apparel and luxury goods companies have agreed to set third-party approved climate targets as part of a process called the Science-Based Targets Initiative. In COP24, in 2018, the UN Fashion Industry Charter for Climate Action was launched, in order 'to drive the fashion industry to net-zero GHG no later than 2050, in line with keeping global warming to below 1.5 degrees'. 57 companies signed up including brands such as Nike, Gap, Puma, Adidas, H&M, and Target.
At the August 2019 G7 meetings, Kering industries, (luxury brands Gucci, Yves St Laurent and Alexander McQueen), was charged to bring together various sustainability initiatives into an umbrella G7 Fashion Pact for climate, biodiversity and oceans protection. Scientists still think there may be a chance to maintain a 'semblance' of the ecosystems we have at the moment if we can keep to 1.5 degrees of global warming. The UN Fashion Industry Charter for Climate Action was renewed in 2021, there are 8 Working Groups to help led by those from large brands such as Kering, adidas, Puma, H&M Group, Conde Nast, Textile Exchange among others in order to strengthen support and share tools and knowledge.
The creation of the G7 Fashion Pact and the UNFCCC Fashion Charter has generated awareness and momentum to change to a clean energy policy and strive for climate reduction in the supply chain. Stand.earth in *A Roadmap for Fossil Free Fashion* warns that the 30% reduction, the bar set in the UN fashion Charter falls far short of the massive cuts scientists say are needed in the next nine years to stay within the 1.5 degree Celsius target. The major cut that needs to be made urgently is the phasing out of fossil fuels, coal being the first to go. Fashion Revolution has been crying out for the fashion industry to clean up their act for some time. There is a warning with carbon offsetting that it should be the last thing and not the first thing to consider. Transportation using fossil fuels and the making of fabrics using fossil fuels should be the first to go as a priority.

ACCESSORIES

Description of Scope in Accessories

Accessories encompass many items, such as shoes, bags, belts, hats, jewellery and masks, each available from a variety of materials: plastics, rubber, wood, textiles, leather, among others. Accessories exist in all social contexts (sportswear, casual wear, workwear, etc.) and at all market sectors from luxury to lower levels of markets, including fast fashion.
The complexities of variables between forms and shapes make for many markets originating from global sources. Of clothing and accessories imported in the UK (3.6% of all 2020 UK imports (Workman, 2021)), 70% originate from outside the EU (Shahbandeh, 2021), implying a more challenging and complicated supply chain to track. The accessories industry is set to increase, Mintel reports a buoyant £3.6billion in 2018. (Mintel Store, 2020)

The sustainability challenges relevant to Accessories

For Shoes

- Many accessories are discarded due to poor manufacture
- Complicated recycling processes and the need for scaled-up recycling centres
- Leather finishes involving chromium (see leather)
- Leaking of microplastics in shoes
- Poor working conditions (see fashion)

Overall accessories

- Many accessories are discarded due to poor manufacture especially in the fast fashion sector
- Lack of transparency in the supply chain
- Lack of skills for repair, and lack of desire/respect for items to be repaired (see fashion)
- Few take back schemes -- people do not know what to do with them.

Many accessories are discarded due to poor manufacture especially in the fast fashion sector

The CFDA reports it is 'not uncommon to find upwards of 20 different materials in any one shoe' (CFDA, 2019), thereby complicating the recycling process. The materials vary between leathers, rubbers, plastics and natural fibres, among others. The Centre for Sustainable Manufacturing and Reuse/recycling Technologies (SMART) at Loughborough University estimates that only 15% of postconsumer shoe waste is collected and re-distributed in the UK. In the UK, 149 million pairs of shoes are discarded into landfill every year, in a global market where 22 billion pairs of shoes annually go to landfill. (Footwear Today, 2020)

The SMART centre, Loughborough has been investigating shoe recycling since 2007-2022. SMART recommends operating large-scale footwear recycling operations to be commercially viable due to the complexity of disassembling shoe materials. Recycling manufacturers could reduce recycling steps, but this would mean materials becoming down cycled with a reduced quality. In doing so, this would hinder a truly circular economy (SMART, 2021). According to bettershoes.org, out of all the shoes that are discarded only 15% are redistributed and the rest go to landfill. Oxfam believe that door to door collections prevent shoes going to landfill, as they can recover shoes and avoid post-consumer waste. (SMART, 2007)

Today, the most prominent shoe recycling manufacturer is located in Wolfen, Germany (Dover Council, 2021).

Vivobarefoo**t** uncovered research where in 2020, 46% of consumers planned to buy new footwear in Black Friday sales. Vivobarefoot is the first company that has offered an end of life solution for its footwear products, called ReVivo. Vivobarefoot as well as other brands are starting to opt out of Black Friday shopping deals since 2020. Wightman-Stone, D. (2020). Adidas have launched FUTURECRAFT.LOOP a 100% recyclable performance running shoe. In collaboration with Parley for the Oceans in 2015, Adidas launched an entirely recyclable upper made from marine plastic waste and illegal deep-sea gillnets. Adidas News Site | Press Resources for all Brands, Sports and Innovations. (2019).

A new scheme from Cyclon is offering a subscription to running shoes. After 600km or 6m the subscriber is entitled to a new kit, so the old kit is sent back to Cyclon for recycling Cyclon use the old product as raw materials for new products. www.on-running.com. (n.d.). *Cyclon*.

Much of the cheaper end of accessories end up in landfill as they are poorly made and do not stand up to long term wear. This is true of earrings, bags, and shoes, where shoes are the worst, as millions of shoes go to landfill. Packaging issues, returns and deadstock (see Fashion section for packaging). Low recyclability of materials, plastics, leather, (see Textiles section for materials). Regenerative agriculture (see Textiles). Traceable supply line, (see Recommendations). Washing micro plastics into the ocean, (see Fashion).

Leaking of Microplastics in Shoes

Microplastics are not limited to plastic-based textiles but also emerge from footwear and soles (Chemical Watch, 2015). Plastics allowed for significant innovations in footwear, especially with the growth of sneakers and heels in the last few decades. Today almost half of the footwear exported globally is made of rubber or plastic 47%, with the most significant development in shoe technology identified as vulcanised rubber (Borunda, 2019).

Lack of skills for repair, and lack of desire/respect for items to be repaired (see fashion)

In luxury products and accessories each bag comes with a serial number which can be returned to the manufacturer for repair. This service is not offered at a lower market in accessories and the repair is the responsibility for the consumer. Whether the responsibility for the repair is on the consumer or seller (EPR), the skills required to mend and fix, such as professional cobblers, are a disappearing business in the UK. The UK's footwear & leather goods repair currently has an estimated market value of £27m (IBISWorld, 2021).

In the luxury industry, ReStory based at Selfridges, they offer services for bags, shoes, and clothes to be mended, in fast fashion, H&M and Uniqlo advertise lessons in repair – but not relevant to accessories. Repair café's are a means of community and social interaction where people can get advice and help in repairing their kit. The Repair Café encourage participants to start their own café for a fee, and they will help people get started, (Repair Cafe, 2021).

Bags, Belts, Gloves

Regarding synthetic materials for bags and belts, microplastics can leach as previously mentioned in microplastics.

In bags and belts made from leather, including shoes there are a wide range of materials which are needed to make accessories. There are many components that are needed to make a successful leather product such as leather board, adhesives, metallic accessories, threads, fabric, tapes, finishes including waxes, polishes and cleaners. Often in leather good, smaller items are made to minimise the waste of leather skins, such as key rings or small purses.

Leather industries consist of clothing items such as jackets, trousers, gloves, leather garments, saddlery, upholstery and sport goods. Leather is manufactured all over the world, and in certain countries they have established emission levels for some pollutants.

Waste in Sunglasses

Many consumers do not know how to recycle sunglasses, so many are discarded as waste. There are operations to clean up plastic and reuse as sunglasses. According to Johnson and Johnson, figures show 750million contact lenses being thrown away either down the drain or to landfill, filling the oceans with plastics. Contact lenses are usually made of silicon hydrogel which is not biodegradable and so they are currently difficult to recycle. When they are discarded into the sea they sink down to the bottom of the sea bed and are a threat to marine life or they break up and are swallowed by whales, dolphins and seals. (Optical Express, 2019).

Since 2019, Boots Opticians have partnered with ACUVUE and Terracycle to collect used contact lenses for safe disposal. These used lenses can then be safely recycled to form outdoor furniture. (www.boots-uk.com. (n.d.). Eyewear frames are cut from sheet acetate to which there is a large amount of plastic materials being thrown away annually. (Bekind, 2020). Glasses and sunglasses suppliers recommend reglazing glasses to avoid wasting the frame. When it comes to recycling, the materials are usually mixed metal and plastic, which are currently not fit for household recycling (Peep Eyewear, 2020).

Examples of Good Practice in Tackling Waste in the Textile Industry

New and accelerated solutions are being developed and scaled up to national and international levels. More can be done to help acceleration and to help new innovation and start-ups in materials and recycling.

In reusing and recycling knitwear waste including textile deadstock, iinouiio, a British knitwear company with 40 years of experience of recycling created a unique custom-built recycling plant to unravel knitted panels and woven textiles, to unravel, to reuse and remake fibre. The machinery is able to be scaled up to close the loop for recycling in knitted and woven textiles this practice has been referenced to a Case Study on iinouiio with Dr John G. Parkinson and Linda Parkinson. [Please refer to the Case Study Textiles: iinouiio]

Around the world Evrnu, based in Seattle USA, is a textile recycling innovation start-up which has partnered with Stella McCartney, Adidas and Levi's among others and has raised $24m to scale up circularity**.** Evrnu, make rapid prototyping, developing circular versions of existing products, as well as new product lines, impact reduction, through data modelling from sampling to scale, diverting deadstock and waste from being burnt or landfill, into becoming new fibre, and opportunities for bespoke R&D customising fibre development

The Lenzing Group are a group based in Austria that are making sustainable developments with indigo dyestuffs and Tencel in denim among other processes, with the ambition of pulping 25000 tons of textile waste by 2025 to turn into new textiles. In textiles recycling, Lenzing are developing the Refibra brand https://www.tencel.com/refibra, which is cotton waste and old textiles are reused together with pulp as new raw materials, with the ambition of processing 100,000 tons of textile waste by 2028. Lenzing have linked up with TextileGenesis, using blockchain technology in order to identify Lenzing fibres at every stage of the supply chain from fibre to the sale of finished garments. The technology will reassure consumers that they can buy with confidence to transparency and ethical products. Lenzing adheres strictly to the Global Supplier Code of Conduct mentioned earlier in working practices**.** Lenzing claim UN SDG's 1, 3, 6, 7, 8, 9, 12, 13, 14, 15 and 17, on their website and have ambitious sustainable goals.

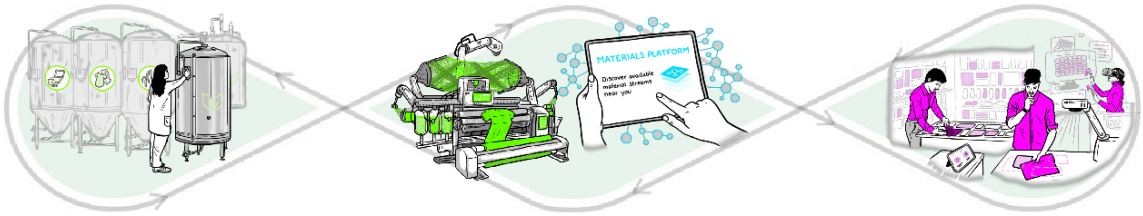
Using waste goat skins that would have been thrown away, Jack Millington, and Rory Harker inspired by the revulsion of food waste developed an idea of reusing waste goat skins into a sustainable tannery and making leather products in the Midlands. Billy Tannery is the first micro tannery in the UK for a century, and now do small batch tanning using sustainable dyes and make accessories. They work with Authenticae, who are responsible leather specialists, testing dyes and the biodegradability of the leather and the impact on the ecosystem. [Please refer to Case Study Leather: Billy Tannery]

Addressing the challenges of polyester, polyester cottons, blended fabrics and PET plastics (polyethylene terephthalate), are being examined by Worn Again Technologies, are a UK company who are solving some of these issues by replacing virgin resources. They are developing circular, closed loop systems for this area of PET and cellulosic raw materials. The system is able to separate, decontaminate and extract polyester and cellulose from cotton, from non-reusable textiles and polyester bottles in order to produce dual PET and cellulose outputs putting sustainable resources back into the supply chain. The key is in the dual worn again processes, in PET is dye removal, dissolution, separating polymer solvents, then purifying and restoring polymer through a closed loop solvent system, and in cellulose is dissolution, filtration and cellulose dope. PET becomes PET resin and in cellulose it becomes cellulosic pulp before spinning into new recycled fibres and becoming recycled fabric.

Sustainable Practice in the Fashion, Textiles and Accessories industries.

Textiles Circularity Centre

The Textiles Circularity Centre, (TCC), led by Professor Sharon Baurley (Royal College of Art), together with Professor Phil Purnell (University of Leeds), launched in May 2021, funded by the UK Research and Innovation Fund, (UKRI), together with four other Circularity Centres. The purpose of the TCC is to stimulate innovation and manufacturing in the UK textile manufacturing, SME apparel and other areas of the fashion and textile industry. Focussing on ethical and environmentally healthy models, diversifying supply chains, and reducing the reliance of imported, unethical and environmentally impactful materials. Through research they are looking at a figure of eight recycling loop in the circular economy as illustrated by the diagram below.



The Circular Supply Chain © Textiles Circularity Centre

The Circular Supply Chain Research Strand, illustrates the Materials Circularity research strand on the left hand side and the Consumer Experience as a separate research strand on the right hand side. The Textiles Circularity Centre is an important research centre into material engagement in textiles and wider materials, however it also has an opportunity to not only research into materials but also consumers and the supply chain.

Materials consist of two main areas of research into Human-Centred Materials, social science, multi-sensory experience and alternative materials, such as Materials Biology, bio-materials, material science and composites. Research is being made into the supply chain, transparency and developing textile materials. Bio-waste looks at three types of waste streams, energy, chemical, and water. In terms of pre-consumer waste TCC are looking at pre-production in cotton, wool and silk as well as other materials such as petroleum based synthetics.

Together with Professor Steve Evans from the Institute of Manufacturing, University of Cambridge, the TCC are examining feedstocks, bio-waste, moving away from fossil fuels and rather than having separate circles, finding opportunities to close loops in their models. Food waste is complex to process, and municipal waste can contain contaminated items such as cardboard, paper, food waste in black bin bags for instance and TCC are looking into generating cellulose fibre pulp.

There is scope for the TCC to look at types of cities, the retail environment, plastics in packaging and alternatives, how development and production can be produced more locally. The circular model means keeping more materials in use for as long as possible and reducing waste, this can be made possible through investigating local schemes such as re-selling, social communities and bringing consumers closer together. There is also an issue of custodianship, who owns the product and who/how to be responsible for the next chapter of the life of the product, and how it returns to the eco-system. There is potential for creating narratives with products and consumers, to promote the relationships we used to have with

products and identifying with them, in order to solidify trust and respect of that product with the consumer.
The TCC are creating ideas for types of toolkits, thinking of how different product sectors would look in future such as luxury markets and although these repair markets as mentioned previously exist, how can this be made more democratic? These and other questions are being followed through to fast fashion ideas of how clothing be made better and more ethically, with less pollution in order for a resale market. (RCA website, 2021)

Rental Schemes
Rental schemes, where clothes are hired for an occasion rather than being bought are fast becoming a circular way of wearing clothes – especially at the high end of fashion, without the commitment to buy them. There are mixed ideas on hiring as companies have a policy of being worn a number of times before being advertised for resale. There are hidden costs of cleaning clothes, with dry cleaning pieces (solvents are polluting chemicals that can leach into soil and water), packaging and environmental costs in transportation. The company Oxwash, is offering a solvent free sustainable washing alternative. (Ng, 2021). New Standard Institute raises the fact that in order for the fashion industry to change, they need to address their disposable relationship with clothes, and to start by taking the ideas of trends which promote throwaway. (Chan, 2021).
Rent the Runway argue that as the resale aspect on their rental site has been added and they have monitored customers and they maintain that most of them buy less clothing than they did before joining their site. (Chan, 2021).
Burberry, a luxury British brand, in 2018 was infamous as one of the (many) brands that burnt its deadstock in order to protect the brand pricing as well as counterfeiting; more recently, joined the Ellen MacArthur Foundation, and as of December, 2021, have launched a rental and resale scheme of their clothing with My Wardrobe HQ, being able to rent for 4, 7, 10 or 14 days. Burberry has pledged to customers to be more sustainable and Burberry are hoping to become Climate Positive by 2040 and the rental scheme helps the company to achieve their goals. 40% of each transaction goes to Smart Works the UK charity to help support unemployed women getting work. This is Burberry's first step into a more circular economy.

Manufacturing Schemes
Project Plan B based in Plymouth, decided to make a 'no end of use' better workwear product through pioneering a closed loop recycled polyester system where virgin polyester no longer used thereby eliminating waste and reducing CO_2 emissions. Within their full manufacturing service the design is made from conception to end of life recycling. Once the garments have finished their wear they are returned to Project Plan B so that they can be recycled. The clothing is returned to raw polyester and reknitted or woven into new fabrics.
Nothing is wasted the garments can be returned again.
Every year, nearly 40 million garments are provided to wearers, 90% of which go to landfill or are incinerated after their end use. Natural fibres do not have the longevity for wear as polyester fibres, nor colour fastness or fabric stability for durable usage in some workwear. Designing with end of life in mind is a responsible way forward in today's climate. The values of Project Plan B are transparent and are committed to standards such as the Global Recycled Standard, Oeko-tex Standard 100, as well as Sedex and Ethical Trading Scheme, (https://www.projectplanb.co.uk/, 2021)

Exhibitions on Waste

The exhibition at the Design Museum on waste called Waste Age highlights the problems on waste and promotes good practice and circularity. These schemes are excellent at high lighting the problem of waste and making ideas public so that information can be communicated and the wider public and be informed. Design will change, and the fashion and textile industry will look very different in years to come. (Design Museum, 2021)
https://designmuseum.org/exhibitions/waste-age-what-can-design-do

Institute of Positive Fashion
In May 2021, Caroline Rush from the British Fashion Council launched the Institute of Positive Fashion. The Institute of Positive Fashion align themselves with UN SDG's 5, 8, 10, 12, 13 and 17. In September the Institute of Positive Fashion produced a comprehensive report on the state of the fashion industry. (instituteofpositivefashion.com, 2021). The Institute of Positive Fashion report provides three target outcomes, which combined together will allow for a viable, resilient and prosperous ecosystem for the fashion industry.

- 1: Reduced volume of new physical clothing
- 2: Maximised utilisation and revaluation through product circularity
- 3: Optimised sorting methods and materials recovery

These 3 target outcomes have10 priority actions and 30 recommendations for an ecosystem of stakeholders who collectively need to act in order to achieve a sustainable industry. These ten actions involve the very heart of the fashion value chain. Each of the ten actions are equally important, and have consequences if one is favoured over the other as they all affect each other:

1. Circular design
2. Consumer empowerment
3. Circular and sharing business models
4. Demand for circular and sustainable fibres
5. Post-use ecosystem
6. Sortation and recycling
7. Enhanced identification and tracking
8. Ecosystem modelling
9. Policy and regulation
10. Infrastructure investment

(instituteofpositivefashion.com, 2021)

The Institute of Positive Fashion recommend government legislation to enable the infrastructure, through incentives and investment for innovation. More investment in research and digital technologies in order to achieve ambitious targets. Educating the consumer is critical in fabric and material care, promoting longer garment usage, repurposing and reusing clothes and fabrics. Marketing positive messages of the circular economy in order to reinforce the message and shift linear thinking to circular usage.

World Circular Textiles Day, October 8
In response to the textile industry becoming net zero by 2050, annually on October 8, has become World Circular Textiles Day, (https://worldcirculartextilesday.com/). The initiative is around celebrating circular thinking, celebrating community efforts around the world with the aim to reach net zero by 2050, through dignity, equality and equity (SDG's) in:
1. Raw Materials

2. Products and Services
3. People and Services
- with the ambition that circular textiles will be realised and the sharing of resources and where products and raw materials being reused and in continual circulation.

The day celebrates raising awareness, cultivates an umbrella of ideas from the growing community consisting of companies, academia, government agencies, brands, cities and individuals who are generating ideas in circular thinking and projects. The aim is to build a framework for a collaborative roadmap over the next 30 years and to achieve net zero by 2050.

How the team see the years progressing, are the Innovation and R&D years will be from (2010-2025), which will grow awareness. The Infrastructure and Rollout years (2025-2040). The Expansion and Completion years (2040-2050). The World Circular Textiles Day, founded by Professor Rebecca Earley, from the UAL Centre for Circular Design, Cyndi Rhodes from Worn Again Technologies and Gwen Cunningham from Circle Economy. (World Circular Textiles Day, n.d.)

WRAP and TEXTILES 2030 initiative

In April 2021, WRAP launched TEXTILES 2030, (https://wrap.org.uk/taking-action/textiles/initiatives/textiles-2030), building upon the success of SCAP, Sustainable Clothing Action Plan (SCAP2020) where 34 brands and organisations signed up to take action and make better decisions in sustainable practice. TEXTILES2030 action is to reduce greenhouse gasses (GHG), to cut the water foot print in products by 30% and deliver a UK circular road map in textiles and work towards maintaining the science based target of 1.5 degree Celsius emissions, aligned with the UN Paris Agreement, less than ten years away, (WRAP, 2021). Since launching WRAP's TEXILES 2030, over 100 brands to writing date, organisations and universities have signed up to accelerate sustainable collaboration in carbon, water and circular textile targets as well as contributing to national policy to shape Extended Producer Responsibility, (EPR) and other critical requirements. WRAP have extended their website to add toolkits in Textiles together with a Knowledge Bank to help businesses take on responsibility. (WRAP, 2021).

Although acceleration and heightened awareness is admirable over the last two years - 30% cut is not nearly enough - the Global Fashion Agenda and McKinsey joint report (Berg, Magnus and Lehman, 2020), and Stand.earth (2020) report, conclude that a cut of nearer 55% is the massive reduction needed to maintain 1.5 degrees Celsius in nine years.

Conclusions for Fashion, Textiles and Accessories

There is no doubt that the fashion textiles and accessories industries must change radically in order to keep to the 1.5 degree Celsius and Paris Agreement. Retail and manufacturing are going through a reset due to the pandemic. The slowing of the world allowed all areas in materials, manufacturers, retailers, consumers' opportunities to re-evaluate and consider how the industry can make the supply chain more transparent and fare better with the relationships between the materials of products and the consumer. Unless change is implemented more rapidly, the targets of 2050 will be far too late. Net zero needs to be brought forward to 2030. In order to do that manufacturing, environmental pollution through transportation and consumer education needs to be put into action.

One of the main barriers to affect change is the lack of transparency in the supply chain from the farmer to the consumer. Each process, down to the environment of the grown product to the environmental damage in transportation from global manufacturer to consumer, each

part of the journey needs to be documented, cleaned up and transparent. Lack of transparency of supply affects employment and SDG8, where due to confusion in international regulations a living wage is not regularly paid to international workers in farming or fibre/fabric manufacture or in making garments.

There is innovation and desire to change in the fashion, textiles and accessory markets to a cleaner and less polluting model. The change is in slow progress but needs to be accelerated in all areas of the globe in order to provide an economically and ethical change which will benefit the environment for all. It is evident that 30% by 2030 will not be enough, and clearly more biting cuts will need to be made to maintain the target of 1.5 degrees in global warming. This is a climate emergency and change needs to be made now, without any procrastination.

In order to do this, the FTA business needs to accelerate responsible and ethical practice and the government needs to support this in legislation to make all companies comply. There are the fore thinkers in business who are taking active practice now and trying to move their business to a more circular model. In consumers and young people, education at all levels needs to be made in making skills and materials. Government regulation can speed up this change by making the antiquated linear model uneconomic, unprofitable and costly for industry.

In June 2021, UKFT reported the United Nations Economic Commission for Europe (UNECE) (set up in 1947), and UN/CEFACT, jointly with key industry stakeholders have launched a project for an international framework initiative to enhance transparency and traceability for sustainable value chains in the garment and footwear industry, (UNECE Call to Action for Traceability and Transparency in the Garment and Footwear Sector, 2021). There have been a number of good initiatives that have started in the last 12 months which are admirable, but much more needs to be done to help industry as well as consumer to change. The industry as we know it now, will be different.

Glossary

ABP	Animal By-Product
BFTT	Business of Fashion, Textiles and Technology https://bftt.org.uk/
CC	Crafts Council https://www.craftscouncil.org.uk/about/our-work
CFDA	Council of Fashion Designers of America https://cfda.com/
EPR	Extended Producer Responsibility
ECOSOC	UN Economic and Social Council https://www.un.org/ecosoc/
FFF	Future Fashion Factory https://futurefashionfactory.org/
GHG	Greenhouse Gases
GOTS	Global Organic Textiles Standard https://global-standard.org/
HCA	Heritage Crafts Association https://heritagecrafts.org.uk/mission-and-aims/
HKRITA	Hong Kong Research Institute of Textiles and Apparel https://www.hkrita.com/home.php
ICAC	International Cotton Advisory Committee https://icac.org/
Kering	Luxury Conglomerate. https://www.kering.com/en/group/discover-kering/
LDPE	low density polyethylene
LVMH	Louis Vuitton Moet Hennessey, often shortened to Louis Vuitton. Luxury Conglomerate. https://www.lvmh.com/group/
PET	polyethylene terephthalate

SCAP	Sustainable Clothing Action Plan 2020 https://wrap.org.uk/taking-action/textiles/initiatives/scap-2020
SMART	Centre for Sustainable Manufacturing and Reuse/Recycling Technologies Loughborough https://www.centreforsmart.co.uk/
WRAP	WRAP and TEXTILES2030 https://wrap.org.uk/#
UKFT	United Kingdom Fashion and Textiles Association https://www.ukft.org/
UKRI	United Kingdome Research and Innovation https://www.ukri.org/
UN/CEFACT	**Centre for Trade Facilitation and Electronic Business** **https://unece.org/trade/uncefact**
UNECE	United Nations Economic Commission for Europe https://unece.org/
UNFCCC	United Nations Framework Convention on Climate Change https://unfccc.int/
UNEP	United Nations Environment Programme https://www.unep.org/
UN SDG	United Nation Sustainable Development Goals https://sdgs.un.org/goals

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Chapter 7: Film and Photography

Itandehui Jansen & Emily MacDonald

Description of Scope

Film and Photography refers in this report to different practices using both analogue and / or digital camera equipment to make either still photographs or audiovisual productions, whether these are commercial, fictional, documentary or experimental in approach. Both film and photography have been shifting in the last fifteen years from a predominant use of analogue equipment and materials, to a predominant use of digital equipment and materials.

Many Professional Photographers are sole traders or operate as a small enterprise. They can be hired, or commissioned for services ranging from portraits, to food photography, fashion shoots, or event photography. With respect to film production, this is slightly more complicated. Most film practitioners in different disciplines are sole traders and are hired for a specific department in the context of a specific project.

Film production is inherently interdisciplinary and involves a variety of different practitioners. There are different approaches to film production and each film project will have it's own specificities. For example, the production of a documentary is considerably different to that of a fictional drama in the sense that different departments that are common in fictional drama production, such as Art Department, Costume, Make-Up and Special Effects, are not required for documentary production. The different departments in fictional film production all engage with specific use of different materials. For example, whereas cinematography, sound and editing are departments that mainly use electronic and electrical equipment, the art department generally uses timber and paint, whereas the costume department is mainly concerned with the use of textiles.

In general the following approaches can be distinguished in terms of film production:

1. Mainstream film productions, both fiction and documentary, generally financed through larger studios, broadcasters, and increasingly by streaming platforms (such as Netflix/ Amazon/ Disney).

2. Independent film productions, fiction or documentary generally produced with lower budgets.
3. Commissioned films, generally made as promotional or informational videos, for institutions, NGO's, and other companies, with varying kinds of budget.

Within Photography the main distinction in this report will be:
* Analogue Photography
* Digital Photography

As the use of materials differs in these two approaches.

The main different disciplines in fictional film production are also known as departments and can be distinguished as follows:

* Film Producing
* Film Directing
* Cinematography Department
* Sound Department
* Art Department
* Costume Department
* Editing
* Special Effects
* Post Production

Documentary, television and commissioned promotional films might not engage an Art Department, Costume Department, or Special Effects.
This report will look at different issues of sustainability within photography and film production. The report will mainly focus on the use of different raw materials. This report does not consider the costume department in depth, as the issues overlap with those in the chapter on Fashion, Textiles, and Accessories and the chapter on Performance Art. Similarly, the report only briefly touches upon the use of timber and paints in the Art Department, as these materials are more extensively discussed in the chapter on Performance Art.

Raw Materials in Film and Photography Equipment

Analogue film use in Photography and Film

In recent years the use of analogue and celluloid film in film productions has drastically diminished. In 2004 Kodak announced it would stop making and selling 35mm photographic cameras as their digital photo cameras outsold analogue. Similarly in 2011 the last movie camera using 35mm was manufactured and Fuji announced in 2012 that it would stop manufacturing film for motion pictures. As most movie theatres have transitioned to digital projection, and are increasingly losing audiences to streaming platforms, it seems that the use of analogue film in the cinema industry is coming to an end.

Nevertheless between 2014 and 2019 Kodak doubled its production of Eastman 35mm film for still photography. Hence in the realm of still photography, both professional and amateur, the use of analogue film is still present.

Materials involved in the use of analogue film are summarised in the below table:

Product	Elements
Film developer	Popular developing agents are metol, phenidone, dimezone, and hydroquinone. Paraphenylene diamine is used for developing colour film.
Film stop bath	Acidic agents such as sodium carbonate, borax, or sodium hydroxide.
Film fixer	Sodium sulfite.
Photographic Paper	Silver, nitric acid, a combination of potassium, bromine, chlorine, iodine, fluorine or astatine, and gelatin (and sometimes sulphur).

The impacts of these chemicals on the environment depends on how they are disposed of by the practitioner. Pouring these chemicals down a drain after use negatively impacts water ecosystems and marine life. For instance, the toxic effect of silver nitrate (silver + nitric acid) on aquatic life has been widely tested.

Alternatives to chemicals in developing and printing film are practiced by niche practitioners. Alternatives to film developer chemicals include plant based materials such as wine and coffee for acidic solutions. Alternatives to photographic paper include biodegradable materials such as plant matter. There are many botanical and food grade recipes and do-it-yourself tutorials which can be found online. These practices have not been taken up by mainstream photography however and remain experimental.

The Digital Shift in Film and Photography

Electronic equipment is used for cinematography, sound and post-production, consisting of cameras, lights, microphones, sound recording equipment, computers, laptops, and portable batteries. Cinematography for film and photography share similar electronic equipment, not only the camera itself, but also lights, and for example drones. Aspects to consider are the production of, and the discarding of the electronic equipment, the life span of the equipment, and the consumption of energy through the use of this equipment.

While fictional film sets generally rent equipment, it is quite common for independent documentary filmmakers or filmmakers working on commissioned films to own equipment. Generally this equipment can be characterised as “prosumer equipment”. An issue here is that cameras have an increasingly short life span, as we change from HD to 2K, to 4K, and now 8K cameras that are available on the market. Additionally, streaming platforms such as Netflix now require films to be delivered in 4K thus driving the need to keep up with the technological developments in digital cinema.

In the last fifteen years both in the field of film production, as well as photography, the amount of work produced digitally has radically increased and currently the amount of work produced through digital means surpasses that shot on celluloid film. Since 2013 most cinema theatres in the UK are equipped for digital projection. Since 2012 the shooting format for the top 100 U.S.-grossing fiction films has increasingly been digital. The increase in digital productions coincides with a decrease in productions shot on celluloid. Since 2014, the majority of short films presented at Raindance Film Festival have also been shot on digital cinema. (Data: StephenFollows.com)

Initially digital files were perceived as more sustainable, as they appeared to have no material elements involved and hence no waste production. However this has now been disproven.

A report by the Science and Technology Council of the Academy of Motion Picture Arts and Sciences considers that the costs of storing films on 4K resolution is eleven times more expensive than storing a traditional 35mm print. The report additionally states that the expected lifespan of a 35mm film print that is stored in ideal conditions is 100 years. At present there are no hard drives with a similar lifespan. This creates issues for the archival of digital works, but also means that there will be an ongoing requirement to transfer digital works, both film and photography, from one storage hard drive to another, thus creating electronic waste in the process. This example serves to highlight that digital productions have a material component in terms of storing and sharing files, generally in the shape of hard drives, even if the material is stored in “the cloud”.

Another matter is that because the shift to digital has been quite recent, there is still a sense of ongoing shifts to industry standards and formats. This situation can lead to early obsolescence of equipment, either due to incompatibility with new formats and standards, or due to the mechanism of perceived obsolescence. For example, while Cinema Screens changed to 2K digital projection in 2013, Sony has recently launched new 4K projectors for cinema (Sony website). Most feature films are currently post-produced to 2K, but this is also because most film projectors in cinema currently have a 2K resolution. If the projection resolution in cinemas starts to change, more films will likely be finished to be delivered in 4K. The streaming platform Netflix requires films and programmes to be delivered in 4K in anticipation of increased popularity of 4K television.

These ongoing and accelerated developments with regards to image resolution have material consequences for both the production of audiovisual content and the consumption of this content. On the one hand, if higher resolution is available, it seems possible to persuade consumers to purchase screening devices with a higher resolution, on the other hand if screening platforms and theatres change to a higher resolution, there will be an increase in film productions filmed and finished in a higher resolution. At present there are still debates on whether the difference between 2K resolution and 4K resolution is really noticeable. Nevertheless, considering that in 2013, 2K was considered the industry standard for Cinema projection and at present digital cinema prosumer cameras have become available that film in 12K, it seems only a matter of time before there is another shift in expected industry standards for image resolution.

This again can be expected to have an impact on equipment use and purchase for smaller film production companies and sole traders. Whereas larger big budget productions for broadcasters, streaming platforms or studios will probably work with rented equipment, independent documentary filmmakers and small production companies making commissioned films, usually purchase equipment. For example a quick look at the resolution changes in the Blackmagic Pocket Cinema Camera (BMPCC), a popular camera among prosumers, such as film students, emerging independent filmmakers, and filmmakers making promotional videos, highlights how the lifespan of a camera may be affected by developments in digital image resolution. Blackmagic first introduced the Pocket Cinema Camera in 2012. This first generation of the BMPCC shot on 2.5K resolution had a price of $2995. A year later the price of this first generation camera fell 30% as Blackmagic announced it was going to launch a 4K version of the BMPCC. The 4K Blackmagic Pocket Cinema Camera became available in 2014. Yet, in 2019 Blackmagic introduced a Pocket Cinema Camera that filmed on 6K resolution, drastically reducing the lifespan of both previous cameras through the mechanism of perceived obsolescence.

The following table presents components of electronic and electrical equipment used in the film industry, and the raw materials they consist of.

Component	**Key Materials used in the Component**
Camera Body/Case/Chassis.	Can be made of metals, plastic or polycarbonate compounds typically made of glass fibre.
Camera shutter	Discs/plates/'curtains' are typically made of metal or plastic.
Digital image sensor (CMOS and CCD sensors)	Digital image sensors consist of semiconductors including microchips and connecting wires and a glass plate (Lucid Vision Labs). The raw materials used in semiconductors are typically: copper, gallium, silicon, nickel, palladium and gold. The raw materials used in microchips are typically: Boron, silica, phosphorus, gallium, and arsenic.

Lens	The lens can be made with optical glass, plastic or glass bonded with resin. They also contain protective coatings which can include metal oxides, light-alloy fluorides, and layers of quartz. The lens mount can be made of metal such as brass, aluminium, or plastic (How Products are Made, Camera Lens). Lens filters are typically made of glass or resin.
Viewfinder	Viewfinders typically consist of either a LCD or OLED screen but OLED are increasingly popular in this size screen. OLED screen technology involves a substrate made with plastic, glass, or metal foil; carbon based film layers and conductive film electrodes (Universal Display). Viewfinders also typically contain optical glass, plastic, or glass/plastic combinations (How Products are Made, Camera).
Display Screen	Typically still LCD. Each pixel of an LCD consists of a layer of molecules between two transparent electrodes, often made of Indium-Tin oxide (ITO) and two polarising filters made of glass or plastic (Wikipedia).
Circuit boards	Predominantly consist of copper, nickel, aluminium, iron, tin and lead. They can also contain precious metals (gold, silver and platinum) as well as sulphur, zinc, strontium, zirconium, antimony, barite, lead and mercury. The substrate material is predominately made from a laminate material consisting of glass cloth and epoxy resin.
Lithium-ion Batteries	Predominantly cobalt, lithium and graphite. Batteries can also include diamonds (used as electrodes), manganese, nickel, cadmium, as well as REEs: terbium, dysprosium, erbium, thulium, ytterbium, and lutetium.

Semiconductors (integrated circuits and sensors)	Copper, gallium, silicon, nickel, palladium and gold.
Microchips	Boron, silica, phosphorus, gallium, and arsenic.
Permanent magnets (used in microphones)	Typically a neodymium iron boron compound.
Voice coil and cables (microphones)	Copper wire.
Microphone casing	Aluminium or plastic.

See Chapter 10 for information on the supply chains of the raw materials listed above.

Introduction to Sustainability Issues in Film and Photography

In 2006 the UCLA published a report analysing the environmental impact of film production in Hollywood. More recently the BFI published the report “Green Matters. Environmental sustainability and film production: an overview of current practice”, focusing on the UK film industry. The reports look at the environmental impact and carbon footprint of the film industry through the consumption of energy (through e.g. transport/ equipment/ construction of sets) and the production of waste. While the UCLA report focuses specifically on fictional film production, the BFI report clarifies that most analysed data relates to tv production rather than to film production. Both reports focus on the mainstream film industry and have no specific data on independent film production or on freelance filmmakers working on commissioned films or documentaries. Both reports highlight that certain specific data is unavailable or inaccessible.

Film sets consume energy e.g. through the participation and transport of large crews of people and its use of equipment. Film sets produce waste among others in the form of discarded props, costumes and single use plastic for catering purposes. It is estimated that 95 % of sets, props and costumes end up in landfill.

The UCLA report states that the carbon footprint of an average Hollywood film production is similar to that of 108 cars during one entire year. The report also

highlights that the carbon footprint increases with larger budgets. It is important to note that the average budget of mainstream films has exponentially grown in recent years. Also, the BFI report states that environmental impact increases with larger budgets.
Other investigations highlight that film productions shot on location can potentially damage natural environments. For example: “The magnificent sand dunes as seen in “Mad Max: Fury Road” caused extensive damage to the Namibia desert, disrupting the ecosystem of what is known to be the oldest desert in the world. In 2017, the filming of “Pirates of the Caribbean: Dead Men Tell No Tales” allegedly dumped toxic chemical waste into the waters of Queensland, Australia where film technicians, painters, and sculptors washed out various materials such as paint used for construction and special effects. (source: Vice)
Tandem productions produced an independent fiction film *Black Bear,* trying to keep environmental impact as limited as possible by using the green guide. The film was presented at Sundance and the mode of production was extensively discussed at the film festival as well as in the magazine Greenbizz.
Julie Christeas, founder of independent production company Tandem picture, states in an interview for Greenbiz: "Any person who endeavours to make a film knows that every aspect of our business is inherently wasteful. The amount of sheer garbage that's created is really heartbreaking." Jonathan Blitstein, chief operating officer and co-owner of Tandem, considers that every film production creates a lot of emissions. "Studio films release from 2,000 to 10,000 metric tonnes of carbon dioxide. We’re estimating that [larger] indie films are anywhere from 50 to 200 metric tonnes of carbon dioxide emitted.”
There is only limited data available on documentaries and commissioned films, but it can be expected that emissions are far below this number, as these productions generally operate with much smaller crews and less equipment and generally have considerably smaller budgets; and all reports agree that the bigger the budgets, the higher the emissions.
The sustainability issues this report will cover coalesce around the following areas:

- Material Supply Chains
- Manufacturing Processes
- Lifecycle e.g. product obsolescence, repair and recycling
- Dissolution & Recycling

Video cameras are a critical piece of electronic equipment used in the film industry and therefore their impact will be examined closely. Two video cameras popular among independent film practitioners and documentary makers (practitioners who are more likely to purchase their equipment rather than rent) are the Sony PXW-FS5 and the PXW-FS7. These cameras, and Sony as a brand and manufacturer, will be used in this report to explore the sustainability issues as well as good practice in video cameras and other electronic film equipment used in the film industry.

Material Supply Chains

Electronic and electrical film equipment largely depend on technology metals, many of which are critical for the functioning of technological components. There are many sustainability issues related to the sourcing of technology metals. They are enmeshed in the global mining industry and therefore have varying impacts on the environment, human health and human rights depending on the country of origin and the mining practices. See chapter 10 for information on the sustainability issues of sourcing technology metals.

Sony Material Supply Chains

In 2020, the total weight of products shipped was 448,990 tonnes, a reduction from 2019 (425,555 tonnes) and further from 2018 (510,443) and the amount of waste landfilled was 604 tonnes, less than half of the 2018 amount which was 1761 tonnes (Sony, 2021.a.pp188).

According to the *Sony Group Statement on U.K. Modern Slavery Act* (Sony, 2021.b.), there are 12 Sony-operated manufacturing sites for their electronic products located in Japan, China, South Korea, Thailand, Malaysia, and the UK, in addition to other sites managed by third parties (pp2) and the supplier countries where Sony procures their raw materials and component parts are; China, Japan, India, South Korea, Oceania, the UK, France, Germany, Russia, Spain, Sweden, the US, the Middle East, Brazil, Mexico and Canada (pp3).

According to the *Sony Group Code of Conduct* (Sony, 2021.c.) “Sony expects its suppliers and contractors to adhere to Sony’s ethical values and comply with applicable Sony policies concerning compliance with laws, respect for human rights,

fair labor and employment practices, environmental conservation and the safety of products and services (pp11)."

In October 2017, Sony established the *Sony Group Policy for Responsible Supply Chain of Minerals*. In the policy, Sony pledges that, "in order to avoid contributing to conflicts or serious human rights abuses through its sourcing practices, Sony identifies certain minerals that are sourced in conflict-affected and high-risk areas and that are high-risk for Sony from the perspective of corporate social responsibility ("High-Risk Minerals"). Sony's policy is to refrain from knowingly purchasing any products, components or materials that contain High-Risk Minerals that contribute to conflicts or serious human rights abuses in the chain of custody. At the same time, in implementing the policy, Sony makes sure that it is still able to source responsibly from those areas and avoid a de facto embargo. Sony currently identifies tantalum, tin, gold, tungsten and cobalt as High-Risk Minerals." (Sony, 2021.a.pp108) See Chapter 10 for more on conflict minerals.

To obtain full compliance with this policy, Sony requires its suppliers to source from smelters that comply with the Responsible Minerals Assurance Process (RMAP), a program in which a third party certifies that the minerals handled by the smelter are from sources that do not fund armed conflict or engage in human rights violations, or from smelters certified as being free from involvement in any armed conflicts or any serious human rights abuses, based on other trusted traceability projects such as the Good Delivery List compiled by the London Bullion Market Association (LBMA). (Sony, 2021.a.pp108)

The Sony Conflict Minerals Report (2021) reports on Sony's due diligence management of sourcing tantalum, tin, tungsten and gold (3TG) during the period of January 1 to December 31, 2020. (See Chapter 10 and the Case Study 14 for more on 3TG).

Sony designed a due diligence framework to determine the country of origin and chain of custody for any High-Risk Minerals in its supply chain to conform to the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas (OECD, 2016).

Sony reported the following regarding the origin of 3TG used in their supply chains:

Sony in-scope direct suppliers identified a total of 305 smelters and refiners (SORs) as potential sources of 3TG in Materials supplied to Sony that were reported to be in their supply chain at some point during 2020 (Sony, 2021.d.pp7). These SORs were

compared to the list of compliant and active SORs published by the Responsible Minerals Initiative RMI on its website, as of March 14, 2021. The below table shows their findings of conformant SORs for each 3TG mineral.

	Total Number of SORs	Conformant SORs	Not listed as Conformant SORs
Gold	154	112	42
Tantalum	37	37	0
Tin	70	61	9
Tungsten	44	42	2
Grand Total	305	252	53

Sony reported that their due diligence did not reveal that any 3TG mineral used in their electronics products was sourced from a 'covered country' (country of high-risk), except for those sourced through RMAP conformant SORs. However, Sony concluded that for 2020 they lacked sufficient information to determine the location or mine of origin of a portion of the 3TG in their electronics products (Sony, 2021.d.pp8)

Manufacturing Processes

Manufacturing processes employed to produce electronic and electrical film equipment can also pose significant sustainability risks. For instance, the use and management of chemicals and processes that produce large volumes of waste.

An example from the manufacturing of a video camera is the production of OLED screens. The standard technique for depositing the required organic materials on an OLED substrate is a vacuum evaporation process in which a mask is laid over a substrate, molecules are deposited, the mask is taken off, and the mask is cleaned in a vacuum chamber. Industry insiders have estimated that the standard technique for manufacturing OLEDs wastes between 70 and 90 percent of the expensive involved in the process (c&en, 2016).

Life Cycle Management

Sony and Life Cycle Management

Sony states that they utilise Life Cycle Assessments (LCA) in order to quantify the environmental impact of products at all stages of their life cycles. Sony's use of the LCA found that among product categories such as smartphones and digital video

cameras, a large portion of CO2 emissions occur at the manufacturing stage and in the production of materials and parts, rather than during use. They found therefore that for these products, measures such as reducing product weight are crucial in lowering life cycle CO2 emissions (Sony, 2021.a.pp146).

Sony's "Road to Zero" Environmental Plan aims to achieve a zero environmental footprint throughout the life cycle of their products and business activities. The tangible actions Sony identify as achieving this are; a) reducing the amount of plastic packaging in small products by using their own blended paper material made of bamboo and sugarcane (Sony Webpage: Original Blend Material), b) reducing raw materials in certain products through lighter and more compact design, c) phasing out and replacing any chemical substances that may pose environmental risks in production while prohibiting suppliers from using specified substances, and d) requesting raw material suppliers and manufacturers to monitor and manage the impact of their production and supply chains. (Sony Webpage: Road to Zero)

For example, the Sony VENICE video camera was made 20% lighter and 40% smaller than the previous F65 video camera which they claim reduces the heat emission and uses less resources during the manufacturing process (Sony Webpage: More resourceful using fewer resources). The VENICE lens has approximately 34% less non-recycled plastic relative to previous interchangeable lenses. The lens structure weighs less than previous models as well, in part due to a lightweight fluorite used in place of optical glass (Sony Webpage: A clear vision for the environment).

Repair

Sony offers repair support for their video cameras for 2 years free after which, extension of this cover comes at a cost (Sony Webpage: PrimeSupport) and there are currently 3,862 Sony repair service locations worldwide (Sony, 2021.a.pp117). This level of consideration for repairability is in sharp contrast to tech companies that integrate repairability into the design of their products, and enable consumers to repair devices themselves (See the Case Study: Fairpone). The sustainability issues related to the repair of electronic and electrical equipment in the film industry are typical of the issues that exist in general electronic and electrical equipment related to repair. See Chapter 10 for more information.

Dissolution & Recycling

The issues that exist in the dissolution and recycling of electronic and electrical film equipment mirror the issues across general e-waste management (See chapter 10). An issue that is pertinent to specialist electronic film equipment however is to do with how the complexity of equipment and composite materials affects its recyclability. Components made of many different materials that require intensive processing to break down into single materials, may be more difficult, more expensive and therefore less likely to be recycled.

If a piece of equipment is still functional but not for the purposes the practitioner requires of it, it can be donated or resold to a second hand market, rather than being disposed of as waste. There are many mechanisms both online and physical for practitioners to sell or donate their unwanted equipment.

Recycling Video Cameras

If a video camera no longer functions, certain components such as the lens may be able to be removed before recycling the entire product, to be reused. Video cameras can be disposed of in the same way as general e-waste, through recycling centres, where components such as batteries and circuit boards are removed for special recycling.

Lenses

The lifespan of lenses is much longer as it is possible to use them across a range of cameras. There is for example a thriving market of vintage lenses. The main reasons for the use of vintage lenses are budgetary or creative considerations. Many filmmakers are interested in the use of vintage 35mm lenses and there are a range of companies that specialise in rehousing vintage cinema lenses, such as P+S Technik, or True Lens. Lenses previously used with 16mm and S16mm film cameras, suddenly became popular again in combination with 2K cameras such as the Digital Bolex and the first generation BMPCC.

Art Department

Key materials used in the Art Department of narrative film production, television and streaming platforms are: timber, polystyrene and paint for the building of sets. Questions with regards to these materials are: Where and how were the materials sourced? Are there any hazardous elements in the materials? How are the materials

discarded / recycled after use? ALBERT recommends the use of FSC-certified timber and VOC free paints for set building. As these materials are very similar to those used in Theatre and Performing Arts this will not be discussed in detail here.

Logistics

Larger film and television productions generally use a variety of materials linked to organisation and logistics. One can think of paper and other office materials used in pre-production. Important elements related to logistics, are for example providing transportation, catering, and heating or air conditioning for larger groups of people. The use of materials to consider are packaging (plastic water bottles) used for catering on set, paper in pre-production, food and consequently food waste, as well as the choice of vehicles and fuel. The BFI report for example mentions different productions using biodiesel for heating.

Obstacles, Existing Good Practice and Innovations

Actions recommended by both ALBERT and the GREEN GUIDE to improve sustainability on film sets are among others:

- Introducing reusable water bottles.
- Limiting or eliminating packaging in catering services.
- Donating leftover food to local charities.
- Limiting transport, for example through the employment of local crew members.
- Choosing sustainable transport options, such as hybrid cars.
- Separating waste at all stages of production.
- Reusing and recycling prop and set materials.
- Donating costumes or reselling costumes to avoid sending them to landfill.

There are a number of challenges with regards to improving sustainable practice in film and photography. Particularly the BFI identifies among others the following challenges:

- There is a lack of consistency in approaches across productions.
- There is a lack of data. There is little to no data on independent film productions or commissioned films as ALBERT certification is connected to different funding

schemes. There are many U.S. productions filming in the U.K. which use a different sustainability practices recording system. Hence data is at present incomplete.

- Because most professionals in film industry work as freelancers it is harder to built an industry culture around sustainability
- Independent productions might have limited resources available and therefore might not hire a dedicated sustainability manager, and may not engage in the same way with sustainability.

The BFI report points out that whereas larger film studios generally have a sustainability officer, knowledge and resources for sustainable film practice are not as readily available for independent and smaller production companies. The Green Production Guide, was created in 2010 by the major film studios as a way to share their tools, knowledge and experience with smaller independent productions. The guide includes among others sheets with best practices, a vendor guide, a carbon calculator and a lumber tracking tool, all publicly available for free on internet. A similar green guide is currently not available in the UK, instead sustainability certification is given through ALBERT. The certification is generally connected to funding, in the sense that projects submitting funding application need an ALBERT certification to receive BFI funding. However, independent productions made outside of this financing scheme currently have no real incentive to obtain ALBERT certification.

A different challenge is measuring the actual effects of green approaches. Both the UCLA report and the BFI report agree that productions with higher budgets tend to have larger environmental impact. The BFI report notes that the emissions created by film and television production have been steadily increasing and there is a growing demand for content. The current market is almost exclusively dominated by large studio productions or content made by streaming platforms such as Netflix, and the distribution available for smaller independent productions is extremely limited. Hence a question that arises is, why do the emissions keep increasing if larger studios and higher budget productions are indeed adopting all kinds of sustainability approaches? Different scholars question the impact of these “green approaches, for example Özdemirci 2015, and Kääpä 2018. In his study Environmental Management of the Media: Policy, Industry, Practice (2018) film scholar Kääpä argues that many

incentives promoting more sustainable film production are merely marketing strategies "greenwashing" the mainstream film industry.

It is noticeable that neither the UCLA report, nor the BFI report examine in depth the use of electronic equipment and the raw materials associated with these. The reports also do not consider issues arising from the shift to digital, such as the perceived obsolescence of equipment and the desire to continuously upgrade to a higher image resolution and as a result the need to purchase new equipment (from 2K to 12K).

Sustainable Practice in Film & Photography

A well developed sustainable practice around materials would drastically reduce waste production of film sets, through donations, reuse and recycling. It is important that there is increased knowledge around and attention for the choice of materials used within different departments of a film production so that the use of harmful materials are avoided, such as using polystyrene for set building. It is essential that there is greater awareness about the use of resources and the impact on the environment within different departments of film and television productions.

The different recommendations of ALBERT need to be structurally implemented across all film and audiovisual productions, such as introducing reusable water bottles, choosing sustainable transport options, donating food, recycling or reusing materials for set design and costumes. Additionally, the industry should address the correlation between higher budget productions and environmental impact. Knowledge on sustainable practices should be structurally incorporated in educational contexts and the teaching of film production (University film programmes, colleges, and other media courses).

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Chapter 8: Fine Art

Peter Oakley and Rebecca Lardeur

Definition
Fine art covers the field of traditional creative practices: drawing, painting, print, and sculpture, which each relies on an established platform of materials with coherent supply chains, exclusive distribution networks and a sense of self-identity as a unique practice.

Though this was initially anticipated to be a more inclusive sector, research on this area uncovered the difficulty between distinguishing between contemporary art practice and other creative industry sectors in relation to material and equipment sourcing, use and disposal e.g. differentiating between screen-based fine art and film, or textile art and studio textiles. Taking account of the focus of the research being relationships to materials, it became apparent that restricting this chapter to the more traditional modes of fine art production and treating contemporary art practice using alternative media as covered by the chapters focusing on the related sectors was the most practical solution.

Artists' Materials

Paints
All paints use pigments mixed with a binder. Watercolours use arabic gum, obtained from the dried discharges of sticky stems and branches of Acacia senegal. Oil paints use different types of oil, such as linseed, flaxseed and more. Acrylic paints are made with by-products of crude oil and are a type of liquid plastic.
Different cleaning products will be needed for each, that are for most paints highly toxic processes: paint thinners, mineral spirits, turpentine. These are highly toxic, made of chemical components and release dangerous flammable fumes. These harsh chemicals would likely leak into watersheds and pollute waterways and groundwater when disposed of incorrectly. Paint thinners are highly toxic waste and should be carefully disposed of.

General Issues

Paints are mainly discussed relating to toxicity for human health and environmental concerns.
California's Proposition 65, referred to as the Safe Drinking Water and Toxic Enforcement Act, became law in 1986 and is one of the main drivers behind paint regulations (American Cancer Society, 2021). Proposition 65, alongside the State of California, requires information to be given on pigment and, as such, has enforced by influence this practice worldwide (Water Colour Affair, 2020).

Levels of toxicity are, however, still severely misunderstood. Companies like Winsor & Newton are still producing paints with heavy metals such as Cadmium read, claiming the levels aren't high enough to exert an effect (Vines, 2019). The levels refer to a small paint tube, hence misleading the customer. Toxicity research is also hard to formulate, as we know what happens in two weeks after animals ingest it, but research has not been pushed further.

The word non-toxic is unregulated, another chain allowing abuse in the field (Kinnally, 2011). Guidelines do not specify what a chronic health effect might be or how serious it might become, what qualifies to be adverse, or a 'foreseeable misuse' (MacEvoy, B., 2015).
Because of toxicity, the secondary focus is waste disposal. Paints made with heavy metals might often end in river streams, with factors as how much and long for impacting toxicity levels. However, the State of California said no site had been ruled to be polluted because of the use of watercolour paints (MacEvoy, 2015).
The last general issue regarding fine arts is that most material compositions stay undisclosed for young artists and designers. Compositions are hard to find and comprehend. Most paint product names are based on marketing narratives to seduce through misleading claims while basing on

historical colours. The European Artists' Colours Association does not recommend voluntary labelling due to the lack of space on small package sizes for additional statements.

Regulation is low, with one notable: the term 'hue' as a compound word in a paint name indicates a hazardous pigment named paint that doesn't contain the pigment itself. For example, the traditional Vermilion Red is made of cinnabar and contains mercury. Until cadmium red, a heavy metal less toxic than mercury was discovered in the early 20th century, vermilion was the most widely used "red" in the world. Traditional vermilion red, made from the cinnabar, can still be found in China. And 'Vermilion Red' hue is available widely in Europe, to many unaware of the pigment origins (Andrus, 2019). Similarly, Ivory Black was traditionally made with charred elephant tusks, and large-scale production was stopped in 1929 (Old Holland, 2021). Ivory black paints are readily available in all paint palettes but are made of something different. Paint manufacturers now use charred cattle and park bones instead, a fact not known unless a certain level of expertise is acquired.

The results are a set of loose definitions of toxicity, allowing, for example, levels of hazardous methyl isothiazolinone (MIT) to be used in paints. These levels are high enough to concern affected individuals but are below the legal requirements for labelling (EuACA, 2016).

Pigments

Regardless of their binders, pigments are still produced using potentially toxic heavy metals, especially reds, yellows, some blues, and many whites (Martin, M., 2019). Today, many available pigments contain small amounts of lead or other known cancer-inducing chemicals such as cadmium and manganese (Agora Gallery, 2015), antimony, chrome, cobalt, lithol, and zinc (Roberts, 2009). In contrast, pigments might be less harmful when in sealed containers, 'prolonged exposure and improper handling can lead to serious health complications' and bring many health concerns to those working with large quantities of the pigment in factories.

California's Proposition 65, mentioned in General Issue, has enforced warning signs on cadmium paint tubes (Bergman, 2021), a pigment often used for red, orange and yellow hues that have replaced vermilion red in most cases.

Earth pigments are gaining traction as non-toxic alternatives to heavy metals pigments. Artists, such as Leah Mebane, are promoting in their blog this type of pigment as non-hazardous to invite others to replicate this process and ensure good human health (Artists and Illustrators, 2022). Other artists also promote less harmful pigments to reduce adverse environmental impacts (Jyotsna, 2020).

Pigment compositions are indicated by letters and numbers and can be accessed on one website, Color of Art Pigment Database (Art is Creation, 2022). The website last update was in 2016, and a plurality of databases is not present in the field. This database holds no information on where and how the pigment was extracted, and paint manufacturers also do not disclose this information (MacEvoy, 2015).

Paint Binders

Paint binders deliver a binding effect that holds the pigments together, creating a dry film on the surface. It is an essential ingredient that directly relates to paint performance, including adhesion, washability, scrub resistance, fade resistance or gloss retention.

Each type of paint (acrylic, watercolour, oil) will use different binding agents. Oil paints are usually referred to as 'safer' because of natural oils such as linseed, walnut and flaxseed (Martin, 2019). Acrylic paints have been identified as another form of plastics, hence being one of the most polluting binding agents for marine environments (Clarify Green, 2020).

Paint meant to be used in indoor environments, such as homes, discuss sustainability in terms of water-based media (Earthborn Paints, 2021). With water-mixable oil paints replacing acrylic paint through chemical engineering of the oil binders, the paints stay true to oil paints instead of an acrylic formula under a different name. They have no liquid plastic (Martin, 2019).

Paint thinners

A paint thinner is a solvent utilised to reduce the thickness of oil-based paints or clean up after their use. This is where oil painting is no longer classified as non-dangerous. The fumes from turps, mineral spirits, and other thinners, emit Volatile Organic Compounds (or VOCs) and are highly toxic to humans and pollute waterways (Martin, 2019). Long-term exposure can lead to cancer and damage the liver, kidneys and central nervous systems. These toxins are released directly into the water supply when disposed of in the sink.

Solvents such as turps, paint thinner, mineral spirits, and varnish emit Volatile Organic Compounds (or VOCs) as they dry. Long-term exposure to them can lead to cancer and damage to the liver, kidneys and central nervous system. When solvents are poured down the sink drain, they deliver these harsh toxins into our water supply (Artists and Illustrators, 2021).

Companies providing sustainable paints
Companies have started to provide sustainable paints. Cobra, a paint line in the Netherlands, promotes no white spirit and turpentine. Natural Earth Paint in the US are refusing all heavy metals in their pigments and instead focuses on earth and mineral pigments with organic ingredients to develop non-hazardous art supplies. Lutea, in Belgium, provides paint also based on mineral and clay-based pigments.

Disposal of paints
Golden Paint, a US-based company, started to share information on acrylic disposal in 1996 (Golden Paints, 2017). The equipment to properly salvage liquid plastics includes coffee filters, funnel, plastic pails, paddle, aluminium sulfate, hydrated lime and pH paper. The process needs at least several hours to be completed.

Painting Canvas
Painting canvas are the surface painted on that is often made from tightly stretched unbleached cloth or a closely woven fabric. Pesticide-heavy cotton canvas has been a strong environmental concern, with hemp, unbleached and recycled materials have been proposed as a sustainable alternative (Artists and Illustrators, 2021).

The fabric will be stretched on wood that can easily be linked to unsustainably harvested wood (see chapter 4).

Gesso, also known as glue gesso, is a traditional mix of an animal glue binder (rabbit-skin glue), with chalk and white pigment to coat the fabric as an absorbent primer coat substrate for painting. This becomes a problem for those who want to avoid animal-based products and not use acrylic alternatives (liquid plastic). Alternative solutions have included methylcellulose from plant fingers, whiting and honey (Artists and Illustrators, 2021).

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Chapter 9: Performing Arts

Roberta Mock & Siobhan Bauer

Part 1: Introduction

1.1. Scope of this Chapter

This chapter benchmarks current practices, initiatives and attitudes related to the sustainable use of materials in the Performing Arts, which include theatre, dance, opera, circus, performance/live art, immersive/participatory performance and/or installation, performance poetry, stand-up comedy, cabaret, sound walks, and music of all forms played by bands, choirs, orchestra and DJs. These creative and cultural acts, which are framed or marked off from everyday behaviour and actions in some way, encompass the five processes in Figure 1. This open-ended process-driven modelling of a performance-making ecology echoes that of the basic flow of materials in circular economy principles.

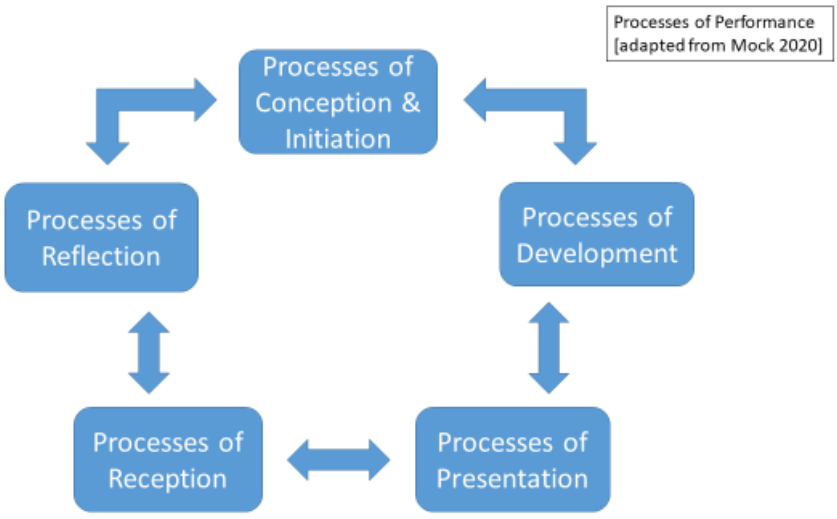

Figure 1: Processes of Performance

Our chapter focuses only on "live" performance forms. This means, in relation to Figure 1, that the processes of conception/initiation, development, presentation, reception and reflection can operate in any direction, as well as occasionally non-consecutively, at any given moment. By way of contrast, in "non-live" performances, the processes of presentation and reception, in particular, can only move or influence in a clockwise direction. It is important to note that "live" performance is not synonymous with either "in person" or unmediated, as exemplified by the various hybrid, digital and online forms of performance which have proliferated during the pandemic (see, for example, Neuss 2021).

As such, we do not consider sound and music recording formats in this chapter; see Brennan and Devine (2020) for a full discussion of the environmental costs of playback formats, which takes into account what recordings are made of, where those materials come from, and what happens to them when they are disposed of. Similarly, performances made primarily for screen and/or camera are the purview of the "Film and Photography" chapter of this report, rather than this one. However, much of the former is relevant to hybrid, remote and multi-media performances and/or AV elements of live productions or shows.

It should also be noted that, while sustainability challenges and issues related to theatres and other buildings where performances take place are discussed in Part 3 of this chapter, this is strictly speaking outside its scope. While materials such as brick, concrete and steel are also used in staging, sets and rigging, they fall under other research councils' remits in the context of buildings. Sustainability issues related to the use of materials in architectural design practice is discussed in the "Design" chapter of this report.
Sustainability challenges and solutions related to musical instrument-making are discussed in the "Crafts and Applied Arts" chapter of this report and the Case Study on Urban Forestry.

1.2. Organisational Approach and Definition of Terms

The Performing Arts, in this chapter, are defined as creative practices that revolve around or culminate in at least one aesthetic, communicative and/or cultural event which can be delineated temporally and/or spatially.
As this chapter takes into account many diverse genres, forms, formats, purposes, presentational styles and locations, it is organised via three inter-related cross-disciplinary sections:

- *Production* – This refers to the making of a show, event or performance, as well as the material and operational elements that support and enable its specific presentation and the creation of its inner world. In Figure 1, *Production* runs between processes of development (e.g. design, rehearsals and construction) through to processes of reflection/conclusion (e.g. disposal, recycling or storage of materials).
- *Venues and Environments* – This section focuses on the places and spaces in which the processes of development, presentation and reception of live performance occur, whether these are purpose-built, multi-use or appropriated. These may include buildings (such as theatres, concert halls, art centres, exhibition halls, stadia, studios, workshops, galleries and homes), as well as outdoor sites and festivals. This section also considers the operational infrastructures of these environments that enable, arise from, and maintain these performance processes.
- *Performance* – While the word "performance" might be used to describe the meta-disciplinary framework that includes generic forms and practices from theatre, dance and music to rituals and parades, it is used in this chapter to describe the confluence of elements in a live moment of interchange between processes of presentation and reception in Figure 1. Our primary, but not exclusive, focus is on people – that is, on performers, technicians, and audiences coming together at a specific time to experience something and make cultural meaning, emotion and/or entertainment with and through all material elements of production. It therefore also includes touring, transport and travel to participate in a performance, as well as its subject matter, messaging and thematic/visual/narrative content.

The nature and extent to which each of these categorisations relate to the sustainability of materials in industry and practitioner concerns and activity is discipline specific. In theatre, dance and opera, for instance, it tends to be focused around *Production* whereas, in the live events and music industry (which includes festivals, exhibitions, conferences, music arenas, and indoor sporting events, although the latter is outside of our scope), it is primarily linked to *Performance* and *Venue or Environment*.

As is evident above, the word *theatre* may be defined in many different ways: as the building in which performances take place; as a distinct aesthetic form or genre of performance; or, as a way to describe a company or organisation that produces this type of performance. In this chapter, we employ it in all of these senses where appropriate – that is, when it is used in this way by an organisation, company or its stakeholders. Importantly, not all "theatre" takes place in a "theatre"; an outdoor production may have more in common with elements of a music festival and a touring production to schools might have more in common with a burlesque act in terms of its approach to sustainable materials.

Mirroring *The Theatre Green Book* (see Case Study), which itself embraces opera, dance, circus and site-specific and outdoor performance, this chapter considers theatre as a diverse sector within the creative industries that operates in a wide range of scales and across multiple locations. It includes, for example, commercial and subsidized production work and spaces; small-scale and rural touring companies; SMEs and freelance practitioners; large building-based organisations and receiving venues; theatre-in-education and amateur dramatic societies. In an article in the recent "Climate Crisis" Special Issue of *The Stage,* Ned Glasier and Sadeysa Greenaway-Bailey of Company Three reflect on the collaborative creation of *When This is Over*, their show about being a teenager in a pandemic and a climate crisis: "In an era of climate emergency," they write, "Small community companies should no longer be expected to replicate the structures and ways of 'real' theatre, but to challenge them, so that we might rebuild our work in a vision of the world we want to create" (2021: 11).

Additionally, in keeping with *The Theatre Green Book*, we use the terms *sustainable* and *green or greener practices* "as catch-alls to cover decarbonising theatre productions, reducing waste and eliminating environmentally harmful practices" (Buro Happold and Renew Theatre 2021a: 14). *The Theatre Green Book* also recommends the Future Materials Bank's lexicon of terms to ensure shared understanding (www.futurematerialsbank.com/lexicon).

When discussing sustainable practice, it is often impossible to neatly segregate *Production*, *Venues and Environments*, and *Performance*. This also aligns with overarching holistic and interconnected approaches to tackling ecological impact across the sector and is evidenced, for instance, in the **Sustainability and/or Environmental Policies** that many (if not most) UK theatres publish on their websites. One such example is the Royal Court in London, which is "committed to becoming a carbon net zero arts venue". A producing theatre that focuses on new writing, over 200000 people visit the Royal Court each year and many thousands more experience their work through touring, West End transfers, residencies etc. Its 2018-22 Sustainability Policy Framework (https://royalcourttheatre.com/about/environmental-policy/) is articulated through the UN Sustainable Development Goals with commitments that include: engaging artists and audiences with environmental issues through its artistic programme (*Performance*); investing in technologies to enable designers to use low energy lighting and encourage sustainable practices throughout the production process (*Production*); encouraging a culture of shared responsibility for environmental sustainability; and reducing waste, preserving resources and recycling across all areas of the organisation (both encompassing *Production*, *Venue and Environment* and *Performance*).

We can also see the interrelationship between materials and our three categories at work in the planning and promotion of Coldplay's 2022 "Music of the Spheres" World Tour, which has gained significant media attention. After pledging they would not tour

before finding a more sustainable way of doing so, the band published a "12 point action plan" (https://sustainability.coldplay.com/) in order to curb and offset their carbon emissions. Among the interconnected areas they address are Merchandise, Power, Travel, Stage Show, Fans, Water, Waste, and Food. One example for which it is difficult to distinguish between *Production*, *Venue and Environment* and *Performance* is the use of "kinetic flooring", so that the band is partly powered by energy created through audience participation and dancing (all the press coverage has focused on the battery being developed in partnership with BMW, rather than the presumably composite material that will comprise the flooring). Others include the band's intention to use bamboo and recycled steel staging, biodegradable glitter, and recyclable LED wristbands for audience members.

Finally, it needs to be noted that the 3 substantive sections of this report do not neatly align with the three volumes of *The Theatre Green Book* (see the Case Study) as might be expected. While most of its first volume, *Sustainable Productions* (Buro Happold and Renew Theatre 2021a), shares the terminological sense used to structure this chapter, its Toolkits on "Touring" and "Outdoor and Site-Specific Shows" are more relevant here to *Performance* and/or *Venues and Environments*, and the sections on "Workshops" and "Lighting, Sound and AV" fall more coherently within the latter. Similarly, although all of Volume 2, *Sustainable Buildings* (Buro Happold and Renew Theatre 2021b), and the majority of Volume 3, *Sustainable Operations*, are most relevant to *Venues and Environments*, the elements of the latter that focus on travel are more appropriate to *Performance* using our typology.

1.3. Summary of Sustainability Issues in and across the Performing Arts

The following Sustainability Issues (SIs) in the Performing Arts are referenced by number in the sections below. They largely align with **UN Sustainable Development Goals (SDGs)** numbers 4 (Quality Education), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation and Infrastructure), and 12 (Responsible Consumption and Production).

SI1	Lack of knowledge, expertise and/or infrastructure for the sustainable sourcing, storage, recycling, repair and disposal of staging and production materials – including technical equipment, rigging, costumes, objects/scenic elements and their component elements
SI2	Lack of accessible, free, context-appropriate, reliable tools to measure, report and compare the carbon emissions associated with all elements of live production and performance (separately and together), including those produced directly (in the control of the organisation), indirectly (not in the control of the organisation) and embodied (cumulative emissions through the supply chain) – "You can't control what you can't measure" (Conteh 2021)
SI3	Fears and assumptions that sustainable practices will limit aesthetic and creative freedom and vision
SI4	Real or perceived financial costs and investment requirements, including those arising from increased time commitments, people and/or training to enable sustainable practice
SI5	Sustainable practice relies on collaboration, clarity of responsibility, shared and/or agreed vision and values, and a sense of ownership by everyone involved in the

	chain of production, which is particularly challenging in precarious industries with significant freelance workforces.
SI6	Environmental considerations are not systematically embedded into touring practices, the transport of materials at any stage of the production process, or audience travel to venues, all of which are fundamental to the Performing Arts.
SI7	Real or perceived audience expectations and/or cultural values, including those related to production standards, 'value for money', technical originality and levels of spectacle, as well as environmental impact within the context of climate crisis.
SI8	While generally and broadly welcomed, the proliferation of guidelines, commitments, codes of practice, standards and regulations available to support sustainable practice in the Performing Arts can seem overwhelming, onerous, and guilt-inducing; there are some fears that they might ultimately exclude or limit organisations and practitioners who are unable to meet them.

Part 2: Production

2.1. Challenges and Concerns

- [SI1, SI4, SI8] A 2020 survey conducted by Ecostage (https://ecostage.online/), a grassroots initiative for the performing arts sector that embeds ecological thinking at the centre of the creative process, identified the following reasons why practitioners and companies are not choosing sustainable production options. These include: not knowing how to start implementing changes; "a lack of unified thinking across the sector" and "contradictory information" available; the need for "a clear value statement", "public recognition of values" and "practical knowledge from case studies exchange"; "feeling alone", "time constraints" and "lack of funding or budget" (Stringer 2021).
- [SI1, SI3, SI4, SI5, SI7] Aesthetic concepts and assumptions of audience expectation (e.g. as expressed at the Theatres Trust 2021 conference, that shows should "hit you between the eyes") are often disproportionately prioritised over environmental impact. Theatre as an industry tends to be conservative in its professional practices and this tendency can be further aggravated by a lack of communication between artistic and technical teams, leading to working at cross-purposes, the need to scrap ideas that have already been built, and overlooking environmentally friendlier alternatives which have little impact on production values or effect. There are also fears that sustainable sets "will all look like junk yards" or else "Peter Brook's empty spaces".
- [SI1] Although shared storage and reuse facilities are available in some regions in the UK (e.g. Scotland), these are few and far between. Well-managed storage of props, sets and objects (with well-catalogued and recorded management systems, online browsing capabilities and easy booking systems) is essential to make reuse and repurposing of materials achievable and flexible for designers and production teams. However, such storage also generates its own power needs (e.g. heat and light).
- [SI1, SI4] According to Theatres Trust Director, Jon Morgan, "We work in such a labour-intensive, quick-delivery industry, and some of this means we have quite bad practices around sustainability and production" (Clark and Snow 2021: 13). Not only does theatre tend to operate within under-resourced infrastructures that demand fast, paradoxically costly solutions, but there is an expectation that taking time to build a more sustainable workflow will not prove cost effective in the short-term. This is especially true in the current landscape of staff shortages and reduced hours due to the pandemic.
- [SI1, SI4, SI6] As the Unicorn Theatre's *Greening Production Practices 2020* document states, "Time gives us choices. The more time we have to assess and realise designs, the more sustainable we can be" (Unicorn Theatre website 2021). However, even with

best intentions, pressurised lead times and high event turnover may prevent sustainable practice in a volatile political landscape. For instance, the time required for ordering mechanical parts from abroad has increased due to Brexit and designs may have to be abandoned: “We’ve designed it and then can’t get the materials so have to make it quickly however we possibly can make it” (RSC Workshop 2021).

- [SI4] The Performing Arts are characterised by their use of precarious labour; currently 71% of the theatre workforce, for instance, is self-employed or freelance (Freelancers Make Theatre Work website 2021). AAPTLE and BECTU have recently (December 2021) launched a petition to halt the practice of “forced multi-skilling” (e.g. across costumes, hair, wigs and make-up) in commercial theatres, arguing that a lack of appropriate training will lead to lower standards and health and safety risks. This practice also potentially impacts on the knowledge of and ability to access and use materials sustainably.
- [SI2] Although carbon calculators are in constant development, they are still not reliable or fit for purpose. See the chapter on Carbon Footprint Calculation Tools in this report. Although there are attempts to calculate the carbon dioxide equivalent of production materials, this remains crude and tends to be specific to the organisation. In 2008, the Office for the Mayor of London published *Green Theatre: Taking Action on Climate Change,* with an associated online carbon calculator to “identify the environmental impact of decisions made in the pre-production stage”. While still regularly referenced, the carbon calculator itself is no longer available for use; however, its methodology is outlined in the document, making it seem that its focus (on lighting, power, building management systems, audience travel and so on) aligns more closely with the *Venues and Environment* and *Performance* elements of this report.
- [SI1, SI2, SI8] “Siloism” creates barriers at the disposal end of a product’s life cycle, with waste management solutions for some materials purposefully mystified in order to “corner the market”. The tension between profit and the open dialogue that is required for sector-wide collaboration prevents informed choices about both the sourcing and measurement of raw materials for a production. IP clauses can prevent transparency around the provenance of a material and its composite parts. As a result it can be very difficult to determine how much of a material has been previously recycled.
- [SI1, SI8] Moreover, there is a murkiness about who the responsible custodians of materials are; for instance, “at least one of the UK’s largest hire houses appears not to be registered as a producer of electronic waste, nor as a licensed waste carrier” (Atkinson 2015: 76). For more about the sustainability issues of lighting and control equipment, as well as solutions and innovations arising, see the sections on EEE in the “Electronic and Electrical Equipment” chapter of this report.

2.2. Responses, Actions and Initiatives

- [SI1, SI2, SI8] In 2014, professionals from across the Performing Arts production industry came together to form the Sustainability in Production Alliance (SiPA). Among them were representatives from the Professional Lighting and Sound Association (PLASA), the Association of British Theatre Technicians (ABTT), the Stage Management Association (SMA), the Production Services Association (PSA), the ALD (now ALPD), the Theatres Trust, Julie’s Bicycle, BECTU, Equity, the Arts Council, SOLT/UK Theatre, the Society of British Theatre Designers (SBTD) and Women in Stage Entertainment (WiSE). The following year, SiPA produced a list of 10 Goals

(actually, 9, since the 10th one was left blank to signal that "it's impossible to imagine the way our field will look in 10 years' time"). Most relevant for this chapter are Goals 4-7: "Zero Loss – cradle to cradle for materials, resources and expertise"; "Responsible resourcing – choosing forever", "Running on renewables – powering sustainability" and "People, Planet, Profit reporting – sustaining transparency" (SiPA 2015). The intention was not only that individuals and companies would sign up as "Goal Allies" but also that there would be a network of "Goal Guardians" who act as advocates and collate and record information, and "successes and failures" for inclusion in an annual report (Atkinson, 2015). The latter does not seem to have taken root; however, the network and collaborative approach established seems to

have paved the way for *The Theatre Green Book* later (see Case Study).

Figure 2: Screenshots of some of SiPA's 10 Quick Sustainable Wins (2021)

- [SI1] In 2020, SiPA published lists of "10 Quick Sustainable Wins" for 21 different production areas or roles on its website (See Figure 2). Some that are relevant for this section of the chapter are:
    - *Staging* – considering "what will happen to the set after the show"; working to circular economy principles; and minimising "virgin materials"
    - *Video* – considering how video elements can form part of a wider sustainable solution for a project (resulting in less physical materials use); ensuring there are upgrade paths and that technology investments are made with long term life cycles; packaging; using equipment of the lightest weight
    - *Costumes* – recycling; checking the credentials of suppliers and fabrics; replacing fabric softeners
    - *Winches and automation* – repairing rather than replacing damaged equipment; renting where possible; using sustainable synthetic ropes

- *Theatre Production Managers* (See Figure 2): (re)considering choice, sourcing and use of materials, especially non-biodegradable; encouraging designers to reuse set; asking suppliers to supply their sustainability policies
- *Audio* – investing in equipment that is recyclable and planning for disposal; using less gaffa tape; minimising and recycling consumables; avoiding additional or oversized cable.

- [SI1, SI8] In March 2021, Volume 1 of *The Theatre Green Book* was published in "Beta version". It is open access and can be downloaded for free. Led by the Theatres Trust and ABTT, and developed with and supported by all leading UK theatre bodies and sustainability organisations, it was created with a broad coalition of UK theatre-makers, including freelancers, venues, companies and producers. Its purpose was not to produce an alternative or "reinvent the wheel" but to synthesise, amplify and find commonality across existing practices and guidelines (including, for instance, those produced by SiPA, Ecostage, Julie's Bicycle, etc).*The Theatre Green Book* therefore presents a statement of shared and negotiated values, draws together current best practice in sustainable production, and sets out collective standards for achieving change in response to climate crisis. Within months, the National Theatre, National Theatre of Scotland, and National Theatre Wales, as well as many other companies and organisations, committed to making all their shows to Green Book standards. (See Theatre Green Book Case Study for further details, including the National Theatre's approach to meeting those standards.)

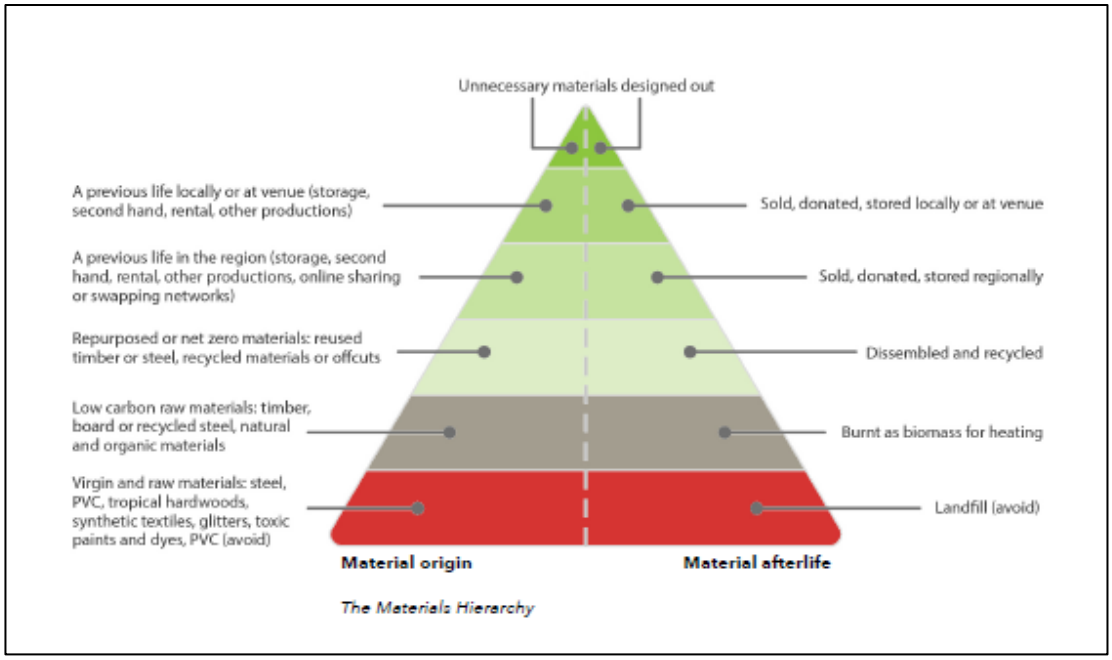

Figure 3: The Materials Hierarchy from The Theatre Green Book. Part 1: Sustainable Production (2021) © Buro Happold and Renew Theatre

- [SI1, SI8] *The Theatre Green Book*'s key materials principles include: doing more with less; spending more on people's time and less on stuff; and reducing harmful chemicals (Buro Happold and Renew Theatre 2021a). In its Materials Hierarchy (see Figure 3), everything in a truly sustainable show will have had a previous life and everything will be used again in a circular economy. The goal is to start by designing out the need for materials. Whatever is needed should come from a reused or recycled source – locally, if possible, to reduce transport. Next best are materials which are, at

least, sourced sustainably. At the bottom of the pyramid are raw materials which involve carbon, and are destructive to manufacture, and ought to be avoided. There's a similar process for thinking about what to do with materials and objects after a production closes, from best – reusing it in the theatre – down to the worst: becoming landfill.

- [SI1, SI2, SI8] *The Theatre Green Book* offers detailed models and guidelines for 3 standards: Baseline, Intermediate and Advanced. Baseline productions, for instance, will use only sustainably sourced materials and at least 50% previously used materials in their making processes and commit to 65% reuse or recycling when disposing them. Only Advanced Productions are expected to use carbon calculators; this is because more data is needed to establish carbon budgets for shows, and few theatre-makers are trained in their use. *The Theatre Green Book* therefore recommends the use of Materials Inventories, enabling organisations to use the data to create their baseline, track improvements, identify problem areas and prioritise "easy wins". In an inventory, all materials in a production are recorded, by weight if possible. While a large organisation like the National Theatre has developed its own bespoke Carbon Calculator, it is also using this Materials Inventory method as well (see the Theatre Green Book Case Study).
- [SI8] There is no body to enforce *Theatre Green Book* guidelines and standards, but its creators and lead partners hope the industry will implement the code voluntarily (Clark and Snow 2021: 14). At the 2021 Theatres Trust Conference, ACE's Director for Theatre & London stated that working to *Theatre Green Book* standards, while not mandated ("for complicated reasons"), will be expected by NPOs as part of ACE's next funding process in order to meet its "Environmental Responsibility" Investment Principle.
- [SI3, SI5, SI7] Stories are starting to emerge of "compromise" between technical teams, designers and directors – for example, cutting or minimising "balloon drops" and/or recycling balloons afterwards into bricks. Venues and design teams are also reducing the use of, or exploring alternatives to, special effects such as smoke, haze and dry ice (which involve chemical manufacture) and snow (which becomes waste).
- [SI1, SI2] *The Theatre Green Book* lists 6 initiatives that will quickly enable more sustainable production practices. These are: modular design; virtual modelling (increasing use of CAD and so on to eliminate the waste associated with White Card models); the use of materials passports (to record and monitor the carbon footprints and histories of specific objects); the use of shared regional storage facilities; the development of carbon calculators and training for their use; and design for disassembly.
- [SI1] Disassembly techniques, such as using visible and physical fixings (preferable over toxic adhesives, as once bound to a material it cannot then be recycled) are starting to be implemented at the technical design stage, so that items can be returned to constituent parts at the end of their use-phase (RSC Workshop, 2021).

Figure 4: Props in storage at the RSC Workshop
(photo: Siobhan Bauer 2021)

- [SI1, SI4] Theatre production managers are beginning to prioritise alternative forms of procurement such as borrowing, hiring, and sourcing locally. Some organisations and companies, such as the Unicorn Theatre, are buying from large-scale providers online with rapid delivery as a last resort (Unicorn Theatre Sustainability Action Plan 2021-2022). Some producing theatres, such as the RSC, with large storage facilities, are beginning to sort and catalogue their collection of props, costumes, and materials for easy access and reuse.
- [SI1, SI8] Many organisations, unions and associations also have their own sustainability groups. For instance, the ALPD is currently working on a new Green Guide and Code of Practice for lighting to complement *The Theatre Green Book*.
- [SI1] The SBTD Sustainability costume group is planning to launch THE ATTIC, a service for freelance theatre designers, wardrobe supervisors, companies and organisations. The aim is to create a circular economy for unwanted costumes. A survey is currently open (December 2021) to gauge interest in and inform its establishment as a CIC business with permanent premises, workspace and workshops.
- [SI1] In early 2021, a survey was commissioned by Greater London Authority about the development of a Reuse & Recycling facility for London theatres, asking whether productions were likely to use recycled materials in general, components (doors, windows, stairs), flats, floors, costumes, props, stage equipment, lighting practicals, drapes/curtains, and if so, using what criteria (e.g. location/travel distance, assets and material on offer, their condition, etc).
- [SI1] There are some free online resources for the reuse and recycling of objects and materials in the theatre, television, film and live event industries – for example, Set Exchange (https://www.set-exchange.com/), where unwanted items can be posted and made available to the wider community; and the Props List (https://thepropslist.co.uk/), which is a set, costume and prop hire database.

- [SI1, SI5, SI8] There are carbon literacy training courses specifically tailored for the creative industries, such as that offered by Climate EQ. With accreditation granted by the Carbon Literacy Project, this online course is designed to educate stakeholders across the music industry about climate science in order to spread awareness about sustainable practices and initiatives already in the sector. Upon completion, individuals and organisations are certified when they pledge to take action to reduce their environmental impact.
- [SI1] At a Scenography Working Group session at the International Federation of Theatre Research (IFTR) annual conference 2021, Sofia Pantouvaki discussed the concept and examples of "eco-materiality" in costume design, starting with a list of "R's to guide sustainability in costume" (See Figure 5). Many companies already recycle or donate excess or scrap fabric (e.g. the RSC to Jericho Social Enterprises: https://www.jericho.org.uk/social-enterprises). For more about the sustainability issues related to the materials used in and for costumes, costume props, backdrops, scrims, etc., see the chapter on "Fashion, Textiles and Accessories" in this report.

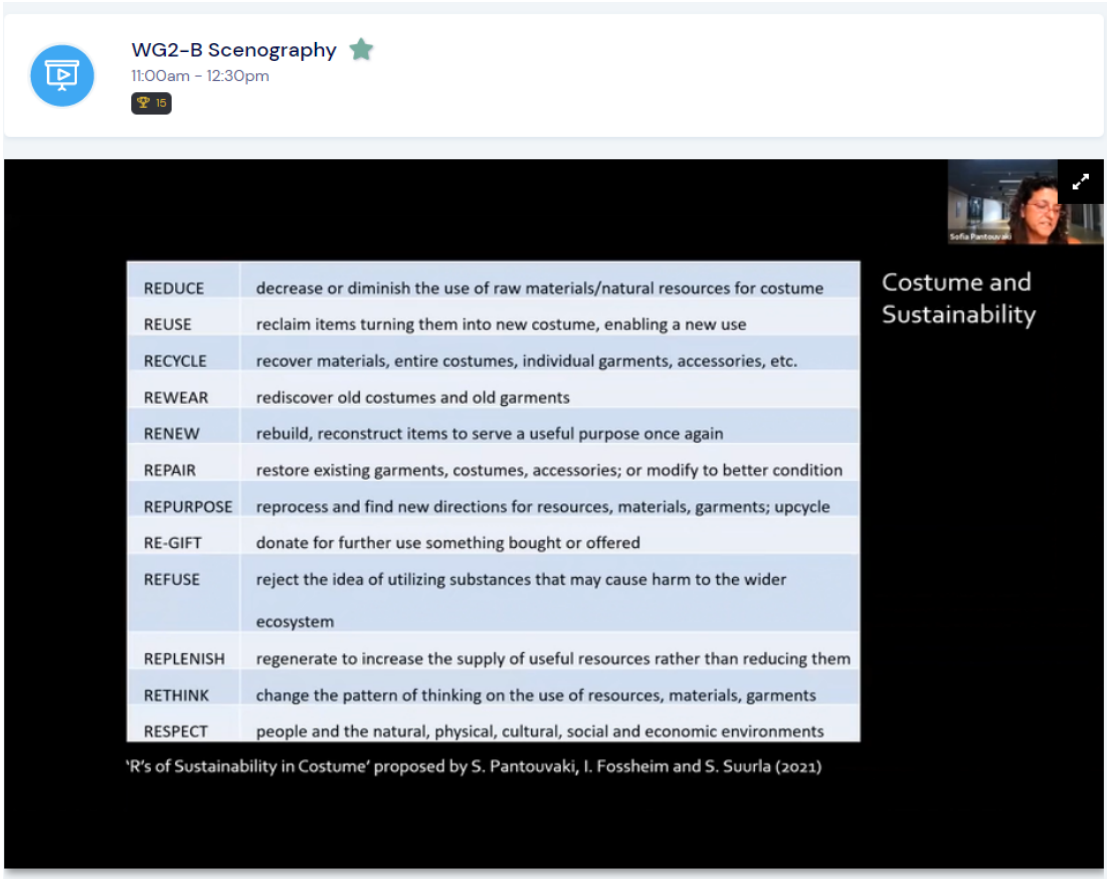

Figure 5: Screenshot of the "R's of Sustainability in Costume", from Sofia Pantouvaki's presentation at IFTR2021

- [SI1] EcoStage's website includes a range of resources related to sustainable production including case studies, guidelines, and a catalogue of links to organisations, projects and documents. It has also produced a pledge for individuals and organisations to sign up. This is in line with other networks and organisations including LIVE Green, Culture Declares Emergency (https://www.culturedeclares.org/), and Music Declares Emergency (https://www.musicdeclares.net/)
- [SI1, SI3, SI8] EcoStage is also an example of one of the many formal and informal networks within the Performing Arts committed to sustainability. Others include

Variable Matter (www.variablematter.com), a collective of creatives (mainly academics but not identifying as such in this context) focusing on intersection of design, social impact and environmental legacy via commissions, consultancy and experiential activations; and, Staging Change (https://www.stagingchange.com/the-network), a group of 250+ performers, makers & venues in the theatre & entertainment industry, with a website which publishes resources and updates members on events, workshops and opportunities.

- [SI1, SI3] Tanja Beer (2021) defines her concept of "ecoscenography" as the integration of ecological thinking into all stages of scenographic production and aesthetics. Her performance installation, *Strung* (2013), for instance, dissolves boundaries between performer and designer, installation and costume, site and material (See Figure 6), by exploring the journey of a material (reclaimed salami netting) rescued from landfill and its capacity to create immersive performance spaces and wearable artefacts (auctioned after the show for charity). Instead of limiting resources in response to concerns about sustainability, ecoscenography considers how ecological and artistic integrity can be a fundamental part of the scenographer's ideas, processes, and aesthetics. It comprises three, equally fundamental, stages: co-creation ("pre-production" – which is place-based, local and works with opportunities and resources that are readily available), celebration ("production" – whereby performance is not an endpoint but a platform to materially showcase and test sustainability with audiences) and circulation ("post-production" – taking afterlife of theatre materials into consideration, rethinking potential of refuse as a valuable resource, and advocating for sharing cultural ideas, tools, networks as well as artefacts).

Figure 6: Strung (Tanja Beer, 2013)

Part 3: Venues and Environments

3.1. Challenges and Concerns

- [SI4] Theatres Trust reported in November 2021 that making a typical British 600-seat theatre fully sustainable and accessible will cost £11m. It is therefore estimated that it will cost £1.1bn to make 100 representative UK theatres sustainable and suitable for modern audiences, although this would save 6,500 tonnes of CO2 per year as well as £3.3m annual revenue. Finance is the major obstacle for improvement; as a result, 24% of theatres have not made any green improvements to their buildings in the past 15 years.
- [SI4] In addition to the cost of retrofitting buildings, many venues also need to pay for the installation of infrastructures that will facilitate less future waste (for example, digital signage to replace volumes of printed and bespoke one-off production signs).
- [SI2] There is a tendency to focus on either the "operational" carbon emissions of buildings (maintenance and running costs) or construction/build/regeneration costs, rather than Embodied Carbon which takes into account the entire lifecycle. Moreover, in theatres, spatial flexibility leads to the over-specification and underuse of buildings. There are variations in how energy and energy savings are measured (e.g. by ticket sales or seats in the house, or by square foot), which don't always account for other building uses (e.g. community activities in foyers).
- [SI5] Sustainability is more than a "value system" and it is not always clear where overall responsibility for sustainability sits within an organisation. There is additional blurriness when a company is a tenant in a building.
- [SI1, SI3, SI4, SI8] Between 2018 and 2020, UK theatres and production organisations negotiated with the EU to make changes to new Ecodesign regulations which aimed to bring the energy efficiency of stage and studio lighting in line with that of homes and offices. This resulted in the UK-wide #SaveStageLighting campaign which appeared to be in tension with sustainability targets and aspirations. Julie's Bicycle noted that the proposed regulations could "generate a false conflict between culture and action on climate" (Thompson 2018). In addition to aesthetic considerations, it was estimated that the total cost of replacing bulbs and equipment by the UK theatre industry would be £1.2 billion, with smaller venues unable to afford these changes. Ultimately there were amendments to the EU regulations which were also adopted by BEIS following Brexit, so that most fixtures and bulbs remain available (with the key exception of tungsten M16 lamps). However, it is likely that manufacturers will be unwilling to continue selling or even making those products. More positively, new EU revisions to Ecodesign seem to be concentrating on improving the working life of products, their repairability and recyclability (Halliday 2021).
- [SI2] There is lack of agreement about which evaluation methods should be used to assist with TBL (triple bottom line) reporting of the economic, social and environmental impacts of live events and festivals. While methods of assessment have become increasingly more sophisticated, there remain challenges in providing a quantitative assessment due to their complexity and period of time over which they take place; thus, "any quantitative evaluation method used to assess the environmental impacts of festivals is likely to be partial in scope" (Collins and Cooper 2017).
- [SI1, SI7] Festivals also represent one of the music and live event industry's largest sustainability challenges. They involve the transportation of large quantities of materials and people to create temporary ecosystems reliant on vast quantities of power. To move away from their reliance on generators, for instance, local authorities would need to facilitate their connection to a "green grid". The RAW Foundation (2018)

has stated that: “Mirroring the proliferation of disposables in society, festivals consume vast amounts of single-use plastics and other materials, such as serveware for drinks and food. Images in the press in recent years have highlighted the shocking sea of litter often left by audiences at events, a metaphor for a global addiction to convenience and a disconnection from the environmental impacts of this throw-away culture”.

- [SI1, SI7, Si8] Many festival vendors are not resistant to eco-alternative serveware and plant-based food options, although this tends to be genre-specific. Furthermore, while onboard in principle, venues such as the NEC Arenas have expressed concern about moving away from single use plastic cups citing health and safety reasons (GEI2021).
- [SI1, SI4, SI5, SI7] Huge quantities of single-use materials, again mostly plastic, are used to dress and create the atmosphere of live events of all kinds. This is coupled with “very little in the way of stewardship of those materials on their journey from manufacturing to disposal.” A 2020 report describes “a lack of post-event ownership”, and cites the challenges related to materials recovery and circularity as being due to a “lack of unified resource recovery systems”, “incorrect provision of materials for recovery”, “opaque processing”, and “greenwashing and misinformation” (The Ocean Race 2020). While there are dedicated recovery systems in place for some materials used in the live event industry, these are few and far between, and not always known about.
- [SI1, SI8] For more about the sustainability issues related to the fabric and textiles used to dress live events, as well as in and for theatre drapes, stage curtains and merchandising, see the section on “Textiles” in the “Fashion, Textiles and Accessories” chapter of this report.
- [SI7] Many events and venues will not publicly discuss their green initiatives as they’re afraid of being open to criticism of hypocrisy and “green-washing”. This has led to the trend of “green-hush”.

3.2. Responses, Actions and Initiatives

- [SI1, SI5, SI6, SI8] The SiPA lists of “10 quick sustainable wins” (see 2.2 above) relevant to this section of the report are:
    - *Rigging* – including the refurbishment of equipment, hoists, etc; collaboration across supply teams from resource providers to collectors to design out waste; designing for utility and standardisation rather than novelty; using waste (e.g. plywood, SWR and metal work stripped out of theatres) as a repurposed resource in other settings
    - *Rock N Roll Production Office* – including the use batteries for radios; printing, stationary and supplies; the use of recycling bins; towels and washing; single use plastics.
    - *Venue Designers* – including the selection of locally sourced materials; “reduce-reuse-recycle’ of materials on new builds and renovations; thinking beyond the BREEAM code; selecting renewable energy; calculating embodied carbon (e.g. demolition, foundation work, construction and running of the building)
    - *Venue Operation* – including creation of staff engagement and action plans that include facilities, production and IT managers, caterers, etc; encouraging sustainable travel by audience members and staff; introducing sustainable procurement policy (e.g. minimum tech, biodegradable laundry products); going paperless
    - *Vendor Guidelines* – including many of the above, plus the use of ecological reusables (e.g. hand soap and sanitisers); reduction of packaging; choosing

eco-conscious partners with sustainability policies that cover end of life cycle use of products, RoHS (Restriction of hazardous substances) and WEEE (Waste Electrical and Electronic Equipment) statements

- *Lighting* – including many of above, plus training crew in road repairs and regular equipment maintenance to reduce use of full spare fixtures; minimising truck space and the impact of carrying extra weight; careful consideration of ordering, use and recycling of consumables; working with all production departments to lower overall power consumption
- *Catering* – including reduction of single use portion packs; using biodegradable and compostable disposable cutlery or else real china etc; using reusable water bottles; working with venues to provide recycling facilities (SiPA 2020).

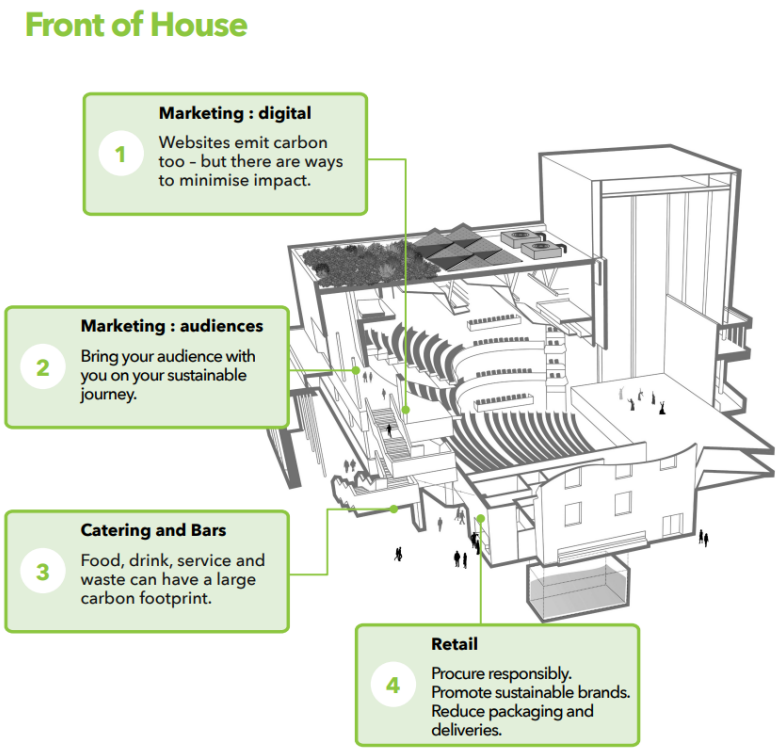

Figure 7: From draft of The Theatre Green Book. Part 3: Sustainable Operations (2021) © Buro Happold and Renew Theatre

- [SI1, SI8] Volume 3 of *The Theatre Green Book*, focusing on *Sustainable Operations*, is due to be published by the end of 2021; however, a summary of its content was presented at the Theatres Trust "Making Theatre Sustainable" Conference (Lyric Hammersmith, 4 November 2021) and the Sustainable Materials in the Creative Industries' "Greening Theatre" event (Bristol Old Vic, 2 December 2021). Volume 3 of *The Theatre Green Book* recommends that, to become more sustainable, theatres must: re-think both front of house (FoH) and back of house (BoH) operations; manage and maintain the building efficiently; manage waste sustainably; enable sustainable travel by staff, audiences and visitors; and, set standards for third parties such as contractors in order to influence Scope 3 emissions. Like Volume 1, there will be a Baseline, Intermediate and Advanced Green Book standard for theatres to target and guidelines in each of the above areas to help them achieve that target (Conteh 2021). As can be observed from Figure 7, the *Green Book* aligns with and builds upon SiPA recommendations (2020).
- [SI1, SI2, SI4, SI5, SI8] The 2nd volume of *The Theatre Green Book*, focusing on sustainable buildings, was published in November 2021. It is based on 4 key hierarchical principles, the first and last of which relate most to materials – that is, to

become more sustainable a theatre building must: BE LEAN (improve walls, roofs etc. so as to lose less energy); BE CLEAN (improve services systems to use less energy); BE GREEN (draw energy from renewable sources); and finally, support biodiversity and reduce waste (Buro Happold and Renew Theatre 2021b). A Home Survey Tool that allows theatre managers to develop a Sustainability Plan for their building is currently being trialled and will be made available soon.

- [SI1, SI2, SI8] Opera North, a member of ACE's Spotlight group of building-based organisations focusing on energy management and carbon reduction, has decreased electricity use in its main building by 23% through behaviour change campaigns and has switched to a 100% renewable electricity contract. Music Works, its £18 million capital project, included a range of low and zero carbon measures – from improving insulation to installing lighting control systems and solar photovoltaic panels on the roof to generate zero carbon electricity (Julie's Bicycle 2019). The 14 members of the London Theatre Consortium (LTC) made a carbon and energy commitment that has resulted in a collective reduction of energy use by 56% since 2012.
- [SI1, SI2, SI6] In the US, Broadway Green Alliance (BGA) has developed resources (including a "Theatrical Materials Reuse Database"), toolkits (including "Measurement Tools") and educational programmes, as well as acting as an advocate for environmentally-friendly practices. Its work spans all areas of *Production*, *Venues and Environment*, and *Performance*; relevant to this section of the chapter, for instance, the BGA led the change all of the lights on Broadway to energy-efficient LED and CFLs, saving over 700 tons of carbon each year. In 2021, it published a *Reduce, Reuse, Reopen: Backstage Toolkit*, offering sustainable, safe solutions for reopening theatres following Covid-19 shutdowns. This covers cleaning and hygiene products; food and hospitality operations (with a focus on plastics); green room supplies, stage and company management, musician and playing areas (much of which would be equally relevant prior to the pandemic).
- [SI1, SI6] The BGA has implemented a wide-ranging "Green Captains" programme, whereby individuals are assigned to venues or productions to help support and implement sustainable practices. Within this scheme, "Venue Green Captains" are representatives from a road house who collaborate with "Touring Green Captains" when they arrive at their venue, as well as implementing greener practices at the venue year-round. *The Theatre Green Book* is beginning to develop and trial a version of the Green Captain scheme in the UK.
- [SI1, SI2, SI8] The European Theatre Convention (ETC) has designated sustainability as one of its "Key Themes" and created an ETC Green Theatre Committee in early 2021. In June 2021, it published the "ETC Sustainable Action Code for Theatres" which begins "We, theatres in Europe, are committed to measure, understand, reduce and offset our carbon footprint through information, mobilization and legislation on European level." In 2022, it is running two courses: "Sustainable Cultural Management for European Theatres" and "Ki Culture Sustainability Training Programme" to enable 10-12 ETC members to "support policy creation to reduce carbon footprint; decolonise institutions and practices; create inclusive and accessible spaces; and work towards sector-wide circular solutions and implementation" (https://www.europeantheatre.eu/news/ki-culture-sustainability-training-programme)
- [SI1, SI2, SI3, SI4, SI8] LIVE Green have an ongoing commitment to knowledge sharing within and across the live music sector, and hosted a series of sustainability webinars in June 2021 that are available to all online. The topics include: offices, touring, festivals, venues, and artists and management. It has pledged to campaign throughout 2022 to support the sector's transition to a regenerative future, including the launch of a free-to-access resource hub and industry-wide measurement of CO2 emissions.

- [SI1, SI8] In November 2021, Vision: 2025 launched a consultation for its Green Code of Conduct, to provide clear minimum environmental standards for all UK outdoor events. In explaining why, Vision: 2025 notes that it is a sub-sector response to the one LIVE Green Vision developed for the whole UK music industry in 2021 and that "the DCMS is currently exploring the role which Local Authorities might take in regulating the environmental performance of events. Many local authorities are already putting guidance in place. It is important that the industry drives this conversation forward, to ensure that outcomes are work-able for the industry" (Riach 2021). Most relevant to this chapter are the minimum standards and targets for "Materials and waste", which are to "Manage waste according to the EU Waste Hierarchy"; "Eliminate single-use plastic"; and "Establish waste reduction and recycling targets".
- [SI1, SI7] Some temporary and semi-permanent theatres and performance venues are themselves constructed of either biological or technical materials operating within a circular economy. For example, the Willow Globe (Y Glôb Byw) is a 1/3rd size, scaled down, living version of the Globe in London, woven entirely of willow (See Figure 8) with its energy generated onsite by solar panels and a wind turbine (https://www.shakespearelink.org.uk/about-willow-globe). The Jellyfish Theatre designed by Kaltwasser and Kobberling in London (2010) was built entirely from recycled and reclaimed materials: "the detritus of markets, timberyards and building sites; from redundant school furniture, hand-me-down front doors, recycled nails and pretty much anything that … would otherwise be 'landfill'" (Glancey 2010).

Figure 8: Willow Globe Theatre (Powys)

- [SI1, SI5, SI6, SI7] An initiative called Green Deal Circular Festivals was launched in 2019 by the Dutch Government (https://www.circularfestivals.nl). They are treating European festivals as a testing ground for the circular economy concept, as they represent experimental, temporary autonomous zones in which macro-economic policies can be tested on a micro-economic level. The Shambala Festival (https://www.shambalafestival.org/) in Northamptonshire is one of the festivals that signed up. As the Shambala website states, "We have reduced the carbon footprint of

the festival by over 80%, achieved 100% renewable power, become meat and fish free and eradicated disposable plastics"

- [SI2, SI8] A Greener Festival Certification now extends to events of all kinds, providing independent audit and verification, and helping to improve resource efficiency and environmental impact (https://www.agreenerfestival.com/agf-awards/a-greener-festival-award/). Such schemes also help to promote best practice through support networks and expertise; The Bring Me the Horizon Tour (see 4.2 below) is a good example of this.
- [SI7] The Association of Independent Festivals (AIF) launched the digital *Drastic on Plastic* campaign in 2018 in order to educate festival attendees about the harmful impacts of single-use plastic. Participating festivals pledged to eliminate single-use plastic at their events by 2021. The RAW Foundation (2018) believes that festivals "can choose to take action to limit plastic waste and, by doing so, can positively influence the attitudes and behaviour of their audiences".
- [SI1] New material technologies are in development, such as fabric solar panels. This could lead to marquees and tents being able to generate their own power. Project Plan B (https://www.projectplanb.co.uk/), a closed loop design and manufacturing service for the garment industry, is currently running a pilot project to test if polyester scrims from the London Marathon can be converted back into rPET pellets. If successful, these circular textiles will prevent banners and festival flags from being incinerated or going into landfill.
- [SI1, SI7] The 1975 have been screen-printing new designs onto old existing merchandise from previous tours and albums (See Figure 9). The band's innovative circular economy approach includes installing screen-printing stations at live shows where concertgoers can bring their own t-shirts for reprinting (McSherry 2020).

Figure 9: Overprinted 1975 merchandise

Part 4: Performance

4.1. Challenges and Concerns

- [SI3, SI4, SI6] By its very definition touring is not sustainable; it is not 'of place'. Therefore the "sustainability solutions" offered are mostly exercises in reducing damage. In 2010, Julie's Bicycle published the 3 volume report, *Moving Arts: Managing the Carbon Impacts of our Touring* which remain relevant today; the volumes focus on Bands, Orchestras and Theatre respectively. It is worth noting that the theatre report did not include GHG emissions related to stage set materials, merchandising, etc (i.e. related to either *Production* or *Venues & Environment* as defined in this chapter). The reports for both orchestras and theatre state that reducing environmental impacts will require the development of new touring models (for example, more performances per tour at a single or multiple venues) and assessment of logistics (performer travel and freighting of instruments, sets, etc). This will require tools, guidance and training, as well as investment to pilot and demonstrate models that reduce environmental impacts while extending audience reach and maintaining economic viability and artistic quality.

Figure 10: Promotional image for Cinderella (Birmingham Royal Ballet, 2017)

- [SI1, SI6, SI7] The design, construction and choice of materials for sets, rigs and staging for touring does not tend to prioritize issues such as weight or truck/air pallet/container packing or space requirements, which contribute significantly to the carbon emissions arising from transport and freighting. For instance, the promotional material for the 2017 Birmingham Royal Ballet production of *Cinderella* proudly boasted that "Ten articulated lorries packed with scenery flats, props, lighting rigs, rails of costumes, flight cases of wigs and all the materials necessary to stage this beautiful ballet [will] pound the motorways of Britain", "harnessing the equivalent power of 4000 horses […] on a scale comparable to any major rock band's road trip" (North East Theatre Guide 2017).
- [SI3, SI6, SI7] *The Green Touring Guide* (2016) was written for and with musicians, agents, tour managers, promoters, venues and booking agencies but resonates across all areas of the performing arts. The challenges it identifies (before offering a practical toolkit) for establishing sustainable touring practices are: dealing with unknown or

complex concepts related to climate science; lack of clarity about the personal benefits of changing practices; suspicions of “green washing” (putting a performer’s reputation at risk) and fear of high additional costs which will reduce profits. Similarly, Julie’s Bicycle touring report on bands (2010) noted that financial decisions and constraints alongside artistic considerations are the main drivers dictating touring practices and therefore override environmental considerations.

- [SI1, S16] Performances and artworks are not always perceived to enact what they call for in terms of ecological knowledge and sustainability. For example, Ernesto Neto's *Gaia Mother Tree* (2018) was a giant biomorphic structure of hand-knitted cotton that was installed in Zurich’s railway station to create a locus for collective discussion, singing, and meditation on the environment (See Figure 11). Made in Brazil with no nails or screws, the fabric and re-construction in Europe involved a huge amount of travel and transport (Weins 2021).

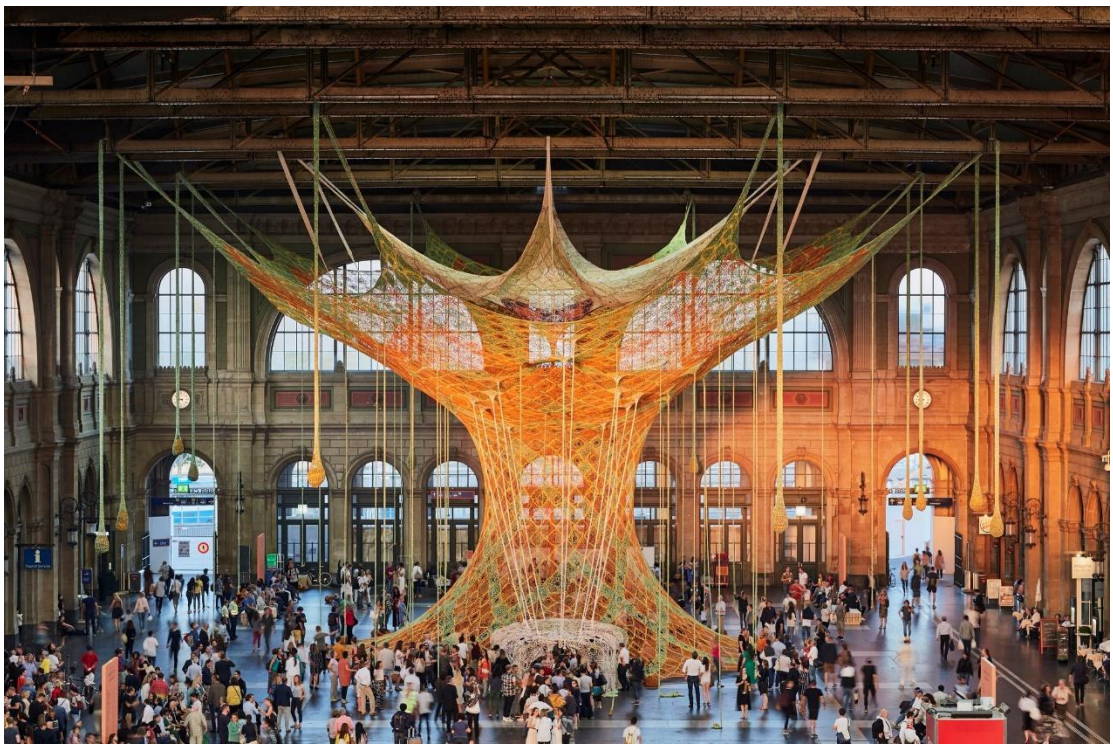

Figure 11: Gaia Mother Tree (Ernesto Neto, 2018)

- [SI6] A Perform Europe (2021) report concludes that, across the EU and UK, “current funding and cultural policies do not stimulate and support the growing environmental awareness in the sector to be put in practice”. In all 41 countries, “structured incentives for ecologically considerate touring and presentation are insufficient” and many other support programmes are “at odds with greening ambitions: they require producing and presenting new work instead of ‘recycling’ existing productions, overfocus on quantitative indicators, do not stimulate using green transport means, etc.”
- [SI6] A report commissioned by ACE, UK Theatre and SOLT found that while “live-to-digital” theatre is one way to “focus on touring work” in an ecologically sustainable way, at that time only 21% of organisations did so for that reason in order to “fulfil their organisational mission” (AEA Consulting 2016). While the Covid-19 pandemic meant a widespread shift to digital production, largely in order to reach and provide access to audiences (as per 2016 motivations), several theatres and companies are now making digital productions with the reduction of environmental impact as a key driver.

However, there are often assumptions that such productions have little or no set costs for physical materials and it has also been widely noted that many theatres have either withdrawn or vastly decreased their "post-pandemic" digital offerings, thus undoing many sustainability and access gains and benefits.

- [S1, S2, SI7] It is also widely assumed that digital production, streaming and downloading is inherently "green" and sustainable. As Devine (2019) notes, however, this relies on hidden, often exploitative regimes of labour to produce electronic components, as well as the concealed material realities of servers, routers, etc., in order to meet "expectations of infinite access and infinite storage". See also the "Electronic and Electrical Equipment" chapter of this report.
- [SI4] *The Cost of Innovation* (2021), a three-year investigation into models and tools for technological and environmental innovation in the arts, found that many practitioners want to use certain technologies but can't access them; that such technologies are normally phenomenally expensive; and "chasing the new through technological innovation is bad for the environment" (in Bernard and McAlister 2021).

4.2. Responses, Actions and Initiatives

- [SI2, SI6] In 2019, the band, Massive Attack, commissioned the Tyndall Centre for Climate Change Research to explore the reduction of emissions associated with live music touring. Phase 1 reviewed Massive Attack's own touring practices and phase 2 focused on developing a roadmap for the wider live music sector. The final report outlines targets for energy use in buildings and outdoor events, surface travel and air travel (for people and equipment) and audience travel. It also provides interim targets, but not a "net zero" date. Instead, it outlines the progress needed to reduce emissions across different areas of activity. In those areas where low carbon options are currently not available (e.g. aviation) the proposal is to focus on reducing demand. If offsets are used to claim "net zero" status then these should be carbon removals with long term geological storage and should only be used where further reductions in emissions are not possible (Jones, McLachlan and Mander 2021).
- [SI2, SI6, SI7, SI8] The 3 major record labels – Sony Music Entertainment, Universal Music Group and Warner Music Group – plus independents such as the Beggars and Secretly groups of labels, Warp, and Ninja Tune have signed the Music Climate Pact to pledge "actionable climate targets" related to global touring, vinyl manufacturing, and the energy used to power streaming. They have agreed to collaborate on measuring carbon emissions, to help artists to speak out on climate issues, and to communicate with fans about how the music industry impacts on the environment. They aim to work with streaming companies such as Spotify "to obtain data and drive emission reduction projects in a collaborative fashion" (Beaumont-Thomas 2021).
- [SI2, SI6] For 2019-20, 636 (of 828) National Portfolio Organisations (NPOs) provided environmental data to Arts Council England (ACE) through the Creative Green Tools, a set of free online tools developed by Julie's Bicycle to help cultural organisations and tours calculate their carbon footprint and track progress over time. Of these, 445 NPOs included information regarding their environmental attitudes and practices using the "Beyond Carbon" field, through which 51% reported producing or programming work exploring environmental themes and 13% used a Green Rider for visiting/touring productions (Arts Council England 2021: 9).
- [SI4, SI5, SI6, SI7, SI8] In addition to guidelines produced by organisations like Julie's Bicycle (2015) and the Green Touring Guide (2016), SiPA (2020) collated and published clear and concise lists of "10 quick sustainable wins" for "Trucking", "Vendor

Guidelines", "Flights & Hotels" and "Catering". By trialling the SiPA guidelines, Jamal Chalabi (tour manager and co-facilitator of the TPG Sustainability Working Group) gained AGF certification for the Bring Me the Horizon six-date UK 2021 tour. All vendors, venues, promoters, and technicians were involved. KB Event supplied 10 Megacube Box Artics; all trucks were Euro VI rated and powered by HVO biofuel which cut approximately 23 tonnes of CO^2 emissions in total. While the fuel costs were higher, they represented a third of the cost required to remove/offset the carbon, an example of mitigating at the source (https://www.tpimagazine.com/a-greener-way-of-touring-2/)

- [SI1, SI6] United Independent Music Agencies (UIMA), which represents more than 1000 acts in Europe and worldwide, has introduced a Green Rider as part of its Green Charter for "eco-friendly touring". Its focus is on re-usability (no single use items), zero waste, green energy and plant-based food (https://uima.org/green-touring/).
- [SI1, SI3, SI6] One of the proposed "solutions" to touring that combines concerns with sustainability (performer travel and materials use and transport) and audience access is the use of Virtual Reality (See Tripney 2021). For more about the sustainability issues related to AR/VR technologies and equipment and what is being done about them (related to sourcing, design and waste management), see the sections on EEE in the "Electronic and Electrical Equipment" chapter of this report.
- [SI1, SI3, SI6] Another model, simultaneously questioning traditional production processes and practices of global touring, is "theatre as blueprint or as franchise" (Tripney 2021) such as Katie Mitchell and Jérôme Bel's collaborative project for Théâtre Vidy-Lausanne, *Sustainable Theatre?* (2021-22). Mitchell and Bel, neither of whom will fly, have produced the text and material required for mounting the production at various venues, each of which will adapt their own version of the shows, working with a local director and actors. Similarly, Tanja Beer (https://www.tanjabeer.com/) is currently exploring new models of stage design for touring in which, as lead designer based in Australia, she produces "a recipe" for a set design that is then interpreted and built in London where all materials are sourced.
- [SI6] The HandleBards are a UK-based Shakespeare company that tours by bicycle, inherently limiting the materials they use in production work. Their work is "more attentive to modes of production than to the enactment of an ecocritical reading of Shakespeare's plays" and they draw attention to green modes of transport and the importance of locality by "working within rather than attempting to harness the ecologies of place" (O'Malley 2020). The HandleBards won the 2014 Award for Sustainable Practice at the Edinburgh Fringe and were nominated for *The Stage*'s 2017 Sustainability Award; the fact that such awards exist indicates the extent to which sustainability is seemingly valued and celebrated.
- [SI6, SI8] Perform Europe (2020-21) is an 18 month European project involving 5 partners that is testing sustainable touring practices in the 40 countries of Creative Europe and the UK. It includes a digital platform, support scheme for artists and companies, and will result in policy recommendations.
- [SI1, SI2, SI6] Creation Theatre's report, *Digital Theatre: A Route to Sustainability* (2021), estimated that its staging of a digital show resulted in a 98% reduction in its carbon emissions compared to an in-person production. This was largely due to a reduction of audience travel, combined with no need to design/build/transport sets or produce/dispose of single use marketing materials made of coated paper or board (Masso 2021).
- [SI2] Vijay Mathew has developed a carbon emissions calculator for streaming media in collaboration with Axess Lab in order to provide a simple tool for cultural managers

to budget their programme's internet carbon emissions, and to provide a proof-of-concept design strategy that embodies justice-based values (Mathew 2021).

- [SI2, SI8] Fast Familiar's 2020 app-based interactive game/performance for remote audiences, *Smoking Gun*, had a net result of zero carbon emissions (McAlister 2020). Their main learning points were the need to build apps from scratch using modules and to measure everything (e.g. battery use of audience participants). Fast Familiar are working with Abandon Normal Devices (AND) and Arts Catalyst (https://artscatalyst.org/) on a collaborative research-led project, called *The Networked Condition*, which explores the environmental impact of the creation and delivery of artworks using digital technology. They've created and distributed a free-to-use carbon calculator, to help artists and arts producers understand and reduce the impact of digital production.

Figure 12: Rubbish Collection at the Science Museum, London (Joshua Sofaer, 2014)

- [SI1, SI3] There are an increasing number of examples of the content/message of a performance aligning closely with the sustainable use of materials. One is Pigfoot Theatre's children's show about climate change, *How to Save a Rock* (2019) which is entirely carbon-neutral; the lighting is powered by a bike cycled live on stage, and production materials are recycled and recyclable, with any unavoidable emissions off-set (https://www.pigfoottheatre.com/). Another, very different, example is Joshua Sofaer's *Rubbish Collection* (2014), a two-part participatory art installation in which every single thing discarded by staff and visitors of the Science Museum in London for 30 days was photographed in a purpose-built temporary archive in the basement (https://www.joshuasofaer.com/). Members of the public were invited to open the bags of rubbish and lay out the contents and photograph their arrangement, before repacking the contents and sending it towards recycling or incineration. This work led to changes in the material practices, including recycling, procurement and waste disposal, of the Science Museum (Harvey 2020).

Part 5: Conclusions

5.1. Sustainable Materials Practice in Performing Arts

There is no shortage of vision for a sustainable materials practice in the Performing Arts, nor even route maps to achieve it. Detailed practical "solutions" are largely discipline and context specific, given the scale and breadth of the sector in terms of missions, locations, audiences, styles and aesthetics. In the diverse community of practice that is "theatre" alone, one milestone for the achievement of sustainable materials usage would be that all productions are able to demonstrate that they meet the *Theatre Green Book* Baseline standard. Indeed, the *Green Book* in and of itself is already being considered a beacon of good practice and a potential model for other sectors, within and beyond the Performing Arts. Some mechanisms – like formal and informal networks and associations that pool and share expertise, and the development of open access resources produced by coalitions of practitioners – are already in place.

Across the Performing Arts, the infrastructure for sustainable practice would be characterised by: widespread, accessible storage, hiring and reuse facilities and resources for materials, objects, items and equipment and their components; the embedding of environmental sustainability in all operations, production, touring and investment planning; the effective use of tools to collect, measure and analyse environmental data over an extended period of time; the use of clean procurement and transport; effective partnership and collaboration with the construction industry to ensure economies of scale; knowledge, resource and research sharing with other creative industries; government investment and support programmes that enable change and innovation; and widespread accessible training to develop knowledge, skills and expertise.

What is also clear from this report as a whole is that the Performing Arts do and can not operate in a national and/or global legislative and infrastructural vacuum. This includes the need for: electronic equipment standardisation; further clarity and understanding of Extended Producer Responsibility (EPR); the strengthening of vulnerable supply chains and development of alternative materials as mitigation; systems and policies that allow for maximum recovery and reuse of raw materials; better understanding and control of hazardous bi-products and chemical usage in textiles; more informative labelling and transparent identification of the provenance of materials; and the valuing (via healthy working conditions and fair wages) of creative and cultural practitioners, as well as all involved in the chain of production. As SiPA asserts in its Sustainability Goals (2015): "People and planet will take their place in the profit and loss accounts of our industry". This requires audience engagement and outreach that directs attention to their role, creativity and influence.

By way of a final example, Walk the Plank's 2022 production of *Green Space Dark Skies*, currently in development, exemplifies how the various elements in this chapter associated with *Production, Venues and Environment* and *Performance* are able to powerfully coalesce toward a long-term, collaborative sustainable practice. *Green Space Dark Skies* will be "a mass gathering [that] celebrates nature, our responsibility to protect it and everyone's right to explore the countryside." Walk the Plank is a producing company, specialising in fireworks, pyrotechnics and special effects, with workshops in Salford and also a training and engagement programme (https://walktheplank.co.uk/). They are an active member of Manchester Arts Sustainability Team (MAST) and produce Manchester Day, "a parade that is pushed, pulled, cycled and recycled" and won a 4* Creative Green award from Julie's Bicycle in 2019. They are also a core partner in the Green Production Lab, an initiative that

brings together production management professionals working across the Outdoor Arts sector to explore the challenges and opportunities for reducing the environmental impacts of outdoor festivals, events, and touring productions. According to the Walk the Plank website, *Green Space Dark Skies* "will be carbon positive, ultimately removing more carbon from the atmosphere than it produces. The aim is to leave no trace and to empower everyone involved to make a difference locally too."
Such work begins to fulfil the principles articulated by the Broadway Green Alliance which is shared, more or less explicitly, by the coalitions of Performing Arts practitioners working toward sustainability in the UK. BGA states that "Climate neutrality is insufficient" and the industry needs to promote, inspire and activate positive climate action and commitment; that "There is no climate justice without racial justice"; that "The climate crisis is the result of millions of decisions" and change can only result from the cumulative effect of industry actions, big and small; and, finally, that "It is impossible to be 100% green – we can only be *greener*." As the key players in the making of the *Theatre Green Book* have said, "No matter where you are in sustainability, there's a next step to make": "We knew we couldn't come up with something that was future-gazing, we had to ask: 'What can we do today?'" (quoted in Clark and Snow 2021: 14, 13).

Part 6: Supporting Information

6.1. Glossary

AAPTLE	The Alliance of Associations & Professionals in Theatre & Live Events https://aaptle.uk/
ACE	Arts Council England, national development agency for creativity and culture and a non-departmental public body of the Department for Digital, Culture, Media and Sport (DCMS) https://www.artscouncil.org.uk/
AIF	The Association of Independent Festivals, a UK not-for-profit trade association and the UK's leading festival representative body. https://aiforg.com/
AGF	A Greener Festival, non-profit organisation dedicated to improving sustainability of events, tours, venues, festivals and all live sector contributors. https://www.agreenerfestival.com
ALPD	The Association for Lighting Production and Design https://www.thealpd.org.uk/ald-working-groups/sustainability
AV	Audio/video
BECTU	Broadcasting Entertainment Communications and Theatre Union https://bectu.org.uk/
BEIS	The Department for Business, Energy and Industrial Strategy, a department of the UK government
BGA	Broadway Green Alliance, an ad hoc committee of The Broadway League founded in 2008 in collaboration with the Natural Resources Defense Council to implement environmentally friendly practices on Broadway and beyond https://www.broadwaygreen.com/
BREEAM	A third party certification, assessment method and standard for the environmental, social and economic sustainability performance of a masterplan, project or building https://www.breeam.com/
Carbon Literacy Project	One of the 100 worldwide Transformative Action Programs (TAP100), offering carbon literacy training courses that cover climate change, carbon footprints, and specific guidance on how individuals and

	organisations can become more sustainable and reduce their emissions. https://carbonliteracy.com/
CFL	Compact fluorescent lamp
ClimateEQ	An organisation that provides carbon literacy training to the music industry https://www.climate-eq.co.uk/
DCMS	Department for Digital, Culture, Media and Sport, a UK government department with responsibility for culture and sport
EEE	Electrical and Electronic Equipment https://www.gov.uk/government/publications/electrical-and-electronic-equipment-eee-covered-by-the-weee-regulations
ETC	European Theatre Convention, the largest network of publicly-funded theatres in Europe (48 theatres in 26 countries including the UK) https://www.europeantheatre.eu/
Equity	Trade union for performing arts practitioners https://www.equity.org.uk/
Freelancers Make Theatre Work	An independent community for self-employed and freelance workers from all areas of theatre, opera, dance and live performance https://freelancersmaketheatrework.com/
GEI	The Green Events and Innovations, a partnership with AGF and the International Live Music Conference (ILMC), which is the world's leading platform for the touring and festival sectors. https://www.agreenerfestival.com/green-events-innovations-conference-gei/
GHG	Greenhouse gases
Green Rider	An additional provision provided with the live performance contract for an event or festival which stipulates the sustainable requirements of the band or artist. https://juliesbicycle.com/resource-green-rider-2015/
Greenwashing	The practice of launching adverts, campaigns, products etc. under the pretence that they are environmentally beneficial, often in contradiction to the company or artist's environmental and sustainability record in general. https://www.ethicalconsumer.org/transport-travel/what-greenwashing
ISE	Institute for Sustainable Events, online training and development for event industry professionals https://www.ise.world/
Julie's Bicycle	The leading UK charity supporting environmental sustainability within the creative industries https://juliesbicycle.com/
LED	A light-emitting diode is a semiconductor light source
LIVE Green	Live music Industry Venues & Entertainment, a federation of 13 live music industry associations representing 3150 businesses, over 4000 artists and 2000 backstage workers https://livemusic.biz/live-green/
LTC	London Theatre Consortium, a network of 14 of London's leading not-for-profit producing theatres https://www.hampsteadtheatre.com/about-us/london-theatre-consortium/
NPO	National Portfolio Organisation, an organisation that holds a funding agreement with Arts Council England (ACE) https://www.artscouncil.org.uk/our-investment/national-portfolio-2018-22
The RAW Foundation	The RAW Foundation is a not-for-profit consumer-facing organisation targeting plastic from an environmental life-cycle perspective http://rawfoundation.org/making-waves/

RSC	Royal Shakespeare Company, a major British theatre company. In a 'normal' year, the RSC produces around 20 shows, employs over 1000 staff and plays regularly at its home theatre in Stratford-upon-Avon, in London, and on tour across the UK and internationally. https://www.rsc.org.uk/
SBTD	The Society of British Theatre Designers http://www.theatredesign.org.uk/
SDGs	Sustainable Development Goals, a collection of 17 interlinked global goals for a more sustainable future, published by the United Nations. https://sdgs.un.org/
SIPA	The Sustainability in Production Alliance https://sipa.global/
SME	Small or Medium-sized Enterprise https://stats.oecd.org/glossary/detail.asp?ID=3123
SOLT	Society of London Theatre, an umbrella organisation that works on behalf of West End theatres https://solt.co.uk/
The Stage	UK entertainment industry newspaper and website https://www.thestage.co.uk/
Theatres Trust	UK national public advisory body for theatres http://www.theatrestrust.org.uk/
TPG	The Touring Production Group, an independent, UK-based association of live music touring professionals dedicated to enhancing professionalism through education, best practice and advice https://www.tourproductiongroup.co.uk
UK Theatre	UK's leading theatre and performing arts membership organisation https://uktheatre.org/
Vision: 2025	UK-based steering group of live events industry associations representing over 600 event businesses and leaders in the field of sustainability. https://www.vision2025.org.uk/

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Chapter 10: Electronic and Electrical Equipment

Peter Oakley and Emily MacDonald

Introduction

Description of Scope

In the scope of this research the term ‘electronic and electrical equipment’ (EEE), covers general equipment used by all creative industry practitioners e.g. laptops and mobile phones, as well as specialist equipment used almost exclusively by practitioners in specific creative industries e.g. digital film camera bodies. This chapter covers: raw material sourcing, design, use, repair, and disposal/destruction, including the generation of ‘e-waste’, also known as WEEE, and the issues of its storage, relocation and treatment, all key areas where sustainability issues exist and are likely to persist within EEE.

The general electronic and electrical equipment that were examined are:

- Mobile phones
- Laptops
- Laptop transformers
- Desktop computers
- Monitors
- Projectors
- Low voltage power cables
- Mains or high voltage power cables
- Light bulbs
- Lighting tubes
- Electrical Hand Tools (e.g. drills, saws)

The specialist electronic and electrical equipment that were examined are:

- Digital film camera body
- Microphones
- Speakers
- Photocopiers
- Drawing tablets
- Lighting rigs
- Lathes
- Milling Machines
- Laser Cutters
- 3D printing machines
- Digital temperature gauges and thermocouples

Terms Used

Electronic Equipment - Electronic equipment involves the transfer of information between small electrical currents via intricate circuitry and microchips. The inclusion of circuit boards and digital memory chips is characteristic. Examples are mobile phones, laptops, and digital film cameras.

Electrical Equipment - Electrical equipment involves the use of electricity to power the equipment, either directly from a mains circuit or from batteries. Items used to transfer electricity or change electrical voltage and current are also included. Examples include power cables, light bulbs and handheld tools such as an electric drill.

Critical Raw Materials (CRM) - A term used by industry actors in reference to raw materials deemed critical to their industries, which are considered have vulnerabilities in their supply chains. This focus makes CRMs a supply-side definition. The term CRM is used by national and supranational governments e.g. the European Commission's periodic Critical Raw Material Lists and related assessments for EU industry and economy (EU Commission, 2018 and 2020a.b.).

Conflict Minerals/Non-conflict minerals - Minerals which are sourced from areas of conflict/political unrest and may be used to fund conflict or war. The term was coined and formally defined as minerals which have come from "Conflict-Affected and High-Risk Areas", as identified in the OECD's *Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas* (OECD 2016). The same report coined the reciprocal term, non-conflict minerals. The term conflict mineral has since become legal jargon through national and supranational legislation e.g. the Dodd-Frank Act in the US (U.S. Government, 2010) and the EU Conflict Minerals Regulation 2017/821 (European Parliament, 2017). However, in general usage, conflict mineral is used to describe any mineral extracted in a conflict zone. As with CRM, the focus on the geo-politics of the source makes conflict minerals a supply-side term.

3TG - Acronym for Tin, Tantalum, Tungsten, and Gold (3TG). These were identified by the OECD (2016) as minerals which are of special risk of being sourced from 'conflict-affected or high-risk areas' and therefore which suppliers of should practice specific due diligence for in their supply chains (See the OECD Guidance Supplements on Tin, Tantalum, Tungsten, and the Supplement on Gold). Conflict-affected or high-risk areas are areas which pose significant risks for adverse impacts associated with the extracting, trading, handling and exporting of minerals such as the direct or indirect support to non-state armed groups (OECD, 2016. pp22).

e-waste/WEEE - e-waste (electronic waste) is waste produced from electricals and electronics. E-waste varies in its constituent materials depending on the nature of the circuitry, but consists mostly of technology metals, (including precious metals), steel, aluminium, and plastics. WEEE is the technical acronym for waste electrical and electronic equipment. The term e-waste is more typically used in journalism and mainstream articles.

Technology Metals: Metals necessary for technological applications and constructing advanced technological equipment. The list includes: Tin, tantalum, tungsten, gold, cobalt, copper, gallium, indium, lithium, graphite, nickel, palladium, tin, the platinum group metals (ruthenium, rhodium, palladium, osmium, iridium, and platinum) and Rare Earth Metals (see below).

Precious Metals: A term originating from these metals' historic use in coinage. It covers gold, silver, and platinum. However, in terms of UK hallmarking legislation it covers all materials that are required to be hallmarked, so also includes palladium.

Rare Earth Metals/Rare-Earth Elements (REEs): A group of 17 metals used across the electrical and electronic industry. Demand for REE has increased due to their applications in sustainable energy generation and, potentially, electric cars. The Rare Earth Metals are: lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu), scandium (Sc), and yttrium (Y).

Uses of Raw Materials in Electronic Circuitry

The following table presents key components of electronic and electrical equipment used across the creative industries, and the raw materials they consist of.

Component	Key Materials used in the Component
Circuit boards	Predominantly copper, nickel, aluminum, iron, tin and lead. They can also contain precious metals (gold, silver and platinum) as well as sulfur, zinc, strontium, zirconium, antimony, barite, lead and mercury. The substrate material is predominately made from a laminate material consisting of glass cloth and epoxy resin.
Batteries	Currently predominantly cobalt, lithium and graphite. Batteries can also include diamonds (used as electrodes), manganese, nickel, cadmium, as well as REEs: terbium, dysprosium, erbium, thulium, ytterbium, and lutetium.
Semiconductors (integrated circuits and sensors)	Copper, gallium, silicon, nickel, palladium and gold.
Microchips	Boron, silica, phosphorus, gallium, and arsenic.
Shields and metal parts	Nickel, manganese and silicon. Also hydrogen, fluorine, magnesium, chlorine, titanium, chromium, and bromine can be used.
Capacitors	Tantalum, copper and silver.
Display panels	Predominantly indium and tin. Touch screen glass can also contain sodium, potassium, and cerium. The rare earths: praseodymium, europium, and gadolinium are used in display colours.
Solder	Predominantly tin, copper and silver.
Connectors and wires	Beryllium, copper, molybdenum, tantalum, gold and bismuth.

The table below compares amounts of various metals listed above found in the earth as mineral deposits compared to amounts of these metals found in computer printed circuit boards (PCBs).

Table 4. Metal content of ores and PCBs.

Metal	Ores (%) [a]	PCBs (%) [b]
Copper	0.5–3.0	12.0–29.0
Zinc	1.7–6.4	0.1–2.7
Tin	0.2–0.85	1.1–4.8
Lead	0.3–7.5	1.3–3.9
Iron	30–60	0.1–11.4
Nickel	0.7–2.0	0.3–1.6
Gold	0.0005	0.0029–0.112
Silver	0.0005	0.01–0.52

Figure 1. Image reproduced from the journal article by Bizzo et al. (2014) “Characterization of Printed Circuit Boards for Metal and Energy Recovery after Milling and Mechanical Separation”.

Introduction of the Sustainability Issues Relevant to Electronic and Electrical Equipment

Much of the electronic and electrical equipment used by creative industry practitioners is generic, and produced for a much wider customer base. Consequently, resolution of the related issues around more sustainable practice of these materials is enmeshed with a need for wider changes in electronic and electrical product supply chains and waste management.

All of the creative industries also employ specialist electronic or electrical equipment. In some disciplines e.g. film, photography, and product design, specialist electronic equipment now dominates current professional practice. In these sectors the leading platforms for distribution of this equipment have a significant impact on the longevity or obsolescence of practitioners’ equipment, and consequently a significant impact on the sustainability of this equipment and the discipline.

There are a number of problems in the production, use and disposal of electronic and electrical equipment which impact the environment and human health. This report will cover issues related to sourcing, design, use and e-waste production and treatment. There have already been attempts to resolve specific issues related to supply chains through legislation. However, the implementation of legislative support that supports circular economy principles with respect to the sourcing of technology metals, design of electronics and management of e-waste is in its infancy. Academic research work has been undertaken into material recovery of the elements and compounds in e-waste, with the recovery of precious metals being the most advanced. However, commercial scale applications of material recovery beyond precious metals for electronic and electrical equipment are still at the development or pilot stage.

The sustainability issues of electronic and electrical equipment this report will cover coalesce around the following areas:

- Sourcing Technology Metals
- Planned Obsolescence of Products
- System Development Leading to Product Obsolescence
- Difficulties in Repair and Reuse of Electronic and Electrical Equipment
- Difficulties in Recycling E-waste
- International Dumping of E-waste
- Toxicity of E-waste as a Compound Material and its Impacts

The initiatives & developments related to the sustainability of electronic and electrical equipment coalesce around the following areas:

- Legislating for E-waste
- Extended Ownership
- Design for Repair and Disassembly
- Recovery of Precious Metals from E-waste
- Research on Recycling Elements and Compounds from E-waste
- Pilot Implementation of Recovery Technologies

Key Issues Affecting the Sustainability of Electronic and Electrical Equipment

Sourcing Technology Metals

The production of electronic and electrical equipment and their components is dependent on the sourcing and availability of technology metals. Due to the diverse locations of extraction sites, including many in the developing world, the supply chains for technology metals are complex and enmeshed with the global mining industry and the socio-political context of each mining country. Consequently, a range of issues have been identified relating to technology metal suppliers and sites of extraction and processing. These include social and humanitarian injustices, impacts to the environment, ecological systems, and biodiversity.

The following examples of issues that exist in technology metal supply chains are taken from the report, *Smartphone Material Profiles* (Fairphone & the Dragonfly Initiative, 2017).

In Peru, the sharp rise in violent conflict from 2015 onwards has been associated with the operation of industrial copper mines, with cases of mine-protester deaths from police attacks (pp12).

The nickel industry in Russia has been linked to extreme sulfur dioxide pollution of air and vegetation, acid rain and heavy-metal contaminated water. Norilsk is considered one of the most polluted places on earth due to nickel mining and smelting (pp21).

Aluminium is refined from bauxite and bauxite mining has been the cause of extensive deforestation in Jamaica (pp14).

Cobalt, Copper, Gallium, Nickel and Tin can be extracted from ores that generate hazardous airborne pollutants, threatening human health when not managed responsibly, in industrial and informal mining contexts. For example, inhalation of cobalt dust is a primary cause of hard metal lung disease in the DRC and copper mining is at the root of Yueyang's "cancer villages" caused by toxic air pollution and water contamination by heavy metals (pp12).

In Chile, copper mining is associated with depletion of water resources in one of the world's most arid regions - the Atacama desert and in the Ting River Basin extensive water contamination has been caused by wet copper smelting (and gold heap leaching) of low grade ores combined with poor tailings storage (pp12).

Tantalum production in the Brazilian Amazon region is associated with deforestation and wetland degradation (pp27).

I*n China, "Intact forest landscapes" in Yunnan province, which are designated UNESCO world natural heritage sites, have been lost due to the expansion of tungsten and molybdenum ore extraction activities* (pp31).

Tin mining creates competition for, and pollution of, water supplies, as well as large-scale environmental degradation and soil erosion. The Bangka and Belitung islands produce 90% of the tin in Indonesia, where widespread environmental degradation, including marine habitats and seabed mining has been documented (pp29).

Malaysia is home to the world's largest REE refinery outside of China, which was constructed without adequate community consultation, leading to local protests and campaigns to close the facility. The refinery has been criticized for its poor radioactive waste facilities. In China, serious environmental violations in the REE mining industry over the last 20 years have left

toxic lake legacies (Baotou, Inner Mongolia), but regulation is now becoming more stringent. REE mining has also contributed to the contamination of farmland and air pollution, leading to severe public health risks – especially respiratory illness, skin diseases and cancer(pp23).

Planned Obsolescence of Products

Planned obsolescence is when a product has been designed or manufactured so that by a predetermined date, the product becomes unusable by consumers, whether or not the product remains functional. Planned obsolescence can create an illusion of need for a newer product in consumers. ome companies are releasing newer models sooner than necessary or engineering the product to fail after a certain amount of use (Barros & Dimla, 2021).

Planned obsolescence of electronic and electrical equipment occurs through two ways. One is through material decline of components that are not replaceable in the product e.g. battery life decline without the option to easily replace the battery. The other form is through design e.g. brands releasing an advanced version of a product and marketing this to consumers, while previous versions are still functional.

The outstanding example of planned obsolescence in digital equipment is the iPhone 6 'upgrade', which introduced a decline in the phone's performance prior to the release of a new model which resulted in lawsuits and financial penalties from various countries. Euroconsumers, (a network of consumer organizations in Europe), state that despite being aware of the damage that the update could have produced on the iPhones 6 series, Apple failed to inform consumers who were forced to update their phones and replace a product that they otherwise would not have replaced, voluntarily creating a loss of performance. A court in Italy imposed 10 million euros against Apple for "unfair and aggressive commercial practices" in relation to this update (Euroconsumers, 2021).

System Development leading to Product Obsolescence

Product obsolescence as a result of system or platform development is another example where design renders products as waste while they may still be functional. A prime example of this which applies to the film industry is the requirement made by Netflix in 2018 that all made-for-Netflix productions must be made on cameras with at least a 4K UHD Sensor. For many filmmakers this would render their equipment useful if they wished to produce a film for Netflix (See chapter 9).

Product obsolescence of electronic and electrical equipment dramatically increases e-waste as it shortens the life cycle of products and forces consumers to purchase new products.

Difficulties in Repair and Reuse of Electronic and Electrical Equipment

A critical reason why repair and reuse of electronic and electrical equipment is not the norm is because there is little economic incentive for manufacturers to do this. For example, the repair of PCBs for reuse has not been viewed as an economical practice, it has historically cost less to replace the PCB than to repair it (Brown et. al., 2004). Without incentives or regulations to enforce repair and reuse, it is unlikely manufacturers across the industry will employ and encourage repair and reuse in a meaningful way. There is progress moving toward legislation in this area however it has not yet changed the industry widely..

For example, in 2019, the European Ecodesign Requirements were updated for six specific products, importantly for this report these included electronic displays and welding equipment (see European Parliament, 2009 and European Parliament, 2019a.b.)The update required

manufacturers to design products in a way that allows for repair with commonly available tools and to keep spare parts available for professional repairers (European Court of Auditors, 2021.pp35).

The requirements have been criticised by the European Consumer Organisation however (which represents 45 consumer organisations from 32 European countries), for not encompassing general equipment such as mobile phones and computers and for not giving end users the same right of access to spare parts as professional repairers. (European Court of Auditors, 2021. pp.35)

Difficulties in Recycling E-waste

E-waste is the fastest growing waste stream globally (World Economic Forum, 2018). Research and development into effective recovery and reuse of raw materials is well underway but a fully circular model for e-waste management still has still not reached its full potential.

Both general and specialist electronic equipment can be difficult to recycle due to their size, complexity and the small amounts of each constituent element, alloy or compound within them. The more complex the product is designed and the more individual raw materials that exist in one product, the more difficult it is to break it down to individual raw materials, required for recycling.

Electrical equipment is typically less complex than electronic equipment, though still consists of different metals and alloys; their combination adds complexity to recycling and recovery in comparison to single material objects e.g. aluminium cans.

The recycling rates for certain electronic and electrical components is low also due to the lower value of replacing high value materials compared to the higher cost of reclaiming the materials from recycled components. With the example of PCBs, there would need to be tonnes of PCBs recycled together to make a profit from the reclaimed raw materials. Recycling Companies have suggested there would need to be 50 to 100kg in weight of PCBs to make the reclamation economical (Newbury Electronics, 2019).

For Critical Raw Materials particularly, recycling is not economically attractive for most, due to, on the one hand, huge capital required in the development of reclamation technologies and, on the other, low and volatile prices of CRMs (CEWASTE Consortium, 2021).

Legislation on material use also impacts recycling of e-waste. For example, a proposed blanket ban on lead in the EU (due to its hazardous properties) will have a direct impact on the bloc's future ability to recycle PCBs, due to the necessity of lead in the current recycling processes.

Prof. Dr. Dr. h.c. mult. Markus Reuter, metal recycling specialist, stated in an interview (Arubis, 2019): "*Lead is unfortunately toxic, and this is prompting the EU to consider banning its use. But it is also a fact that lead – like copper – is crucial as a metal collector in multi-metal metallurgical recycling. It is a key enabler of the CE [Circular Economy], as it recovers metals such as gold, silver, bismuth, and antimony. Therefore, the circular economy paradigm is in danger without lead. This is often forgotten and overlooked in today's contentious and often unfortunately superficial discussions on circularity. The result of premature policy decisions and bans of metals opens up the risk of metal production migrating away from Europe. This would severely disrupt our control of metal production and recycling.*"

In the paper *Future E-waste Scenarios* (Parajuly, K. et al., 2019), the authors state that current e-waste management systems have not been able to fully capture the functional and material

value of End of Life (EoL) products due in part to; a lack of incentives for actors in the value chain, a lack of collaboration among stakeholders in the product lifecycle related to implementing 'design for EoL' solutions, and a lack of public awareness of e-waste management (pp32).

International Dumping of E-waste

Dumping of e-waste by large waste producing nations onto nations with weaker legislation to protect against this is a critical issue in e-waste management that impacts the environment and human health. Companies and governments can avoid paying for waste management by illegally dumping e-waste. Further, countries that have committed waste management crimes, historically have not faced great punishments for this.

In an experiment conducted by the Basel Action Network from April 2017 until September 2017, 314 items of used electrical and electronic equipment were secretly equipped with GPS trackers in WEEE collection points and deployed in 10 EU Member States. Out of the 314 tracked units, 303 remained in the EU, while 11 ended up in seven different non-OECD countries and territories (Ghana, Hong Kong, Nigeria, Pakistan, Tanzania, Thailand, and Ukraine) (European Court of Auditors, 2021. pp28).

In June 2020, Spanish authorities found an organised criminal group to be illegally shipping hazardous waste, including WEEE, from the Canary Islands by intentionally misclassifying e-waste as second-hand goods and shipping it to buyers in Africa, totalling over 750 000 kg of WEEE in 2018 and 2019 (European Court of Auditors, 2021. pp29).

Toxicity of E-waste as a Compound Material and its Impacts

Examples of toxic materials in equipment include indium oxide and tin oxide in touchscreens; aluminosilicate glass; carbon, mercury, cadmium and lithium cobalt oxide which are found in batteries. ead and arsenic found in circuit boards and microchips in phones, computers, and laptops (Electronic Recycling Association, 2018).

Many components inside electronic and electrical equipment contain materials that if not reclaimed or recycled properly, can drastically impact human and environmental health. The illegal dumping of e-waste in nations that do not have legislation to protect against this or to treat e-waste safely can exacerbate this issue. For instance the practice of ‘urban mining' in developing nations such as recovering copper from cable by burning e-waste in large heaps.

Initiatives & Developments

There have been a range of initiatives and developments focusing on responsible sourcing of raw materials, design of equipment for extended ownership, repair and disassembly, e-waste management and recovery of materials from e-waste.

Responsible Sourcing of Raw Materials

Initiatives working in this area:

- Responsible Cobalt Initiative (RCI)
- Responsible Raw Materials Initiative (RRMI)
- Fairtrade Gold
- Fairmined
- Solidaridads Gold Program
- Just gold project (PAC)
- CRAFT
- Tin supply chain initiative
- ITRI Supply Chain Initiative (iTSCi)
- Better Sourcing Program
- Scaling Up Mineral Traceability
- Conflict-Free Smelter Program

Relevant legislation working in this area:

- OECD Due Diligence Guidance (OECD, 2016)
- The Fundamental International Labour Organization Conventions (ILO, Conventions and Recommendations)
- Sustainable Development Goals (SDGs) (UN, 2015)
- EU Conflict Minerals Regulation (European Parliament, 2017)
- US Dodd Frank Act (US Government, 2010)
- UK Modern Slavery Act (UK Government, 2015)

Extended Ownership

Economic models based on the circular economy principle of extended ownership favors sharing and reuse of products and materials. This reduces consumer ownership of products which can lengthen the life cycle of products and reduce waste.

The film industry has established protocols & expectations for extended ownership of electronic equipment. The common practice for filmmakers of larger productions is to rent their equipment and for smaller and independent productions, filmmakers who are more likely to be purchasing their equipment will tend to purchase resold and refurbished equipment. (See chapter 9).

Another important development in extended ownership is the growing popularity of material libraries which typically allow users to purchase or freely take used materials/equipment rather than purchasing new. See for example:

- The Islington Council Library of Things (www.libraryofthings.co.uk/finsburypark)
- The Glasgow and Edinburgh material 'scrap stores' (https://www.glasgowplay.org.uk/, https://community.changeworks.org.uk/reusemap/edinburgh-scrap-store)
- The Edinburgh Tool Library (https://edinburghtoollibrary.org.uk/)
- The Glasgow based Circular Arts Network (https://www.canarts.org.uk/)
- Online recycling networks e.g. Freecycle, Freegle.

Design for Repair and Disassembly

An example of a design approach to electronic and electrical equipment that accommodates repair and disassembly is modular design. Modular designs allow users to disassemble and either repair components or replace them, rather than replacing the entire product. It is critical that this is considered at the design stage to allow for accessible, simple and effective disassembly and repair. See Case Study 16: Fairphone as Industry Disruptor and Demonstrator of Designing Electronics for Repair and Disassembly.

The authors of the paper *Future E-waste Scenarios* (including authorship from the UN Environment Programme and the UN University) state that better product design of electrical and electronic equipment can lengthen product life cycles through repair and reuse of products and components and can allow for better recovery of valuable resources through designing for recyclability (Parajuly, K. et al., 2019. pp21).

Legislating for e-waste

There are two main pieces of EU legislation related to e-waste; the WEEE Directive and the RoHS Directive. The WEEE Directive (European Parliament, 2012) sets the rates and targets for EU member state collection and recycling of e-waste. The Directive on the Restriction of the use of certain Hazardous Substances or 'RoHS' (European Parliament, 2011) restricts the use of hazardous substances in electrical and electronic equipment.

Other important developments in EU e-waste legislation includes:

The European Commission mandated the European Committee for Electrotechnical Standardization (CENELEC) to develop common European standards for the treatment of e-waste in order to harmonise treatment requirements across the EU. CENELEC developed thirteen standards between 2014 and 2020 however they are not mandatory and although the Directive states that the EU may mandate EU-wide minimum quality standards based on the CENELEC standards, according to the European Court of Auditors, this had not been done as of January 2021 (European Court of Auditors, 2021. pp24).

As part of the EU Circular Economy Package, the European Commission intended to present a Sustainable Products Policy Initiative including a revision to the EU Ecodesign Directive, a Circular Electronics Initiative and 'New design requirements and consumer rights for electronics' in the 4th quarter of 2021.

The Circular Electronics Initiative is meant to promote longer product lifetimes and include:

- regulatory measures for electronics and ICT including mobile phones, tablets and laptops under the Ecodesign Directive;
- implementation of the 'right to repair', including a right to update obsolete software;

- regulatory measures on chargers for mobile phones and similar devices (including the introduction of a common charger);
- improvement of the collection and treatment of waste electrical and electronic equipment;
- review of EU rules on restrictions of hazardous substances in electrical and electronic equipment. (European Commission, 2020.c)

The aim of the Ecodesign Directive is to ensure that mobile phones and tablets are designed to be energy efficient and durable; that consumers can easily repair, upgrade and maintain them; and it is possible to reuse and recycle the devices. According to the European Parliament Legislative roadmap, the regulation is expected in the second quarter of 2022. (European Parliament, 2021.a)

The Sustainable Product Policy has been pushed to be put in place before January 2022 and will entail widening the scope of the Ecodesign Directive beyond energy-related products, and propose additional legislative measures. It will also address the presence of harmful chemicals in products, such as electronics & ICT equipment; textiles; furniture; steel, cement and chemicals.

According to the European Commission Work Programme 2022, the Commission intends to present a “European chips act” in the second quarter of 2022 and an “Initiative on the right to repair” in the third quarter of 2022. (European Commission, 2021.a)

They also intend to revise the EU restriction of the use of hazardous substances in electronics in the fourth quarter of 2022 which they state will take into account the move towards a process of ‘one substance – one assessment’ and providing for greater transparency when prioritising action to deal with chemicals, as well as by encouraging innovation for the development of safe and sustainable alternatives, as highlighted in the European Green Deal.” (European Commission, 2021.a)

In its resolution from 10 February 2021 on the New Circular Economy Action Plan, the European Parliament stressed the importance of providing market incentives for the most sustainable companies and sustainable products and materials, in parallel to legal minimum standards for product design. (European Parliament, 2021.b)

In November 2021, the Commission proposed a revision to the Regulation on Waste Shipments (WSR) in response to the call under the European Green Deal and the Circular Economy Action Plan to revise the WSR with the aim of:

- facilitating shipments of waste for reuse and recycling in the EU;
- ensuring that the EU does not export its waste challenges to third countries; and
- tackling illegal waste shipments. (European Commission, 2021.b.pp2)

“The new Regulation should result in an increase in waste materials reused and recycled in the EU, an improvement in standards and practices for waste management in countries importing waste from the EU and a reduction of illegal waste shipments both within the EU and between third countries and the EU. It should also contribute to building robust and dynamic markets for secondary materials and increasing the transition to a circular economy in the EU and third countries.” (European Commission, 2021.b.pp16)

A statement from The European Suppliers of Waste-to-Energy Technology (ESWET) saying they welcome the Commission’s proposal to revise the WSR to reduce waste exports and treat municipal waste in Europe under EU standards, but calls for clearer rules for intra-EU

shipments. They comment; “While a proximity principle should apply for treatment of waste, ‘unnecessary obstacles’ to intra-EU shipments of municipal solid waste could ‘disrupt national waste management chains and its mission to prevent waste-related pollution’”. (Circular., 2021)

In its resolution on 10 February 2021 on the New Circular Economy Action Plan, the European Parliament called for the integration of issues linked to early obsolescence including product obsolescence caused by software changes; and for the harmonisation and improvement of recycling infrastructure for waste electrical and electronic equipment in the EU. It asked for a mandatory certification scheme for recyclers of electronics waste to guarantee efficient material recovery and environmental protection. (European Parliament, 2021.a)

Although the UK is no longer a member of the EU, EU legislation on e-waste and sustainable electronics remains foundational for e-waste management in the UK and the devolved administrations.

In the United Kingdom the pieces of legislation that cover e-waste include the Waste Batteries and Accumulators Regulations (The UK Government, 2009) and the WEEE Regulations (The UK Government, 2013).

Other notable work in the UK includes the Digital Buying Guide created by the UK Government Digital Service (GDS) which provides practical advice at each stage of technology procurement (The UK Government).

Legislation and policy in the Scottish Government related to e-waste management includes:

- The Waste (Scotland) Regulations 2012 covers e-waste management.
- The Green ICT Strategy (The Scottish Government, 2015) manages risks and ensures compliance with UK and EU requirements on sustainable buying of IT equipment within the Scottish Government.
- Zero Waste Scotland delivers waste-reducing initiatives on behalf of the Scottish Government. They developed The Scottish Material Flow Accounts (MFA) detailing the size of Scotland’s material footprint for the first time. The MFA Interactive Tool (Zero Waste Scotland) includes extraction, import and export data on metal ores and non-metallic minerals for the EU 28 member states, the UK and Scotland.
- Scottish local authorities can voluntarily sign up their civic amenity sites as ‘designated collection facilities’ (DCFs). If they do, they must comply with the Code of Practice for DCFs, which requires minimum levels of separate storage of WEEE at the sites. (SEPA) For example, the following items are collected at recycling centres in Edinburgh City Council Recycling sites; lithium ion batteries; metal; small electrical equipment: irons, hairdryers, IT or telephone equipment, tools and game consoles; TV and monitors. (The City of Edinburgh Council)

Recovery of Precious Metals from E-waste

Large refineries have been practicing precious metal recovery from e-waste for many years. (See for example the recycling practices of refineries Boliden & Umicore, both of which have been involved in this industry for years. Recovery and recycling of precious metals from e-waste is more well established and more likely to be practiced at an industrial scale, compared to other elements and compounds found in e-waste, due to their generally higher economic value when balanced with their recovery cost. Recycling of other technology metals is less established as they are more likely to appear in several components of a product and require

large volumes of the products to be recycled together to be economically efficient (Mathieux, Ardente et al. 2017).

Research on Recycling Elements and Compounds from E-waste

The authors of the study *Characterization of Printed Circuit Boards for Metal and Energy Recovery after Milling and Mechanical Separation* (Bizzo et al., 2014) compared metal-recovery and pretreatment processes used for recycling PCBs based on their main environmental impacts and related issues. They found that "mechanical separation", which involved milling and separating particles according to their size , to have the most technological and environmental advantages. The authors state that while such processes are "unlikely to allow metals to be recovered with the purity needed for immediate recycling, they can help increase the concentration of metals, facilitating final recovery operations" (pp4557).

In their sample study of refinery processes, the CEWASTE Consortium (2021) identified a sample of refiners that had employed recovery processes and technologies for certain materials used in electronic and electrical equipment, these are:

- Precious metals from printed circuit boards (well established and and commercially practiced);
- Cobalt from lithium-ion batteries and nickel-metal-hydride batteries (had been practised on industrial scale);
- Antimony from lead-acid batteries;
- Rare earth elements from fluorescent powders in fluorescent lamps (practiced until 2016 when it slowed due to decreasing prices of REEs, but could theoretically be practicable on an industrial scale).

The CEWASTE Consortium (2021) argues that recycling technologies at an industrial scale can be implemented for other critical materials as well. However, not unless the necessary financing and sufficient volume of feedstock is made available.

Conclusion

The sustainability issues that exist in electronic and electrical equipment used in the creative industries are largely enmeshed in the wider and non-practice-specific issues of responsible electronic metal supply chains; overconsumption of electronics; design issues that affect the longevity, reuse, repair, and recyclability of products; and the global problem of increasing electronic waste.

Work is ongoing across industry actors to address these issues. Manufacturers of electronic and electrical equipment can increase product sustainability through responsible raw material sourcing, designing and creating products that have extended life cycles, durability, repairability and recyclability integral to their design for instance through modular design (See for example the Fairphone Case Study). Policy makers can increase the sustainability of electronic and electrical equipment by incentivising both consumers, and manufactures and waste managers to reuse, repair, and recycle electronic and electrical equipment and by incentivising effective e-waste management with a minimal carbon footprint and maximum volume of reusable materials recovered. Consumers and indeed creative practitioners can increase the sustainability of electronic and electrical equipment by choosing to purchase from brands that have made efforts toward sustainability in the areas discussed in this report and by knowledge sharing. Funders of the creative industries can address sustainability issues in electronics and electrical equipment through the above mentioned ways.

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Chapter 11: Carbon Footprint Calculation Tools

Rebecca Lardeur and Peter Oakley

Explanation of the scope of the section

The Race to Net-Zero has forced many companies and institutions to calculate their carbon emissions in order to reduce them based on science-based targets and in a majority of cases, offset their carbon footprint (Race to Zero & Race to Resilience, 2020). The UK government has committed to net-zero by 2050, and the Mayor of London has committed to the more ambitious target of reaching net-zero by 2030.

'Embodied' carbon is the term most often used to describe carbon emissions regarding materials. This covers emissions from the extraction of materials, processing, manufacturing of materials to the manufacturing of products and selling. This is referred to as 'cradle-to-gate' and calculation post-use (what would be called either cradle-to-grave or cradle-to-cradle) is currently a very problematic estimation for most producers (Braungart and McDonough, 2009).

Terms defined -

Carbon footprint calculation tools, also known as carbon tools, are platforms where users can insert data (such as type of materials and weight) to report on their carbon footprint. This is helpful to understand the hot spots of emissions and target actions with potent impact.

Carbon accounting: when states, corporations or individuals report their impact, the process by which any examined carbon emissions is determined and reported is most often referred to as carbon accounting. The calculations might be undertaken by measuring but usually, it involves modelling. The quality of the results varies on the methods used and the accuracy of the data. Carbon accounting is also used in the context of carbon offsets.

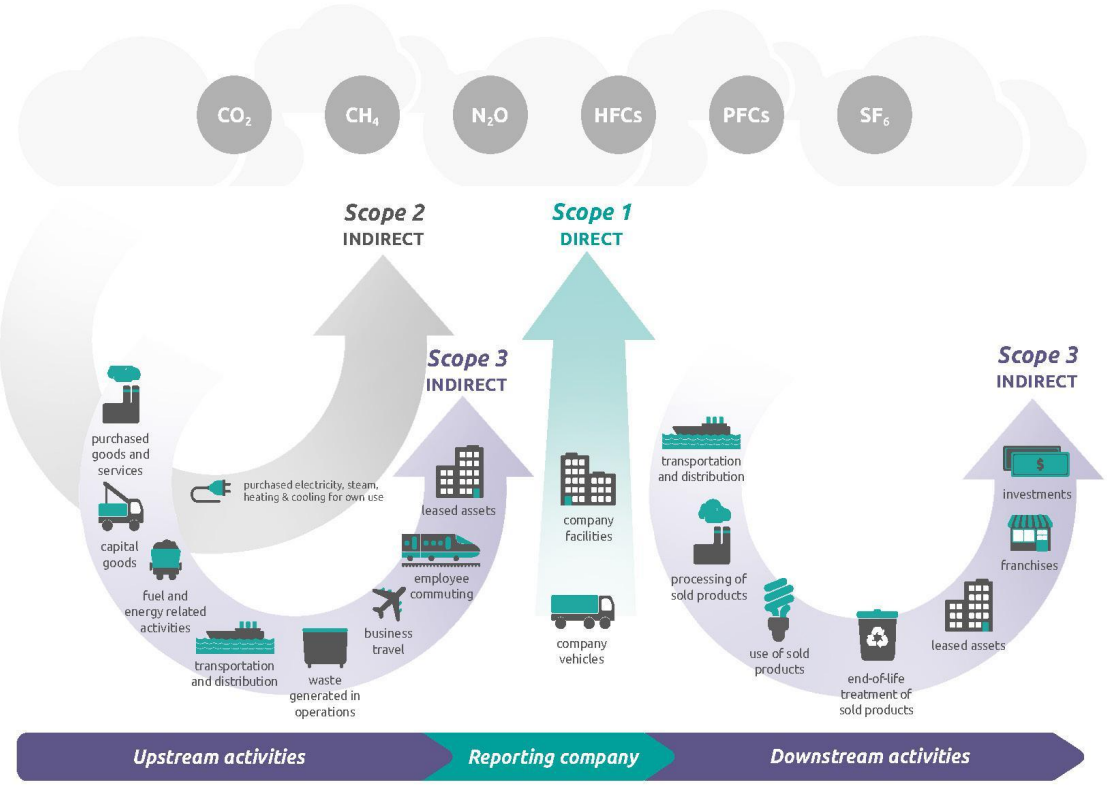
Company reporting: most of these tools are used for company reporting, which finds an anchor in the GHG Protocol (World Resource Institute and World Business Council for Sustainable Development, 2004) which establishes a common ground between nations and companies to classify different types of carbon emissions. See the glossary for more details.

Reporting scopes: the GHG protocol identifies three scopes (The Carbon Trust, 2021):

> Scope 1: direct emissions from owned or controlled sources
> Scope 2: indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company
> Scope 3: other indirect emissions that occur in a company's value chain

According to the GHG Protocol, scope 1 and 2 are mandatory to report (Bernoville, 2020), although scope 3 emissions, for many businesses, accounts for more than 70% of their total emissions (Deloitte, 2021). In 2016, the GHG protocol had estimated that 92% of Fortune 500 companies had used directly or indirectly the GHG protocol (Greenhouse Gas Protocol, 2021). Although scope 1 and 2 are mandatory to declare for these companies, all carbon tools are self-reporting.

Figure [1.1] Overview of GHG Protocol scopes and emissions across the value chain



Materials, for many businesses, fall under scope 3 as voluntary reporting. The issue here is of responsibility and if a company is 100% in control. If a creative practitioner outsources the making of their creations to another company, they wouldn't be liable for these emissions unless they do so voluntary.

Introduction of the sustainability issues relevant to the area defined.

When calculating carbon emissions of materials, energy and transport become hot spots and affects the decision-making around materials. Weight of materials, for example, will affect transport emissions and so a light material might be preferable for some, making plastics a good option. Not all aspects of sustainability are easily quantifiable, such as care of materials, quality of recycling, renewable or finite sources, effects on biodiversity, limiting the understanding of sustainability by omitting context in the numbers.

It is important to note that whilst carbon tools are useful to give a general understanding of the carbon footprint of materials, the numbers cannot be considered precise. There will be a consequent margin of errors due to datasets relying on averages that do not take into account variations between different producers and production methods. Steel from China and Germany will have different footprints, but this precision is hard to find within the free-to-use tools (2030 Calculator, 2021). Hence carbon footprint calculation tools should be kept for a general understanding of hot spots.

Carbon footprint calculation tools also struggle to encompass the full life cycle of materials. As most material calculations focus on 'cradle-to-gate', the end of life of materials and circular economy benefits are not counted within emissions. The carbon footprint calculations surrounding re-use, re-purposing, or recycling are still too loose to fully comprehend the impact and if some companies do calculate Scope 3, they might focus only on cradle-to-gate

and not take into consideration the afterlife of materials, which might happen a few years down the line – when carbon reporting happens yearly.

Barriers/obstacles:

1. **Data quality and origins**
    a. The need for precise and transparent datasets
    b. The lack of traceability in the supply chain
    c. Bias and personal gain in the tools
    d. Scoping everything
2. **Lack of clear language definitions**
    a. Over-reliance on generic terms
    b. An overly simplified expert knowledge: different production methods
    c. An overly simplified expert knowledge: ignoring the virtuous consequences of multiple recycling loops
3. **Lack of material focus in most current carbon footprint calculation tools**
    a. Primary focus on energy and travel
    b. A big gap between carbon footprint calculation tools and LCAs
4. **Ethical issues**
    a. Balancing carbon production with other pollutions
    b. Self-reporting and easily manipulated results
    c. Offsetting add-ons ethical dilemma

1. Data quality and origins

Because of a lack of clear, precise, and transparent datasets, carbon footprint calculation tools are currently limited to improving decision making and identifying hot spots of carbon emissions. When it comes to becoming thorough and precise, one needs to move away from the tools and outreach to a specialist.

A. The need for precise and transparent datasets

It is not always easy to determine where the datasets used for calculators originate from, or if they are reliable in terms of addressing all the aspects of carbon generation relating to a material's extraction, processing, use and disposal.

There are many inconsistencies between different carbon tools results. For example, hotel nights have an impact of 14kg CO2e for a 4-star hotel/night in London according to a UK-government backed calculator (Greenview, 2021); but Staze (Staze, 2021), a business that promotes itself as the leading carbon reduction company for hotel bookings, states the CO2e impact for a 4-star hotel/night in London is only an average of 5.4kg CO2e. However, users are not able to access the underlying data that is used to make these calculations. This data is kept secret with the company claiming this approach is needed to maintain a commercial advantage. Therefore it is not possible for a site user to contest the company's results. It is evident that such an approach could be open to abuse.

As another example, the UK government's BEIS carbon conversion factors 2021 (GOV.UK, 2021) have used the same CO2e impact recycling figure for metal, wood and plastic, an approach that implies there is no difference between the carbon cost of these materials.

B. The lack of traceability in the supply chain

In practice, it can be hard for users of carbon footprint calculation tools to get the information required for correct calculations. The materials might pass through a chain of different suppliers before reaching the manufacturer. Each supplier's profit margins are usually hidden in the overall material price, making them reluctant to pass on details of their suppliers and the price they paid. Consequently, it is difficult for purchasers to track back through supply chains and find out where their plastic has come from. Some companies will use commercial sensitivity as a reason not to share these details.

There can be a significant difference between where a product has been bought and where it was manufactured and the materials used in its production extracted. Currently, this information is not a requirement for suppliers to provide in the context of carbon footprint calculation tools.

C. Bias and personal gain in the tools

Tools are becoming more specialised, with certain sectors building their own. The film and production industry use Albert (Albert, 2021), festival and museums are likely to use Julie's Bicycle Creative Green tool (Julie's Bicycle, 2021), product designers will verge towards the 2030 Calculator (2030 Calculator, 2021), marketers and advertisers are recommended to use AdGreen (AdGreen, 2021), and the list continues.

Each of these tools being built by the industry for an industry often lacks a holistic understanding of carbon calculations and have their own interests. Julie's Bicycle's tool does not calculate materials but unlike others showcase audience travel. 2030 Calculator does not mention building energy and team travel and is only to be used for a specific product.

As the scope and understanding of what needs to be reported and accounted for leads to many different approaches, the results of the tools are too often omitting part of the picture and playing in the interests of the tool creator.

D. Scoping everything

As a rule of thumb, if money was spent there is a carbon footprint. There are carbon emissions in travel, procurement, development, shipments, energy, etc. Some data are not available easily (i.e.: a pack of crisp bought at Tesco) and some others are not a requirement for reporting.

When using the carbon footprint calculation tool for decision making, it might also be complicated to fully comprehend the full picture. For example, the storage criteria of certain materials. Wood would require storing in a building with heat, while plastics will stay intact in an outdoor shed in the winter months. These added activities are also not present in the tools, bringing the numbers of variables in a real-life scenario hard to comprehend.

2. Lack of clear language definitions

The fine line between expert and amateur knowledge leads to overseeing many details. Categorising wood as an entity material will disregard many details (European, Chinese, Brazilian forests management, slow-growth or fast-growth trees) and an amateur will not be aware of the delicacies in picking different types of a material family.

As most carbon calculation equations are hidden with the user entering basic numbers such as weight, the ability to understand the process is only left to a selected few. Amateurs will trust the tool as the expert with no critical capacity. Talking about complicated and abstract systems are prone to abuse, such as the Volkswagen scandal (Campbell and Pickard, 2018).

A. Over-reliance on Generic Terms

The use of generic terms such as metal, wood, paper, flattens the data, sometimes significantly skewing the results. In reality, each type of material has variations.

For example, different metals have different figures. Although the quality of metals after recycling tends to stay of high quality; the recycling processes are highly different. Aluminium

takes up to 8 times more energy than steel to be recycled, hence the next focus would be to understand the energy source of different recycling centres (Posco Newsroom, 2017).

Wood species would also vary greatly on their impact. The strongest difference in carbon footprint is felt through slow-growth or fast-growth trees, where pine and oak are not born equal (Aspen & Ash, 2016).

B. An overly simplified expert knowledge: different production methods

Production of a material can be undertaken in different ways, which may vary in terms of the amount of carbon being generated. The country of origin for raw material extraction will have different legal systems, energy sources and impact on the direct environment. Using hydroelectric or wind power for a manufacturing building will generate less carbon than using coal or gas energy. The assembling of materials impact, such as textiles, might vary greatly when it comes to finishes, with different consequences on the environment.

Cotton, for example, would have a very different footprint if the fabric was treated for anti-wrinkle, water resistance, fire retardance, colour treatment, etc. This information is not present on the tag of the end product nor on most carbon footprint calculation tools.

C. An overly simplified expert knowledge: ignoring the virtuous consequences of multiple recycling loops

Some materials can be recycled multiple times, others can be recycled indefinitely. As aluminium can be recycled indefinitely, aluminium in cans that has been recycled multiple times has a lower average carbon cost than aluminium that has been recycled only once. Therefore, in any bale of recycled aluminium cans, each can will actually have a different carbon cost.

The number of recycling loops that occur in practice - and hence the carbon footprint of the material - may be more dependent on local factors, such as the behaviour of consumers or collection and sorting facilities, than the nature of the material itself. PET plastic bottles have a lower carbon cost in Norway than anywhere else because the Norwegian recycling programme for PET bottles is so encompassing, with a 97% recovery rate, and there is a direct loop from recovery to new PET bottle manufacturing (Infinitum, 2021). As PET plastic from bottles is being used in Norway to make new bottles, their lowered carbon cost is cumulative in a way it would not be if the recovered PET was used for other products that were then not recycled.

3. Lack of material focus in most tools

Relating to an earlier point on scope 1, 2, and 3; it needs to be noted materials do not fit into the mandatory carbon reporting for most states, corporations and individuals. This means the majority of tools companies will use will give the responsibility of material usage to another company (the assigned fabricators), hence limiting the quality of easily accessible carbon footprint calculation tools.

A. The big focus on energy and travel

Most carbon calculation tools focus primarily on energy and travel, which are well researched and developed carbon calculations. Energy usage of material production englobes most of the emissions of a product, disregarding the true meaning of sustainability of materials such as finite or renewable sources, pollution, and recycling capacities among others.

B. A big gap between carbon calculators and LCAs

The database numbers found in carbon footprint calculation tools are often averages from sources originating in official research and university bodies. These numbers have been simplified for a lambda user. To receive a precise carbon account of a product, a life cycle analysis by an accredited practitioner is recommended.

This leaves a big gap in the market, where the lambda user understands principles superficially with little understanding of processes and finishes treatment which will vary the impact greatly.

4. Ethical issues

Carbon reports are for now a good indication of the impact but should not be relied upon to understand a full picture, as there are still questions on environmental impact measurement, transparency and authenticity at play.

A. Balancing Carbon Production with Other types of pollution

Carbon footprint calculation tools do not necessarily take any account of the wider pollution a particular material, production process or product causes. Focusing exclusively on Net Zero might have perverse consequences in ignoring or encouraging the production of other pollutants. The creation of more holistic calculation tools is, therefore, a necessity.

Lithium mining, that are currently leading the way for electric batteries, use a lot of water—approximately 500,000 gallons per metric ton of lithium, in a region with already limited access to water (Institute of Energy Research, 2020). Dead fish have also been found due to contamination from mines. This is not calculated when estimating CO2e footprint of lithium batteries, with instead a focus on

> "the total energy used for each activity in the value chain over a specific period of time (MJ/kWh), the source of energy for each activity during the specific period of time (CO2e/MJ), and the actual throughput during the specific period of time (units or kg or kWh/MJ)" (Melin, 2019).

B. Self-reporting and easily manipulated results

Carbon emissions are self-reported by companies and individuals. Each report might have been omitting details or overviewed part of their supply chain, intentionally or not. Recently, the fashion sector was identified as having boasted about their emissions reduction all the while dismissing their scope 3 (Bauck, 2021). H&M estimates 99.5% of their environmental impact lies in Scope 3. The Financial Times interviewed Linda Greer, a senior global fellow at the Institute of Public and Environmental Affairs, who commented "ignoring Scope 3 when assessing total climate impact constitutes, in Greer's opinion, "professional malpractice"."

As Scope 3 is also underregulated, it is easy to measure bits and not all. The more carbon calculations will be achieved, the most refined they will become.

C. Offsetting add-ons ethical dilemma

Many tools and services now offer carbon offsetting as part of their services. This is likely to invite the further practice of business as usual when it is urgent to reduce emissions as soon as possible. Many scientists are pushing for a reduction in every sector as soon as possible, such as Sir Brian Hopkins who founded the Grantham Institute. Hopkins recommends avoiding offsetting as compensation for emissions, and instead focusing all energy and capacities on the reduction of emissions.

Best practice in respect to constructing Carbon Footprint Calculation Tools

Ideally, the data used in carbon footprint calculation tools should be open-access and easily verifiable as well as completely encompassing the situation, including recognition of incidental harms. There should be confirmed agreement over what the terms used mean. This would allow for better comparison between tools as well as assist understanding of the results from each tool. Carbon capture tools are often linked to the government or institutional policies and funding. In such cases, it is even more relevant that the tools do not generate perverse incentives.

Glossary

Carbon Footprint Calculation Tools:
A digital tool to measure the total greenhouse gas emissions (carbon dioxide, methane, nitrous oxide, …) caused directly and indirectly by a person, organisation, event or product. Users are invited to enter specific data that the software will use to then calculate the total emissions.

Race to net-zero:
Race To Zero is a global campaign led by the UN to lower carbon emissions in all sectors. It aims to rally leadership and support from the business, policy, and finance sectors among others.

Carbon emissions:
Carbon emission is the release of carbon into the atmosphere. This also includes greenhouse gas emissions; the main contributors to climate change. Since greenhouse gas emissions are often calculated as carbon dioxide equivalents, they are often referred to as "carbon emissions" when discussing global warming or the greenhouse effect.

Carbon accounting:
Carbon accounting, also known as greenhouse gas accounting, refers to processes used to quantify the amount of carbon dioxide equivalents an organization emits. It is used by states, corporations, and individuals to create the carbon credit commodity traded on carbon markets.

Cradle-to-gate:
An analysis of the environmental impact of a product measuring the impact of materials from extraction to exiting the factory gate. This covers the extraction of raw materials, manufacture of the material, and manufacture of objects. It is similar to life cycle assessment (LCA), but LCA is most often used in the UK, compared to Cradle-to-Cradle being most popular in the US.

Cradle-to-cradle:
An analysis of the environmental impact of a product measuring the impact of materials from extraction to recycling facilities. This covers the extraction of raw materials, manufacture of the material, manufacture of objects, the use stage to the re-manufacture of the material. It is similar to life cycle assessment (LCA), but LCA is most often used in the UK, compared to Cradle-to-Cradle being most popular in the US.

Cradle-to-grave:
An analysis of the environmental impact of a product measuring the impact of materials from extraction to landfill. This covers the extraction of raw materials, manufacture of the material, manufacture of objects, the use stage to the end of life. It is similar to life cycle assessment (LCA), but LCA is most often used in the UK, compared to Cradle-to-Cradle being most popular in the US.

GHG Protocol:
The GHG Protocol was established by World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) in the late 1990s. Its goal is to establish a comprehensive global standardised framework to measure and manage greenhouse gas (GHG) emissions from the private and public sectors.

The GHG protocol divides carbon emissions into three scopes:

Scope 1: direct emissions from owned or controlled sources (mandatory)
Scope 2: indirect emissions from the generation of purchased electricity, steam, heating and cooling consumed by the reporting company (mandatory)
Scope 3: other indirect emissions that occur in a company's value chain (voluntary)

Life cycle analysis (LCA) or Life cycle assessment:
Life cycle analysis (LCA) is a method used to measure the environmental impact of a product through its life cycle comprising extraction and processing of the raw materials, manufacturing, distribution, use, recycling, and final disposal. It is similar to Cradle-to-Cradle, but LCA is most often used in the UK, compared to Cradle-to-Cradle being most popular in the US.

BEIS (Department for Business, Energy & Industrial Strategy) emissions conversion factors:
Conversion factors enabling organizations and individuals to calculate greenhouse gas (GHG) emissions from a variety of activities, including energy use, water consumption, waste disposal, recycling and transport activities. BEIS started sharing the factors in 2002.

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Case Study 1: ASGM Certification Programmes

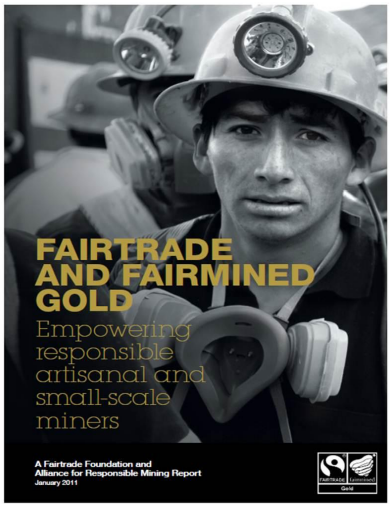
Peter Oakley

The past decade has seen the appearance of ethical gold certification programmes, intended to assist artisanal and small-scale gold mining (ASGM) communities in the developing world.

As with most other classical commodities, at the beginning of the twenty-first century the global gold trading market was operating according to free trade principles. The leading gold exchange platform is the London Bullion Market Association (LBMA), with the twice daily spot price determined by the LBMA's direct market participants through rounds of competitive bidding (LBMA 2021). Though the centre for physical gold trading is based in London, since the 1970s the leading country for gold refining has been Switzerland (Green 1985; O'Callaghan 1993). The scale of the LBMA's daily trades, amounting to hundreds of tonnes of gold, means the LBMA spot price determines the price of all other commercial and private gold sales made on that day. This includes goldfield trades across the developing world, though the prices paid are often heavily biased in the buyers' favour.

The notion of ethical gold is linked to a wider desire of social justice for the developing world's population (Bloomfield 2017). In an ethical gold programme, the ASGM miners are paid a guaranteed price for their output, closely linked to the LBMA's spot price, making them independent of exploitative local gold buyers. In addition, the schemes involve a premium on purchases that is to be re-invested in the mining community. In return, the miners promise to adhere to legal, safe and socially and environmentally responsible mining practices as well as jointly determining how the premium would be spent (Maldar 2011; Oakley 2015a). Such certification schemes therefore incentivise the miners to operate in a sustainable manner.

The Fairtrade and Fairmined Gold (FT/FM Gold) certification programme was the outcome of a partnership agreement between the Fairtrade movement, advocated for by the Fairtrade Foundation (the UK & Ireland's Fairtrade promotional body) and the Alliance for Responsible Mining (ARM), a grassroots miners' organisation begun in Latin America in 2004 (ARM, 2021). FT/FM Gold was launched in the UK in February 2011. The first 20 jeweller licensees included Stephen Webster, creative director of his eponymous company and Garrards, the Bond Street jeweller (Webster 2015). The other licensees were sole traders or SMEs (Taylor 2011). Though the FT/FM Gold scheme lasted just over two years, its two successor programmes - Fairtrade Gold and Fairmined Gold - have persisted and expanded.



Fairtrade and Fairmined Gold - promotional literature (2011-2013)

Fairtrade Gold, run by the Fairtrade organisation, has remained the dominant ethical gold sourcing programme in the UK. It is supported by a core group of committed and experienced licensee jewellers and facilitated by an established infrastructure of intermediate companies. To broaden its range of gold suppliers, in 2012 Fairtrade started to search for new licensee producers in East Africa. In 2012 it secured a grant from Comic Relief to support miner certification initiatives in Kenya, Tanzania, and Uganda (Butler 2017). The first shipment of African Fairtrade Gold arrived in the UK in 2018 (Catchpole 2018). CRED was the largest UK Fairtrade gold importer over this period, shipping between 10 and 20kg per year. In 2017 this rose to 28kg (Frampton 2017). But in late 2019 CRED went into administration. CRED's new CEO blamed the company's collapse on poor trading conditions and increasing difficulties purchasing sufficient Fairtrade gold (Faulkner 2019).

Fairmined gold, managed by the ARM, retained a small customer base amongst jewellers in the UK. But its most substantial successes came from new partnerships, including the Swiss jeweller and watchmaker Chopard. In 2014 Chopard launched the L.U.C. Tourbillon Qualité Fleurier Fairmined watch, produced in a limited edition of 25 timepieces and retailing at $144,570. Uniquely at that time, the watch's rose gold case was made of Fairmined gold. This was heavily promoted in the promotional literature and a feature picked up by the industry media. Chopard had taken an enormous risk in producing a watch that sat squarely in the crowded and highly competitive luxury watch category yet relied heavily on the ethical provenance of its gold to gain market share. Since the revival of the Swiss luxury watch sector in the 1990s, such watches have been promoted on the basis of their manufacturer's heritage and the strength of the manufacturing technology, (Donzé 2015; Glasmeier 2000). The success of the L.U.C. Toubillion Fairmined encouraged Chopard to release further models made from Fairmined gold over the following five years. In 2019 Chopard announced all its future watch and jewellery production would be using ethically sourced gold, consolidating their confirmed market position as an ethical and responsible luxury brand (see Liu 2015).

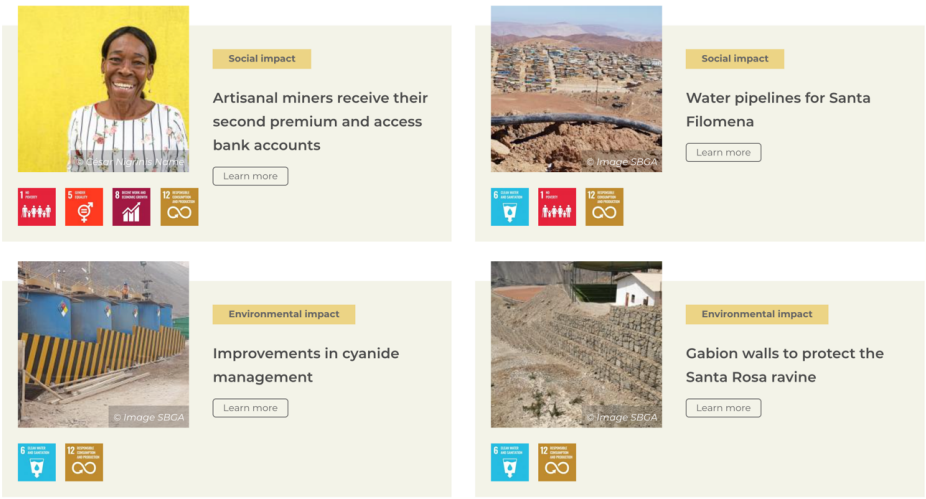
Chopard L.U.C. Tourbillon Qualité Fleurier Fairmined - promotional literature (2014)

ARM's Swiss connections also developed along other fronts. In 2013 a small but influential group of companies: the gold refiners Argor-Heraeus, Metalor and PAMP, the banker Impact Finance, the watchmaker A. Favre & Fils and jeweller Cartier, came together to form the Swiss Better Gold Association (Swiss Better Gold Association 2021a). The SBGA partnered with the

Swiss State Secretariat for Economic Affairs (SECO) to create the Better Gold Initiative (BGI). From 2013-2016 the BGI ran a series of pilot implementation activities in Peruvian mines linked to ARM, resulting in the export of 1,500kg of certified Fairmined gold to Switzerland. The second phase (2017-2020) involved a more ambitious programme, encompassing Columbia and Bolivia as well as Peru. The initiative's remit was also extended to cover international dialogue on the formalisation of the ASGM sector (Swiss Confederation 2019).

Over the first five years the SBGA took on a few new members (Chopard joined in 2017), but the number of companies associating significantly accelerated over 2019-2020. By 2021 SBGA's membership included all four of the largest Swiss gold refiners, with a combined production capacity of 2,900 tonnes (Ruysschaet 2015), as well as a strong showing of Swiss watch manufacturers and leading swiss jewellers. 2021 saw the launch of the third phase, re-branded as the Swiss Better Gold Initiative (SBGI). SECO has contributed CHF4,600,000 (almost seven million dollars) alongside an assumed industry contribution of CHF 11,200,000 (just over twelve million dollars) (Swiss Confederation 2021). The SBGI aims to extend ASGM certification into new jurisdictions, improve framework conditions for responsible ASGM, develop collaboration and cooperation with international partners, and strengthen institutionalized multi-stakeholder dialogue (Swiss Better Gold Association 2021b).

The SBGI does not operate its own ASGM certification scheme, instead relying on the existing Fairtrade Gold and Fairmined Gold programmes, as well as utilising the Responsible Jewellery Council's member certification scheme for medium and large gold mining operations (Better Gold Initiative 2021). The SBGI's significance in the ethical gold sphere not only lies in offering ASGM communities direct access to the Swiss gold trading market at an advantageous price, but also in its ability underwrite the entirety of any certified ASGM community's production, including the Fairtrade or Fairmined premium. As the SBGI also provides funding for environmental and social investment projects (financed by a 1% supplement on the gold purchases collected and managed by the BGI), the ASGM community benefits directly through the guaranteed purchases and premiums and indirectly through associated international aid projects.



Recent projects at the SOTRAMI mine supported by the SBGI

Recently, ARM have also been active in trying to extend the reach of responsible mining further by tackling the biggest barrier: the hurdle of miners' certification. This is being attempted through development of the Code of Risk mitigation for Artisanal and small-scale miners engaging in Formal Trade (CRAFT) programme. Launched in 2018 and revised in 2020, CRAFT is an open-source tool for ASM miners who want to make their practice more responsible, with the intention of preparing them to apply for certification (ARM/Resolve 2021).

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Case Study 2: Bolex D16

Itandehui Jansen

Digital Bolex was a partnership between different camera manufacturers to develop a digital cinema camera version inspired by the Bolex H16. The development and manufacturing were initially funded through a kickstarter campaign. The first camera's were sold in December 2013. The camera contains a Kodak designed Super 16mm size CCD sensor , and shoots 2K RAW footage. Bolex D16 intended to position itself as an affordable digital cinema camera. The camera has a C-mount and in combination with the Super 16mm size sensor, this allows for the use of vintage 16mm lenses.

Former CEO Joseph Rubinstein explained in a personal interview that the camera was designed with the leading principle that the camera needed to remain relevant and not become obsolete in a short period of time. The design therefore focused on certain essential aspects that would withstand time. One of these leading aspects was the camera's ability to record RAW images instead of on a compressed format. Another element was the choice for a sensor that would provide very good quality colour and good movement cadence as this would maintain its appeal over time. Rubinstein considers that higher resolution not necessarily leads to better image. The guiding principle for the design of the camera was therefore never guided by the need for constantly increasing image resolution. Similarly a choice was made for a variety of often used lens mounts, such as a PL-mount for different professional cine lenses and a C-mount for vintage 16mm lenses. This was primarily guided because Rubinstein himself was a great aficionado of shooting on 16mm analogue film, with 16mm lenses such as the Kern Paillards, Schneider and Kreuznach lenses.

The camera design was completely based on existing "off-the shelf" components, that is previously existing components used for other electronic equipment. This was primarily done for economic reasons, but it also meant that there was an opportunity to allow for the re-use and recycling of different electronic components. Although the Design of the Bolex D16 was not primarily guided by environmental concerns, it engaged with different sustainable practices, such as planning for a long life cycle of

the camera, in contrast to the programmed or perceived obsolescence that is often part of electronic equipment. Additionally designing the camera with only off-the shelf, previously existing electronic components allowed for sourcing of such components for re-use. The design also offered a new use for vintage 16mm lenses that would otherwise probably have fallen in disuse. To encourage the use of vintage lenses Digital Bolex had a list on its page of which older 16mm lenses would definitely cover the sensor of the Bolex D16.

Due to the absence of new investors, the camera is no longer manufactured or available for sale through retail stores. However it has a base of committed users, and it is still being sold second-hand on eBay and similar platforms. Former CEO Joseph Rubinstein continues to provide users with advice through a dedicated FB page and FB group Digital Bolex User. He also repairs camera's that may have a faulty battery or need a new hard drive. For this purpose he is collecting camera's that do no longer work to use parts to repair others. Rubinstein mentions that he knows of only 4 camera's that were beyond repair. As the Bolex D16 has increased in value since its launch on the market, he assumes all other camera's are still in use. Examples of feature drama films shot on the Bolex D16:
La Defensa del dragon (2017) Directed by Natalia Santa, Cinematography by Iván Herrera and Nicolas Ordoñez.

Nasir (2020) Directed by Arun Karthick, Cinematography by Saumyananda Sahi.

Case Study 3: Fairphone

Emily MacDonald and Peter Oakley

Industry Disruptor

Fairphone was founded in 2013 as a social enterprise company aiming to develop smartphones that are designed and produced with a lower environmental impact. Fairphone disrupted the market by producing a phone with sustainability and fairness as its bottom line. Fairphone's first phone was the Fairphone 3, followed by the 3+ and in September 2021, the Fairphone 4 was released. Demonstrating how design for disassembly, repair and recycling can be implemented into a product successfully without sacrificing aesthetics or functionality.

Fairphone Demonstrator of Design for Disassembly

Fairphone uses modular design techniques which allows for simple disassembly by the consumer and for repair or replacement of single components without sacrificing the entire phone. Designing for disassembly and repair is designing products that last. The ability to repair or replace single components lengthens the life cycle of the phone and reduces e-waste. The Fairphone 4 also comes with a five-year warranty - beyond the standard 2 years that the EU requires - thus keeping products in use for longer. The Fairphone has an iFixit score of 10/10 and a French Repairability score of 9.3/10.

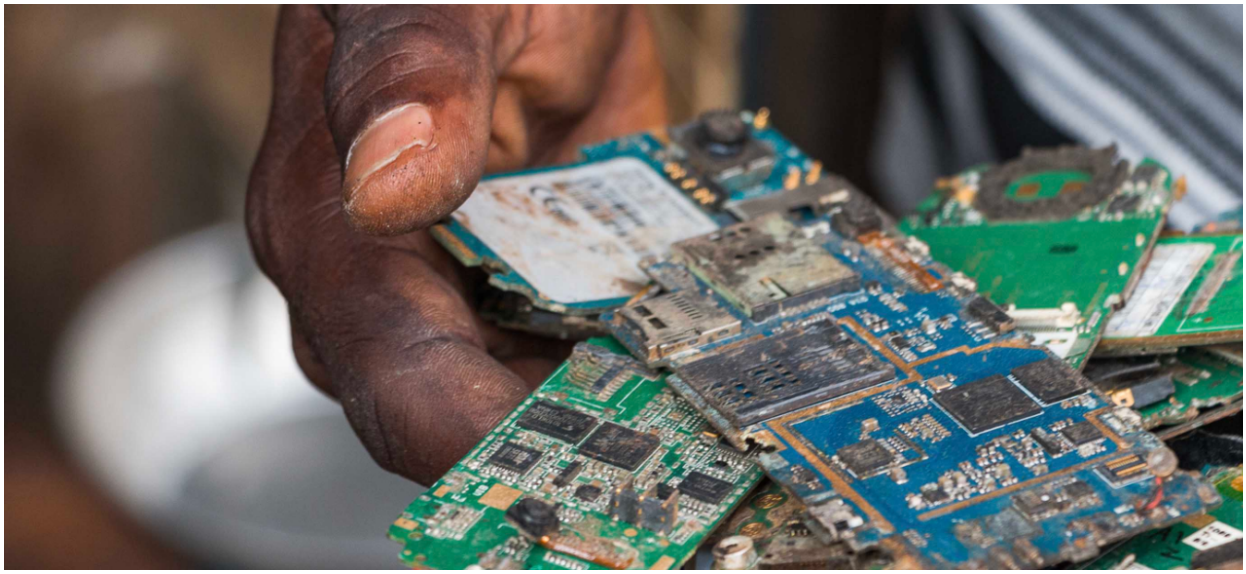
"*This device is a challenge to the industry to rethink the modern smartphone: True innovation should be about solving problems, rather than creating new ones.*" - Taylor Dixon, iFixit.

Fairphone Raw Material Supply Chains

Fairphone exemplifies what transparent and sustainable procurement can look like even for a product that inherently has complex supply chains. Fairphone are transparent about their raw material supply chains, including the materials they use, where they come from and the efforts they are making to improve the sustainability of each material chain. Fairphone uses Fairtrade Gold in their phones (an industry first), 100% recycled plastic in the case, and responsibly sourced technology metals working with other industry bodies.

Reducing E-waste

When you buy a Fairphone it comes without a charger, cable or headphones. This encourages consumers to use pre-owned accessories and reduces unnecessary production. Fairphone are ‘e-waste neutral’ meaning that when you buy a Fairphone 4, they recycle or give one old phone a second life. You are also given a financial credit by sending back your used Fairphones. Fairphone also works with Closing the Loop, collecting used phones from landfills in Africa and recycling them in Europe (65,000 phones were collected and recycled in 2020).



Industry Impact

The impact of Fairphone on the tech industry is evidenced by major tech brands starting to integrate circular economy principles into their models and working to reduce their waste.

- In November 2021, Apple announced it would launch Self-Service Repair, allowing product owners to disassemble and repair their devices themselves, starting with the iPhone 12 and 13 display, battery, and camera. Customers will be able to send back their used components and receive a purchase credit (Circular, 2021).

- Apple has also recently transitioned to 100% recycled gold in the plating of the main board and the wire in the front camera and rear cameras, 100% recycled rare earth elements in all magnets, 100% recycled tungsten in the Taptic Engine, and 100% recycled tin in the solder of the main logic board and battery management unit. They have also transitioned to using 100% recycled aluminium in the enclosures of many devices (Apple, Environment).

- Dell has pledged that by 2030, for every product a customer buys, they will reuse or recycle an equivalent product and more than half of their product content will be made from recycled or renewable material (DELL).

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Case Study 4: Feature Drama Film Black Bear

Itandehui Jansen

Black Bear is an independent feature drama film produced by Tandem Pictures and directed by Lawrence Michael Levine. The film premiered at the Sundance Film Festival in January 2020. In different interviews, for example for the Hollywood Reporter, Magazine Greenbiz, and magazine The Cherry Picks, the producers of the film discuss the production process and their choices to make the production more sustainable. The producers mention that they used the Green Production Guide tools to plan the project and implement more sustainable approaches.
For example, the production avoided the use of plastic water bottles and instead supplied all cast and crew members with reusable water bottles with their names.
Similarly, no single-use cutlery or plates were used by catering. The set had separate bins for different kinds of waste, to allow for separating and recycling. The location of the film film was a remote, solar powered cabin. The lights used on set consisted of low power led lights. For the production design furniture was locally sourced. At the end of the production leftover props, wardrobe and furniture were donated to a local charity.
The producers have shared their sustainable approaches with film students and highlight that decisions early on in the production process, like a choice of location, can have a big impact on the sustainability approach of a film production. The producers mention that there exists a misconception that implementing sustainable approaches in a film production will require additional budget, but in their experience implementing more sustainable approaches also supported the production in cutting costs.

Interview in Greenbiz on the production of Black Bear: https://www.greenbiz.com/article/indie-films-are-catching-major-studios-sustainability-standards

Case Study 5: Billy Tannery

Jules Findley

"Billy Tannery is a new kind of leather company. Our vertically integrated supply chain is traceable from our leather goods, to our own tannery and all the way back to a handful of UK goat farms. It all started with a discovery that thousands of goatskins leftover from the food chain were going to waste each year. We were determined to turn the waste into worth."

Micro tannery ©Billy Tannery

Recovering waste

Realising that annually thousands of goat skins were being wasted and were being either thrown away or burned, in 2016 Jack Millington and Rory Harker started up Billy Tannery. The tannery is the newest micro tannery to be started in the UK in the last nearly100 years and produces sustainable goats leather. Goats leather makes for high quality, fine leather,

and is sought after in leather products as the grain is so fine and produces soft leather. (Billy Tannery, n.d.)

Jack Millington and Rory Harker started the idea of tanning realising that no one was making anything out of leftover goatskins, despite of a growing goat meat and goat milk market in the UK. There were no domestic tanneries using leftover skins, the result was the skins would go to waste, so in investigating what to do with valuable skins Billy Tannery the micro tannery became an idea that came to fruition through Kick Starter funding and a farm. (The Dining Room PR, n.d.)

Finding second hand equipment that could be reused, two small wooden tanning drums were moved from a tannery in Somerset which closed in 2013, up to the Midlands into old farm buildings where the small tannery resides. The tanning process is made in small batches, allowing the tanning to be focussed and made at high quality and being more conscious of the environment. (Billy Tannery, n.d.)

High quality goat skins ©Billy Tannery

Sustainable thinking

In collaboration with Paul Evans from the Institute for Creative Leather Technologies in Northampton, tanning is made using bark extracts, and the treating of all of the effluent form the dye process is made at the micro tannery. Jack Millington and Rory Harker learnt their craft putting sustainable practice into their tannery by using vegetable dyes, and as they dye small batches the team are able to experiment, using the skills from Authenticae, responsible leather specialists, in order to make their skins high quality using sustainable dye processes. (Authenticae, n.d.)

The focus of the tannery and making small leather goods is on recreating the traditional supply chain from farm to leather good, and to tell a positive story of leather and making through sustainable processes. Billy Tannery promotes British manufacturing as well as creating high quality sustainable leather products. The Tannery make collaborations with Cabrito and their yearly Goatober celebration, as well as with restaurants like Temper, who serve Cabrito's delicious goat meat in order to promote the sustainable food chain and the provenance of meat and using the waste in circular design. (www.leathernaturally.org, n.d.)

Billy Tannery
https://www.billytannery.co.uk/
Photographs from Billy Tannery

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Case Study 6: Precious Plastics

Rebecca Lardeur and Peter Oakley

Plastic Processing Equipment © Precious Plastic

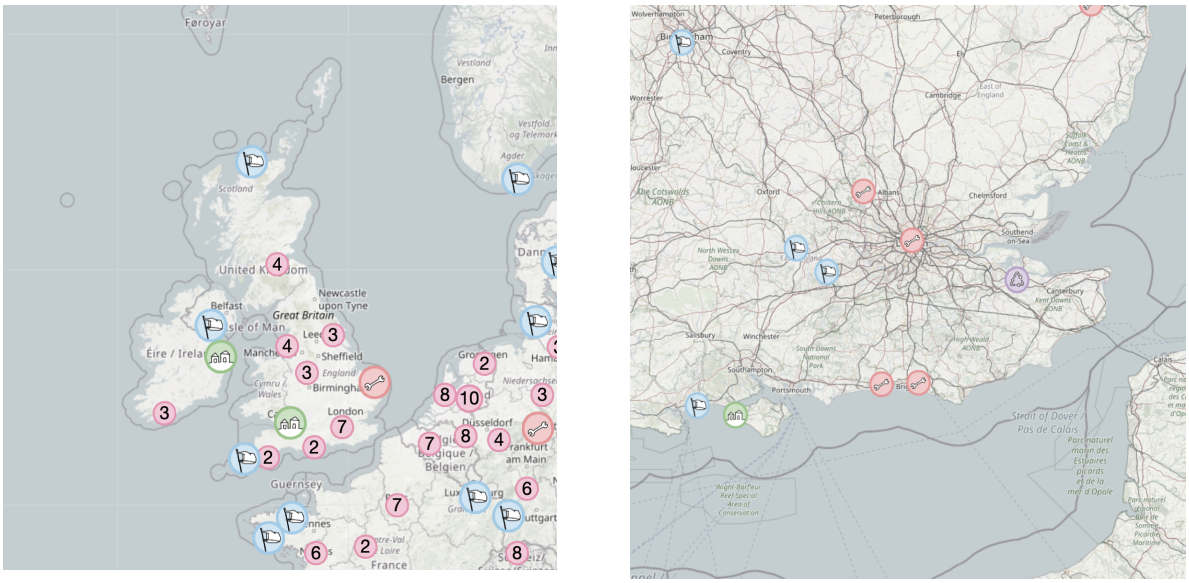
Wikipedia describes Precious Plastics (PP) as 'an open hardware plastic recycling project and is a type of open-source digital commons project' (Wikipedia, 2021). PP presents itself as "a global movement of thousands of people applying their creative genius to solve the plastic waste problem. Together. As a recycling army." (Precious Plastics, 2021).

In practicality, PP provides blueprints to build DIY or professional machines that grind, melt, and inject recycled plastic, facilitating the creation of small scale recycling hubs all over the world. PP also encourages knowledge exchange through different engagement channels: a website, YouTube tutorials, social media accounts, an interactive map to find members and a Discord channel.

PP started in 2012 as Dave Hakkens' graduation project at Eindhoven University of Technology (NL). Since then, the initiative has gone through four iterations. The first version, released in 2013, was Hakkens' completed university project. In early 2016, the second version was published with refined machinery plans alongside a marketplace selling machines and products to DIY designers. A year later, the third version was delivered. In 2018, PP received a 300,000€ grant from the Famae award and free-of-rent offices in Eindhoven. In 2020, the release of the fourth version included free business models and recycling systems starter kits and is the most advanced iteration to date.

PP categorises five types of recycling spaces: workspace, collection point, community point, machine shop, member. To promote their designs, PP shares video tutorials and virtual 3D models, alongside examples of objects to create, such as bricks, plant pots, benches, skateboard planks and more. The platform also promotes and manages an online shop for makers, selling versions of the equipment, raw materials and finished plastic products.

The impact in the UK



Community map © Precious Plastic

There are 27 established PP groups in the UK: 18 in England, 5 in Scotland, 3 in Wales, and 1 in Northern Ireland. Some act as workshop spaces, community points, collection points or machine shops. People identifying as members are not present on the PP map, but some can be reached via PP's Discord channel (a network app similar to Slack).

PP has supported the growth of DIY plastic recycling in the UK; some of the practitioners were interviewed and shared their perceptions of the initiatives. Most responses were positive. Still Life in Glasgow, Relic Plastic in Lancaster and Brothers Make in Bournemouth all affirmed their businesses started thanks to Precious Plastics. They valued the professional practice materials and access to a supportive and broad community.

> "The platform has been and continues to be a fundamental part of our work. We've learnt pretty much everything we know about plastic from there. The community is such an amazing tool we use when building machines or sorting to think about new products."
> *Will, from Still Life in Glasgow (Still Life, 2021)*

> "Precious Plastic was where it all began for us to be honest. Although we don't use Precious Plastic machines, the machines we are using are heavily inspired by them. We also are part of the Precious Plastic verified workspace program via the One Army website."
> *Brothers Make in Bournemouth (Brothers Make, 2021)*

Still Life product on the left, Relic Plastics products on the right

> "The very basis of our business is dependent upon Precious Plastics as it was created as an open-source framework for others to copy, adapt and expand upon. The machines we use are reiterations of the designs created by Precious Plastics, and even they even provide documents to help with basic business calculations like establishing product costs, break-even points, etc. The fact that there is a community of people connected to this work who are mostly open, friendly and share experience and knowledge is a bonus but was driven by the way that Precious Plastics has operated from the beginning."
> *Relic Plastic in Lancaster (Relic Plastic, 2021)*

However, it also emerged that one respondent was not able to build the machines using the plans available. They felt the level of knowledge required to construct the equipment was far in excess of what was indicated and that the waste plastic they had access to turned out not to be suitable for PP's recycling system.

> "Many plans are very incomplete, some machines didn't even work and if you are not a skilled mechanic (trained or not) with a bit of material science background or electronics, it is unlikely that you will succeed."
> *Julien, Plastic@Bay in the Highlands (Plastic@Bay, 2021)*

The responses reveal a range of engagements with the Precious Plastics platform and the promoted products. These include relationships that appear tangential to those anticipated by its founder and individuals disillusioned by the realities of constructing the production equipment. Whether the online platform has reached its full potential is

unclear but it has certainly acted as a focal point for aspirations and expectations and as a catalyst for change.

PP's Global Impact

PP published a global impact report in 2020 (Precious Plastics, 2020). This covered responses from a total of 1083 respondents located in 102 countries who had taken part in PP's survey. The results showed an average of 376 176 Kgs/year of plastic waste recycled by all workspaces, amounting to 835 kg/year or 69 kg/month for every PP workspace.
PP calculated a total revenue of over 2.1 Million € in yearly income. (7 279 €/year or 606 €/month for each workspace around the world. Workspace teams are typically composed of about 5 members, a third of these team members being women. 45% of team members are below 30 years old, 33% are between 30 and 40 years old, and 20% are above 40 years old. In 2020, 42% of the workshops registered started less than a year ago, showing promise of rapid growth.
In terms of profits, PP has calculated that 10% of workspaces generate a profit and 21% are financially sustainable, with spaces in Western Europe and South-East Asia being most successful. This happens through direct sales of products, machines and services. These figures were prior to the release of PP version 4, which included business models canvas and recycling systems starter kits. This version was released in early January 2020.

PP's relationship to sustainability and the circular economy

PP's mission is to remove plastic waste from the environment. They make no explicit mention of sustainability or the circular economy on their website. Instead, they focus on advocating small and direct actions, promoting zero waste living and new materials. They stand clear on their opinion of a theory of change: "We don't believe in techno-utopian, fix-it-all, dream technology.".
Hakkens has shifted to tackling other global problems through his online network, such as addressing e-waste and fashion waste, promoting sustainable living, and supporting education.

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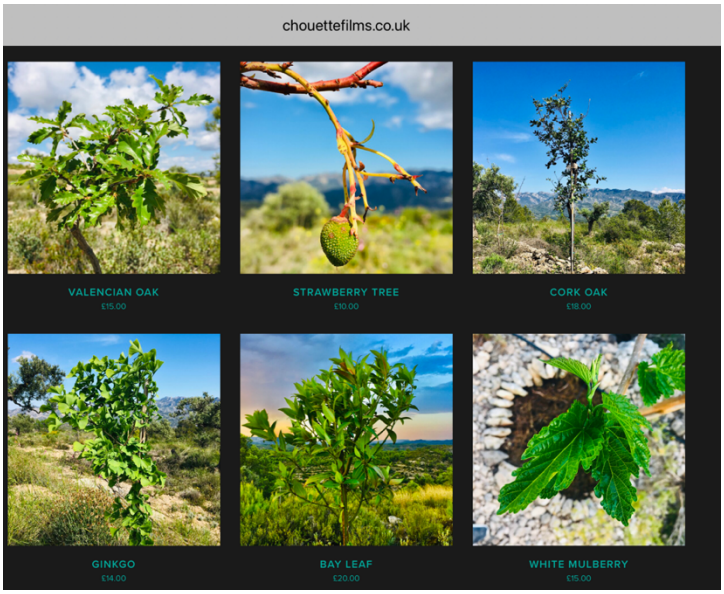
Case Study 7: Production Company - Chouette Films

Itandehui Jansen

Chouette Film Productions specialises in educational content and documentary films on social and academic subject matter. The production company is affiliated with SOAS University London and with ALBERT. On their website is explained that as the company was making different films on environmental issues, they realised they required a coherent approach to sustainable practice in filmmaking. The company explored therefore how to improve aspects of sustainability with regards to transport, recycling, catering and other aspects of film production. Choices involved for example working with local crew.

Documentary producer Anna Sowa explains that the production company had to redesign the way it makes films in order to become more sustainable. The company worked with a “Green Mentor” to rethink their production practices. She points out that some sustainable practices are more time consuming, such as consciously choosing to travel by land instead of travelling by air.

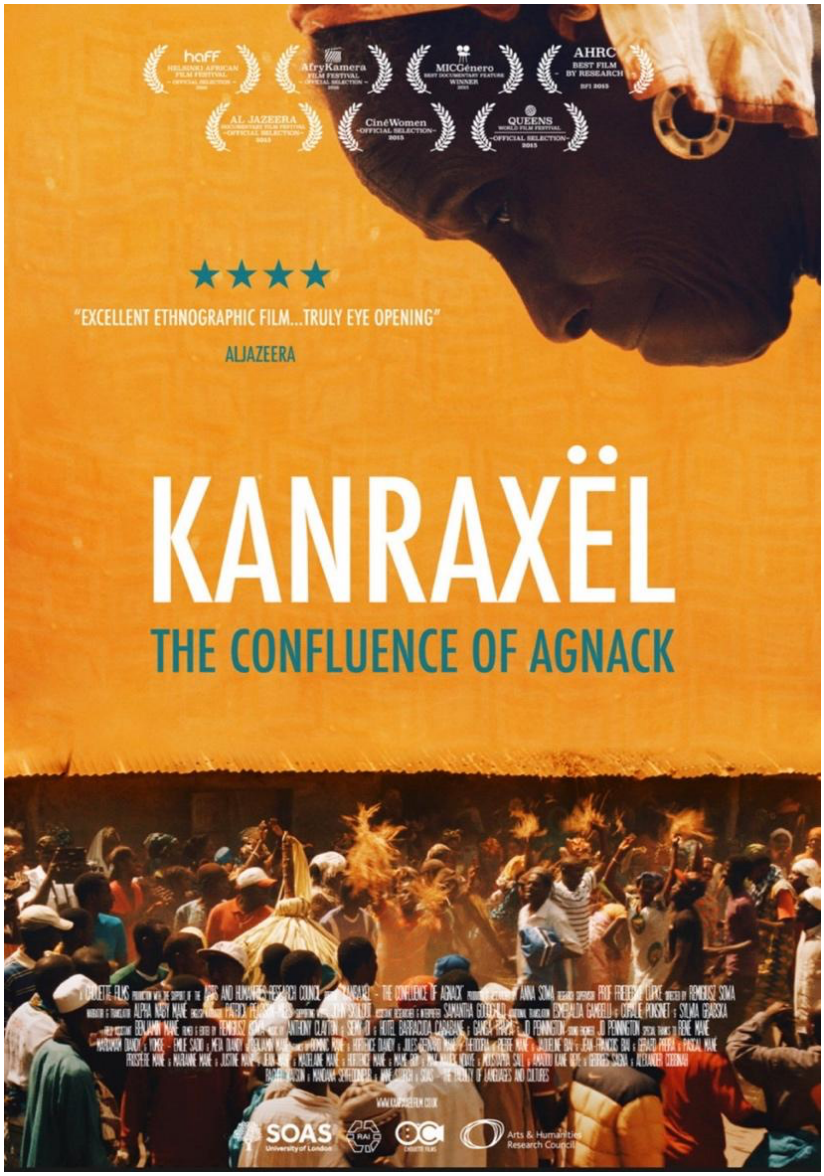
The company furthermore considered options such as using a PHEV car, using solar powered batteries on location, working with LED lights, switching to a green electricity provider, and recycling and disposing of old equipment. Additionally, the production company also started to consider the number of people involved in the making of each production, mindful of the fact that larger crews lead to more sustainability issues.



Therefore different members of Chouette learned to practice different film disciplines. The company also encourages freelancer to participate in their ‘green principles’.
The members of the company “offset” their carbon footprint by planting trees. The trees are planted in Catalonia and consist of different varieties. The general public can support Chouette’s conservation efforts by adopting or donating trees for planting. There is the possibility to choose between twelve different varieties of trees.

Information on Chouette Productions, their approach and produced films is available through their website: https://www.chouettefilms.co.uk

Chouette Productions has produced among others the documentaries:
Kanraxël: The Confluence of Agnack (Chouette 2015).



Case Study 8: Reset Scenery Scotland

Itandehui Jansen

Reset Scenery Scotland was founded in 2018 and specialises in collecting discarded set materials and props, to refurbish and repurpose them for reuse by other theatre or film productions. The company states on their website that they want to explicitly con tribute to a circular economy.

The company provides clearance service, collecting sets and props for reuse. The company is aware of copyright and IP concerns and states on their website that they will discuss the terms and conditions of reuse with the clients requesting collection of sets and props, in order to ensure protection of original IP.

Other services consist of separating waste materials by disassembling sets and props that have no other reuse purposes and separating materials to discard appropriately.

Reset Scenery also provides workshops to schools and communities in order to promote reuse of materials when constructing scenery materials. Furthermore they can also support carbon calculation and inform theatre and film producers about more sustainable alternatives when choosing materials for sets and props.

Reset Scenery has a wide range of set elements and props that can be rented to use in film, television and stage productions. The elements for hire vary from rolls of artificial grass to different kinds of doors, desks and even a small boat.

Reset Scenery provides theatre and filmmakers with the opportunity to choose to reuse materials and thus contributes to limiting the use of new (natural) resources and raw materials, such as timber and textiles. At the same time Reset Scenery provides theatre and filmmakers with an option to responsibly discard set and prop materials after use. The initiative is important as it creates more awareness about circular economies and ecological approaches within the film sector, but also provides concrete alternatives that limit the production of waste.

Information on Reset Scenery can be found on their website: https://www.re-setscenery.scot

Case Study 9: Short Film - *Time and the Seashell*

Itandehui Jansen

The short film *Kii Nche Ndutsa* (Itandehui Jansen, Mexico 2020), english title: *Time and the Seashell*, explores indigenous reflections on the environment and landscape. Presented through a monologue in Mixtec (an indigenous language spoken in Mexico which is currently under threat), *Kii Nche Ndutsa* relates the protection of Indigenous cultural heritage, and the revitalisation of threatened languages, to the protection of landscape and environment. It is the result of practice-based research into environmental cinema and was created using a combination of approaches aimed at limiting the carbon footprint of filmmaking.

As the short film touched upon environmental subject matter, it was appropriate to recur to a variety of sustainable approaches in the film making process with regards to travel, equipment, props and other aspects of production.

Equipment

The short film was shot with a pre-used Bolex D16 camera with internal batteries and internal hard drive. No additional batteries or drives were added and filming was thus limited to the camera's storage capacities and battery life. As the Bolex D16 alllows the use of vintage 16-mm cinema lenses, this production employed second hand Kern Paillard Switar lenses from the 1960's. The equipment furthermore consisted of an on camera Rode microphone powered by the camera. All equipment continues to be in use. The film was shot with available light and no additional lighting or rigging equipment was used. The sustainable approach hence consisted in this case of limiting the equipment to the bare essentials and working with second hand equipment.

Logistics

Limiting the cast and crew for the production of this film allowed to limit the requirement of logistical operations that have a negative environmental impact.

The crew for the short film was kept very small on purpose to avoid additional carbon footprint through travel or catering. The crew consisted of one person as the director operated the camera and recorded sound with an on-camera microphone. The cast consisted of three people who were all already present at the different locations, in order to limit additional travel,

accommodation and catering which would negatively impact the locations. No packaging for catering purposes was used as cast and crew consumed local products in small family owned restaurants in the different locations.

Props and Sets

The short film was shot entirely on existing locations and no materials were used to built or alter sets. All costumes and props were already at the locations or in possession of the filmmakers. Hence no waste was produced through the fabrication or purchase of props or costumes. Consequently also no props or costumes were discarded after the production,

Travel and Locations

Filming took place while the filmmakers were presenting a feature drama film at different University campuses in the state of Oaxaca, Mexico. Travel to and within Mexico was therefore organised by the State University of Oaxaca, SUNEO.

The filmmakers filmed in their hometown Santa Maria Apazco and in locations visited during the screening of the film In Times of Rain at SUNEO. No additional travel took place for the filming. No interventions were made by the filmmakers at these locations that would alter or interfere with the natural landscape.

Outreach

The film was presented among others at the IMPAKT Film Festival – Zero Carbon Footprint, the Climate Crisis Film Festival, the COP26 Resilience Hub and was nominated for both an Ocean Bottle Award as well as a RIFA Award for Best Climate Emergency Film.

Case Study 10: Textiles - iinouiio

Jules Findley

“Textile materials (normally referred to as 'waste' or 'by-products'), are better interpreted as 'raw materials' that are sometimes limited by our imagination and innovation. All of us can do better.” Dr John G Parkinson, iinouiio: recycling our past; creating a future.

unravelled mixed fibres ©iinouiio

Unravelling Wool

Dr John Parkinson, CEO & Founder of iinouiio has worked in textile recycling since 1977. In 1990, he co-launched ‘Evergreen’ the first UK business of its kind, to produce fibres, yarns and fabrics using responsible materials and production methods, however with the setback of a fire in 1995, John had to start the company again from scratch. After peaking in the 1990’s, there has been a global decline of the woollen industry, being substituted by mixes of synthetic fibres and blends. (Gro Intelligence, 2017).

In 2019, John co-founded iinouiio with his wife Linda, (acronym: ‘It Is Never Over Until It Is Over’), to re-energise the ‘endangered’ craft of traditional UK textile recycling.

Based in Yorkshire, iinouiio are working with various partners in order to create a future for the UK’s wool and cashmere recycling industry. Through John’s experience, he has been able to unravel knitted wool into recycled yarn from knitted and woven waste streams. This has allowed for the creation of closed loops in the knitwear industry.

The company provides bespoke opportunities to each of their clients taking part in reducing the estimated 92 million tons of textile waste in the fashion industry created each year. (Dean, 2019).

More recently, iinouiio have built a £165k mechanical textiles recycling plant through funding from WRAP in 2021. The R&D was supported by a government backed scheme from The Business of Fashion, Textiles and Technology, https://bftt.org.uk/ to deliver market leading innovation in textile recycling.
Dr John Parkinson has a highly skilled team including, two kickstart apprentices who are working on the project, together with a Textiles R&D project lead, Alice Timmis (MA RCA), with circular textile experience and two high profile academics in research and innovation who are experienced in recycling from UAL, London.
The new mechanical plant is the only machine of its kind in the world and iinouiio are the only known R&D facility providing recycling with pre and post-consumer wool and luxury fibres. With John Parkinson's over 40 years of experience in developing circular textiles from wool waste in partnership with the Business of Fashion, Textiles & Technology [BFTT] will develop a unique textiles and recycling R&D service.


©iinouiio

How iinouiio develops waste recycling

As manufacturers, iinouiio consult companies in order to discover the best frameworks to feed pre and post consumer waste back into textile production for the highest quality finished outcomes.
Waste streams may include spinning waste, knitting or weaving waste, knitted panel or pattern cutting scraps, deadstock fabrics or knitwear, textile take back schemes or deadstock.
Applying experience in developing waste streams into new desirable textiles, iinouiio offers both development and production in developing custom recycled yarns for knitting and weaving, recycled woven fabric development and production. In partnering with UK spinners and mills putting textiles back into fibres, using the new mechanical machinery, iinouiio can offer 100% Made-in-Britain recycled fibres, yarns and woven fabric closing the loop in yarn in knitting and weaving textiles industry.

Over the next 15 months iinouiio will be working with their research partners to develop a scalable and replicable R&D production service for global manufacturers and brands.


textile waste in bales ©iinouiio

In future endeavours iinouiio look to working with fashion and textile companies that are sustainably conscious, developing research in oversupply knitted yarns or unsold knitted up knitwear, woven textile deadstock and yarn waste continuing to develop research to supply recycled high-quality yarns and fabrics.
The future feels bright for iinouiio with potentially really interesting R&D in waste streams which can only enhance the recycling area in knitted and woven fibres in textiles.

iinouiio
https://www.iinouiio.com/
Photographs from iinouiio

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Case Study 11: The Green Production Guide

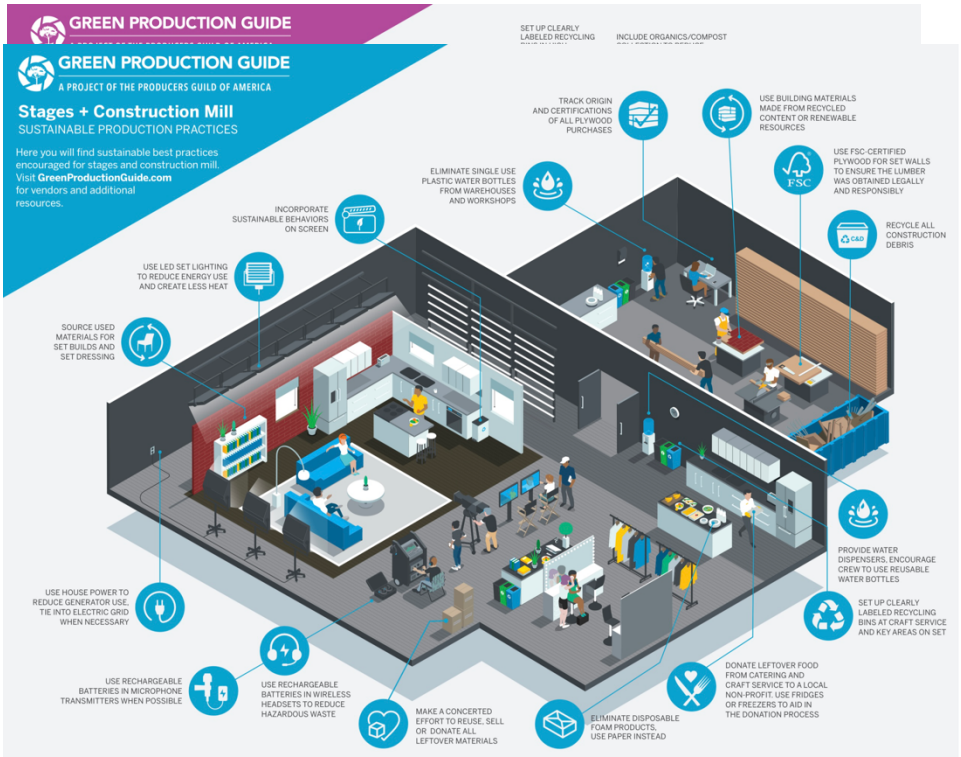
Itandehui Jansen

The Green Production Guide is a collection of tools for filmmakers who want to engage in sustainable production approaches. The Green Production Guide is freely accessible online. The guide was established in 2010 and is the result of a joined effort between film, television and streaming companies and the Producers Guild of America. The website mentions among others companies such as Warner Media, Disney, Amazon Studios and Netflix as participants in the initiative.

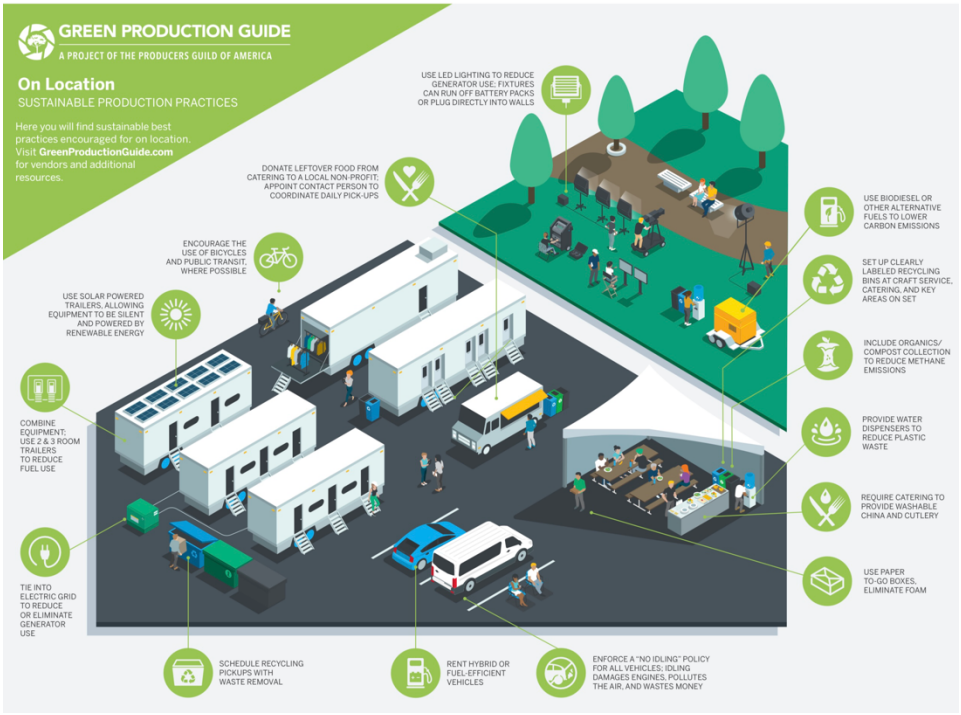
The guide includes among others a tool to calculate the production's carbon footprint, through a Production Environmental Accounting Report (PEAR). The guide additionally includes recommendations on best practices per department in the form of the Production Environmental Actions Checklist (PEACH). Other tools are the Plywood Tracking Worksheet (PLUM), infographics on best practices, and resources for food and material donations. The website links to other sustainable initiatives with respect to film production, such as ALBERT in the UK, and a resource library with fact sheets.

PEACH (the Production Environmental Actions Checklist) is a tool that each film department (Art Department, Cinematography, etc) can use to prepare for a film shoot while implementing more sustainable approaches. PEAR (the carbon footprint calculator) allows the production to track energy use in offices and on set, the use of fuel for vehicles and generators, emissions from air travel and accommodation and makes it possible to report on waste and donations. This permits an overall picture of the environmental cost of film productions, but also stimulates productions to consider more environmental friendly alternatives.

The different infographics that are part of the tool kit give a clear overview of what the possible actions are to diminish environmental impact, at different stages of productions.



The infographics contain suggestions to reduce and recycle waste in an office context, the context of set- or stage building, and when filming on existing locations.



These actions are all standard practices in bigger studio productions that have a sustainability manager or coordinator. However, this is not always the case for independent film productions. The toolkit is therefore particularly useful to independent film producers who want to limit the carbon footprint of their productions.

Case Study 12: Theatre Green Book

Roberta Mock

> *"[I]f there is one unquestionably positive thing to have come out of the pandemic, it might just be the creation of the Theatre Green Book."* (Editorial, *The Stage*, 11 November 2021)

> *"This isn't about individual practice or passion. It's about change to interconnected systems… The last thing the sector needed was a thousand sustainability guides… What we needed was one set of guidance everyone could follow. Not an idealistic dream for the future, but guidance you could start using today. Guidance that may change, but could at least get this stone turning. Guidance that didn't place an extra burden on busy people."* (Paddy Dillon, Co-ordinator of *The Theatre Green Book*, at the Theatres Trust "Making Theatre Sustainable" Conference, 4 November 2021)

Figure 1: Gary Lilburn and Tanya Moodie in Trouble in Mind (National Theatre, 2021). Director: Nancy Medina. Set and costume designer: Rajha Shakiry (Photo by Johan Persson)

The Theatre Green Book is a published document, an intervention, and an industry-wide movement committed to improving the sector's environmental sustainability. It emerged from conversations that the architect, Paddy Dillon, was having in order to start identifying themes for sessions at the next International Theatre Engineering and Architecture Conference (ITEAC). Dillon was repeatedly told that while there's a great deal of knowledge and expertise, the sector as a whole was not moving forward fast enough in response to climate emergency. What he kept hearing from theatre

professionals was that “We feel like we’re all waiting for somebody to invent something” (Dillon 2021).

And so, led by Dillon and spearheaded by Theatres Trust and the Association of British Theatre Technicians (ABTT), *The Theatre Green Book* was born. Developed and researched during the Covid-19 pandemic “lockdowns” in 2020-21, it has the support of all of the leading UK theatre bodies and sustainability organisations (many of which had produced guidance and resources that it scaffolds upon). These include Society of British Theatre Designers (SBTD), Sustainability in Production Alliance (SiPA), Association of Lighting Designers (ALD), UK Theatre, Society of London Theatre (SOLT), Independent Theatre Council (ITC), Federation of Scottish Theatre, Theatre and Dance NI, Creu Cymru, Community Leisure UK, Stage Sight, Scene/Change, Ecostage, Julie’s Bicycle, and Creative Carbon Scotland. While a stakeholder consortium funded the input of sustainability engineers, Buro Happold, as well as elements of its design and publication, the *Green Book* has involved hundreds of unpaid participants in focus groups, interviews and surveys.

In short, it has been – and continues to be – shaped, informed and facilitated by an unprecedented coalition of UK theatre-makers, including freelancers, venues, companies and producers. The publication presents a statement of shared and negotiated values, draws together current best practice, and sets out collective standards for achieving change in the face of climate crisis. It has been described as “a chance to reset how we work as a sector” and a “one-stop shop the whole industry can use” (Clark and Snow 2021: 12).

The name of *The Theatre Green Book* was inspired by the ABTT’s “Yellow Book” (as *Technical Standards for Places of Entertainment* is more commonly known), which offers venues and technicians health and safety guidelines: “There was no point in lots of individual theatres coming up with their own sustainability guidance because this is an industry of freelancers, and it won’t work if at every venue you go to, you have to reinvent the wheel … Like the Yellow Book, it provides a unified standard” (Dillon in Clark and Snow 2021: 12, 13).

A number of overarching drivers influenced the *Green Book’*s form and content: 1) It needed to include actions that could be taken by any and all theatre-makers, now, from whatever their starting point; 2) It needed to paradoxically arise from what theatre-makers *do* and build on current practice while simultaneously advocating for systems change: “There’s a whole chain of people: producer, director, production manager, set builders, wardrobe, lighting and so on, all of whom are collaborating, and one person in the middle can’t change the system as a whole” (Dillon in Clark and Snow 2021: 13); 3) It needed to be underpinned by the best science that is available and current sustainability expertise; and, 4) It would, and could, never be “finished”.

Overview of *The Theatre Green Book*

The Theatre Green Book has been conceived as three, inter-related, open access volumes. All either already are (or will be soon, in the case of Volume 3) available to download separately for free.

Sustainable Productions, the first volume, focuses on the making of shows. Published in "Beta version" in March 2021, it draws together current best practice in sustainable theatre-making and sets out tiered standards (Baseline, Intermediate and Advanced) for achieving change. The cumulative meeting of even the Baseline standard will significantly contribute to the sector's cutting of emissions. The *Green Book* also acknowledges the wide range of scales and multiple locations of theatrical production, which includes, for instance, commercial and subsidized small-scale touring, in addition to building-based ones. At the same time as the full version of *Sustainable Productions* was published, a short version was made available for smaller companies and productions. According to the *Green Book,* while small-scale shows may involve fewer people and less resource, the principles of sustainability remain: "to create more with less; to collaborate more closely; to focus on people not objects; to replace the consumption of resource with creativity" (Buro Happold and Renew Theatre 2021a: 15).

The second volume of *The Theatre Green Book*, focusing on *Sustainable Buildings*, was launched at the Theatres Trust "Making Theatre Sustainable" Conference (Lyric Hammersmith, 4 November 2021). It is based on four key hierarchical principles, the first and last of which relate most to materials – that is, to become more sustainable, a theatre building must: BE LEAN (for example, by improving walls and roofs, so as to lose less energy); BE CLEAN (by improving services systems to use less energy); BE GREEN (by drawing energy from renewable sources); and finally, support biodiversity and reduce waste (Buro Happold and Renew Theatre 2021b). A Home Survey Tool that allows theatre managers to develop a Sustainability Plan for their building is currently being trialled and will be made available soon.

Volume 3 of *The Theatre Green Book*, on *Sustainable Operations*, is due to be published by the end of 2021; however, a summary of its content was presented at both the Theatres Trust Conference and the Sustainable Materials in the Creative Industries' "Greening Theatre" event (Bristol Old Vic, 2 December 2021). Volume 3 recommends that, to become more sustainable, theatres must: re-think both front of house (FoH) and back of house (BoH) operations; manage and maintain the building efficiently; manage waste sustainably; enable sustainable travel by staff, audiences and visitors; and, set standards for third parties such as contractors in order to influence Scope 3 carbon emissions. Like Volume 1, there will be a Baseline, Intermediate and Advanced Green Book standard for theatres to target and it will include guidelines in each of the above areas to help them achieve that target (Conteh 2021).

Because of its more explicit emphasis on the use of materials, as well as having existed "in the wild" for a longer period of time, the remainder of this Case Study focuses on the first volume.

Sustainable Productions

The *Sustainable Productions* volume of *The Theatre Green Book* begins by offering a set of principles and creative challenges that revolve (quite literally) around a cyclical model of sustainable theatre-making (See Figure 2). Echoing circular economy

principles, key sustainability milestones, responsibilities and processes are associated and align with its various elements throughout the rest of the document.

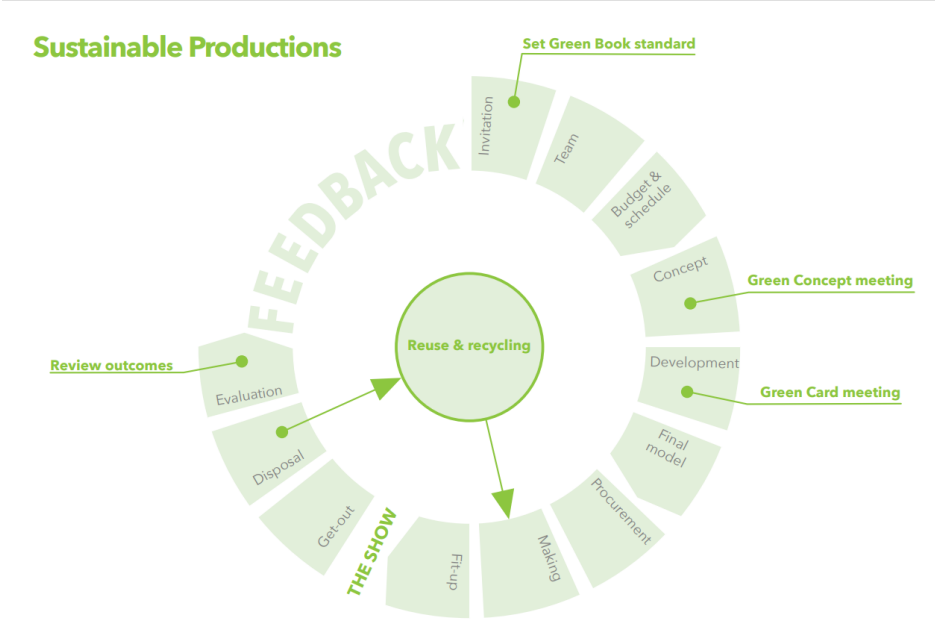


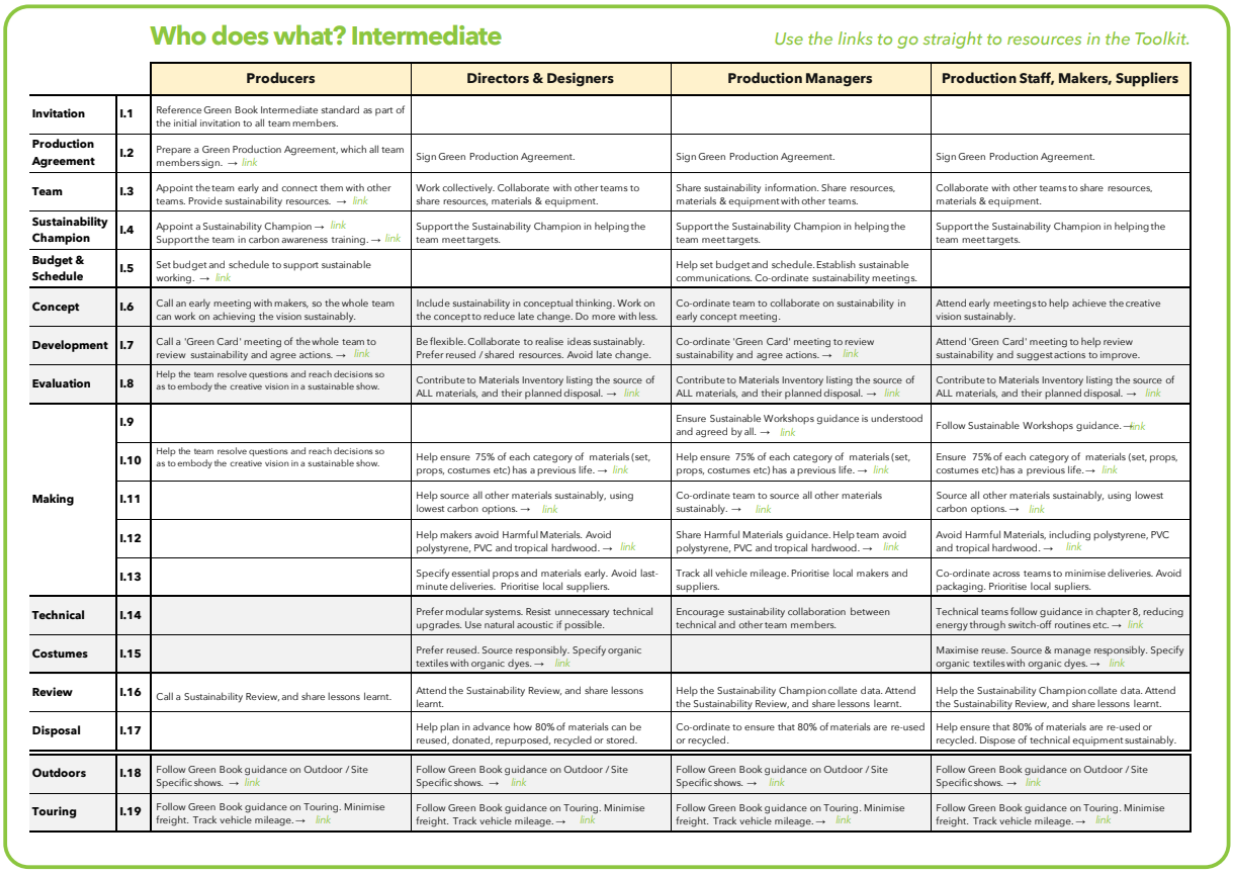
Figure 2: Sustainable Productions model, from The Theatre Green Book. Part 1: Sustainable Productions (2021) © Buro Happold and Renew Theatre

In order to produce a show sustainably, the *Green Book* outlines both why it is important, as well as how, to set a clear sustainability target at the outset; set up the team, budget and schedule to support sustainable working; and collaborate to achieve a sustainable outcome: "In the collaborative chain that makes a show, no one person can 'own' sustainability. Everyone's practice is affected; everyone is dependent on others, from producers to set-builders, to work in new ways. Responding to the climate emergency is a collective responsibility". The need for shared languages and expectations is especially important in a predominantly freelance ecology whereby individual practitioners are moving between companies and theatres. The *Green Book* is clear that its purpose "is not to suggest creative solutions, but to define the parameters within which theatre must work" (Buro Happold and Renew Theatre 2021a: 15).

Sustainable Productions presents specific tools and techniques for individual members of the production team (See Figure 3, which is a chart outlining "who does what" in a team working toward an Intermediate standard). For designers, for instance, it is recommended that they create sets and scenery that can be easily disassembled and reused (for example, by using demountable joints) and they are encouraged to use CAD modelling, which is zero-waste, instead of the foamboard, glues and paints (all of which might contain harmful chemicals) used to create model boxes.

Volume 1 of *The Theatre Green Book* offers detailed recommendations and guidelines to meet its three standard levels. Baseline productions, for instance, use only

sustainably sourced materials and at least 50% previously used materials in their making processes, and commit to 65% reuse or recycling when disposing them. Advanced level productions are expected to ensure that all materials have already been used before, or else are accredited carbon zero; after the production ends, 100% of materials must be reused or recycled. Productions operating at Advanced level should also only use electric vehicles, trains, bikes or public transport, and no toxic production materials, however mitigated.



Who does what? Intermediate

Use the links to go straight to resources in the Toolkit.

		Producers	Directors & Designers	Production Managers	Production Staff, Makers, Suppliers
Invitation	I.1	Reference Green Book Intermediate standard as part of the initial invitation to all team members.			
Production Agreement	I.2	Prepare a Green Production Agreement, which all team members sign. → *link*	Sign Green Production Agreement.	Sign Green Production Agreement.	Sign Green Production Agreement.
Team	I.3	Appoint the team early and connect them with other teams. Provide sustainability resources. → *link*	Work collectively. Collaborate with other teams to share resources, materials & equipment.	Share sustainability information. Share resources, materials & equipment with other teams.	Collaborate with other teams to share resources, materials & equipment.
Sustainability Champion	I.4	Appoint a Sustainability Champion → *link* Support the team in carbon awareness training. → *link*	Support the Sustainability Champion in helping the team meet targets.	Support the Sustainability Champion in helping the team meet targets.	Support the Sustainability Champion in helping the team meet targets.
Budget & Schedule	I.5	Set budget and schedule to support sustainable working. → *link*		Help set budget and schedule. Establish sustainable communications. Co-ordinate sustainability meetings.	
Concept	I.6	Call an early meeting with makers, so the whole team can work on achieving the vision sustainably.	Include sustainability in conceptual thinking. Work on the concept to reduce late change. Do more with less.	Co-ordinate team to collaborate on sustainability in early concept meeting.	Attend early meetings to help achieve the creative vision sustainably.
Development	I.7	Call a 'Green Card' meeting of the whole team to review sustainability and agree actions. → *link*	Be flexible. Collaborate to realise ideas sustainably. Prefer reused / shared resources. Avoid late change.	Co-ordinate 'Green Card' meeting to review sustainability and agree actions. → *link*	Attend 'Green Card' meeting to help review sustainability and suggest actions to improve.
Evaluation	I.8	Help the team resolve questions and reach decisions so as to embody the creative vision in a sustainable show.	Contribute to Materials Inventory listing the source of ALL materials, and their planned disposal. → *link*	Contribute to Materials Inventory listing the source of ALL materials, and their planned disposal. → *link*	Contribute to Materials Inventory listing the source of ALL materials, and their planned disposal. → *link*
Making	I.9			Ensure Sustainable Workshops guidance is understood and agreed by all. → *link*	Follow Sustainable Workshops guidance. → *link*
	I.10	Help the team resolve questions and reach decisions so as to embody the creative vision in a sustainable show.	Help ensure 75% of each category of materials (set, props, costumes etc) has a previous life. → *link*	Help ensure 75% of each category of materials (set, props, costumes etc) has a previous life. → *link*	Ensure 75% of each category of materials (set, props, costumes etc) has a previous life. → *link*
	I.11		Help source all other materials sustainably, using lowest carbon options. → *link*	Co-ordinate team to source all other materials sustainably. → *link*	Source all other materials sustainably, using lowest carbon options. → *link*
	I.12		Help makers avoid Harmful Materials. Avoid polystyrene, PVC and tropical hardwood. → *link*	Share Harmful Materials guidance. Help team avoid polystyrene, PVC and tropical hardwood. → *link*	Avoid Harmful Materials, including polystyrene, PVC and tropical hardwood. → *link*
	I.13		Specify essential props and materials early. Avoid last-minute deliveries. Prioritise local suppliers.	Track all vehicle mileage. Prioritise local makers and suppliers.	Co-ordinate across teams to minimise deliveries. Avoid packaging. Prioritise local supliers.
Technical	I.14		Prefer modular systems. Resist unnecessary technical upgrades. Use natural acoustic if possible.	Encourage sustainability collaboration between technical and other team members.	Technical teams follow guidance in chapter 8, reducing energy through switch-off routines etc. → *link*
Costumes	I.15		Prefer reused. Source responsibly. Specify organic textiles with organic dyes. → *link*		Maximise reuse. Source & manage responsibly. Specify organic textiles with organic dyes. → *link*
Review	I.16	Call a Sustainability Review, and share lessons learnt.	Attend the Sustainability Review, and share lessons learnt.	Help the Sustainability Champion collate data. Attend the Sustainability Review, and share lessons learnt.	Help the Sustainability Champion collate data. Attend the Sustainability Review, and share lessons learnt.
Disposal	I.17		Help plan in advance how 80% of materials can be reused, donated, repurposed, recycled or stored.	Co-ordinate to ensure that 80% of materials are re-used or recycled.	Help ensure that 80% of materials are re-used or recycled. Dispose of technical equipment sustainably.
Outdoors	I.18	Follow Green Book guidance on Outdoor / Site Specific shows. → *link*	Follow Green Book guidance on Outdoor / Site Specific shows. → *link*	Follow Green Book guidance on Outdoor / Site Specific shows. → *link*	Follow Green Book guidance on Outdoor / Site Specific shows. → *link*
Touring	I.19	Follow Green Book guidance on Touring. Minimise freight. Track vehicle mileage. → *link*	Follow Green Book guidance on Touring. Minimise freight. Track vehicle mileage. → *link*	Follow Green Book guidance on Touring. Minimise freight. Track vehicle mileage. → *link*	Follow Green Book guidance on Touring. Minimise freight. Track vehicle mileage. → *link*

Figure 3: "Who does what?" toward an Intermediate Standard production, from The Theatre Green Book. Part 1: Sustainable Productions (2021) © Buro Happold and Renew Theatre

Only Advanced productions are expected to use carbon calculators; this is because more data is still needed to establish carbon budgets for shows, and few theatre-makers are trained in their use. *The Theatre Green Book* therefore recommends the use of Materials Inventories, enabling organisations to use the data generated to create their baseline, track improvements, identify problem areas and prioritise "easy wins". In an inventory, all materials in a production are recorded, by weight if possible. *The Theatre Green Book*'s key materials principles include: doing more with less; spending more on people's time and less on stuff; and reducing harmful chemicals. In its Materials Hierarchy (see Figure 4), everything in a truly sustainable show will have had a previous life and everything will be used again in a circular economy. The goal is to start by designing out the need for materials. Whatever is needed should come

from a reused or recycled source – locally, if possible, to reduce transport. Next best are materials which are, at least, sourced sustainably. At the bottom of the pyramid are raw materials which involve carbon, and are destructive to manufacture, and ought to be avoided. There's a similar process for thinking about what to do with materials and objects after a production closes, from best – reusing it in the theatre – down to the worst: becoming landfill.

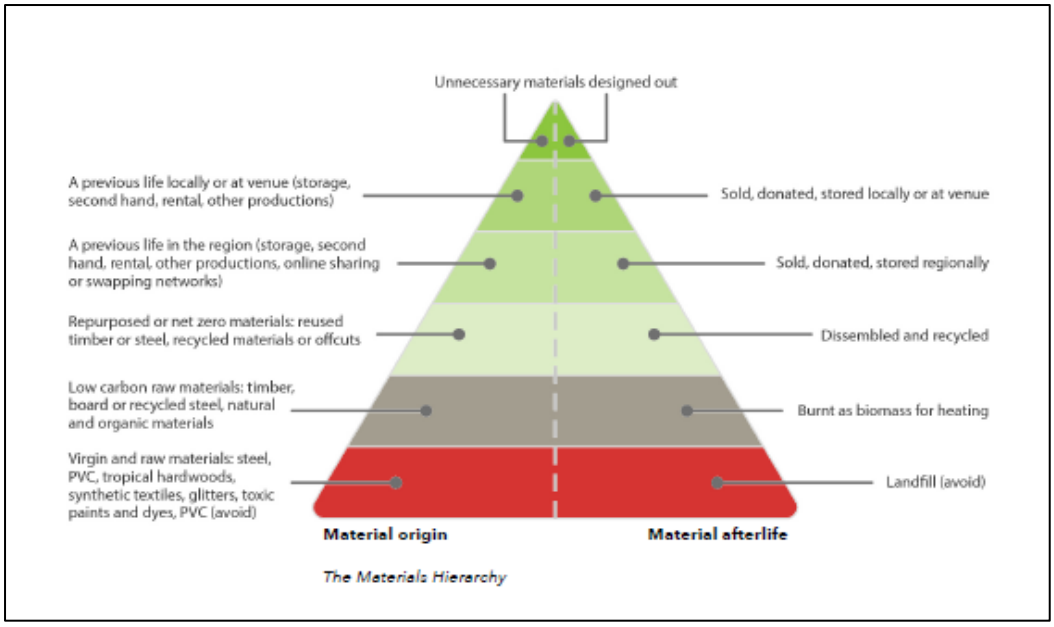


Figure 4: The Materials Hierarchy from The Theatre Green Book. Part 1: Sustainable Productions (2021) © Buro Happold and Renew Theatre

The Theatre Green Book recommends quickly phasing out of use those materials that are particularly damaging, through scarcity, manufacture, or chemical harm. These include polystyrene, PVC, unrecycled steel, glitter, synthetic textiles and tropical hardwoods. It notes that some materials used in costumes, wigs and make-up (such as synthetic dyes and products containing parabens and triclosan) are particularly harmful. Sewing, ties, pins and clips should be used for fastenings instead of tapes, pastes and glues for costumes and wigs. The *Green Book* recommends that all cosmetic products should be accredited with an EU Ecolabel, Ecocert, COSMOS or similar, and come in 100% recyclable, compostable or reusable packaging. Laundry should be washed below 30°C with products that meet AISE or EU Ecolabel requirements, and tumble drying avoided.

The final section of *Sustainable Productions* is a compilation of "Toolkits" that effectively act as appendices to the previous pages. These are organised under four headings: "Producing", "Designing and Making", "Technical" and "Site Specific and Touring". They include, for instance, a "Typical Green Production Agreement" and a role descriptor for "Sustainability Champions" within each production.

Ultimately, Volume 1 of *The Theatre Green Book* emphasises that sustainability requires new and different ways of working which depend on collegiality and collaboration, demand more time, and promote different kinds of creative relationships (2021a: 15). It suggests that there are additional benefits to this form of sustainable

practice: “Working collaboratively improves working culture for everybody. Working collectively brings more diverse talent into the industry. Working locally connects theatre to communities” (2021a: 16).

Belfast-based Tinderbox Theatre Company decided to trial *The Theatre Green Book* for its production of *Sylvan* (October and November 2021) because, “in line with our values, we felt that our work should also explore environmental working practices as well as artistic themes” (2021: 1). Publicity material describes *Sylvan* as “a nightmarish immersive experience bringing together live performance, horror and sound design” in site-specific woodland locations. The company published a full evaluation report of their experience, including Materials Inventories, and summaries of their challenges, solutions and findings.

For *Sylvan*, Tinderbox achieved their Baseline standard target, with 53% of materials having had a previous life and 97% of materials either recycled or intended for reuse afterwards. Furthermore, the Artistic Director notes that creating performance while adhering to *The Theatre Green Book* was “liberating” because it offered:

> the opportunity to place an incredibly important and necessary mission into the creative process [and] opened up a space for creatives and performers to discuss the effects of climate change and develop a strong sense of personal/shared values, responsibilities and awareness on Environmental themes as an Ensemble… Artistically, the work actually became much more ambitious and richer in style and form along with a sense of accomplishment for such a valued cause. The Theatre Green Book is fuel for the artistic process. (Tinderbox Theatre 2021: 11)

The company identified one of their major challenges as a “combination of Brexit and our geographic location” which “means that Northern Irish companies are quite limited in terms of suppliers” of sustainable materials (Tinderbox Theatre 2021: 7). When they are able to comfortably achieve Baseline standard for four productions, Tinderbox will aim for Intermediate standard for new shows. They also plan to develop a “sustainability info sheet” for teams and venues who are in a sharing relationship with them, detailing local suppliers of sustainably sourced materials (Tinderbox Theatre 2021: 5).

Figure 5: Sylvan *(Tinderbox Theatre, 2021). Director: Patrick J. O'Reilly. Design: Stuart Marshall. Costume Design: Enda Kenny (Photo by Carrie Davenport)*

The National Theatre Construction Workshops' Approach to Sustainable Production

The Royal National Theatre (NT) is based on London's South Bank. Its Environmental Policy explicitly states its commitment "to leading by improving our practice, shaping public conversation through storytelling, and galvanizing industry action to combat the climate crisis" (National Theatre 2021). In its 2017-18 Annual Review, the NT describes itself as "technically one of the largest factories in central London, with hundreds of skilled craftspeople, practitioners and artists working together to produce world-class theatre". In 2018-19 (the most recent Annual Review published on its website), the NT created 23 productions for its stages; there were 10 NT productions in the West End and New York; and 7.2 million people worldwide engaged with live theatre and events, NT Live broadcasts, television and radio broadcasts, learning and participation activity, and in-depth digital content (National Theatre 2019).

In May 2021, the NT was one of the first institutions to commit to making all of its productions to Green Book Baseline standard. This "new approach", according to the theatre, is "an enormous team effort, which needs every single person working on a show to rethink what they do…. We aren't experts yet, but we will be. Everything we learn along the way will help us change the way we make theatre for good" (National Theatre 2021).

The NT Construction Workshops are therefore working to achieve the following italicized bullet points for all of their productions, monitoring the data and reporting on their outcomes:

- *50% of each category of materials used in the production (set, props, costumes etc) has a previous life*

- *65% of materials have a future life and are recycled or reused*

To facilitate the above, the Construction Workshops adapted their costing sheet and created a Materials Tracker. They added a traffic light system to quickly identify at an early stage what elements can be reused or repurposed from stock or previous shows and whether they are likely to have a future life. This provides visual guidance to help identify which scenic items are the most sustainable (i.e. those with more green cells) and which should be addressed and reviewed as part of the "White Card" stage (i.e. those with more red and orange cells); *The Theatre Green Book* repurposes traditional White Card model meetings as "Green Card" meetings in which the production team audits the design against Green Book targets and workshops options, and agrees actions.
Figure 6 is the Materials Tracker for *Trouble in Mind* (premiere 2 December 2021). It includes all flying pick up points but not, for instance, wires/bottles or castors (which are assumed to be available from stock).

ITEM No.	SCENIC ITEM NAME	Component Details	Construction Notes	Scenic Art Notes	Previous Life (Reused or Recycled)	Future Life
1	Show Floor	Sacrificial floor 18mm MDF	Sacrificial floor 18mm MDF and non FR 6mm birch ply rips	Stained planks - potentially double sided painted	No	Yes
		6mm NFR birch ply rips			No	Yes
2	Forestage Elevators Infill	Fascia 9mm MDF	Steel deck - fascia & scaff legs from stock. Fascia will be 610mm wide and will be kept for future use Serge will not be glued; it will be stapled at the back so it can be taken off in the get out and kept for future use.		No	Yes
		Black Serge			No	Yes
		Steeldeck			Yes	Yes
		Scaff Legs from stock			Yes	Yes
3	Moving Platform	18mm MDF cladding	Birch Ply rips fixed with less staples to 18mm MDF sub-floor for easier removal. It is the intention to keep the ply rips for future used. The platform will be made out of 8x4 steel decks and 2 custom made 8x4 metal frame to house the Friction Drive units. This frame could be reused in the future.	Wooden planks effect.	No	Yes
		6mm NFR birch ply rips			No	Yes
		Steeldeck			Yes	Yes
		Casters			Yes	Yes
		Friction Drive Frame x 2			No	Yes
		Friction Drive Unit x 2			Yes	Yes
4	USR Tower	Stock Flattage	Hard Cladded external walls with brickwork effect (vacform). Combination of stock flattage and new flattage. Vacform to be applied with the thought of reusing it: it will be fixed with less staples and more time will be allocated for removal of vacform sheets. Key clamp handrails could potentially be from stock TBC.	Brickwork	Yes	Yes
		Vacform Cladding			No	TBC
		Stock flattage			Yes	Yes
		New Flattage			No	Yes
		Vacform Cladding			No	TBC
		Steeldeck			Yes	Yes
		Scaff Legs			Yes	Yes
		Handrails (key clamp scaff)			TBC	TBC
		Floor Cladding			No	Yes
		Stock flattage (bottom half)	Hard cladded with paint finish. Stock flattage to be used for the bottom half and new flattage to be made for header. Header		Yes	Yes
		New Flattage (for header)			No	Yes

Figure 6: Materials Tracker for Trouble in Mind *(courtesy of National Theatre)*

Once they began to explicitly consider the future life of the materials they use, the Construction Workshops started to change their approach to building scenery – for instance, using fewer staples so they can keep ply rips as planks, stapling vacform onto flats instead of gluing so they can be reused, and using fewer nails on serge so it can be removed and repurposed (see Column 4, "Construction Notes", in Figure 6).

- *New materials are sustainably sourced if possible and 100% of plastics are reusable, recyclable or compostable*
- *Materials and products which damage the environment are avoided if possible*

In 2019, the NT made the decision to stop using Far Eastern ply in order to reduce their carbon footprint. All of the Construction Workshops' timber and sheet material are now FSC certified products and sourced responsibly. All metal comes from Europe and so has a relatively low carbon footprint. The ambition is to use recycled metal and

they are opening discussions with their suppliers to try to achieve this. They are also avoiding plastic and polycarbonate as much as possible and have started using bamboo sheeting to replace plastic sheeting; if no alternative can be found, the Workshops source polycarbonate from a responsible supplier.
The Construction Workshops now only use water-based paint and are moving away from Rosco paints which can contain hazardous pigments and come from America. They are mainly trying to use Bristol paints which contain fewer hazardous elements and are from a UK-based company.

- *Deliveries are minimised, and last minute deliveries and orders avoided.*

The NT Construction Workshops are liaising with Flints Theatrical Chandlers (the largest single source for specialist theatrical hardware in Britain) to start operating a twice weekly delivery service, rather than almost daily deliveries from orders across the various departments at the NT. They are now looking to extend this to primary and regular suppliers such as Screwfix and RS Components. If the Workshops need products urgently, they try to either collect them from Central London in person or ask companies like Flints to use their pedi-van.

Materials Inventory
In addition to the Materials Tracker which forecasts production materials' lifecycle at an early stage (see above), there is another related tool for reporting that information once the production build is complete. The latter is referred to as the Materials Inventory and this is what ultimately enables the NT to determine whether they achieved Green Book Baseline standard. The NT Construction Workshops created their own version of the Materials Inventory and, as suggested in *The Theatre Green Book*, based their calculations on weight. Figure 7 is the Materials Inventory for *The Normal Heart* (premiere 23 September 2021).

THE NORMAL HEART - SUMMARY						
TOTALS	No Previous Life		Reused or Recycled		Future Life	
SHEET MATERIAL	2,077.30 kg		1,292.83 kg		372.60 kg	
TIMBER	121.45 kg		190.20 kg		0.00 kg	
METAL	213.05 kg		0.00 kg		0.00 kg	
SOFT MATERIAL	28.78 kg		29.60 kg		0.00 kg	
OTHERS	0.00 kg		598.00 kg		598.00 kg	
TOTALS	2,440.58 kg		2,110.63 kg		970.60 kg	
FINAL PRODUCTION TOTAL	4,551.20 kg				1,941.20 kg	
	Total Material with No Previous Life	54%	Total Reused or Recycled Material (Aim 50%)	46%	Total Set Material with Future Life (Aim 65%)	43%

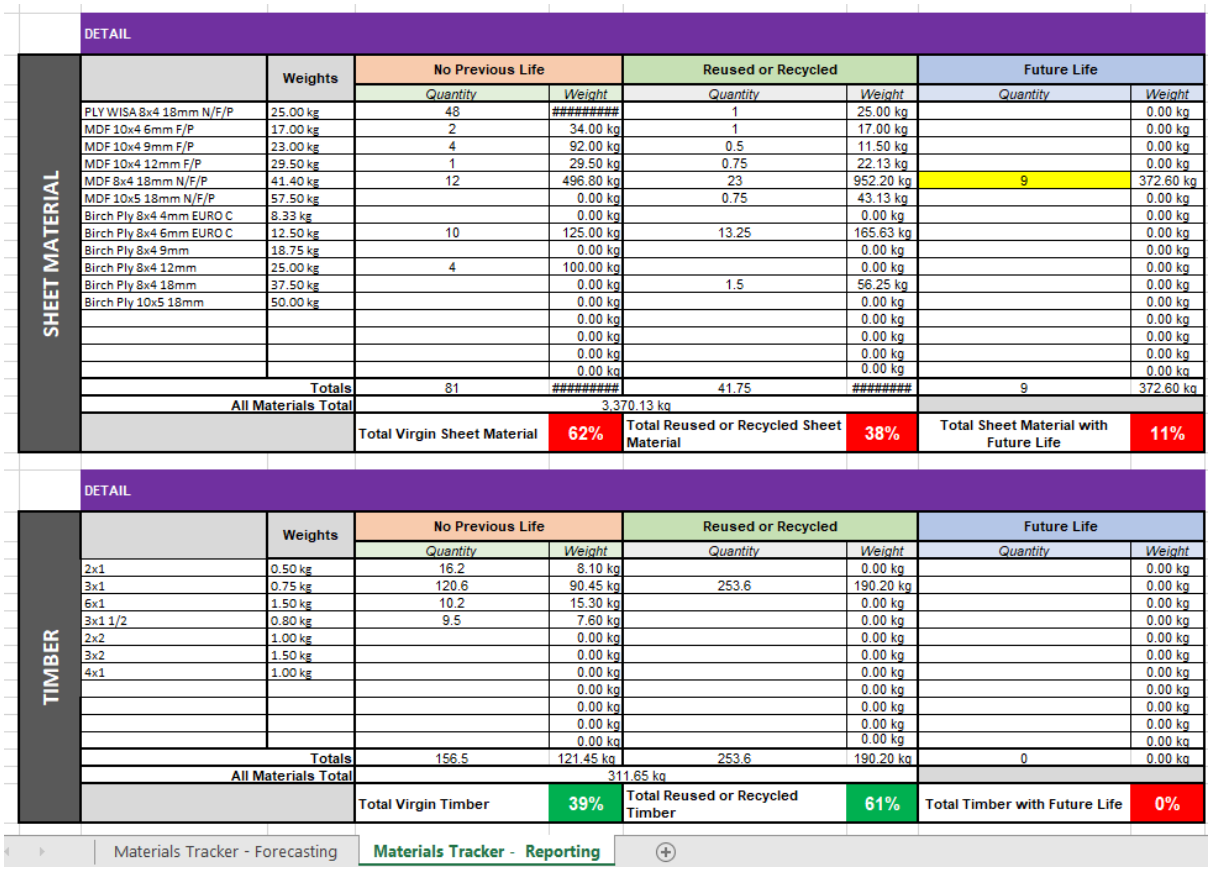
Figure 7: NT Materials Inventory for The Normal Heart *(courtesy of National Theatre)*

This overview chart is then broken down into specific areas: sheet material, timber, soft material, metal, and scenic art (See Figure 8). These are based on the signing out sheets the teams on the workshop floor complete each week, on which they input how

much new material has been used and how much/what they have been able to repurpose. As can be noted, there is often a great deal of variation between types of materials.

There is also an 'Other' section to capture items not listed on NT stock sheets (such as handrail and steeldeck) or materials specific to a project (such as pondliner, carpet, and polycarbonate). This also then feeds into the main chart to produce the overall figures for the show or project.

The NT have learnt that, while it is possible to predict some of the items they will keep and reuse (such as steeldeck and scaffolding legs), they can only accurately complete the "Future Life" part of the chart after the "get out" has finished and when there is a breakdown of what materials could be salvaged and stored.



DETAIL

SHEET MATERIAL

	Weights	No Previous Life		Reused or Recycled		Future Life	
		Quantity	Weight	Quantity	Weight	Quantity	Weight
PLY WISA 8x4 18mm N/F/P	25.00 kg	48	#########	1	25.00 kg		0.00 kg
MDF 10x4 6mm F/P	17.00 kg	2	34.00 kg	1	17.00 kg		0.00 kg
MDF 10x4 9mm F/P	23.00 kg	4	92.00 kg	0.5	11.50 kg		0.00 kg
MDF 10x4 12mm F/P	29.50 kg	1	29.50 kg	0.75	22.13 kg		0.00 kg
MDF 8x4 18mm N/F/P	41.40 kg	12	496.80 kg	23	952.20 kg	9	372.60 kg
MDF 10x5 18mm N/F/P	57.50 kg		0.00 kg	0.75	43.13 kg		0.00 kg
Birch Ply 8x4 4mm EURO C	8.33 kg		0.00 kg		0.00 kg		0.00 kg
Birch Ply 8x4 6mm EURO C	12.50 kg	10	125.00 kg	13.25	165.63 kg		0.00 kg
Birch Ply 8x4 9mm	18.75 kg		0.00 kg		0.00 kg		0.00 kg
Birch Ply 8x4 12mm	25.00 kg	4	100.00 kg		0.00 kg		0.00 kg
Birch Ply 8x4 18mm	37.50 kg		0.00 kg	1.5	56.25 kg		0.00 kg
Birch Ply 10x5 18mm	50.00 kg		0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
Totals		81	#########	41.75	########	9	372.60 kg
All Materials Total		3,370.13 kg					
		Total Virgin Sheet Material	62%	Total Reused or Recycled Sheet Material	38%	Total Sheet Material with Future Life	11%

DETAIL

TIMBER

	Weights	No Previous Life		Reused or Recycled		Future Life	
		Quantity	Weight	Quantity	Weight	Quantity	Weight
2x1	0.50 kg	16.2	8.10 kg		0.00 kg		0.00 kg
3x1	0.75 kg	120.6	90.45 kg	253.6	190.20 kg		0.00 kg
6x1	1.50 kg	10.2	15.30 kg		0.00 kg		0.00 kg
3x1 1/2	0.80 kg	9.5	7.60 kg		0.00 kg		0.00 kg
2x2	1.00 kg		0.00 kg		0.00 kg		0.00 kg
3x2	1.50 kg		0.00 kg		0.00 kg		0.00 kg
4x1	1.00 kg		0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
			0.00 kg		0.00 kg		0.00 kg
Totals		156.5	121.45 kg	253.6	190.20 kg	0	0.00 kg
All Materials Total		311.65 kg					
		Total Virgin Timber	39%	Total Reused or Recycled Timber	61%	Total Timber with Future Life	0%

Materials Tracker - Forecasting | Materials Tracker - Reporting

Figure 8: Breakdown of Materials Inventory for The Normal Heart (courtesy of the National Theatre)

Carbon Calculator

In addition to the Materials Inventory for each production, the NT has developed its own Carbon Calculator to monitor the carbon impact of making a show. This is expressed in terms of comparable flight hours "which is more tangible and understandable". The Carbon Calculator has been described to us as "a huge piece of work" which is "so specific to the NT that it probably isn't that helpful for others".

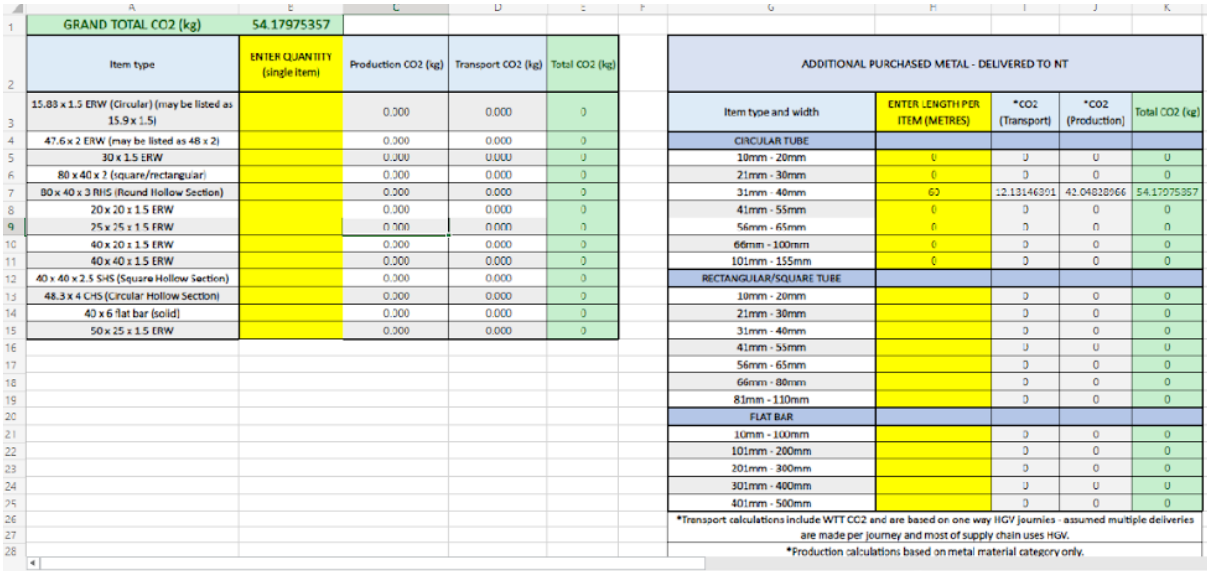
For each production and project, the NT Carpentry, Metal, Scenic Art, Props and Costume departments feed the relevant data into their spreadsheet tabs. Each department tab has a list of the stock items and each member of staff on the workshop

floor notes how much of each material they used each week for each project. From this, they input the total quantities into the yellow column (See Figure 9, which is a Carbon Calculator tab page for Carpentry). This then generates a total CO2 figure for each stock item. For example, 8 sheets of 18mm MDF were used on this project, which represents a total of 304kg of carbon. The calculator also shows the amount of carbon used to produce the stock item and the amount used in transporting it from its original source to the NT. In terms of the 18mm MDF, 283kg of carbon were used in its making and 20kg in transporting it from Ireland to the UK. This is done for every item which then produces a grand total of carbon used in Carpentry for that show or project.

	A	B	C	D	E	F
1	GRAND TOTAL CO2 (kg)	1797.33885				
2	Item type	Number of single items/metres per pack or roll (approx.)	ENTER QUANTITY (single item/single metre)	Production CO2 (kg)	Transport CO2 (kg)	Total CO2 (kg)
3	Sheets					
4	WISA PLY 18mm 8x4	1	29	494.052	89.526	583.58759
5	MDF 4mm 9x4 F/P	1	0	0.000	0.000	0
6	MDF 6mm 10x4 F/P	1	2	29.119	4.008	33.12739856
7	MDF 9mm 10x4 F/P	1	0	0.000	0.000	0
8	MDF 12mm 10x4 F/P	1	0	0.000	0.000	0
9	MDF 18mm 8x4 N/F/P	1	8	283.658	20.543	304.2006327
10	MDF 18mm 10x5	1	2	98.492	7.154	105.6457757
11	BIRCH PLY 4mm 8x4	1	0	0.000	0.000	0
12	BIRCH PLY 6mm 8x4	1		0.000	0.000	0
13	BIRCH PLY 9mm 8x4	1	0	0.000	0.000	0
14	BIRCH PLY 12mm 8x4	1	1	17.037	6.296	23.33221154
15	BIRCH PLY 18mm 8x4	1	0	0.000	0.000	0
16	BIRCH PLY 18mm 10x5	1	0	0.000	0.000	0
17	BIRCH PLY 4mm 8x4 EURO C	1	8	45.413	20.500	65.91295502
18	BIRCH PLY 6mm 8x4 EURO C	1	17	144.811	65.360	210.1707945
19	Poplar ply, class 1 6mm 2440x1220	1	0	0.000	0.000	0
20	Soft Materials					
21	3 METRE/118 INCH CANVAS PER M	55	0	0.000	0.000	0
22	4.2 METRE/165 INCH COTTON CANVAS PER M	55	0	0.000	0.000	0
23	BLACK WOOL SERGE PER M (5ft and 6ft wide)	52.5	0	0.000	0.000	0
	UNDERFELT WOOL PER M (1.37m	12.5	0.5	1.036	3.113	4.14813767

Figure 9: NT Carbon Calculator Carpentry Page (courtesy of National Theatre)

Figure 10 (below) is a similar Carbon Calculator for Metal. When a material isn't a stock item, it is recorded in a separate "additional items" list which is completed in the same way as the stock list. Some shows are very light on metal; in this instance, only 60m of circular tube was used, so the metal carbon total on this show is low.



GRAND TOTAL CO2 (kg)	54.17975357

Item type	ENTER QUANTITY (single item)	Production CO2 (kg)	Transport CO2 (kg)	Total CO2 (kg)
15.88 x 1.5 ERW (Circular) (may be listed as 15.9 x 1.5)		0.000	0.000	0
47.6 x 2 ERW (may be listed as 48 x 2)		0.000	0.000	0
30 x 1.5 ERW		0.000	0.000	0
80 x 40 x ? (square/rectangular)		0.000	0.000	0
80 x 40 x 3 RHS (Round Hollow Section)		0.000	0.000	0
20 x 20 x 1.5 ERW		0.000	0.000	0
25 x 25 x 1.5 ERW		0.000	0.000	0
40 x 20 x 1.5 ERW		0.000	0.000	0
40 x 40 x 1.5 ERW		0.000	0.000	0
40 x 40 x 2.5 SHS (Square Hollow Section)		0.000	0.000	0
48.3 x 4 CHS (Circular Hollow Section)		0.000	0.000	0
40 x 6 flat bar (solid)		0.000	0.000	0
50 x 25 x 1.5 ERW		0.000	0.000	0

ADDITIONAL PURCHASED METAL - DELIVERED TO NT				
Item type and width	ENTER LENGTH PER ITEM (METRES)	*CO2 (Transport)	*CO2 (Production)	Total CO2 (kg)
CIRCULAR TUBE				
10mm - 20mm	0	0	0	0
21mm - 30mm	0	0	0	0
31mm - 40mm	60	12.13146301	42.04838966	54.17975357
41mm - 55mm	0	0	0	0
56mm - 65mm	0	0	0	0
66mm - 100mm	0	0	0	0
101mm - 155mm	0	0	0	0
RECTANGULAR/SQUARE TUBE				
10mm - 20mm		0	0	0
21mm - 30mm		0	0	0
31mm - 40mm		0	0	0
41mm - 55mm		0	0	0
56mm - 65mm		0	0	0
66mm - 80mm		0	0	0
81mm - 110mm		0	0	0
FLAT BAR				
10mm - 100mm		0	0	0
101mm - 200mm		0	0	0
201mm - 300mm		0	0	0
301mm - 400mm		0	0	0
401mm - 500mm		0	0	0

*Transport calculations include WTT CO2 and are based on one way HGV journies - assumed multiple deliveries are made per journey and most of supply chain uses HGV.

*Production calculations based on metal material category only.

Figure 10: NT Carbon Calculator Metal Page (courtesy of National Theatre)

The same process is undertaken by the other departments, each recording the materials used and then completing the stock and additional items tables for each show or project to give an overall total. The overview page for the production then provides a carbon total, which is expressed as flight hours (See Figure 11).

Workshop	TOTAL CO2 (kg)
Carps	1797.34
Metal	54.18
Scenic Art	882.40
Props	739.60
Costume	0.00
Other - Store Runs	495.75
GRAND TOTAL (kg of CO2)	3969.27
APPROX. EQUIVALENT HOURS ON AN AVERAGE FLIGHT (PER PASSENGER)	59.7

Figure11: NT Carbon Calculator Overview Page (courtesy of National

The NT Construction Workshops' Next Steps

The NT Construction Workshops continue to identify the "next steps" on their sustainability journey with *The Theatre Green Book*. Some are very specific to their materials use – for example, the NT has little stock flattage or scenic elements. However, when building upcoming shows, they will be introducing modular metal 8'x4' frames which, like steeldeck, can be configured to various heights and sizes, with any custom made infills added accordingly. Canvas can then be wrapped to hide join lines, and then removed at the end of the run. The metal frames will go into stock and the only waste will be the canvas – which potentially could be reused depending on the finish. Kate John, Head of Production Workshops, notes that, "While this is not radical,

it is a big turning point for us and a new approach that we are welcoming and celebrating".

The NT Construction Workshops intend to continue collating and analysing the data from their Materials Inventories and Carbon Calculators, and anticipate that they will soon start to see a drop in their carbon footprint and an increase in the percentage of the materials they are reusing. The NT is already working with various sustainable companies to develop alternatives to materials such as polystyrene and MDF, and have recently connected with a production company that makes cardboard sets and props.

The NT is planning to stage a *Theatre Green Book* event in summer 2022 where it hopes to showcase and launch these new products, as well as to share broader ideas and new findings as they learn and develop: "We don't have all the answers and we shouldn't be afraid of getting it wrong or not hitting the targets or standards at these early stages. The most important thing to remember is that we're talking about it, and are trying to figure it all out, and that in itself is a positive step forward" (John 2021).

Figure 12: Daniel Monks, Danny Lee Wynter and Henry Nott in The Normal Heart *(National Theatre, 2021). Director: Dominic Cooke. Set Designer: Vicki Mortimer. Costume Designer: Lisa Duncan (Photo by Helen Maybanks)*

A Living Document

The Theatre Green Book itself notes that its principles, guidelines and targets will require refinement as more options for low carbon and reused materials become available, and the wider political and infrastructure landscape unfolds (Buro Happold and Renew Theatre 2021a: 57) – that is, at a time when theatres are prioritising economically viable reopening strategies and production resumes in an extremely

uncertain, fragile environment. The first edition of Volume 1 was produced while practitioners were largely on hiatus – with time for reflection that is unavailable during production schedules constrained by cost and scale – and based on knowledge and practices established pre-pandemic and prior to Brexit.

To be adopted and have sector-wide impact, *The Theatre Green Book* must be useable, current, and reach mass awareness and acceptance. The latter seems to be happening with exceptional speed, reinforced and accelerated by the wider public attention given to sustainability issues in the lead up to and during the UK's hosting of COP26 (the United Nations Climate Change Conference, held in Glasgow from 31 October to 13 November 2021). *The Theatre Green Book* Co-ordinator, Paddy Dillon, has reflected that: "We thought this would bleed slowly out into the industry's blood-stream. In fact, the take-up has been fantastic. That's partly due to Covid, with people thinking hard and coming back with a mind to think differently about how they work. It's also the amount of pent-up energy in the sector" (in Clark and Snow 2021: 15).

However, *Green Book* processes and recommendations still require real-world trialling and the availability of clear examples demonstrating its implementation in different contexts and types of production work. In addition to the knowledge that is increasingly being shared by companies and organisations such as Tinderbox and the National Theatre, our "Transitioning to Sustainable Production across the UK Theatre Sector" project (co-commissioned by the Creative Industries Policy and Evidence Centre and Arts Council England) will be producing three Case Studies of productions trialling *The Theatre Green Book* throughout 2022 (Mock 2021). There are also a number of new groups and networks that have been created to enhance and inform future versions – including with performers, devisers, writers and dramaturgs; with stage managers; with educators (particularly in higher education); and to enhance guidelines and recommendations related to touring practices. *The Theatre Green Book* was always designed as a living and evolving document.

At the 2021 Theatres Trust Conference, Arts Council England (ACE)'s Director for Theatre and London, Neil Darlison, stated that working to *Theatre Green Book* standards, while not mandated ("for complicated reasons"), will be expected by its NPOs (National Portfolio Organisations) as part of ACE's next funding process in order to meet its "Environmental Responsibility" Investment Principle.

In December 2021, *The Theatre Green Book* was shortlisted for the Stage's Innovation of the Year Award, on the basis that not only are its recommendations "changing internal and outward-facing policy" but that it "sets the UK's theatre industry apart in its progressive response to the climate emergency". In offering guidance, priorities and targets at a range of levels for all of the roles that contribute to the industry, *The Theatre Green Book* is "truly holistic" and makes it clear "that reducing theatre's carbon footprint can no longer be thought of as someone else's problem" (The Stage 2021).

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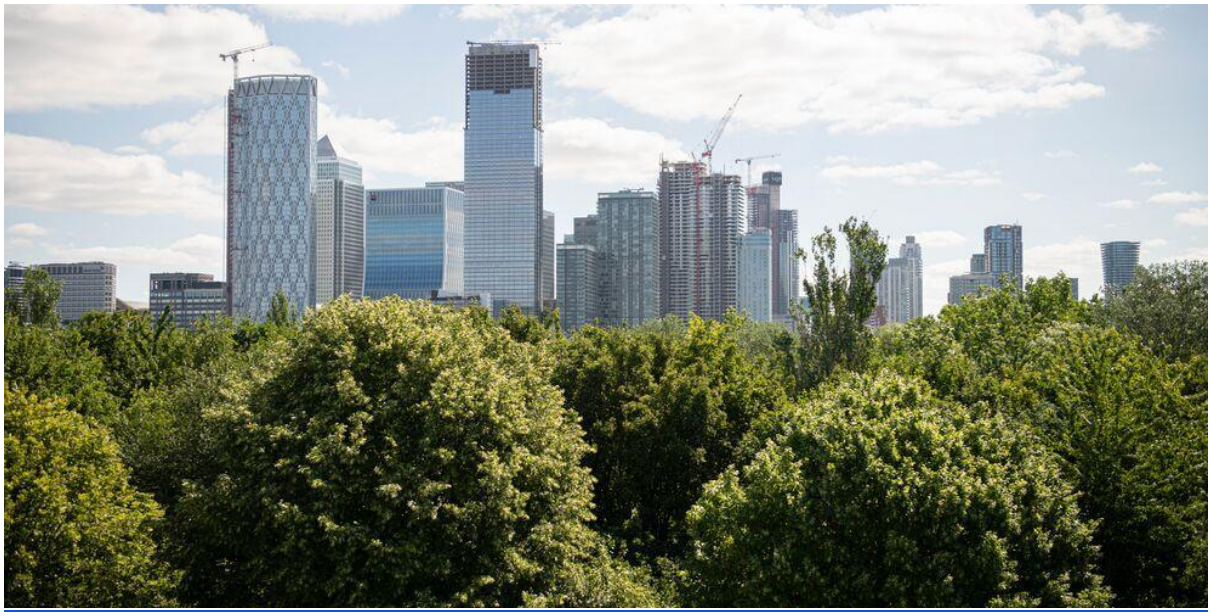
Case Study 13: Urban Forestry

Rebecca Lardeur and Peter Oakley



The Urban Forest. London Government Website

> "Every year, 36 million trees come down in cities across the United States due to old age, disease and new development, resulting in economic losses up to $786 million each year. Much of this wood could become valuable products, but instead often gets chipped, thrown in a landfill or burned as firewood. Rethinking urban wood waste could be an unexpected climate and economic solution, turning a burden on the climate and city budgets into a financial engine for reforestation across the broader landscape."
> World Resources Institute (Gartner and Christensen 2020)

Urban forestry refers to trees in the urban environment. London has, for example, an urban forest (London Urban Forest Partnership 2020). As London councils need to cut down trees for legal reasons or due to failing tree health, sawmills have been collecting these trees to turn into wood suitable for cabinetmaking and other similar purposes (Legislation.gov.uk 2021).

Benefits

Because such trees have to be cut down, rescuing their wood for a high-value use has opened a new opportunity to realise a circular economy. As the wood needs a minimum amount of transportation the carbon footprint of urban wood is extremely low. Vibrant Cities Lab, in Washington DC, has led research on the benefits of urban wood, highlighting:

> "Urban wood reuse can reduce greenhouse gas emissions, improve environmental quality, reclaim abandoned housing, stimulate new local enterprise and increase career opportunities for hard-to-employ individuals." (Vibrant Cities Lab, 2021)

Another benefit of urban wood is the availability of rare and high-quality wood species. The species planted in cities are usually chosen for their aesthetic qualities, whereas forestry plantation trees are selected for speed of growth and ease of harvesting.

Urban trees are allowed to mature, it being in the interest of council tree officers to ensure their trees live long and healthy lives to reduce planting and removal costs. Urban trees are therefore more likely to reach a girth that makes them viable for sawmills.
Some species are extremely well suited to urban conditions. The London plane, a hybrid species, was originally planted in the city due to its hardiness and pollution resistance. In addition, its unique lace grain makes it a very desirable wood for cabinetmakers.
Walnut trees release chemicals in the soil to inhibit biodiversity and so reduce competition, which is problematic in most woodland management contexts. But as street trees are often isolated, walnut trees are great candidates to be planted in the urban environment. This would help the species to recover in England; the English Walnut tree is currently classified as 'Near Threatened' by the International Union for Conservation of Nature (Meier 2020). Walnut wood is dark, well grained and has excellent working properties, which makes it highly desirable to craftspeople, with walnut lumber selling for up to four times the price of oak (Brown 2011). A walnut tree takes at least 60 years to mature. In comparison pine trees typically take 25–30 years in the same environment (Gardening Channel 2021) to reach the required size to harvest. Consequently, planting pines is the investment preferred by many forest managers. There is also growing demand for urban orchards to feed local urban populations; walnut trees could provide a regular nut supply.
Instrument makers have found salvation in urban trees, due to these trees' capacity to fill in as replacement tonewoods. A tonewood is known for its aesthetically pleasing sound properties and such woods are a necessary material for musical instrument makers. Only certain types of trees are suitable and most of these are found close to the equator. However, recent research has shown that rosewood trees (traditionally a highly prized wood for guitar-making) replanted in the Amazon Forest after deforestation grew too rapidly, due the lack of shade. They lacked the compact grain and associated tonal characteristics found in rosewood harvested from old growth forest where young trees had been shaded by mature growth (Errede 2017). However, in urban environments, due to the shade of surrounding buildings, trees grow slowly and develop a close grain that gives tonewood properties, making many urban species suitable replacements for use in music instruments.

London's Urban Wood Supply

Urban forestry relationships have been established in London. Bruce Saunders (Saunders Seasonings n.d.) is a sawmiller and maker who has established connections councils and tree surgeons to salvage urban trees. Saunders' promotes his lumber products as low carbon hardwoods and has received awards for his work. Bruce comments on his website:

> "Over 5,000 mature trees are felled in London every year – oak, London plane, sycamore, ash and more. Most are simply chipped and burned. It's a huge waste. And when you consider 93% of hardwood sold in the UK is imported, it's also an environmental opportunity missed."

Cabinetmakers such as Sand Buchanan (Sand Buchanan 2021), use urban forestry timber in studio cabinet making businesses.

Left: Saunders Seasoning. Right: Furniture by Sand Buchanan

Sand comments on the value that the individual histories of each piece of local wood bring to his practice and his journey towards sustainability:

> "Only by understanding where they [materials] come from can you begin to understand the impact you are having by using them. Knowing which wood, estate, or street my timber has come from, I can understand why it was felled. In the case of my timber, it is because of storm damage, disease, or as part of a regulated woodland management plan. (...) Through my work, I hope to play a small part in supporting the forestry industry in the UK and am a firm believer that if we don't use it, we will lose it." (Clanford 2020)

International Urban forestry

The urban forestry model is winning supporters internationally. There is a growing trend for using urban wood to make musical instruments, as some rare species are now more readily available from urban forestry than any other source.

Clark's head of wood technology, Karl Krauss, head of a municipal council near Melbourne, Australia, saw his council removing sycamore-maple trees (Gibson and Warren 2021). He recalled their historical use in Renaissance instruments and salvaged them for a limited run of guitars.

In California, Taylor Guitars Inc. recently introduced three "Urban Ash" models made from trees felled by municipal governments in California and Arizona (Miller 2020). Taylors commitment to urban forestry now also extends to supporting city tree planting events, including replanting Shamel Ash, the same species they are now using to make guitars.

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