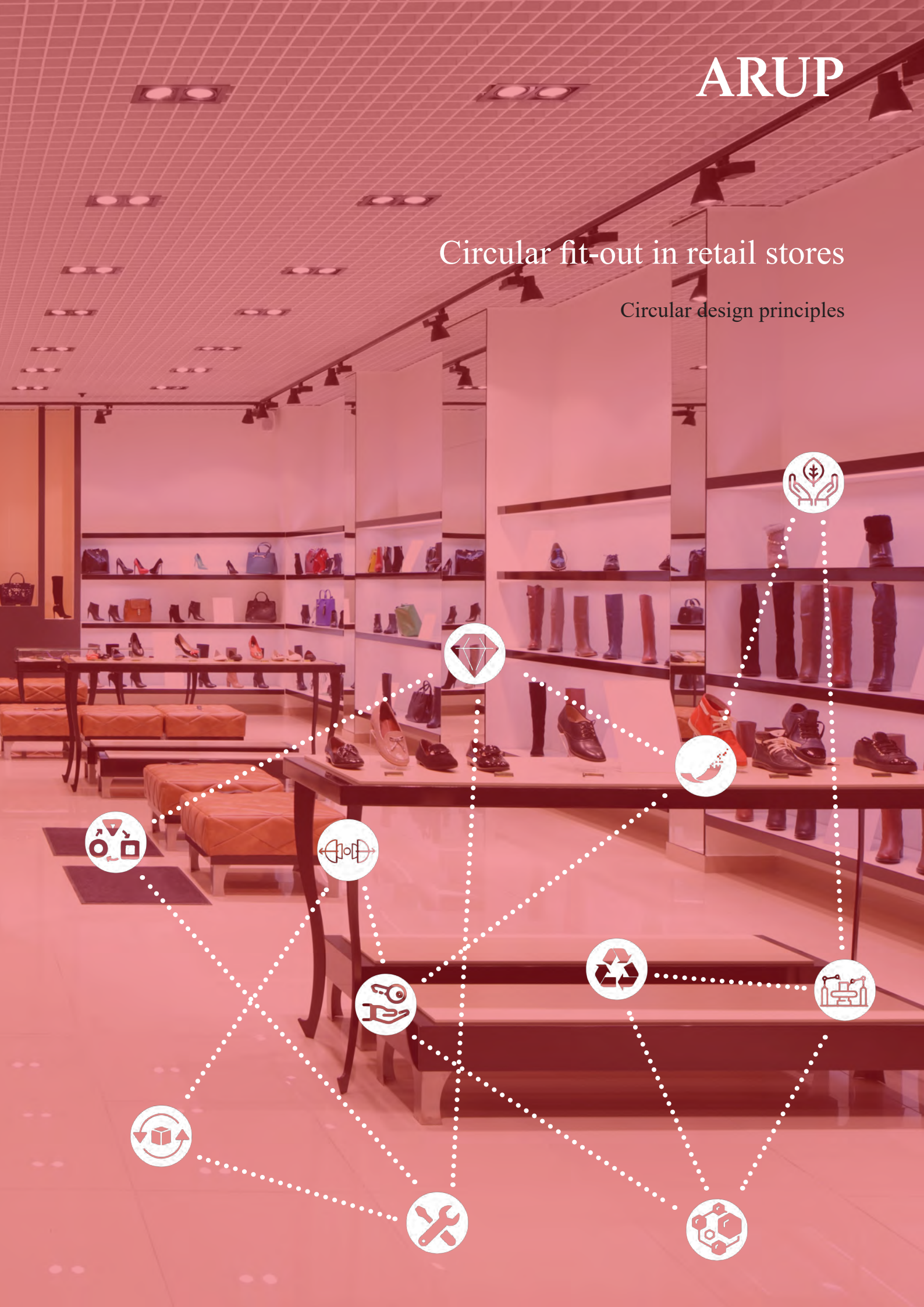
ARUP

Circular fit-out in retail stores

Circular design principles



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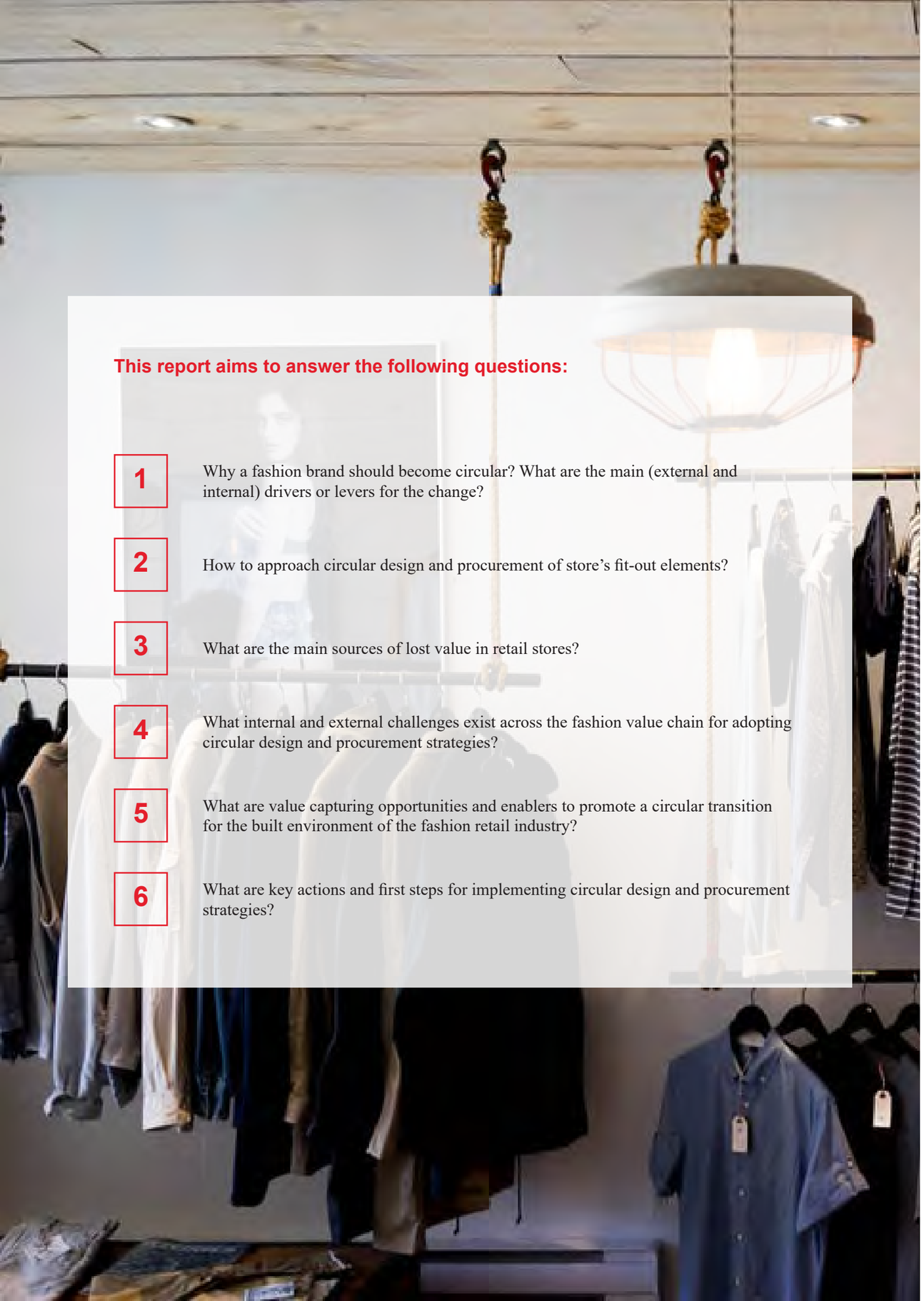


This report aims to answer the following questions:

1. Why a fashion brand should become circular? What are the main (external and internal) drivers or levers for the change?
2. How to approach circular design and procurement of store's fit-out elements?
3. What are the main sources of lost value in retail stores?
4. What internal and external challenges exist across the fashion value chain for adopting circular design and procurement strategies?
5. What are value capturing opportunities and enablers to promote a circular transition for the built environment of the fashion retail industry?
6. What are key actions and first steps for implementing circular design and procurement strategies?

Foreword

The circular transition is an urgent matter for the retail sector and a necessary step for companies after recovery from Covid-19 restrictions and to align with the European Green Deal. Moving towards a truly circular economy will not be achieved in one step. This report is intended to raise awareness on circular design approaches for the fit-out of stores, as part of a more comprehensive strategy for the transition towards a circular built environment.

Fashion is often highlighted as one of the most critical sectors in terms of its environmental impact, mainly due to the fast pace of change according to market trends and customers needs.

The internal fit-out of retail stores (internal wall cladding, pavement and flooring, temporary tools, props, graphic materials, furniture, lighting, etc.) changes frequently, on a seasonal or even weekly basis, following different holiday calendars, marketing strategies and maintenance on a global level.

It results in a shorter lifecycle compared to the potential materials' design life and, in most cases, a continuous flux of locally unmanaged waste.

In recent years a lot of fashion brands have started developing sustainable and circular strategy. However, little has been done in relation to the shift towards a circular built environment.

Through re-designing store fit-outs to better enable disassembly, remanufacture, reuse, upgrade or recycling of components, significant opportunities can be realised for reducing the environmental impact of the fashion industry. With the evolution of design the potential for carbon reduction dramatically lowers.

The systemic nature of the circular economy requires a holistic approach for the shift towards a circular business model at a corporate level across departments, by engaging with relevant stakeholders within the entire value chain.

Systemic thinking and innovation enable value capturing opportunities to be identified through reconsidering asset and resource use.

To get there, this report provides a set of guiding principles across circular design for retail store's fit-out elements, besides key value capturing opportunities and first steps to help driving the change across the industry from different stakeholders' perspective.

Methodology

This report is intended as a guide for retailers and stakeholders across the fashion value chain who would like to explore circular design and procurement approach for the fit-out of stores.

We developed a four-stage methodology to substantiate the report both with theoretical research approach and business perspective. We hope to influence retailers and the related key stakeholders to adopt a circular design approach and be inspired by value capturing opportunities across the value chain to scale this thinking across the industry.

1

Literature Review

Knowledge gathering on circular design principles, through literature review and based on our experience of working across the circular economy field and in the retail industry.

2

Circular Design Workshop

Internal workshop with our designers, architects and engineers across Europe to identify key opportunities for the application of circular design principles to fit-out elements of retail stores.

3

Stakeholder's Engagement

Engage with key stakeholders and retailers across the fashion value chain through interviews to validate key insights from a business perspective.

4

Experts Review

Final exper review of Arup experts and Academia.

The circular economy is one that is restorative and regenerative by design, which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles.

From: Ellen MacArthur Foundation

The Definition of Circular Economy

The three main principles of circular economy

PRINCIPLE 1

Design out waste and pollution

promoting the reduction and elimination of negative impacts during the design phase

- Waste and pollution are largely a consequence of the decision made at the design stage
- A mindset shift is required to consider waste as a design fault in order to rethink design practices in a new and creative way

PRINCIPLE 2

Keep products and materials in use

preserving the value of materials and products over time

- Extend products and materials lifespans
- Keep them in use as long as possible by reusing, repairing and remanufacturing
- Ensure that fast consuming goods can be reclaimed and materials recycled

PRINCIPLE 3

Regenerate natural systems

favoring the use of renewable energy and materials

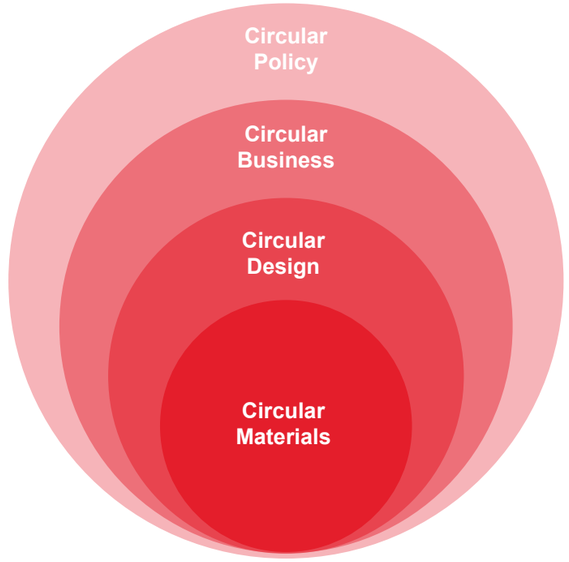
- Return valuable nutrients to the soil to support regeneration
- Preserve and enhance natural resources
- Use renewable energy as opposed to fossil fuels

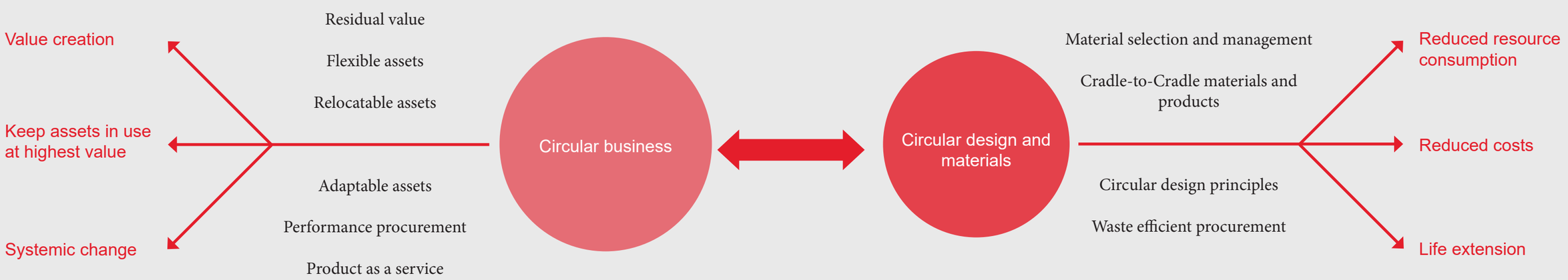
Circular economy as a cohesive strategy

Circular economy needs to be considered as a design, materials and business strategy. A circular approach could help the retail sector to reduce its environmental footprint, and to avoid rising costs, delays, and other consequences of volatile commodity markets that will arise in the future. Adopting circular economy principles can change public and private sector through a systemic approach and mutually supportive strategies across four distinct levels: planning, business, design, and materials.

Policies are key enablers for setting the directions and requirements to enable the circular transition. By applying circular economy principles at corporate level influences governance and dictates how value is created across the business.

Circular design approaches and materials selection influence resources flow both now and in the future. Each of the strategies will need to be aligned with the interests and ambitions of stakeholders from across the value chain. For private businesses, it is suggested to start applying circular economy principles at the business strategy level as it dictates how revenue is generated and value is created. Starting here means that the business case for designing and managing materials in a circular way will be stronger.





The 9R Framework

Several frameworks have been developed with the aim of identifying circular economy's main principles. The 9R framework provides 9 strategies ranked in a descending order according to their "circularity", as indicated by the arrow.

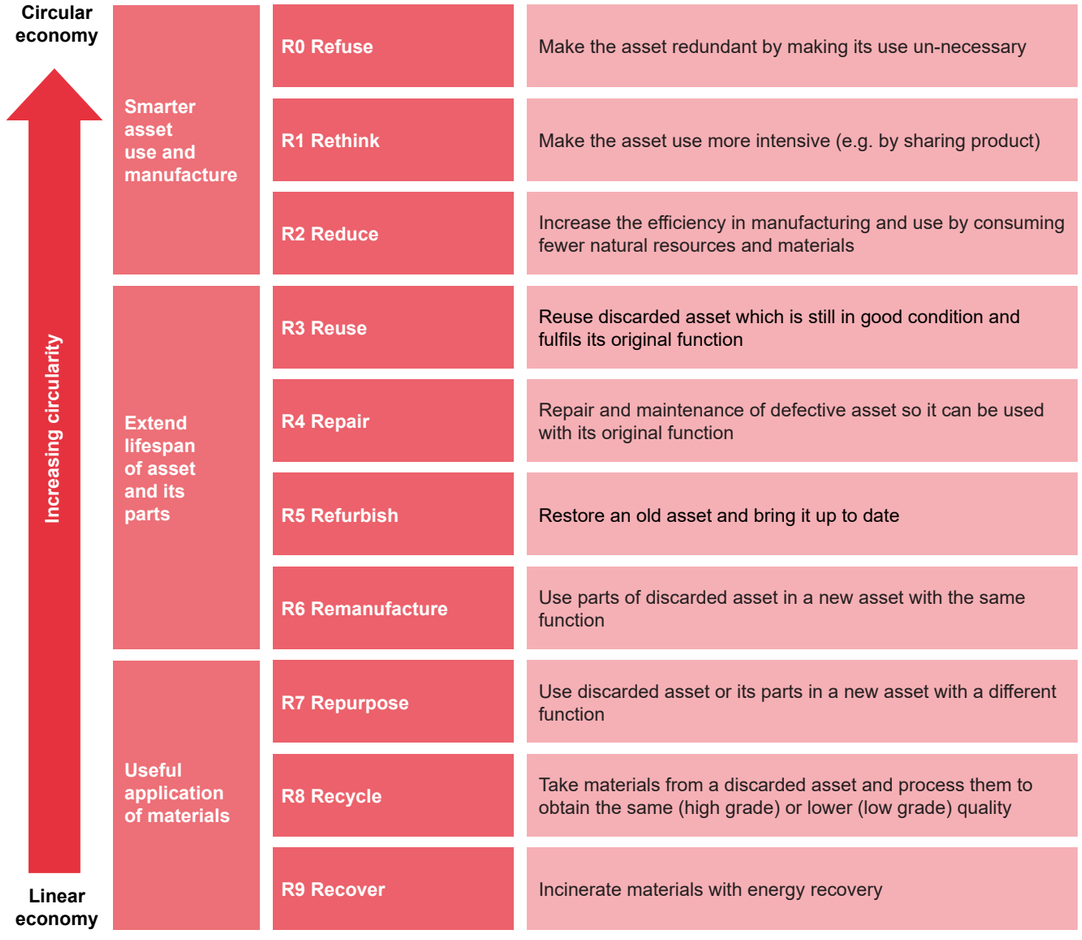
The first strategies are the ones that allow higher level of circularity. Coherently with the EU Waste Hierarchy included in the Waste Framework Directive 2008/98/EC, the decreasing circularity of the 9 strategies suggests to practitioners a sort of priority order for their actions, supporting them in the decision-making process. To make an example, refusing the usage of plastics in packaging is more effective than recycling it.

The 9 strategies to achieve circular economy are divided in 3 different categories according to the dimensions impacted.

1 **Smarter asset use and manufacture**
related to the manufacturer process and user behaviour

2 **Extend lifespan of asset and its parts**
to keep in the same loop the functionalities and the value retained in product and components

3 **Useful application of materials**
to exploit product or components for other purposes, when they can no longer be cycled within the original loop



Adapted from Potting et al., 2017

The value of a circular economy

Health and environment

Reduce virgin materials

Decarbonisation and reduction of raw materials and virgin inputs.

Save energy and water

Use of more efficient and to the extent possible renewable productive ecosystems.

Reduce waste and emissions

Resources in production-consumption systems are used many times, increasing products life.

Reduce health risk

Safe and non-toxic material inputs would reduce health risks for people across the full supply chain and wider environment.

Social prosperity

Provide job opportunities

New employment opportunities supporting growth and innovation.

Support local communities

Local procurement and relationships support small businesses compared to big enterprises.

Increase sense of community

A sharing economy enhances co-operation and participation of communities as compared to individual product ownership and consumption.

Economic productivity

Market potential

Green investments enhances brand image and attracts investors.

Economic reliability

Regulatory compliance and investment reliance risks are reduced.

Reduce operational costs

Product life extension drives higher quality and reliability, reducing both operational and product returns costs.

Reduce procurement costs

The use of costly scarce resources is minimised. Transportation cost savings through local procurement.

Waste management costs

Disposal and dismission costs are reduced considering refurbishment, reuse and repurpose activities.

New market opportunities

New revenue streams can be created through systemic business rethinking.

Resilience of supply chain

Reduction in planning risk. Enhanced reliability against price volatility and low availability of materials.

A win-win concept

A successful circular economy contributes to all the three dimensions of sustainable development: economic, environmental, and social.

The Retail Sector: why circular?

Over the past few years the retail sector has been facing important changes, from both regulations and the market. Companies are being encouraged at a corporate level to undertake a transition towards circular economy.

Driving forward circularity is a strategic decision that companies are evaluating and starting to implement. External drivers and system conditions are currently driving the implementation of circular economy and business models.

Policies and frameworks

The new and upcoming regulatory trends and policy alongside emerging market needs are having an impact on the retail sector to achieve identified targets toward reducing environmental impact (GHG emissions, pollution and waste, biodiversity, water, land use and natural resources conservation).

With the 2015 Paris Agreement entering into force, countries from all over the world are now developing action plans to make the economy sustainable, such as the main EU Green Deal and Biden Sustainability Act. These set the intermediate targets to achieve the overall goal of keeping global warming below 2°C. In particular, the European Commission has delivered even more ambitious objectives through the Climate Law, aiming for the carbon neutrality of the continent by 2050.

Also, finance flows need to become consistent with this pathway towards low emissions and resilience, both regarding large public investments (e.g. EU Just Transition Fund) and bringing on board private investors to reach a significant step change. Sustainable Finance within the EU sustainable action plan sets targets for projects to be economically supported by investors and financial players. Companies have to provide disclosure agreements and reporting of their commitments. To support the decision-making process of private investors, the EU Taxonomy provides a wide definition of sustainable investment, suggesting actions which narrow from climate change mitigation to circular economy. In this light, it is possible to notice how more and more investors and managers are now adopting Environmental, Social and Governance (ESG) criteria to guarantee green finance.

According to the EU Circular Economy Action Plan, the focus should be put on the most resource intensive sectors. Since construction & buildings is one of the main contributors to greenhouse gas emissions, investments in this sector play a significant role and, thus, must be considered a priority. If sustainability certifications such as BREEAM and LEED are already increasing the value of the project itself, circularity assessment will soon be the next step. To gain competitive advantage, several real estate players have become early adopters in embedding circular economy principles in the design and planning phases, shifting the focus from operational carbon to whole life-cycle analysis.

Business trends

The retail landscape is drastically changing and physical stores are expected to have a new role moving forward.

Some retail brands act as a sort of a centre of gravity: they drive the change in the industry.

Policies and regulations are coming but brands need to be ahead of change and anticipate trends.

The COVID-19 pandemic was the cause of a drastic change in the customer's behaviour, that is shifting towards digital purchasing channels, driving the closure of many retail stores.

Omni-channel retail strategies blend the digital and the physical channel, delivering a seamless purchasing experience to customers across multiple touchpoints. The customer is then able to switch from one channel to another with no friction. This is expected to unlock store design strategies from sales logics, becoming a sort of exhibition for the brand identity, as the final stages of the purchase will be mainly online.

This trend may reduce the time pressure related to a number of stores' openings, therefore allowing circular design to be implemented from early store planning phases.

Customer engagement that goes beyond the point of sale unlock economic opportunities and promote sustainable behaviours. It reflects on store design toward improved circular customer experience.

The increasing societal awareness of broader environmental issues affects the market needs, with customers putting more attention to the impact not only of the product itself, but also of the activities performed by the brand. Customers are already asking for the change and want brands to be responsible and committed to social and environmental actions.

Brand identity and reputation is interconnected with company ethics and health & safety management of human capital. Sustainable and circular transition shall be undertaken with tangible and quantifiable actions against identified goals and targets.

Transparency and accuracy of accounting methods would be therefore necessary to drive decisions and set directions. Innovation and digital technologies have the potential to bring value at a corporate level for environmental impact reduction, customer experience improvement and economic opportunity generation.

The future of retail

As identified in "A Framework for the Future of Real Estate" by the World Economic Forum, three key success factors are expected to drive the store of the future: resilience, liveability and customer experience, sustainable development.

These three can be considered a fertile ground for the implementation of circular principles.

Ralph Lauren © uses behavioural data for customer segmentation, potentially applicable to circular designed stores' objectives

Resilience

To face a fast-changing environment, retailers should adopt a data-driven portfolio approach to manage stores as a network (e.g. customer feedback, most viewed item), to better understand aspects like brand identity, trend behaviour and target audience, or also developing collaborative relationships with landlords to share risks.

Illy © modular store in Milan, Italy

Liveability and customer experience

Flexible and dynamic store design (e.g. modularity, adaptability) to be equipped with digital solutions that allow to adopt omni-channel strategies.

Country Road © green store in Chadstone, Australia
Certified by the Green Building Council of Australia

Sustainable development

Store design as part of a more comprehensive decarbonisation and circular strategy at the firm level (e.g. low-carbon materials, energy efficient stores) to comply with new policies and frameworks and secure brand's loyalty.

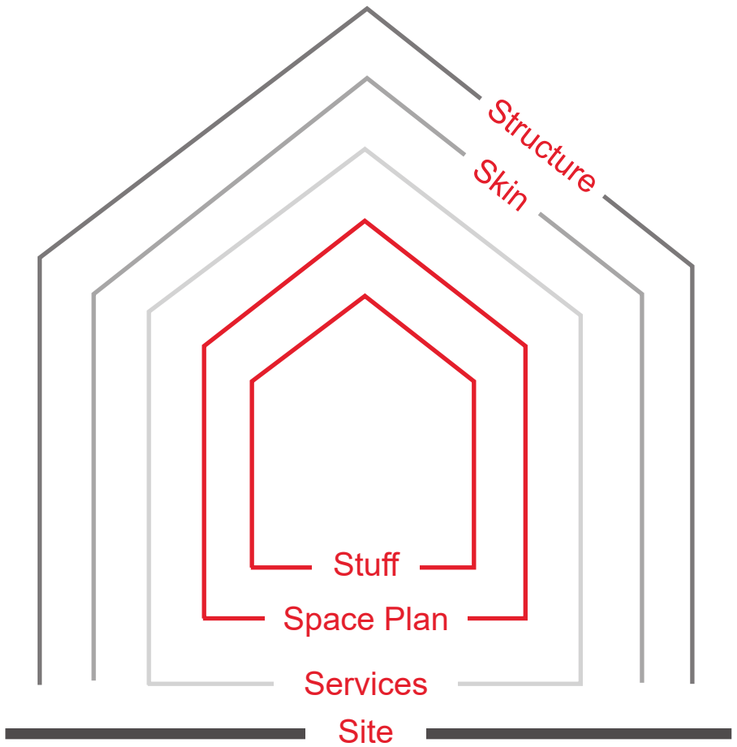
Retail stores built environment

The present study refers to the retail store environment, considering medium-size stores in a leasing model.

The considerations proposed in this report mainly apply to retail brands who sell personal goods: apparel and accessories, cosmetics and fragrances, watches, and jewellery.

Brand agreements with landlords may be of different types: the following assumptions refer to store types in which brands do not have the control on building skin, structure and services.

Indeed, the analysis provided in the report only applies to the store interior, or the so called “space plan” and “stuff” layers according to the “Building Shearing Layers” or onion layers model, where each layer has a distinctive functional cycle and life span. These elements are highlighted as key for consideration as with the shortest lifespan.



Building Shearing Layers Model

Retail store layers and their lifespan

SITE

Site is the fixed location of the building.

STRUCTURE

30 / 300 yrs

Structure is the building’s skeleton including the foundation and load-bearing elements.

SKIN

20 / 35 yrs

Skin is the façade and exterior.

SERVICES

15 / 30 yrs

Services are the pipes, wires, energy and heating systems.

SPACE PLAN

5 / 7 yrs

Space plan is the solid internal fit-out including walls and floors.

STUFF

0,5 / 5 yrs

Stuff is the rest of the internal fit-out including the furniture, lighting, and ICT

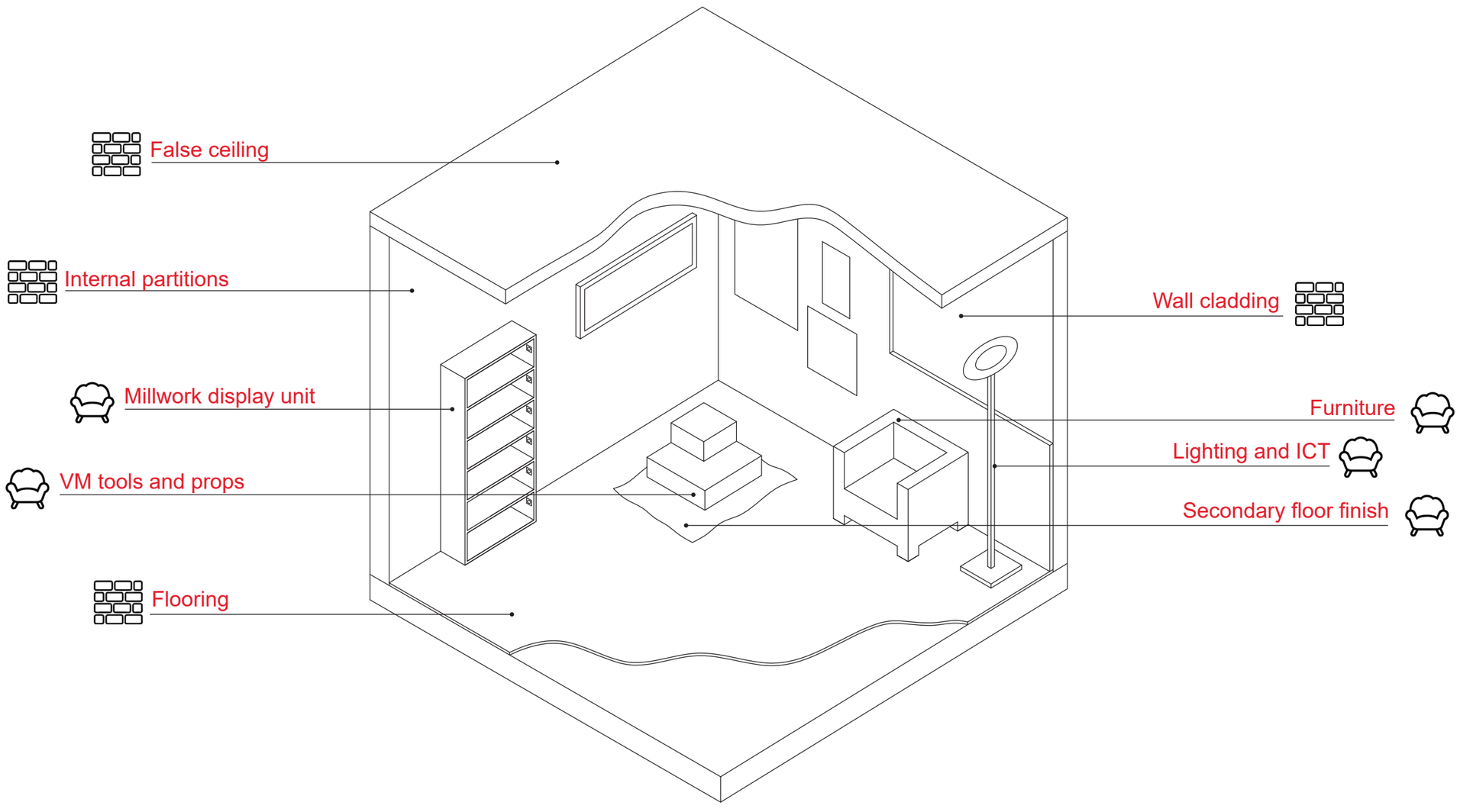
Store fit-out elements

SPACE PLAN

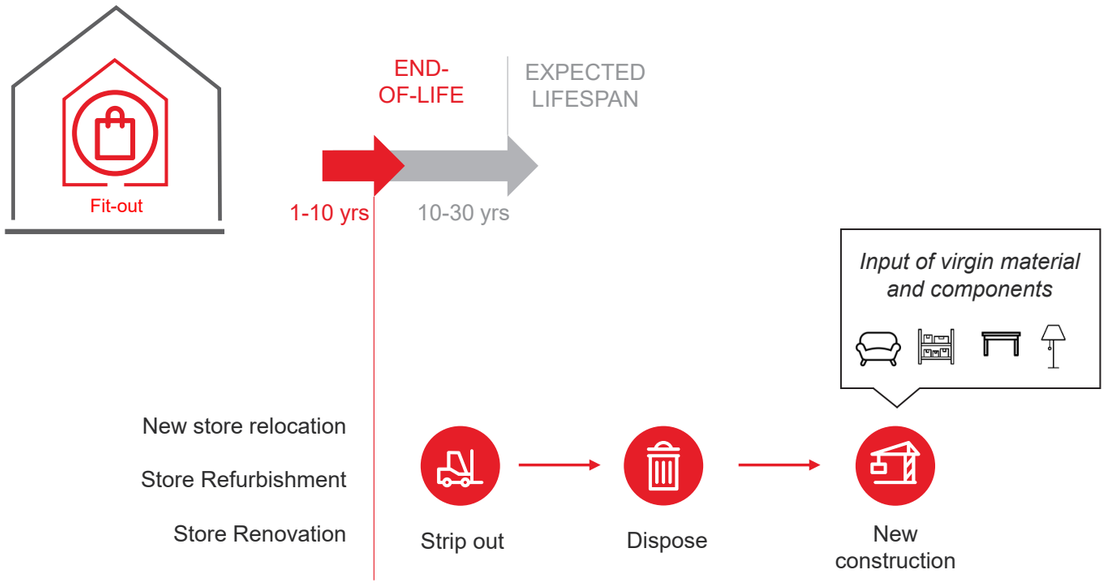
Solid internal fit-out including walls and floors

STUFF

Rest of the internal fit-out including the furniture, lighting and ICT



Sources of lost value



Construction has the highest raw material consumption when considering all types of materials together (Eurostat) and is responsible for around a third of all of EU waste generated.

Around 80% of investment in construction goes into buildings (FIEC Statistical Report) so this sector is especially important for circular economy. Overall, the built environment in Europe is reportedly just “8.6% circular” (Circularity Gap Report).

A circular economy sounds good, but it is affected by many barriers and obstacles. It is more a challenge related to mindset of teams and stakeholders. Focus should be put on creating business models that ease the adoption of circular economy by filling the existing gaps.

Fit-out is often excluded in circular economy conversations as it may appear that building foundations, structure and façade generally impact for the greatest part building carbon footprint calculations, associated building material and energy. However, by looking at the whole life cycle over 60 years building lifespan, store’s fit-out may be replaced 7-8 times.

Space plan and stuff layers undergo more frequent changes and have the shortest lifespan, impacting on carbon footprint and waste generated if not properly designed and managed across their lifecycle.

Retail store’s re-fitting can occur for a number of reasons, like store relocation, store refurbishment and store renovation. The process can be broken down into a series of stages.

After the design of a new store is developed, the old store is initially stripped out. Notably, landlords and new clients often demand that the site is stripped out completely prior to new fit-out activities, starting new construction from scratch. The removed elements are eventually disposed and new construction occurs. New operations mainly involve use of new components and virgin materials.

Main sources of lost value are identified in the next page.

2-10 yrs

Typical design life and replacement cycle for commercial fit-out design for retail use.

An assessment of carbon emissions from retail fit-out in the United Kingdom, 2009

50%

Of the total use of raw materials can be attibuted to the construction industry.

The Routemap for Zero Avoidable Waste in the Construction Sector, 2020

£11 bn

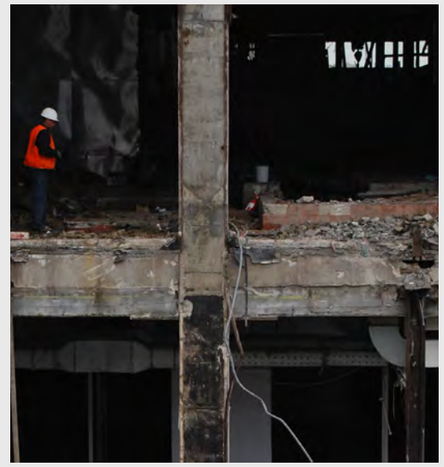
Are spent on waste every year in the UK construction industry, accounting for 3.5 million tonnes of CO_2 emissions.

A framework for circular building. Indicators for possible inclusion in BREEAM, 2018

78 %

Of embodied emissions in retail department store’s fit-out belong to false ceilings (30%) and flooring (48%).

An assessment of carbon emissions from retail fit-out in the United Kingdom, 2009

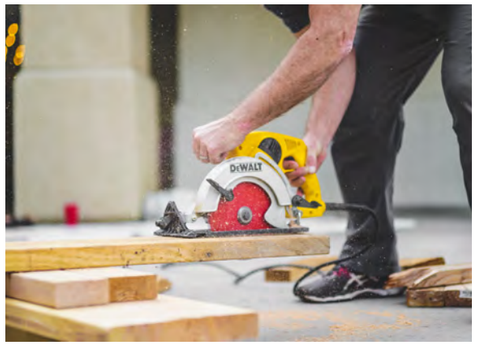


Between 2005 and 2018, construction waste levels grew more than 10 times faster than from 1990 to 2005.

United States Envirnomental Protection Agency

23% of the US national waste stream is estimated to be C&D waste

US Bureau of Trasportation Statistics



Frequent stores' refurbishment

Description

Retailers tend to dispose store's fit-out well before materials have depleted their intrinsic value, due to the frequency of store refurbishments. Flagship and street stores are usually refurbished every 6 to 8 years, while shopping centers stores may have shorter lifespan (3-4 years). The lifecycle of temporary stores and pop-ups are extremely short (from less than 15 days up to 2 years) and shows last just for the duration of the specific event (one night or a weekend). In-store visual merchandising and windows are replaced yearly or even once a season (4 times per year).

Causes

- A store can be heavily refurbished for commercial reasons like improving sales, moving location due to presence of competitor brands.
- Change in the top management of a fashion brand often corresponds to a change in philosophy. This implies rethinking the store design concept.
- As for fashion, also fit-out of stores is affected by market design trends.
- Launches of new products (or re-push) and the start of a partnership with a new brand ambassador often causes store's concept renewal. Launches can happen 3-4 times per year, according to brand and type of launch.

Material selection

Description

Fit-out materials are often more durable than the expected lifespans for which they are designed. Durability is not commisured to their specific use. As a result, their high residual value is not captured at store's end-of-life.

Causes

- Stores are characterised by intensive use due to significant customers fluxes, damaging the integrity of fit-out.
- Fit-out elements may be sometimes mistreated by sales assistants, who are mainly focused on keeping high the customer engagement to sell products rather than having care of the fit out elements.
- Maintenance cost may be reduced by purchasing more robust components.
- Stores' fit-out is often used to communicate brand identity to customers. Circular materials quality could be sometimes hardly compatible with luxury brands high end positioning.
- Needs to move fit-out elements for temporary events or shows within the store could be enhanced through durable elements.

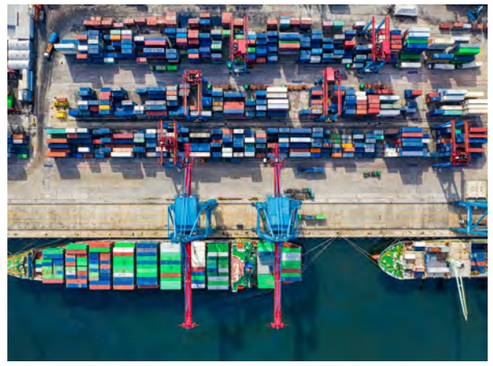
Limited fit-out second life

Description

During store refurbishment, fit-out components are rarely reused or redeployed, becoming waste going to landfill.

Causes

- The fashion industry is strongly dependent on intellectual property for their design. Fit-out elements clearly represent a style or a concept, meaning that retailers do not allow others to reuse them. This is valid also at group level to avoid non-authorised brand image appropriation with other brands of the same group.
- Internal reuse between stores of the same brand could sometime be difficult to be implemented in case of limited possibility of components to find their place in new store concepts.
- Often, due to stringent ergonomic requirements, it is not possible to reuse old store's chairs and desks in offices and back of houses.



Logistics

Description

Retail industry is characterised by frequent and long transportations to procure fit-out elements. They also require robust packaging, resulting in larger amount of materials disposed. In addition, productions volumes are fluctuating according to a make to order model, where products are manufactured only once orders are received, in small quantities. This model is widely adopted by fashion brands and multiplies the number of shipments.

Causes

- The common practice is to source from centralised partners to optimise quality, time and costs.
- It is common to give rewards for those warehouse managers able to keep stock volume low, like the turnover ratio, which leaves room for opportunistic behaviour and frequent orders with low and variable volumes.
- For retailers it is important to keep high asset turnover ration as it states the efficiency of the company in generating revenue from its assets. Products stored in warehouses are decreasing this performance.

Barriers

The following internal barriers may require a change in the mindset of brand's organisation and in their business model towards the implementation of circular economy practices.

Brand identity and intellectual property

The fashion industry is strongly dependent on intellectual property. A brand's identity associated with materials themselves often does not allow to easily cycle end-of-life items, inhibiting the possibility to adopt service models (e.g. product-as-a-service) or to reuse and repurpose fit-out elements externally in secondary markets or for donations. Suppliers are affected too by intellectual property issues for a competitive advantage in the B2B market.

Decision making

Often the timing is too tight to make it right.

Store concept design is mostly developed by the brands' design team or through collaborations with architectural firms, driven by the Creative Director's instructions and close supervision. Each design concept is different from another and provide uniqueness to the brand. Bespoke solutions and high-quality manufacturing are often foreseen. High quality and aesthetic level, fast delivery and project budgets are the main drivers for design development.

Adoption of responsibly sourced and reclaimed materials may be resisted due to their aesthetics that could not often meet the design intent. In addition, standardisation and modularity may be perceived to be in contrast with a brand's uniqueness and exclusivity standards.

The design of the fit-out and material choices are direcly sent to suppliers which realise the detailed design. After brands validation, value engineering activities are carried out to bring improvement and optimisation of costs and resources. Sometimes the value engineering happens in the tender stage. However, key stakeholders in the value chain (suppliers, integrated design consultancy companies, etc.) perceive themselves more like executors with few possibilities of influence on the approved concept design of the brand.

Supply chain readiness

Cost-time issue is a key barrier for retailers.

Responsible sourcing is often affected by low market availability and time pressure constraints that manufacturing companies have to respect. Suppliers of low-impact materials might also choose to keep production volumes low with high prices, generating higher revenues by selling fewer material. This results in the reduced feasibility of circular procurement as manufacturing will take longer time than conventional materials.

In addition, environmental product declarations, not mandatory by law, may present a pricing problem as certified products may be more expensive.

Waste management

"Waste is material without an identity"

Thomas Rau, Madaster founder, author of 'Material Matters' book

Waste from stores is not usually tracked and it is managed by third-party companies. The main challenge for brands is to understand how all over the world waste is managed, considering also the differences in local regulations for disposal. From a geographical perspective, there is often an unequal distribution of recycling facilities between countries and a lack of local waste treatment guidelines provided by municipalities. Several countries do not have a reticular waste collection system and waste needs to be sent far away from where it is produced. In addition, reverse logistics is often inhibited by limited amount of waste volumes to be kept in the loop and cost issues related to the lack of local waste management involvement and of waste division criteria.

Centralised procurement

In the fashion industry, most suppliers of fit-out are European or Italian, due to their high quality manufacturing level, especially required for high-end stores. Even if local purchasing could be an option, economies of scale, time pressure and quality reasons in delivering fast changing design concepts let brands rely on trusted suppliers, centrally managed and with which they can establish exclusive contracts.

Physical connection

Visual mock-ups and prototypes are needed for design and material selection approval. Virtual prototypes with digital tools are not often adopted as they could provide sometimes a non-realistic perception of the real object. Specific surface finishing could look differently according to the light exposure. For this reason, brands and suppliers have dedicated spaces to test visual mock-ups and try different finishing options in real time under specific light scenarios.

Circular design

Design is a key project stage according to the first principle of circular economy, “design out waste and pollution”. The aim of circular design is to prolong the life cycle of a product, reduce resource and materials use and to loop existing ones continuously back into the system.

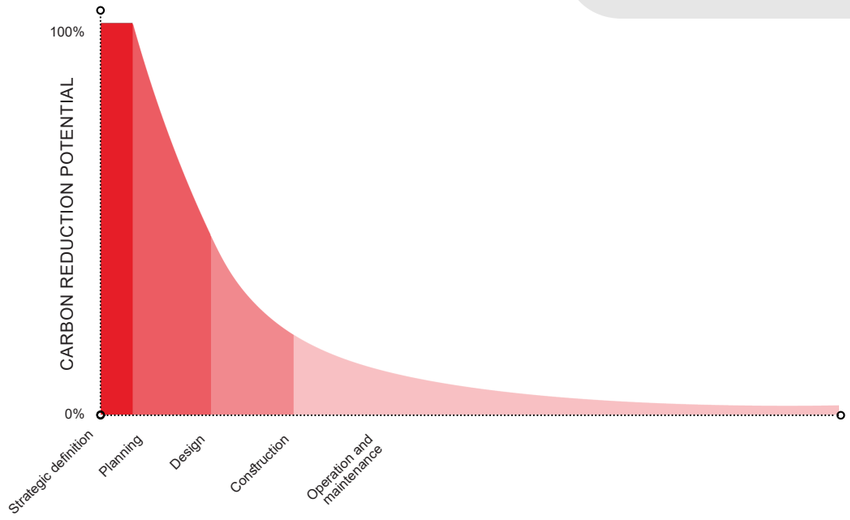
Fit-out elements’ lifespan could last much longer than their design lifecycle: this should be considered in the design phase to embed circular principles right from the start.

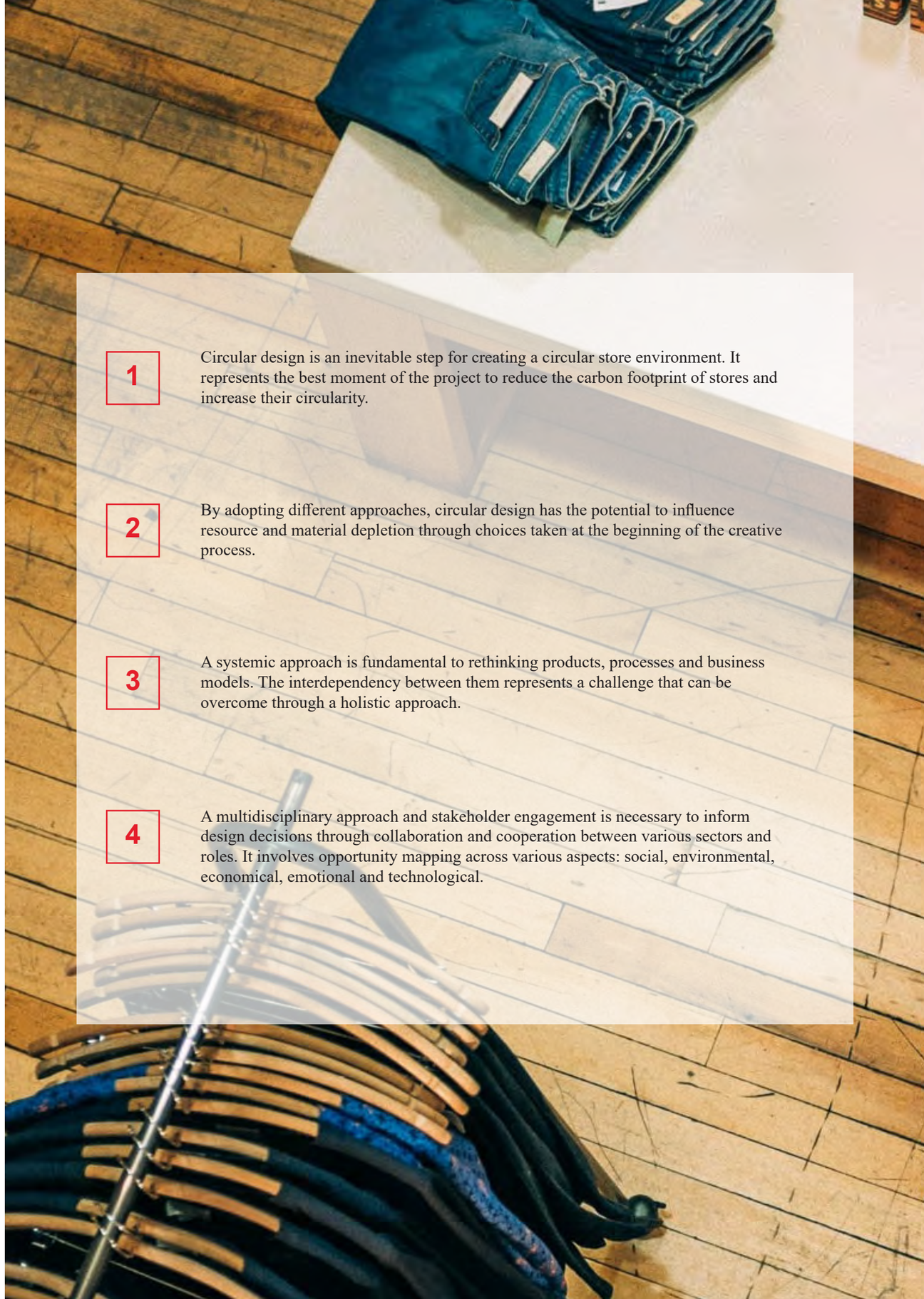
Opportunities for a circular fit-out are not just related to decarbonisation, the amount of materials reduction or the lifespan of an element. A commitment should be made at the start of a project to rescue and reuse materials in a range of lifecycles rather than just one.

Circular design requires a transformation in the way fit-out elements are manufactured, by rethinking the system they are part of. In order to apply this systemic approach, the full life cycle of stores must be considered to inform the design and enable the application of circular economy principles.

Why is circular design essential?

Because the carbon reduction potential reduces dramatically as the design progresses.





1. Circular design is an inevitable step for creating a circular store environment. It represents the best moment of the project to reduce the carbon footprint of stores and increase their circularity.

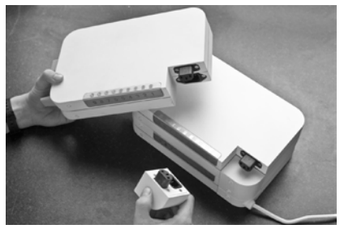
2. By adopting different approaches, circular design has the potential to influence resource and material depletion through choices taken at the beginning of the creative process.

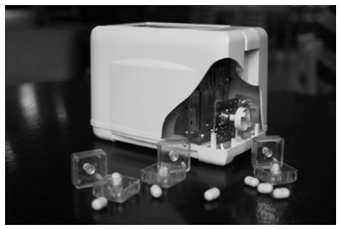
3. A systemic approach is fundamental to rethinking products, processes and business models. The interdependency between them represents a challenge that can be overcome through a holistic approach.

4. A multidisciplinary approach and stakeholder engagement is necessary to inform design decisions through collaboration and cooperation between various sectors and roles. It involves opportunity mapping across various aspects: social, environmental, economical, emotional and technological.

There is “no one size fits all” solution when designing for a circular economy

As an example, the Agency of Design in their “Design Out Waste” project designed a common household good, the toaster, through three different circular design approaches.





The optimist

Design to last for generations

Nothing to break

Unclip and replace components

Few moving parts

Recycled content

The pragmatist

Relationship with customer & suppliers

Create ongoing material flows

Take-back scheme

Modularity and standardisation

Easy to disassemble, repair and reuse

Simple construction

The realist

Easy to recycle

High quality material reprocessing

Closed loop solution

Easy to disassemble

What is the circular store?

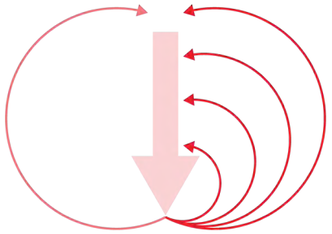
The circular store integrates adaptable, flexible and reactive elements to reduce premature obsolescence and replacement. It is made of refurbished, reclaimed or recycled materials to reduce the exploitation of virgin materials and design out hazardous/pollutant materials. Products are rethought to provide the same function with less resources and materials. Their design is optimised to make them light, compact, easily transportable and assemblable/disassemblable on-site to enhance reusability and recyclability.
If they fall it is easy to repair them or substitute damaged parts, being easily accessible. When the replacement is required, the residual value is kept by extending the life of the entire product or of its parts and components through sharing models and/or remanufacturing.

It is a space that engages customers and tracks their behaviour to reduce waste generation and optimise resources consumption. It is part of an interconnected network of stores that talk to each other and exchange materials and components of their fit-out according to on-demand needs. This generates a symbiotic ecosystem in which the waste of one is the resource for another. The ecosystem is permeating along the entire value chain, by influencing all stakeholders and partners.

It is a store that considers end-of-life from early stage design and procurement processes by partnering with waste management companies, or by adopting procurement contracts that enable suppliers to be fully responsible for the products by keeping their ownership, as is true for product-as-service models where the users only pay per use or pay per products performance.

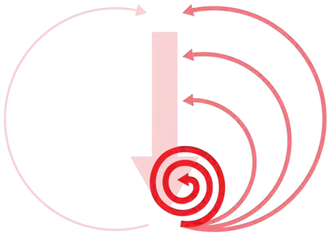
It is a space that integrates digital technologies to improve information and database management to keep track of material flows for their recovery at the end-of-life, but also to allow predictive maintenance by integrating sensors in elements more prone to failure and deterioration of components.

It is finally a journey of creative expression to find upstream design solutions for the transition towards a circular built environment.



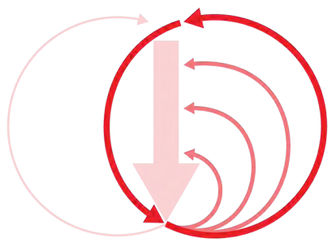
Narrow resource loops

Design for smarter product use and manufacture by using fewer materials and resources.



Slow resource loops

Design for prolonging inner loops through sharing models, maintenance and repair. Longer and multiple uses are encouraged for products designed for high quality, durability and longevity. Refurbish and remanufacture are enhanced against replacement.



Close resource loops

Circular treatment at end-of-life shall always be considered. Design for recycling allows to close the loop between post-use and production, resulting in a circular flow of materials and resources.

Adapted from Bocken et al. (2016)

How to approach circular design?

The approach to circular design will be strongly influenced by a brand's identity and business approach. It will be dependent on internal resources, activities, standard practices and the partnerships that are in place.

Narrow resource loops

The approaches that unlock greater levels of circularity are related to improving design input with the aim to narrow resource loops. It requires from companies the flexibility to refuse, rethink and reduce material and resource consumption through a strong interaction of internal departments and a solid expertise on circular design principles and systemic thinking.

In the current trend, physical stores will increasingly have a completely different role: the main sales channel will be the e-commerce, while stores become the major point of contact between brands and customers. This allows to prioritize local existing context and slightly decouple the store refurbishment from volatile and changing trends driven by the sales activity.

In this light, stores can reduce the quantities of seasonal elements following a simplicity strategy while reflecting cultures and identities of people and places, enhancing traditions, craftmanship and local materials.

Many brands recognise that customer journey often relies on the mood experienced through people working in the stores and the range of products sold.

It would be also interesting to make an overall balance in site selection between market and sustainability drivers. Due diligence can help in prioritising investments towards buildings with good energy performances and in which it is possible to reuse and refurbish as much as possible what already exists instead of building something new in order to keep as much as possible of the existing building.

Slow resource loops

Stores should be designed for adaptability and flexibility, enhancing resilience to adapt to the continuously changing customers demand. For instance, it could enable to keep in use existing visual merchandising tools by adapting only their external layers and graphics to customer needs. The store layout could be composed of multi-use spaces, visual displays could be designed to be moved and easily

host different products.

Given the mismatch between materials durability and their expected lifecycle, and given the intellectual property issue, an interesting opportunity could be redeploying fit-out components into offices when ergonomic requirements are not an issue, or into other stores internally to the brand, especially for freestanding elements and during intermediate phases between new/old concept (e.g. temporary stores) in closed locations. Internal sale to employees is an option already pursued by some retailers and GCs. Another option could be to transform fit-out elements with temporary interventions for runway shows (e.g. by changing finishing colors or by adding with elements to camouflage). Is it really necessary to own all the furniture in a store? Opportunities to keep and retain the existing components and materials taken from the previous tenant, or at least part of it, shall be investigated. This saves money, time and provides benefits to the environment. An example of this could be refurbishing an existing staircase. Design for longevity and product life extension could also be foreseen and enhanced through leasing & product-as-a-service models thanks to partnerships with suppliers and manufacturers to take-back and remanufacture products.

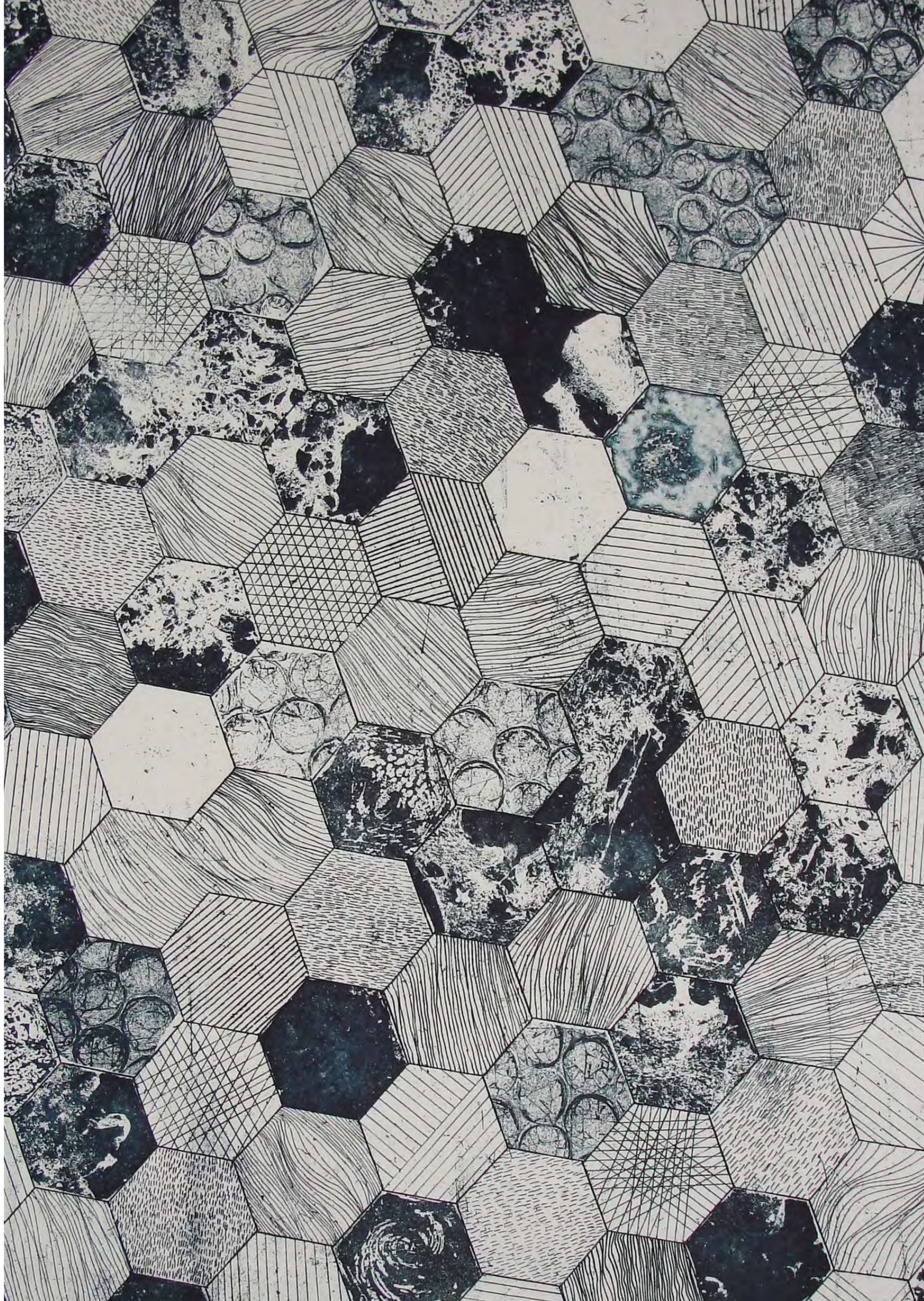
Increasing product life and energy efficiency (e.g. LED retrofit) by keeping fit-out elements in a 'ready-to-use' state would limit the need to purchase new items when there is an urgent need to replace something in a store. If end of life items are grouped together to be taken back and refurbished, transportation and packaging costs could be split among a larger amount of products (large volume discounts and fixed costs sharing). For installations including lighting systems, electrical components and similar, it is easier to predict the date of expirations (predictive maintenance) and regularly plan and provide planned inspections, optimising travel for the local team.

Close resource loops

Closing resource loops shall be considered the minimum practice for the implementation of circular design. Recyclability and biodegradability shall be adopted if the other approaches, that keep the highest value possible of materials and resources, are constrained.

Thinking of fit-out as elements in layers drives opportunities for deconstruction, repair, remanufacture, recycle at end of life.

Stores can be made from different layers: a first core layer made of supporting elements, sub-frames and hidden parts not visible to customers could be made with low-impact and durable materials to be kept longer. Conceived to drive the brand's identity, the finishing layer can be much lighter, deconstructable and adaptable to be exchanged with a higher pace as long as it is made by responsibly sourced materials.



Circular Design Principles

Dematerialisation
Design and deliver the same product or service with none or less material and resources required.

Responsible Sourcing
Specify and source materials and other resources regeneratively and sustainably.

Design for Durability
Design products that last and have a long lifespan, extended through fixing and repair.

Performance Procurement
Maximise products utilisation by procuring sharing/service models rather than relying on individual ownership.

Design for Repair
Products can be designed so that parts are physically accessible for repair to prolong their life cycle.

Design for Adaptability & Flexibility
Prevent premature obsolescence by developing a new design culture focused on adaptation to different use scenarios in the future.

Design for Remanufacture
Exploit residual value of products by designing for facilitating reuse of parts of a discarded product in a new product with the same/different function.

Design for Manufacturing & Assembly
Ensure that a product is designed so that it can be easily and efficiently manufactured and assembled with minimum effort, time, and cost.

Design for Recyclability
Prioritise easy recover and recycle of end-of-life products so that they can be collected and recycled after use.

Design for Disassembly
Products and components shall be designed such that they can be deconstructed at end-of-life.

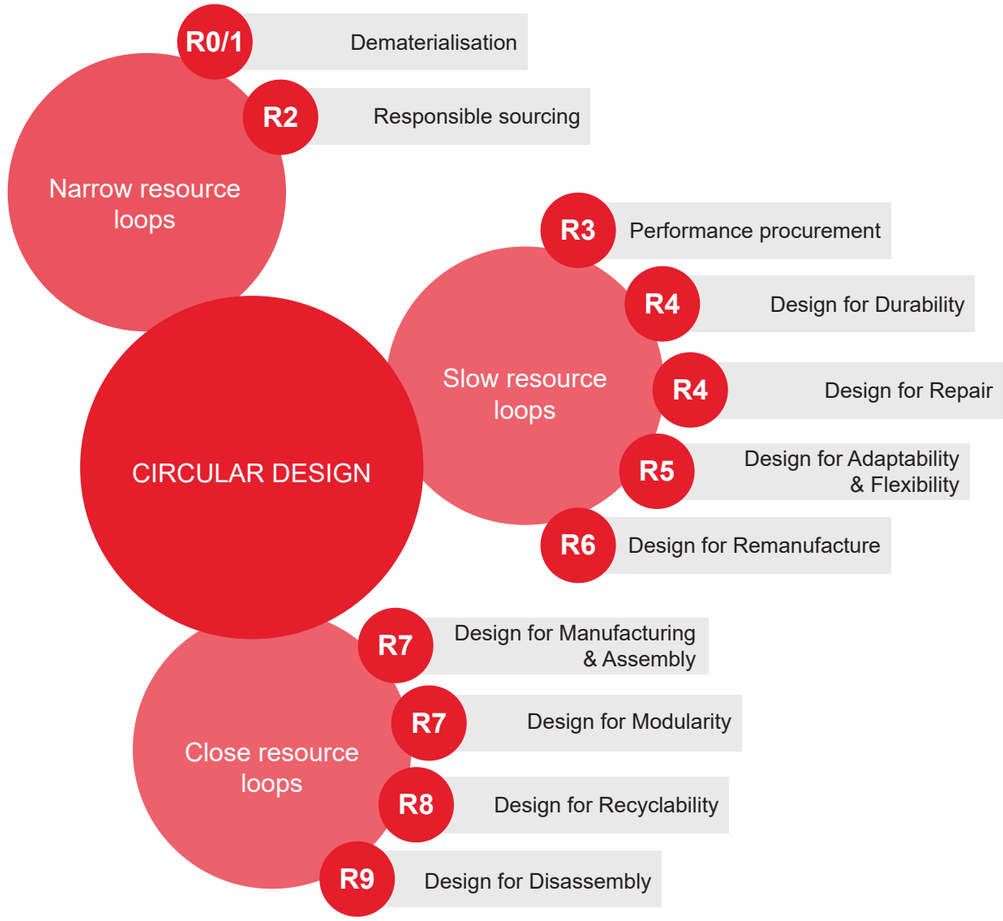
Design for Modularity
Establish uniformity across manufacturing materials and processes.

The 9R Strategies

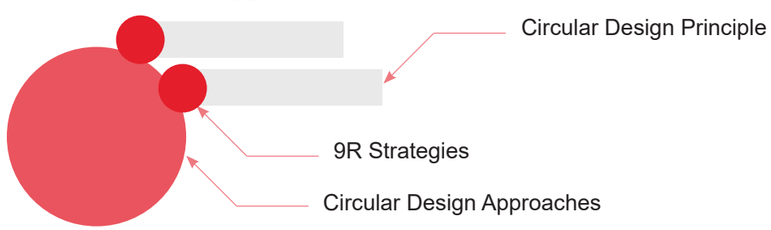
- R0 Refuse
- R1 Rethink
- R2 Reduce
- R3 Reuse
- R4 Repair
- R5 Refurbish
- R6 Remanufacture
- R7 Repurpose
- R8 Recycle
- R9 Recover

Circular design strategy framework

Circular design principles have been identified according to the 9R strategies of a circular asset and related to the identified three circular design approaches. Circular Design Cards are provided for each principle at the end of this report.



How to read the strategy framework



Circular fit-out in retail stores

Component specific considerations are provided for each fit-out element of retail stores. The level of applicability of each circular design principle to retail stores vary according to the specific fit-out element, its function and typical materials adopted in the concept design.

1 False ceiling

Typical materials: plasterboard or gypsum-based mouldings, MDF, mineral wool, metal, suspended ceiling systems.

Are ceiling finishes and false ceilings really necessary? What functional role does the ceiling play for customer experience? Ceilings offer opportunities for innovation and dematerialisation. Ceiling design should combine accessibility for maintenance, easy assembly and disassembly. If possible, interegrated functions shall be foreseen such as acoustic insulation. Digital technologies, geometric optimisation and artistic expression can overlap to provide material reduction and promote efficient manufacturing techniques.

2-3 Internal partitions and wall cladding

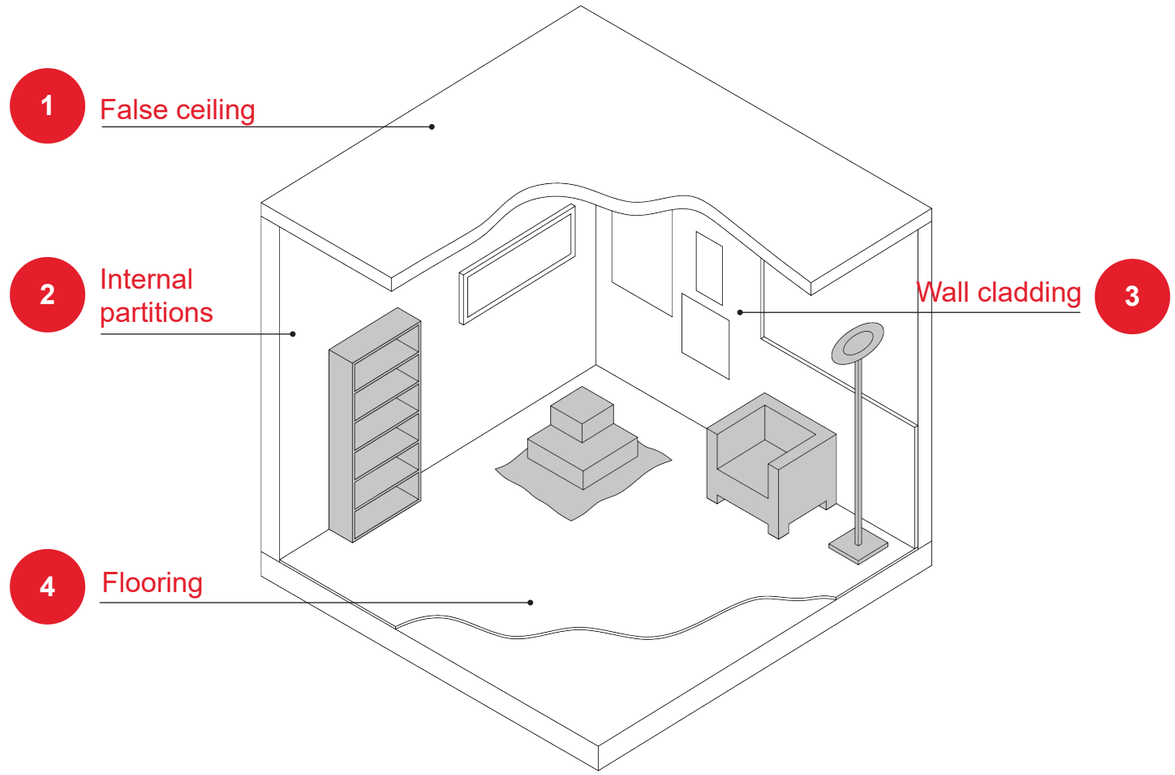
Typical materials: plasterboard, laminated MDF, plywood.

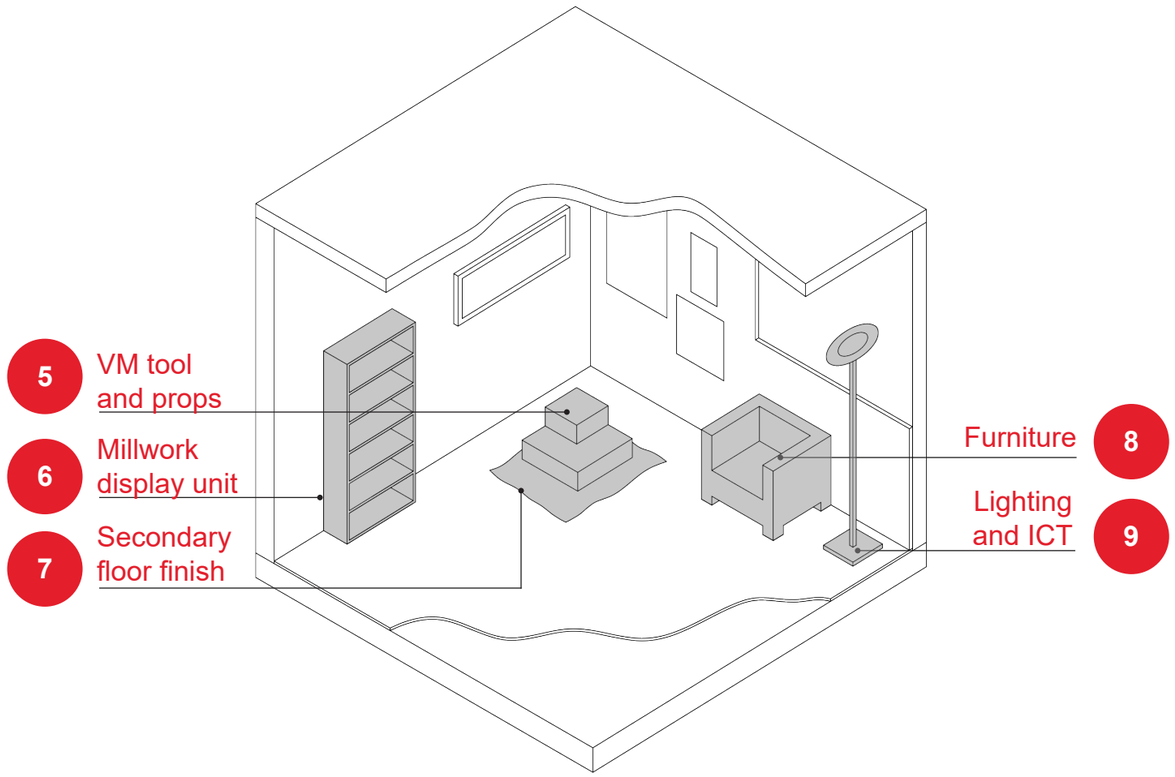
Can we rethink internal partitions to be light, flexible and adaptable as for museums or temporary exhibitions? What is their main function? Could it be provided through less materials or integrated functionality? Internal partitions can be dematerialised by using furniture serving as partitions and storage or seating simultaenously. If still needed fine textiles/hanging materials might do the job. Sustainable materials can create a healthy environment within the shop boundaries. Cork and bamboo are rapidly renewable materials. Green walls can help with indoor air quality (IAQ) requirements and provide a strong image for storytelling and customer experience.

4 Flooring

Typical materials: vinyl, rubber, marmoleum, ceramic, terrazzo, stone, hardwood.

Are flooring built to last or to be adaptable? Long lasting materials could be used for “high-traffic” stores and conceived with timeless design. Raised floor systems are an easy to disassemble alternative. Recyclable and natural materials can be used for floor tiles.





5 Visual merchandising tools and props

Typical materials: acrylic, PVC, cardboards, metal, MDF/wood.

Is VM seasonal frequent refresh and replacement really necessary? New guidelines should be developed to reduce their quantity and frequency of change to follow a simplicity strategy. In alternative, design for adaptability and disassembly could be crucial to accomplish seasonality. The short lifespan of displays and graphics is a great opportunity to test innovative and low-impact materials (e.g. natural, rapidly renewable, upcycled or recycled) due to the less strict performance requirements.

6 Millwork display unit

Typical materials: MDF/wood, metal, glass, acrylic, cardboards.

Sub-frame hidden components present a great opportunity for applying circular design principles. Adaptability may be addressed by keeping the core structure for long time with the design changes only impacting external layers and finishes.

7-8 Secondary floor finish and free-standing furniture

Typical materials: carpet, textile, wood, MDF, metal.

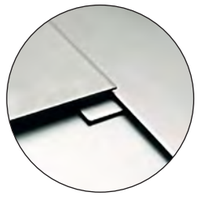
The environmental impact of furniture can be considerably high if not properly managed due to the fast changes and the intensive reource use and manufacturing processes involved. Is it really necessary to own furniture? Could carpets be procured in leasing models? Could it be possible to adopt a take-back or closed loop recycling scheme? Design for disassembly and modularity if implemented could offer potential for remanufacturing and reuse. Relocation between stores, warehouses and offices will retain brand ownership. Re-sale of items can also drive additional revenue streams if intellectual property is made not an issue by designing elements to be adaptable and not recognisable. Where furniture is owned and stored between projects, it should be kept in a ‘ready-to-use’ state and locally repaired.

9 Lighting and ICT

Typical materials: PVC, glass, metals.

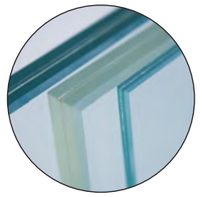
Information and Communication Technologies (ICT) must be accessible and easily replaceable as it may require upgrade after a relatively short period of time. How much does lighting need to change from one season to another? Baseline lighting can be owned by the brand, while more variable components can be procured as a service or through leasing models. When designing eletrical systems, materials reduction and cost saving shall be considered, especially in peripheral elements. Retrofit of lighting to upgrade LEDs drives consistent energy consumption reductions. Collaboration with local artisans will support local procurement.

Embodied carbon of most used materials in stores' fit-out

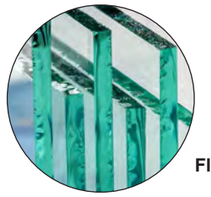


Stainless steel sheet (1 mm) - 1m2

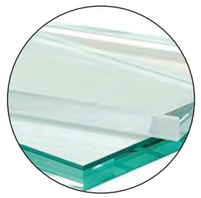
Rockwool insulation (100 mm thick) - 1m2



Toughened safety glass (4 mm) - 1m2

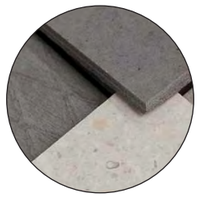


Float glass (4 mm) - 1m2



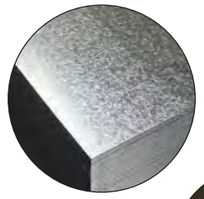
Laminated glass (8 mm) - 1m2

MDF (18 mm, 700 kg/m3) - 1m2



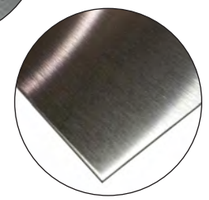
Porcelain tiles - 1m2

HPL flooring (8 mm thick) - 1m2



PVC wall cladding (2 - 2.5 mm) - 1m2

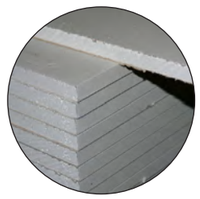
Galvanised steel sheet (1 mm) - 1m2

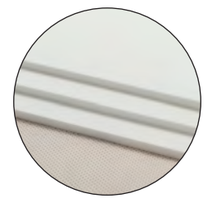


Anodised aluminium sheet (1 mm) - 1m2

Double plasterboard - 1m2

Acrylic (8 mm thick) - 1m2





Global warming potential (A1-A3)
(Source: OneClick LCA)

Key insights

Circular design approaches shall be integrated within a transformational change in a company's business model to implement a wider vision and mindset shift to exploit value capturing strategies across the value chain. The combined analysis of background research and stakeholder interviews has identified improvement opportunities and enablers across the value chain.

Realising the potential of a circular economy requires a new approach to all aspects of the value chain. This includes financing, procurement, design, construction, operation, maintenance, repurposing and recycling. It requires a step change in design, technology and economic approaches.

Many of these changes cannot be made by the design team alone, and enhanced or new relationships along the supply chain will be required. A multi-disciplinary and systemic approach through stakeholders' engagement is necessary to inform design decisions through collaboration.

FIRST ACTIONS	STAKEHOLDERS
Enhance end-of-life items exchange without the need of physical warehouses by directly connecting supply and demand.	Retailers
Implement material exchange platform and virtual warehouse to share information about materials and products which will no longer be required.	Retailers
Network with local parties for recovering, repairing and remanufacturing fit-out elements.	Retailers, suppliers
Encourage interiors reuse between stores and for donations at city or country level, especially for free-standing elements.	Retailers
Design temporary/modular stores to be dismantled and reused in other locations. Utilise very low-impact or second-hand materials.	Designers
Fit-out and decorative elements can be sold to employees at lower price.	Retailers
Reuse fashion shows items in stores and viceversa.	Retailers
Involve regional hubs in sourcing local materials and suppliers to avoid shipment of items and transportation impacts.	Retailers
Encourage the implementation of returning practices through local suppliers engagement and IP protection.	Retailers, suppliers
Plan monitoring for maintenance purposes on monthly basis, depending on store's traffic.	Retailers
Enhance collaboration within the value chain through industrial symbiosis or association between industrial facilities and companies.	Retailers, suppliers
Manufacture fit-out elements from waste generated by retailers: for instance, tiles from coffee capsules and cork stoppers, antique from newspaper, recycled glass and plastic from bottles.	Suppliers
Use large amount of scraps from manufacturing processes or obsolete items as raw materials for new fit-out elements.	Suppliers
Launch start-up to sell products' manufacturing leftover.	Suppliers
Explore the potential of modularity and disassemblability in design fit-out elements.	Designers
Conduct pre-demolition audit. It may induce to generate building's materials inventory, reduce time pressure at dismantling phase and facilitate reuse.	Retailers
Involve certified waste management and recycling companies.	Retailers
Integrate disassembly instructions and indication of materials used through QR codes labels and material passport.	Retailers, designers
Collaborate with other retailers to reach minimum waste volumes and enable recycling, repurpose and reuse.	Retailers
Synchronise waste pick up through database of recycling partners.	Retailers

Enablers

Governance

The sustainability department can actively promote a formalised strategy with long-term goals by collaborating with other key departments within the company, exploiting different expertise and perspectives. The strategy needs to include directions, standards, guideline and clear targets with key roles and responsibilities. When a global group has brands and stores located across a range of countries, it can be complex to have a single approach that complies with all local legislation. A possible solution for setting the group's direction can be to identify the most stringent legislation to be compliant with and apply it at global level. External collaboration with a specialised consultant could be beneficial to make sure the strategy is ambitious enough. Through its strategy, the retailer is able to influence all the actors and stakeholders involved in project execution to drive the sector's transition.

You can't manage what you don't measure.

Metrics are under heavy discussion in the industry. Currently, no common protocols are available due to disaggregated information. However, a lot of companies are reporting against their own targets.

Increased reporting and transparency in the market will enable companies to benchmark themselves against competitors and allow consumers to better evaluate the performance of different companies.

Fashion brands shall prioritise investments in projects which are very well rated from a sustainability point of view. Through targeting building standards, it is possible to motivate architects, designers and suppliers to act and perform in a sustainable manner. Credits and incentives could be given for carrying out research and development projects, implementing LCA analysis or for locally sourcing materials (<500 km) or changing the mode of transport to a less polluting one. A materials library could be also proposed to designers.

Fashion brands should target suppliers according to their sustainability performance (e.g. Corporate Social Responsibility), not only according to the price. Supplier's selection and auditing has to be performed to select partners which comply to the company's ethics according to transparent reporting.

Partnerships and networks

Circular economy is not something that can be implemented by one single actor, it requires a systemic change. Partnerships are fundamental for a company that decides to embrace sustainability as all the supply chain actors are involved in the change. Establishing collaborations with stakeholders will be useful to handle end-of-life fit-out, by allowing reusing by other parties and exploiting incentives to repair them (e.g. tax reductions).

Fit-out is an area in the built environment that would gain radical benefits from joint discussions, partnerships, and collaborations between different parts of the value chain: designers, clients, suppliers, city makers and policy makers.

Collaborations with new/existing business partners and ventures are fundamental to find new materials. Relationship with eco-materials companies shall be foreseen and integrated in databases for designers. If required, sustainability and circularity measurements can be outsourced to specialised companies. Reverse logistics implementation could require agreements with waste management companies and suppliers. Regional hubs can facilitate partnership's management with local stakeholders and recycling infrastructures. At the city level, a good opportunity would be to test a geographically specific partnership approach to pilot and support the cost/feasibility of investing in circular approaches.

Landlord collaboration

Contracts can be defined as agreements to share risks between parties. However, the current landlord-tenant main contractual model is based on fixed re-payments of medium-long term leases, putting all the risk in the hands of the retailer. Collaboration between landlords and tenants is identified as a solution that would enable both the parties to exploit and share the higher benefits that a physical real estate can provide when managed according to adaptability and flexibility principles. The collaborative approach is expected to be particularly effective under changing external conditions, like demand variability, climate change and other scenarios that increase risks and uncertainty.

In light of this, it is a great opportunity to establish longer-terms, wider and strategic collaborations between brands and landlords, regardless of the specific site and location, with shared terms and objectives around a sustainability agenda. The sustainability and circular requirements shall be agreed outside of the contractual obligations before starting a lease negotiation in order to prioritise list of actions. This could drive several opportunities to integrate circular practices through the design and construction phases, when delivery times are often an issue, and to keep in the loop some elements of the fit-out and structural parts after the end of the contract.

Education

Nowadays, in the retail sector, there is a lack of awareness and competencies regarding design for circularity and sustainability. Re-designing, re-modelling, material selection, asking what can be reused are practices that cannot happen without internal education. Even if the top management is usually aware of circularity and sustainability, information is not shared within departments. Educational activities could start from explaining better the impacts of what they do, how they do it and how they can contribute. Stakeholders and employees should be more targeted, making them understand how certain practices could be valuable and, at the same time, not impactful for the environment.

Awareness is not only important from the business environment, but it has to be spread to customers. Communicating to customers about buildings is a long process/journey to help them understand what sustainability means and the benefits they could get from it in their personal life.

Data management

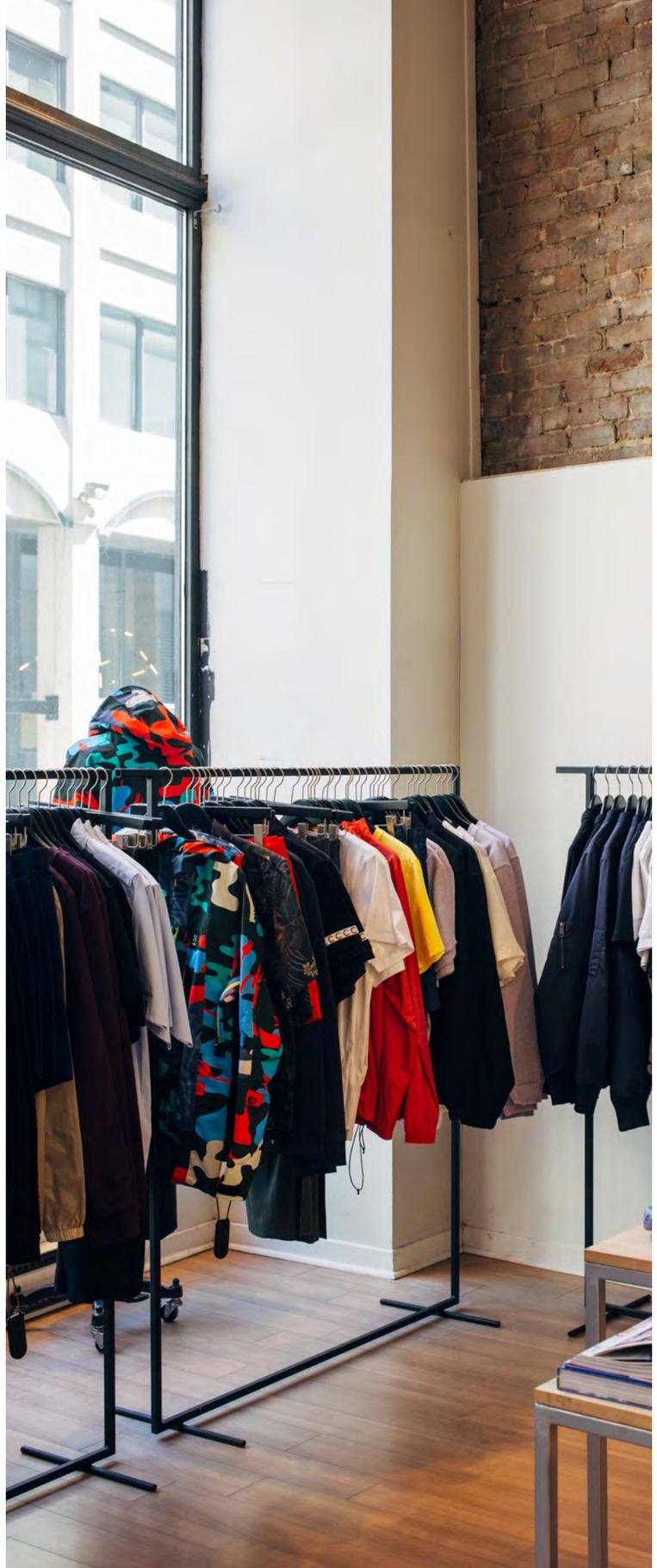
The IT sector is characterised by a continuous and fast development in the way we collect and manage data.

Retailers conceiving the store network as a dynamic asset in which physical and digital channels are merged in a non-intrusive way have the opportunity to optimise the production of new items and the organisation of the new campaign accordingly to the emerging needs. Knowing customers flows and feedbacks in specific sites can meaningfully reduce the number of store closures, openings or relocations, and consequently of virgin materials and resources employed.

Digital technologies, like RFID, artificial intelligence, machine learning and visualisation tools, could be employed directly to the monitoring of resources flows and tracking materials, detecting improvement opportunities both from the resource efficiency (energy, materials, labour) and waste management perspective. This is interesting from a circular economy point of view as it enables value capturing opportunities to keeping resources in the loop.

Online inventories of what is present in a space could be helpful to the Company if a store needs to be renovated: what can be reused?

Data analytics can be implemented with RFIDs for procurement, to understand where the asset is physically located in the space and have a greater control on physical assets. Items could be delivered equipped with a QR code working as material passport. Material passport enables the transparency of data and of end-of-life cycles. QR codes are currently used on some products and contain disassembly instructions. 3D printing technologies are being used for simulations and prototyping. 3D design tools are used to avoid issues in the assembly stage, which often occur with 2D modelling.



Circular economy is driving the generation of data, so that companies need a digital twin of the reality to know where materials are and which process they have encountered.

Historical data can support the store design for flexibility and adaptability, how data sharing and analysis enable a closer interaction and collaboration between landlords and tenants, or how materials and waste's flux tracking and performance measurement set the basis for a new circular retail industry.

Conclusions

1. The transition towards a circular economy is becoming no more an option but an obligation, as changing regulations and sustainable finance demonstrate

2. A transition from linear to circular business models is necessary to support circular design to move from principles to actions

3. Retailers should partner with experts to develop their circular vision and strategy from policy and target definition to architectural design of fit-out elements of stores

4. The journey to become 100% circular shall consider the built environment of retail industry: the point of sale

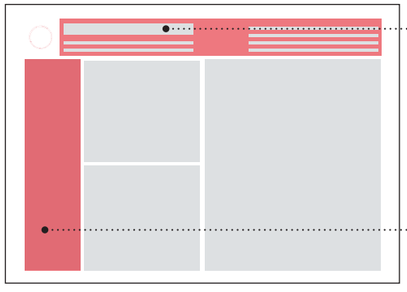
5. Fit-out of stores represents a critical system of building’s layers due to frequent changes of design

6. Core enablers to support circular design application rely on partnership and collaboration agreements with stakeholders across the value chain

7. Digital transformation and innovative technologies can support implementation of circular design and business models at a corporate level

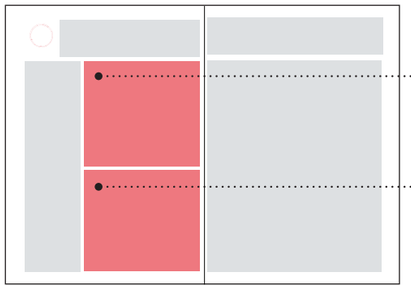
Circular Design Cards

How to read the cards



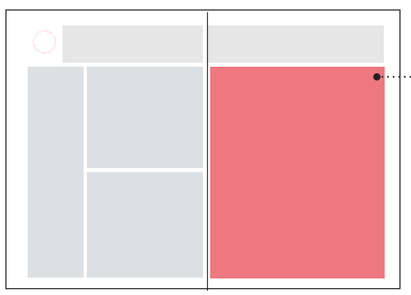
Statement
Short description of the circular design principle

Criteria



Definition

Benefits



Case studies
Several case studies are presented with supporting factors, key insights and benefit for the company, the user and the environment

Dematerialisation

Design and deliver the same product or service with none or less material and resources required.

Is the minimum amount of material possible designed?
Do digital tools help in delivering same functionality of physical products?
Are there solutions to purchase the utility of the product as a service?

CRITERIA

- Optimise resource effectiveness by reducing the mass or material types in the product;
- Avoid overdimensioning;
- Adopt stiffening profiles;
- Minimise thickness and weight;
- Design for compactness;
- Design integrated functions products to serve different needs;
- Virtualise physical products;
- Use digital tools for design, modelling and prototyping.

DEFINITION

As a guiding principle, new products shall be created only if truly needed. Designs should consider opportunities to reduce the demand for materials and resources.

Design to Dematerialise reduces the amount of materials required whilst still maintaining the core functionality. Digitisation also allows for the conversion of physical products to digital resources.

BENEFITS

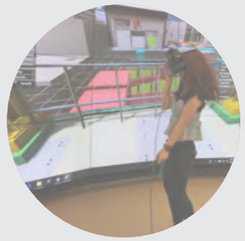
Dematerialisation may provide reductions in cost, inventory, manufacturing time or negative environmental impacts. Converting to digital allows companies to capitalise on emerging trends like big data or the Internet of Things (IoT).

CASE STUDIES

© Unsplash

Digital display technology

To prevent waste generated by advertising banners and posters, digital display technologies are becoming ever-more popular. The digitalisation in stores, using interactive tools to replace the traditional advertising boards and posters enhances the customer experience.

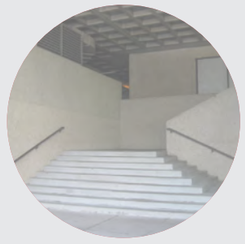


© Arup

Virtual prototyping

Virtual reality as a design tool

Designers and architects can create virtual 3D models. The designers can edit the forms, add material finishes, and walk through the creation in immersive 3D. This reduces the need for physical models and the material waste associated with them.



© D Coetzee

Reuse existing assets

Fit-out with existing staircase in retail store

When a store closes, the next tenant can take over parts of the fit-out and reuse. Negotiations with landlords to keep part of the existing fit-out and refurbish can enable the process.

KEY TAKEAWAYS

- Quick installation across the world.
- Relevant messages updated in real time.
- Increased time and cost efficiency.
- In-store staff working less on content management, so that they can dedicate more time to looking after customers and enhancing their in-store experience.

- Virtual prototypes reduce the need for physical prototypes resulting in time, resource and cost reductions.
- Iterative steps are allowed by narrowing time for implementation for testing different version and quickly getting feedbacks.

- It is crucial to take into account the potential behind existing buildings and the opportunities that they offer for future tenants. Therefore, architects and brands alike endeavour to provide new and innovative customer experiences by restoring and maintaining parts of the original building.

Responsible sourcing

Specify and sources material and other resources regeneratively and sustainably.

CRITERIA

- Avoid materials, additives and surface treatments that are toxic;
- Use renewable and bio-based materials;
- Use recyclable/reused materials, with recycled content and/or sourced from by-products/waste streams;
- Use regional materials from local suppliers;
- Use products/materials with environmental certification (e.g. EPD, C2C);
- Promote manufacturing using renewable energy;
- Incorporate power-off mechanisms;
- Set default status at lower energy consumption.

DEFINITION

Responsible sourcing implies the adoption of materials, finishes and components that do not compromise human or ecological health, but improve the whole ecosystem to regenerate itself. Material selection is a key factor for project sustainability, health, safety and wellbeing of occupants and durability of systems.

The use of quickly diminishing resources and materials should be avoided. Specify energy efficiency requirements for the products can also influence energy consumption during use phases.

BENEFITS

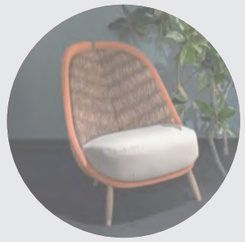
Providing opportunities for the local supply chain can drive social and environmental benefits to reduce transportation and energy emissions. By optimising the value and usefulness of resources purchased as inputs, a company may save in production/operations costs while mitigating negative environmental externalities.

Are sustainable materials identified and sourced?

Can energy saving solutions be integrated in the design?

Is local procurement a common practice?

CASE STUDIES



© Pianca

Sustainable furniture

Pianca designed a completely recyclable and compostable chair,

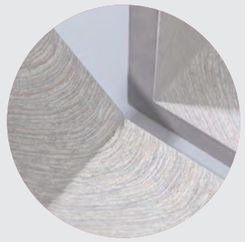
The upholstery is made of polyester eco-fiber coming from the recovery of mineral water bottles in PET plastic, composed of 100% virgin polyester, completely recyclable.

© Mogu

Bio-composite panels

Mogu managed to turn waste into value, running its production processes starting from low-value materials,

By feeding on the organic matter, and thanks to Mogu's design and engineering skills, the mycelium, the vegetative stage of mushrooms, converts the low-value input matter into a product with high added value, characterised by unique aesthetics.



© NewspaperWood

Sustainable veneer in furniture

NewspaperWood reverses a traditional production process; not from wood to paper, but from (news)paper to wood.

For a project in collaboration with Van Eijk and Van der Lubbe, various pieces of furniture, including the welcome furniture of the new headquarters of Woonbedrijf in Eindhoven, were covered with NewspaperWood veneer and thus tell the story of the history of this place in a poetic way.

© Ricehouse

Eco-paint

Mural paint based on long-aged pit lime and rice bran for indoor and outdoor use, natural and breathable.

RH500 ecopaint by RICEHOUSE is composed of lime milk and represents a line of fine finishes that exploits the chemical characteristics of the lime and the rice bran. It is supplied white or coloured in paste with natural earths both for external and internal use.

KEY TAKEAWAYS

- The designer reinvented each element of the Calatea design after reconsidering the environmental impacts of the piece.
- The shell is in plywood, the legs are in FSC® certified solid ash wood.
- The fabric covers use a cotton yarn produced with the Open End system using 100% recycled material guaranteed by the GRS (Global Recycled Certified 4.0) certification.
- Fungal mycelium-based matrix is a 100% plastic-free and coherent material composite.
- At the end of the production process, mycelium materials are inertised by slow drying, for reduced energy consumption. The resulting products are completely stable, safe and durable and biodegradable.
- Sustainable office furniture coming from Newspaper Wood can tell the story of a modern organisation, with an eye to the future, where social responsibility and sustainability are an important part of the design as well as the company itself.
- Ricehouse Eco paint is the result of enhancement of by-products from the rice cultivation and it is configured as a vehicle of innovation, with a high degree of sustainability.

Performance procurement

Maximise products utilisation by procuring sharing/service models rather than relying on individual ownership.

Can product-service-systems be procured? Is product leasing being considered?

Can underutilised or end-of-life products be integrated in sharing platforms for second use?

CRITERIA

- Consider implementing products' leasing for services continuous access over a defined period of time;
- Design product/services for sharing use rather than individual ownership;
- Integrate methods for used product collection.

DEFINITION

Materials, components and products can be sourced as part of a leasing / buy-back scheme or a Product Service Systems as an alternative to owning or buying. Customer pays for access to a product or for its performances over an agreed period rather than buying it, while suppliers are responsible for service quality (i.e. delivery, installation, maintenance and take-back). The sharing model allows for reuse of underutilised products, extending their lifespan by giving them second or more lives. One of the main differences with leasing is that the typical period of usage for sharing platforms is much shorter and the number of users is much greater.

BENEFITS

Sharing, access and performance models allows for higher specifications and quality of design to increase service life and durability as products stays in the ownership of the supplier and value is kept within the system. Purchasing services instead of products is also financially attractive as it results in less resource consumption and smoother OpEx (e.g. tax deductions and the avoidance of high upfront expenditures).

CASE STUDIES

© Unsplash

Light as a service

Manufacturers that take ownership over the items they produce tend to perform better in maintenance, reconditioning, and recovery of their goods. Having integrated sensors and controller systems help keep energy use to a minimum while dimming and brightening the artificial lighting when sensing motion or in the presence of daylight.

© Ahrend

Furniture as a service

Furniture as a service by Ahrend. Customers pay a monthly fee and return the furniture when they no longer need it.

Ahrend manufactures office furniture products with modularity, disassembly, and life extension as core design principles. In this way repair, upgrades, and modifications are easily achieved so that every single product can have multiple lives.

© Unsplash

Buy-back furniture

Based on Circular Economy's principle of "Keeping Products and Materials In Use", the concept of purchasing back used goods by brands and reselling them as second-hand or donating them to charities, is gaining popularity.

The brands can buy back the unwanted goods for up to half the price to resell, recycle or donate. Platforms have been developed to enable the customers to register which items they want to return, drop-off at a store, and to receive their vouchers.

© Unsplash

Furniture sharing platform

Platforms have been created for the concept of "furniture sharing." This is an online marketplace that provides the possibility of keeping furniture in use for longer cycles. The platform functions in a way that they primarily review the high-quality unwanted furniture, then collect it from the current owner and lastly place it on the platform. The platform works on a subscription-based business model.

KEY TAKEAWAYS

- Lighting system to fit the requirements of the space, at a manageable price and providing energy savings.
- Manufacturers capitalise on overcapacity and retain greater control over the items they produce and the embodied energy and materials.
- Customers benefit from maintenance, service and a manageable price as they only pay for the service they require and use, and often receive a better service as the manufacturer has a greater interest in providing a product that lasts.
- A reduction in material usage and carbon emissions.
- Closer relationships with customers, more profits, and a more secure materials supply chain.
- Lower office set up costs and more flexibility in a fast-changing business environment.
- For larger business customers, leasing rather than owning furniture reduces the level of asset-management required within its operations.
- Keeping materials and products in use will contribute towards designing out waste and pollution, as well as reusing goods which still are in good condition for use by another user.
- Monetise a burdensome or underutilised asset rather than simply disposing of it, a process that might itself cost money.

Design for Durability

Design products that last and have a long lifespan, extended through fixing and repair.

How long will the used materials, systems and components last?

Are technical components and fit-out items designed for durability?

Will architectural surfaces age gracefully?

What are the life-cycle costs of each material and component?

CRITERIA

- High quality and easily repairable materials;
- Provide incentives through performance-based contracts that promote the optimal design of the product;
- Simulate different scenarios of durability and compare costs;
- Use construction techniques that facilitate maintenance and repairs to different parts to enhance product durability;
- Standardised components manufactured off-site to higher quality control standards can reduce long-term maintenance requirements.

DEFINITION

Designing for longevity ensures the long-term durability of material choices to overcome functional and premature obsolescence. It relates to products resistance to wear and tear throughout certain time if properly maintained.

BENEFITS

Design for longevity prioritises highest value opportunities for inner loops such as reuse, sharing and remanufacturing.

Durable materials and robust construction standards can reduce maintenance costs and extend the economic viability of a product.

CASE STUDIES

© Stonethica

Upcycled marble

Stonethica upcycles marble by reusing and assembling waste

The left-over pieces deriving from the processing of marble and natural stone, are recycled and assembled in Stonethica slabs thanks to a non-toxic two-component resin.

© Unsplash

Marble from recycled glass

Following biomimicry, learning from nature's doing, preventing waste generation, it is possible to use recycled raw material to produce stones.

KEY TAKEAWAYS

- Stonethica is a product that is realised with a recycled content between 98.6% and 99.4%.
- With the same finish and touch of leathered marble, the Stonethica slabs have also the same duarbility and ease of maintenance and are guaranteed for residential and commercial indoor use.
- Stones manufactured from recycled glass.
- Turning waste into a new resource.

Design for Repair

Products can be designed so that parts are physically accessible for repair to prolong their life cycle.

Can systems and components be maintained and repaired over the life cycle?

In order to keep materials at their highest possible level, can materials and components be repaired and maintained without compromising the element functionality?

CRITERIA

- Information and guidelines help achieve proper maintenance and repair;
- Modular components and parts standardisation facilitate disassembly and replacement;
- Integrate monitoring systems, Internet of Things (IoT) and big data to identify, locate, track and communicate need of maintenance, repair or replacement;
- Regular self-testing, error recognition and notification;
- Ensure access to all parts and connections for easy repair and maintenance;
- Components should not be integrated to such a degree as to make individual replacement of functional components impossible;
- Place quickly worn parts towards exterior.

DEFINITION

Design for easy Repair & Maintenance requires a designer to consider easy access to all parts and components prone to fail or requiring periodic maintenance to keep the product in working conditions. Proper material selection shall consider material properties in terms of their durability. Monitoring and assessment technology is critical to maximise the performance of elements and facilitate repair and prolonging of products' lives.

BENEFITS

Maintenance and repair strategies, not only prolong product use, extending its useful lifetime, but keep materials at highest possible level, so that recovery is ensured, and embodied energy, materials and water are conserved.

CASE STUDIES

© Tarkett

Cleaning protocols

IQ vinyl floors by Tarkett reach increased durability due to dry buffing maintenance methodology that restores the surface's properties.

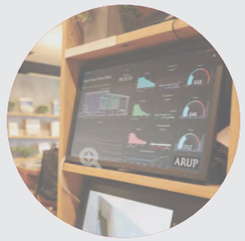
Dry polishing on a regular basis keeps the floor surface smooth and sealed so that dirt does not penetrate the floor.

© Durat

Long lasting service agreement

Zero Waste Bistrot in Manhattan is featured with all surfaces made with easily repairable recyclable material.

DURAT is a solid surface material which contains recycled plastic and is 100% recyclable. The finish of Durat products can be easily renewed: scratches and other marks removed. A quick re-polish will make the surface of your Durat look as good as new.



© Arup

Digital twin for facility management

Arup Tokyo office implemented digital twin model.

The convergence of existing, emerging and affordable technologies like BIM, 5G, sensors, backed with programming expertise.

© Arup

IoT for predictive maintenance

IoT Internet of Things Desk by Arup.

In collaboration with the University of Southern California, Arup has developed the Internet of Things (IoT) desk as a platform for providing information and interaction.

KEY TAKEAWAYS

- Tarkett's cleaning protocols based on dry buffing are very low Life Cycle Cost (up to 30% savings in maintenance costs with a 3-year payback period). This cleaning protocol reduces water consumption by 18%, electricity consumption by 20%and the use of detergent is 2.3 times lower than with traditional floor cleaning regimes.
- The lifecycle of the product can be extended with proper care and maintenance. Durat can offer a long lasting service agreements to ensure a lifelong quality for our products.
- Digital twin model enable assets to be represented in a virtual form, displaying every aspect of their current use, occupancy, performance and cost, in real-time, accessible from anywhere.
- digital twin's increasing use is not only fundamental in terms of facility management but allows to improve the design of store and to have continuous feedback on the behavior of the elements that compose them, not only as individual elements but as part of a system.
- Rather than performing routine calendar-based inspections and component replacement, predictive techniques monitor equipment for pending failures and notify you when a part replacement is required.
- Sensors embedded in equipment check for abnormal conditions and trigger work orders when safe operating limits are breeched.

Design for Adaptability & Flexibility

Prevent premature obsolescence by developing a new design culture focused on adaptation to different use scenarios in the future.

Can the product adapt to different use/requirements scenarios in the future?

Can changeable finishes/internal cladding be designed while keeping the supporting structure?

CRITERIA

- Anticipate with consideration of need of the present and changes in requirements in the future (e.g. periodic or frequent reconfiguration);
- Adopt innovative approaches that allow the product to adapt to a user's changing needs as time passes;
- Design for modularity;
- Dry assembly and layering help in change only selected elements.

DEFINITION

Identify and promote alternative uses for products that can no longer serve their original function. Enable adaptations and transformations of the product for better use and reuse, new ways of using it, and prepare for the end-of-life and future lives of the product and its components.

BENEFITS

Design for adaptability and flexibility allows for extending product life, by keeping it in use for as long as possible and avoiding premature obsolescence.

When foreseen lifespan and intended use period of products and materials are far shorter than their intrinsic longevity, products value and performances updates create carbon savings that outweigh the carbon associate with creating the new product.

CASE STUDIES

© Unsplash

Adaptable VM displays

Store concepts should include visual elements and fixtures that can be adaptable to the seasonal change in needs of the design, by allowing the replacement of the aesthetic layers by keeping the core structure.

© WOOD—SKIN

Flexible partitions

Maison Margiela boutique in Milan with flexible wrapping skin.

Dry assembly technology patented by WOOD—SKIN enable wall systems to change form and assume a new life, thanks to the possibility of ever-changing configurations.

KEY TAKEAWAYS

- This will allow visual merchandising and communication elements to be adaptable to any store concept.
- Flexibility can accommodate a bespoke and up-to-date indoor materialisation in line with the design concept change requirements.
- They also ensure quality and sustainability of material choices (e.g. FSC certificated wood) and production processes/work sites due to digital manufacturing and flat shipping.

Design for Remanufacture

Exploit residual value of products by designing for facilitating reuse of parts of a discarded product in a new product with same/ different function.

Can products which have ceased to function be recovered for remanufacturing?

Can product elements and parts be reconfigurable for repurposing with a different function?

CRITERIA

- High potential for disassembly;
- Design products to be redeployed as modules;
- Kit of parts designed to be reused in same or different environment;
- Design high-demand components with standard dimensions and specifications.

DEFINITION

Products can be refurbished by the manufacturer or service partners. Design for reusability in manufacture aims at recovering, disassembling, repairing and using parts of a discarded product in a new product with, respectively, same or different function to be subsequently resold.

This is usually done through take back programmes provided by manufacturers and suppliers to collect used products or materials from consumers and reintroduce them to the original processing and manufacturing cycle.

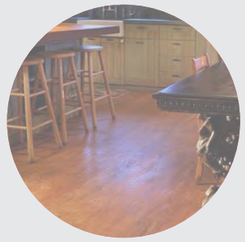
BENEFITS

The re-capturing of material through new system guarantees the return of the product into their material stream. It can reduce a company's risk to increased price volatility and price of goods sold due to secondary material supply.

Value chain relationships are enhanced as loops are closed and waste from one business is captured and used as raw material for another.

Alternative supply of raw minerals incentivises investigation into designing products and services that lasts through durability or upgradability.

CASE STUDIES



© Pacific Northwest Timbers, LLC

Reclaimed wood flooring

Pacific Northwest Timbers, LLC sells reclaimed wood.

Reclaimed wood floors are remanufactured from reclaimed timbers, or reused reclaimed lumber flooring, from old buildings.

© Unsplash

Remanufactured furniture

Once the use cycle of the product is over, the item is brought back, so that it can get remanufactured and resold again. This is a circular business model that unlike the linear one of extracting resources, making, and selling the furniture, and leaving them to be disposed of as waste, uses a three-step model of buyback.

KEY TAKEAWAYS

- Remanufactured items include timbers from the deconstruction of old buildings, fences or crates/ dunnage, reclaimed planks and beams that are then re-milled into new products such as flooring.
- Flooring grades depend on the quality of wood received from each deconstruction project.
- Buyback programme allows for extending the furniture's useful life and providing more income for the manufacturing company for the same amount of desks produced.

Design for Manufacturing & Assembly

Ensure that a product is designed so that it can be easily and efficiently manufactured and assembled with minimum effort, time, and cost.

Are components available in standard stock configurations (e.g. bar stock, sheet, standard extrusion)?

Does the design lend itself to automated assembly and most desirable manufacturing processes (e.g. ease of forming, casting, machining)? Are tolerance dimensions realistic?

CRITERIA

- Minimise number of components/materials and production steps;
- Avoid excess cutting and jointing of components/ materials;
- Optimise shape and dimension according to production constraints to minimise manufacturing waste and scraps;
- Eliminate unique parts wherever possible, by preferring standard components;
- Decreasing the amount of labour required for assembly;
- Make parts multi-functional to reduce complexity;
- Facilitate parts handling that does not require special tooling or fixturing for assembly;
- Where possible make parts identifiable and symmetric;
- Design tolerances to meet process capability.

DEFINITION

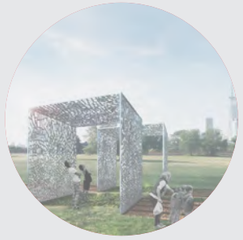
Consideration of manufacturing and assembly processes during product design and material specification can increase efficiency of production and reduce the environmental impact and waste generated.

Technology innovation and advanced tools are enablers of Design for Manufacturing & Assembly (DfMA) as they drive production optimisation.

BENEFITS

Through the choice of the optimal construction solution in relation to the manufacturing process, Design for Manufacturing & Assembly allows to reduce the time and costs of production, to optimise resources avoiding waste and to achieve high performance of a product by taking advantage of an industrialised production process.

CASE STUDIES



© Cast & Place pavilion

Casting

Cast & Place is a pavilion made entirely from waste and used locally excavated dredge and fill, recycled aluminum cans, and reclaimed wood to create the structure.

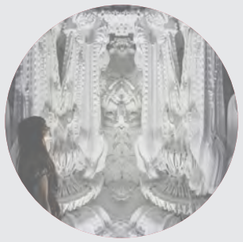
Efficient production methods for minimising manufacturing scraps production is combined with reusing of wasted and recycled materials.

© ArboSkin pavilion

Circular production

The ArboSkin pavilion in Stuttgart is made from bioplastic.

The pyramidal modules are made by extruding bioplastic granules into sheets before thermoforming them to create the faceted shapes and trimming off the excess material.



© Digital Grotesque

3D printing

Digital Grotesque is a 3D printed room by Benjamin Dillenburger and Michael Hansmeyer.

The complex and articulated room was designed in one year, while printing requires a month and assembly only one day!

KEY TAKEAWAYS

- Wooden frames and shallow trays of cracked clay will serve as the formwork for panels that make up the shade structure.
- Molten aluminum will be poured in between the crevices of the clay, cohesively blending together to form a series of permeable metal surfaces.
- Cracked-clay reflecting pools will also be built into the ground on each side of the panels, showing in real time how the material responds to hot and rainy weather conditions. After the summer, the panels will be turned into benches and trellises for supporters on the project.
- Thermoformable sheets of bioplastics represent a resource-efficient alternative as they combine the high malleability and recyclability of plastics with the environmental benefits.
- The double-curved skin is formed by linking the pyramids together, with bracing rings and joists helping to create load-bearing walls. CNC-milling was used to remove sections from some of the modules, creating apertures in the facade.
- The waste material from production can be re-granulated and fed back into the production process.
- Create complex structures through wide choice of materials (e.g. plastic, resin, metal or multicolor material) with high personalization and few time for manufacturing and assembly.

Design for Modularity

Establish uniformity across manufacturing materials and processes.

Can parts of the product be standardised or prefabricated?

Can we standardise the design, e.g. for prefabrication?

Have we identified repetitive systems to reduce the product complexity?

CRITERIA

- Increase communication between the design teams working on complex products and systems;
- Use standard components where possible;
- Reduce number of parts and components enhance modularity;
- Design parts as separate, self-contained modules.

DEFINITION

Design for Standardisation & Modularity aims to increase suitability of components and parts for other product and functions.

Prefabrication and modularity reduce products complexity both in Manufacturing & Assembly processes and in the Disassembly phase.

BENEFITS

Off-site manufacturing and prefabrication will help lower production and procurement costs/time while providing greater product quality and waste reduction.

The use of standard components in a design reduces the number of tools required for assembly, lowers assembly cost and makes problem identification easier.

Modular assembly simplifies inventory, improves maintenance and serviceability and reduces disassembly time.

CASE STUDIES

© Arup

Modular lighting

David Chipperfield Architects and Arup created a sustainable and modular luminaire design.

An innovative optical tool kit that allows the design of a series of different light distributions using the same luminaire body shape in the entire building. A luminaire product line as a modular system.

© Magis

Modular sofa

Costume is a modular sofa designed by Stefan Diez for Magis.

Unlike pre-existing sofa systems, which often fix elements together permanently, Costume is described by Magis as “modular through and through” and is designed to be fully dismantled into its constituent parts. In addition to improving its adaptability to different users and spaces, all components of the sofa can be dismantled and replaced. the sofa is also made from recycled materials that could go on to be recycled at the end of their lifetime.

KEY TAKEAWAYS

- The bespoke lens product is adaptable for all occasions and allows full replacement of parts, making easy transitions for the changing needs of the building. As the luminaires can be modified for any changes in the building use during their lifetime, without compromising the design, the luminaire design implements the principles of circular economy.
- The design features four modules – a seating module, armrests and a pouf – that can be arranged in numerous configurations and joined together with colourful plastic connectors to suit the needs of the user.

Design for Recyclability

Prioritise easy recovery and recycling of end-of-life products so that they can be collected and recycled after use.

Can the used materials be easily recycled or reused at the end of life?

Have we used renewable and “carbon-light” materials and environmental product declarations?

Can we recycle materials at the end of life?

CRITERIA

- Limit the number of material types and composites;
- Make use of easy to dismount elements and products;
- Limit use of adhesives, dyes, paints and coatings;
- Limit or eliminate hazardous materials and contamination;
- When optimising product recyclability consider product types and geographies;
- Partner with end-of-life resource management companies to integrate the appropriate product features and facilitate end-of-life handling;
- Prescribe in procurement contracts that waste should be separated on site to facilitate recycling;
- Clearly marked or permanently label products, showing their inherent properties and date of manufacture to enable reuse.

DEFINITION

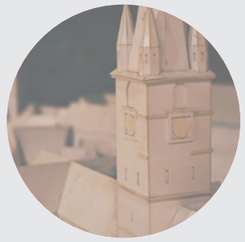
Design for recoverability & recyclability aims at closing outer loops, after products have been maintained, reused, refurbished and remanufactured.

Components that can no longer be repaired, upgraded or reused, but also fast-flowing products and materials need to be recovered for upcycling or recycling.

BENEFITS

Recovering and recycling valuable materials reduces resource use and minimises waste, and it can cut costs and earn revenue for stakeholders in the built environment. Designing for recoverability & recyclability has the potential to significantly reduce carbon emissions and mitigate fluctuating materials prices.

CASE STUDIES



© Unsplash

Cardboard window displays

Cardboard can be easily broken down and is completely recyclable.

Corrugated and honeycomb cardboard have a high strength to weight ratio. In addition, the material can be highly customisable and very cost-effective.

© Tarkett

Flooring take-back programme

ReStart® programme by Tarkett is dedicated to the collection of post-installation and post-consumer flooring, with the aim to recycle and reuse it as a new resource.

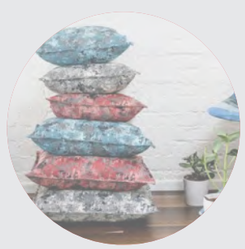
ReStart® allows Tarkett’s customers to sign up to a local take-back programme for flooring through established partnerships with waste collectors and transporters.

© Charlotte Kidgers

Upcycled window display

Visual displays are made with recycled industrial waste salvaged from local CNC factories.

Charlotte Kidgers show innovation in creating circular design solutions by mixing recycled PU foam dust (which she collects from London-based CNC factories) and hand-dyed resin for Braun Fashion new store display.



© Trend Hunter

Upcycling from fashion scraps

Furnishing objects made from fashion scraps.

Using scrap materials from the fashion industry’s waste-by-products including surplus leather, last season’s fabrics, unused buckles, etc. These materials are then used to create fit-out elements for the stores.

KEY TAKEAWAYS

- Logistics are less impactful due to high strength to weight ratio material.
- Cardboard can be left unprinted or fully printed with graphic designs.
- Companies participating in ReStart® contribute to safeguarding the world’s natural resources, protecting the environment and shifting towards a circular economy model.
- Smooth collections and sorting are enabled by multiple drop off sites offered by global waste management companies.
- While many stores focus on temporary disposable structures, which often end up in landfill due to the nature of their creation, this approach puts forward a more sustainable solution and one that simultaneously engages the audience of another industry.
- Upcycling discarded materials and turning it into new interior fit-out elements enables to close the loop within the same fashion brand.

Design for Disassembly

Products and components shall be designed such that they can be deconstructed at end-of-life.

Can parts of the product be standardised or prefabricated?

Can we standardise the design, e.g. for prefabrication?

Have we identified repetitive systems to reduce the product complexity?

CRITERIA

- Ensure comprehensive disassembly plan and product disassembly instruction, illustrating how elements should be deconstructed and recovered, are provided;
- Design for reused number of parts, components and fasteners to speed up disassembly;
- Screws are faster to unfasten than nuts and bolts;
- Glues should be avoided;
- Design compact and lightweight product to be manually handled to allow on-site assembly/disassembly;
- Avoid mixed use of incompatible materials and connections if not separable and manipulated as individual parts;
- Adopt reversible and compatible joints and connections.

DEFINITION

Design for disassembly (DfD) facilitates reuse, recycle and recovery of products with the aim of diverting them from the waste stream. This need is driven by the increasing disposal problems of large amounts of consumer goods, and the resultant pollutant impacts and loss of materials resources and energy that is embodied in these products.

BENEFITS

Deconstruction is crucial for retaining resources and materials value at end-of-life. Designing for disassembly is a transversal strategy that makes products repair, upgrade, reuse and recycle easier. The application of DfD principles allow building products to reclaim their embodied value, by enabling them to enter the re-life options at high quality.

CASE STUDIES

© Niaga

Design to use again

Niaga® future-proofs everyday products by making sure materials don't have to end up as waste. Ever.

Together with its partners, Niaga® designs out waste, completely. By scanning the Niaga® tag on its partners' products, you'll see exactly what they are made of and how they can be returned.

© Unsplash

Disassemblable laminates

Laminates can be disassembled and recycled based on today's new technological innovation.

Based on design for disassembly principle, there could be no additives, so that laminated surfaces can be unclicked. Therefore, the bulk of the material can be in use for multiple phases.

KEY TAKEAWAYS

- With the help of the Niaga® signature polyester adhesive, different materials can be disconnected on demand at the end of a product's use cycle – much like a glue that works like a screw.
- A recyclable product that isn't returned won't be recycled. That's why return is the cornerstone of a circular economy.
- So far, Niaga® has developed mattresses, carpet, and furniture panels. They are healthier and fully recyclable, without compromising on performance.
- Technology provides a closed-loop process to convert waste resources into materials.
- Addressing a range of unique global challenges, from failing recycling markets for paper and cardboard, as well as problematic agricultural waste being burned across the globe by farmers.

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About Arup

Arup is an independent firm of designers, planners, engineers, consultants and technical specialists, working across every aspect of today's built environment. Together we help our clients solve their most complex challenges – turning exciting ideas into tangible reality as we strive to find a better way and shape a better world.

Arup was founded in 1946 by Ove Arup, a gifted engineer-philosopher with an original and restless mind. Arup is owned in trust for its members, still guided by its founder's spirit and principles. We choose work where we can make a real difference in the world, stretch the boundaries of what is possible, delight our clients and achieve socially valuable outcomes.

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Disclaimer

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