

DESIGN GUIDELI

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This design guide has the purpose of offering designers an overview of the aspects relevant for designing products with an improved impact on resource scarcity. Currently, consumer electronics still rely on critical raw materials and other non-renewable resources. In order to maintain our quality of life, basic needs, and a stable system, rethinking our use of resources is essential. Product designers and manufacturers, along with the consumers, play a significant role in this topic.

It is the twenty-first century's designers' responsibility to work towards a transition of sustainable resource use. This design guide offers an overview of implementing positive changes to be part of the mentioned transition. The established guidelines are relevant for designers, manufacturers, and other actors in the system around the design, manufacture, distribution use, and waste management of consumer electronics.

GUIDELINES

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OVERVIEW

4.1 MATERIALS AND PHYSICAL PROPERTIES

The guidelines listed under the category of 'materials and physical properties' directly impact the designed product's physical nature. They were created to improve the impact of the physical properties (e.g., the types and quantities of materials) to improve the direct impact of the feedstock and the end-of-life factors required for products.

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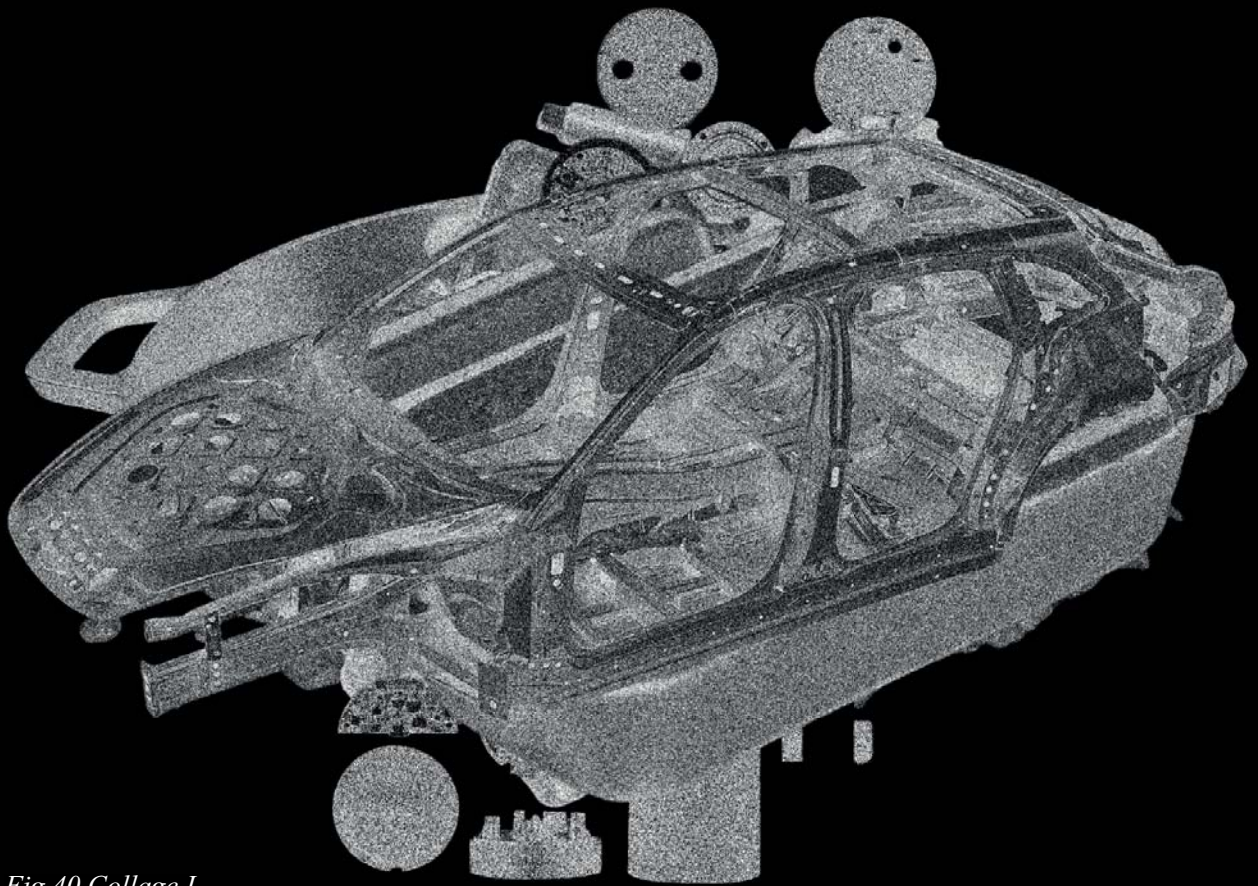


Fig.40 Collage I

MATERIALS

4.1.1 CREATE LONGEVITY

The longer the product life, the later it needs to be replaced; thus, fewer products are produced. This saves energy required for producing products and materials, the emissions for transport, and fewer raw materials are required. This also means that easy repairability should be possible.

Design Implications:

1. Never design for planned obsolescence
2. Define the reasonable lifetime for the product to be designed
(Shorter for single-use bottles, longer for thermal flask)
3. Design the product to have the lifetime defined. If the product lifetime is longer than reasonable, resources may be wasted.
(e.g. a single-use bottles out of stainless steel are wasteful, while stainless steel is a suitable material for thermal flasks)
4. Product aesthetic needs to suit the defined lifetime (e.g., a long product lifespan calls for a trend-independent aesthetic)
5. Design product to allow easy repairability (e.g., allow for the replacement of thermos flask lid in case it breaks)

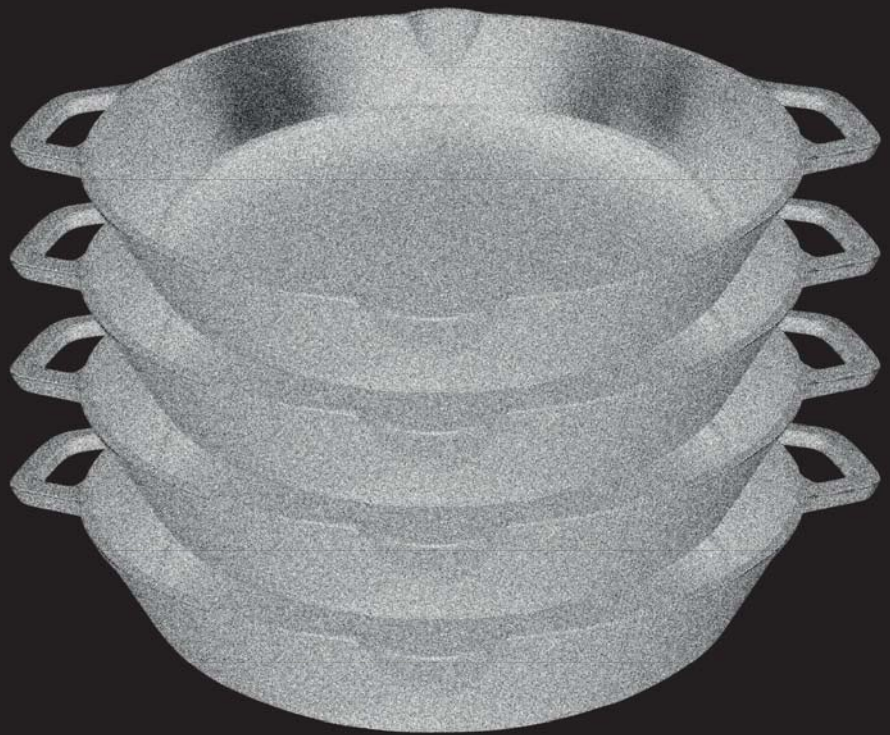


Fig.41 Cast iron pans

4.1.2 PLAN FOR DISASSEMBLY

When a product comes to its end of life and enters the waste stream, in order to have good recycling properties, disassembly must be possible and easy - this also is important for good repairability. That easy disassembly is possible; it must already be considered in the design phase of a product.

Design Implications:

1. Allow for easy disassembly of building parts
2. Allow for easy separation of materials
3. Consider the impact of connections in a product on the following aspects: Longevity, recyclability, repairability of product, and the disassembly of the product (e.g., bolts allow disassembly and reassembly and thus repairability but have a more negative impact on recyclability than, for example, adhesive bonds, which, however, do not allow repairability).
4. Minimize the quantity of building parts and materials used

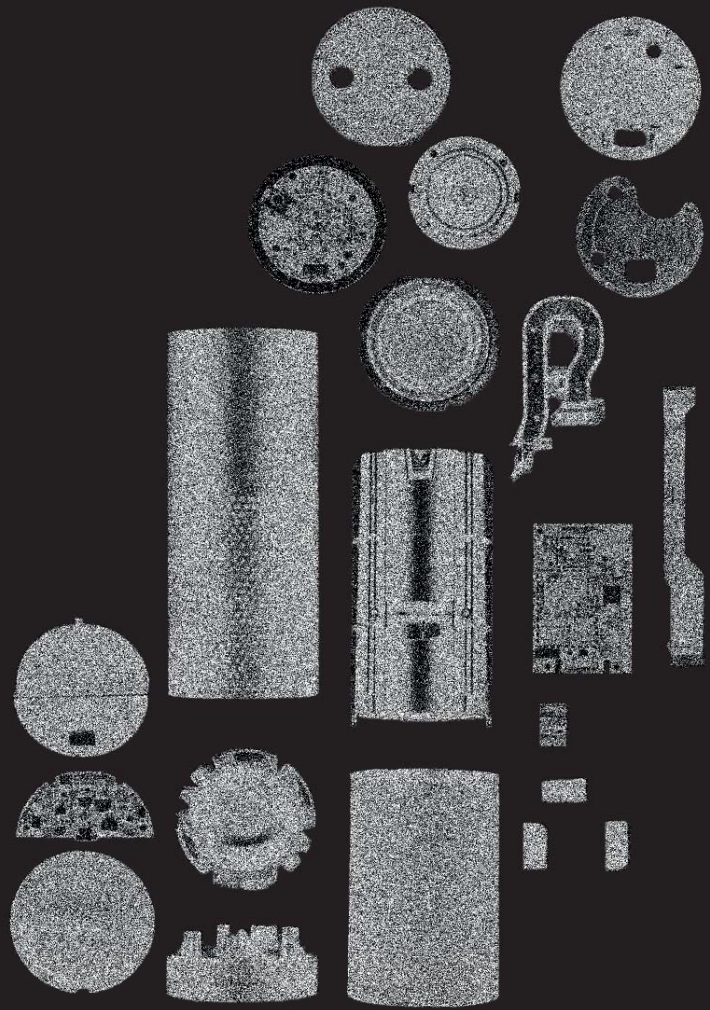


Fig.42 Loudspeaker parts

4.1.3 SELECT MATERIALS

Since ABS, PS, and PP make up about 55% of the plastic in WEEE, their recycling is the most lucrative and, therefore, most efficient (Sliz, 2019). In contrast, other materials such as PC or PMMA are only present in small quantities (1-2%); thus, their recycling is economically uninteresting. Therefore, materials that are as common as possible should be chosen (Sliz, 2019).

When considering materials in the design of a product, the following points should be considered when deciding which materials to use: Suitability, recyclability, scarcity, the energy required for production and transport, durability, and other applications which require these materials.

Design Implications:

1. Chose materials with good recycling properties and high recycling rates
2. Chose materials suitable for the use case
3. Chose common materials (e.g., ABS, PS, PP)
4. Replace critical materials with noncritical substitutes if available
5. Replace fossil-based materials with renewable materials

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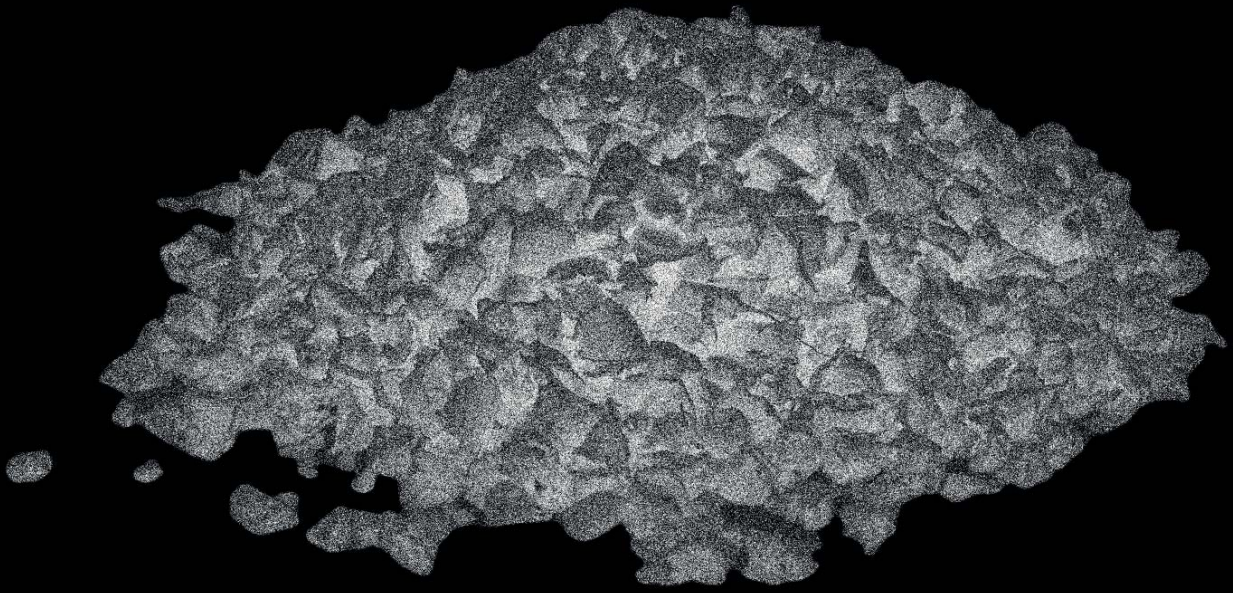


Fig.43 Recycled granulate

4.1.4 USE RECYCLED MATERIALS

The properties of recycled materials may vary in comparison to their virgin counterparts. Products should be designed in a way so that recycled materials can be used.

It must additionally be considered that WEEE plastics are sorted for recycling with near-infrared detection (NIR). This technology only reliably detects light-colored plastics. Dark ones are detected unreliably or not at all but make up 60-80% of WEEE plastics (Sliz, 2019).

Design Implications:

1. Choose recycled materials (e.g., rABS instead of ABS)
2. Check variation in properties of recycled materials versus their virgin counterparts (e.g., higher stiffness of rABS in comparison to virgin ABS)
3. Design products to fit the properties of recycled materials (e.g., rABS might need thicker walls than ABS due to it being slightly stiffer)
4. Consider the impact of color on recycling (e.g., lighter-colored plastics can be reliably detected in the sorting process while darker plastics cannot)

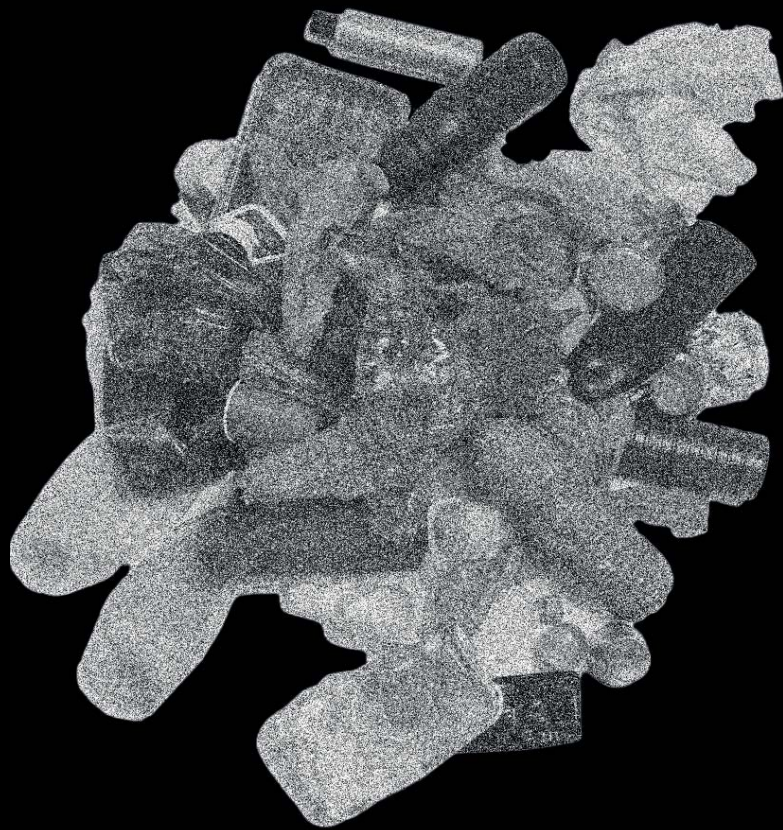


Fig.44 Plastic waste

4.1.5 OPTIMIZE MATERIAL USE

The quantity of material should be used as optimized as possible. Regarding quantity, products should contain the least amount of material possible to meet the properties and requirements. This not only improves the impact of the product regarding resource scarcity but is also the best way economic-wise.

Design Implications:

1. Rethink if the product is necessary
2. Consider if products need to be physical or if they can be a service
3. Consider a sharing system instead of product ownership
4. Reconsider which parts are necessary
5. Design products with the minimal resource use
6. Collaborate with other companies and institutions to build networks toward introducing circular products.



Fig.45 Car frame

MATERIALS

4.1.6 OPTIMIZE MATERIAL QUALITY

A big issue when recycling is the pureness of materials. The use of composites and other multi-materials is therefore problematic concerning the recyclability of a product. Mono-materials should be used in as many building parts as possible. Additionally, coatings and paints are often problematic since they are hard to remove and impair material purity.

Design Implications:

1. Choose mono materials instead of blends (e.g., PC or ABS instead of PC/ABS blends)
2. If mono materials are not an option, consider the impact of blends on the recyclability of the product (e.g., using blends in small quantities might make the complex recycling of them unfeasible, or if pure ABS is combined with an ABS/PC blend, both materials might be recycled as a blend, thus reducing material purity)
3. Design for the use of mono materials (e.g., grip surfaces can be textured instead of rubberized)
4. Choose non-hazardous and safe materials (not only the hazardous level of the materials (e. g. the green screen score) but also the hazardous level of additives need to be considered here)
5. Avoid coatings and varnishes to keep materials pure

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Fig.46 Gold bar

4.2 BEHAVIOR AND AWARENESS

Products and consumer behavior are interrelated. Products influence our consumption patterns and other behaviors, influencing the design and demand for products. Thus behavior patterns play an essential role when targeting our resource use. This section focuses on aspects a designer can consider when targeting consumer behavior concerning the sustainability of consumer electronics.

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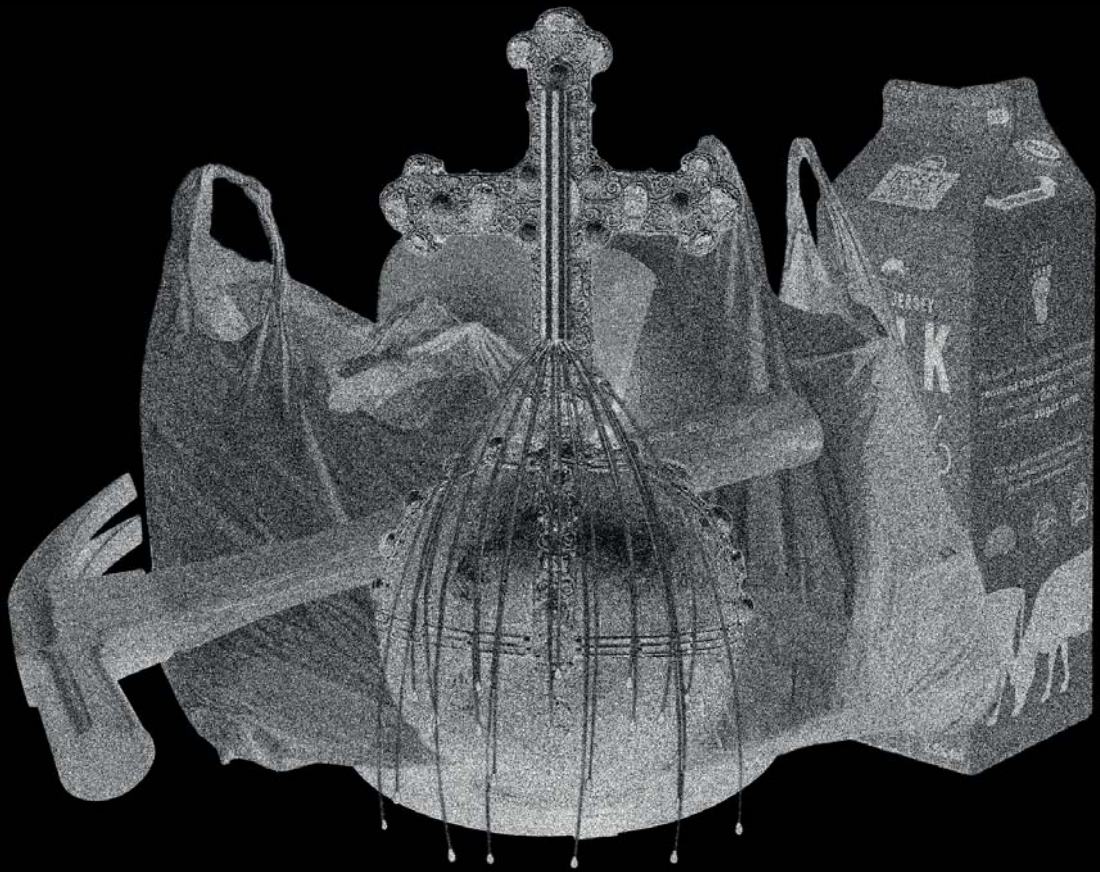


Abb.47 Collage II

BEHAVIOUR

4.2.1 CREATE SATISFACTION THROUGH USE

Since experiences fade quickly in everyday life, it cannot be generally argued. ‚Experiences are better than objects‘. This is because the pleasure of the purchase can last longer, depending on the product, and thus have a disproportionately greater value (Oberhuber, 2016). Those who buy a nice bicycle and ride it on nice tours have long and often deep satisfaction.

Design Implications:

1. Design for stronger emotional bonds of users to products
2. Design for good experiences during purchase and use
3. Combine product with satisfying activities to create sustained satisfaction with each use

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Fig.48 Scalp massage

4.2.2 STRENGTHEN VALUES AND PERSPECTIVES

Beyond showcase consumption, products are means of communication that help a social group maintain exchange and thus defend its values externally.

If we assume a group that already consumes responsibly, products and the exchange about them help defend themselves against the influences of society's mass consumption. If these products can be the focus of a group meeting, this improves the effect.

Design Implications:

1. Create a product that supports trends with positive impacts, supporting the values and perspectives both internally and externally
2. Target consumer groups that already support values relevant to tackle resource scarcity and are open to change

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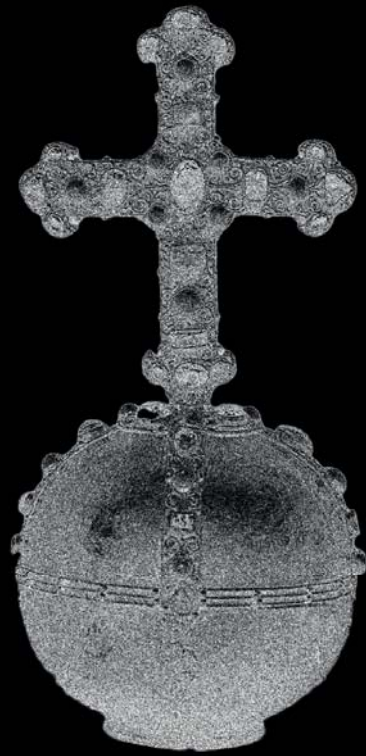


Fig.49 Orb

4.2.3 MAKE IDEALS AND VALUES VISIBLE

After communicating internally, products can also have communicative aspects externally. If products are seen to be different through their form, materiality, use, or branding (e.g., Veja shoes), they become the medium of the new ideals. Even more, using these objects can have an educative effect on others, stimulate thinking and thus influence other social groups.

Design Implications:

1. Analyse the values of interest present in the consumers of designed product
2. Design for target values, make them visible and present (e.g., a product that targets repairability not only needs to be repairable but also needs to communicate its repairability)
3. Create products that stand out to increase their communicative effect.
4. Create products with an honest design

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Fig.50 Siren

4.2.4 STRIVE FOR COMPLETENESS IN PRODUCTS

These products can exist somewhat detached from innovations. Many new products are constantly replaced to keep up with the pace. Traditional objects are generally more consistent, they often no longer have an „actual “ function, but they still carry a strong symbolism. The completeness characteristic stands in strong contrast to a rapid change of life and helps to come to rest and decelerate life.

Design Implications:

1. Dispense with components that frequently require updates or brake
2. If components that require frequent updates are necessary, allow easy upgradability for them by designing them modular. This also allows improved repairability if a part breaks.
3. Analyse wether innovations bring actual benefits to use and function or if they serve primarily as an incentive to buy the product.
4. Only innovate when there is a real benefit for the user, the manufacturer, the function and the environment.

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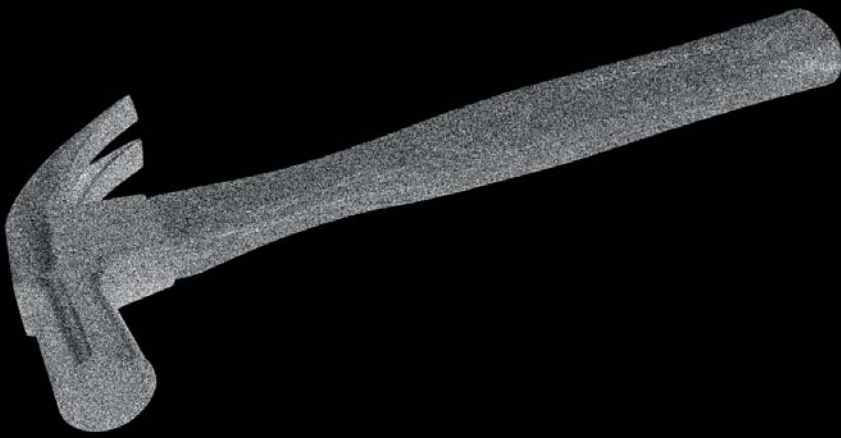


Fig.51 Hammer

BEHAVIOUR

4.2.5 CONSIDER FREQUENCY OF USE

We only build a bond with products we need and use, which brings an appreciation for their effort to use and maintain them. The Norwegian industrial designer Roar Høyland already addressed this in 1938. He gave the example that improving the milk carton was more important than improving another expensive chair.

Design Implications:

1. Analyse whether a product with low impact, but high frequency of use or a product with high impact and low frequency of use is better at achieving the impact desired



Fig.52 Milk carton

4.2.6 CHANGE CONSUMPTION

If consumption does not make us happy, we should rethink how we consume. Owning fewer products means taking responsibility for fewer products that take time to use (if we use them) and maintain.

Design Implications:

1. Rethink if the problem the product is supposed to solve is actually a real problem
2. Analyse if other options than products can solve this problem in a better way (e.g., a service)
3. Analyse whether it is beneficial if one product can solve multiple problems

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Fig.53 Shopping bags

4.3 COMMUNICATION AND MARKET POSITIONING

Creating ,good-example-products' helps influence policymakers, product trends, and manufacturers. These good examples need to enter the market for maximal impact efficiently.

This section offers various aspects that help bring good examples to life. The guidelines offer ways to influence and convince key actors of the importance of this topic, find points of entry into the market and establish good examples.

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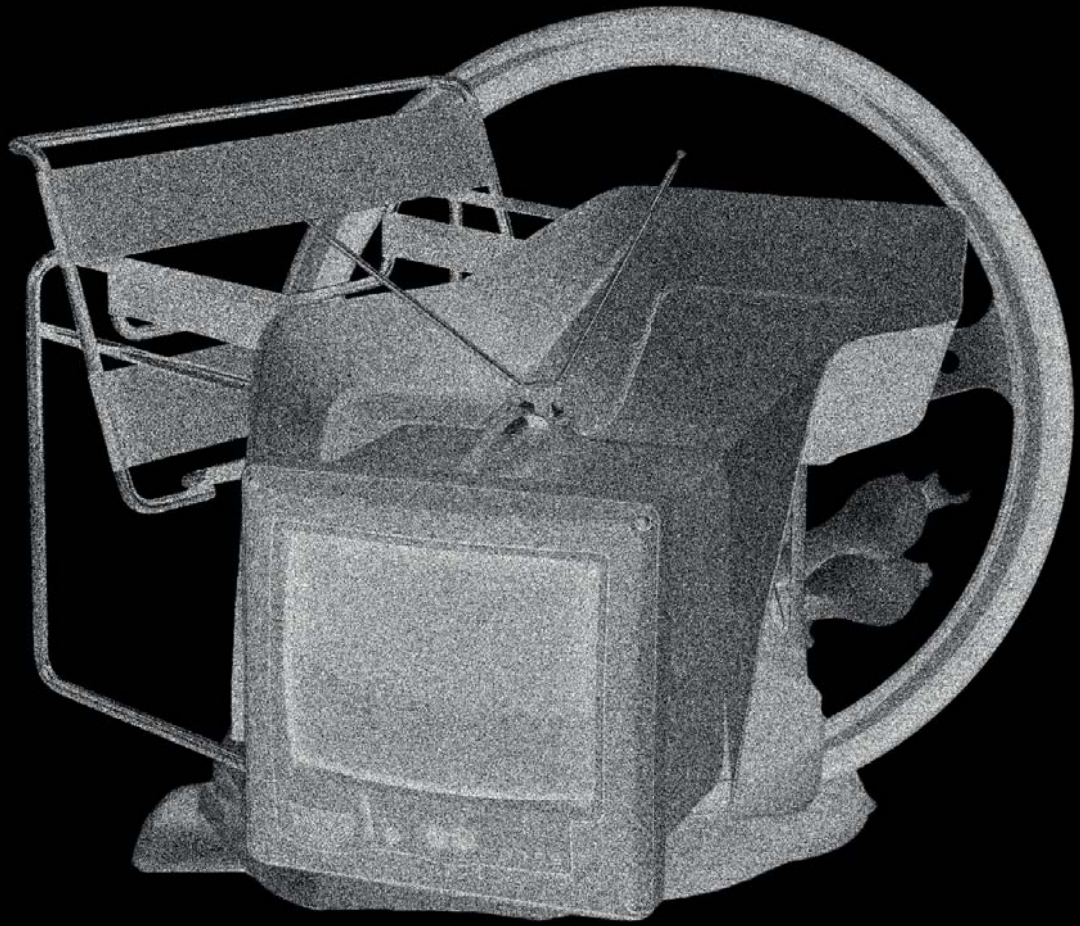


Fig.54 Collage III

COMMUNICATION

4.3.1 OFFER COUNTER-DESIGNS FOR NEGATIVE PRODUCT TRENDS

Creating designs outside of existing trends with negative impacts or steering the existing trends with product design into directions with improved impact helps shift the widespread understanding of „good design“ toward improved environmental impact.

Design Implications:

1. Question existing product trends
2. Counter design for negative product trends - create good examples

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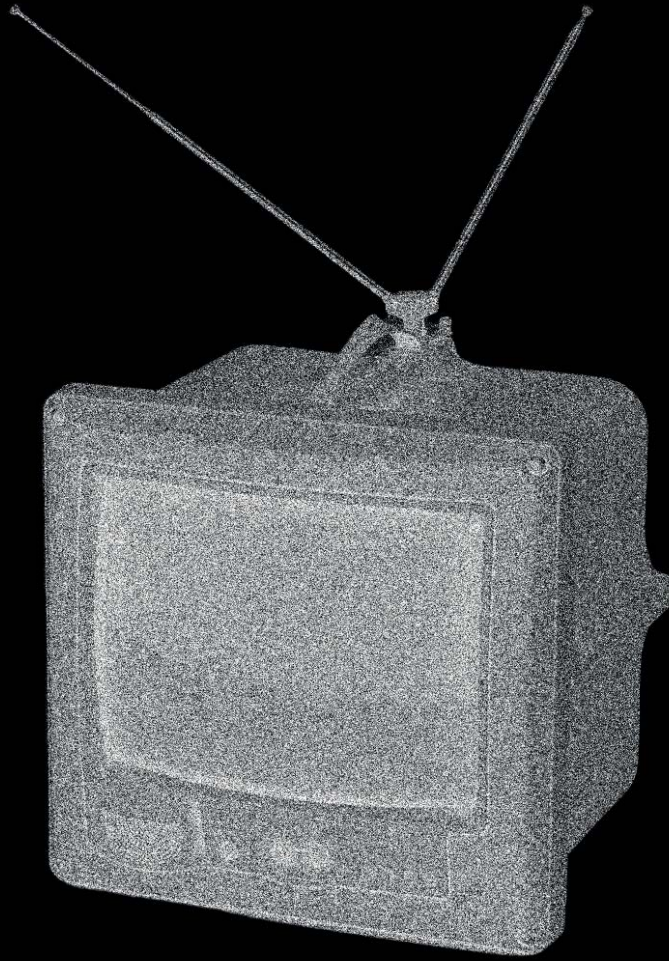


Fig.55 Jim Nature Portable Television (Philippe Starck)

4.3.2 KNOW THE TARGET GROUP

A movement brought to public attention as early as 2000 by the study of sociologist Paul H. Ray and psychologist Ruth Anderson is LOHAS - Lifestyle of Health and Sustainability. The 'Trend Report Target Group LOHAS - How the Green Lifestyle is Conquering the Markets' (titles translated by the author) published in 2007 assigns 30% of the German population (similar to the USA) to this group (Glöckner et al., 2010). The central aspect of their actions is strategic consumption, which aims to change and influence the environment through new values such as authenticity, information, honesty, and sustainability - influencing the purchase of new products.

The great opportunity is that these values reach the broad, middle-class. With their purchasing power, they are in a position to change the economy. Changing their purchasing criteria can encourage the economy to bring complementary products onto the market.

Design Implications:

1. Target groups open to changes and more strategic consumption decisions (e. g. the LOHAS group)
2. Analyse complementary trends and developments present in such groups and integrate them, if possible, to maximize the effect on sustainable transitions and establishing products

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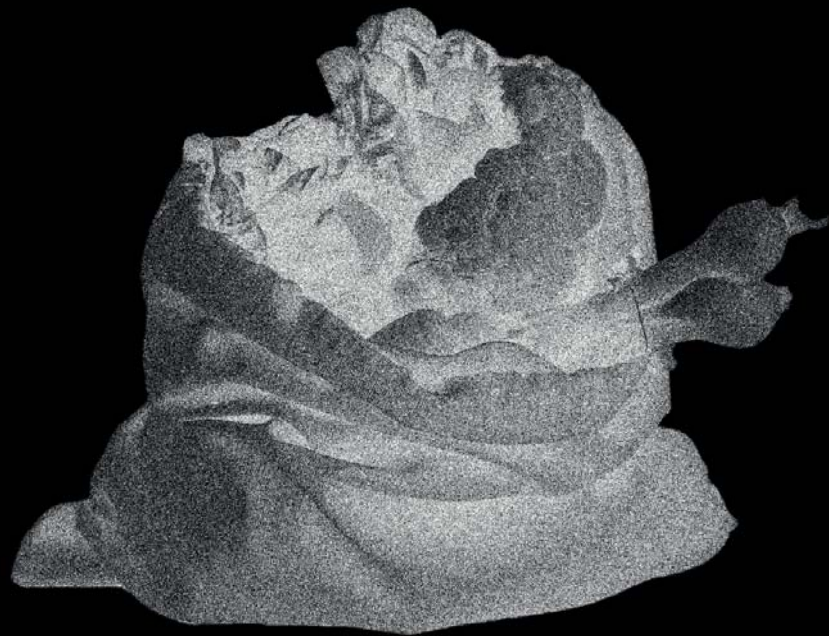


Fig.56 Conscious purchase

4.3.3 CONVINCING CUSTOMERS

Resource-oriented product design might conflict with short-term economic or operational goals but is essential for the long-term performance of companies. It also has the potential to conflict with established practices, customer expectancies, and supplier networks.

Therefore establishing resource-oriented product design practices must be well argued.

Implications:

1. Policies regulating resource use will come and get stricter. Companies that act early stay ahead of policies and will have market advantages when policies are introduced over non-acting companies
2. Customer expectancies are already changing towards more sustainable and aware behavior. Their product expectancies will likely continue shifting within the near future. Acting companies can fulfill these expectancies while non-acting companies cannot. This helps keep existing and aware customers and likely win new ones
3. The aware consumer target groups appreciate honest and value-oriented production of products. Thus good practices will have beneficial effects on customer loyalty.
4. With resource scarcity getting increasingly severe, their availability, especially critical raw materials, will be at risk while their prices will experience severe increases. Resource-oriented product design buffers these effects and secured the position in the market

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Fig.57 Steering wheel

4.3.4 USE CONTEMPORARY LUXURY CONSUMPTION PATTERNS

The contemporary consumption of luxury is, in contrast to traditional luxury, strongly linked to competencies. Such competencies are aesthetic taste, sensitivity to symbolism, and expertise. Consumers of these products want to satisfy their desires linked to these competencies and communicate them to their peers and surrounding.

This creates a market for products supporting more aware consumption with positive impacts and thus provides possibilities for economic success when introducing resource-oriented products into the market.

Design Implications:

1. Design products that openly show values, properties, and symbols
2. Design products with a striking and well-made aesthetic
3. Create a good use experience of the designed product - the functions may be simplified, but the functionality of the designed product needs to be optimized

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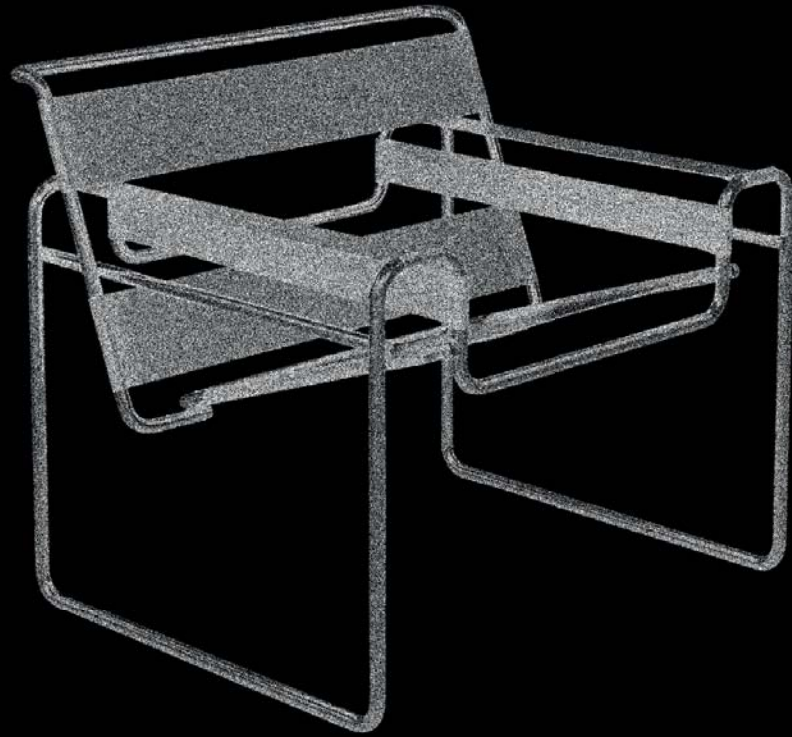


Fig.58 Wassily Chair (Marcel Breuer)

4.3.5 MARKET ,AESTHETICS OF SUSTAINABILITY'

The guidelines focusing on the physical properties will also affect and limit the aesthetics of the designed product. Existing trends and established product aesthetics will likely conflict with the new aesthetics. This conflict has a critical communicative role. This conflict allows the new product to stand out in the near future, thus offering marketing opportunities and helping establish good practices and trends in the long term.

Design Implications:

1. Embrace the newly created aesthetic - do not hide it
2. When this aesthetic of sustainability is not established, use it as a selling point for early adopters
3. When this aesthetic of sustainability is starting to be established, it becomes the new normal and can then be further intensified/advanced.

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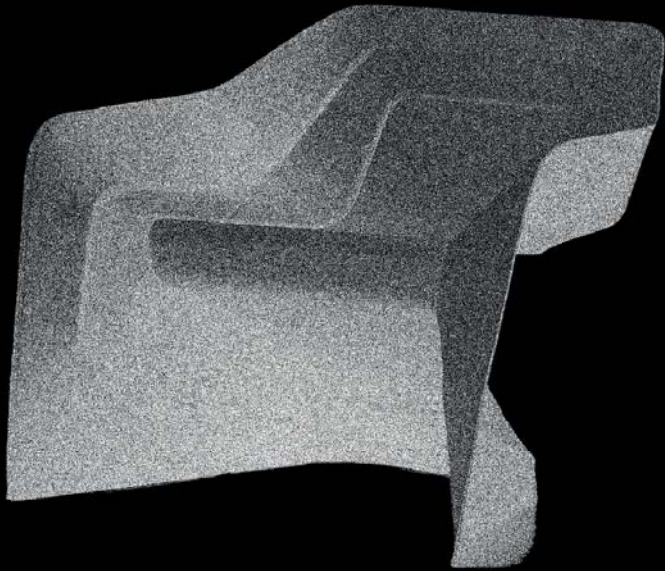


Fig.59 Hemp Chair (Werner Aisslinger)