A GUIDE TO

Circular product design

by Ruard Dijkstra

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1 Introduction

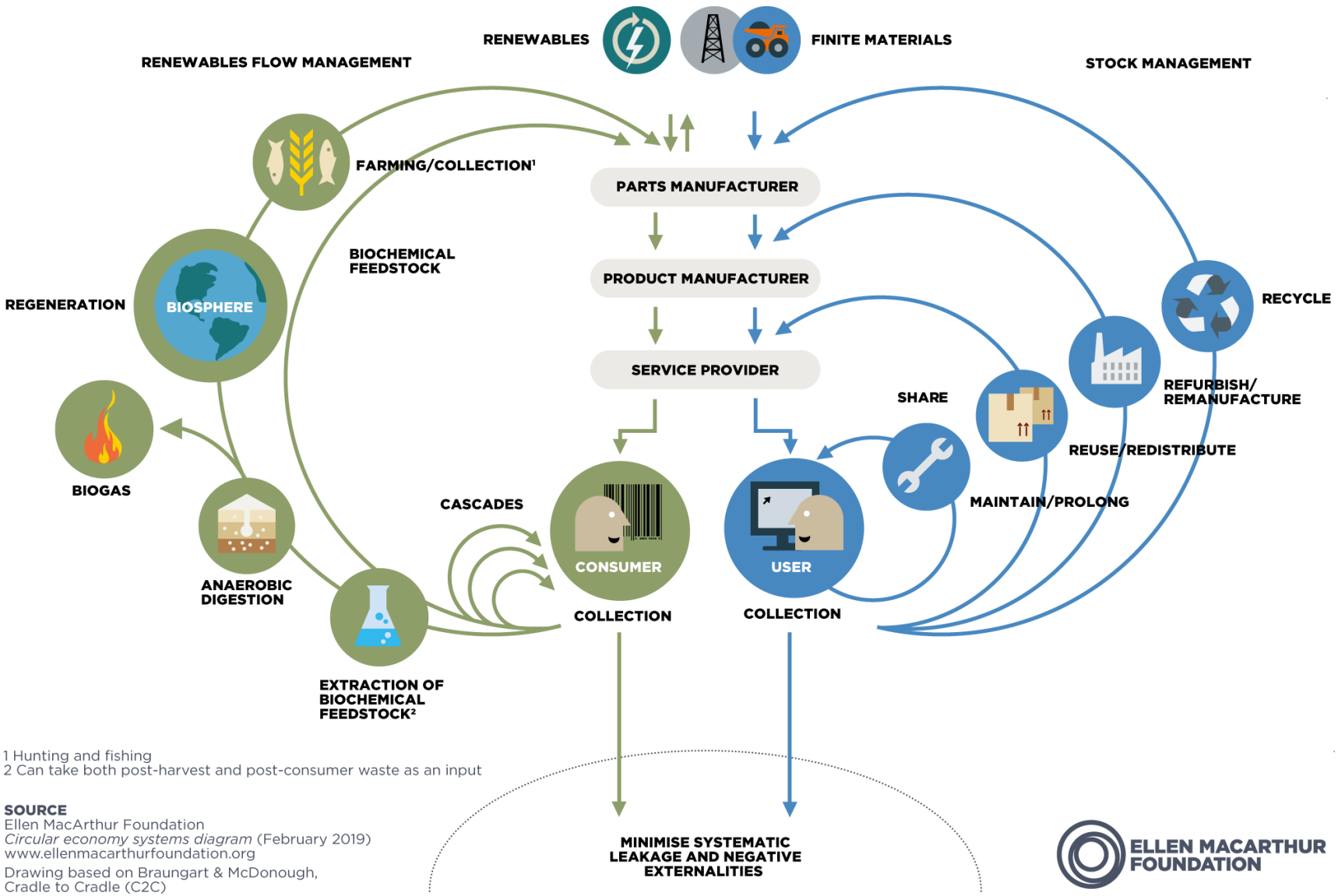
The goal of this E-book is to inform the reader of the possible ways a company can design their products in a circular and more sustainable way. We are currently taking on the challenge to make our way of living more sustainable and a good place to start is with circular product design. Design is crucial for the circular economy as there is only so much, we can do with the linear products in regard to circularity. Due to these linear products the consumer is often tempted to buy new and improved products and discard their ''low-grade'' products, which fuels our unsustainable consumerism. Unfortunately, changing to circular design is not as easy as changing one or two things in your product, it requires a shift in thinking. Designers are forced to not just think about the design and the materials used but also thinking about the system in which the design will exist. The way of designing is not the only thing that changes because a circular design often requires a change in business model. Luckily there have been some frameworks and strategies that have been established to help with circular product design. This E-book will present and explain the strategies and tools that will help with circular design and will give some example cases of products that have implemented circular design strategies.

2 Circular design

So, what defines a circular design? Circular design means designing products and services that work well in their intended function and have minimal negative and maximal positive impacts during their life cycle. Secondly, it means understanding the importance of choosing the right raw materials and assembling products with their end-of-life possibilities in mind. Thirdly, circular design aims to improve resource productivity along the whole life cycle ensuring that value chains are efficient, and all synergy possibilities are taken into account. (Aho, 2016)

Circular design can prevent value loss by keeping products and materials in closed loops as shown in figure 1. There are ways to slow the loop for example by extending the life cycle of a product. But the best ways to close these loops are reuse, repair, remanufacture, refurbishment, recycling. By closing the loops, a product or a part of its will can be used for the same application or for another purpose. Using old components for the same product can be achieved by remanufacturing

Choices made during the design phase will affect the products life cycle as it can determine the ease with which a product can be reprocessed, for example by using highly recyclable products. As well as considering the multi functionality, compatibility, modularity and durability of a design. And that is why it is important that designers are able to use tools and strategies to assist them in their designing process (Ellen MacArthur foundation, 2021)



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input

SOURCE
Ellen MacArthur Foundation
Circular economy systems diagram (February 2019)
www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

ELLEN MACARTHUR FOUNDATION

Figure 1 circular economy systems diagram

3 Circular design process

A circular design process has been created by the Ellen MacArthur foundation in order to aid designers in designing a circular product or service (shown in figure 2). The process follows four steps.

1. **Understand:** Designers should know the users of their product or service and the system (environment) in which the product or service exists.
2. **Define:** The designer should formulate the challenge of the design and the intention of the design.
3. **Make:** the purpose of this step is to come up with as much solutions and designs that can be tested in order to find the best working solution. In this phase it is possible to experiment with different strategies, different materials, different business models etc.
4. **Release:** When releasing the design into the unknown it is important that there is a narrative around the design. the narrative invokes loyalty from customers and deepens the investment from stakeholders.

Designing a circular product is an iterative process and therefore the designing does not stop after the release. Designers should always be looking for ways to refine and improve on their design and how it fits in the wider system. (Ellen MacArthur foundation, 2021)

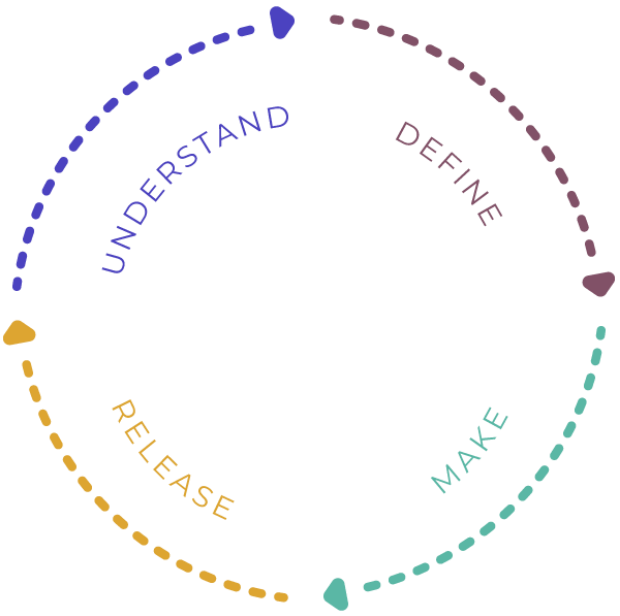


Figure 2 Circular design process

4 Circular product design frameworks

Finding the right approach for a circular design can prove to be quite difficult and that is why some organisations have developed their own tools. One of these frameworks is the circular product design framework and the other tool is the online circular X tool by Circular Design.

The circular product design framework (figure 3) developed by Circle economy, can be used to create circular products by visualizing a list of circular strategies that can be used for creating a long-lasting product or service. The circular product design framework can also help with exploring new opportunities for circular design. The strategies are clustered into groups based on the 10R-model; design for reuse, design for remanufacture, design for refurbishment, and design for recyclability. The great thing about this framework is that it is widely applicable in various industries and at different scales. Different innovation levels are shown in the framework in order to indicate the relevancy of the given circular design strategy. (Circle Economy, 2021)

These different levels are.

- Material level: Create new materials and the components made from these materials, or redesign existing materials.
- Product level: Improve existing products or develop completely new product solutions.
- Service level: Go beyond individual products and towards combinations of products and services.
- System level: Consider the interconnected set of elements that are coherently organized to achieve a function or purpose.

The second tool is the circular X tool. The circular X tool is a Circular Design project is the output of three years PhD research on Design for X (X = a circular design strategy) at University Iuav of Venice. The aim of this project is to help companies and students to learn, explore, play and try to use a collaborative approach to accelerate the circular economy from the earliest phase of the design process. (Circular Design, 2021)

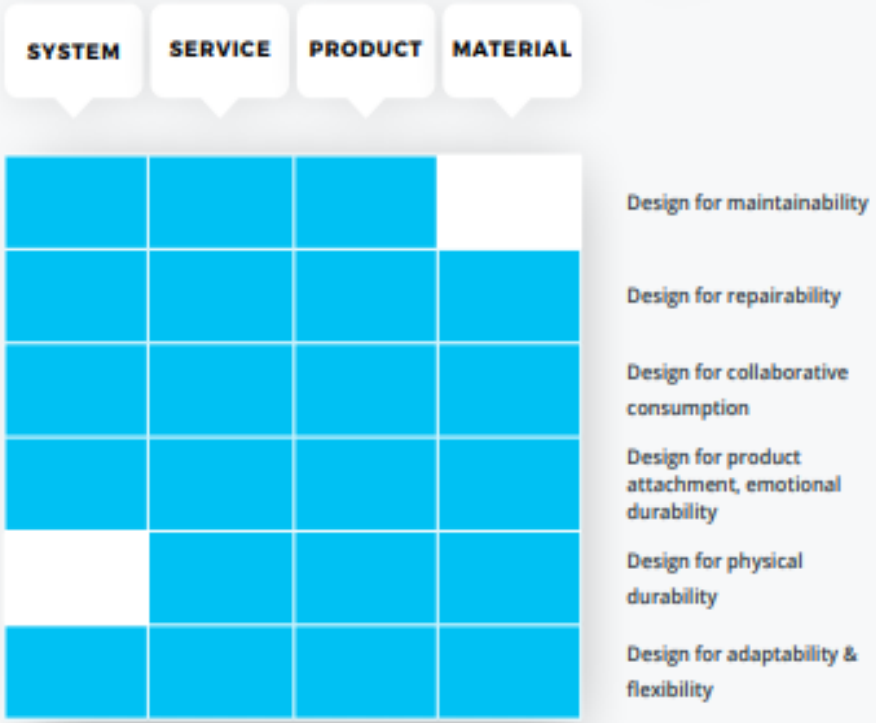
It shows a big wheel with different strategies and possible business models that can be used. This creates a great overview and the tool also gives a explanation on how it can be utilized the most and what kind of questions you should ask yourself.

To visit the online tool, click here

DESIGN STRATEGY RELEVANCE ACROSS INNOVATION LEVELS

Relevant

Does not apply



DESIGN FOR REUSE

- Reuse by another consumer of discarded product which is still in good condition and fulfils its original function.
- Designing products to be reused for the same or different purposes in multiple lifecycles.

DESIGN FOR REFURBISHMENT

- Restore an old product and bring it up to date.

DESIGN FOR REMANUFACTURE

- Use parts of discarded product in a new product.

DESIGN FOR RECYCLABLITY

- Designing products to remove any barriers to recycling and enable easy recyclability.

CIRCLE ECONOMY

5 Circular design strategies

Now that we have seen the frameworks for circular design, it is important that we understand the different strategies that can be used. In this chapter the different strategies will be explained, and it will provide a case example of a product or service.

Design for reuse

The key principle of designing for reuse is that the product will stay in the same loop with relatively little restoration while maintaining the original purpose. A limiting factor of the strategy is that the products must be durable enough to make them last through all the reuse loops. The benefit of this strategy is that the total environmental impact decreases after each reuse loop. Design for reuse should be considered when the designers are dealing with products of medium- and high-quality. The circular product design framework demonstrates some strategies that can help with designing a reusable product. These strategies are designing for maintainability, designing for repairability, design for collaborative consumption, design for product attachment, emotional durability, design for physical durability and design for adaptability & flexibility. (Circular Design, 2021)

Design for maintainability

It is essential that products to be maintained properly in order to keep the performance and value as high as possible for the longest time. Therefore, designers can try to keep the ease of maintenance in mind while designing a product. This could mean that components are easily accessible and easy to maintain. When the complexity increases a maintenance kit or user manual could improve the maintainability of the product. Other options for design for maintainability are.

- Design a program to maintain products regularly
- Design for a technical and interactive simplicity
- Design for a multi-systemic application
- Design the product for a better prediction of maintenance
- Design for proactive maintenance (such as regular cleaning or lubrification)

A design for maintainability often goes well with a different business model because it is reasonable to assume that due to the life extension a lot of less new products will be bought. It is a good strategy when the supplier still has ownership of the product as the decrease in sales can be covered by maintenance revenue. This is often the case with leasing business model. A great example of this is the aero-engine business model of Rolls-Royce. Although the engines are sold to the aircraft owner, the TotalCare service package means that Rolls Royce is still responsible for the performance of the product thus also for the maintenance of the engine. The revenue is generated by servitised performance-based model. This ensures that the performance of the engines is maintained. Furthermore, it gives the Rolls-royce visibility of the product during its life. This helps at the end of the life cycle as to create the opportunity to recover resources, re-condition components or remake the product and thus closing the loop. (Smith-Gillespie, Muñoz, Morwood, & Aries, 2019)

COMPANY NAME
Rolls-Royce

SECTOR
Electronics

Rolls-Royce

Rolls-Royce's Civil Aerospace business is a leading manufacturer of aero engines for the large commercial aircraft, regional jet and business aviation markets. The company uses its engineering expertise, in-depth knowledge, and capabilities to provide solutions for customers over their product's lifetime.

CHALLENGES

Aircraft engines are complex, expensive assets whose value needs to be managed over a long operating lifetime. This is needed to not only meet mission-critical safety requirements, but also to provide reliable performance. Rolls-Royce's TotalCare solution emerged from customers demanding a service which addressed their challenges, enabling them to transfer risks on to the engine manufacturer.

INNOVATIONS

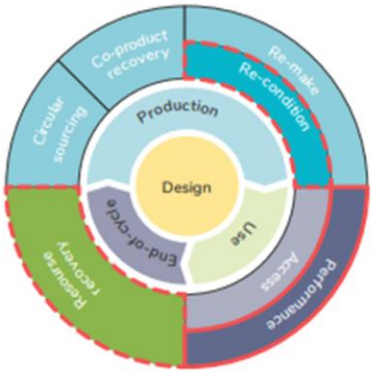
- A value proposition that shifts risks and uncertainties associated with engine maintenance from the aircraft operator to Rolls-Royce.
- Aligning incentives between Rolls-Royce and TotalCare customers by charging for the service on the basis of 'power-by-the-hour': Revenues are dependent on ensuring engines provide the required performance.
- Risk and Revenue Sharing Partnerships with key value chain players sharing costs, risks, and benefits. Revenue sharing aligns incentives between Rolls-Royce and its partners in a similar way to that with its customers.
- TotalCare has multiple variants to meet evolving maintenance and asset management needs of customers over their engines' lifetimes.
- TotalCare allows Rolls-Royce the option to buy-back and reclaim end-of-life engines so that materials can be cycled back into the manufacturing supply chain. Rolls-Royce can in turn benefit from reduced material input costs and security of supply.

KEY ENABLERS

- A compelling value proposition addressing key customer needs, with a revenue model based on aligned incentives.
- Deep knowledge of service operations and engine technology, enabling Rolls-Royce to take on and manage transferred risk.
- Growing digitisation, enabling engine health monitoring and diagnostics as well as value added services that can be integrated into a service-focused proposition.
- Key partnerships that enhance and de-risk the business model.

"We care about the performance of our solutions throughout their lives. Our whole-life capabilities maximise availability and enable us to meet changing customer needs"
Rolls-Royce 2017 Annual Report

CIRCULAR ECONOMY BUSINESS MODELS

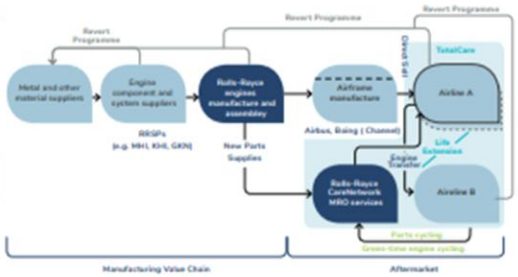


KEY OUTCOMES

The TotalCare solution has resulted in a number of positive financial and sustainability outcomes:

- Profitable service-focused revenue model, with service revenues over the lifetime of an engine programme being typically four times that of revenues from actual engine sales.
- Material efficiency during asset operating life through extending engine lifetime and utility; better parts management and reuse; and better repair processes.
- Material efficiency at end-of-life by capturing and recycling engine materials.
- Increased customer satisfaction and deeper relationships.

MATERIAL FLOWS



Read More →

R²π The route to circular economy

Figure 3 businessmodel canvas Rolls-Royce

Design for repairability

A great example of the decrease in design for repairability is the repairability of old cars and new cars. In the past is was far more common for the users of the car to repair the car by themselves. This is because due to technology the products have been become more complex. So, in order to fix a car, you need to have some mechanical skills but also electrician skills.

Design for repairability is similar to design for maintainability for example it should be easy for the user to repair the product or they should be notified that it is possible to send the product to a repair station. A user manual or a repair kit would be useful to incentivise the user to repair the product by themselves. The availability of spare parts plays an important factor as they could prevent someone discarding a product when only a component of it has failed. Maybe in the future when 3D-printing technology is more widely available it could be possible to print out a component that can replace the malfunction product. (Mead, 2015)

A good example of design for repair is a jacket from Patagonia as they offer a free repair service as well as supplying an extra zipper and extra pieces of cloth to patch up holes. Patagonia looked at the components that were most likely to malfunction and supply the user with spare parts when the user buys a new product. Patagonia is also willing to take back old jackets so that they can be reused. (Patagonia, 2021)

Figure 4 Patagonia common threads initiative

Design for collaborative consumption

Collaborative Consumption involves sharing, renting, gifting, bartering, swapping, lending or borrowing between individuals. (Piscelli, 2015)

Adapting collaborative consumption prevents unnecessary purchases and therefore decreases the use of resources. There are different kinds of collaborative consumptions. These include redistributing used products to new users so that they can be used again. A well know example of this is martktplaats.nl. Over the last couple of years another method of collaborative consumption has become more common, namely the product service system. The product service system promotes using rather than owning and revenue can be created by a performance-based model like previously discussed with Rolls-Royce areo-engines. An example of the collaborative consumption is the Felyx electric scooters or the Go-sharing Electric scooters. The user does not have the need to buy their own scooter and due to it being electric it saves on emissions.

Design for product attachment and emotional durability

Designing a product for attachment and emotional durability might be the most challenging strategy as the design must succeed in creating an emotional bond between the user and the product. This way the user is more likely to maintain and repair the product. According to a study from the TU Delft in cooperation with Phillips researchers defined 5 distinct qualities a product that can create emotional durability. These characteristics are involvement, adapt to the user's identity, animacy, evoke memories and rewarding.

Involvement is needed in order to prevent the loss of meaning for a product. By providing a special presentation, extra (exciting) functionality and interaction are great ways to raise attention for the product. This way a product can continue to stimulate and intrigue the user. Adapting to the user's identity is of importance because people can use physical objects to express themselves and therefore these objects need to have an identity so that a user can relate with it. To make the experience last the identity must change over time just like the identity of the user. Animacy can give a product a soul and therefore making it more likely that a user will cherish the product. This is often achieved by adding mistakes and imperfections to give it a livelier look. Memories can be used to improve the chance that people will keep the products for longer. This is a very challenging task and is often achieved by giving things a vintage look. The product should be rewarding because it makes the relation more durable for example people are more likely to notice your car if it is nice and clean and therefore the user in enticed to clean his car more often (Van krieken, 2012).

The researchers from the study about emotional durability developed a water kettle together with Philips to see if they can create emotional durability. The name of the product is the Sneaky Kettle which would move around, rotate and behave ''inappropriate'' after usage. The movement gains the attention of the user and give the feeling that it has a soul.

To read the full study click here

Another good example of emotional durability is the luxury watch brand Patek Phillipe. They achieved emotional durability through the following statement: *You never actually own a Patek Philippe. You merely look after it for the next generation.* This creates a strong nostalgic and emotional bond mostly between father and sons. This bond incentivises the user to take great care of the watch as it has great monetary value as well as emotional value.

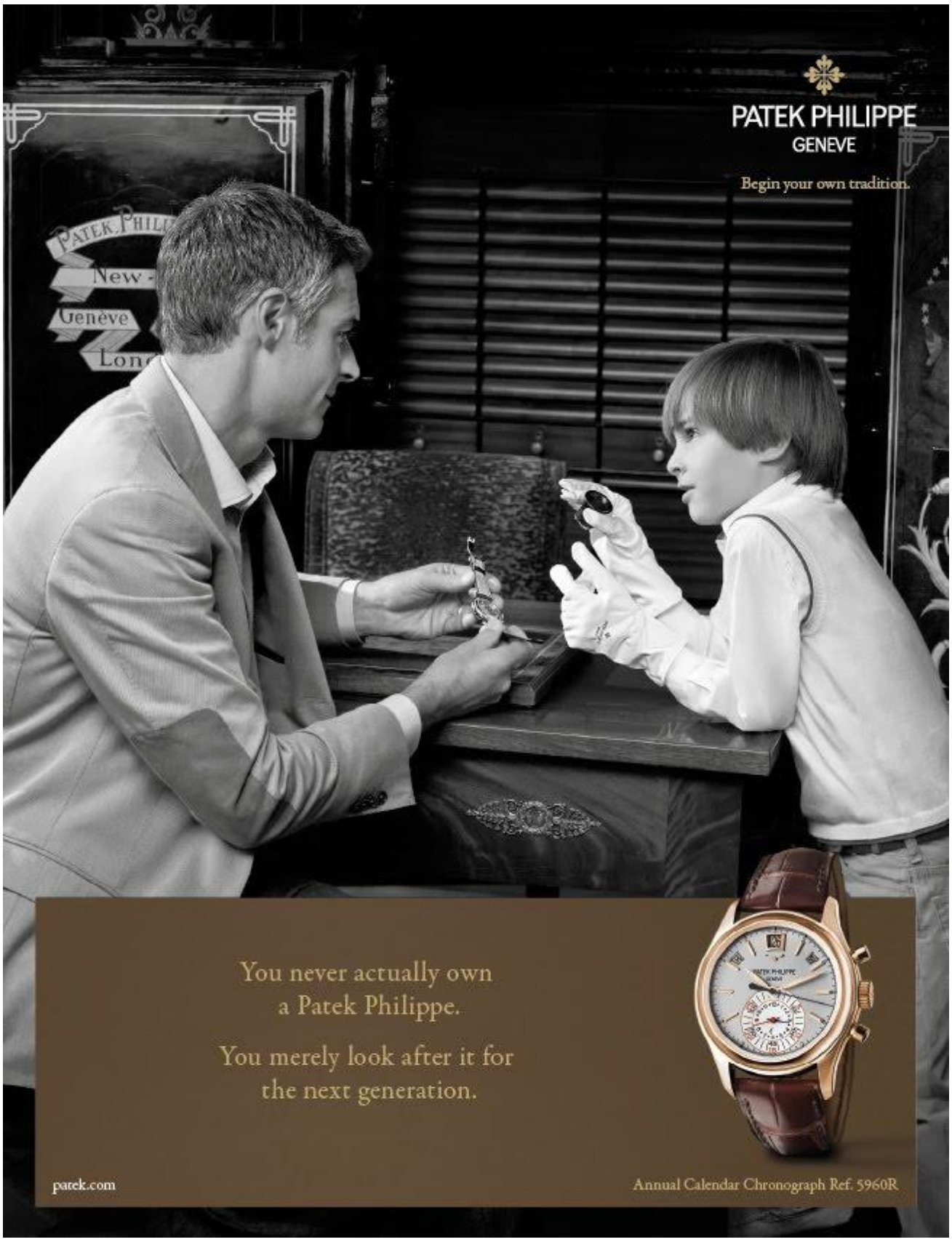


Figure 5 patek philippe

Design for durability

Designing with durability in mind while promote the longer use of a product by designing it to resist damage and wear. This could mean that durable materials are used or that important vulnerable components are protected. The problem with this is that it should also remain up to date in order to be used. That it is best to avoid this strategy when it comes to technology, but it can work out great for other products. For example, cast iron pans are known to last for a very long time.

Design for adaptability and flexibility

Often used in the building industry design for adaptability and flexibility means that the product is designed to be able to be used for multiple purposes. In the building industry it can be used to design an office that can also be used as a residential home preventing the disassembly of the old building.

Design for refurbishment

Refurbishing is the process where discarded or damaged items are repaired to functional conditions or bringing an old product up to date. Most of the time refurbishing means replacing or repairing a certain component. Designing for disassembly has a crucial role as it relates to the time and cost to the disassembly and reassembly of a product especially because they should compete with a brand-new product. The 3 main principles for design for refurbishment are, upgradability, standardisation and, compatibility and disassembly.

Design for upgradability

A product designed for upgradability is able to adapt future enhancements of product performance and functions. To achieve this the designer must predict what the product performance and functions will be in the future (Masato Inoue, 2014). designing for upgradability prevents products from being outdated and therefore avoiding the rebuying of the updated product thus preventing the unnecessary use of materials. There are two main methods for designing for upgradability, namely upgrade by exchanging components and upgrade by adding components or modifying the structure of the product. Upgrading by exchanging components is more commonly found in product design.

In order to correctly plan the upgrades of the product, a couple of things should be taken into consideration. The first thing is the estimated time until upgrade or the time until the customer wants to replace the product. Costumers replace the product when they feel that the value of the product has deteriorated. The second thing that should be taken into consideration is what is the impact and effect of this upgrade. For example, getting a faster CPU for a computer could mean that the heatsink needs to be improved as a faster CPU will lead to a higher Core temperature.

A great example of a product that is designed for upgradability is a PC, as all the components are replicable as long as they are compatible. If the user wants a faster PC, they can buy a new CPU and sell their old one for second life use. Or if the user wants more graphical processing power that can buy a new graphics card and replace the old one.

Design for standardisation and compatibility

Standardization is the process of establishing uniformity across manufacturing materials and processes. Potential benefits of standardization include lower production and procurement costs through economies of scale, easier and less expensive repair and replacement, and faster and more efficient processes (CircularEconomy, 2021).

Because the products are more standardized components are more easily interchangeable and the availability of components will make it easier for users to repair the product. A fun example of design

for standardisation and compatibility is LEGO. LEGO bricks are all compatible with each other and most of the bricks are standardised. So, after building the original blueprint the user can always decide to break down the original product and build whatever the user want with those bricks.

Design for disassembly

Designing for disassembly will make designers think about the end-of-life options on how to deconstruct the product, components, and the materials. Designing for disassembly comes with several benefits. It will make it easier to repair and upgrade the product, which will extend the lifecycle. It will also help in the recycling of the product as different materials are more easily separated from each other. (CircularEconomy, 2021)

There are some tactics that can be applied that will assist with disassembly.

- The fewer parts you use, the fewer parts there are to take apart.
- As with parts, the fewer fasteners (e.g. glue, screws, etc.) used, the better.
- Common and similar fasteners that require only a few standard tools will help to simplify and speed disassembly.
- Screws are faster to unfasten than nuts and bolts.
- Glues should be avoided.
- Building disassembly instructions into the product will help users understand how to take it apart.

The computer producer DELL has decided to take on the challenge and improve the disassembly of their products as a lot of scarce and expensive resources are being lost due to electronic waste. Dell improved the disassembly by keeping the amount of screws, glues, and adhesives to a minimum as this can cause difficulties for recyclers. Instead DELL has opted for alternative methods such as innovative snap fits in order to accomplish a secure fit. DELL also supplies the user with online videos that show the disassembly of the product in order to inform the user and aid them in the disassembly process.

Figure 6 Disassembled DELL Laptop

Design for remanufacturing

Designing for remanufacturing is very similar to design for refurbishment and that is why a lot of principles can be applied to both design strategies. The key difference between refurbishment and remanufacture is that when we talk about remanufacturing the product is restored to the same specifications as a new product and can therefore be sold as new, whereas a refurbished product cannot be sold as new Remanufacturing returns a used product to like-new condition; it is a process of recapturing the value added to the material when a product was first manufactured (Casper Gray, 2006). Remanufacturing results in reduced energy and material use and production cost reductions. Often the products that are being remanufactured are designed for longevity and disassembly to not waste the value of the product. The use of reverse logistics is essential if the manufacturer wants to receive their products.

There are some key issues in designing the products for remanufacturing for reconditioning the product at least like-new condition: (Circulardesign, 2021)

- Non-durable material that may break during recovery or may be deteriorated during the first life cycle.
- Joining methods which prevent the separation in disassembly operation.
- Features of the product restrict the up-gradation or require banned substance or processing methods or may be costly affair to recover.

There are 3 main principles for designing for remanufacturing are modularity, minimal waste and resource efficiency.

Design for modularity

The first strategy that can be applied is designing for modularity. This strategy is often combined with designed for upgradability, disassembly, and compatibility. A modular product is a product that consists out of different modules which can be used for the same functionality in different systems or products. The different modules allow for customisation as the user more easily swap out different modules that fit the best to their needs. This also allows the product to be upgraded as older components can be swapped with newer components to increase performance. In addition, the modules allow the user to swap out broken components to repair the product.

When it comes to designing for modularity the biggest challenge for the designers is the find the right components that will form a module. Luckily there are some tips for identifying modules for the product. (circular product design guide, 2021)

Identify modules

- Locate unrecyclable components and materials and unify in one module to be easily removed
- Locate materials with a certain recycling method and unify in one module to ease recycling. Strive to design for mono materials in these modules.
- Locate components that do not change throughout all generations and unify in one module
- Locate components which are subject to a stress, wear, corrode, stain, break or fail and unify in one module
- Locate components with a high cost and unify in one module

Modularity can offer a great solution to products that are prone to quickly become irrelevant due to the fast development of technology. A great example of this is the smartphone industry, where the average user replaces their phone within 3 years. A company called fairphone have developed a modular smartphone, which consist out of 8 different modules, the top module, the camera module, the backplate module, the display module, the speaker module, the bottom module, and the battery module. The modules are all compatible with each other so that modules form older modules can still be used. Also, older models can be upgraded by swapping out old modules. The fair phone is able currently cheaper than the newer high-end mobile phones while using sustainable materials. Although the fairphone is not trying to compete with the new high-end phones when it comes to performance (Fairphone, 2021)

Figure 7 fairphone modules

Design for minimal waste and resource efficiency

The goal of designing for minimal waste and resource efficiency is to designing products so they limit waste and use as little materials, water, energy, etc. as possible during use and production. This can be achieved by using energy components or providing how-to-use manuals and procedure for more efficient and effective use of products. When designing for minimal waste the packaging is an essential aspect, as that is the component that is most likely to become waste. therefore, great care should be taken when selecting the right packaging.

Designing for recycling

Design for Recycling is a strategy that includes recycling and recyclability criteria in the design phase of products in order to obtain recycled and/or recyclable products at the end the first life cycle, returning them into the supply chain. When designing for recycling, it is useful to focus on the product rather than on the singular materials of the product. This because the design should consider the materials of a product together and how they will be managed in the system (Circulardesign, 2021).

Designing for regenerative material

Regenerative design may be a principle that incorporate products or services to contribute to systems that renew or replenish themselves. This ultimately means the materials and energy that go into a product or process are reintroduced into the same process or system, requiring little to no inputs to take care of it (Pamela Mang, 2021). There are four key premises to regenerative design:

- Understanding the product's or processes' relationship to place throughout its life cycle
- Determine goals that recognize regenerative capacity
- Become a partner to place instead of purely extracting from it
- Strive to achieve harmonization between people and place

To achieve true regenerative design, you must incorporate systems thinking, interdisciplinary collaboration, and recognize dependence on natural capital.

In the build environment regenerative design is often used by building with a lot of wood that will take Carbon dioxide from the air which makes it a carbon neutral solution. The oldest example of the use of regenerative material is probably the mud bricks humans used to build their houses.

Design for recycled materials and mono-materials

When designing for recycled materials it is important that the recycled materials are easily separated from each other to help with the recycling process. This is why products that are designed for recycled materials are often made from a single material (mono-material). This simplifies the recycling process immensely by eliminating the need to separate the materials begore recycling. Some of the challenges of the use of mono-materials are;

- There are limited possibilities for re-utilisation due to lack of facilities that process into new high value materials.
- Compromises on for example functionality and quality of the product may be necessary.

The chair, Nobody by Komplot Design is produced in 100% polyester fibre mat without any additives or additional materials for assembly or reinforcement.

Figure 8 the nobody chair by komplot design

Circular Business models

The adaption of new circular design strategy requires a new circular business models, as also mentioned with the Rolls-Royce aeroengines. These models concentrate on long lasting products offered as services, and enabling a product access or performance, instead of ownership. Because the main producers' and manufacturers' focus is not on volume, additional revenues need to be generated from additional services offered along the whole product life cycle to counteract the decrease in sales. The aim of the new business models is to retain products, components, or materials of the best utility and value. It includes easy maintenance, cost-effective repair, refurbishment, and remanufacturing. Additionally, resell and remarketing of used products are included, because the first user isn't meant to be the last one. The re-commerce and value recapturing activities require a functional take-back system and reverse logistics. the supply chain is no longer more one-way only, but it includes both directions: to the market and from the market. (Fifield & Medkova, 2016)

The five-business model for slowing resource loop are (Bocken, 2016) (Bakker, 2014).

- access and performance model; providing the access to a capability or service that satisfies the users needs with the need to purchase and own the physical product, for example the felyx scooters.
- Extending product value: Exploiting residual value of products – from manufacture, to consumers, and then back to manufacturing – or collection of products between distinct business entities. An example of this is the remanufacturing in the automotive industry.
- Classic longlife model; Business models focused on delivering long-product life, supported by design for durability and repair for instance. The Patek Phillipe watch is a great example of a classic longlife model.
- Encourage sufficiency; Solutions that actively seek to reduce end-user consumption through principles such as durability, upgradability, service, warrantees and reparability and a non-consumerist approach to marketing and sales (e.g. no sales commissions)

Some business models for closing the resource loop are;

- Extending resource value: Exploiting the residual value of resources: collection and sourcing of otherwise "wasted" materials or resources to turn these into new forms of value
- Industrial symbiosis: A process- orientated solution, concerned with using residual outputs from one process as feedstock for another process, which benefits from geographical proximity of businesses

Conclusion

So as the world is shifting towards a circular economy it is important that designers are educated on circular product design as it is not only just about designing a product. A designer now has to design a system and environment in which the product or service has to exist. In addition, a total new business model has to be considered in order to make it all profitable. The tools and frameworks presented in this E-book can provide a lot of assistance to product designers looking for the right circular product design strategy and hopefully it will guide them into the right direction. So all in all, designing a circular product or service demands that multiple elements are taken into consideration like circular design strategies, systems thinking and circular business models.

Reader response

This E-book has been presented to 2 readers with a product design background and 3 readers were chosen from the general population.

- Reader 1

Job description; student industrial design

Review;

I generally really like the presented tools and frameworks presented in the E-book, especially the design for x tool. As a student this will be nice to use for any upcoming projects that I might have to do. Very informative and a pleasant read.

- Reader 2

Job description; senior product designer

Review;

The E-book does show the challenges involved with designing a circular product as it is not only about the product but an entire system, which I thought was nice. When I look back at my own education little attention was spent to this subject and I hope that the new generation of designers are well informed on the subject of circular product design.

- Reader 3

Job description student; industrial engineering and management

Review

Informative E-book on a topic I was not that familiar with. And I got me curious about the remanufacturing of products. The shown pictures were nice and informative and made the read a bit easier.

- Reader 4

Job description project manager

Review

Interesting subject and this E-book provided a lot of information. I liked the clickable links to some articles or design tools, personally I think there were more opportunities to provide the reader with these links, but I liked the book in general.

- Reader 5

Job description History student

Review;

nice description of the different strategies and business models although the flow of the book could be better. The relation between chapters is not always great and could have been improved. With that said I think it was interesting to read and I have definitely gained more knowledge on this topic

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