PHASE 1
STARTING POINT

Predict future valuable aspects

"Starting point aims" to find certain opportunities in the future to design for, and to minimize risks, by highlighting essential valuable aspects of the current product.

Approach:

Phase 1 and 2 have a workshop approach is best done with a group of designers or employees with various backgrounds to include different perspectives.

Before you start, gather:

- Previous files and research on the current product (such as personas, visuals, 3D models, business models, visions, etc.).
- Template X
- Two second hand items of the chosen product for the Redesign

PROCESS

A chosen product, to redesign for repurpose

a. b. c.

Parallel validation

Future valuable aspects

A. KNOW WHEN TO CHANGE

1. Disassemble the product and create a functional decomposition.

Note down for each module and component:
- the abstract function,
- the material element
- (if applicable) the operation.

Use template z.
Highlight, if there are any, distinguishable component groups and essential functions.

2. Define the current product timeline & define current EoL.

Briefly note down for each phase what the product goes through:
- owner, location, context and activity,
- what happens with the product at the EoL
- after how many years the product reaches EoL.

B. KNOW WHAT YOU HAVE

3. Deduct from various perspectives the valuable product aspects, *feeding a mind-map.*
There are various types of value: product, user, brand and business (see Template x: product timeline). The question for each perspective can be answered: what gives it value in this situation/view?
There are most likely more valuable aspects than meets the eye/than for which the product was sold.
Various methods can be used to find valuable product aspects.
- Use earlier done research on the product, user, brand and market.
- By holding and interacting with the product and its parts (from the disassembly) it helps to understand the product quality, materials, components and construction.
- Acting out user scenarios
- helps to emphatize with the
- user needs and product experience.
- Methods like Value Proposition and Business Model Canvas help to understand for which essential value the product is sold.(Boeijen et al., 2014)(van Boeijen, A.G.C., et. al. 2020 ,Rev. ed.)(ellenmacarthurfoundation, z.d.)

4. Highlight the most essential aspects which make the product and/or specific parts valuable within template x; product timeline.
- Highlight which valuable - aspects you want to focus on for the future use-cycle.
- Keep in mind that some aspects might change over time (see step: future prediction)

5. Scope the project
Make a choice on the future marketing strategy, dependent on how much experience you have with Circularity and Repurposing, the subsequent product for a familiar user and/or market or design for a new user and/or market**.**

C. PREDICT FUTURE CHANGE

6. Prediction of future demand.
Create a future strategy to feed brainstorm on future product opportunities.
- Predict how the chosen valu able aspects evolve. Focus the future prediction on a specific chosen time frame: the subsequent product will most likely happen when the current product or product parts become obsolete.
- Draw a line from each chosen valuable aspect to the future prediction area in template x.
- Various methods can be used to predict future change (see below).
- Write down a future predition in keywords for each chosen valuable aspect.
- On each 'Search Area' card are future prediction questions written as inspiration

Methods: Apply a method which fits your design style. Let the chosen valuable aspects lead the future prediction.
A few methods which might be used are (Boeijen et al., 2014)(van Boeijen, A.G.C., et. al. 2020 ,Rev. ed.):
- Research future type of users about their needs or -envision a future context
- Use Design Roadmapping to predict future technological innovations
- Look at which patterns are most likely to occur in the future around the found valuable aspects.
- Use SWOT analysis to under stand strong and weak aspects
- Use 'Trend Foresight' to predict future trends
- Apply the 'VIP' method to envision a future context, interaction and product

Attention points:
- Research can give correct and insightful information, however, can also be time consuming.
- This worksheet is focused at creating a quick over view of value.
- For some products not all parts become obsolete at the same time.
- It is important to maintain specific focus in the future prediction, as it can be a challenging and broad process.
- Designing for a new user and/or market creates a larger choice in subsequent poduct opportunities, but might not succeed or be too costly as Redesigning subsequent products for Repurpose can be challenging or requires a learning curve.

● VALIDATE essential future product aspects

- The future prediction step is important as the value proposition and business model of the subsequent product will rely on this.

PHASE 2
PRODUCT OPPORTUNITY

Create subsequent product ideas

"Product Opportunity" helps to guide the designer from evolved valuable aspects towards 1 chosen product opportunity, in which the current product can be repurposed. The search areas within this phase aim to inspire how value of a current product can be extended towards the future.

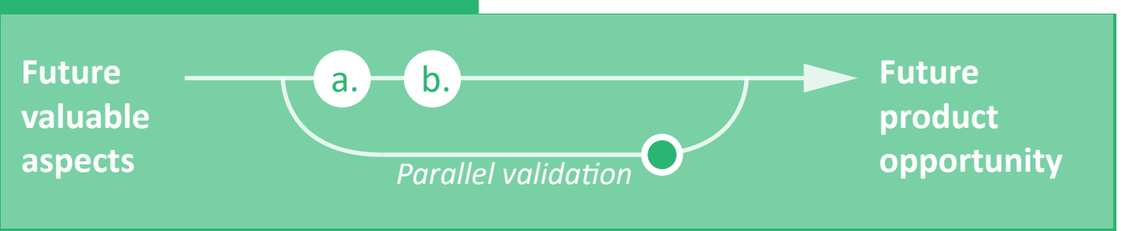
Approach:

Use the template to create focused questions for brainstorming. Use the Search Area cards for inspiration. An intuitive ,practical approach works well to symphatise with valuable product aspects: such as Tinkering with the disassembled parts and acing out ideas.

Before you start, gather:

- Future valuable aspects on template X & Y
- Preferred tools for brainstorming
- The disassembled product parts
- Search Area cards

PROCESS



A. 'SEARCH AREA' BRAINSTORM

Explore the search areas with the future valuable aspects to find new product ideas. This guideline aims to help designers to find product opportunities of which product parts might be exchanged with the current product.

Gather future valuable aspect from the previous phase and *fill in template X,* by doing:

- Draw a line from each future valuable aspect to the ideation area on template X.
- Do various short brainstorm iterations per future valuable aspect. Each Search Area Card has a set of brainstorm questions, which can be used as an eye opener/inspiration. Make sure to find ideas in a time frame close to the current products EoL.
- Use the 'Similarites in functionality' as this is important for Phase 3 of the guidelines. Use the other cards to your own preference/ preferred order, as some might be more applicable to specific contexts.

Apply a brainstorm method which fits your design style, corresponding to the types of value you've selected. A few examples to brainstorm which are:

- Acting out future user scenarios or exploring the future context (see search area A, B, E).
- Tinkering with the disassembled product parts: what else can you make of what you have? (see search area D, C, F).
- Ideate in which other contexts the same main functionalities and similar modules (component groups) are used (see search area C,F).

B. WEIGHTED CHOICE

Fill in the criteria list in the template:

- Fill in the main future predictions (per chosen valuable aspects) you would like to include in the subsequent product under desirability, feasibility and/or viability.
- Choose 5-10 best matching ideas and fill in the weighted objective table template Y.
- Give each idea a score per objective.

● VALIDATE the future product choice

Select product ideas which are most viable, desired and feasible.

- Position the main ideas in the feasibility, viability and desirability circles in template Y. Choose a solution within the overlap of the circles.

Methods which might be used for this are:

- *Desirability:* interview the future type of user or future stakeholder(s) about their needs

- *Feasibility:* check (research in technology and check on matching modules)

- *Business model viability:* discuss the various "blocks" from the business model canvas with the design team. Divide the blocks in 3 parts: viability, feasibility and desirability. (ellenmacarthurfoundation, z.d.) (Boeijen et al., 2014) (van Boeijen, A.G.C., et. al. 2020 ,Rev. ed.)(Haffmans & Gelder, 2020)

Attention points:

- Don't limit yourself too much by specific components & design of the first product's, as a redesign will happen in the next Phase.

- Validate the chosen subsequent product, as the business model & value proposition rely on this.

A. TIME BOUNDED USERS AND EVENTS

Find a new product idea that fulfills a future demand

AIM

Find a new product closely related to an already familiar field of the company.

Future prediction

- How will user needs, product experience and/or product demand have evolved when the current product or product part becomes obsolete?

Brainstorm questions:

- Which events are likely to occur over time (life events, seasons, age, innovations, arising problems etc.)?
- How will the user behave differently?
- Who can become a new user?
- Which solutions come to mind with above questions?

B. FUTURE CONTEXT/ LOCATION

Search for product within the evolved context/ location for a specific time frame.

AIM

Find a new product closely related to an already familiar field of the company.

Future prediction

- If so, how will the context/ location be different after the current product becomes obsolete?

Brainstorm questions:

- What is the future society like?
- What happens in the future location?
- What other products are used in this location?
- What topics are closely related to this context/ location?

C. SIMILAR FUNCTIONALITIES

Search for product ideas with common functionality as in the current product

AIM

Find low-hanging fruit by reusing valuable parts which can also be found in other products.

Future prediction

- What are future technological improvements, related to current product parts?
- Can it be predicted which product parts are likely to stay the same over time? (only in quality perception?)
- Use the outcomes of template x (functional decomposition)

Brainstorm questions:

- What is the quality of the current product modules and in what other product/ways can these be used?
- In what way is the current product
- multifunctional?
- In what other locations, contexts and markets are similar product modules used?

D. FUTURE BRAND

Generate ideas fitting with already established aspects or future vision of the brand

AIM

Strengthen the brand experience in the future or make use of market gaps

Future prediction

- How does the brand evolve over time?
- What is the future vision and market of the brand?
- What is the current user experience with the brand and how can I strengthen that over time?
- What are the essential brand aspects which can be strengthen over time?

Brainstorm questions:

- What other products could fit with the
- current brand experience?
- What other products could I expand my
- product portfolio with?
- What other products fit with my future
- brand?
- What product aspects are recognizable and have a special feature related to the
- brand?
- How can I use these recognizable parts of the current product in the new product?

E. EMOTIONAL VALUE

Generate product ideas based on the power of emotion to connect future users as well

AIM

Establish a strong user-product connection between the subsequent products, by extending the experience which is already there.

Future prediction

- Does the current user have a strong emotional experience with or around the current product?
- How does this experience evolve over time?

Brainstorm questions:

- Are there other products which capture the same (future) emotional value?
- What activities/events does the user do while going through this emotion?
- Which other products are related to this?
- Which parts are related to the (future) emotional experience? In what ways can we reuse/maintain these?
- How can this experience be maintained?
- What current elements are very recognizable or have a special feature?
- How can I use recognizable parts of the current product in a new product?

F. ECONOMIC VALUE

Generate product ideas with sufficient economic value

AIM

Minimize the economic value loss in the transition towards a subsequent product.

Future prediction

- How does the current demand change over time (quantity & quality)
- Can a new demand be found with one of the valuable product aspects?
- Do market strategy research
- Find future market gaps (e.g. with a product benchmark)'

Brainstorm questions:

- Which products are most likely sold in a larger quantity than the current product?
- Which products have the similar or higher value in terms of economic value.

G. FIXED AND FLEXIBLE PARTS

Brainstorming with changing product parts in mind

AIM

make use of predictable changes and strengths of the current product, at the right time. Standardized parts can be applied more easily in future use cycles as they are more likely to be used. Flexible parts can be seen as special features of a product.

Future prediction

- Use template x
- Functional decomposition.
  Predict which parts would be different selling the product in future.

Brainstorm questions:

- For the product parts which change or more quickly become obsolete: is there another context or way to reuse these after the first EoL?
- For products which are durable or likely stay the same: in what future or other contexts or ways can the functionality be reused?

PHASE 3
DESIGN FOR CHANGE

Redesign for efficient transition

"Design for Change" aims at redesigning the subsequent products and parts for efficient and effective part transition into the subsequent use-cycle.

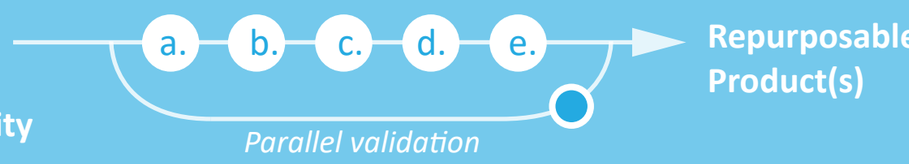
Approach:

Work top-down. First focus on the overall system and modules (guidelines A+B). Then focus on components and details (C, D, E). Work in iterations: adapt, redesign, repeat, add, and remove parts to increase the reuse of parts.

Before you start, do:

- Disassemble the current product
- Do a functional decomposition in template Z to find essential and valuable modules, components, and connections.
- Analyse current part reusability (use-cycle analysis & modularity analysis)
- Discover various design solutions for the main function the future product (e.g. with a collage or sketch)
- Gather template Z

PROCESS



A. MATCHING MODULES

This guideline focuses on finding and creating generic common modules.

Make sure the product consists of separable functional modules: a company should eventually be able to re-assemble the current product into subsequent products.

- Quickly scan and compare product parts and modules of both products.
- Highlight in Template z, elementary functions and modules which occur in the first and second product.
- Prototype to find quickly matching modules: determine which parts have the potential to become generic across products (see also the guideline 'simple construction').
- First do redesign-iterations on the main modules and the overall construction before designing detailed components
- Determine which dependencies and similarities exist between components within the existing product and which (internal) connections prevent separation of modules.
- Determine how modules, components and interfaces should change to enable reuse across subsequent products. Also apply the next guidelines for this.

Methods:

- Use the disassembled product, Template Z, functional decomposition(Roozenburg & Eekels, 1998), and future product benchmark
- Rearrange parts in a 'quick & dirty prototype' to design from a 'zoomed out' perspective.
- Modularity and Repurposability analysis template.
- Use your preferred prototyping and sketching techniques for redesign.

B. SIMPLE CONSTRUCTION & SHAPE

Keep it simple in geometric shapes, reduce interfaces and prevent irreversible adjustments.

There are 4 different actions to consider:

1. Simple construction & modules

Make sure the construction is as simple as possible to enable efficient and effective reuse of each module and component.
Create a simple construction by finding design solutions which require a minimal amount of connections between main modules and components.

2. Reduce or cluster complexity

Reduce complexity where it prevents separation of modules. For example: move complex modules, such as internal connection linked to a mechanism, towards the location of operation (such as within generic adaptable connections), if possible. See also the guideline: Generics.

3. Simple shape

- Apply basic geometric shapes when parts need to be reused.
- Divide too specific or organic shapes in smaller basic geometric shapes which are more reusable, unless the specific shape can be reused as is and does not harm the separation of modules.

4. Prevent specific shapes or adjustments

- Try to prevent shapes that are impossible or difficult to reverse in case these are not applicable on the subsequent product design. For example: use fasteners which do not require holes were possible and prevent specific material finish.

Methods:

- A product-market benchmark can provide ideas for simplification of modules and construction.

C. GENERICS: STANDARDIZATION & ADAPTABILITY

Increase reuse by making generic modules and parts.
Make them adaptable to fit in multiple specific situations.

First highlight generic and similar functions within the functional products' structure, see Template Z.

Standardization

- Check if similar design solutions can be applied: copy embodiment solutions for generic functions, throughout the product and between the subsequent product.
- Puzzle with standardized shapes and sizes that already available in the industry.

Adaptability

- Increase reuse by making generic modules/parts which can be adapted to specific situations.
- Create generic modules which can be adapted to various configurations if the same type of functionality occurs multiple times but slightly different.
- Examples of common variations for
- which adaptable interfaces can be designed are variations in angles around an axis, rotating around an axis, fasteners, buttons, etc.
- Copy adaptable product solutions for similar functions, throughout the product and between the subsequent products.

Attention points:

- Watch out for sticking too much too the current product's embodiment solutions as both products are to be redesigned.
- Simple shapes are a means to an end.
  When specific shapes fit in both subsequent products and do not harm separation of modules, simplification is not necessary.
- A product benchmark can inspire to design simple solutions.
- Redesign main modules in the overall construction first before designing detailed components.
- Find the right balance in number of modules & inter faces: find groups of components which can be transferred as one module to the subsequent product in one go, leading to less modules which means less reassembly steps.
- Only use interfaces were necessary to prevent more reassembly steps.

D. EFFICIENT TRANSITION

Increase ease of reassembly and reduce costs during transition

The product should be designed in such a way that it takes the least amount of effort and costs to transition from the first to the subsequent product.

The different process phases of transition are roughly (Boeijen et al., 2014)(van Boeijen, A.G.C., et. al. 2020 ,Rev. ed.):

1. Quality check,
2. Disassembly of the first product,
3. Cleaning, Refurbishment and remanufacturing to maintain and improve quality.
4. Reassembly into the subsequent product
5. Quality check.

To get as easily and most cost-effective through this process, the product and its parts should be designed for (dis)assembly, made to last, and must be effectively and efficiently cleansed and if necessary refurbished and remanufactured.

A few factors influence the ease of (dis)assembly (Vezzoli & Springer, London, 2018, p. 193)(ceguide, 2018)

- The number of steps to execute,
- The effort to execute each step,
- The time cost per step and of the procedure as a whole,
- Understandability of each step and the procedure as a whole.

Actions:

- Apply long-lasting materials, finishes and mechanisms
- Prevent shapes, materials, and texture on or in which dirt is difficult to remove.
- Isolate mechanisms with closed off spaces so dirt cannot influence the mechanism performance.
- Apply the following guidelines to improve the ease of disassembly:

Design with modules

- Divide the product into easily separable sub-assemblies, also to minimize the amount of (dis)assembly steps.
- Reduce complexity of disassembly by making components have fewer hierarchically dependent connections.
- Prioritize the disassembly of parts with a higher economic value, those that have a different durability and those that are more quickly subject to change.

- Fasteners:

Minimize the overall number of fasteners and aim for only fastening components once.
Prevent irreversible fasteners, such as glues or rivets.
Apply easy to handle and similar fasteners.
Apply fasteners which can be quickly unfastened.

- Shape:

Avoid difficult to handle components.
Aim for applying symmetrical components.
Build “instructions” into the product to make disassembly and the order of disassembly more obvious.

(Vezzoli & Springer, London, 2018, p. 193)(ceguide, 2018)

E. QUALITY PERCEPTION

Redesign what is perceived to influence quality perception

Aim

Maintain quality/value over multiple use cycles. Use the following two facts as an advantage:

1. 70% percent of quality perception comes from aesthetics,
2. Aesthetics are most likely to change quickly over time, due to faster changing demand.

- Highlight long lasting components and/modules in the product’s functional structure
- Highlight short lasting components/ modules in the functional structure of the product.
- Highlight high valuable components/modules in the functional structure of the product.
- Apply neutral and timeless aspects of the brand’s aesthetics on long lasting components.
- When applying specific short-lasting aesthetics primarily on short-lasting and temporary components.
- Apply durable finish on long-lasting components.
  i.e. prevent visible wear, as this makes products look less valuable than they likely are.
- Parts which are not visible do not need to be optimized for aesthetics.
- Make long-lasting components separable from short-lasting components.

● VALIDATE the subsequent products

Are the two subsequent products feasible, viable and desirable?

- Determine long term economic benefits.
- Measure expected ‘demand’ of the future products as one business model having a changing value proposition.
- Reflect upon the circularity of the business model. (ellen macarthurfoundation, z.d.) (Boeijen et al., 2014) (van Boeijen, A.G.C., et. al. 2020 ,Rev.ed.)(Haffmans & Gelder, 2020)
- Make use of the business model canvas.

Template x: Product Timeline

First product cycle

Subsequent product cycle

product development	sale	usecycle	EoL/ return	transition phase	sale/ distribute	use	EoL/ return

Notes.....
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Notes.....
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1.B Current valuable aspects

Use a mindmap to write down the essential aspects of the current product's value proposition

Current product:

- Product aspects:
- User aspects:
- Brand aspects
- Business aspects:

1.C Future valuable aspects

Write in keywords how the essential current product aspects evolve after EoL 1

2.A Idea generation

Generate ideas per future

Template y: product choice

2.B Weighted objectives

Ideas:

How feasible, desirable and viable is the subsequent product choice?(ellenmacarthurfoundation, z.d.)(Boeijen et al., 2014)(van Boeijen, A.G.C., et. al. 2020 ,Rev. ed.)(Haffmans & Gelder, 2020)(Gedeon, 2019)

Future predictions										
.....										
.....										
.....										
Feasibility										
simpel construction										
similar functionality										
Desirability										
Fit future demand										
Fit future brand & business										
Viability										
Sufficient economic value										
Total weight:										

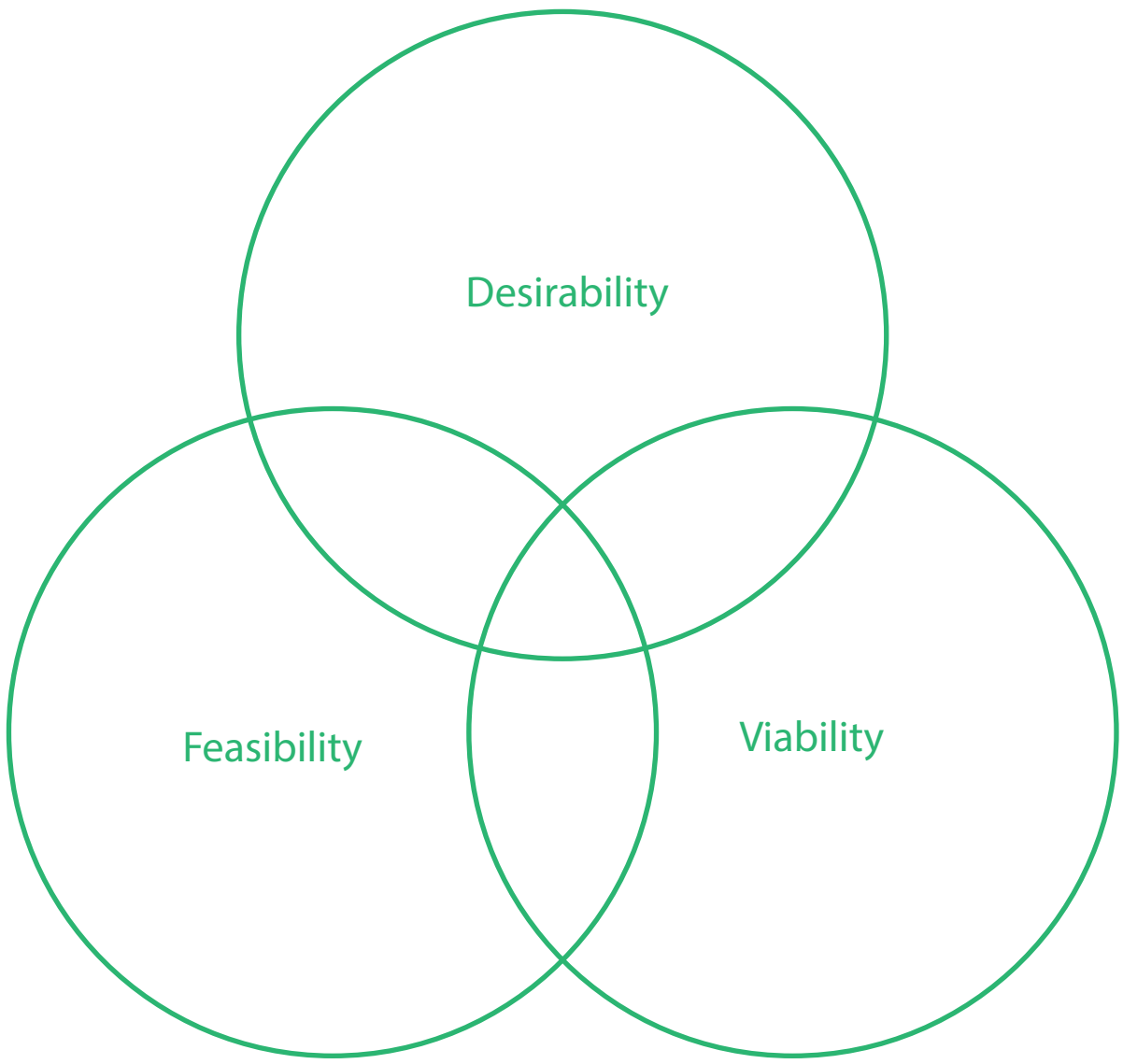
2.C Validation of the subsequent product opportunity

Use the below overview to position the chosen categorize and reflect the chosen ideas upon. (Boeijen et al., 2014)(van Boeijen, A.G.C., et. al. 2020 ,Rev. ed.)(Haffmans & Gelder, 2020) (Gedeon, 2019)

Feasibility:
can it be made?
- possible to construct, against acceptable time, effort and money?
- use of existing or new to be developed technology (risk)?

Desirability:
attractive to producer and user?
- does the user express sufficient need?
- is the business case positive?
- is the risk acceptable for the producer?

Viability:
will it stay feasible and desirable over time?
- continuously sufficient economic value and/or quantity of sales?
- will the resources sufficiently stay available (people, material, logistics)?

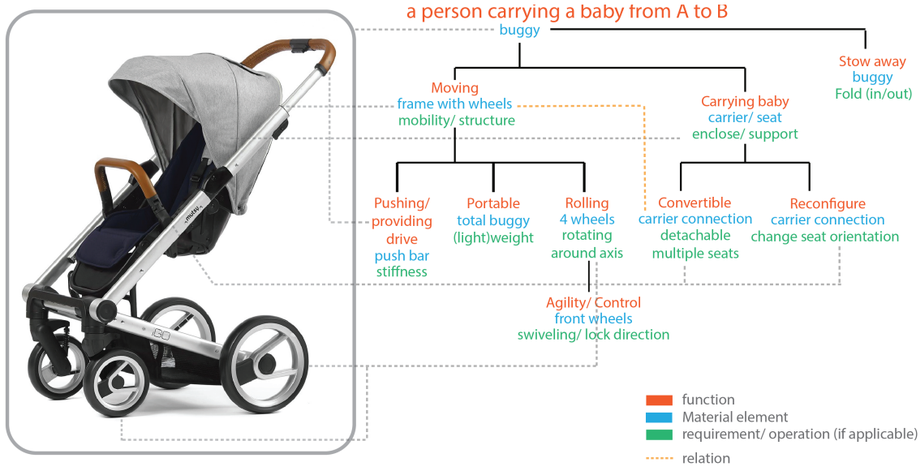


Template z: matching functional structure & modules

3.A.1 Functional decomposition

Create a functional decomposition(Roozenburg & Eekels, 1998) (Boeijen et al., 2014)(van Boeijen, A.G.C., et. al. 2020 ,Rev. ed.)(Suh, 1998, p. 202) (Gu et al., 2004, p. 541) (Gershenson et al., 2004, p. 46) (Gershenson et al., 2003, p. 298) , by naming the function, material element and if applicable the operation. Highlight the elementary functions (modules, components, materials). Note down the (internal) connecions/ relations. A detailed 3D model or a disassembly of the current product can help in analysis. See fig. 1 for an example.

Figure 1 Functional Decomposition, see step 3.A.1 (Amazon & Mutsy, 2019)



3.A.2 Subsequent product structure

Make a quick sketch to find out the matching functions between the subsequent product. Prototyping helps to get an idea of how generic modules could be found and designed. A product-market benchmark can provide insight in various design solutions for the same function and provide inspiration for simplification of modules and construction. See fig 3 for an example.

Figure 2 Prototype and benchmark to match modules see step 3.A.1 ((Jipfish, 2018))