

# DESIGN&ENGINEERING

## Department of Machinery MET 70 LT Curriculum MADM10/10 – Design and Engineering

Iuliia Vorobiova

### **Environmental aspects in the design process.**

Developing guidance for the new approach of a product development with systematic environmental thinking in a product development, focusing on a furniture industry.

### **Keskkonnamõju osakaal disaini protsessis.**

Arengunõustamise uus lähenemine tootearendusse süsteemse keskkonnateadliku mõtteviisiga, mööblitööstuse näitel.

## Contents

Abbreviations	4
Case Studies	4
List of Figures	5
<b>Introduction</b>	6
Environmental aspects during the design process	6
Waste reduction in Design	6
Reduce waste before production	6
Research process and methods	8
<b>Part 1 Sustainability</b>	9
Prevention is better than cure	10
Case study 2 IKEA	12
Case study 3 PROOFF	13
Case study 4 Steelcase	13
Case Study 5 Republic of Fritz Hansen	13
The role of waste prevention	14
The Positive and Negative side of Technology	14
<b>Part 2 Step by step systematic approach</b>	16
Introduction	17
What is system?	18
Case study 6: Formway: A New Zealand Life Cycle Management	19
Profile of tutorial second part	20
Step 1 Describe the use in a context	21
Step 2 Create an overview of the environmental impacts	23
Step 3 Create your environmental profile and identify root causes	25
Case Study 7 MET Matrix	25
Step 4 Sketch the stakeholder-network	28
Step 5 Material selection	32
Case study 8: Synthetic stone Damian Palin sandstone stool	33
Step 6 Environmental criteria	36
Step 7 Develop an environmental strategy	39
Case Study 9 Smart KID	39
<b>Part 3 Practical Pilot Project</b>	41
Introduction	42
Step 1	42
Benchmarking	44
Step 2	47
Step 3	48
Step 4	52
Case study (field study)	55
Step 5	56
Step 6	58
Step 7	59
Visualisation of a concept	62
Rapid Prototype	63
Scenario testing	69
Modelling	64
Conclusion	68
References	69

The idea to create this guide came from a need to have a clear understanding of what sustainability is and how it is possible to apply this practice in design, involving sustainable design strategy at the early stages of a product's development process.

This tutorial is intended for people who have basic understand what product design is and what product life cycles are. It is for people who would like to learn in practice how to involve sustainability consideration in their projects. This work is a combination of different commonly used approaches and methods which have been modified at some stage by the author.

After completing this tutorial, the reader will gain theoretical knowledge about what sustainable design strategy is, and will be able to use in practice all the tools described in this guide.

## Abbreviations

LCA - Life Cycle Assessment

EOL - End of Life

UCD- User Centred Design

E – Environment

GST- General System Theory

IKEA- Ingvar Kamprad Elmtaryd Agunnaryd (Swedish home furnishings retailer; derived from founder's initials and hometown)

LCM- Life Cycle Management

TBL- Triple Bottom Line

## Case Studies

Case Study 1: Better by Design Faith Products

Case study 2: IKEA “Sustainability is a great driver of innovation at IKEA – from how we design our products, to how we produce, package and transport them.”

Case study 3: PEOFF “And suddenly you have created a room within a room.”

Case study 4: Steelcase

Case study 5: Republic of Fritz Hansen “Show how sustainability, quality and exclusive design are all part of the same solution”.

Case study 6: Formway (LCM) A New Zealand Life Cycle Management

Case study 7: MET Matrix

Case study 8: Synthetic stone Damian Palin sandstone stool

Case study 9: SMART KID” Conversion Kit

Case study 10: Field Trip, Sunorek

## List of Figures

Figure 1: TBL

Figure 2: Chain of product sustainability

Figure 3: LCA in waste management planning

Figure 4: System

Figure 5: Life Cycle Management at Formway

Figure 6: An example from CES ECO audit tool

Figure 7: Sandstone stool

Figure 8: Whole Systems Design

Figure 9: Factors which have influence on product lifetime

Figure 10: Smart KID

Figure 11: K Work Station

Figure 12: A suitcase desk

Figure 13: Vilfred Desk

Figure 14: The Camille Wall Desk

Figure 15: Modern Multifunctional Desk

Figure 16: Homework desk

Figure 17: Visiting production

Figure 18: Waste

Figure 19: Types of bending process

Figure 20: Wood Workshop

Figure 21: The Process

Figure 22: Dexitner

Figure 23: Office as city

Figure 24: Concept dimensions

Figure 25: Concept

Figure 26: Prototype

Figure 27: Scenario testing 1

Figure 28: Scenario testing 2

Figure 29: Model 1

Figure 30: Model 2

Form 1: Functional Unit

Form 2: Environmental impacts

Form 3: MET Matrix

Form 4: Stakeholder network

Form 5: Materials and processes selection

Form 6: Environmental Criterias

Form 7: Environmental strategy

## Introduction

*“Sustainability is a new idea to many people, and many find it hard to understand. But all over the world there are people who have entered into the exercise of imagining and bringing into being a sustainable world. They see it as a world to move toward not reluctantly, but joyfully, not with a sense of sacrifice, but a sense of adventure. A sustainable world could be very much better than the one we live in today.”*

Donella H. Meadows, Limits to Growth: The 30-Year Update

How can we reach zero waste in our life?

80% of products are thrown away within 6 months.

90% of raw materials used making durable products become waste before product leaves the factory.

(Resource, 2014)

### Goal and scope:

**Abstract: “It is a guide for the designers to help them to integrate environmental consideration into design and product development processes.”**

#### Environmental aspects during the design process.

The idea of this project was to create a guide for people who are interested in sustainable strategy development during the design process. Following this guidance will help you to understand where sustainable aspects should be taken into account at each stage of the development. From one side, a very systematic and well planned process is shown. From the other side, it is inspiring and creative.

This work is divided on three main parts:

The first part is dedicated to explaining what sustainable design is and why it is so important to develop sustainable design strategy in general. In the second part it will be shown a step by step approach which would help to choose right strategy for the product's development. The third part will show how this method works in practice.

The main objective is to obtain product life cycle thinking with the ability to elaborate development strategies. For this purpose we have to look at details of each product's development stage and discover all the potential impacts such as: environmental, financial and social problems; presume the potential solutions.

There to it's important to mention that this work is going to be focused mainly on the furniture industry. Nevertheless the guidance itself could be used for any kind of product development.

#### Waste reduction in Design

First of all we have to look how we design our products and if there is a way that we could design them in a better way. Could we reduce waste or add an extra value which would make them serve longer?

“Zero Waste” it's a movement which calls for minimalism in our daily life, by reducing the amount of unused items and mainstream consumption and searching for new ways to reuse items. It is also to help people and companies to turn to a more sustainable way, by building waste reduction into design (“theehugger”, 2014).

#### Reduce waste before production

The more thought through products are designed, the greater the opportunity to profit. Savings in terms of resources, labour and cost across a product's lifetime. The most effective way to reduce waste is to understand which activities and processes cause waste increment. Products should be designed taking into account the supply chain and life cycle of the product; keeping in mind repair, reuse and other possible processes.

Waste should be seen as a valuable resource by becoming more circular. There are broad opportunities in the waste management sector to reduce unnecessary loss. That is why it is so important to choose the right strategy at the very beginning of a product's development.

### Part 1

**What is sustainable design strategy?  
Prevention is better than cure!**

### Part 2

**Step by step systematic approach.**

### Part 3

**Theory in practice  
Pilot Project**

## Research process and methods

(After J.-E. Baars and M.Vogtlin, 10.05.2014)

Challenge:  
What is the  
problem?

Research of the field,  
analysis, defining goal  
and scope of the research

Gather facts:  
What?

Planning, gathering infor-  
mation, developing first  
part of the guide, expla-  
nation what is sustain-  
ability and how to link  
designing strategy and its  
environmental impact.

Gain insides:  
Why and How?

Developing second part  
of the guide step by step  
systematic approach.

Build scenarios  
Developing

Third section of the  
guidance - practice

**Solution**

**Abstract**

**Concrete**

## Part 1 Sustainability

**We live in the world of constant move-  
ment we need to move in order to sus-  
tain. To move in order to be ready for  
a change.**

## Prevention is better than cure!

### What kind of products are sustainable?

In the world with limited recourses we are obliged to change our lifestyle to be more sustainable. During the last century, environmental problems were often seen as local problems, such as an impact from the certain product. Now it is obvious that the problems are much more complex and occur in all phases of a product's lifecycle. However, there are no possibilities to reduce all environmental impacts to zero. It is clear that the earth is populated by its inhabitants and this causes a situation which is non-sustainable by itself. The world could have more than ten billions inhabitants by 2025.

*“Even if many products, such as cars, have become more environmentally friendly over the last years, they cannot reduce the total amount of materials and energy used due to the population increase. According to the laws of thermodynamics, total sustainable products are impossible to develop in general. Our planet is not a sustainable system by itself”* (Arne Remmen, 2007).

### In this case we are facing the question what kind of product could we name sustainable?

A sustainable product is a product which will give as little impact on the environment as possible during its life cycle. The life cycle in this simple definition includes: extraction of raw material, production, use and final recycling (or deposition). As said before it is not possible to reduce all the impacts to zero, decreases in one aspect could have the opposite effect on another. Some criteria contains overlaps and conflicts with one another, and should be taken into account simultaneously. Sustainable design strategy should not limit the primary functionality of a product. It must maintain all functionality but in a “better way” – attempting to integrate and improve economic, environmental, and social/ethical performance of a product.

*According to Green Brand Survey of 9000 consumers in Australia, Brazil, China, France, Germany, India, the US, and UK, over 60% of consumers want to buy from environmentally responsible companies. As well 40% of people willing pay 10% more if product is green* (Green Brand Survey, 2011).

### What is the difference between terms sustainable and eco or green design?

*“The optimisation of social, ethical and economic issues is not included into eco-design. In most of the cases eco-design approach is not enough in order to achieve goal of reducing the environmental impacts”* (Fuller, 2003).

The second question is how to measure sustainability if it is possible in general.

To give an answer on this query let's look into what is Triple Bottom Line (TBL).

TBL (Figure 1) term was first coined by John Elkington and according to him: *“the term triple bottom line is used as a framework for measuring and reporting corporate performance against economic, social and environmental parameters”*. (Elkington, 1997) In each individual case it has to be decided which aspect to emphasize and take the most into account.

A simple example to explain the statement above: the replacement of a product by a service can have implications in terms of employment for a company's personnel at many life cycle stages.

Furthermore let's look on the chain of product sustainability:

**Material.** Minimise the material and energy usage, choose rather renewable materials, avoiding toxic materials, etc.

**Economy.** The product itself must be cost efficient and comparable with similar goods. Considering the total cost during the life cycle including the cost for the restoring environmental impacts.

**Design.** Designing product which would be environmentally friendly, user-centred, and easy for the transporting.

**Market.** Developing products which are designed according to the needs of the specific market and target group.

**Equity.** Developing product taking into account local and global communities.

**Technology.** Optimising the extraction of raw materials, production, lifetime, quality and functionality of the product.

**Ecology.** Elimination of the emissions and waste, minimising the environmental impact.

## Triple Bottom Line

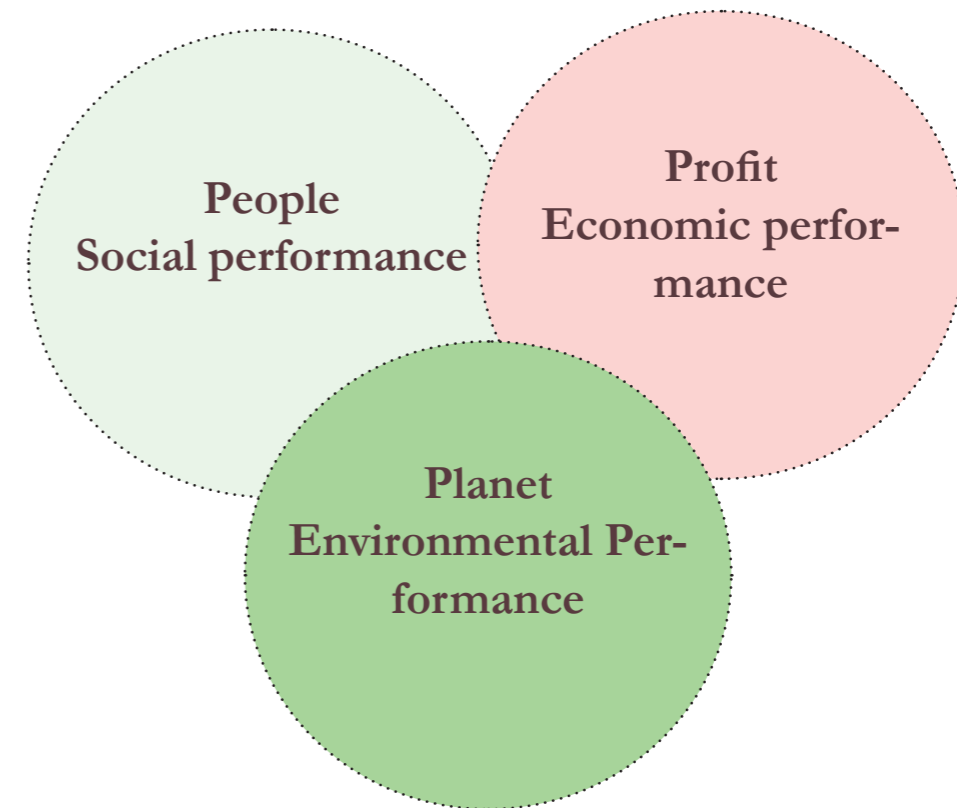


Figure 1 Triple Bottom Line

## Chain of product sustainability



Figure 2 Chain of product sustainability

For the companies which took a challenge to develop sustainable products it seems at first glance like a complicated task to complete. In the same time there are a lot of additional expenses. But as practice shows, this approach pays off after a while, bringing positive results and benefits. The sustainable strategy in a product's development should be implemented from the early stages of a product elaboration.

For better understanding of what is a sustainable strategy and how it could influence different impacts, let's look at some examples/case studies of different companies.

## Case Study 1 Better by Design

**Faith Products**, a small manufacturing company which has safeguarded annual sales worth £150,000 and saved almost £19,500 year, by improving the way it manages energy, material and water resources.

The business was founded over 40 years ago in a small farmhouse kitchen but today it employs about 45 staff and has an annual turnover of £3 million. It trades as Faith in Nature and specialises in making natural hair and skin care products without artificial additives.

The company switched to 100 per cent recycled plastic packaging and reducing the size of each container by six grams. These measures have saved 23 tonnes of plastic waste from going to landfill each year, and reduced the amount of plastic bought in by another five tonnes. They have also brought annual savings of £2,700 and 14 tonnes of CO<sub>2</sub>e (Enworks, 2014).

The early stages of a product's design offers the strongest influence on the environmental impacts. But at the same time: "the early stage design knowledge contains subjective, ambiguous, uncertain, and incomplete nature" (Ljungberg, 2009).

## Case study 2 IKEA

THE IKEA GROUP had operations in 44 countries, including 30 service trading offices in 25 countries. They also had 33 distribution centres and 11 customer distribution centres. The IKEA Group had a total of 298 stores in 26 countries.

"Sustainability is a great driver of innovation at IKEA – from how we design our products, to how we produce, package and transport them."

Mikael Ohlsson (President and Chief Executive Officer)

*IKEA it's one of not a lot of furniture companies which offers environmental friendly products with affordable prices.*

*People & Planet Positive commitment highlights:*

*-A more sustainable life at home- designing products in a way that customers enable to live in a more sustainable way.*

*IKEA induction hobs use magnetic field technology to heat the pan, not the rest of the hob or surrounding air. This reduces cooking time by up to 60% and energy use by up to 40%.*

*Resource and energy independence.*

*Using resources within the limits of the planet and by encouraging all waste to be turned into resources.*

*Develop own business through investing in renewable energy sources, energy efficiency, store expansion and refurbishment, low carbon transportation and range development.*

*- A better life for people and communities.*

*Support the realization of human rights and have a positive impact on people's daily lives.*

*Looking for the IKEA report it's possible to conclude that they are trying to take in account all the aspects: Environment, Social, Economic, putting on the first place Environment and Social issues.*

*Taking care of pollution, material waist, almost all the products are recyclable and designed especially for the better transportation.*

*For the social issues IKEA take care of employee, providing healthy and safe environment, trainings, and exchanges in different countries in order to get new experience and ideas(IKEA official website, 2013).*

## Case study 3 PROOFF

*Dutch innovative furniture brand which was born to provide solutions to the new paradigm of work, New Ways of Working, activity based, that standard products could not offer. For the office furniture and the problem of the space sharing and concentration of employees they came up with ideas of the furniture which absorbs sound and create separate spaces. Main idea to keep in mind that piece of furniture should behave like a room. One of the products its EarChair, which has been designed with a proper height and is built with a rounded aesthetic the result is a well resolved acoustic chair.*

"And suddenly you have created a room within a room."

*The sound absorption of a material is not a material property. It should be taken into account that the sound absorption of a construction depends on the dimensions, the way of mounting of the material and its position in the room.*

PROOFF is another example of a company which produces furniture with really specific criteria's as: sound absorption, space creation. In this case aesthetic plays leading role in strategy development (PROOFF official website, 2013).

## Case study 4 Steelcase

*Office Furniture Company. Main principles:*

*Innovative Products and Applications*

*Energy Use and Efficiency*

*Renewable Energy*

*Transportation and Packaging*

*Waste Reduction*

*Water Conservation*

*Social investment*

*Most of the products are recyclable, designed for easy assembly, disassembly and packaging. Long product life, nontoxic material, manufactured close to customers.*

*Steelcase has partnered with the leading environmental life cycle assessment consultant Quantise to analyse the water footprint of Eastside visitor chair. This research has measured the water impact all along the product life cycle.*

Steelcase covers main environmental and social issues, working to formalise global community, outreach practice by designating local volunteer to develop action plans (Steelcase official website, 2013).

## Case Study 5 Republic of Fritz Hansen

Republic of Fritz Hansen Vision for 2020 is to

"Show how sustainability, quality and exclusive design are all part of the same solution".

*Creating long lasting products*

*Design and manufacture products of the highest quality whilst taking environmental challenges into consideration during the development process.*

*Reduce toxic chemicals*

*Aim to reduce toxic emission and exposure to toxic chemicals during the production process as well as in the final product.*

*Reduce CO<sub>2</sub> emissions*

*Focus on the areas where the right balance between efforts and impact on the environment can be achieved.*

*Responsible sourcing*

*Ambition to work with existing suppliers and seek new suppliers who are living up to the same standards as Fritz Hansen, in regards to materials, employees and environment.*

*Employee Health and Safety* (Republic of Fritz Hansen official website, 2013).

All above companies have similar aims- to develop high quality environmentally friendly products. Each company has its own strategy, focusing on different aspects: environmental, economic or social issues.

## The role of waste prevention in moving to a more resource efficient economy.

Great Recovery Project is an ongoing partnership between the Technology Strategy Board (TSB) and the Royal Society of Arts (RSA). This initiative is supporting a shift toward design which is mindful of the whole system or life cycle of products, including a £1.25 million investment by the TSB in 'new design and business partnerships that re-think products, components and systems that 'close the loop'.

Waste should be seen as a valuable resource by becoming more circular.

Supporting re-use and repair, giving second or third life, gives a positive impact not just to environment but also helps businesses to save money and generate new jobs which cause a positive social impact.

A 'circle economy' works in a way that we have to look first of all how we design our products in a better way that we would be able to repair them and resell in the future. The second stage is how companies market their goods, ideally it should be lifelong products which have great value at the end of life.

The third step in a 'circle economy' is the re-usage of a product. Even if a company manage to create a system that would imply that the end-user has to return goods after utilisation, would it be possible to reuse them?

Finally the fourth step is the recycling of products. The question is whether it is possible to recover all the material and use them to replace virgin materials and save money for the business (Waste prevention programme for England, 2013).

Companies all over the world are trying to reduce human impacts on the environment. Meanwhile, there must be a focus on the creation of a new value for the customers and users. There needs to be new opportunities for companies and business strategies, where the sustainable aspects and the value creation would be ahead of all the development for products and services ("Wrap", 2014).

The purpose of this paper is to show how to design products that would not cause any harm to humans or environment.

## The Positive and Negative side of Technology and its influence on Environment.

### Technology for what? And technology for whom?

Here is no direct answer on whether technology should exist or not. The system which has been developed by now made us extremely thrifty. If we think about our lives in general, all we do is keep what we got today for tomorrow, getting things which we don't need and overcrowding our beings. This system was thoughtfully designed in order to make people consume more goods and in the same time generate big amount of waste. There is a clear understanding that this system needs to change. One of the complex questions is how to make customers to readjust their behaviour and habits.

In our society people spend most of the time gathering information that does not directly relate to any aspects of their life.

Politics, economy, technology- to keep all this information is like a second full-time job, as a result there is no time to rest. Our mind does not have time to relax, to be under the pressure is a normal mental state for us. We cannot sit even 5 minutes without an action, and all this came to us with technology's development. It gave us new abilities with opportunities, but in turn it has changed us as well. Almost impossible to live without technology and constant flows of the information.

It's difficult not to agree with the statement that we are a complicated creation, with behaviour of which does not always depend on structure of society

William Morris in his book "News From Nowhere" described the "perfect world" where all the people are content and delighted to work. The architecture changed there are more natural spaces and no "philistine vulgarity", no huge expensive building, everyone lives in a small house, and not because they cannot afford to have more, but they simply prefer simplicity.

There is no need for the technology or megalopolises or other things which do not have a direct effect on the vital aspects of a human life. Usage of machine labour does not always mean cheaper and faster, in a lot of cases it is the opposite situation, when people cannot do even simple things without machine as they have lost the primary skills.

The time spent on transporting the equipment to the work place and returning it back was much longer, when few experienced workers could do it much faster and with better quality.

In Morris' perfect world everyone prefers to work without any machine assistance.

People got the idea that things not made by hand looks not as artistic and there is no art in a machine made item. Goods which are made with the help of machines seemed to be rough. Just after people had obtained the freedom from the technology they were open to create something really amazing and outstanding, comprehend the mysteries of handcrafting with the high level of the imagination. This all became true just because they stopped thinking about work as a work, but satisfaction or personal development or even art.

In the same time all buildings, constructions, factories, transport cause harm to the environment. Technology is one of the things which separate human from nature. People destroy everything around them by using recourses unwisely.

## Technology can help...

If we look at the situation right now, in some cases pollution went to the critical point. It is important to make technology not a destructive tool but use it thoughtfully. To place sustainability in the first place. The development gave us the opportunity to produce as much as we wish, but sometimes we do not even use or need all these amounts of goods.

One way to ensure that technology works in a right direction is to take into consideration all the conditions where it is used and by whom. This is to create the system which would promote sustainable development which in turn reduces poverty and safeguards the resources.

Doubtless people made a lot of mistakes by using technology in a wrong way. But to stop applying technology is not the solution as most tools in this day and age require technology in the first place.



## Part 2 Step by step systematic approach

“Most men either compromise or drop their greatest talents and start running after, what they perceive to be, a more reasonable success, and somewhere in between they end up with a discontented settlement. Safety is indeed stability, but it is not progression.”

Criss Jami

## Introduction

This Guide is based on a standard life cycle of a product. In order to adapt to life cycle approach have to look into each stage of the development and re-think where it's important to involve environmental consideration.

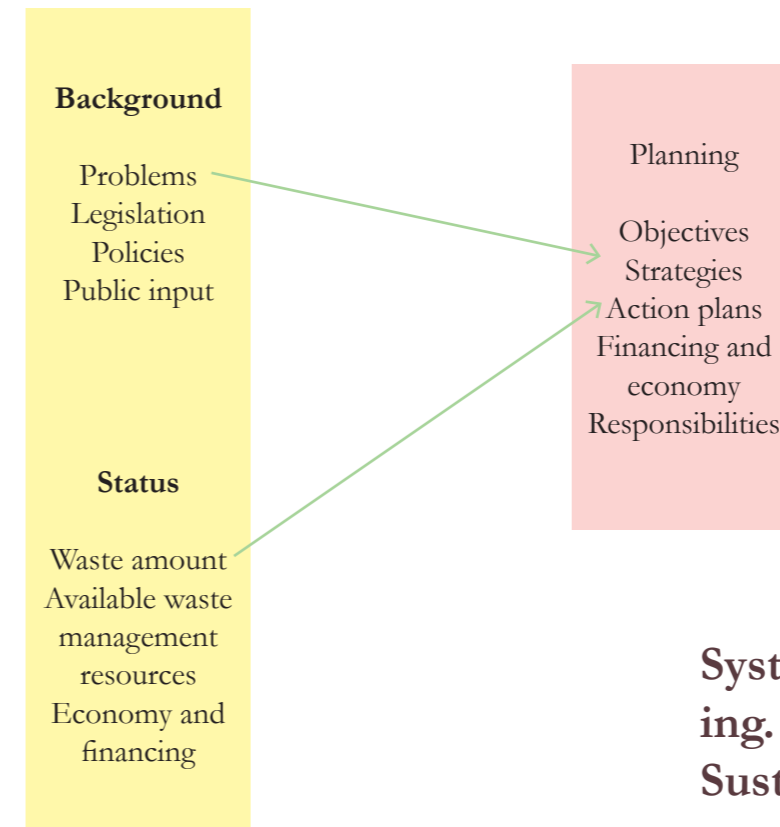


Figure 3 LCA in waste management planning(Viktoria Voronova, 2011).

This approach consists of seven steps which are described in detail with practical explanation and methods/tools suggestions. Therewith, it will inspire the process of development turning it into a new directions. It's would be possible to get an idea what kind of relation in between environmental improvement and business creation. The approach for this project does not require choosing the product from the very beginning. In this way designers would have a wide range to implement innovative ideas.

## Systematic environmental thinking. What is System Design for Sustainability?

*“The design of the product life cycle stages that, while considering all requirements, aims at minimising the environmental impact of the whole of the life cycle phases in relation to the functional unit.”*

Vezzoli & Manzini, Springer, London, 2008

### Different approaches:

- 1) Satisfaction- System Approach  
Design the satisfaction of a particular demand (satisfaction unit) and all its related products and services
- 2) Stakeholder Configuration Approach  
Design the interactions of the stakeholder of a particular satisfaction-system
- 3) System Sustainability Approach  
Design such a stakeholder interactions (offer model) that continuously seek after both socio-ethical and eco-efficient new beneficial solutions(Carlo Vezzoli, 2011).

## What is the system?

System- is a general name to an examined object, consists of linked to each other elements surrounded by its boundary (Wikipedia, 2014).

Each system has inputs and outputs- resources, information.

All the elements in the system related to one another. There are different kinds of relations, which are described in details later in the chapter. The system is a limited structure which has its boundaries, meanwhile we still have to take into account surrounding conditions.

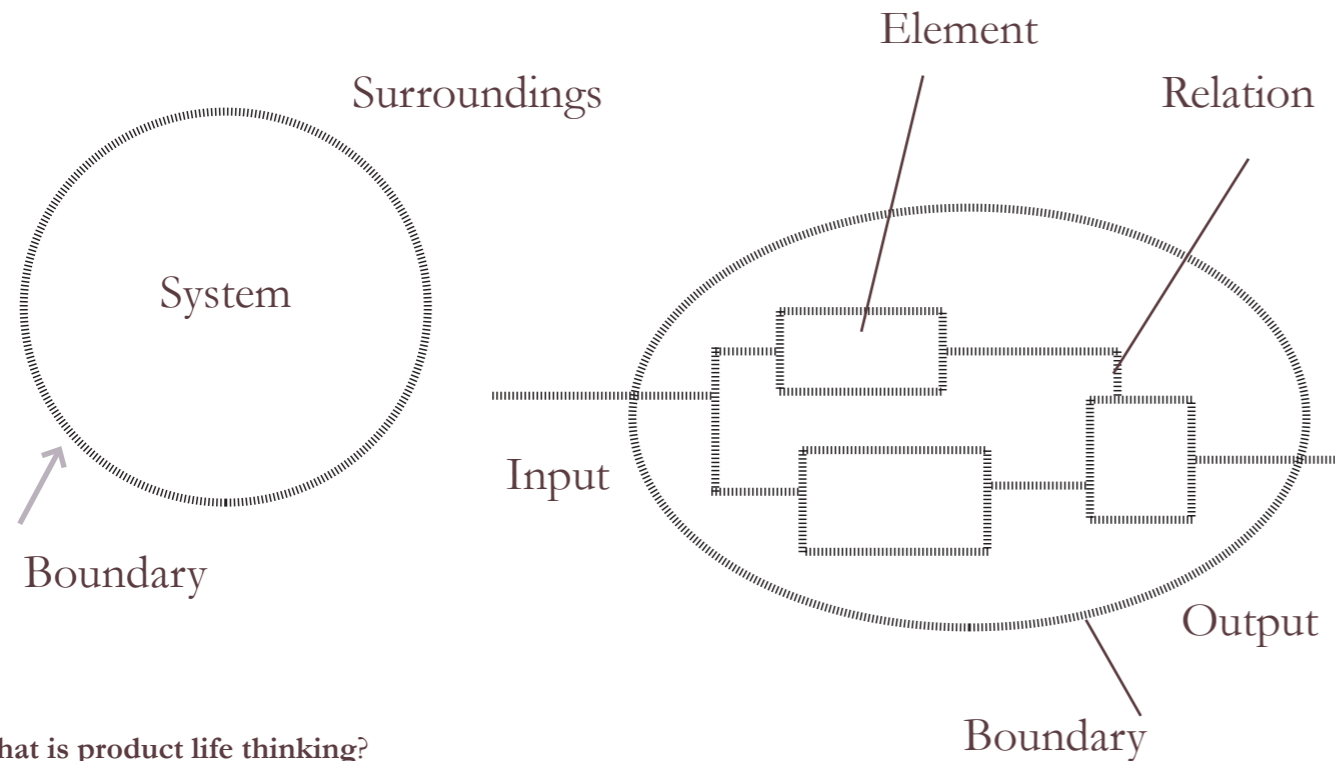


Figure 4 System

## What is product life thinking?

Product life thinking is an ability to form whole life cycle of the product. Practically speaking, this approach is an excellent tool which gives an important insight into different processes which occur through the entire cycle and in a result, it sets the direction for improvements. In our case, we try to identify potential environmental, economic or social impacts in order to draw the picture of resources, consumption and the actual nature of the impacts.

## Solution-oriented process.

The approach of solution-oriented process will be described during the product development process, using environment as an innovation asset.

Let's consider the case study, which shows how the company used systematic approach to the organization of its product development.

## Case study 5 Formway:

*A New Zealand Life Cycle Management Formway is a medium-sized New Zealand business that has developed an LCM approach within its business. The insight and proactive attitude of the design team back in 1998 has enabled Formway to build an improved product environmental profile and strong product marketing story, and has ensured longevity of the product in the marketplace. The Changing Workplace*

*Task chairs are linear, unidirectional and constraining. They have been designed to facilitate a singular relationship with the computer. We have a mechanistic relationship with the chair and the task at hand. Most*

### Office chair:

*The relationship we have with the computer and the screen has changed. Computers are now tools for collaboration and our work is now more open, more collaborative. We lean into create and recline to be entertained. With this in mind, there is now no fixed sightline or correct posture. Instead we need to cater to many tasks, many modes and many postures. The nature of work is changing. Work is less sedentary; it is more fluid, more interactive. We are moving continuously. We move from task to task, from mode to mode. We need work environment that support this level of flexibility and foster office-wide interaction. People need chairs that support them in all the different positions they subconsciously adopt (Formway official website, 2014).*

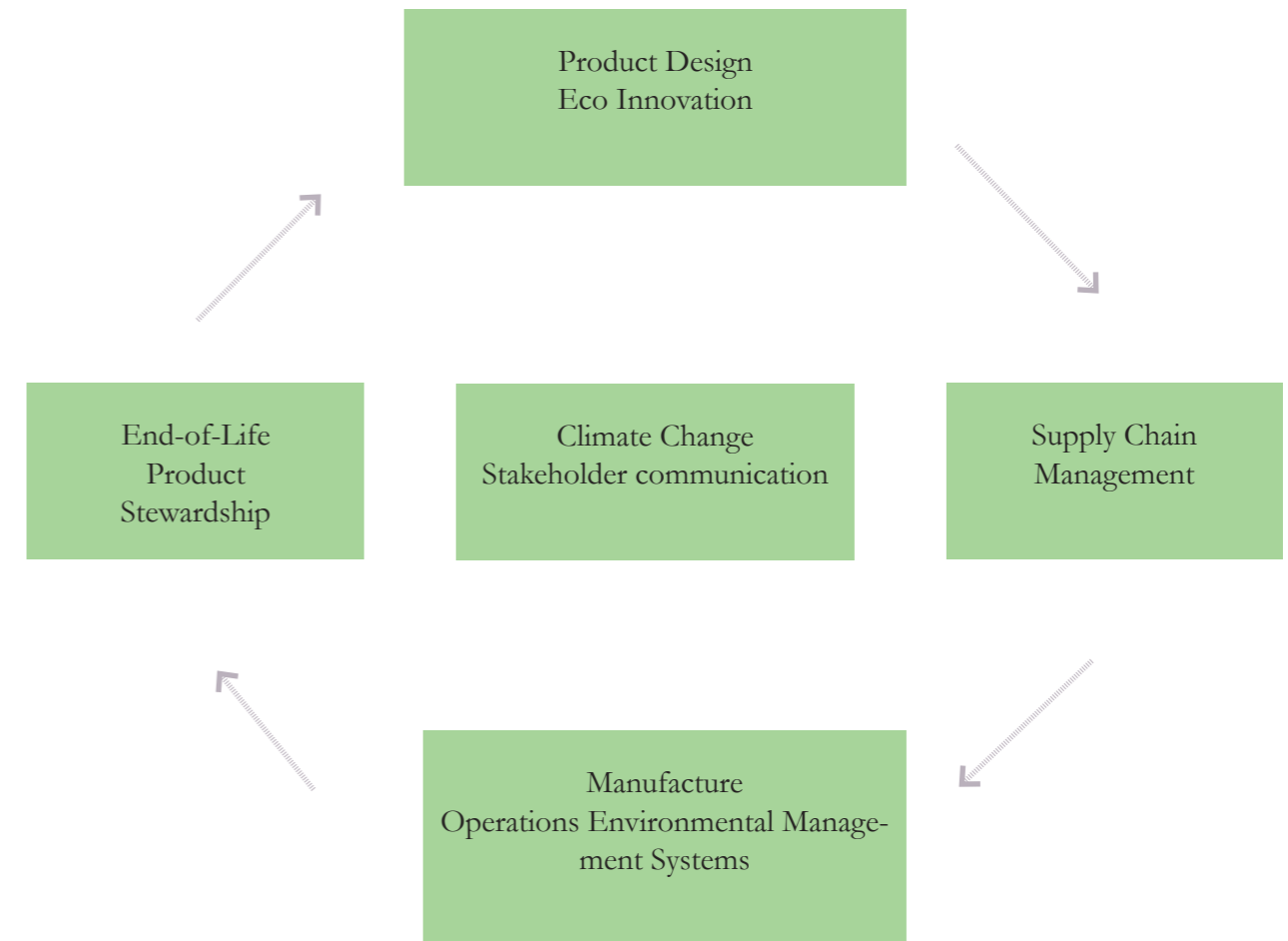


Figure 5 Life Cycle Management at Formway

## Profile

With what to start? -> Introduction

For whom is this important? -> A guide for anybody who interested in product development

What is the motivation -> be found of an environmental challenge!

What to follow ->

Step 1: Use in a context

Step 2: Environmental impacts

Step 3: Environmental profile

Step 4: Stakeholder-network

Step 5: Materials&Processes selection

Step 6: Environmental concepts

Step 7: Environmental strategy

## Step 1 Describe the use in a context

The approach for this project does not require to choose the product in the very beginning. Never the less, we have to define its functionality to the user. In this way, design process would have broader field for developing which is the key point for the innovation. *“The functional unit is a measure of the studied system and it provides a reference to which the inputs and outputs can be related. It enables comparison of two essential different systems.”* (Tim McAloone, 2009)

To define functional unit, we have to answer on following questions:

- **What is the purpose of the present study?**
- **Who does need it? Description of a target group: what are the age, gender and nationality of the users?**
- **Descriptions of technologies which should be used, main functions and supportive functions?**
- **What product is evaluated, against what alternatives?**
- **What do we consider to be the life cycle of the product?**
- **What is left out and why?**

This task should be carried in a group of people who are related to a project. The questions have to be written down on a paper, and all together answers have to be agreed, taking into account opinion of each team member. It's important to refer some questions with product specification or business strategy. The process could be moved to a next stage, once everyone has a clear picture of the product's functions and importance for the user.

### Examples of functional unit:

“A functional unit for a coffee machine is determined as following:

What is the purpose of the coffee machine? To make coffee and keep it hot for 30 minutes. What is its life cycle? The coffee machine needs to last for 5 years, 5 cups of coffee twice a day and it uses new paper filter each time.

The functional unit is then: A coffee machine which brews 5 cups of coffee 2 times a day and keeps this coffee hot for 30 minutes after brewing.”

(Guide to using Eco-it 1.3, 2014)

This exercise allows to check whether all the necessary aspects are considered. The team members from the beginning could agree on common strategy. After completing this part, it's suggested to go through the products benchmarking on market which have similar functionality.

In the end, it would give us an idea, depending on what exist and current trends, which direction to take in order to develop our future concept.

**Product functional unit**

What is the purpose of the present study?  
.....

Who does need it? Description of a target group: what are the age, gender and nationality of the users?  
.....

Descriptions of technologies which should be used, main functions and supportive functions?  
.....

What product is evaluated, against what alternatives?  
.....

What is left out and why?  
.....

**Step 2 Create an overview of the environmental impacts**

On this stage, we are going to create scenario for the product life cycle and the possible impacts. The importance of investigating the whole life cycle of the product is the decision of what the most environmentally sufficient phases are and which phases should be though through meticulously. As an option, product could perform as an environmentally friendly on one stage, but have negative impacts on the other. For example product could appear as green during the usage phase as it does not consume any energy, but in the same time this product cannot be re-used or re-cycled.

**Typical product life cycle consists of:**

- Raw materials**
- Manufacture**
- Transport**
- Use**
- Disposal**

The main goals of life cycle thinking are to reduce a product's resource use and emissions to the environment, as well as improve its socioeconomic performance throughout its life cycle.

**Raw material** - is the basic material from which product is manufactured or made.

**Manufacture** - includes purchase of the components, manufacturing and assembly.

**Transport** - the process of delivery from suppliers to the end-user, by any kind of transportation.

**Use**- is a direct and indirect usage of a product and all the additional resources which should be taking into account.

**Disposal**- recycling, reuse, recovery; have to think who disposes a product, user or a company.

A product system or life cycle can begin with extracting raw materials from natural resources in the ground and generate energy. Materials and energy are all parts of production, packaging, distribution, use, maintenance, and eventually recycling, reuse, recovery or final disposal.

On the stage **Materials**: have to think about the ways of a treatment and how to deplete resource (depletion is the exhaustion of raw materials within a region). For example if we talk about material as a wood, we have to think of environmental impacts as erosion, increasing risks of landslides.

**Manufacture**: how much energy during the production process is consumed and how many additional objects as equipment or cleaning products are needed and, as well as how intensively they are used.

**Transport**: different types of transport have different levels of impacts and it depends on the amount, size, dimensions and weight of the products which are needed to be transported as well should be taken into account distance of transportation.

**Use**: what is the life time of a product, what additional objects we need in order to use it (to use printing machine, we use energy, paper and ink and sometimes we have to clean it).

Also, it is needed to decide the way which could be easier to maintain the product, if one part is broken, and find the answers on either it still functions or possible to fix or replace.

**EOL (End of Life)**: In order to reuse material, it has to be separable, recyclable and nontoxic. (George Howarth, 2004)

To start with the task, you have to map all the stages of a product life cycle on the big piece of paper.

This step is dedicated to brainstorming: you have to come up with as much impacts as possible and map them under each life cycle stage. Currently, it's not really important to create any connection. The main idea of this task is to define focus on areas with potential environmental impacts.

After completing first step, it's possible to give answers on following questions:

**Which stages of a product life cycle have the most significant impacts?**

**How possibly impacts could be reduced?**

**What are the alternatives?**



**MET Matrix**

	Materials	Manufacture	Transport	Use	End of Life
Materials					
Energy					
Chemicals					
Other					

Form 3: MET Matrix(after René van Berkel, 1997)

## Step 4 Sketch the stakeholder-network

*Society must be reconsidered as a complex network of groups of interacting individuals whose membership and communication patterns are seldom confined to one such group alone.*

—Diana Crane, Invisible Colleges (1972)

During the last steps, the focus areas have been indentifying from the product itself. But to broader and discover more factors, occurred stakeholders have to be indentified during all product life cycle.

*System thinking means that designers consider the whole system, its components, and the relationship between them throughout the design process. The main goal is to understand how system behave in different situations, examining problems from multiple perspectives, and replacing some linear thinking with cyclical design. It's important to understand how design will interact with and impact the natural systems around them (McDonough, 1992).*

### Exchange and resource dependence.

Selected method for this stage is a stockholder mapping.

The model will provide us following information:

- 1) More details/advices on the Sustainable Development aspects.
- 2) Details of a different stakeholder views and concerns range.

(George Howarth, 2005)

- First of all, you have to identify all stakeholders which are related to selected product and write them down on a big sheet of paper.
- Make connections between stakeholders.

In some cases, it will appear that there are more than one type of dependence between stakeholders. We will be using different kind of relations explaining each of them below. Undermentioned list of relations was described by Birger Sevaldson, 2011.

*SYSTEMS THAT ARE DEPICTED WITH NODES AND CONNECTORS  
STRUCTURAL RELATIONS, HIERARCHICAL SUPRA AND SUB SYSTEMS (GREENS)*

**Structural relations** *Very often systems are described as the assembly of parts where the sum is more than is parts. This is not a cause effect relationship but structural.*

*Relationship. Example: there is not a causal relationship between the wheels and the frames of a bicycle in the sense that e.g the frame decreases if the wheels increase. They are assembled in a structure where they generate together a surplus output.*

*Example: The relation in the air traffic system between the planes and the control system. (The amount of plains do not automatically decrease if the control system is reduced. It only happens through institutional regulations.*

**Macro systemic relations:** *Relations that are caused by the entities being subsystems in the same "sur-system" but without necessarily being inn direct contact with each other.*

*Example:*

*Bikes and cars are related because they are sharing the same macro system: the roads (They are related in additional ways than this). Examples: The winter coat and the bikini are both part of the clothing wardrobe of the same person.*

**Micro systemic relations:** *Systems that are related because they share a relation through a sub system: Example: The rubber in the tires of the cars and the bikes come from the same producer. Example: A Mixmaster and a hair dryer can share similar electrical engine form the same manufacturer.*

*ASSOCIATIVE SEMANTIC AND THEMATIC RELATIONS (BLUE)*

**Thematic relations:** *Thematic relations are entities being part of the same thematic field or category. Themes are man-made sorting devices and there needs not necessarily to be e.g. a causal relation between members of a theme. Example: the relation between Universal Design and Ergonomics. Example: Genres of music. There are many possible relations between genres of music but if we think of the relation between the music of the Australian aborigines and a symphony by Bach we can only think of very few like biological (music being programmed in our genes) and thematic relations (both being music).*

**Associative relations:** *Metaphors and analogies: These are the types of relations that pop up in brain storms by associations. Example:*

*If two people are very similar to each other in their look there is an associative relation. Example: If I say bird, you say fish.*

*SOCIAL RELATIONS (Yellows)*

*Structural social relations Example: Family, friends etc. Institutional social relations Example: Work, municipality nation etc. Actions social relations created through action.*

*HARD RELATIONS, CAUSAL, FLOWS ETC. (REDS)*

*Causal relations Cause and effect relation. The nodes depict what causes an effects and what entities are being affected while the relations (normally arrows) depict the effect. Example: If the heat is turned on the kettle start to boil Example: If the tolls for entering the city by car increases the passengers on public transportation go up.*

Different relation flows:

- 1) Information
- 2) Material exchange
- 3) Environmental aspects (to identify where environment impacts are)

Make analyse of a network and discover which stakeholders could improve product environmental impacts. This exercise gives a clear overview of all the stakeholders we deal with.

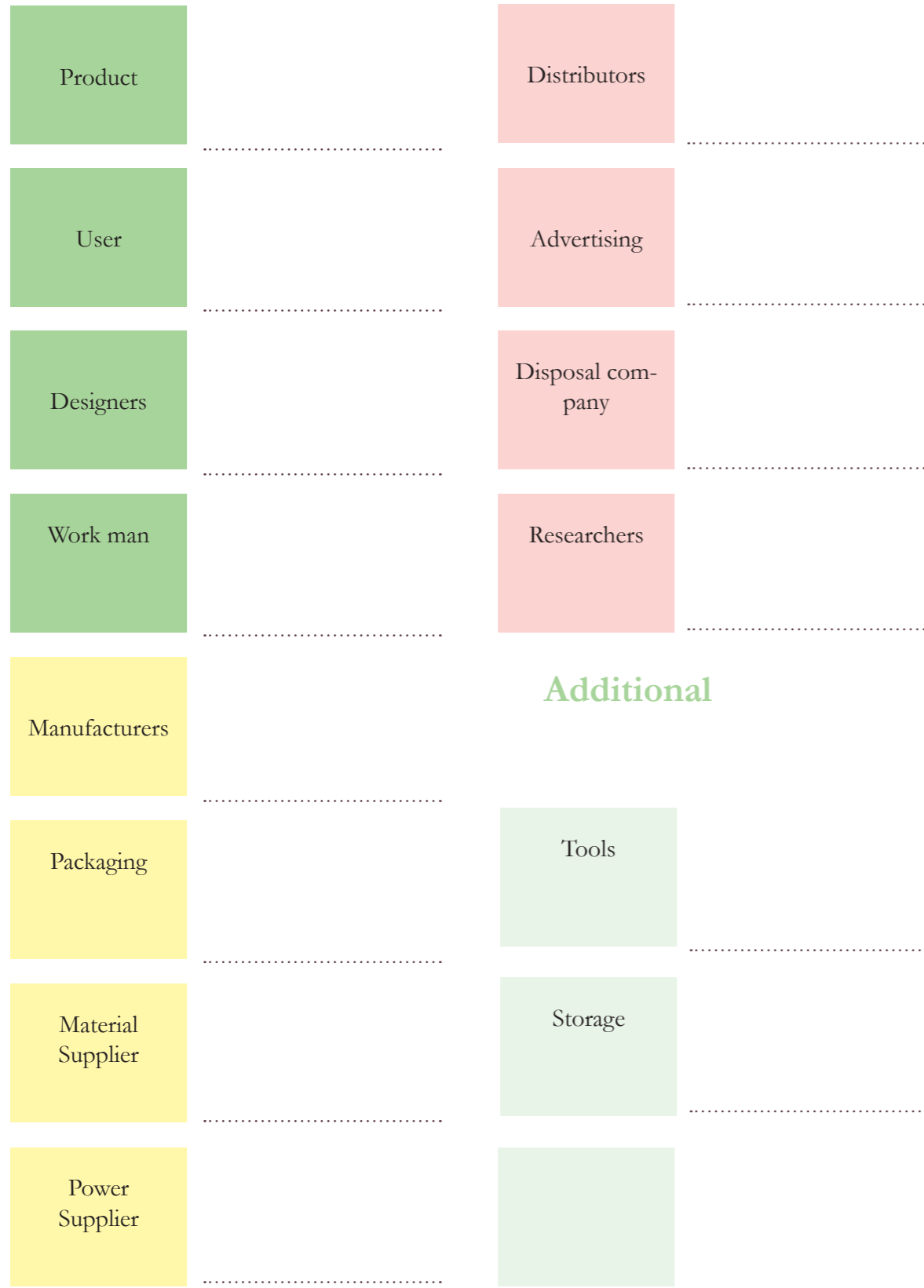
During the step 4, stakeholder system should be developed and is needed to cogitate of various components of the system, for that you have to think about various components of it. After placing all the stakeholders, you have to analyze what kind of relation each of them has to other components of the system. Making connections are the most complicated task due to a big amount of the data and flows. The stakeholders system helps overview of all the system, and after completing the task, it would be possible to give answers on the following questions:

**Which stakeholders are involved into the processes and have the most significant environmental impact?**

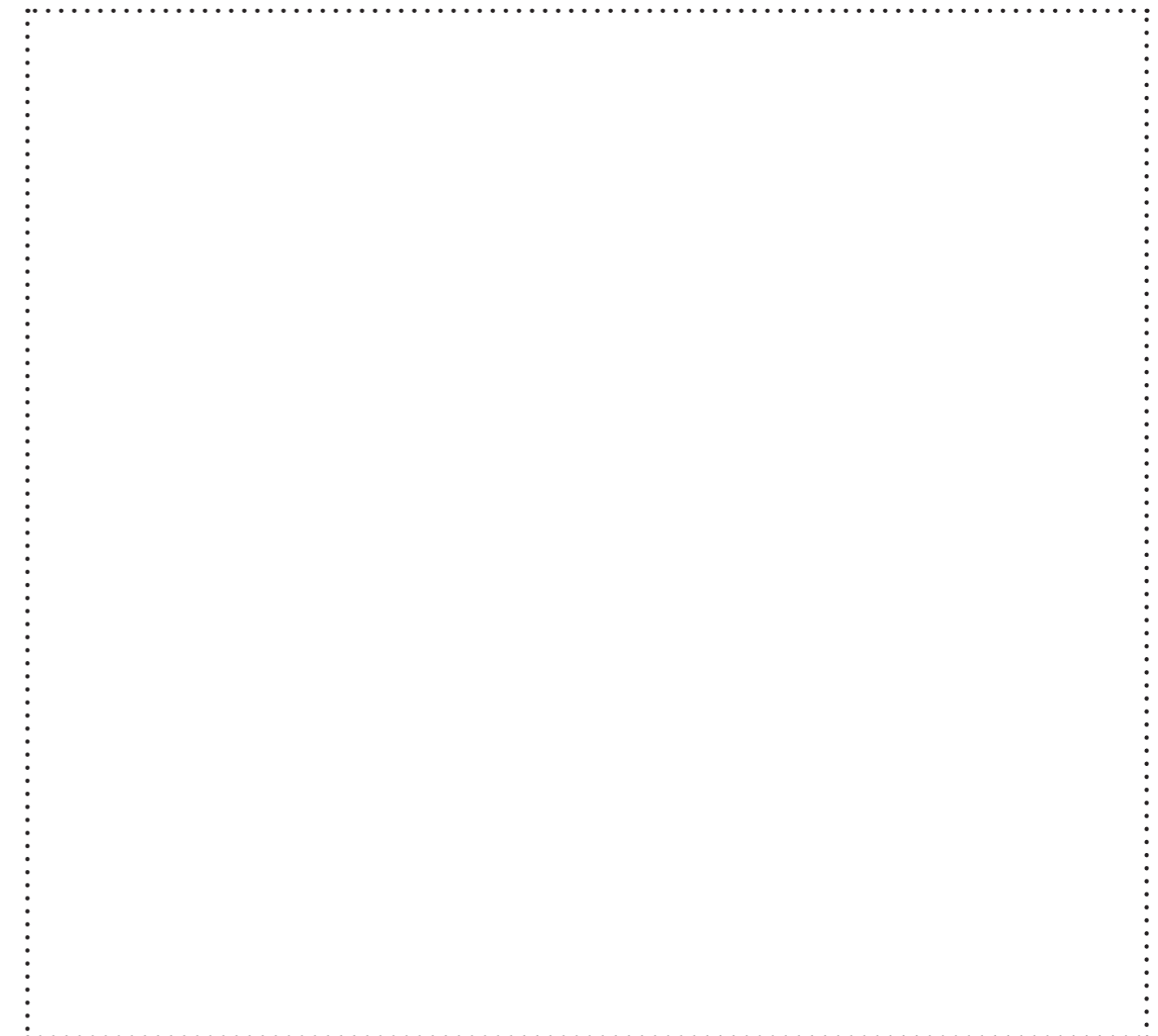
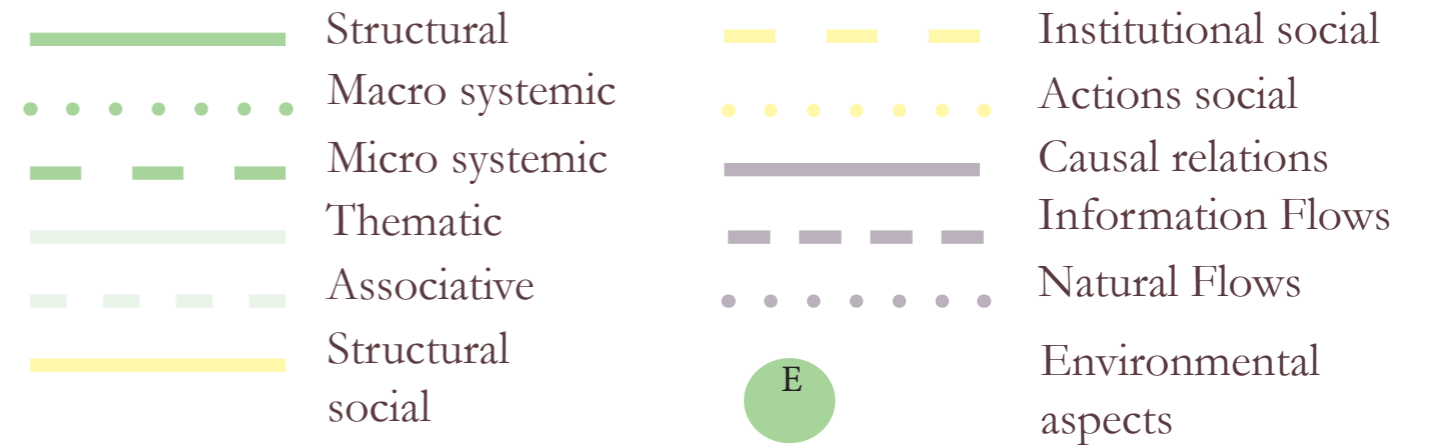
**Which stakeholders are nonessential or replaceable?**

**Could we modify the system itself in order to improve overall performance?**

Stakeholders



Relations



Form 4: Stakeholder network(modified from original by Iuliia Vorobiova, 2014)



## Step 5 Material selection

### Material and process evaluation

In order to give more accurate evaluation regarding the product life cycle we should go through the quantitative analysis of it. There is a large number of different tools available.

First of all we would like to select the most suitable material. In addition to that you should have basic knowledge of materials and its properties.

#### The CES ECO audit tool

*Software tools that provide a powerful, visual way to explore the world of materials and processes.*

*Which has 3 levels, depending on which you have bigger database of the material and process. We will use level 2, in order to search for the materials and select process (which has 95 of the most widely used materials and 105 of the most commonly used processes).*

- **BROWSING** Exploring the database and retrieving records via a hierarchical index.
- **SEARCHING** Finding information via a full-text search of records.
- **SELECTION** Use of powerful selection engine to find records that meet an array of design criteria (Granta, Material intelligence, 2014).

During the material search it is important to take into account the following criteria: typical applications and limited data for mechanical, thermal and electrical properties, using ranking where appropriate, design guidelines, ecological properties and technical notes. As well all the possible processes and detailed description of each. In the same way it's possible to search for the process and then see which materials are applicable.

An example of a softwood:

#### Eco properties

Production Energy	14.4	-	15.9	MJ/kg
CO2 creation	-1.16	-	-1.05	kg/kg
Recycle	✗			
Downcycle	✓			
Biodegrade	✓			
Incinerate	✓			
Landfill	✓			
A renewable resource?	✓			

#### Impact on the environment

Wood is a renewable resource, absorbing CO2 as it grows. Present day consumption for engineering purposes can readily be met by controlled planting and harvesting, making wood a truly sustainable material.

Figure 6 An example from CES ECO audit tool

The choice of materials and processes is a creative process, which can be time consuming. From our side it should be given special attention and additional consideration on the early stage of the product development. This method primarily consists of data research and the comparison of various materials and their properties. The task is not limited as you could see from a case study it's possible to come up with own idea of a new kind of material or process in a specific context.

In our case we would select several potential materials and processes, which are suitable for our product development strategy. Subsequently we will choose the most efficient ones:

**What is the potential material?**

**How was this material produced? What are the impacts? Is this material available locally?**

**What are the alternatives?**

**Is this material durable? Is this material recyclable? How could this material be processed? What is the most efficient process?**

## Case study 8: Synthetic stone Damian Palin sandstone stool.

*Damian Palin, a recent graduate from the Royal College of Art, is using bacteria to create a new type of synthetic sandstone for building and manufacture. His work explores how a departure from current production methods can result in new materials through the study and use of biological processes. Working at temperatures that are considerably lower than current industrial methods, Palin uses *Sporosarcina pasteurii* bacteria as a binding agent to cement natural granular materials and create moulded artefacts. Palin's greatest difficulty is producing the right conditions for the bacteria to live homogeneously within a mould during casting, resulting in discrepancies between cast and form. The result is an uneven, organic aesthetic and an object that is more sustainable and thought-provoking than one created using standard methods of fabrication. (PHILIPPA WAGNER, WGSN, 2010)*



Figure 7 Sandstone stool

### Materials selection

Production Energy				
CO2 creating				
Recycle				
Down cycle				
Biodegrade				
Incinerate				
Lawnlift				
A renewable resource?				

### Selection of processes

**E** Relatively environmentally efficient

Form 5: Materials and processes selection (Iuliia Vorobiova, 2014)

## Step 6 Environmental criteria

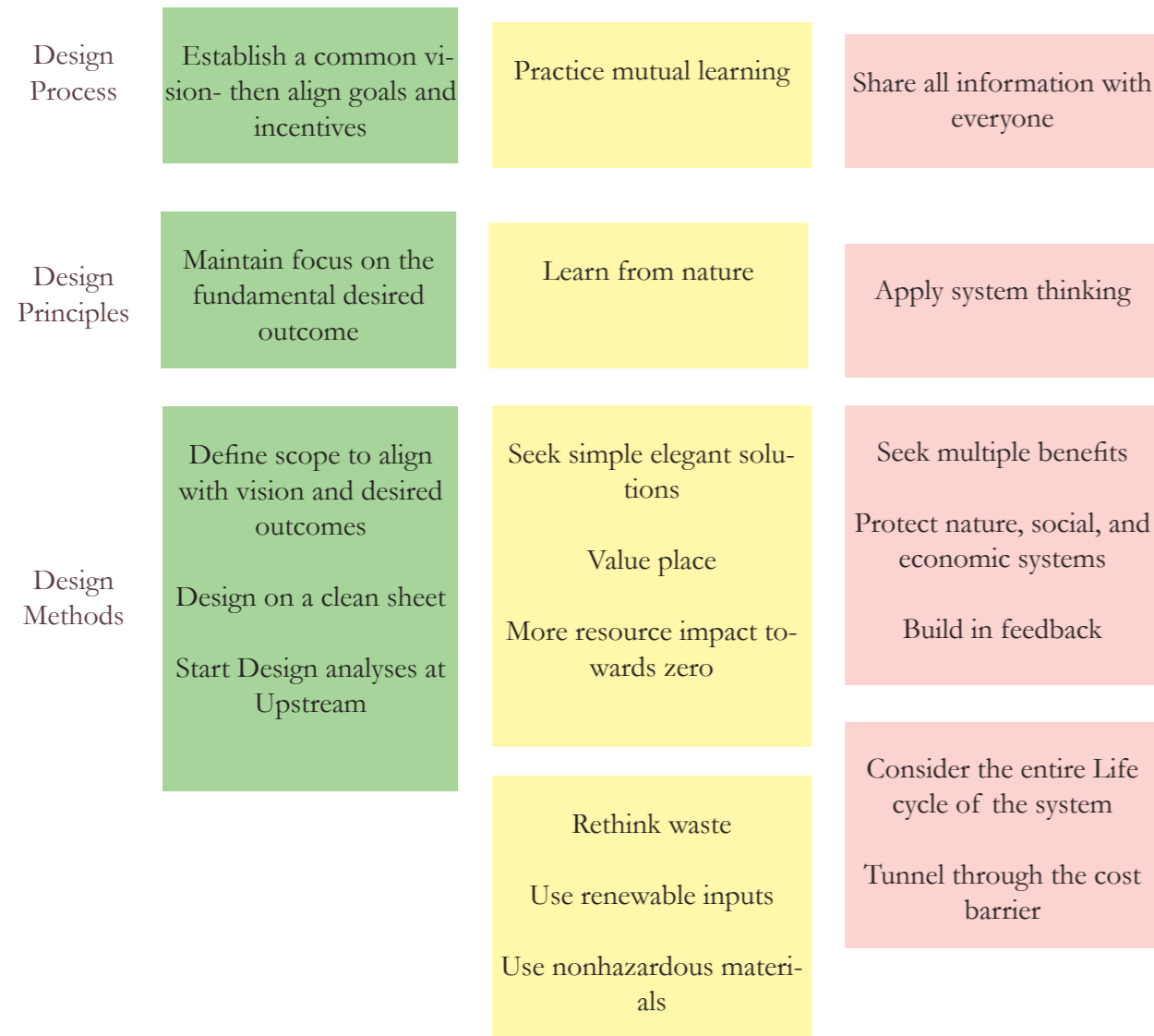
In order to create an ideal concept we have to select what our focus areas are and which parameters should be optimised:

- Minimise material consumption (work on shape optimization of a product, choosing simple shapes for the concept)
- Minimise energy use (decide on material and processes which do not require a lot of energy during the production, choose manufacturing company which use renewable energy, optimise transportation system)
- Minimise or reduce toxic substances (to reduce pollution and make the product more user friendly)

- Reusability
- Durability (choose material and functionalities which last longer)

Most of the parameters are linked between each other for example:

Optimising the dimensions of the product lead to less material consumption and transportation which is directly linked to less energy use.



## Main factor which have influence on product lifetime

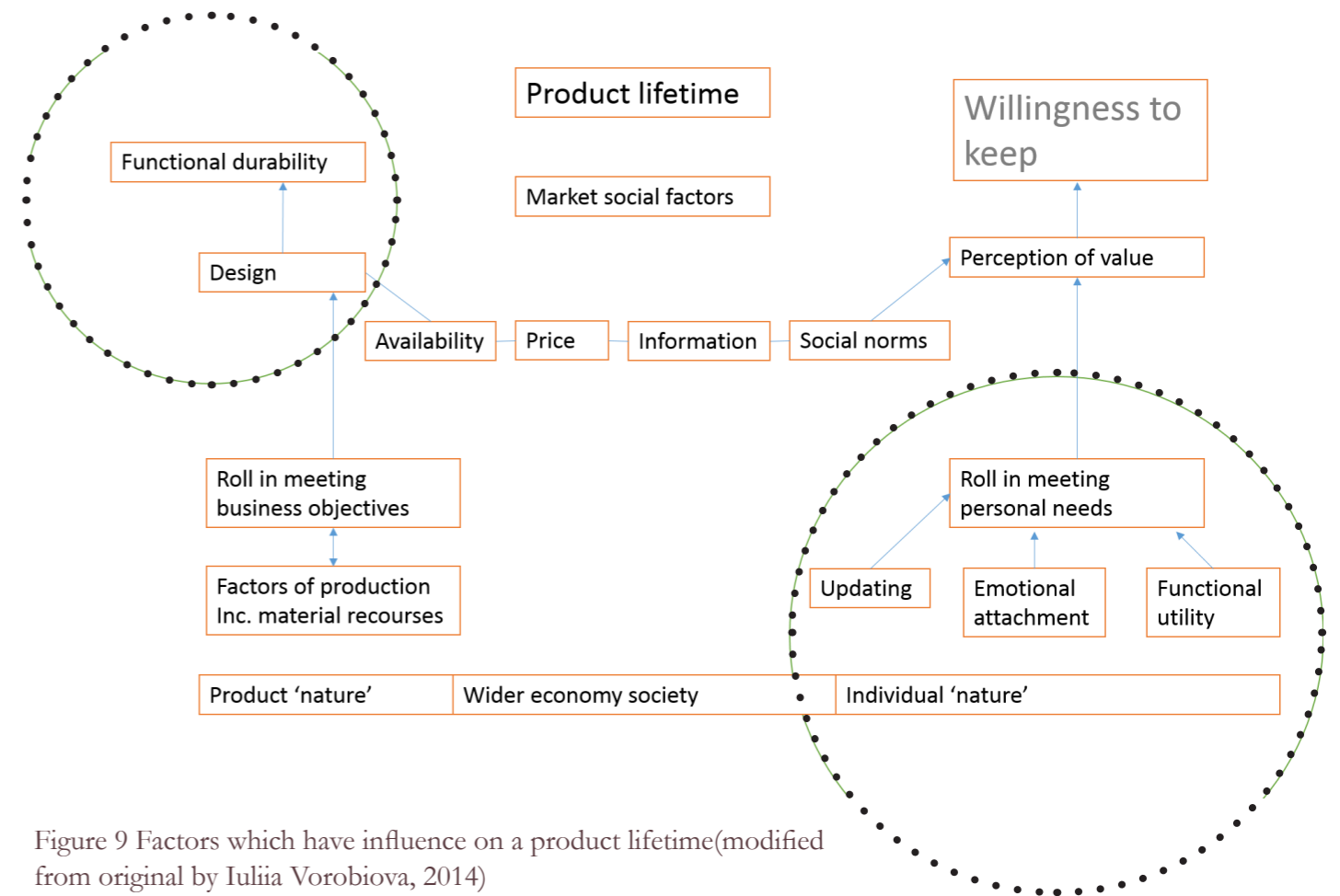


Figure 9 Factors which have influence on a product lifetime(modified from original by Iuliia Vorobiova, 2014)

The shown scheme helps to generate the strategy for the product development. As was mentioned prior it's not possible to focus on all the criteria at the same time but to define the factors which would bring the most positive output.

The idea is to create solutions which will lead to environmental improvements.

Designing a new concept has to combine environmental performances with aesthetic look and at the same time fulfil functional unit.

**Methods:** brainstorming, sketching, checklists, scenario creation, eco design principles.

Establish a common vision and maintain focus on the fundamental desired outcome.

Learn from nature, seek simple solutions, value place, and move resource impacts towards zero.

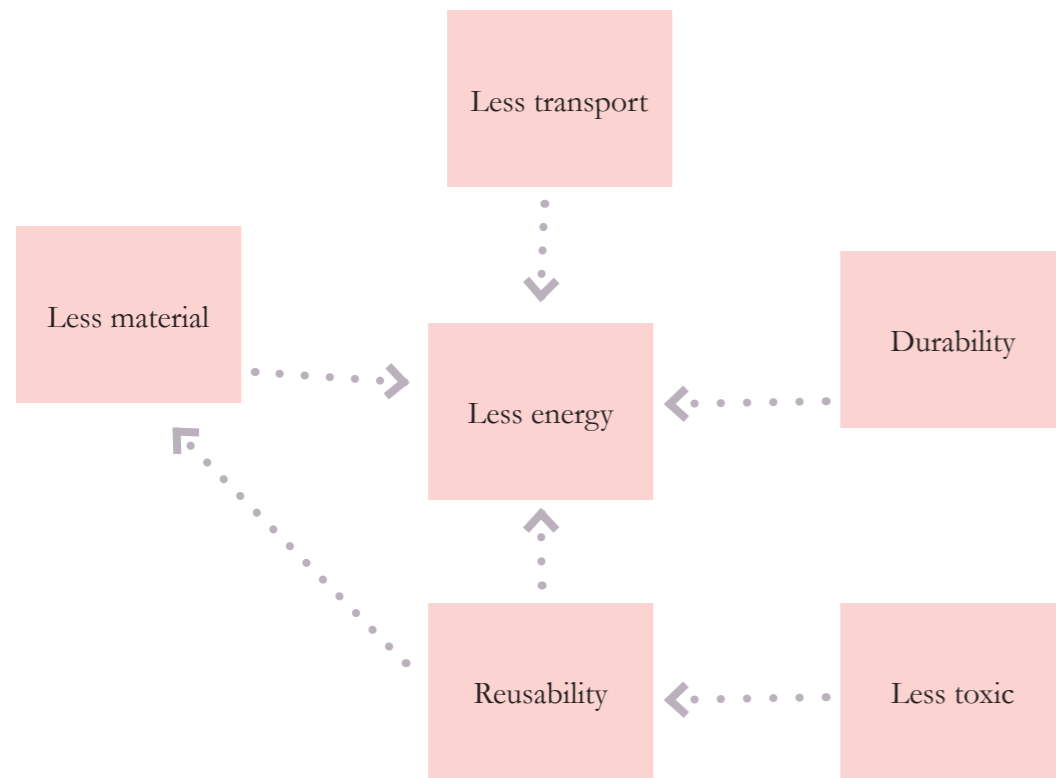
Apply system thinking, seek multiple benefits from single experience.

(Design Studies Voll33 No. 5 September 2012)

Figure 8: Whole system design, Design Studies Vol 33 No. 5 September 2012

## Environmental criteria

### Solutions which will lead to environmental improvements



## Step 7 Develop an environmental strategy

By now reader already should have a wide picture of your product life cycle and stages with high environmental impacts. To develop a strategy you need to set priorities as in step 7. On this stage we have to frame them into one system.

### Eco-design strategy

To complete this task you have to create a table. On the right side you will have all the possible eco-strategies which you have garnered during the previous step. You should indicate which product life cycle stage they cover and what kind of impact they have regarding: environmental, financial and social factors. As its showing below:

After completing the table you have to evaluate all the strategies and choose the most appropriate ones, which take into account environmental, financial and social aspects.

With practical example of using environmental strategy refer to case study bellow:

### Case study 9 SMART KID” Conversion Kit

Do we need to buy new furniture?

*Is a multi- functional article of furniture, which can be assembled into a crib with a changing table and storage drawers for linens and baby care accessories; or a playpen; or a desk with a chalkboard, a bigger bed and all the drawers the baby will need as it grows older. The furniture is suitable for children up to 10 years old. As all the articles of the set can be used multiple times, the furniture conserves both money and natural resources.*

Design by Heiki Must, Pavel Sidorenko

“Smart KID” is self-explaining example of a furniture which has multiple function which makes it life cycle longer.

The environmental stratagem for given product consisted of a few key points:

- Less material conception, reducing production waste;
- Natural material, simple shapes;
- Lifelong furniture, high durability.



Figure 10 Smart KID

During the development of the second part of the tutorial a few product development methods were combined and modified in order to achieve the most positive output. As a result we got step by step guidance which had been visualised for better perception of the material, giving us the opportunity to go from the abstract to concrete solution. For that we have to define our system, which would consist of: main focus; all gathered facts; stakeholders; system insides; different scenario and connections. Methods which had been used: brainstorming, mapping, matrix evaluation, system building.

This guidance is a tool for the evaluation of different factors and significance of its impacts. After all it's possible to say that the combination of methods which have been developed in this guidance significantly expand the stage of the research in a product development. In return for this it's simplifies the process of decision-making at other stages. The strategy helps to focus on the important aspects, trying to cover all the issues which occurred during life cycle of a product.

After completing this task you should be able to give answers on the following questions:

**Which stage of the product development has the most significant impact on the environment, finance and society?**

**Which stakeholders are involved into the system and how can the system be extended or reduced to achieve positive results?**

**Which aspects should be taken into account unconditionally and which are less important and could be neglected or postponed for the later contemplation?**

**Develop an environmental strategy**

Stage	Strategy	Environment	Finance	Social



++ Important improvement + slight improvement – unfeasible

Form 7: Environmental strategy (González-García, 2012)

**Part 3 Practical Pilot project**

**“Furniture has always been made to fit our bodies. Why hasn’t it been designed to fit our minds?”  
Environments that work the way minds work.**

**Formway©**

## Introduction

The third chapter of the tutorial is devoted to the application of the method in practice. In this part we will try to develop sustainable strategy for our project.

### Data collection & defending the problem:

### Data collection & defending the problem:

- Physical aspects of the office environment (lightening, furniture, surfaces);
- Philological aspects: privacy, personal space, interpersonal communication.

### Space in relation to the nature of work:

At the work space the highest dissatisfaction is concerned about the storage facilities and storage in relation to nature of work. In open-plan offices there is an issue with privacy as everyone has a demand for safety, security and privacy, but in office environment there farther need for involvement and interaction.

### Different levels of storage space:

- Personal storage
- Group storage
- Archival storage
- Space for the task management

*‘We have tried to reinforce each independently without recognizing that this is a problem requiring subtle compromise’*

(Propst, 1968)

Females are the most concerned about privacy. The main problem is to feel self-conscious about being viewed from shared workplace which makes it hard to concentrate.

People need an individual space which they can control even if they have to share it.

In order to solve this problems furniture designers have to consider:

- Mobility furniture which would suite new working patterns, the trend towards more informal ways of working
- Flexibility, free-independent work station
- Simplicity
- Privacy and noise control

(Nomana Paul, 2005)

## Step 1

That is a big challenge to improve environmental performances of the office furniture. A lot of possible factors should be taken into account: durability standards, customer demand, materials and technology which are used for the production and as well end of life of the product. To cope with this tangible amount of date environmental profile for the product should be created.

## Product functional unit

What is the purpose of the present study?

Who does need it? Description of a target group: what are the age, gender and nationality of the users?

Descriptions of technologies which should be used, main functions and supportive functions?

What product is evaluated, against what alternatives?

What is left out and why?

To develop office furniture with minimal resources consumption

Office worker/ freelancer working at home; middle class, age range -25-55 year old; North Europe(Estonia, Finland, Sweden)

Main function: create work space in any part of the office or home space;  
Store working assets;

Smart shelf, foldable tables, multifunctional office furniture

1. Materials
2. Production process
3. Recourses used
4. Transportation
5. Interaction with user
6. Durability
7. End of Life

## Benchmarking



Figure 11 K Work station

**K Workstation** incorporates Bamboo laminated plywood for creating efficient space managing working space. The folding curved shape creates shelving and desk space within one working unit. K Workstation could be manufactured each segments for easy fabrication process and transportation, yet it could be configured with multiple possibilities. The bamboo, rapidly renewable material, brings this working units sustainability and elegance of curvature.

(MisoSoupDesign)



Figure 12 A Suitcase desk

### A Suitcase desk

A Suitcase desk is contemporary take on the classic bureau design, allowing users a secure lockable, self-contained, private work space.

(TILT studio)



Figure 13 Vilfred Desk

**Vilfred Desk** by Kristina Kjær is a warm, compact and private workstation, incorporating the tradition of classic writing desks, with clean modern lines, an organizer for pens and other desktop small objects, and space to store a laptop. In stained oak with cork, or oiled oak. Created for Bolia. Kjær is a furniture designer in Aarhus, Denmark.

(MOCO design)



Figure 14 The Camille Wall Desk

The Camille Wall Desk by Vurv Design is Healthily Compact.

(VURV design)



Figure 15 Modern Multifunctional Desk

### Modern Multifunctional Desk

Reminiscent of rolltop desks from the early 1900s, this take on the multifunctional cabinet desk incorporates modern amenities like integrated LED lights and power sockets to enhance your modern workplace. Classic, minimal styling lets you achieve that sought-after vintage look without sacrificing the necessities for powering your modern devices.

Designer: Laura Petraitytė

(Yanko design)



Figure 16 Homework desk

### Homework

Is a work table with refined extension to store document, books.

(Tomas Kral Product Design Studio)

# 1 Stages of a product life cycle and possible impacts



## Step 2

Which stages of a product life cycle have the most significant impacts?  
 How possibly impacts could be reduced?  
 What are the alternatives?

Eventually, after completing second form we see that the significant impacts occur on the material and manufacturing stages. We should be considerable when choose the materials and processes for the production. The same product could have variable impacts depending on the selection. In a frame of this project ways of the transportation won't be considered (type of the vehicle or the network). As well tooling production will be neglected which are needed for our product development. Last thing but not least, End of Life for the product, to consider different strategies.

## Sustainable approaches

**Recycle** - reprocessing waste materials

**Reduce** - design with minimal consumption of resources (energy, materials, water etc.)

**Remake** - design with easy disassembly and possibility of re-use of some parts

**Remind**- design that evoke memories

**Resource** - design which use renewable, natural materials

**Respond** - social design which involves interaction and friendliness

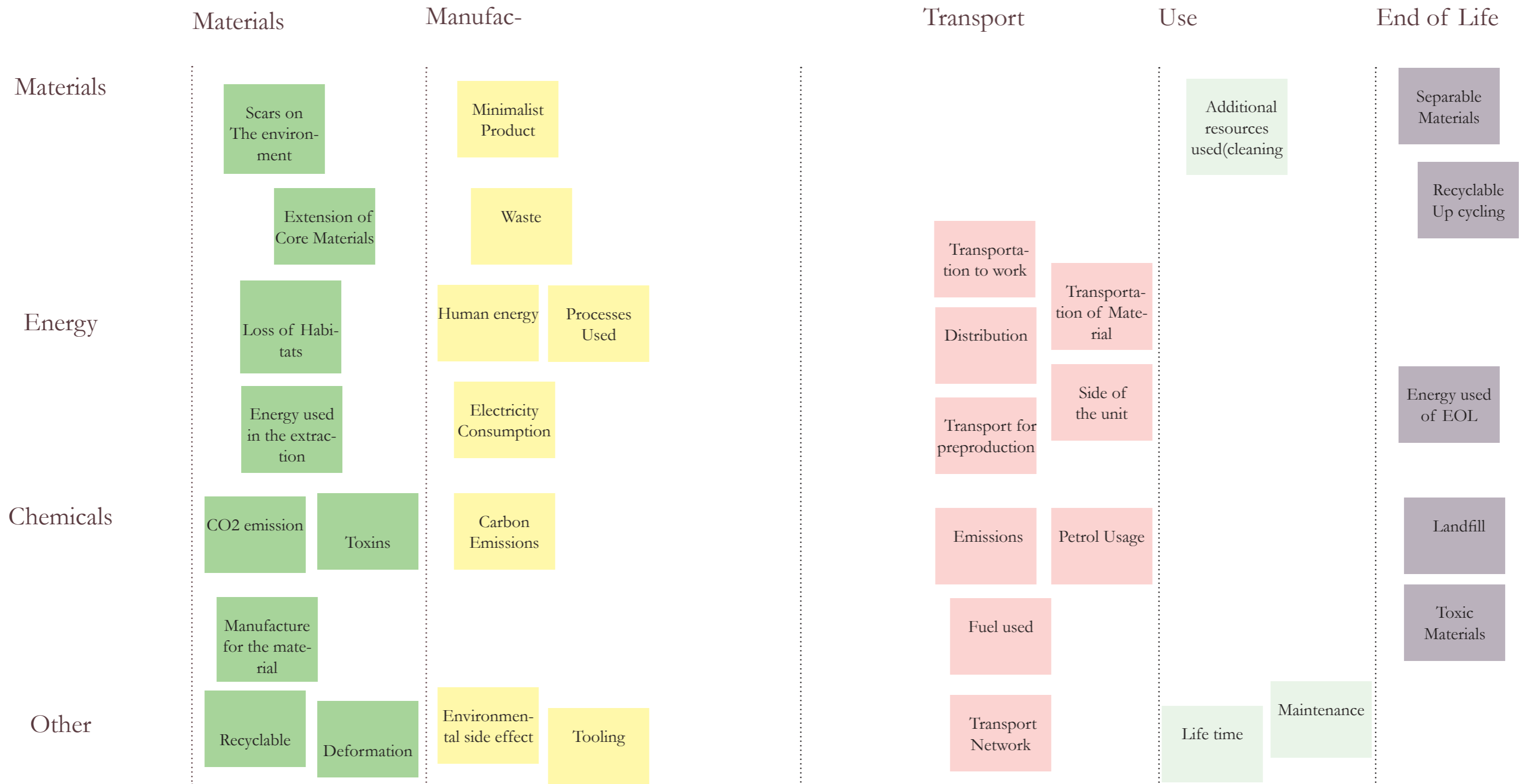
**Reuse** - creative design out of "second hand" objects

**Reclaim** - design using waste materials in the raw without reprocessing

**Recreate** - customised or personalised design, with connection between object and owner.  
 ([Re]design org , 2013)



MET Matrix



Step 3

Which parameters and stages have the greatest impact?

Which parameters are nonessential or replaceable?

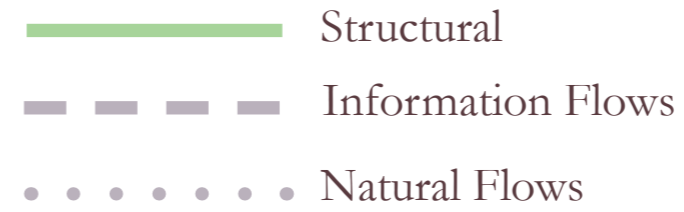
Which elements could be adjusted, changed or removed? How would it change over all picture of life cycle and its impact?

According to the results which we obtained from the Met Matrix analysis, the most impacts in energy consumption on all the stages excluding usage. The same situation with materials and chemicals utilisation. Within the use stage attention should be drawn to maintenance of the product. In the future we have to think about the production processes which consume as less resources as it possible.

### Stakeholders

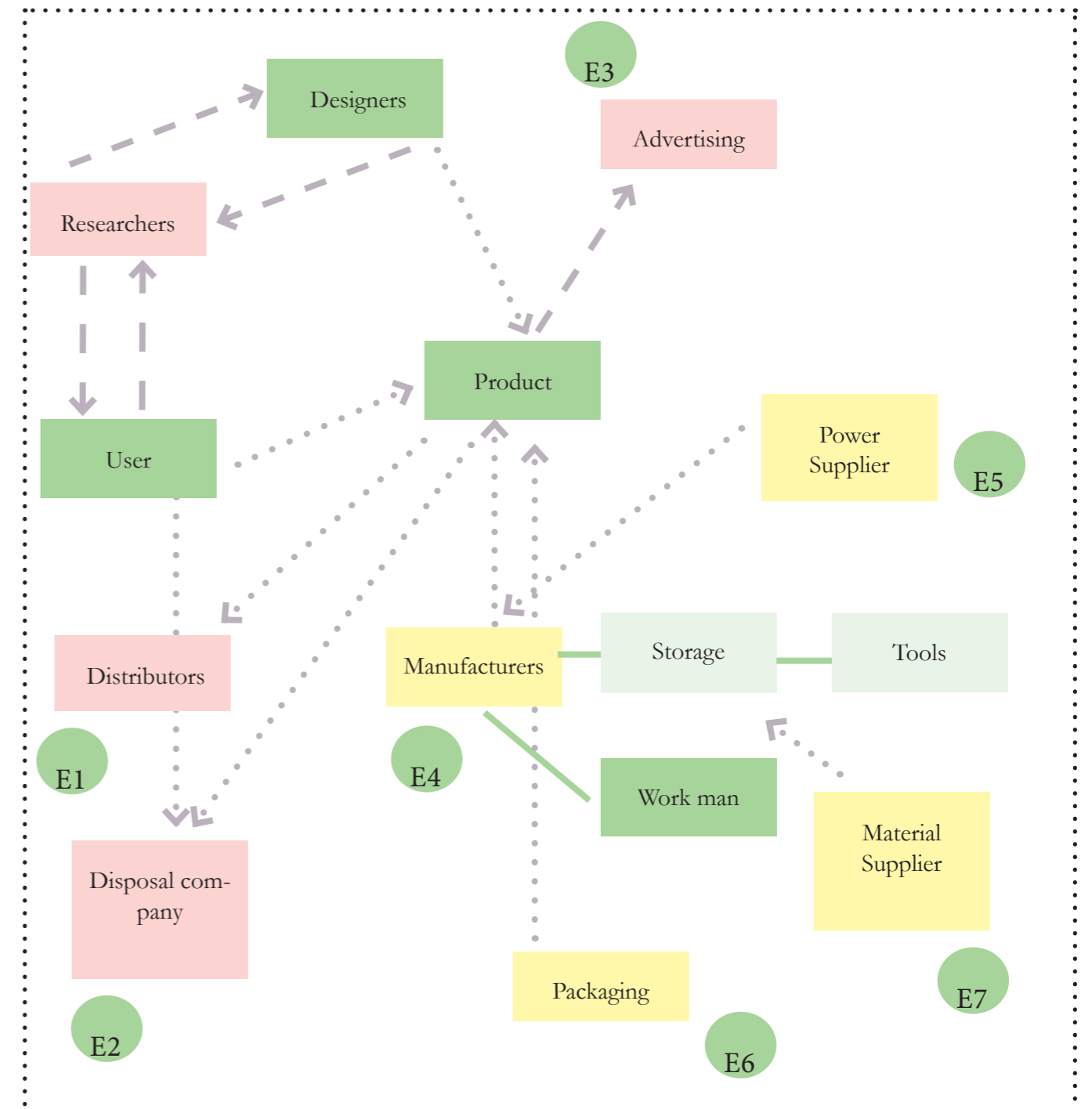


### Relations



- E1 Provide the most sustainable service
- E2 The most efficient EOL strategy
- E3 Cannot "green wash" customers
- E4 Most energy efficient
- E5 Renewable energy
- E6 Reduce packaging
- E7 Sustainable resource

**E** Environmental aspects



## Step 4

Which stakeholders are involved into the processes and have the most significant environmental impact?

Which stakeholders are nonessential or replaceable?

Could we modify the system itself in order to improve overall performance?

Strategy development should not be all the time just on a paper. To name this approach 'truly practical' and discover new aspects it's possible to do field study. Especially, if it's needed to familiarise with all the production processes which are related to a product.

## Case study 10 (field trip)

Production visit, company Sunorek.

The main purpose to visit Sunorek is to observe production processes and track all the waste which is created.

On the picture (figure 18) is showed waste which had been produced after two working days.



Figure 17 Visiting production

## Waste audits

Wooden trims and planks- approximately 100 kg per day; in total 24 tonnes per year

Packaging waste- approximately 15 kg per day

Glass waste- 40-60 kg per day

Steel waste – not certain

Saw dust- not certain

## Where is this waste going?

Steel is going to be sold and after reproduced;

Glass, wooden leftovers and packaging are going to be disposed

Alternative:

Wooden waste materials could be easily reused without processing as the average size of not damaged wooden plank is 60X20 cm.



Figure 18 Waste

After building Stakeholders network and rethinking all the connections between them it's quite easy to indicate all the flows of materials and information. Which gave us clear picture of the stages where environmental impacts are the most critical.

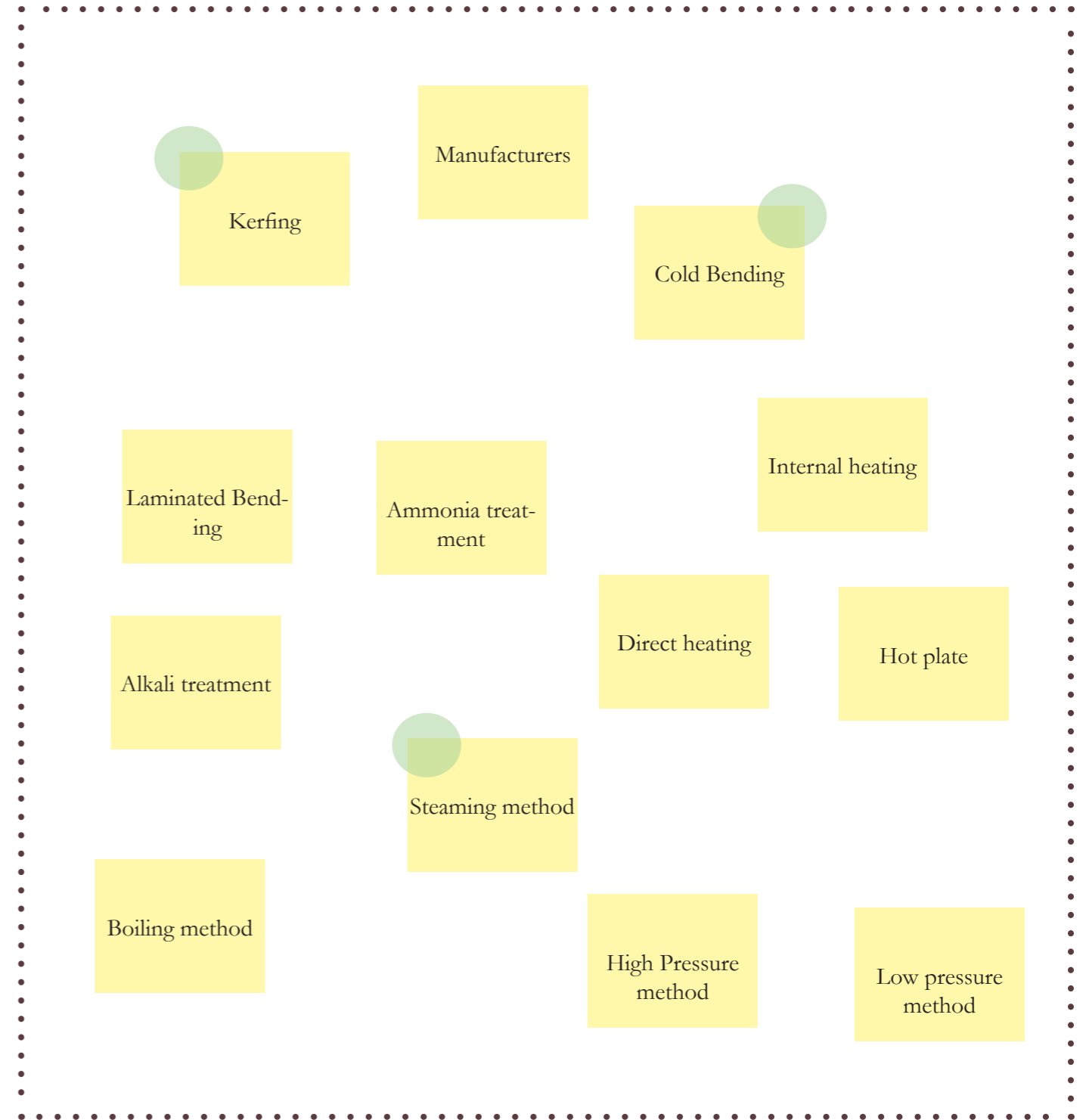
Please look form 4 and check stages which are marked with green circles (the once which need consideration).

- E1 Provide the most sustainable service regarding distribution
- E2 The most efficient EOL strategy
- E3 Cannot "green wash" customers
- E4 Most energy efficient manufactures
- E5 Power supplier which uses renewable energy
- E6 Reduce packaging
- E7 Sustainable resource from material supplier

### Material selection

	Stainless steel	Cork	Wood
Production Energy	72.2-85.3 Mj/Kg	28.5-31.5 Mj/Kg	14.4-15.9 Mj/kg
CO2 creating	4.86-5.37 Kg/kg	0.19-0.21 Kg/kg	-1.16-1.05 Kg/kg
Recycle	Yes	Yes	Yes
Down cycle	Yes	Yes	Yes
Biodegrade	No	Yes	Yes
Incinerate	No	Yes	Yes
Lawnlift	Yes	Yes	Yes
A renewable resource?	No	Yes	Yes

### Selection of processes



 The most efficient methods

## Step 5 Choosing material

Perhaps the most important and complicated task is material and processes selection as we do not have yet potential concept of a product, but already have to set the limit for the materials and processes. For this purpose we made a research using material & processes database, considering environmental properties. We tried to look for the recyclable and renewable materials with minimal energy consumption and CO2 creation during the production processes. In this way it's possible to compare different materials and choose the most sustainable, improving performances of the final product.

Please refer to Form 5.

## Choosing processes

Based on previous step, wood have been selected as a working material assuming that it will be the most appropriate material for our product in respect of environmental performances.

<b>Wood Bending</b>	Laminated Bending			
	Solid Wood Bending	Kerfing		
		Bending process using a chemical treatment	Ammonia treatment	
			Alkali treatment	
		Compression bending		
	Cold bending			
	Hot bending	Internal heating (microwave heating)		
		External bending	Direct heating method	
			Hot plate method	
			Boiling method	
Steaming method			High pressure method	
	Low pressure method			

Figure 19 Types of bending process

On this stage few processes will be selected, the most suitable for the production. For this purpose have to map all the possible processes and high light the most efficient, taking into account resources consumption: materials, energy, time, machinery and people involved.

The idea to minimise amount of parts in the final concept and reduction of usage of chemicals led to consideration to apply wood bending techniques.

**Wood Bending** is a really old techniques used in wood processing. This techniques have been used in furniture industry since middle ages. There are a lot of different way to bend wood depending on chosen shape, material and timing of a process.

**Kerfing.** The method used is to make a saw kerf (cut) on the inner surface of the material. The formula for this kerf bending is the relation between the thickness of the material, the curve 'R' (outer side) and the quantity of the saw cut. The surface where the saw cut is made becomes the inner side, and glue is applied so that the saw cuts are filled.

**Cold Bending.** Bending method used after the material is boiled or steamed usually called as a hot bending. Cold bending is a method where water is applied to the material before it is put into the mould and bended.

**Steaming material** is bended due to application of a moisture and heat.

(Kohji Katsuragi, 2002)



Figure 20 Wood Workshop

## Wood workshop in Art Academy of Estonia

By Masahiro Miura and Kengo Yonezawa from Japan.  
(06.09.2013)

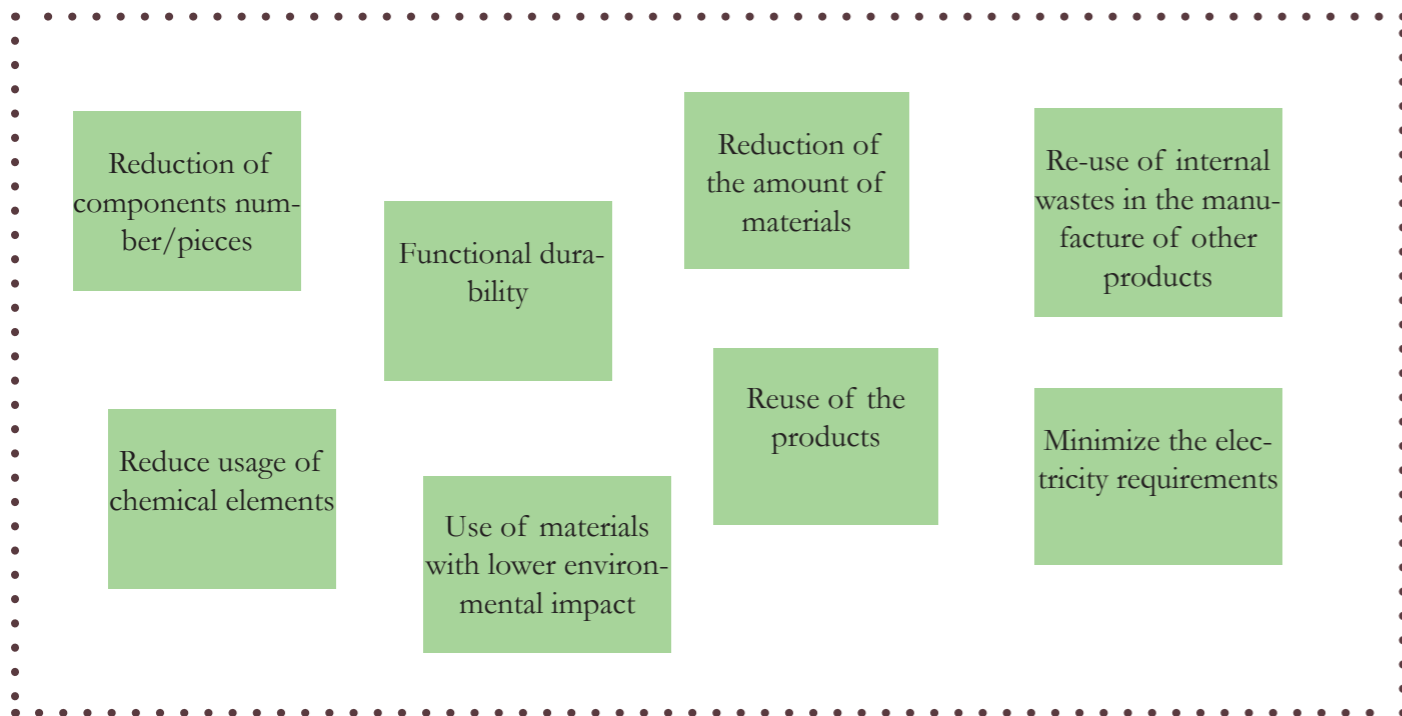
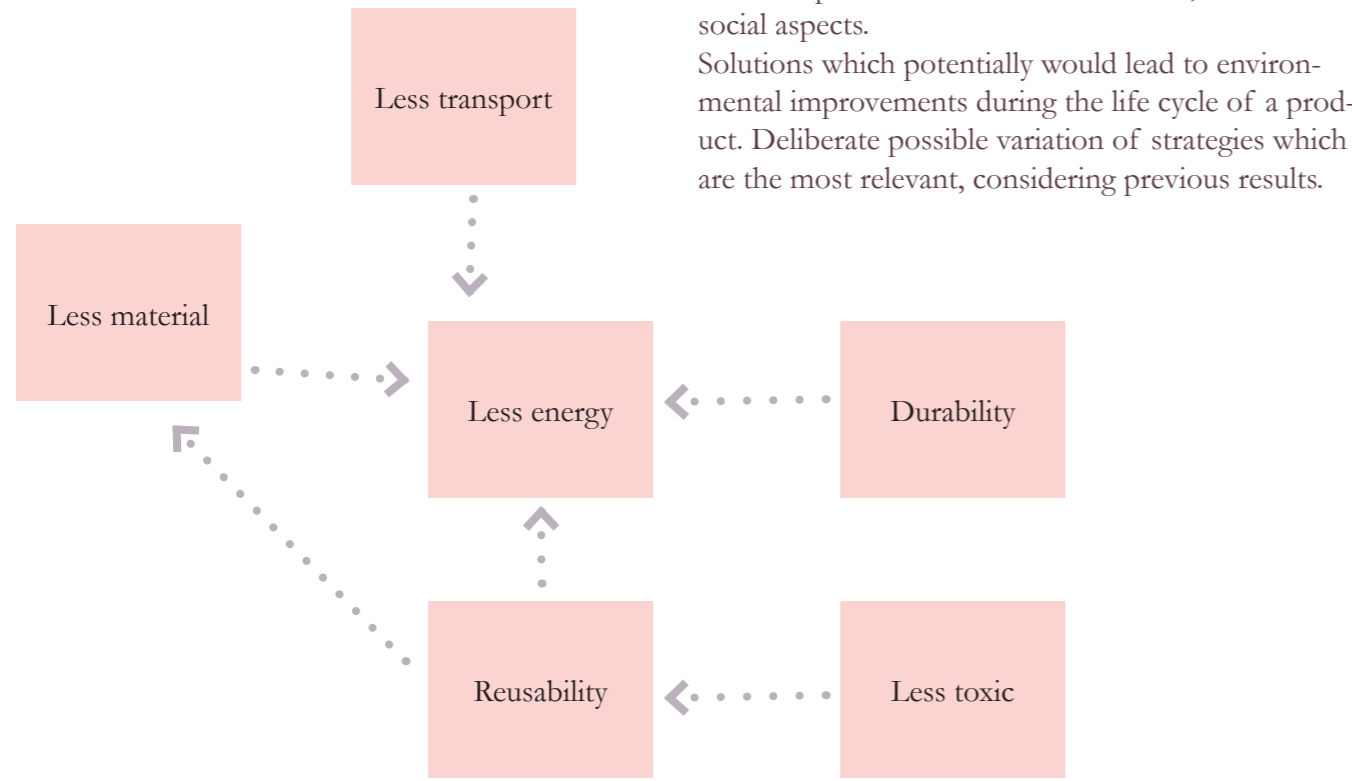
An interesting approach of wood treatment- gluing multiple layers of the bark with natural adhesive mortar. The bark is taken from trees which grow primarily in Japan. It takes up to 3 years for tree to grow back a bark. Kengo Yonezawa making various products with this method.

Environmental criteria

Solutions which will lead to environmental improvements

In order to develop an environmental strategy all the ideas which had been generated in the previous task will be used. Designate which solutions are the most effective and cover the greatest number of impacts from the point of view of environment, finance and social aspects.

Solutions which potentially would lead to environmental improvements during the life cycle of a product. Deliberate possible variation of strategies which are the most relevant, considering previous results.



Develop an environmental strategy

Stage	Strategy	Environ-ment	Finance	Social
Concept	Reduction of components number/pieces	++	++	-
Concept	Functional durability	++	++	++
Material	Use of materials with lower environmental impact	++	-	-
Material	Reduce usage of chemical elements	+	-	-
End of life	Reuse of the products	++	++	++
Concept	Reduction of the amount of materials	++	++	+
Production	Minimize the electricity requirements	++	++	+
Production	Re-use of internal wastes in the manufacture of other products	++	++	+

Concept
Material
Production
End of life
 ++ Important improvement + slight improvement - unfeasible

## Environmental strategy

Even though customers choose rather purchase good quality sustainable products we still have to keep in mind that “green tag” that is not enough. First and foremost products have to be user- centred.

Previously we have pointed that all the materials have to be recyclable but in the same time it’s undesirable to ground our strategy on continuous recycling with a goal of increasing consumption of products. Instead of that we should consider expansion of the life cycle depending on the needs of the customers.

On this basis following strategies are proposed:  
 Reduction of a components and material used  
 Functional durability  
 Preferable material: poly wood  
 Preferable process: kefing, cold or steam bending

On this basis following strategies are proposed:  
 Reduction of a components and material used  
 Functional durability  
 Preferable material: poly wood

Preferable process: kefing, cold or steam bending

## Concept of Condition adjustable furniture

Willingness to keep  
 Emotional attachment  
 Functional durability  
 Saving material recourses  
 Reduce usage of chemical elements  
 Natural painting

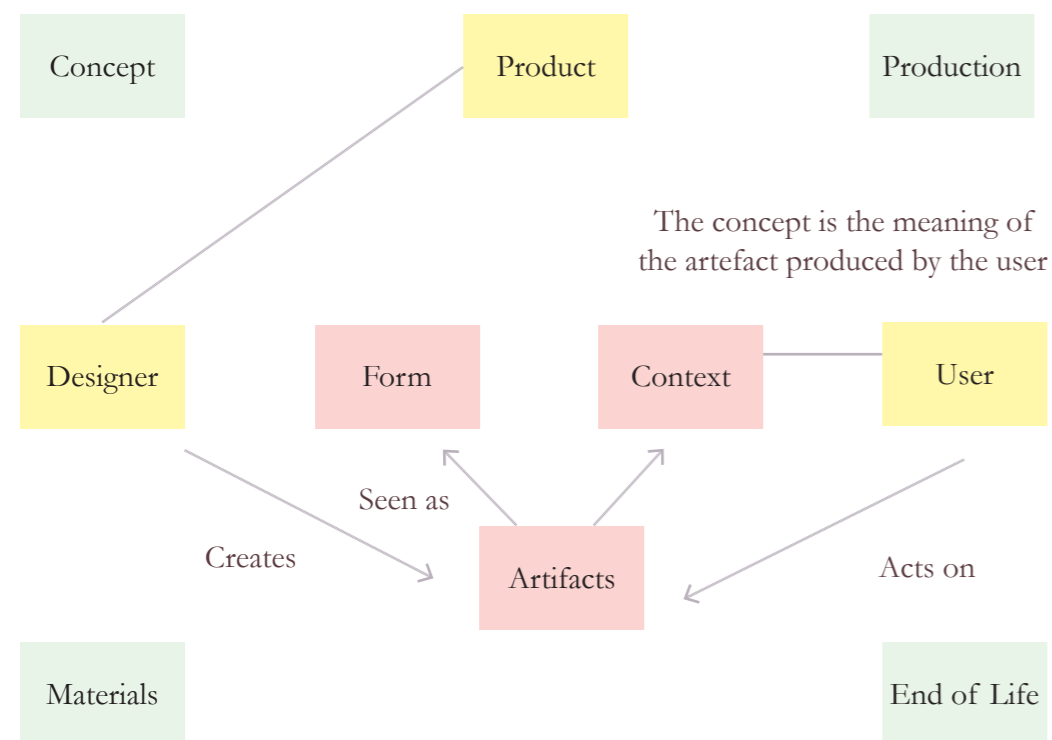


Figure 21 Process After Krippendorff

## Concept

### «Travelling work station»

The idea of a concept came from a willingness to change working place during the day. Even if work station is designed well there is a problem with an arrangement. During the working day people in a need to be more dynamic, changing working positions. In the same time they still need comfort and properly adjusted place.

There is a question should offices be closed or open. From one point of view they should be open which would encourage the process to be more creative and flexible as a source of an inspiration. From the other side closed offices are oriented on “work to be done”, implying high level of concentration. Recent research from the London Business School suggests the average worker is interrupted every three minutes in the office. (The guardian, 2014)  
 From this we can infer that most of the people would prefer to work outside of the office.

*“The fast-and-loose business that is emerging as the new way of work runs more like a forest or a city than a machine. We need to learn by imitating rich ecosystems, where the appearance of chaos yields to emergent order, and reject order imposed by fiat.”*

Stowe Boyd

Feasibly in the future we would have offices “without a desk” and totally different working environment. What do we need for a good working place?  
 Most likely stable place for laptop, Ipad and other devices;  
 Space for storing personal items;  
 We need to write somewhere new coming quick ideas or daily tasks;  
 A bit of privacy;  
 And a good coffee!

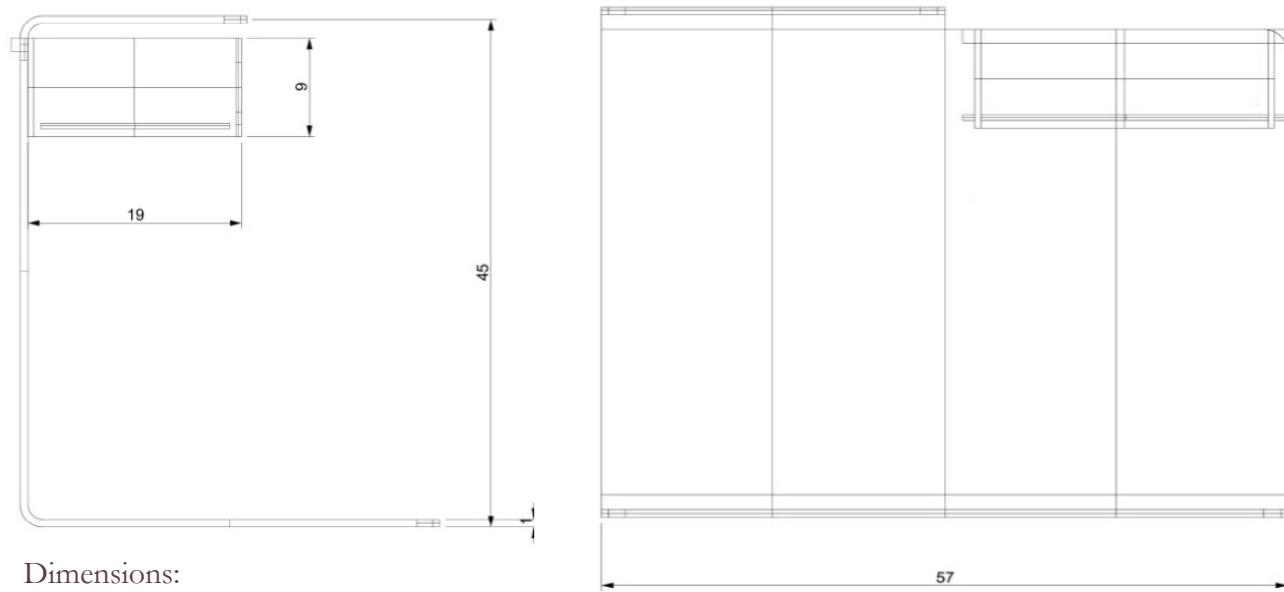


Figure 22 Designer



Figure 23 Office as city

## Visualisation of a concept



Dimensions:

height: 45 cm  
length: 57 cm  
width: 37 cm

Figure 24 Concept dimensions

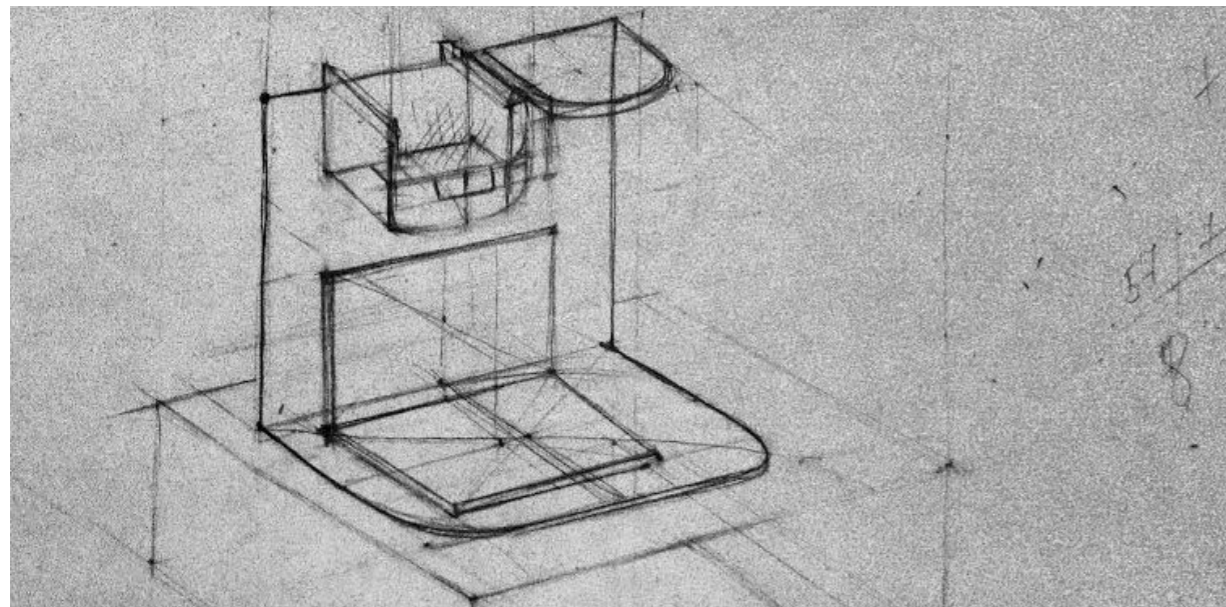


Figure 25 Concept

## Rapid prototype

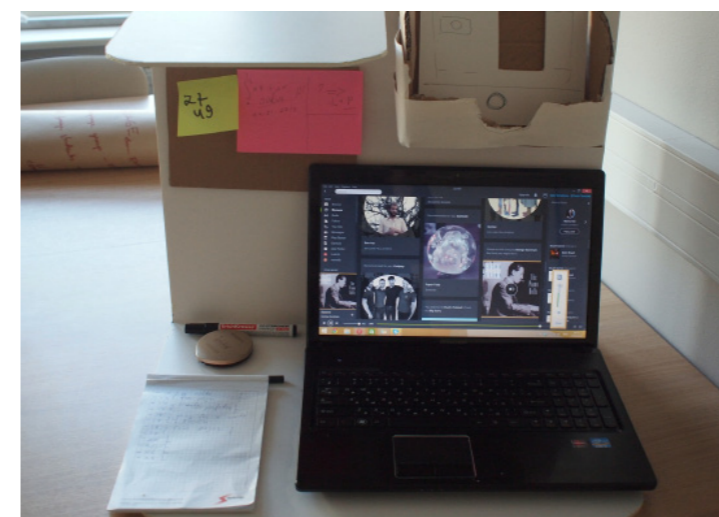
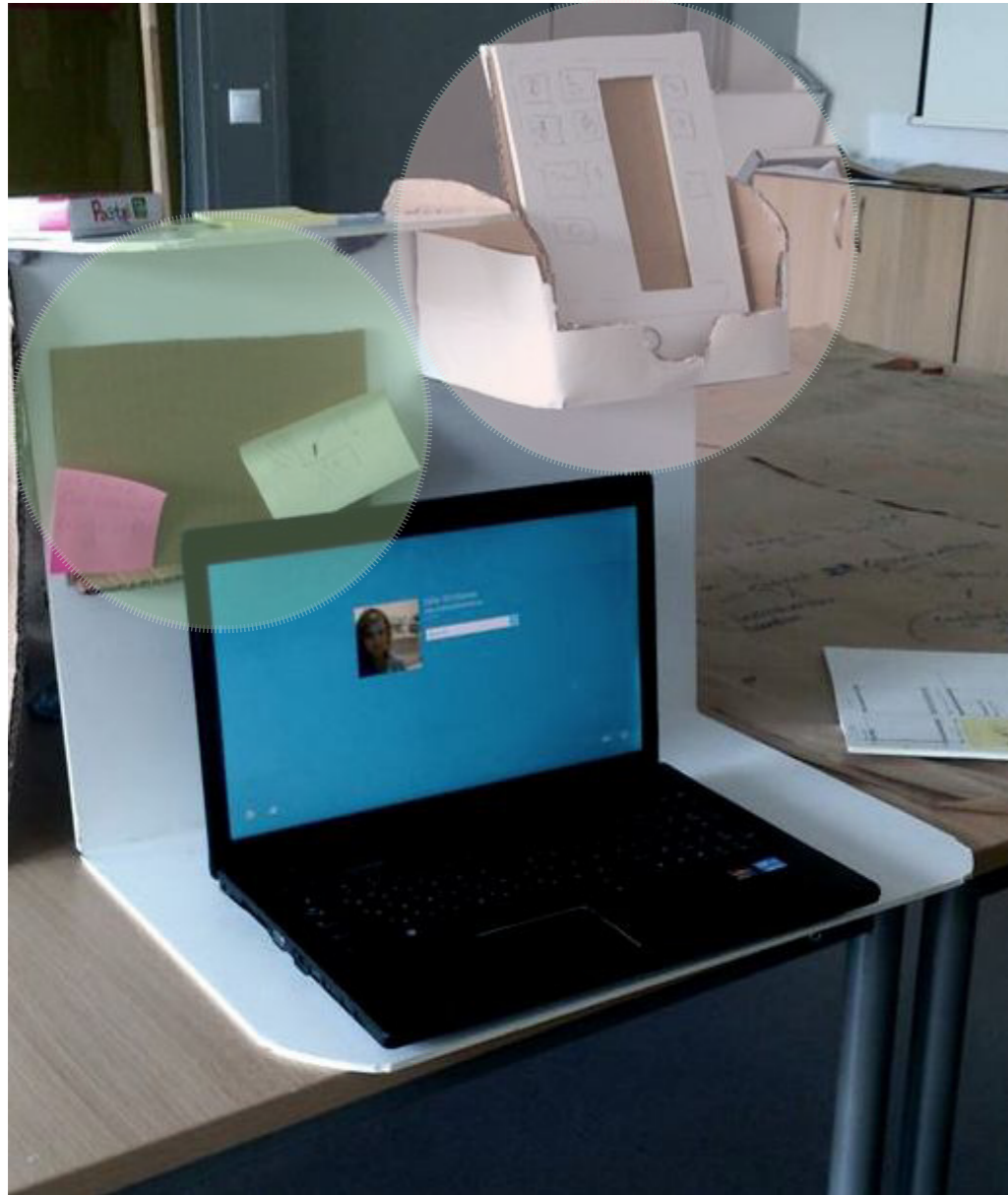


Figure 26 Prototype





**Scenario testing**  
Furniture which gather your mind

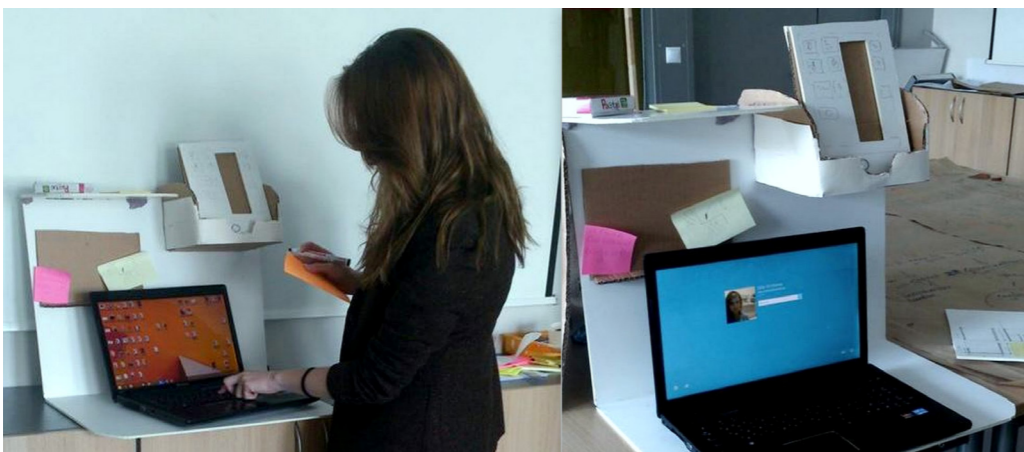


Additional removable shelf, designed to be integrated with iPad or other working materials.

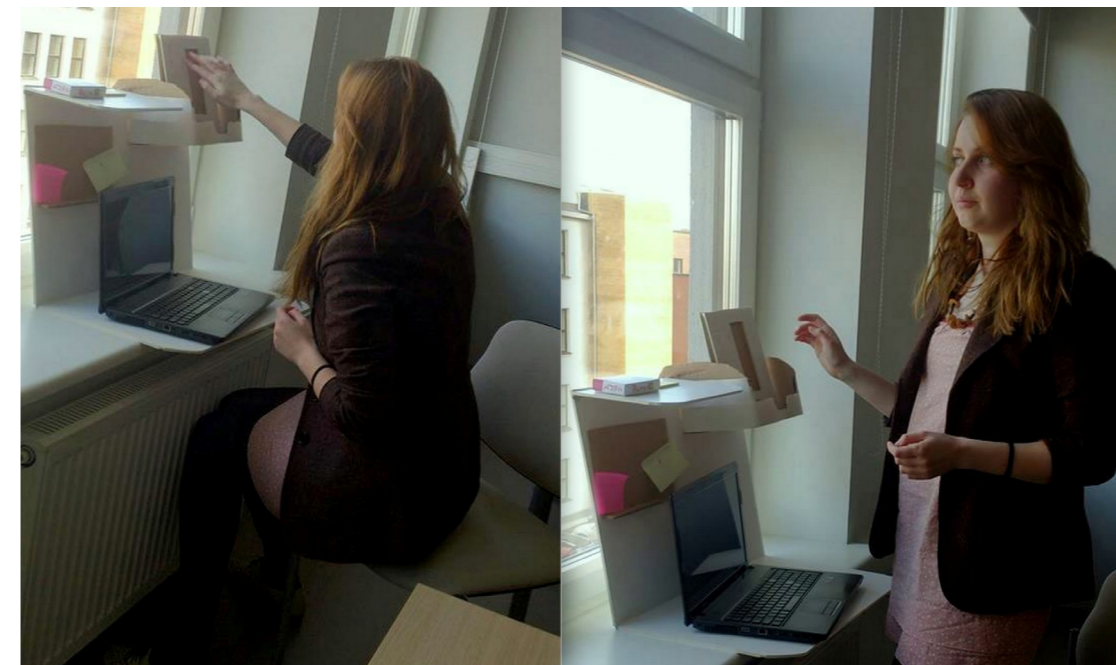
Writing board- daily task reminder. Primary surface for fast ideas and argent information.



Co-working space with privacy; Switching from individual work to teamwork without changing place.



Work on the way, adjust your space anywhere in the office even in tight spots.



Unconventional workplaces.

Figure 27 Scenario testing 1

Figure 28 Scenario testing 2

Model



Figure 29 Model 1



Figure 30 Model 2

## Conclusions

The product which has been developed in the frame of this pilot project is a result of sustainable strategy, which we had been following as a requirement for the product's development. On the first stage we had to generate as many possible impacts as possible. After we tried to group them depending on different factors. This exercise gave as an opportunity to see where the largest impacts are and choose our focus areas. In this case we selected following requirements:

On a conceptual stage we reduced the number of components by choosing a wood bending process for the product's production. To reach functional durability we tried by adding functional values: providing flexibility, comfort and privacy for the user during the working process. This has a direct and indirect influence on environmental, financial and social aspects. On the material stage we selected wood, taking into account its low environmental impact. The diminutions of the product are optimised in order to minimize usage of material and to make it easier for user to transfer. Despite this, the product's functionality is not reduced, the level of privacy and place for storage are not compromised for the working process. The results were verified by the testing of a prototype.

The product is made from one material which makes it easy to recycle or reuse when it reaches the end of its life. Furthermore, we preferred to choose high quality materials which would increase the cost of the production but in the same time make the product more durable and in some cases reduce waste during the production process.

During strategy development we did not pay attention to the issues regarding transportation. The object itself is not foldable and occupies a relatively large space. By reducing the number of the components we increased the size of the package. It is almost impossible to reach a positive level on all the stages and we had to sacrifice some areas they have less value in comparison with other factors.

## Final Conclusions

The aim of the paper was to create a guide which would help to understand what sustainable strategy in product design is. During the guidance development few commonly used methods and tools were combined and modified by the author at some stages. Each situation was illustrated with examples and case studies for better understanding how sustainable strategies are used in practice.

The third and final part of the pilot project was developed to maintain the knowledge which has been gained after reading the first two chapters. The feature of this work lies in the combination of theoretical and practical materials. The reader is suggested to carry out this practice for his own project following step by step instructions. All parts of the tutorial are visualized and easy to perceive.

After completing this tutorial, the reader will gain theoretical knowledge about what sustainable design strategy is. They would be able to use in practice all the tools described in the guidance.

Analysing the results that we got after the passage of the tutorial, it is possible to say that the methods described in this guidance significantly expand the stage of the research in a product's development. In return for this, it simplifies the process of decision-making in the other stages. Therefore, it gives us the basis for the development in different areas from diverse perspectives. Therefore sustainable strategy in the early stages of the product development process has positive influences on the whole process.

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