Bachelor Thesis Spring 2018

WasteLess

*Sustainable modular table design with metadesign thinking*

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Abstract

Waste management has been considered as a significant challenge for sustainable development. From EPA report, furniture is the number one least-recycled item in a household. In current markets, much of furniture is made of composite material, which isn’t feasible to separate. This design project is based on the trend of sustainable furniture as well as the rapid expansion of recycling culture. It contains both tangible furniture design and intangible metadesign thinking. Here it comes with thesis statement: In order to raise public awareness of sustainability, how to design a furniture product with metadesign thinking?

The content of the project is a modular table design that combines both recycle material and mass-producible ready-to-assemble furniture (RTA). This table design is including freehand sketches, hand-made models, Rhinoceros 3D modeling and short instruction movie.

Keywords

Sustainability, waste management, furniture design, metadesign, veneer waste
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1. Introduction

In the current design field, sustainable thinking has become a required ability for designers. Designers should have responsibilities for eliminating negative environmental impacts and create meaningful innovations to improve users’ behaviors and thinking.

Today’s global waste management has been considered as the most significant challenge for sustainable development. Based on the bachelor study at Linnaeus University, the author Junjie Gu explores the relationship between furniture design and waste management in Sweden through research and analysis. Besides, a new sustainable furniture idea is presented to support the theory. This thesis contributes to address a future sustainable design standard to the public.

1.1 Background

According United States Environmental Protection Agency report (U.S.EPA, 2010), furniture waste has increased from 2.2 million tons in 1960 to 9.9 million tons in 2009. Furniture waste accounts for 4.1% of Municipal Solid Waste (MSW) and it is the least-recycled product under the category of household durable products.

On the contrary, Swedish citizens are willing to pay for furniture. As the consequence,
approximately 23 billion SEK is spent to furniture production in Sweden. The large quantity of furniture products directly effects on the environmental issues. According to Office Republic (2017)

Production of office furniture in Sweden is estimated to impact the environment through generation of over 150,000 tones of CO2 equivalent each year (Office Republic, 2017)

Under these circumstances, it is noticed that the huge demand of mass-production of furniture products lead to waste issues. The large amount of furniture waste has negative impacts on environment due to customers’ overconsumption behaviors. In order to solve this problem, designers and companies should offer an advanced recycling solution and raise the public awareness of sustainability.

In nowadays society, several global organizations and governments have taken actions for sustainability development. Sweden’s ruling Social Democrat and Green party coalition promoted repairing services to the public by reducing the VAT rate on repaired products from 25% to 12%. (Richard, 2016) Because of the government’s intervention, this tax revolution may extend products lifecycle in foreseeable future. However, the lack of labor force in Swedish society will still be the main obstacle.

According to Directive 2008/98/EC, the European Union parliament introduced the
‘waste hierarchy’ model to waste legislation in 2008. (European Communities, 2008)

Waste hierarchy demonstrates that sustainable waste management should aim at waste reuse and prevention, meanwhile decrease the dispose. It directly effects on the companies by laws, but is still rarely known by public.

Both actions above are meaningful attempts and it needs to be improved in a long process.

1.2 Object and proposal

As the change agent, the author realized the furniture waste problem contains two aspects: In tangible aspects, furniture designers should consider about the repairing and recycling possibilities through products’ materials and functions. Thus, a long-lasting and recyclable table design idea will be presented to readers. In intangible scale, the combination of environmental sustainability and social sustainability is highly complex. This thesis emphasizes that furniture should increasing public awareness of waste management and correct the customer behaviors with a metadesign thinking.

Therefore, the research question comes out: **In order to raise public awareness of sustainability, how to design a furniture product with metadesign thinking?**
1.3 Collaboration

Figure 1. Potentials in Aterbruksbyn project

The practical furniture design part is based on a local project — Aterbruksbyn Project (Macken n.d.) in Vaxjo, Sweden. Aterbruksbyn project is aimed to expand the current recycle station, Norremark, to a circular recycling center. According to the interview with Anders Lundgren, the project leader of Aterbruksbyn project on 9 March, 2018, the new station will collect a part of waste material and provide recycling workshops for the public. There will also be flea market to sell the workshop results.

Relating Aterbruksbyn project to this thesis project, the author aims to turning the large number of waste materials into furniture products. Inspired by the recycling workshop idea, the new furniture design should encourage customers to participate in
the recycling process.

2. Theoretical framework: design with sustainable thinking

Sustainability is highly emphasized in this design project. Aaris Sherin argues that sustainability is defined ‘as the balanced use of social, environmental and economic capital, so as not to compromise the ability of future generations to survive and thrive.’ (Sherin, 2013, p12) Sustainability development is a unified goal for all the modern disciplines. In modern design field, sustainable thinking has become a required ability for designers.

At the early stage of sustainable design history, sustainable design only focused on reducing harmful environmental impacts (McLennan, 2004). Later, the definition of sustainability expanded to taking social, environmental and economic aspects into considerations.
The diagram above shows that the definition of sustainable design has been self-enriched from the past. This diagram is a summarization of Sanders and Pieter’s (2014) discussion on three stages of design timeline. It can be understood as a continuous upgrading process. Each breakthrough is based on the foundation of previous achievements. By adding more angles, sustainability design becomes more comprehensive and systemic. Thus, interdisciplinary knowledge is required for a complete sustainable design team to deal with the high complexity of sustainability. Since this thesis project is an individual work, the author selects the most essential aspects to readers, which are waste hierarchy, product design and metadesign. The final table design is open for advices from other disciplines experts.

2.1 Waste hierarchy
As mentioned in the Background Chapter, Waste hierarchy is a current guide for global waste management. This triangle model ranks 5 stages of waste management: Prevention, Reuse, recycle, Energy recovery and Dispose. According to waste hierarchy, the development of sustainable waste treatment is a long-term improving process. In a sustainable future scenario, disposal waste will be minimized. The ultimate goal is highly addressing public awareness of sustainability, eliminating the waste issue by waste prevention.

From Swedish environmental protection agency (2005), there was a dramatic decline of Swedish household waste dispose amount, from 1,380,000 tons in 1994 to 380,000 tons in 2004. This data indicates that Swedish society has managed to control the least-sustainable waste treatment. As a developed Nordic country, Sweden is also well known of its energy recovery. For example, Vaxjo city collects food waste to produce biogas for public tranportation. Moving forward, as 2010 Shanghai Wolrd Exposition
Executive Community has addressed,

Cities are at the nexus of a further threat to the environment, namely the production of an increasing quantity and complexity of wastes. (Modak et al., 2011, Chapter 5, p1)

It means, in order to achieve the long-term sustainability, waste management should focus on turning waste into resources in current stage. In global scale, reuse-center has become the latest trend in waste. One famous example is that Kringloop Re-use Centres succeeded in extending products lifecycle from waste. In 2008, Kringloop Re-use Centers managed to collect 50,000 tons of discarded items from waste and extend their lifecycle by repairing and reselling (European Commission, 2010) In Sweden, there are several similar organization, for example Re-turen in Malmo city. The majority of reuse items are products in good condition, for example, discarded garments and kitchenware. However, damaged furniture and electronics products are considered as unrecyclable waste, which is not widely involved in the recycling process. In the following text, the reason behind this phenomenon will be further discussed in product design subchapter. To fully accomplish the waste recycle and reuse goal, it is important to point out that the definition of valuable waste resources needs be widened.

2.2 Sustainable product design
As a traditional design discipline, problem-solving thinking is often considered as the most representative feature. This solution thinking emphasizes on efficiency and end results but excludes things continued after that. (Stefan & Takahiro, 2000) In a word, traditional product design can be understood as linear thinking.

As common knowledge, linear thinking has been widely applied to mass-produced products for quick production process and lower cost. This is because of that Linear thinking focuses on basic functions and practical results. However, if designers only have linear thinking, the final products will be inflexible and hard to recycle. Taking waste furniture as example, disassembly operations in products’ maintenance depend on various situations. Different raw materials, products’ structures and manufacturing technologies must seek different treatments.

Moving forward, Circular thinking assists designers to overcome the recycling challenge. Circular thinking can shift the product design from temporary usage to durable lifecycle. From the diagram below, circular design thinking has the potentials of connecting product waste to a secondary usage.

For instance, Hemmlis is a Swedish company, which applied circular thinking in its business. It collects waste furniture from second store and private donation, then repaints or re-polishes the waste furniture collection for a second selling. (Hemmlis,, n.d.)
Hence, sustainable designers should combine linear product thinking and circular thinking together, considering functions as well as reusability. In the following subchapters, modularity, ready-to-assemble furniture (RTA) and customization theories are explained. These elements will apply to the practical design outcome later in the thesis.

2.2.1 Modularity

Modularity has several advantages. As Steven Bradley (2013) puts it:

- Separation of concerns allowing different aspects of design to be worked on and improved independently of each other
- Reuse of independently created components from general pattern libraries
- Efficiency in being able to combine pre-existing components
- Development of a consistent design vocabulary through the constraints of project style guides and self-imposed design palettes across a career (Steven Bradley, 2013)

Modularity is a solution for sustainable table design. Modular furniture has standardized interfaces, which allow components to be changed. (Benedikt & Dick, 2005) Instead of abandoning the overall product, customers and companies can
replace one part of product. Thus, modularity reveals a way of circular thinking. Damaged components are simple to disassembled and repaired through repairing services. As a consequence, product lifecycle can be extended. For furniture companies, material consumption is highly responds to the market demands. The implement of modularity will make products long lasting so that companies could focus on developing various alternative components for the markets. The material consumption in modular design production is more efficient than the non-module design manufacturing.

### 2.2.2 Ready-to-assemble furniture (RTA)

Ready-to-assemble (RTA) furniture is also known as Knock-down furniture. (‘Ready-to-assemble furniture’, 2018) RTA furniture includes separate components and assembly guide in small volume packaging. Customers are required to assembly RTA furniture by themselves. One advantage of RTA is saving the production cost by skipping the assembling step in manufacturing process. Another advantage of RTA furniture is its material saving. In many cases, RTA components are designed to be ‘flat’ in order to fit in the tiny packaging. Each component is produced by minimal amount of material to save the space.

What’s more, the assembly guide from RTA can teach unskilled users the basic knowledge of furniture assembling. This pedagogical aspect also enables customers to
understand the structure of RTA furniture they owned. When RTA furniture is damaged, customers can disassemble the broken component easily. Users can either replace the broken component with a new part or send it to repairing service.

Besides all the advantages, RTA has its own weakness that should be well considered in the sustainable furniture design process. As common knowledge, RTA is commonly built by Plywood instead of Solid Wood. On one side, lightweight is the advantage of RTA. On the other side, RTA is hard to recycle because of the material limitation. Plywood is a recycled material that glues veneer wood with adjacent layers, which is compressed and impossible to separate. (‘Plywood’, 2018) Therefore, it is significant to find alternative material for RTA Design

2.2.3 Customization

Nowadays, there is a popular trend of customization in product design field. On the one hand, customers don’t like purchasing mass-produced given-type products in markets any longer. (Piller FT, 2009) This is because that individuals want to escape from the ‘uniformity’ of modern society. (Benedikt, D. 2005). In furniture design field, mass-production furniture has many similarities in colors, shapes and material. Moving forwards, furniture designers should not only focus on the functions, but also design for customization.
Pentti Routio (2007) described that furniture as a ‘second skin’ of individuals is closely related to personal performance and identities. Therefore, by offering customizable furniture to customers, designers should allow users to express their creativities. Customizable furniture provides users opportunities to improve the product based on individual identities due to the fact that nobody knows one individual better than himself. After customizing the furniture, users will have stronger sense of ownership to the furniture. This sense of ownership makes users pay more attention to product maintenance.

### 2.3 Metadesign

Following the tangible product design part, metadesign theory is discussed in this thesis. Metadesign focuses on a collaborative design process rather than over-emphasize on design solution. Unlike the traditional product design, Gerhard Fischer and Eric Scharff (2000) argue that metadesign is ‘out of the box’. This means the end result of metadesign project is intangible and inspiring. Instead of announcing a particular solution, metadesign project allows users to participate in a co-design process by acting as a designer. In this case, participators ideas are collected and shared for future innovations. Therefore, metadesign is also described as a ‘seeding’ process (Giaccardi, 2005)

Metadesign is a great approach to sustainable design. As mentioned in the previous
chapter, sustainability requires interdisciplinary knowledge. This knowledge could be absorbed from participators’ ideas in different perspectives. Meanwhile, metadesign can raise the participators’ awareness of a neglected topic, for example, sustainability.

Metadesign is a slow changing process. Although Metadesign shows its pioneer thinking on conceptual level, it does not make a visible change immediately. Since metadesign is open-ended and intangible, it is also challenging to evaluate the result. Moving forward, metadesign elements should be applied into tangible design, in order to make changes more efficiently and correctly.

3. Methodology and design process

In this chapter, the author lists all the important methods used in the project and discusses about the reason of selecting these methods. The practical implement of these methods is discussed following the project timeline.

3.1 Survey

![Modular repairable table](https://docs.google.com/forms/d/13Do2C32lNKDH8-g9AwkyLsRRRlhXqy2y2h5yQaN3pOc/printform)

Figure 4. a survey to visitors at Norremark.
As a research method, survey can help designers to collect self-reported information from design targets. (Martin & Hanington, 2012) The author selects closed-forced choices for efficiency.

At the early stage of design process, the author made a survey to visitors at Norremark recycling center. This survey was made to estimate the visitors’ knowledge of furniture recycling. From 26 responses, the majority of visitors at Norremark are from 40 to 80 years old. This unbalanced generation structure indicates that younger generation lacks the awareness of waste recycling nowadays. Besides, price, material and durability are the main consideration when purchasing a new furniture.

Based on the survey, the author was thinking of designing an affordable long-lasting table by waste material.

### 3.2 Observation

In order to understand the waste recycling situations, the author visited Norremark recycling center in Vaxjo and ReTuren organization in Malmo.

From the observation at Norremark center, it is noticed that a lot of furniture with slight damage is often considered as waste. Figure 5 shows a discarded solid wood
table cabinet with leg damage. In fact, this cabinet could be repaired to extend its usage. From this example, furniture designers should apply circular thinking to their products, making the product easy to disassemble and repairable. At the same time, it is noticed that veneer waste occupies a huge amount of total waste in Norremark recycling center. Therefore, the author tended to take veneer waste as the material of table design.

Figure 5. Observation in Norremark, Vaxjo

Later, the author visited ReTuren organization, which holds recycling workshops to the public. From the observation, recycling workshops often ends with a ‘down cycling’ of materials. (McDonough & Braungart, 2002) The recycling workshop result might even lower the value of raw material. Therefore, recycling workshop should be properly guided to up-cycling.

Figure 6. Observation in ReTuren, Malmo
3.3 Fly-on-the-wall observation

Unlike the original observation method, Fly-on-the-wall observation requires the observer to avoid interference with targets. (Martin & Hanington, 2012) In Norremark center, this method is used for understanding the visitors’ behaviors. From the observation, some visitors are confused of waste sorting because that a lot of product waste is consist of several materials. Therefore, a sustainable table design should use raw material and able to be disassembled for waste sorting.

3.4 Interview

Interview is a research method for collecting personal opinions and experience. (Martin & Hanington, 2012) The author did an interview with Norremark staff on 9, January. From the interview, although vaxjo is known as the greenest city in Europe, the recycling service is far behind others. Two recycle organizations in Norremark, such as Human Bridge and Tempus, avoid repairing sections in their business due to the high expense and lack of labor sources. From the public donation, they only select products that are still in good condition for reselling. Hence, reparability is an indispensable feature for sustainable furniture design. Customers should be encouraged to participate in the repairing process.
3.5 Competitive testing

In order to generate ideas, competitive testing method is used to absorb knowledge from the existing products. (McDonough & Braungart, 2002) Figure 7 and 8 are two example of customization and modularity in modern furniture design.

From Omkompositioner project (Nordberg, 2014), Jenny Nordberg collected waste materials and crafted them to a new product. The variety of color combinations makes the same product look different. Inspired by this project, the author decided to not provide a given-type product to customers, but let users express their creativity through customization. In this case, the table design can be seemed as a meta-design seed for change.

![Figure 7. Omkompositioner by Jenny Nordberg, 2014](image)

Another project is called BOB. (Bernstrand & Borselius, 2017) The modular sofa system allows the furniture to be either separated or extended. Influenced by this
project, the author tended to add modular feature to his table design and make the table components replaceable.

Figure 8. BOB furniture by BLa Station, 2017

3.6 Image board

Research and inspiration

Figure 9. Image board
Based on a large quantity of product research, the author collected valuable design elements and made this image board as his inspiration. It includes RTA structures, dovetail joints, and epoxy resin.

### 3.7 Concept mapping

![Concept mapping](image)

Figure 10. Concept mapping

Concept mapping is a visualization of concept development. At this stage, modularity, RTA and customization are summarized as the three main focuses in tangible scale. Besides, the implement of open-ended metadesign thinking can enhance the project to an intangible scale.

### 3.8 Iterative design

Iterative design is a self-developing design process. In this project, three iteration stages are made to develop the table design. In the first stage, the author focused on
the durability. Replaceable top surface and dovetail joints were created. In the second stage, modular layers and wooden drawer slide were added. On the third stage, the material of table was selected and RTA feature was presented.

**Figure 11. 3-step Iteration**

### 3.9 Prototyping
After the iteration stage, the author started building the scale table model. There are two important concepts in the table design. One is the ready-to-assemble furniture (RTA) concept. In order to present this part, the author did challenge himself to make small cuts in 1:10 scale. Finally, the model managed to present this RTA concept by showing dovetail joints on the table legs. However, the author skipped some parts of the design, for example, wooden drawer slide. This is mainly because of the scale limitation and lack of precision tools. The modeling skills should be improved in the future.
The other concept is river table concept. The idea behind is taking advantage of veneer waste and epoxy resin to produce modular layers for the table design. In the modeling process, the author used the crystal resin and wood waste to create similar effects. By changing the color of resin and placing the veneer waste differently, users can customize this modular layer in reality.

As mentioned before, users should be encouraged to participate in the furniture production process and assembling the final product by themselves. Based on modeling experience, a 3d product animation can be used as the assembly guide. The author made a 3d model in Rhinoceros and rendered it in Keyshot. Last but not least, it is animated to present the expandable function as well as product exploded view.

Figure 14. 3D modeling and animation rendering
4. Result

Figure 15. Project display in exhibition

Figure 16. Instruction of table structure
This table design is named as WasteLess. On one hand, the table consumes waste materials for its production. On the other hand, the author hopes the customers could raise awareness of waste management and cultivate a less-wasted living behaviors.

A replaceable top surface is designed in WasteLess. It could extend the product lifecycle effectively. The frame part involves RTA feature and dovetail joints, which means users can easily assemble it without glue. When the frame is broken, users can disassemble the broken component and deliver it to repair services. The modular decoration layer is a highlight of the design. It’s slide-able to expand and easily replaceable. The multi-layer structure in WasteLess table design can realize maintenance through simple replacement. More importantly, each layer is a mixture of veneer waste and transparent resin cast, which has unique textures and is made from waste resources. Customers are encouraged to participate in the production of modular waste and they can customize the layers based on their own preference. In the future, these modular layers can be shared and exchanged in a circular system.

5. Analysis

This design project is based on the trend of sustainable furniture as well as the rapid expansion of recycling culture. The author tried to find a solution through proposing a modular durable furniture design combined with metadesign thinking. The content of the project is a table design that combines modular, ready-to-assemble (RTA) and
customized.

Firstly, it’s addressed that sustainable furniture should use raw materials. Currently, many existing products are built with veneer and plywood materials. Unlike these two materials, the untreated material can be easily disassembled or recycled. Secondly, the repairable feature can extend the product lifecycle. What’s more, WasteLess furniture can actively prevent down cycling issue. Last but not least, ready to assemble product consumes less material and could be disassembled. The product is supported by a circular sharing service to keep itself updated.

As the change agent, the most interesting part from the process is idea shifting. This presents a dynamic research process from tangible level to intangible scale. Finally, it planted a seed for change. At this stage, the modular furniture focuses on not only the furniture appearance, recycling materials, functions and environment impacts, but also giving users opportunity to participate in the production process. The customization feature allows users to express their own idea. The main contribution from this thesis is to combine tangible product design with intangible metadesign thinking. During the design process, it is realized that this projects is interdisciplinary. As a designer with product design background, the graphic and service design part is challenging. In order to make sustainable change, it’s necessary to work in a team with different background people. However, working on complex overlapping problems, designers should narrow themselves down first.
Here the author made the Parson Thesis Matrix above to explain the future potentials of this project. At the first stage, the project should focus on the tangible production of WasteLess. Later on the second stage, it should emphasize the importance of repair service and customization workshops. Finally, the combination of tangible and intangible aspects will expand the project from local scale to a larger scale.

Sustainable design is a huge challenge. In reality, according to the regulations in recycling center. The first thing to deal with is whether individuals can collect the waste material or not. This is a social debate and it needs to negotiate through the local and government.

It is also important to address the future designer’s responsibility. Design has become
more comprehensive and interdisciplinary than before. Designers should take consideration of both metadesign and product design. In this situation, a public recycling workshop or a given-type product can’t make a long-term change. Instead, an open-ended product that involves people in its production, repairing and sharing process, is the future sustainable design needs. Moving forward, raising the question to the public and give them a design suggestion rather than solution, and let people to prototype, test and improve, is more objective as well as effective.

6. Conclusion

Sustainability change is highly complex. There are many aspects are included in this environmental issues. Although the design research have been done, this WasteLess furniture only shows one prototype to intervened in this complex environmental issue. As individual design project, here are still many aspects haven’t reached yet. In the current stage, WasteLess still need to face the same question as all the other products. For instance, which target group will purchase this product in order to make it continue being produced? What if the budget is too high to afford and lead the project collapse in the marketing? Therefore, for the next step of the project, the detailed budget and the research about the materials should be further explained. In the foreseeable future, the author hopes that Aterbruksbyn project will create a platform for prototyping this thesis project. And the author hopes reader can expresses their own ideas based on the original idea.
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