Re-Envisioning Material Circulation and Designing Process in Upcycling Design Product Life Cycle

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Abstract

Background Recently, upcycling design arose as an alternative solution to the problem of waste management and sustainable consumption. Upcycling design is also recognized as an environmental awareness movement, expanded from individuals to the state level. Nevertheless, from the aspect of material circulation that aspires to follow cradle-to-cradle design, upcycling design lacks discussions about the next phase of upcycled products.

Methods This study re-envisioned the relationship between upcycled materials and upcycling design product life cycle by ephemeral research. The relations of raw materials, upcycled materials, and circulation system of upcycling product life cycle, were the points of analysis. Based on a literature review, this study utilized design thinking methodology by combining action research methodology –user survey and designers' focus interviews- to examine how the material value works in the upcycling design product system and designing process.

Results Through case analysis, this study identified the value of material life experience in an upcycling design process. As a result, this study developed a sustainable 'Iterative Upcycling Design Process Model' as a conceptual model of continuous material life cycle in the upcycling product designing system.

Conclusions Raising the issue of second life cycle of upcycled product, this study examined the material life experience in the upcycling design process in Korea. A legitimate design process concerned with material life cycle proposed by this study would reach a resolution of sustainable upcycling design.

Keywords Upcycling Design, Material Life Experience, Product Life Cycle

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1. Introduction

1. 1. Background

The product life cycle - from raw materials, design, production, utilization by consumers, and to the stage of waste- is to be circulated as it reaches the beginning phase of upcycling product life cycle. That is to say, material, product and recyclability are crucial to one another. It is expanded so because the product value system applied in the design stage of upcycling product design is different from that of the mass production system.

For the circulation of upcycling product life cycle, based on Cradle to Cradle (2002), to be sustainable, there is a need to discuss the afterlife of the current first generation upcycling products. However, such discussion is yet to be engaged. Hence this study reviews the 'upcycling design process' of designing and producing contemporary upcycling products from a critical point of view.

1. 2. Aim and Objectives

The hypothesis of this study raises the need to re-envision the upcycled materials and upcycling design process within products life cycle. The relationship of raw materials, upcycled materials, and circulation system of upcycling products life cycle were researched and analyzed. In order to closely examine the role and value of the materials in the circulation system, user survey and designers' focus interviews were conducted to extract the fundamental elements in constructing the final model.

Thus the aim of this study is to propose material reutilization from the perspective of resource circulation, which fails to be observed in the process of current upcycling product design, and develop a model of systemic approach that enables 2nd generation upcycling designing process and beyond.

The research objectives are: 1) to study the currently existing theories and opinions focusing on the aspect of resource circulation and product life cycle focusing on upcycling design; 2) to conduct survey to attain understanding of materials used in upcycling products design from user side in Korea; 3) to conduct interview of a designer focus group in Korea (20 studios of designer-in-residence at the Seoul Upcycling Plaza, world's first upcycling design residency); 4) to analyze the features of material life experience and methods of assembly in the current upcycling design process; 5) to develop strategic models for sustainable material life cycle in upcycling product designing process.

This study anticipates making contributions of providing a strategic direction for the sustainable development of upcycling design by addressing the material value in upcycling product life cycle.

2. Literature Review

2. 1. Rise of Upcycling Design

The concern for waste caused by prevalent consumption culture expanded design activities to the environmental reorientation of production and consumption systems as well as social innovation (Meroni and Sangiorgi, 2016) – leading to the rise of 'upcyling' design. Over-using natural resources and overwhelming artificial materials have caused environmental issues such as greenhouse effects and pollution. The culture of transience, newness and perceived obsolescence led to over-consumption and high volume of waste (Han, Tyler and Apeagyei, 2015). The life cycle from raw materials to consumer's disposal is rapid and finite. Pauli (2011) noted that the world market for waste and recycling had reached the worth of 450 billion dollars in 2010. Nonetheless, the market for reusing those materials takes up 0.01% of the overall market (Nam, 2011). Attitudes and perspective on consumption have shifted over the years as the issue of waste came to light.

The pioneering ideas are like the following: Pilz (1994) considered upcycling as keeping the original form of product and adding more value; Braungart and McDonough (2002) saw it as the process of renewing or upgrading product material value in their second life cycle and beyond, creating cradle-to-cradle circulation. Other various definitions stem from the above, with their points on discovering new usefulness in wasted materials (Dervojeda, Verzijl et al. 2014; Fletcher and Grose 2012; Janigo and Wu 2015). Szaky (2014) stated, however, the practice of what is now called upcycling was common before the Industrial Revolution and are currently common in developing countries due to limited resources. 'The developing world recycles informally and broadly practices reuse. [Such] recycling is an economic necessity with the additional benefit of reducing the load on landfills by 75 to 95 percent and providing some form of livelihood' (Pauli, 2011, p.1) Hence the concept and practice of upcycling is a matter to mark in post-Industrial countries today.

2. 2. Current Status of Upcycling in Korea

Upcycling design is currently on the rise in Korea. According to The Seoul Institute (2015), 25 percent of the active designers are involved in upcycling design, mostly limited to fashion articles. While some designer groups and corporations such as Kolon FnC initiated upcycling design in the fashion industry since the beginning of the 2000s, the concept became popular by 2013. And although the number of domestic upcycling brands now reaches three-digit, the production of upcycling design takes place at individual studios or one-man factories, which restricts to the realms of low-volume, open-source, DIY design and manufacture (Richardson, 2011) and limited use of materials.

Opened to the public in 2017, the Seoul Upcycling Plaza has become the platform for upcycling design to develop, connecting designers and materials, products made of recycled materials and consumers with environmental awareness, and advocating the idea and practice of upcycling design to the general public (The Seoul Institute, 2015). Korea has a high percentage of recycling waste (Pauli, 2011), yet domestic practice and research in upcycling are still in need of advancement.

While Upcycling, in theory, would be more effective in addressing negative environmental impacts in a bigger scale (Sung, Cooper and Kettley, 2016), current upcycling in practice is controversial. “Ahypothetical ‘perfectly circular’ product, cycles the same amount of resources indefinitely in order to keep fulfilling its function. In practice however, indefinite cycling of resources is impossible due to material degradation mechanisms or the imperfect nature of material separation and reclamation during recycling. At a product’s end-of-life, its materials are usually of diminished quality and restoration of original material properties is often infeasible” (Haanstra, Toxopeus and Van Gerrevink, 2017). Jung and Kim (2014) restate the contention of McDonough and Braungart (2013) and stress the need for materials to keep their original features in upcycling design process, emphasizing the process of disassembly of products to regress to materials. In the end, it is technology, product, and material recyclability that form the core of upcycling industry to maintain its ecosystem (Korean Ministry of Environment, 2014; Ahn, 2018).

2. 3. Material Value in Upcycling Design Process

Upcycling design is challenged to work within the parameter of prescribed materials to create products. Such has the benefit of assisting material circulation and reduction of waste currently available. Putting its emphasis on sustainable waste management, production and consumption, upcycling process is thought to be more beneficial in the aspect that it requires little energy input and less virgin materials (Sung, 2015). As upcycling design process begins from reassessing waste, adding functionality and aesthetic to the recycled materials, conceptual design becomes the most important phase of design, determining 70 percent of the production cost (Hundal, 2000; Cao and Folan, 2012). In concept generation phase, designers design production and usability in relation to the materials specificity. Hence material effectiveness in upcycling design process is to select non-toxic and ethical material sources, which is feasible with information on material characteristics. When the selection process happens with care, the value of material can be reassessed.

Creating design product out of materials that otherwise would be thrown away raises awareness of responsible material management and usage. Despite the collection and recycling of sorted waste, ‘there are still large amounts of waste material that could have been recycled or re-manufactured but currently gets incinerated or landfilled’ (Ordonez, Khan, Tandon and Rexfelt, 2016). And in order to locate and prevent the target material from being contaminated by other materials (Hamakawa et al., 2017), such perception needs to be expanded to the thorough management of the recycling process. Mahler and Aurik (2010) maintained that considering the life cycle of a product and its materials increases awareness of the implications of every decision and interactions made in the design process. Investigating from a macro view of the production business, from product conception, through design, production, sale, customer use, to decommissioning, Cao and Folan (2012) saw material life cycle as the extension of product life cycle. Distinguishing and separating technical and biological materials in products to keep them at the utmost value at all times becomes possible through effective design and use of materials (Haanstra, Toxopeus and Van Gerrevink, 2017). Thus one also needs to consider upcycling post-consumer waste as to upcycling pre-consumer waste. Upcycling pre-consumer waste, such as fabric leftovers at the

production stage are reused, helps to improve waste management as well as to have direct control over the quality of materials. (British Fashion Council, 2011)

2. 4. Upcycling Product Life Cycle: 2nd Generation and Beyond

As upcycling reconnects people with materials and enables future lives of objects (Bridgens et al., 2018), it is crucial to consider how upcycling of products and materials extends the lifespan and enables multiple life cycles. Gray and Charter (2007) convey that design for multiple circulations involves consideration of cleaning, as well as reliability, durability and remediation of product. Evaluation and revaluation of materials and components lead to such consideration for the paths the products can take at the end of their relationships with consumers. Richardson (2011) points out the limitations of post-production and 'down-stream' upcycling. Upcycling needs to be "developed into a more sophisticated and reliable system, [which enables] to produce ... refined products that can in turn be disassembled and subsequently reused in continuing cycles. Upcycling to date has not effectively achieved this – in most cases it does not consider products beyond their second iterative use" (ibid, p.10).

In order for the design for iterative reuse to become an integral part of upcycling design process, there needs to be a fundamental alteration in the system of design and manufacture, materiality and construction, component and material reuse. This is to readdress how upcycling products are assembled. In other words, design for disassembly determines the future capacity of reuse (Crowther, 2015). Design for recycling and design for disassembly are closely associated, as a product is composed of different materials that need to be disassembled without damage before the phase of recycling (Bakker et al., 2010). Design for disassembly enables a circular approach, increasing the effectiveness of a product before, during and after the life of a product (Pervez, 2017). By embracing such end-of-life value chain, materials of consumption unlink and return to their original states, and the life cycle of upcycling product brings forth the potential of continuing the cycles of subsequent functionalities and values. And as this makes the materials become a part of either the biological or technological cycle, the cradle-to-cradle concept, the loop of life cycles can go one step closer to becoming reality, leading to the second generation of upcycling product and beyond.

3. Analysis

3. 1. Analysis Framework

Alongside literature and case study, this study conducted a survey and focus group interviews in order to consider both user and designer sides. This study provided 18 questionnaires regarding familiarity with upcycling, difficulties faced in the process of recycling and such to 200 general users in Korea from the age group from teens to over 50s to answer; conducted focus interviews with 20 studios of designer-in-residence at the Seoul Upcycling Plaza to examine the role and value of materials in circulation system.

3. 2. Awareness on Upcycling in Korea: Current Afterlife of Products

Upcycling happens through new combinations of situational needs, skills and resources, resulting in ecologically benign uniqueness. While it can be achieved in both macro and micro-scale, the usage of pre-consumer materials allows the bigger-scale upcycling practice, whereas post-consumer materials would be upcycled through individual practice. Obtaining information about the pre-consumer industrial leftovers enables straightforward analysis and achievement of design solution. Post-consumer materials, however, require property investigation into individual articles and complicate suitable material collection.

An online survey was undertaken to examine the overview of awareness on upcycling and recyclability of products from user aspect as well as the current after-life of products in Korea.

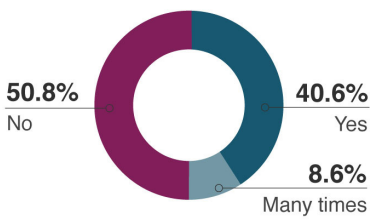


Figure 1 Experience with Upcycling Product (Answer:200)

Total of 200 people responded, with a varied age range from teens to over 50s. Figure 1 displays that while 66% of the respondents heard of the word 'upcycling', 50% have used upcycling products.

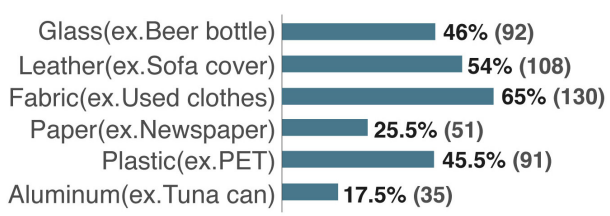


Figure 2 Suitable Material for Upcycling Product (Multiple choice) (Answer:200)

The survey on materials thought to be suitable for upcycling products (Figure 2) indicated how the general public thinks of recyclable materials. Identified by the categories suggested by recycling center, 65% of the respondents thought fabric was the best material candidate for upcycling, followed by leather (54%), glass (46%) and plastic (45.5%). 25.5% answered paper and 17.5% said aluminum are suitable materials for upcycling product.

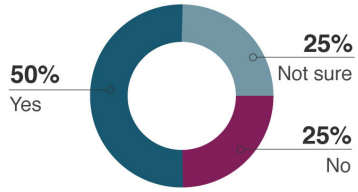


Figure 3 Difficulties in Everyday Recycling (Answer:200)

Almost half of 200 respondents said to have experienced difficulties with recycling in daily life (Figure 3). While 25% said they have no difficulties in categorizing waste for recycling, the same number of people (25%) were not sure, confused about their experience with daily recycling. For the question of how upcycling products that finished its life cycle should be treated (Figure 4), over 80% of all respondents thought the used-up upcycling product should be recycled (58%) or upcycled again (25%).

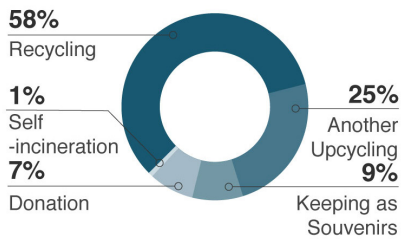


Figure 4 Treatment with Used-up Upcycling Product (Answer:200)

The above survey outcomes indicated that the idea of upcycling is becoming public; yet, from the perspective of user experience of recycling process, everyday recycling still faces difficulties, and the afterlife and treatment of post-consumer products, including upcycling products, remains controversial.

3. 3. Approach to Upcycling in Korea: Current Design Process

Opened in September 2017, Seoul Upcycling Plaza (SUP) is a platform for upcycling education and upcycling design studios and shops. 30 designers and designer groups were selected by the Seoul Institute to move in and work as mediators between upcycling movement and the public.

Among them, 25 studios generate products in the categories of product with upcycling materials, product for upcycling, upcycling education product, upcycling art and non-upcycling product. The categories were identified throughout this study from an analytical point of view. Studios that emphasize the non-product aspect of upcycling or other vendors that did not display the making process of upcycling design products at SUP, such as Terra Cycle and Eco Party Mearry, were excluded from this study. The 20 design studios which openly display their upcycling methods were selected for interview in order to examine their making processes, from locating and processing materials, making products and marketing them to treating leftover materials (Table 1).

Table 1 Products and Designing process of SUP Upcycling Design Studios (1 to 10)

SUP	Type	Name of Studio	Commercial (Y/N)	Image (product)	image (assembly joints)	Main Product(s)	Source of material(s)	Method of assembly	Additional processing outside of studio(Y/N)	Residual materials (Y/N)
1	Product with upcycling material	2ndB(407) Designer : JEONG Jieun	Y			Accessories / Interior props	*Bicycle parts	Screw,Adhere, Sew,Weld,Insert	Y	Y (rare)
2	Product with upcycling material	CUECLYP(405) Designer : LEE Yunho	Y			Wallet / Bag / Pouch	*Umbrella	Adherem,Sew	N	Y
3	Product with upcycling material	EASTINDIGO(313) Designer : JANG Seulah, HAM Minkyu	Y			Fashion Accessories	*Jeans *Recycled fabrics *Natural indigo dyed fabric	Sew	Y	Y
4	Product with upcycling material	Echostone Korea(321) Designer : HAN Kiwoong	Y			Fence / Public bench	*Stone *Wood *Plastic	Adhere	Y	N
5	Product with upcycling material	Fire markers(409) Designer : LEE Kyudong	Y			Bag / Wallet	*Fire hose	Screw,Adhere, Sew	N	Y
6	Product with upcycling material	Fragile(312) Designer : LEE Jeongseok	Y			Tableware	*Ceramics	Adhere	N	N
7	Product with upcycling material	merrywood(404) Designer : KIM Yeongae	Y			Wood workshop / interior ornaments	*Hard wood *Wooden pallet *Cork	Screw	N	Y
8	Product with upcycling material	Milky Project(302) Designer : KIM Sumin	Y			Wallet	*Milk carton	Screw,Adhere	Y	Y
9	Product with upcycling material	OWN U(406) Designer : AHN Jihye	Y			Bag / Wallet / Key chain / DIY Kit	*Leftover fabric *Fashion brands' residual fabric	Screw,Sew, Insesrt	Y	Y
10	Product with upcycling material	RECTOVERSO(311) Designer : CHO Hyoeun	Y			Book Repairs & Conservation	*Old books *Papers *Leather *Fabric	Adhere,Sew, Tie	N	Y

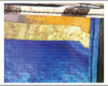
11	Product with upcycling material	saeum(408) Designer : CHOI Seongnam	Y			Wooden furniture/ ornaments	*Woods	**Screw,Adhere, Sew,Weld,Insert**	Y	Y
12	Product with upcycling material	ShareLight(309) Designer : PARK Eunhyoen	Y			Light	*LED Chip *Can *Candle	**Insert**	Y	N
13	Product with upcycling material	Touch4Good(322) Designer : PARK In Hee	Y			Bag/Blanket	*Banner *PET	**Adhere,Sew,Tie**	Y	Y
14	Product with upcycling material	UPCYCLIST(305) Designer : Nukak	Y			Bag/Wallet	*Tire *Safety belt *Wooden pallet *Banner	**Sew**	Y	Y
15	Product with upcycling material	yeomigallery(320) Designer : CHO Sunhee	Y			Stuffed animal	*Socks *Button *Ribbon *Fabric	**Sew**	N	Y (rare)
16	Product with upcycling material	Zenny Closet(401) Designer : LEE Zenny	Y			Fashion accessories	*Jeans	**Sew**	Y	Y
17	Product for upcycling	BPABLE(306) Designer : LEE Jaeho	Y			Toy blocks	*Plastic bottles *Plastic cups	**Insert**	Y	N
18	Upcycling education Product	Play31(402) Designer : UM Hyojung	Y			Children activity tools	*Defected medical equipment *Fabric *Lincture *Stale food	**Adhere**	Y	Y
19	Upcycling art	You Do Young(318) Designer : You Do Young	Y			Sculpture/ Installation	*Electronics *Wood *Paper *Plastic	**Screw,Adhere, Tie,Sew,Weld, Insesrt**	Y	Y
20	Non-upcycling Product	I.D Studio(317) Designer : LEE Kyungrim	Y			Artwork	*Furniture *Metal *Wood *Plastic	**Adhere,Tie**	N	Y

Table 1 Products and Designing process of SUP Upcycling Design Studios (Continued _ 11 to 20)

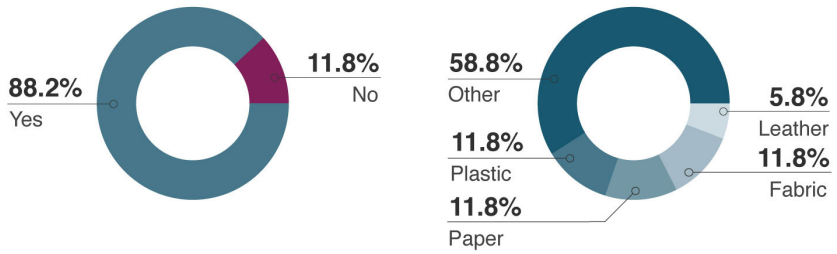


Figure 5 Designer Focus Interview on Materials in Upcycling Products (Answer: 20)

The highlighted column in Table 1 identifies the assembly methods utilized by each studio to construct from different materials in their upcycling design process. Details focused on materiality and assembly methods from the table are further expanded through focus interview with the designers. Figure 5 indicates where and how upcycling designers attain their materials and what they are. Among 20 studios, close to 90% recycled already used materials as main materials for products, the rest utilized unused, raw materials that appeared as industrial leftovers in the process of mass production at factories. 60% of the main materials used by the designers at SUP were not categorized under the general recycling categories, such as wood, metal, ceramics, synthetics and mineral, followed by paper (11.8%), plastic (11.8%), fabric (11.8%) and leather (5.8%) as main materials for their upcycling products.

The questions on treatment of materials and the composition of materials used in upcycling products (Figure 6) revealed that most of the design products (95%) are completed with additional materials, in which 80% of them are not upcycled. Majority of these additional materials were indicated as 'other' (80%) that falls into the category other than the categories of recycling, mostly chemical adhesives, utilized to adhere different materials. Consequently, the most popular method of assembly appeared to be 'adhere' (60%).

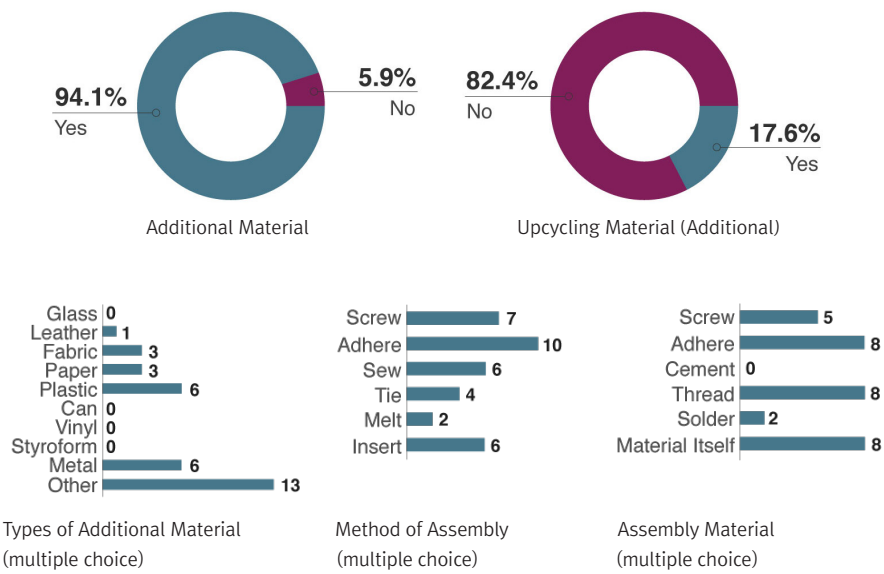


Figure 6 Designer Focus Interview on Treatment of Materials in Upcycling Design Process (Answer: 20)

In regards to the leftover materials after making upcycling products (Figure 7), 35% of the designers discard, 30% recycle within studios for other product making and 15% donate to other organizations or individuals. The rest 20% said to have no leftover materials after making upcycling products.

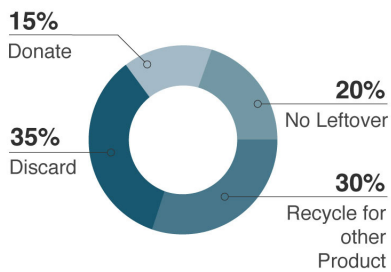


Figure 7 Treatment of Leftover MaterialsDesigner Focus Interview (Answer: 20)

4. Process Analysis and Model Development

4. 1. Material Life Experience in Upcycling Design Process

Based on the above survey outcomes, it was discovered that popular materials utilized for current upcycling products do not match the categories of recycled wastes from everyday life –comparison of general public's idea of upcyclable materials (Figure 2) and the upcycled materials in reality (Figure 5). In addition, it was recognized many upcycling products consist of non-upcycling materials in the process of making. That is to say, the current life cycle of materials is not circulative even in the upcycling design process.

Indeed, after tracing and analyzing the material life experience in accordance to the product life cycle in upcycling design process of the studios at SUP (Figure 8), it was revealed some of the materials in the making processes stay in the stage of waste and pollution until they are completed as marketable products, and in one of the cases was not even upcycled in the end. The states of waste or pollution, raw material, and product were determined according to the effects the methods of treatment and processing have on the recyclability of materials. Each of the 20 studios is represented as a line progressing along the product life cycle in upcycling process in the colors illustrating their main materials.

In Figure 8, colored dots depict the actions undertaken in the design process; height speaks for the material state among waste, raw material, and product, which means the higher it is the more it is considered as marketable product; diameter of translucent circles symbolizes material value in the state, the bigger it is the greater recyclability it has. For example, using the assembly method of chemical adhesion that disables disassembly of materials downgraded the material state –represented by low height– and material value – illustrated with small diameter–as their raw materiality perishes in a considerable proportion of cases. Thus it can be presumed from the figure that current upcycling processes in SUP do not attend high recyclability of the used materials.

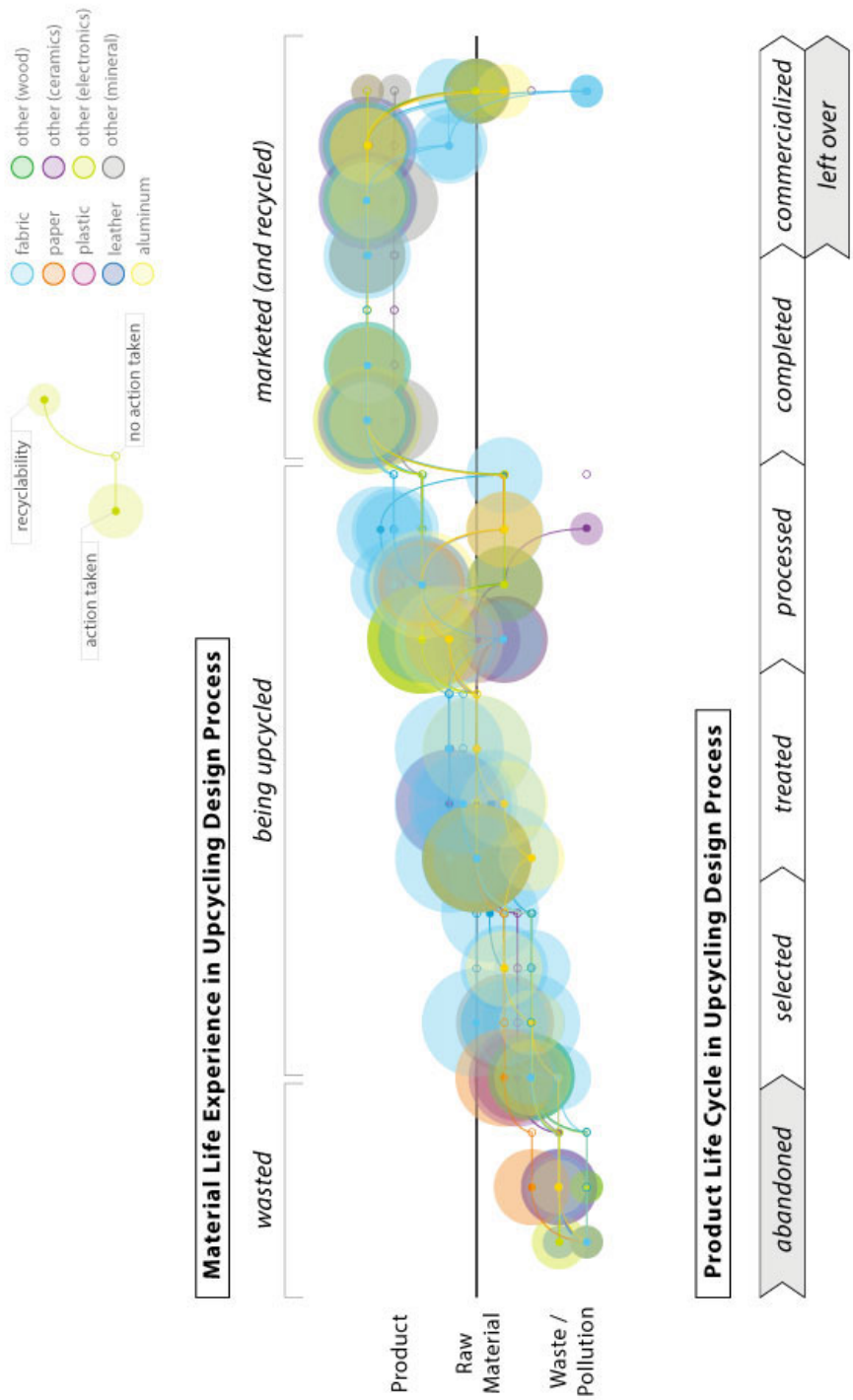


Figure 8 Material Life Experience in SUP Studios' Design Process

4. 2. Upcycling Design Process Model

After analyzing the product design process, it became clear that material is the main factor that affects the circulation of product life cycle. Based on the previous chapter of analysis, this study developed the following upcycling design process model (Figure 9) as a main result of this study based on the shape of Agile model, which sets the process of upcycling design as the 2nd stage of material life cycle in design production process. As some materials after consumer use become waste and discarded, other materials in post-consumer products, along with industrial leftovers, are treated as recycled materials, and join the upstream design, to become upcycling products, part of the upcycling product life cycle. This depicts the current upcycling design process, derived from the analysis of the upcycling design process undertaken in the studios at SUP.

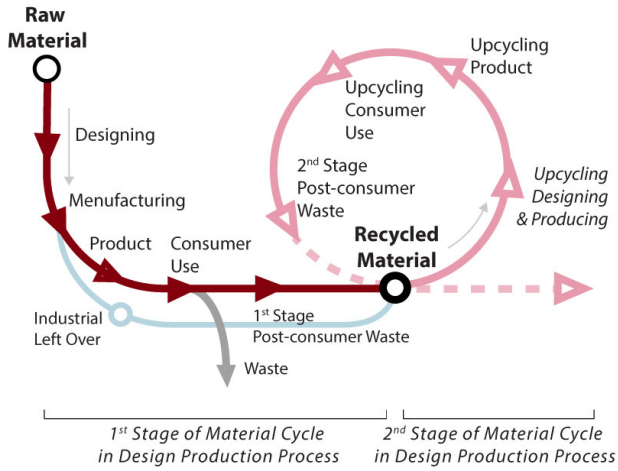


Figure 9 Upcycling Design Process Model

*This model referred to the Interactive Agile Development Process.

4. 3. Iterative Upcycling Design Process Model

The iterative upcycling design process model (Figure 10) is a model developed further in this study, to advocate the next stage of material life cycle after being recycled as the first generation of upcycling products. Once the upcycling product reaches the 2nd stage of post-consumer waste, the phase of disassembly allows every assembled material to go back to its original state and become re-recycled material, theoretically generating no waste.

- 1st stage of material cycle:
  raw material → designing → manufacturing → product → consumer use → 1st stage consumer waste
- 2nd stage of material cycle:
  recycled material (1st stage consumer waste & industrial left over) → upcycling designing & producing → upcycling product → 2nd stage consumer waste → *disassembly*
- 3rd stage of material cycle:
  re-recycled material → re-upcycling designing & producing → re-upcycling product → 3rd stage consumer waste → *disassembly*

As Murray (2002) commented that design for circulation is “not merely conserving the resources that went into the production of particular materials, but adding the value embodied in them by the application of knowledge in the course of their recirculation”, the material can go through the phase of re-upcycling, reaching the 3rd stage of material life cycle with the phase of disassembly. Hereafter, the circulation of materials goes beyond their second iterative use and becomes sustainable.

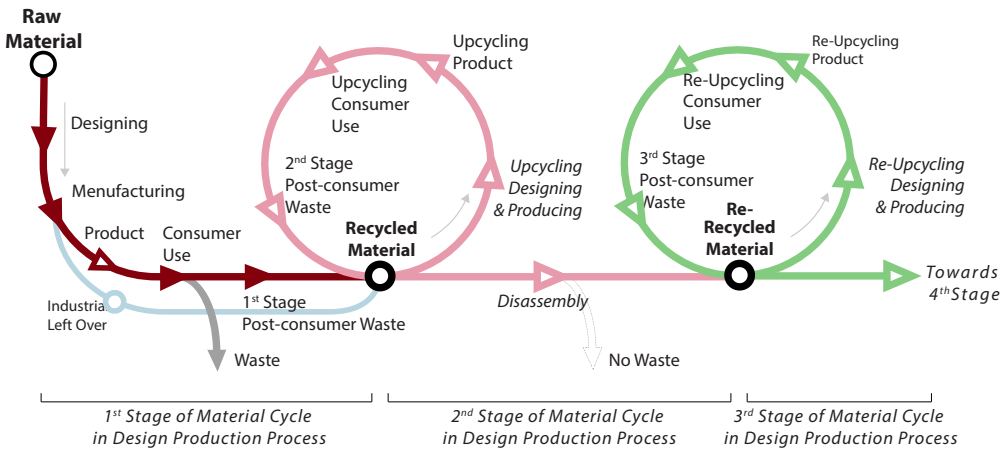


Figure 10 Iterative Upcycling Design Process Model

*This model referred to the Interactive Agile Development Process.

5. Conclusions

This study was derived from a critical perspective on upcycling: when the once upcycled materials in upcycling products are not circulated but discarded, the insistence on upcycling stays as mere a one-dimensional manifesto and political issue, taking in the aspects of energy, labor, and environment. Concerned with the sustainability of upcycling design and material life cycle, this study presented the early stage of re-envisioning upcycling design process that focuses on materials and their recyclability.

After conducting a survey and interviews, and examining the material life experience in the current upcycling design process, this study indicated that the recycling scheme in Korea, as well as majority of the materials in current upcycling products, follow the cradle-to-grave life cycle, unable to reach the next phase of upcycling. Material circulation in upcycling design is an essential feature that assists the sustainable loop of upcycling product life cycle, and is a crucial matter to be considered in the design process. Hence an effective exploration into modular approaches in product assemblies (Kimura et al., 2001) is urgent.

“Upstream design processes need to be evolved to systematize extensible product modularity and encompass component and material variability” (Richardson, 2011, p.10). For materials

to circulate and go back to the state of recycled raw material, resonating cradle-to-cradle design, disassembly is critical. Thus assembly method using chemical adhesive, which is currently used by majority of the SUP studios for assembly, should be the least desired. Such assembly, disassembly and reassembly methodologies in product design process need to be addressed in the overall product design process.

The final model (Figure 10) visualizes material circulation as the core drive of product lifecycle in upcycling design process that leads to sustainable upcycling. Following such iterative upcycling design process, designers can reflect the recyclability of materials throughout the whole upcycling design process. In this way, phases of processing recycled materials and assembling materials to make products become the core points of decision-making that enable disassembly and reassembly in material circulation.

This study has only addressed the questions regarding material life cycle in the current upcycling design process in the cases of Korea, and did not take upcycling methods for the wastes of 21st century, such as mobile phones, or upcycling design practice in other countries into consideration. As of now, there are more upcycling cases revitalizing fabric and leather wastes, which can be approached with non-chemically processed assembly and disassembly. This study was not only researching cases but also testing how theory of sustainable material recirculation could be practiced. Here, upcycling design was not viewed as a mere tool for waste management, but an independent domain of product design, and scrutinized from the aspect of product life cycle. With above mentioned, this study raised the potential value of upcycling product and novel material value in upcycling product design process.

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