

## **DESIGN AGAINST THE PLASTIC SOUP - THE EFFECT OF SMALL PRODUCT DESIGNS IN SUSTAINABLE DESIGN EDUCATION**

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### **ABSTRACT**

Plastics are ubiquitous in our daily life due to their versatile characteristics, however, these excellent characteristics also contributed to the emergence of a gigantic garbage of floating plastics in our ocean, called the plastic soup. Within this research project we investigated the opportunities by design to cope with this wicked problem. The hypothesis is that picking small opportunities in a wicked problem can have a large impact on the related ecosystem. In addition, we also wanted to investigate how design students would deal with the problem to create larger awareness of the designers' impact and responsibility. Although there is no ideal answer to a systemic problem such as the plastic soup, intervening on systems is possible. As the characteristics of a product directly influence the way the entire value chain works, designers have a large responsibility / opportunity to influence the system. An experiment was executed with 69 design students to explore the opportunities. The resulting design concepts were discussed by experts, reasoning towards relationships, needs to elaborate the design practices, and ecodesign education in a circular economy.

**Keywords:** Circular economy, Ecodesign, Design education, Plastic soup, Design impact

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# 1 INTRODUCTION

Plastics are the pillar material of the modern economy: because of their combination of characteristics such as versatility, durability, high strength-to-weight ratio, etc. and low cost, plastics are used for many products. Their use has increased twenty-fold in the past half-century, and is expected to double again in the next 20 years (PlasticsEurope, no date). While delivering many benefits, the current plastics economy has drawbacks that are becoming more apparent by the day. As stated by the new plastics economy, introduced by the Ellen MacArthur foundation (McKinsey & Company and Ellen MacArthur Foundation, 2016), and the Plastic waste strategy of the European commission (European Commission, 2017): we should rethink the way we use plastics in order to tackle the problems and enable the usage of plastics in a circular economy, to keep them in the loop and reduce new inputs in the system.

Within this project, we focus on the immense amount of plastics that has found its way to our oceans. Very large quantities of plastic waste leak into the environment from sources both on land and at sea, generating significant economic and environmental damage. Globally, 5 to 13 million tonnes of plastics — 1.5 to 4 % of global plastics production — end up in the oceans every year (Jenna R. Jambeck *et al.*, 2015). Marine plastic pollution continues to be a growing threat to the marine environment but also has possible consequences for the human consumers at the top of the food chain (Van Cauwenberghe and Janssen, 2014)(Kumar, 2018). However, plastics by themselves are not bad. In contrary, today nearly everyone, everywhere, every day comes into contact with plastics. They are ubiquitous and enable us to live much more sustainable, e.g. within transportation lightweight plastics lower the energy consumption (Henri Magnaud and Muriel Gilbert, 2016). Nevertheless, the way we deal with them is harming our planet at large scale. The problem setting of the plastic soup is a typical example of how many social and environmental problems are existing as wicked problems. These so-called ‘wicked problems’ are characterized by large-scaled and multi-organizational complexity and defined by the fact that they cannot be solved with a single solution. There is no ideal answer to these systemic problems due to the fact the problems arise from the interactions between the parts. However, intervening on systems is possible. Interventions on interrelated leverage points can be designed that eventually impact the way a system behaves (Meadows, 1999).

As each of this plastic product that finds its way to the ocean, is once designed, we might reason that it is the responsibility of designers or even partly the designers’ fault. However, it is also the consumers’ responsibility to take part in proper disposal and the government to have an truthful waste policy, as well as the handling of all other stakeholders in the plastics’ lifecycles. Different kinds of product cycles take place within a circular economy, yet a common factor for success is chain collaboration amongst the complete lifecycle. This implies that the role of the designer moves from purely design activities towards a connecting and managerial role to collaborate over the whole chain (Nasr, N., Thurston, 2006)(Souza, 2013). The characteristics of a product directly influence the way the entire value chain will be constructed and managed (Bevilacqua, Ciarapica and Giacchetta, 2008), for example to support closed-loop supply chains, choice of the materials is crucial. However, this also means that designers might be part of the solution to solve this enormous wicked problem. Implementing systemic changes and holistic sustainability strategies inherently involves changes from the very creation of a product or service (Nakajima, 2000). Globally sustainable values inevitably signifies a fundamental change in the practice of design (De los Rios and Charnley, 2017).

The experiments’ objective within the project was to discover small design actions/opportunities to reduce the impact of the plastic soup in an educational context. Our interest is not purely on the solutions that will be generated but on the type of solutions that design students come up with, knowing the limitations that they are given. Having the hypothesis that picking small opportunities in a wicked problem can have a large impact on the related ecosystem. In particular, we are interested in investigating how fresh design students would deal with their responsibility towards large environmental problems. The research questions focus on how to understand the behaviour of future designers challenging complex environmental issues; by questioning the solution assessment with a systemic vision while developing small solutions to the problem.

This paper is structured as follows: at first, an explorative study was done to get more insights in current design against the plastic soup projects and opportunities. Next, the approach of our research design is detailed. Next, in Section 4, the results are given, and in Section 5, these results are discussed towards the hypothesis of the research. Finally, some conclusions are given in Section 6.

## 2 SUSTAINABLE DESIGN EDUCATION

In order to be able to answer the question on how fresh design students would deal with their responsibility towards large environmental problems, more insights are needed into the educational context, especially on the practical design exercises as substituent to theoretical classes, that are educated in order to develop the specific needed skills. Ecodesign or design for sustainability is a discipline within product development in which the focus is put on the eco-impact of products and in which the full product life cycle should be considered (choice of materials, production and assemblage, distribution and packaging, product use phase, and the end of life), aiming to close the lifecycle and reuse or recycle as much material as possible. It is crucial to educate future product designers about the ecological problems and train them how they can minimize the impact of products if we consider that 80 % of the environmental impact of product is determined in the design process (Design Council, 2002).

This research is situated within the faculty of Design Sciences, University of Antwerp, where Design for sustainability is one of the standard courses that is embedded in the bachelor curriculum of Product Development. In this course, the environmental problems are educated and general principles for eco-design are taught such as eco-analysis tools, design guidelines towards more sustainable products and the most used terms and strategies related to eco-design, focussing on either technological, strategic and behavioural solutions. This theoretical course is supported by several practical design courses in which students have to apply their knowledge to design products with a low environmental impact.

Getting insights in how students work individually to imagine and propose concepts of small products aiming at contributing to the diminution (preventive solutions) or the treatment (curative solutions) of plastic waste in the seas, enables understanding how they use the knowledge and methodologies that they have learned. This understanding enables to identify the needs for more adapted educational tools or to adapt future courses according to the students' needs.

Starting from the insights in awareness of people/designers/students' role and responsibility in a bigger or complex system of an ecological problem, this research aims to optimize sustainable education to train students in this awareness creation. Designing small design actions/opportunities can have a big impact when reaching sufficient level of repetition. Furthermore, realising effect on the level of a single individual has a large potential through extrapolation. Embedding these design tasks in the educational program of the bachelor education of product development enables, according to (De Bock & Decker) to go to a higher level of comprehension.

## 3 EXISTING DESIGN SOLUTION

In order to understand the possibilities to design against the plastic soup, in this Section, we explored the variety of existing products and brought them together in an summarizing overview. This overview is further used in the project to structure the type of solutions generated by the students.

At first, the developed solutions to retrieve the plastics from the environment. These solutions can be differentiated based on the scope: the immediate environment of the solution varies from solutions for land litter (such as (Mooimakers, no date)), rivers (such as (The Great Bubble Barrier, no date)), harbours (such as (Mr. Trash Wheel, no date)), beaches (such as (Eneco Clean Beach Cup, no date)), and oceans (such as (The Ocean Cleanup, no date)). Furthermore, differentiation can be made on the size of plastics, varying between macro, micro and nano plastics. Most mature solutions are currently focussing on macro plastics, in addition new projects include micro plastics as well (Plastic Soup Foundation, no date). Some projects are also focussing on a specific type of plastic that is dripping into the environment, such as (Zero Pellet Loss, no date). Others are involving human actions instead of technology. Lastly, projects that are focussing on catching plastics in the water, differentiation is made between surface plastics, under water plastics or soil plastics.

On the other hand, focusing on prevention of plastics to end up in our environment can be seen as completely suiting within the principles and guidelines of eco-design. Strategies such as design for recycling, design for disassembly, design for sustainable behaviour, etc. are all existing for decade(s). However, the biggest reason why these useful strategies individually do not seem to effect is made clear with the new perspective of the circular economy: only if the complete chain is working together, appropriate collection, sorting, reuse, remanufacturing, and recycling will be possible.

Recently, new initiatives came up to approach this chain collaboration, including government and policy. Examples of these projects are from the cosmetics, such as (Beat the Microbead, no date) ,

focussing on plastic packaging (such as (Skipping Rocks Lab, no date)). In contrast, project such as (Precious Plastic, no date) and (Byfusion, no date) focus only on recycling of end-of-life plastics, or on optimization of waste collection of for example textile microfibers, such as (Cora Ball, no date) or (Guppyfriend, no date).

#### 4 MATERIALS AND METHODS

Within this research project, our aim was to investigate “how fresh design students would deal with their responsibility towards large environmental problems”. In this case, the problem of the plastic soup was chosen as focus area. 69 students took part in the experiment, which took part in an educational setting of the bachelor program of Product Development. To be more precise, it was given as design task within the course of design for sustainability, which counts for 3ECTS.

The design task was given by OVAM (which is the Flemish waste management institution) and formulated as: “The plastic soup is the amount of plastics in our seas and oceans, it keeps in increasing. The gigantic problem is estimated in millions of tons. Additionally, the discarded plastics have an immense impact on marine life and leaves its traces until deep in our food chain. A study of McKinsey concluded that if current trend continues, there would be per three tons of fish, one ton of plastic by 2025, and the same amount of plastics by 2050. What are the opportunities from innovation and design to cope with this global problem?”. To support the first ideation, two strategies were suggested: (i) preventing new plastic waste to enter our waters and oceans; (ii) getting the plastic soup out of the ocean and rivers (including all types of litter). In addition, it was also specified what was NOT expected as solution within the challenge: (i) a campaign, event, booklet or other awareness campaign; (ii) an app without further connection of a physical product or service, (iii) solution that will solve the complete plastic soup, as this is not realistic and would not fit within the timeframe. Better to focus on a small , but specific impact that can be achieved. (iv) products that are made out of ocean plastics (nor arts products nor mass production) as material characteristics are still unknown and might vary significantly due to the impact of degradation. In order to support students’ ability towards fully sustainable development, the new concepts should be innovative on function or system level, instead of redesign level (Remmerswaal, 2000).

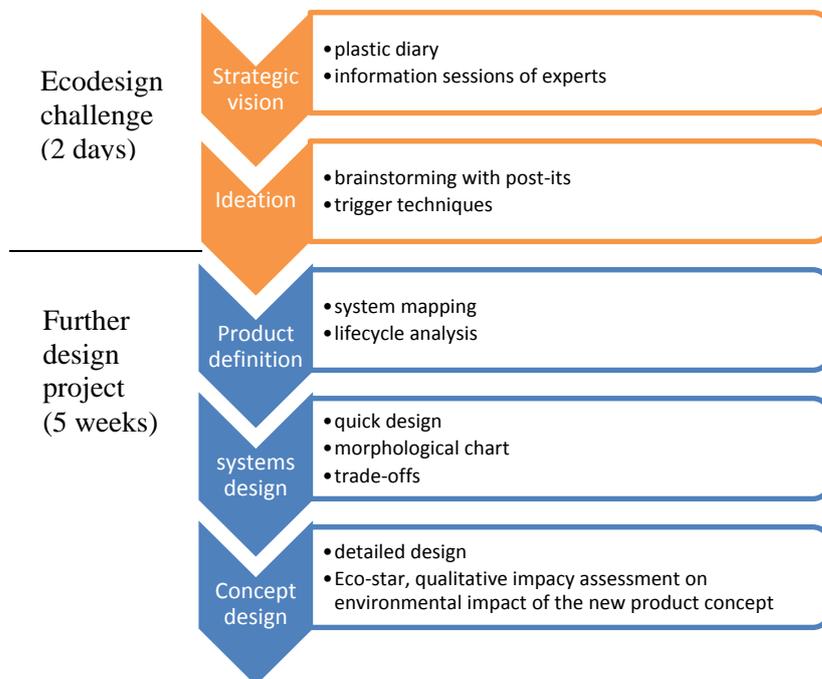


Figure 1. Overview of the different phases in the experiment, including some specific methods and techniques used

The applied protocol can be split into two phases, as further visualised in Figure 1. At first a two day ecodesign challenge was given, which was meant to act as a deep dive into the theme. In practice, students were supported to do their ideation in small groups, assisted by an additional group of 69 students. During these brainstorm session, they were supported by various experts from Mooimakers, Vlaanderen Circulair, VLIZ, OVAM, Dopper, and Colruyt (with expertises in marine litter, circular economy, marine logistics, litter policy, product development, sustainable management). After these sessions, each student had to pick an idea or specific opportunity to work further upon during five weeks. The students were coached to start from a detailed system / context mapping to visualize to complete lifecycle including all stakeholders. These enabled them to detail the product definition and to define all items to develop. Within the system design phase, these items were further developed in separate perspective in order to combine them through a morphological graph into various concepts. These concepts were evaluated through a trade-off. In the concept phase the chosen concept was further detailed till a level where it is possible to execute a qualitative lifecycle assessment using the Eco-star (Van Doorselaer, 2009). During these five weeks, they could meet their supervisors once a week to discuss their progress. At the end of the five weeks, students had to hand in a report, discussing their progress and the resulting concept. In addition, a poster was made on which they discussed the end result. The reports were used for evaluation of the students' related design competences.

The posters were used by a group of experts to discuss the outcome design concepts and the manner of approaching the complex problem. The technique of semantic categorization was used to cluster the project results. The aim of the expert discussion was to reason upon generalization prospects.

## 5 RESULTS

The results of the project are a collection of 69 developed concepts that aim to reduce the plastic soup. A selection of these outcomes is shown in Figure 2 and Figure 3.





Figure 2. A selection of students' preventive concepts

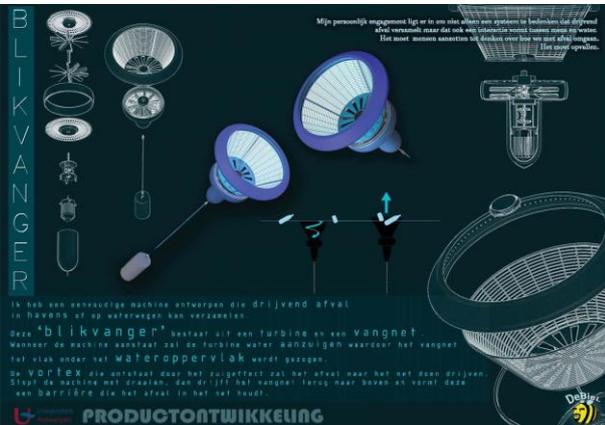


Figure 3. A selection from the resulting students' posters on curative concepts

## 5.1 Semantic categorization

After considering all results, they were clustered semantically, in order to achieve an overview of the results. At first, a distinction was made between the preventive and curative approach. In which we defined preventive as all phases before it might become litter (including waste collection) and curative as starting from the moment that it is not discarded properly and consequently should be cleaned up from our environment (including land as well as water). Surprisingly, only 5 students (7%) chose to focus on a curative solution, whereas 64 students (93%) chose to design towards prevention of litter in various forms. From the small amount of students that chose a curative approach, two were focussing on beaches, two on surface/floating waste in still waters, and one was focussing on underwater floating waste.

Within the group of students that preferred the preventive strategy, 26 students (40,5%) developed a solution to optimize a specific waste collection (focussing on different areas such as ski-mountains, hiking, beaches, on the go, in the car, in cities and touristic places; or focussing on specific types of waste such as tampons, dog poop, and cigarette butts). Motivators were related to optimizing sorting and enabling to carry the waste in a comfortable manner until proper disposal can be achieved. Of these 26 students, 7 focussed specifically on the Asian countries, as based on the background information (ref), it became clear that most plastics that end up in the ocean were originated from Asia and discarded or collected improperly. Some of them combined these argumentation with their own experiences during traveling in specific areas in Asia.

Another group of similar interests within the preventive strategy can be identified by the fact that 26 students chose to design a new type of reusable packaging that can be used in supermarkets, coffee shops, butcheries and bakeries. Related to these solutions, but from another stakeholder's perspective: the remaining 12 students that preferred the preventive strategy were mostly focussing on packaging free offering of food and drinks as well as other consumable products by shops, supermarkets, crowded/ public places such as stations and universities.

## 5.2 Expert discussion of the results

The outcome of the experiment was discussed in a focus group discussion with the four experts in sustainable and social sciences that were supporting the students during their design tasks. Four topics were discussed: (i) the type of outcomes, (ii) the attitude of the students, (iii) the influence of external parties, and (iv) impact of the results. Related to the type of outcome and the fact that students were mainly focusing on prevention strategies: the experts believe that this is caused by the fact that design students understand their responsibility and that the effect on long term is higher when tackling the problem source instead of healing the effects. However, the experts felt as one of the largest problems that students lack the ability to consider the potential impact of their solutions to the problem as they lack the tools to estimate the sustainable impact of the usage as well as to estimate the potential impact on society or behavioural changes and to estimate the acceptance or success.

Although the complexity of the problem, students were very enthusiastic and willing to succeed in the design task, not only because it was obligated, but also because of the societal relevance and empathy with the problem. The big advantage of wicked problems is that everyone is in some way connected to it and has a positive or negative small impact. Nevertheless, the biggest difficulty was experienced in the fact that students only had six weeks for the task, and were having several other courses in the period as well. So, they had to select a very specific and small opportunity to focus on. Considering the end results, it was also clear that students who picked a detailed focus, end up having better results than those who want to save the world with one product idea or those who refused to select a specific target audience.

In general, they concluded that the awareness creation to reduce the plastics consumption for daily life has been very successful. Nevertheless, the esthetical conceptualisation of the products are mainly based on the contemporary consumer behaviour that is characteristic for our throw-away society. Different new design proposals appeared to deal with drinks, food, packaging and consumables in a circular economy, but are still lacking in their expressive value towards consumers to change their behaviour. This might also be related to the amount of time and the experience of the students.

## 6 DISCUSSION

Within this discussion Section, we want to elaborate on two aspects, namely the potential danger of a rebound effect and the potential of designing behaviour change.

### 6.1 Impact of decision making

Due to the short timeframe of the project, students were obligated to select a very narrow opportunity to design in. However, starting from the wicked problem of the plastic soup, this might even be seen as the biggest challenge to cope with. Consequently, they were not allowed to design big ocean cleaning systems. It was noticed that many students experienced a kind of FOMO (Fear Of Missing Out), meaning that they were afraid to decide and limit their focus because it would limit their target audience and the potential impact of the solution. Nevertheless, having a very specific and so perfect matching solution for a very specific small audience, the chance of adoption is much higher, which makes the ability to achieve the (small) impact higher. In comparison, focussing on all people as target audience would result in a product that has to be generalized and applicable to everyone, which is making it less attractive to everyone, because no-one feels related to it. Moreover, within the concept of wicked problems, there is not one true or false solution, rather better or worse solutions.

Related to this insight in potential impact, it was clear that students were lacking support in getting insight in their impact. We assume that it might be of high relevance to visualize the impact of their designs during early development phases, as they are not yet implemented in the market. In other words, there is a need for simplified systems thinking tools, which feels like a *contradictio in terminis*. On the one hand, it should enable to understand a complex problem (through visualisation) and to achieve insights in the impact of specific solutions. We believe that these tools could be retrieved from the domain of systemic thinking and systemic design.

### 6.2 Designing a new plastic product versus real behaviour change

As it was clearly analysed in the previous Section 4, the majority of students (38 out of 69) has chosen to generate a concept with the intention to find a new type of packaging for consumables. It is obvious that replacing plastic single use packaging is important to achieve preventive solutions as designers to cope the plastic soup. However, we believe that it is also important to focus on activating change of behaviour and even sustainable living. A few students developed a concept that tends towards this, fading the border between a packaging or a product in itself. We could debate whether they should be categorized as packaging or not. Most importantly is that their appearance change the disposable mentality. The product concept to clean dog poop is not only interesting to design from a functional and ergonomic perspective, but has also the potential, if design aesthetically pleasing, to change people's behaviour. The integral approach of the concept design allows to start behaviour influencing from common consumption behaviour towards a more sustainable life.

The difficulty of designing packaging that can be reused is the resistance it may evoke with its end users. The design of the appearance to share or pass on packaging is not evident. Designers need more insights in the end users motivations and their intrinsic motivations to care and respect nature, fauna and flora of the oceans and land prevails. Using these insights in designing based on cultural values proved to be promising, yet needs to become more fundamentally known and supported.

## 7 CONCLUSIONS

Within this research project, the aim was to understand how bachelor design students identify small design actions/opportunities to reduce the impact of the plastic soup. Insights in analysing the process enable us to make proposals towards more adapted educational tools or to adapt future courses according to the behaviour of students. Having the hypothesis that picking small opportunities in a wicked problem can have a large impact on the related ecosystem, we were interested in understanding what solutions do students come up with given the limitations that they are given.. Although there is no ideal answer to a systemic problem such as the plastic soup, intervening on systems is possible. As the characteristics of a product directly influence the way the entire value chain works, designers have a large responsibility / opportunity to influence the system. Investigating the students actions will enable to optimize the process and tools needed to support future designers in these activities. The main conclusions of the research were summarized in the following propositions:

#### A. Propositions related to the students' solutions to reduce the plastic soup:

In general, we could conclude that there are many design opportunities to support reducing the plastic soup. However, students tend to choose for preventive solutions rather than curative solutions. This could be explained through the following two reasons: (i) because they understand their responsibility, and (ii) the effect on long term is higher when tackling the problem source instead of healing the effects.

#### B. Propositions related to students' handling complex problems:

Tackling a wicked problem in a short design task requires the ability to relatively fast select a very specific and small opportunity to focus on. Considering the end results, it was also clear that students who picked a detailed focus, end up having better results. Consequently, there is a need for estimating impact in early design phase to handle and make decisions regarding small product design towards wicked problems.

C. Propositions related to the potential of sustainable behavior : There is a large opportunity to use the impact of the design-expressions to trigger a new style of sustainable behaviour. However, it is not evident to introduce reusable packaging for example, considering potential resistance it may evoke with its end users regarding the perception of sharing and passing of products. The design of the appearance to share or pass on packaging is not evident. For now, this was only touch upon slightly by the students solution due to the difficulty understanding the intrinsic motivation of people to change behaviour.

Future research is needed to specify, detail and adjust the used systems mapping technique from a sustainable perspective, meaning that considers lifecycle thinking as a crucial part of it. This technique is needed to support both selection of the small opportunities in the beginning of the design, as well as to reason upon the impact and efficiency of the ideas during concept development.

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