DESIGNING WITH WASTE: COMPARISON OF TWO PRACTICE-BASED EDUCATION CASES

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ABSTRACT

Designing with discarded materials can be challenging, but it has the benefit of helping material recirculation and in doing so may help to reduce the volumes of waste currently available. This idea initiated work in two independent cases of practice-based design education: one at the Chalmers University of Technology at Gothenburg, Sweden and another at the Indian Institute of Information Technology, Design, and Manufacturing at Jabalpur. In both the cases, researchers at the two universities developed their methodology considering their contextual set of requirements. Further, the design students in both cases were presented with the 'challenge' and an 'assistive method' for performing product development using discarded material(s). Both initiatives were developed independently of each other, and the researchers got to know of the other initiative after initial work had been published on each study.

This article is a joint analysis that seeks to compare the two initiatives to highlight the differences and similarities between the experiences in both design education and design processes. This is done to better understand the challenges of designing with discarded materials, with critical insights on the activity, thus enhancing the possible contribution of designers to material recirculation.

Keywords: Design Methods, Design Education, Up-cycling, Design from Waste

1 INTRODUCTION

Design using discarded items, also known as 'up-cycling', deals with reuse of discarded materials in such a way to create a product of comparatively higher quality/value [1]. Up-cycling based design interventions include suitable material recovery options, especially when other material recovery techniques are not efficient [2]. Even though, numerous initiatives have commercially developed up-cycled goods, lacking substantial design research to facilitate designing with waste, the growth of such up-cycling interventions is slow [3]. Even though up-cycled products possess unique value, they are not widely adapted to varying contextual set-ups in the absence of a supporting design process.

Given this background, two independent initiatives explored the potential of design education in producing up-cycled designs as per identified contextual set-up(s). Both the teams, i.e. Design from Waste (in Jabalpur) and Waste to Design (in Gothenburg), developed and observed a process to include and assist the designers so that they can produce contextually suitable up-cycled designs.

Design from Waste (DfW) was a project-based course work done at Indian Institute of Information Technology, Design and Manufacturing, Jabalpur, India (IIITDM Jabalpur). Students from the postgraduate Master of Design (M.Des) program (between 22-25 years old) were guided for two consecutive years (seven weeks for each exercise), starting in 2013 with a motivation to provide effective design interventions to recover waste accumulated at municipal solid waste (MSW) disposal sites. The practice-based DfW coursework was intended to incorporate and train design practitioners to practice up-cycling and propagate it to unapplied areas. Also, in the DfW practice, designers consider the manufacturing capabilities of local marginalized communities in the design, so that these communities could reproduce the design for commercial realization. The method and resulting designs have been published earlier [4].

The Waste to Design (W2D) project was a collaborative effort among Chalmers University of Technology, Sweden, Stena Recycling (industrial recycling company) and Semcon (engineering consultants), and was done in Gothenburg, Sweden. It identified and offered industrial waste currently not recycled so that the students could use it in their product development thesis. The students were from design programs at Chalmers (both at bachelor and masters levels, between 21-25 years old) and were expected to investigate the discarded materials' properties, suggest application areas where the material could be useful and develop a product concept based on the material. Starting in the fall of 2012, the project ran for three consecutive years, where the students dedicated a semester of their time to develop their thesis work. The W2D project has been presented in previous publications [5], [6].

2 CONTEXTUAL COMPARISON

This section compares the contextual differences the two initiatives had: existing waste infrastructure, educational set-up and frameworks used are compared below.

2.1 Municipal solid waste management

Discarded items are the starting point of any up-cycling based intervention. The collection, handling and quality of discards defines the characteristics of the material(s) to be used during the up-cycling activity. In India, most of the recyclables where mixed with organic and inorganic waste and end-up in dumpsites [7], [8]. Also, most tangible items designed in foreign countries are not appropriate for Indian waste handling [9]. Even though the DfW project could not collaborate directly with local authorities on waste management, considerable studies about the waste management sector and related stakeholders were done during the initial stages of the project. This study helped define a standard way to collect and process materials from the unorganized sites.

Waste management in Sweden follows EU directives and is considered to be of internationally high standards. Most of the sorted packaging, biodegradable, and mixed waste are collected and are respectively recycled, used for biogas production or incinerated, leaving less than 1% of the total household waste to be landfilled [10]. However, there are still large amounts of waste material that could have been recycled or re-manufactured but currently gets incinerated or landfilled. Besides, some difficult materials (e.g. PVC from cables, EPDM rubber from vehicles, etc.) need extra incentives to be recycled, since the existing material markets do not consider them valuable enough.

Both the projects (W2D and DfW) identified that in the absence of collaboration between design and waste management there is a gap for recovering difficult materials. Other aspects like culture, behaviour and policy instruments contribute to contextual waste practices [11]. A certain quantity of waste will always be present in the system, and radically different measures to address the waste management system are required.

2.2 Educational set-up

Both the projects incorporated up-cycling to design education, to explore how design can contribute to increase material recirculation while making new products. Most of the students selected for the DfW project had prior industrial experience in various domains (e.g. visual design, interaction design, architecture, etc.), and were grouped to complement their multidisciplinary expertise. These students were in the second semester of their four semester master program (Product Design or Visual Design). During the first year, DfW project ran with 8 groups with 3-4 hours of contribution per week for 7 weeks. Participants visited the waste disposal site and local recycling facility for exposure to the prevalent practices and to select the waste material(s). Also, students identified and surveyed the local marginalized communities to identify their manufacturing potentials and constraints. Depending on the waste recovery and employment generation constraints, students were free to develop a suitable product.

Students in the W2D project worked in pairs and dedicated a semester (around a total of 900 hours of work) for their thesis projects, which consisted of developing product ideas with a selected industrial waste. In total, six W2D thesis were done, three at the bachelor's level (Design Engineer program) and three at the Masters level (Industrial Design Engineering or Product Development programs). The bachelor theses were done at half pace, so they were expected to work around 450 hours on the project. Since all students were part of the W2D project, they kept weekly logs of their activities and had regular supervisions by the supervisors running the project. They were also supposed to contact the recycling industries and the engineering consultant firms. The students were free to choose the material to work with, from the materials offered by the recycling companies and had access to material samples. The students were to define the type of products they proposed to make and did not have any restrictions regarding production systems to be used.

Both the projects identified novel design interventions to handle waste as per the defined set of constraints. It was also observed that the results obtained were highly dependent on the student's experience, knowledge, skills and the set of identified constraints.

2.3 Framework presented

Both the projects were implemented independently. There was an observed lack of described methods to design with waste. The students participated in these exercises and helped develop an understanding for how this is done. Thus, the projects provided a knowledge base to articulate the desired activity.
The DfW project explains a procedure for up-cycling interventions that can be scalable to handle the vast quantity of MSW, during its real life implication. To do so, students in the DfW project considered the capabilities of marginalized communities for future manufacturing. In this way, the designs developed by the students would be made by these communities, thus, facilitating mass production and mass waste recovery. Figure 1 illustrates the framework used, to show step-wise input from various actors to the process. During the concept generation, design students take the material considerations, production feasibility, and user requirements to arrive at a feasible design solution (artefact).

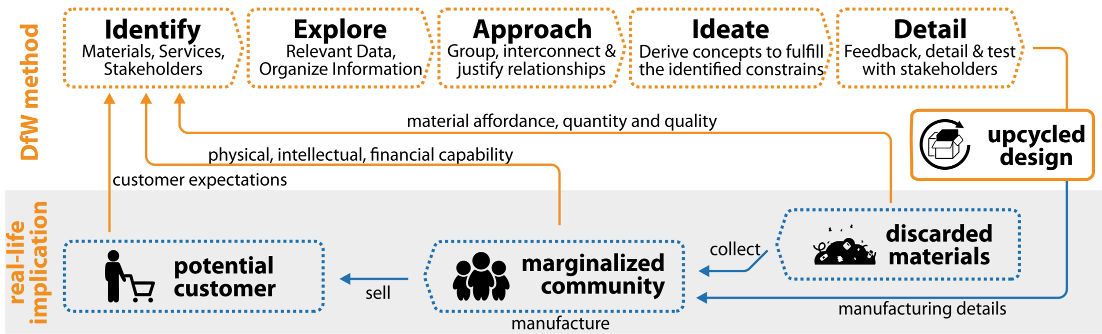

Figure 1. Representation of DfW method and its real-life implication.

The W2D project described the process of designing with waste, as a normal design process that would first need a pre-process, where information about the waste material would be collected and analysed in order to obtain suggestions for the possible products, as shown in Figure 2. Both projects had no constraints on what market or product type to develop, so the students were free to make these decisions. Students in the W2D project had further freedom to determine what type of production processes to use, since the W2D framework did not specify this.

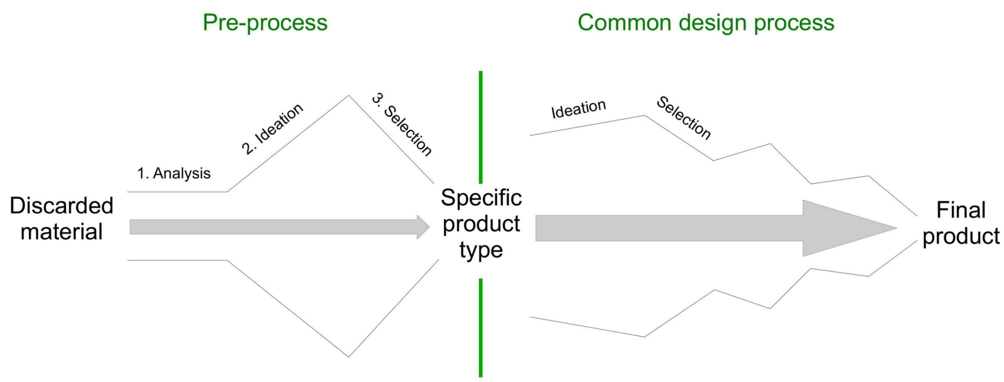

Figure 2. Process diagram for designing with waste, W2D framework.

3 OBTAINED RESULTS

Twenty-eight students participated in the DfW project, generating a total of nineteen up-cycled designs, during the three semesters the project ran. Some projects were carried out by a group of two students while others were done individually. Among the individual works, the six projects with the best visual documentation have been chosen to exemplify the results obtained by the DfW students (shown in Figure 3).

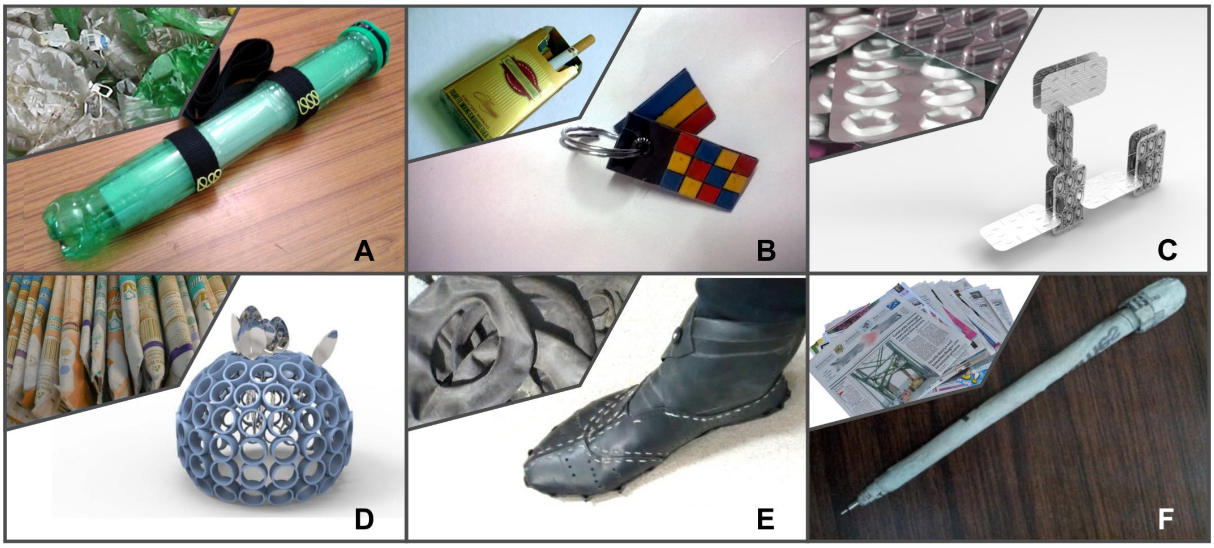

Figure 3. Examples of products developed in the DfW project. Top left corner of each example shows the discarded material used.

Table 1 provides further information on the projects presented in Figure 3, using the same identifier. Despite most of the students having industrial experience, they found it difficult to generate concepts to fulfil all the identified requirements. However, some students did succeed in making up-cycled artefacts.

Table 1. Summary of presented DfW student projects.

ID	Previous Experience	Discarded material used	Proposed design	Potential manufacturer	Development stage
A	Interaction Design (3+ years)	PET Bottles	Drawing sheet holder	Rag pickers	Complete
B	Graphic Design (4+ years)	Cigarette Packs *(Laminated Paperboard)*	Keychains	Rag pickers	Complete
C	Product Design (Bachelors)	Medicine tablet Strip *(PET with Al)*	Reinforcement for bricks	Recycling sector workers	Preliminary Concept
D	Engineering (Bachelors)	Tetra Pak *(Paperboard with PE and Al)*	Multipurpose kitchenware	Household waste collectors	Detailed Concept
E	Textile Design (1+ years)	Motorbike Tube *(Butyl Rubber)*	Footwear	Construction site labors	Complete
F	Product Design (7 Months)	Newspaper (*recycled paper)*	Ball Point Pen	Household waste collectors	Prototype

Six product development projects were done as theses under the W2D project (Figure 4). The projects varied in quality and level of detail they reached, with project 'D' being the best finished and feasible for production. The variation in quality of the proposed products had more to do with variation among student levels and the focus of their thesis, than the difficulty that the different materials presented.

Table 2 gives information on the W2D projects. Please note that in Table 2, columns two and five change in comparison to Table 1. This is because certain aspects, varied between the DfW and W2D projects. For example, W2D students had no previous work experience and never got as far as proposing a potential producer.

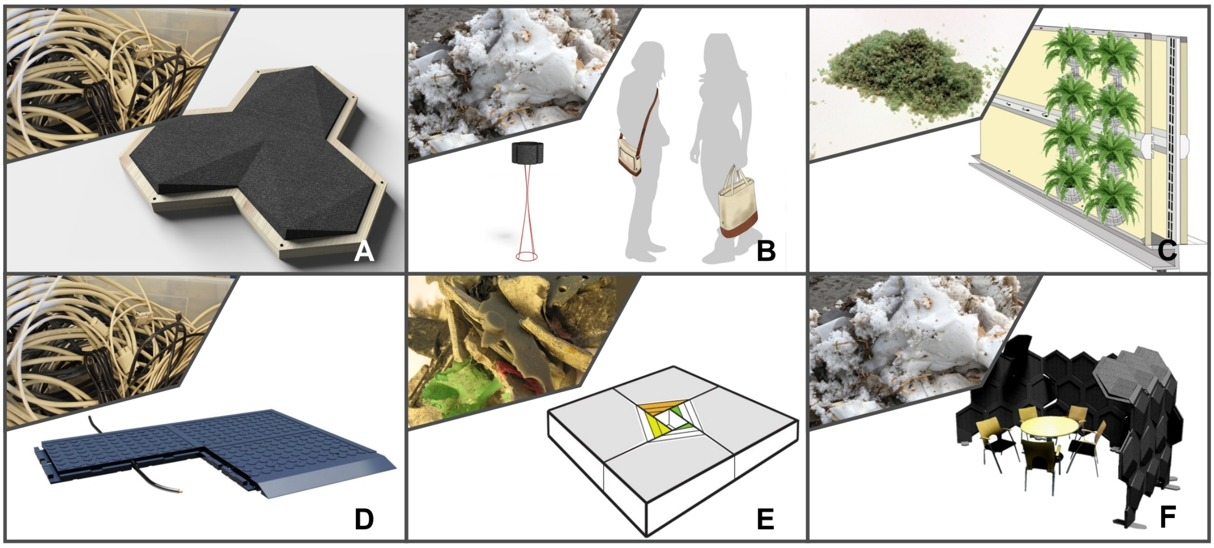

Figure 4. Examples of products developed in the W2D project. Top left corner of each example shows the discarded material used.

Table 2. Summary of presented W2D student projects.

ID	Academic program	Material used	Proposed design	Type of waste	Progress
A	Industrial Design Engineering (Masters)	PVC from cable sleevings	Modular sound absorber	Post-consumer	Detailed concept
B	Product Development (Masters)	PUR foam	Lamp shade, screen walls, cooling bags	Industrial waste	Initial concept
C	Design Engineering (Bachelors)	Polymer foam production waste	Vertical garden structures	Industrial waste	Initial concept
D	Design Engineering (Bachelors)	PVC from cable sleevings	Modular outdoor flooring	Post-consumer	Detailed product
E	Design and product Development (Masters)	Mixed plastic from e-waste	Thin client casing	Post-consumer	Initial concept
F	Design Engineering (Bachelors)	PUR foam	Modular sound absorbing room divider	Post-consumer	Detailed concept

4 LESSONS LEARNED

This section highlights the lessons learned in both projects, prioritizing lessons relevant for education and those that might help facilitate the activity of designing with discards for other actors.

- Designing with waste is a process with multifaceted considerations. Therefore, students found the task challenging in spite of having some professional experience. The time given in the DfW project might have been insufficient for resolving all the identified requirements. Apparently, an increased time span would result in better output.
- Inclusion of marginalized communities limited the DfW project to design handmade consumer goods. Hence, the practice of product development was easier to perform than in W2D. The students there were encouraged to think of designs for industrial production instead. However, la ck of restrictions regarding product type and manufacturing possibilities, increased their options and lead to confusion. Also, the students in the W2D projects had no working experience, limited knowledge about production systems, and, therefore failed to make a prototype or final product. For better end results, considerable knowledge about fundamentals of manufacturing and design are required.
- Students from both projects agreed that up-cycling is an important topic. There is currently very little research and teaching material available in the up-cycling area, regarding design processes and methods. Most examples try to show "it can be done", but not *how*. Hopefully, the initiatives presented here may help fill that gap.

- Both studies identified that waste material has a discontinuity/chaos as an integral characteristic. Safety and hazard norms need to be developed to handle contaminated waste during eventual up-cycling practices. The hygienic conditions for material collection need to be carefully addressed along with the processing of the material to make it safe to use.
- There was a lack of reliable material property information for the discards used by the students. Consequently, norms and regulations about where and how these materials could be used have not been developed either. Because of this some W2D students ended-up restricting potential use scenarios to less sensitive application areas (e.g. products that would not have extended close user contact).

5 CONCLUSION

Designing from waste has proven to be a challenging task, in comparison to the generic design process. Both practice-based education cases considered their contextual requirements and developed methods to uplift local discard recovery through up-cycling interventions. Both projects faced the challenge of the uncertainty in the discards collected. It is recommended that secondary materials should be processed to guarantee certain material quality and provide designers with reliable material information for end-of-life recovery purposes. Designing with waste has to develop a knowledge-base for itself. The methods presented here provide only initial guidance to designers on how to do this. Up-cycling based work depends on context, however, general steps of the work can be: 1) appropriately collect and sort the discarded material, 2) investigate and test its properties (with support from local authorities), and 3), identify a suitable application for the material by correlating the identified material properties with the application characteristics – this being the most critical step. Today all the responsibility of this work lies with the designer that wishes to engage in up-cycling. Up-cycling requires a lot of analytical work to decide whether the creative ideas are feasible. Knowledge in design fundamentals, material science and manufacturing technologies are essential. This makes the design task of correlating materials to possible applications even harder, since designers have to divide their time to cover all the tasks mentioned above. Ideally more actors should be engaged in collecting and analysing the secondary material, thus helping designers simplify the task of designing with waste.

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