EXPERIMENTAL MATERIAL DEVELOPMENT LEADING TO SUSTAINABLE PRODUCT DESIGN

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ABSTRACT

Industrial Designers need to understand the implications of the materials they specify in products intended for manufacture. In order to equip students to be more conscious about the materials utilised and the environmental impacts of these materials, the department of Industrial Design at the University of Johannesburg has incorporated experimental material development into its Design Practice curriculum. This paper present a current annual project undertaken where final year students are tasked with developing their own material composites which are used in the signing and making of a product which they develop. This has been undertaken for two years, where the outcomes of the projects have proved to be extremely valuable for the students. An overview of the project composition and examples of student projects are presented, with recommendations for other design schools to attempt a similar approach.

1. INTRODUCTION: INDUSTRIAL DESIGNERS AS PRODUCT DEVELOPERS

Industrial designers are trained to be able to develop products intended for manufacture using available manufacturing processes and materials. These manufacturing processes are often large industry applications which negatively impact the environment, for example injection moulding using plastic, where the plastic manufacture; tooling and production all have extremely high energy demands and large negative environmental impact. Although the industrial design process is a creative and inventive process concerned with the synthesis of such instrumental factors as engineering, technology, materials and aesthetics into manufacturable solutions (Fiell & Fiell 2006, p.6), there is an increasing need for Environmental Sustainability to become an integral part of this process. For students learning about the processes of creating new products, there is a sense of urgency for them to understand the entire life cycle of the material used in the products, from where it is mined or processed from initial raw materials. It is one thing being able to purchase raw materials from a hardware store, another being able to understand the energy and work that has been undertaken for the material to have been generated.

The incorporation of experimental research within the field of industrial design education allows for students to better understand and appreciate the environmental sustainability of the products which they design. Examples of appropriate theories include Cradle To Cradle, Life Cycle Assessment, Design for Sustainability, Design for Recycling, and Design for the Environment are all methodologies that students interrogate and learn about through the practical undertaking of these projects. A conventional approach to Industrial Design would be a designer would use available material, and for students this would be material purchased from a hardware or material supply store. The students may not have an understanding of the processes which were used to produce that material, nor the environmental impact linked to the generation thereof. This is a problem as the negative environmental impact from industry in the processing of goods is very high. For the undertaking of these projects, a sustainability approach following that of Cradle To Cradle, Life Cycle Assessment an Design for Sustainability. Cradle to Cradle design principles provide a positive agenda for continuous innovation around the economic, environmental, and social issues of human design and use of products and services (C2C, 2016 p.2). Life Cycle Assessment looks at all of the stages and processes that go into the production and entire life cycle of products(and systems), which includes raw material, product processing, manufacture, use as well as death/disposal. Although there are 32 different sustainability tools available to assess sustainability, the most appropriate to the undertaking of this project are Life Cycle Assessment, and Environmental Impact Assessment as they are suited to material processing as well as product manufacture (Ness et al,2007 p.500).

2. STUDENT PROJECT COMPOSITION

In order to integrate this sustainable approach to design thinking we have an annual project currently running within the final year of the BA Industrial Design[1] course, within the primary Design Practice module. Generally a design process starts with an initial project briefing: providing scope for the project and what is required throughout the entire project. This includes deliverables and specific timelines. This entire process in a typical 3rd year level would last about 4 –5 weeks, with 25 hours of timetabled class-time per week. The projects are developed to align with specific module learning units for example design for manufacture / design for the environment, community engagement or designing for brand identity. The student body consist of approximately 23 students each year (2017 and 2018). The design process is illustrated in figure 1, which starts with research, where students undertake thorough research to provide a solid footing for the following steps: brainstorming/ideation, concept development & refinement, and design finalisation.

[Figure 1] 3rd Year BA Industrial Design Process

Throughout the projects, at key points there is lecturer and class contact sessions where students receive input and advice. The peer related feedback is extremely beneficial where students can break into smaller discussion groups and explain their work, and discuss / negotiate / defend their design decisions for the process. It is expected that by the time students graduate, they are able to be independent decision makers and guide their own design process.

2.1 MATERIAL RESEARCH FOLLOWED BY THE DESIGN PROCESS

The first session at the start of the project was that of the Material Experimentation and Research & Development part of the project. It was my thought that the goal of this project section was for students to experiment as much as possible, and not be wholly concerned with 'the product', because at this stage they had no idea what they would be developing. The second briefing takes place once material experimentation was well under way (after 2 weeks of research) and students have a considerable amount of testing and documented findings. Only then are they able to finally find out what they will be developing, and the material research then leads into the design process. As the

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experiment outcomes are not resulting in a project success or failure, the students are more likely to take chances without the worry of an unsuccessful test. This allows for students to push their boundaries and learn as much from experiments that failed as those that were successful.

The aim of the project was threefold: firstly to teach students that experimentation and trial and error are a suitable approach to product design where they are able to learn from failures, secondly that the development of new sustainable materials is possible and able to be done on a small scale, and thirdly: as industrial designers they are able to be environmentally aware of the entire life cycle of a product, from material processing, through to end of product life. Industrial design students (in our department at least) often decide on an idea/concept early on in a project, and hold onto this idea for dear life, even though there are opportunities for it to develop into something much more novel and innovative. It seems as though the assumption is that a good idea automatically will result in a good product outcome, however this is not that case. For these project I intended to remove the students from their comfort zones by separating the project briefing into two different briefing sessions.

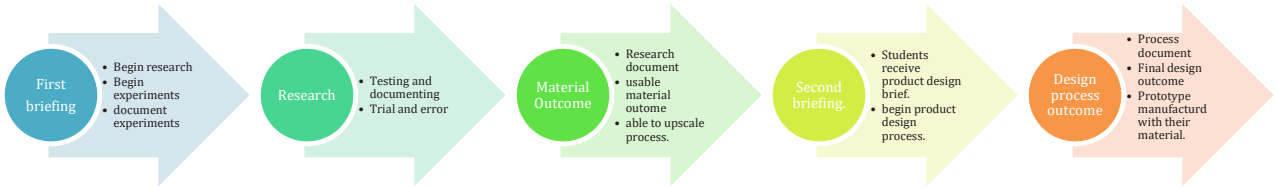


Figure 2: Project sequence and process.

The intention of not providing the students with the final product development requirements was deliberate, as the students were then able to experiment freely without a pre-defined output imposed on the expectations created by their undertaking of product precedent research. Although there were many different student projects, all of which were very interesting and different, four will be presented below, illustrating different project processes that the students followed. Two students from 2017 are presented, and two from 2018. The presented projects include a side table, coat rack, range of watches, and a skateboard, however, there were many different types of projects between homeware, interior and consumer type projects[2].The initial ideas for pursuing a specific direction may have been due to personal observations as in the case of a student who wanted to design biodegradable kids furniture where the idea came about from observing how her younger siblings' toys and furniture pile up in the garage as they rapidly outgrow them, possibly waiting to be handed down or discarded. Through identifying a problem, the student can attempt to eradicate this problem by a more sustainable design solution. One of the questions posed to students regarding what may be considered a sustainable product solutions would be that of 'If the product is left in the garden in the sun and rain, can it slowly return to the elements that it came from?' In the table below several projects are presented with reference to the student online portfolios for more specific content. The materials utilised in the experimentation phase of the project are mentioned, with an indication of the chosen material direction. Finally an image of part of the students design processes included, as well as the final design outcome with short description.

The fact that students are able to explore different directions, and as a group decide which direction seems most viable and suitable makes for an interesting spread of projects, all able to meet the project requirements. At the end of the project students complete a design reflection, which is a short write-up where they provide commentary looking back over the project. It is in these write-ups that it becomes evident that the students have learnt through the projects approach. The following are several comments from the student final reports, which would be submitted together with their final project submission at the end of the project:

- "The process taught me many things that I did not predict when planning and executing the assignment"
- "This project was a great learning curve and made me build a deeper knowledge of the material that was developed and have a better understanding of compression moulding."
- "Development of a natural material is not as easy as one might think as there are many aspects that you must consider such as drying time, the strength verses the purpose of the material, pigmentation, etc. It is basically custom designing the material to suit the end product. One thing I learnt is not to be afraid to try new techniques and different approaches."
- "It comes to attention that this was one of the most exciting and truly innovative projects of the year and would recommend for future students to pick up the material studies to a point where it becomes a multidisciplinary material that is trial tested through different applications through different study year groups.

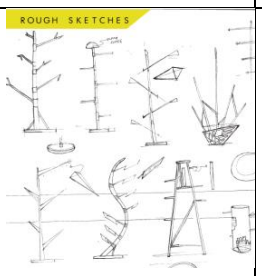
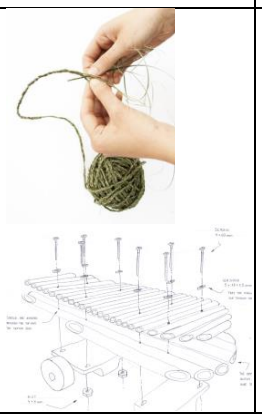
3. DISCUSSION & CONCLUSION

Through hands-on experience of processing their own materials by hand, students (and soon-to-be practicing industrial designers)are able to better understand the consequences of specifying materials which are negatively impacting

[2] Products included various types of furniture and homeware items such as seating, tables, cabinets, lamps, wall cladding, room dividers as well as consumer products fashion items and toys such as a torch, kids rocking toy, play structure, ceiling fan, travel bag, back-pack, board game and peak cap.

the environment. The following is a list of key benefits the undertaking of this project has directly on the students:

- Students learn through experimenting that there is value in attempting various approaches, and learning from what goes well, and when results are not satisfactory it is also a valuable outcome.
- Students are able to experiment freely and learn from their mistakes without the burden of failure. The documenting of what they learn from their failures assists them in the prevailing steps: Progressing through trial and error, and into innovative and sustainable outcomes.

Student / year	Experiments	Material Outcome	Design Process	Design Outcome
Designer Student: Leanne Moore 3rd year BA Industrial Design 2017 (Moore, 2017)	Leaves, Glucose, Vinegar, Wood Shavings, Sugar, Beetroot, Spices, Eggshells, Glycerine, Seeds.	 Seeds, Sugar, heated for 20 min, press-formed into mould.		 Reverse Side Table. Seeds, Sugar, heated till caremelised, press-formed into hand-made moulds, sealed with beeswax.
Designer Student: Faith Ole tselangwe. 3rd year BA Industrial Design 2017 (Ole, 2017)	Gelatine, Oats, flaxseed, Flour, vinegar, orange peels, herbs, charchoal, sand.	 Seeds, oats and sand with a gelatine binder.		 RAK, a functional coat rack made from flaxseeds, animal glue, ash, white stones, charcoal and oats
Designer Student: Ryan Walters. 3rd year BA Industrial Design 2018 (Walters, 2018)	Bamboo, coal, carbon, grass, gelatine.	 Press-formed bamboo coal with a gelatine binder to form solid items, with woven grass to form the flexible parts.		 The Charcoal Watch, made from compressed carbon + gelatine binder, with woven grass strap. (standard internal components).
Designers Student: Anna Schmiedt. 3rd year BA Industrial Design, Exchange student from OTH Regensburg. 2018 (Schmiedt, 2018)	Bamboo, sticks, grass, leaves, gelatine, dextrin glue.			 The Bamboo Board, made from bamboo and grass. (standard skateboard axle components).

[Table 1] Overview of several student projects.

- Students engage with and understand materiality of objects a lot more than just purchasing an existing material. They see that a usable material or object has already had a large amount of processing to get it to this point.
- Developing environmentally sustainably materials has large value for products, where the designer and user are able to fully understand the origin of the product and materials. This consciousness and transparency is empowering for the user and designer.
- The more natural the input materials into a product, the more natural the product outputs can be.

It has thus far been incorporated as a standard not-to-miss project to undertaken for students in this current industrial design course, and it is encouraged to other disciplines and schools to undertake similar practical projects with students. The goal should be developing equipped and ethical decision-makers in the fields of design and any associated manufacture.

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