DE2 - Design 2 - Design Project

Sustainable Design of Personal Care Products

Academic year 2016-2017

Alejandro Durán

Module leader: Marco Aurisicchio

Design Project DE2 - Design 2 - Sustainable Design of Personal Care Products

The Design 2 project is centred on sustainable design of personal care products and will be undertaken individually.

1. Project context

As increasingly acknowledged we live in a throw-away society strongly influenced by consumerism, where millions of products are marketed and disposed of globally every year. Overconsumption and excessive production of short-lived or disposable products - a manufacturing philosophy known as planned obsolescence - is leading to a growing amount of waste and the depletion of finite reserves. Despite significant improvements of recycling systems, many products cannot be recycled because they have been designed with a linear economic model in mind, i.e. mine, process, consume and dispose. These products typically cannot be disassembled and, therefore, the materials embodied cannot be reused. Fast moving consumer goods (FMCG) such as personal care products are especially subject to this phenomenon. For example, every year 1 billion toothbrushes and 2 billion razors are thrown away in the US alone. To overcome the limits of the current linear economy, a circular economic model has been proposed which has two main aims: promote greater resource productivity by keeping products, components and materials at their highest utility and value at all times; and reduce waste and avoid pollution.

2. Problem statement

At present, FMCG are predominantly designed following a linear economic model. If we want to move towards more sustainable personal care products there is a need to shift from a linear to a circular economic model.

3. Project objectives

The objectives of the project are to:

- analyse a personal care product to identify unsustainable aspects of the product-service system, product lifecycle model, the product itself and its manufacturing processes.
- propose a new design for a personal care product delivering the same function and outcome, while improving its sustainability footprint.

4. Product application: personal care products

Among fast moving consumer goods, personal care products such as oral care and hair removal products are typically designed following the traditional linear economic model of 'mine-process-consume-dispose'. This means that material resources are mined, used and disposed of in general waste ending up in landfills or incinerators. The project focuses on proposing a sustainable design for the handle of either a *razor* or a *toothbrush*, see Figure 1.

These products are typically made of a mix of polymers and elastomers but some exclusive models are also made of casted metals. Razors and toothbrushes are designed and branded in different models to target specific market segments and offer different experiences, look and design features.

As part of this project samples of razors and toothbrushes will be provided. In addition, you are welcome to identify other product models, and get inspired from multiple brands and products.

Figure 1. Personal care products

5. User research and product analysis

User research and analysis of existing products are critical steps for anyone in search of circularity. Using interviews, observations and online searches you are required to conduct research to understand trends in the grooming industry and patterns in the purchase, use and disposal of personal care products. This research is expected to deliver insights on male and female personal care products and inform the development of the product that you aim to design.

Disassembly and analysis of a personal care product are important to identify key information about its design and production as well as to predict what will happen to the product when it reaches its end of life and enters the waste system. For example, if a product cannot be disassembled it is unlikely that it will make it into the recycling system. As part of the analysis you are required to identify the number of components in the product, types and amount of materials used, and manufacturing processes employed. To estimate the environmental impact of the product you are advised to apply the Eco Audit methodology available through the Cambridge Engineering Selector (CES). In this way you will be able to estimate environmental costs associated with the materials themselves, product manufacture, transport, use and end of life disposal.

6. System and product design

After conducting user research and analysis of an existing product, you have to propose concepts at system and product level to introduce in the market a personal care product with low environmental impact. At a system level, you have to select the application context, i.e. geographical area, and target market, i.e. users, and develop concepts for the product-service system, product lifecycle model, material origin, material and design, and manufacturing plan, see *Appendix 1: System design parameters*. You then have to select the strongest overall concept to be further detailed. With respect to your final product concept, you have to develop a SolidWorks model for the handle and then proceed towards prototyping it.

The design of the functional head of your personal care product is not within the scope of this project. A standard functional head for a razor and a toothbrush will be provided to be mounted to the prototype. For example, sliding and snap-fitted razor blades as well as snap-fitted toothbrush bristles will be provided as illustrated in Figure 2. You are not required to use the functional head provided but you have to deliver a prototype, which mounts a functional head with a working engineering solution. Whether this mount is fixed or replaceable is your design decision.

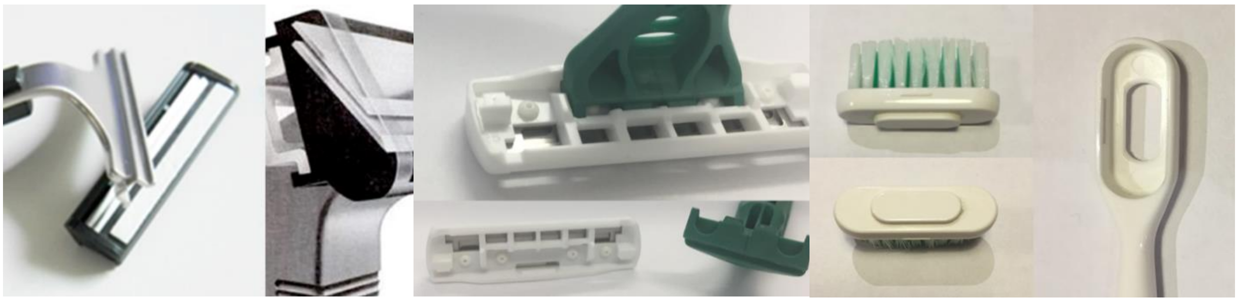

Figure 2. Sliding and snap-fitted razor blades, and snap-fitted toothbrush bristles

7. Materials and prototyping

Any material can be selected and specified for the handle design including metals, ceramics, wood and other organic materials, plastics, and natural and synthetic composites. The material that you specify can be virgin or waste. A virgin material is one that has not been previously used or consumed or subjected to processing other than for its original production. A waste material is one that is unused and rejected as worthless or unwanted. Waste materials can be a by-product or leftover of a production or consumption process. You are encouraged to explore the use of virgin and waste materials from industrial processes or household consumption.

The prototype has to demonstrate the functionality, ergonomics, and material experience of the final product. This means that depending on the chosen material more than one prototype may be necessary. A three-step approach to developing the prototype is proposed.

- Step 1: consists in constructing a crude prototype of the handle using clay and blue foam;
- Step 2: consists in developing a refined prototype of the handle using a selected material;
- Step 3: consists in optimising the handle look and feel.

The prototyping routes supported in the Ideas Lab and STW are shown in Table 1 depending on the material selected. Not all materials can be manufactured and manufacturing processes are limited. Before going ahead you are advised to propose a prototyping strategy, discuss it with your tutor and get approval. The prototype will have to be able to mount the functional head, i.e. razor blade or toothbrush bristle.

Materials can be ordered from the Store in MED. Request can be given to Ingrid Logan or Andy Brand. There is a 48 hours lead time on it. A budget of £ 20 for sourcing the materials you need is available upon request.

Material type	Raw material	Manufacturing process
Metals*/**	Sheet	Forming - hand work: drilling, cutting and filing
	Wire	Forming - hand work
	Block	Turing, milling and CNC
Wood	Sheet	Denford laser cutting, band saw and sander, drilling
	Block	Roland CNC router, milling Wood-work: band saw, drilling, sanding
Plastics	Filament	3D printing
	Sheet	Denford laser cutting, vacuum forming Band saw, sander
	Block	Roland CNC router
Composites (natural or synthetic)	Powder, liquid	3D printing of designed object (3D Systems MJP 2500 ProJet; Zcorp); silicon mould making; resin casting.
*Limited access to machining in the STW; assembly can be carried out in the Ideas Lab. **Download from Blackboard a request form to get access to STW, fill it in and submit it to Andrew Wallace for approval.		

Table 1. Materials and prototyping

8. Design process and expected activities

The project is expected to include the following steps: user research and product analysis; system and product design; prototyping.

User research and product analysis

- Selection of a personal care product and identification of an existing product example to be further studied.
- Analysis of the product context including use, product-service system and product lifecycle.
- Deconstruction of the existing product to understand the design, materials and manufacturing.
- Assessment of the product sustainability footprint and identification of important sustainability issues.
- Development of a product design specification (PDS).

  Suggested outcomes: User research for an existing product; system analysis covering product-service system, product lifecycle model, and working principles; engineering analysis covering parts count, materials used, manufacturing processes adopted, embodied energy and environmental impact; product design specification document.

System and product design

- Exploration and conceptualisation of alternative system design options for a new personal care product, and proposal of a final conceptual system design solution.

- Proposal of a conceptual and detailed design for the personal care product.
- Assessment of the sustainability footprint of the final solution.
- Evaluation of the final system and product design solution against the PDS.

  Suggested outcomes: Alternative system design options and final system design solution covering product-service system, product lifecycle model, material origin, material and design, and manufacturing; alternative product design options and final product design solution; product engineering analysis for new solution covering parts count, materials used, manufacturing processes adopted, embodied energy and environmental impact; evaluation of the new solution against specifications.

Prototyping

- Sourcing of the material.
- Selection of the prototyping method.
- Manufacturing of the prototype.

  Suggested outcomes: Final prototype; discussion of the chosen prototyping method relative to the final manufacturing process.

9. Assessed outcomes and deadlines

Interim outcome

- A report of work in-progress (20%):
  - Background research, analysis, results, prototyping plan.

NB: The report will take the form of a ppt file. The report will not exceed 6-8 slides.

Final outcome

- A presentation of the final project outcomes (20%):
  - At the end of the module individuals will be asked to deliver a presentation of the project.
- A prototype of the final product demonstrating and communicating (20%):
  - Material experience, ergonomics and functioning.
- A report containing (40%):
  - User research, system analysis, and engineering analysis for an existing product; product design specification (PDS) (25%). Expected method to communicate the results: text, calculations, graphs and tables.
  - A system design solution including product-service system, product lifecycle model, material origin, material and design, and manufacturing plan (25%). Expected method to communicate the results: text, models and visuals.
  - A conceptual and detailed design of the final product (25%). Expected method to communicate the results: text, hand sketches, pictures, and SolidWorks models.
  - A description of the material selected and its relevant properties and the proposed manufacturing process (25%). Expected method to communicate the results: process flow chart and pictures of the material.

NB: The report is expected to be visual intensive and make a strategic use of the text to communicate important project decisions, outcomes, reflections and conclusions. The report should not exceed 30 pages, including the models and visuals, and the word count should be no more than 6500 words.

Final competition

- The prototypes will be displayed and jury of DE staff will assess them and award prizes to the best designs.

Deadlines

- **Interim outcome - Work-in-progress report - Deadline: 17:00 - Friday - Week 11 - Term 2**
- **Final outcome - Presentation and prototype - Deadline: Week 7 - Term 3**
- **Final outcome - Report - Deadline: Week 7 - Term 3**
- **Final competition - Deadline: Week 8 - Term 3**

10. Marking criteria

The marking criteria for the interim report are articulated in the Table below.

Criteria	**Interim Report**				
Background research	1 *very little*	2	3	4	5 *extensive*
Analysis	1 *weak, thin and irrelevant*	2	3	4	5 *rigorous and comprehensive*
Results	1 *none, inadequate, incomprehensible*	2	3	4	5 *clear, concise*
Prototyping plan	1 *weak, thin and irrelevant*	2	3	4	5 *rigorous and comprehensive*
Quantity of work done	1 *very little*	2	3	4	5 *a great deal*
Evidence of innovation	1 *negligible*	2	3	4	5 *clear innovation*

The marking criteria for the presentation are articulated in the Table below.

Item assessed	**Presentation**				
Content and discussion	1 *inadequate, shallow*	2	3	4	5 *balanced, professional*
Style and time-keeping	1 *inaudible/ untimely*	2	3	4	5 *audible/ punctual*
Quality of slides	1 *illegible/ confused/ unhelpful*	2	3	4	5 *legible/ clear/ helpful*
Conclusions	1 *none/ trivial/ misleading*	2	3	4	5 *clear/ concise/ accurate*
Audience questions	1 *not answered*	2	3	4	5 *handled expertly*

The marking criteria for the prototype are articulated in the Table below.

Item assessed	**Prototype**				
Materials experience	1 *not considered*	2	3	4	5 *fully considered*
Ergonomics	1 *not considered*	2	3	4	5 *fully considered*
Functioning	1 *difficult/ impossible to follow*	2	3	4	5 *correct, clear*

The marking criteria for the final report are articulated in the Table below.

Criteria	Final Report				
Abstract	1 *none, uninformative*	2	3	4	5 *publishable*
Background research	1 *very little*	2	3	4	5 *extensive*
Analysis	1 *weak, thin and irrelevant*	2	3	4	5 *rigorous and comprehensive*
Results	1 *none, inadequate, incomprehensible*	2	3	4	5 *clear, concise*
Discussion	1 *shallow, muddled*	2	3	4	5 *balanced, professional*
Conclusions	1 *none, trivial, misleading*	2	3	4	5 *clear, concise, accurate*
Structure and presentation	1 *disorganised, turgid*	2	3	4	5 *clear, concise, professional*
Quantity of work done	1 *very little*	2	3	4	5 *a great deal*
Quality of graphical tabular data	1 *scruffy, non-existent*	2	3	4	5 *well chosen, labelled*
Evidence of innovation	1 *negligible*	2	3	4	5 *clear innovation*
Knowledge of relevant background material	1 *very little*	2	3	4	5 *extensive*

References

Ellen MacArthur Foundation https://www.ellenmacarthurfoundation.org/

Appendix 1. Sustainable System Design parameters

Geographical area	Europe	Asia	North America	South America	Africa	Australia
User age groups	Generation Z - Post-Millennials (birth date mid 1990s to early 2000s)	Generation Y - Millennials (birth date early 1980s-mid 1990s)	Generation X (birth date mid 1960s-late 1980s)	Baby Boomers (birth date 1946-1964)	Silent Generation	
Material and design	Materialisation (e.g traditional approach to materials specification)	Dematerialisation (e.g. use of less materials)	Material substitution (e.g. adoption of low-impact materials)			
Material origin	Virgin (non-renewable)	Virgin (renewable)	By-product waste (non-renewable)	By-product waste (renewable)	Second-life waste (non-renewable)	Second-life waste (renewable)
Product-service system (PSS)	Pure product	Product-oriented services (e.g. sales of product with services)	Use-oriented services (e.g. provider owns the product)	Results-oriented services (e.g. no product involved)	Pure service	
Product lifecycle	Linear flow (e.g. design for finite life)	Extended linear flow (e.g. design for infinite life)	Circular flow (e.g. design for after life)	Extended circular flow (e.g. design for after life)		
End of life	Landfill	Incineration	Composting	Recycling	Repair	Reuse
Manufacturing process	Manufacturing (e.g. traditional approach to manufacturing process specification)	Manufacturing substitution (e.g. adoption of low-impact manufacturing processes)				
Manufacturing organisation	Centralised	Decentralised (e.g. local manufacturing)				

NB: The Sustainable System Design parameters are to be used as a morphological chart; for some parameters options are not mutually exclusive, i.e. more than one option can be selected; you are expected to use this chart in your project to outline the key aspects of your given product and design proposal.