Automatic Composter For Home Use

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ABSTRACT

Nowadays, many concepts such as sustainability, environmental-friendly products, green solutions, concern for the planet, etc. are recurring topics. However, very little is still done towards achieving these. Reversing the current scenario is only possible with the commitment of all those in different spheres: governmental leaders, industrials, companies, and especially individuals. Designers can be particularly useful in this process from a prominent position, since they can strongly contribute to the creation of new products, protocols and materials. This paper shows a project aimed at alleviating one of the major problems currently found: organic waste management. The solution proposed is a new concept of automatic composter for residential use.
Key Words: Residues; Composting; Product Design

1. INTRODUCTION

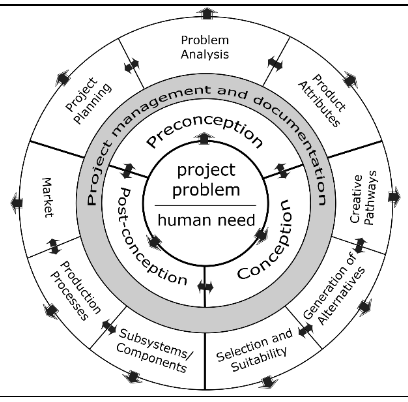
In Brazil, the generation of organic matter corresponds to more than 50% of the total volume of waste, according to the national Institute of Applied Economics Research (IPEA, 2016). Also, according to data from the Brazilian Institute of Geography and Statistics (IBGE, 2012), 50.8% of such wastes are deposited in open-air dumps, 27.7% goes to sanitary landfills and 22.5%, to controlled landfills. By analyzing these figures, it can be seen that these residues, for the most part, are deposited along with other types of waste without any prior specific treatment, causing negative consequences to the environment.

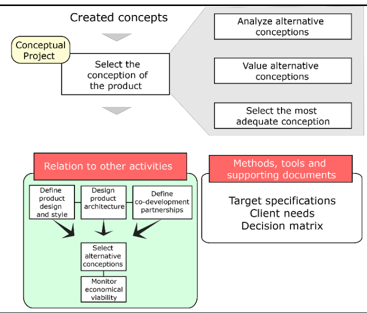
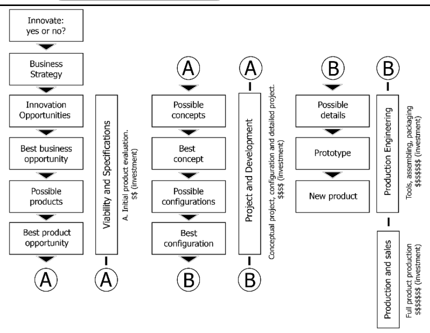
Among these, especially problematic is the manure originated from the decomposition of the organic matter of the waste, since it is a highly toxic liquid that can contaminate subterraneous water streams, which in turn, contaminates the water at a household level. It is also known that there is a need for a real and urgent change of thinking and habits regarding the consequences of our actions towards the environment in which we live in. It is also necessary to raise awareness to the fact that everything we consume generates waste and that this will most likely end up somewhere not suitable for such an end.
One big change would be starting to sort, treat and reduce all the waste right where it is generated. However, this can be very time-consuming and hence, regardless of conscientization and willingness, organization and attention with the waste produced are oftentimes forgotten or neglected. The challenge is to facilitate this process for the population, by sorting and treating their waste – specially the organic – in an automated way, reducing the negative impact of waste generation.
This work proposed the development of a product that makes organic composting feasible. The project was developed using the GOPD – Guide of Orientation for Project Development – established by Merino (2016), which serves as a support for process set-up and development. The GOPD is a methodology that aims to make product designing achievable by everyone by reaching as many users as possible and always taking into account, throughout the design process, the desire and expectations of the target audience, which is the object of the project.

2. LITERATURE REVIEW

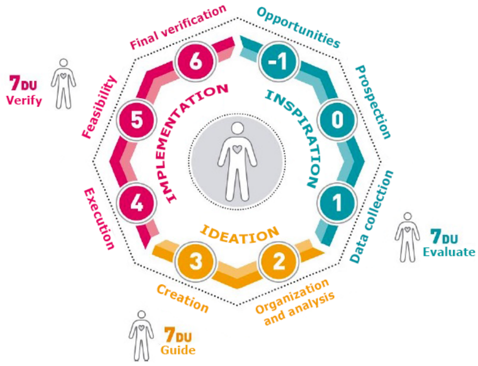
I One way to provide an environmentally-correct destination to more than half of our waste is composting (Kiehl, 1985). The author defines composting as a controlled process of microbial decomposition, i.e. the oxidation of a heterogeneous mass of organic matter. Finding a practical, low-cost solution is key for spreading the culture of recycling organic waste. The development of the automatic residential composter shown in this article, can be presented as a solution to make composting a more simple, feasible way.
This work deals with designing a compact equipment that recycles food in only a few days, due to the super-oxygenation of its remains, which accelerates the composting process. This forces the microorganisms responsible for the process to multiply exponentially, drastically reducing the time of the decomposition cycle and making composting a practice compatible with our daily routine, without the problems observed in the traditional method: strong odors, constant dedication, garbage dirt and other restrictions.
The employment of a proper methodology is necessary when a designing a project, since it assists in the organization of tasks by making them clearer and more precise, i.e. it provides logical support for the development of said project (BONFIM, 1995).
In Table 1, several design methods are presented.

[Table 1] Project methods. Source: Ferroli and Librelotto, 2016.

Method 3SDM - 3-Step Deployment Method. Also known as Open Method of Design. As a differential, the author places the stage of Generation of Alternatives linked to "conception", which receives data from the previous step ("creative pathways") and feeds the next step ("selection and suitability"). Source: Santos (2016).	

PDP - Product Development Process. Establishes the stage of Generation of Alternatives in the conceptual project, which succeeds the informational project and precedes the detailed project. Although it does not list numerical criteria for this, there is a suggestion of valuation of the conceived alternatives, in order to select the most appropriate. Source: Rozenfeld and others (2006).	
Baxter (2011) places the generation stage (referred as *possible configurations*) in an intermediate stage, being fed by the selection of the best concept defined by the design team.	

As already highlighted, the GOPD method was chosen for this project. This methodology is presented in the form of a cycle, where it is assumed that every project promotes opportunities for its continuity or even the beginning of new projects, based on the previous ones. Thus being, step 6 (final verification), which in theory would wrap up the project, leads back to step -1, the opportunities stage, enabling the creation of further opportunities, thus establishing a continuous cycle. (MERINO, 2016). Figure 1 illustrates the GOPD.



[Figure 1] The GOPD method. Source: MERINO, 2016.

The GOPD methodology is based on input and output "tokens", facilitating the projecting activity. The tokens serve as orientation tools and, if complemented with a timeline and a 5W2H tool, for example, promote a safe means of predicting the costs and the time of completion of the project.

The GOPD steps shown in Figure 1 are as follows:

. Steps -1, 0 and 1: Inspiration. In step -1, the market opportunities are identified by analyzing the demands and possibilities. In step 0, the central problem that will guide the project is defined. In the last step of the inspiration stage, the data collection (including field visits, market study, bibliographic material survey, study and choice of analytical techniques, anthropometric survey, among others) is done.

. Steps 2 and 3: Ideation. In this phase, all the collected data are refined and with the help of analytical techniques, the project strategies are defined. Afterwards, the steps of creation of concepts, generation of preliminary alternatives and employment of tools will follow, since these will help choose the alternative that best meets the objectives outlined during the project.

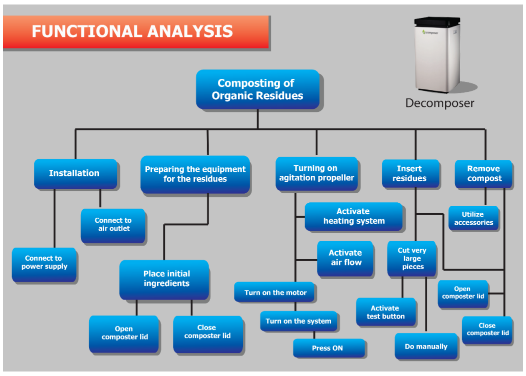
. Step 4: Execution. At this stage, organization of and adjustments to the production process are carried out.

. Step 5: Feasibility. In this stage, already having defined the proposal that meets all the specifications, the product is tested under a real scenario, with potential users. In addition to this, further research is carried

out (in the case of packaging, this can be done at sale points, for example, with potential consumers). In this item, evaluation tools of ergonomics, usability and apparent quality can be used.
. Step 6: Verification. It is the last stage; However, as emphasized previously, it can also serve to point out new opportunities, thus generating a new project cycle. This stage also involves the collection of results, the monitoring of performance and the verification of the impact throughout the whole life cycle.

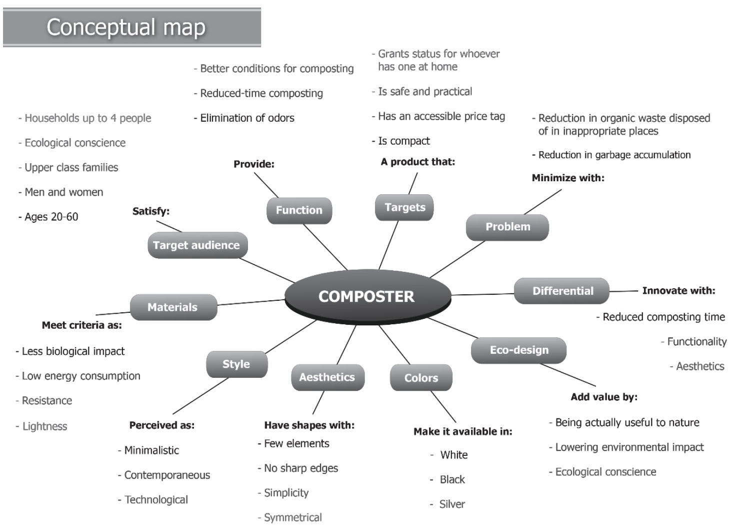
3. DESIGN PRACTICE: DEVELOPMENT OF AN AUTOMATIC COMPOSTER FOR HOME USE

Following the proposed methodology and complementing it with project techniques described by Pazmino (2013), diachronic, synchronic, functional and structural analyzes were employed in this project.
Figure 2 illustrates one of the techniques used – the functional analysis – which according to Pazmino (2013), serves the purpose of visually presenting the functions of the products to be developed. It was based on the Decomposer GG-02 model from Oklin International.



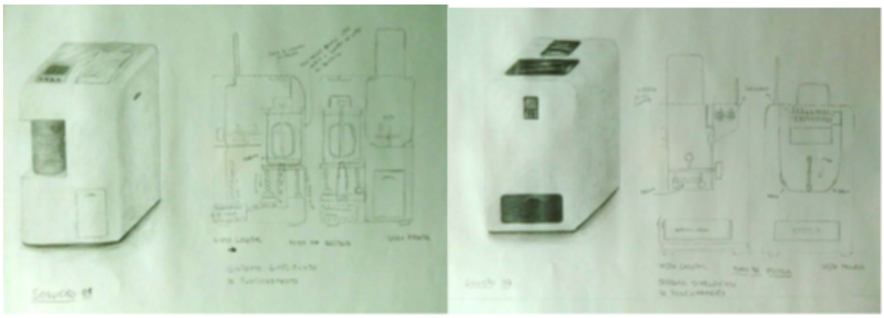
[Figure 2] Functional Analysis. Source: prepared by the authors.

Figure 3 shows the conceptual map generated, which helped define the next steps in the project activity. According to Pazmino (2013), the conceptual map is a graphic visualization that helps simplification and organization of the data obtained in the field study. Its contribution to the project is the possibility of allowing the designer to obtain new information from the association of the data sets. Several alternatives were elaborated and four of these, due to being slightly more comprehensive were pre-selected, since the visualization and understanding of the final solution were clearer with them.

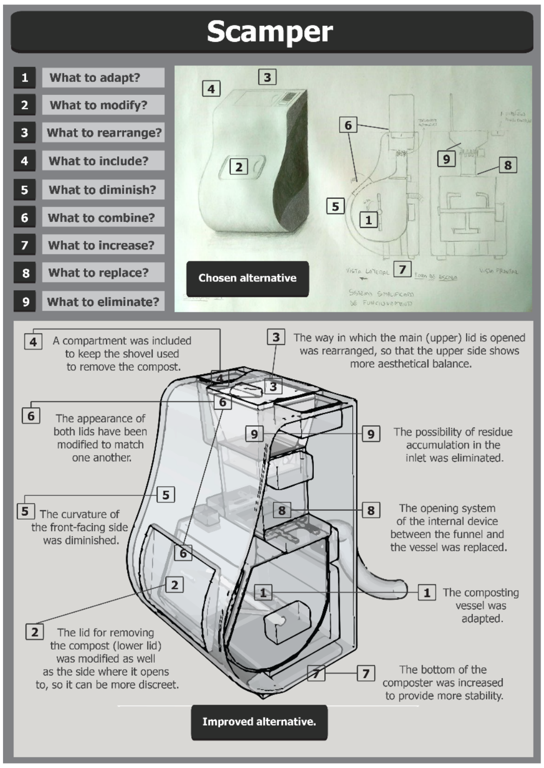


[Figure 3] Conceptual map. Source: prepared by the authors.

Figure 4 shows two of the alternatives created. With the chosen alternative, the next step was its improvement for obtaining a final solution that fulfilled the previously-determined requirements of the project. For refinement, a creative technique known as SCAMPER was chosen, which acts as a checklist to improve or re-work the chosen solution. In Figure 5, it is possible to follow the process and final result of the application of SCAMPER, a creative technique that allows the exploration of different ways of transforming an object, system or process. The tool name comes from the initials of seven words that in Portuguese mean: Substitute, Combine, Adapt, Modify, Look for other uses, Eliminate and Rearrange. SCAMPER is an evolution of another technique called MESCRAI (Librelotto et al., 2012).



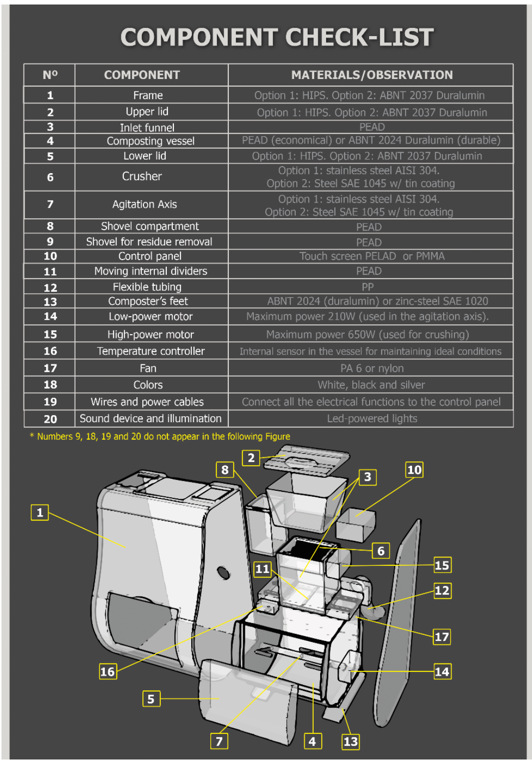
[Figure 4] Some of the alternatives generated for the composter. Source: prepared by the authors.



[Figure 5] Scamper Application. Source: prepared by the authors.

The technique was applied after the decision matrix. The next step included the specification of the product materials. Choosing the right material to be used in the making of the actual design has always been one of the great challenges for the designer. This is increasingly complex because of the amount of materials available for them to use in their projects and also, these number has increased considerably in recent years. New formulations, blends, composites, additives, apart from novel achievements in nanotechnology and modern manufacturing processes contribute to this continuous increase, requiring a careful research by the designer. Figure 6 shows all the materials selected for the product and Figure 7 illustrates the final design.

[Figure 7] Final solution. Source: prepared by the authors.



COMPONENT CHECK-LIST

Nº	COMPONENT	MATERIALS/OBSERVATION
1	Frame	Option 1: HIPS. Option 2: ABNT 2037 Duralumin
2	Upper lid	Option 1: HIPS. Option 2: ABNT 2037 Duralumin
3	Inlet funnel	PEAD
4	Composting vessel	PEAD (economical) or ABNT 2024 Duralumin (durable)
5	Lower lid	Option 1: HIPS. Option 2: ABNT 2037 Duralumin
6	Crusher	Option 1: stainless steel AISI 304. Option 2: Steel SAE 1045 w/ tin coating
7	Agitation Axis	Option 1: stainless steel AISI 304. Option 2: Steel SAE 1045 w/ tin coating
8	Shovel compartment	PEAD
9	Shovel for residue removal	PEAD
10	Control panel	Touch screen PELAD or PMMA
11	Moving internal dividers	PEAD
12	Flexible tubing	PP
13	Composter's feet	ABNT 2024 (duralumin) or zinc-steel SAE 1020
14	Low-power motor	Maximum power 210W (used in the agitation axis).
15	High-power motor	Maximum power 650W (used for crushing)
16	Temperature controller	Internal sensor in the vessel for maintaining ideal conditions
17	Fan	PA 6 or nylon
18	Colors	White, black and silver
19	Wires and power cables	Connect all the electrical functions to the control panel
20	Sound device and illumination	Led-powered lights

* Numbers 9, 18, 19 and 20 do not appear in the following Figure

[Figure 6] List of materials and components of the product. Source: prepared by the authors.

3. CONCLUSION

Designing a product using a sustainable approach is a current trend. Ecological factors have been increasingly essential to the success of a product and should undoubtedly be intertwined with other aspects of such project, such as the ergonomic, manufacturing, aesthetic, marketing and financial aspects, for example.

The project demonstrated in this work sought to take all these factors into account, resulting in a successful product from a sustainability point-of-view, with cost-benefit analyzes in the environmental, social and economic aspects, as recommended by the ESE (Economical-Social-Environmental model) approach.

The use of project methods in the design showed the importance of the systematized design procedure, with well-defined steps and using an "open" methodology. The experiments showed that this type of methodology is more adequate for the inclusion of a sustainability aspect in the design process than the use of methods considered as "closed".

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