Democratizing design: the development of a 'Design for Do-It-Yourself' framework

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Introduction: an unsustainable human-product relationship

Traditionally, design merely focuses on satisfying the increasing 'need' of consumption. However, (1) a higher level of consumption does not elevate the perceived happiness of people (Lipovetsky, 2006; Porritt, 2003). (2) Maintaining the economic principles of growth and profit, in a mass production context, promotes and accelerates the exhaustion of nature; it impedes a healthy human-product relationship and a proper relation with nature (Hirsch & Pauw, 2022). In this context, designers have been 'active agents of an un-sustainable idea of well-being', says Manzini (2006). An alternative "...Interpretation of well-being is (...) required, disconnected from a perceived need to increase consumption" (Thorpe, 2010). A reconnection would help counter so-called 'alienation' and it would align to the views of various scholars (Ehn, 2008; Pacey, 1992; Papanek, 1985) who advocate for a 'new partnership' between people and the products they use and own.

Design for DIY

Anticipating (a) today's distant human-product relationship in a mass-production context (Cerny, 1999; D. Ehrenfeld, 2003), (b) people's desire to create (Csikszentmihalyi, 1998; J. R. Ehrenfeld, 2008; Maslow, 1943; Press, 2007; Sanders, 2006; Sennett, 2008), and (c) anticipating the great potential of novel making tools and the availability of online information (Anderson, 2010, 2012; Bonvoisin, Galla, & Prendeville, 2017; Salvia, Bruno, & Canina, 2016), this paper introduces a 'Design for DIY' scenario and a novel 'Design for DIY' framework. A variety of scholars suggest that the practice of DIY promises to support a sustainable relationship between things and people, respectively between people and nature (Bianchini & Maffei, 2013; Bonvoisin et al., 2017; Hoftijzer, 2012; Salvia, 2013; Van Abel, Klaassen, Evers, & Troxler, 2011). More specifically, this paper addresses the facilitation of DIY activity, the role and responsibility of design therein, and the grounding and design of a 'Design-for-DIY' framework to help designers facilitate DIY activity.

Do-It-Yourself (DIY)

As the opposite of 'passive consumption', designing and making things for oneself aligns better with people's natural motivations (Franke, Schreier, & Kaiser, 2010). DIY enables people to express their intentions, capabilities and identity (Atkinson, 2006; Shove, Watson, & Ingram, 2005; Wolf & McQuitty, 2011). According to Schreier (2006), as a result people benefit from functional advantages, from the uniqueness of the outcome, from enjoyment of the process and from the 'pride of authorship', even in case of limited input. DIY activity enhances awareness and product attachment; it imbues a product with meaning (Csikszentmihalyi & Halton, 1981; Maldini, 2016; Mugge, Schoormans, & Schifferstein, 2009; Seldis, 2017). In short, DIY brings people closer to 'Being' (Helne & Hirvilammi, 2016; Maslow, 1998), and aligns well with Ehrenfeld's definition of sustainability (J. R. Ehrenfeld, 2008) which involves ethics, human and nature. Despite these advantages in the long run, it would be fair and valid to state that DIY activity has the potential of asking a lot time from people, and of producing waste and of littering the environment with DIY experimental results, in the short term (Hulbert, 2015).

The role of the designer, the Design for DIY scenario

According to various authors, the designer has a moral responsibility to try solving the imperfect human-product relationship (Kries et al., 2018; Myerson, 2016; Papanek, 1985; Schumacher, 2010; Sparke, 1987). Schumacher and Myerson suggest that designers need to reverse their thinking and concentrate on 'scaling down': adopting a mind-set of participation, designing for people and aiming for engagement (Myerson, 2016; Schumacher, 2010). In line with Manzini's view (2012), who suggests that designers can no longer maintain their 'monopoly on design, this paper proposes a Design-for-DIY scenario in which the designer takes responsibility and facilitates the layperson's DIY activity. The designer's role thus changes from being a directive, decisive authority to that of a facilitator.

'Design-for-DIY' studies: exploration of the 'Design-for-DIY' process

In order to gain knowledge of the process of designing for DIY, this study considers a series of four 'Design-for-DIY' studies (Table 1). The study presented here focuses on the design steps a designer can perform to facilitate a layperson's DIY activity. The studies were exploratory in nature and designed to help bring to the surface issues to take into account in developing a Design-for-DIY framework. They also helped to discern whether the notion of a generic framework capturing all the various approaches taken and design challenges

name	method	data	facilitators	participants laypersons	partipants design students
1. 'DfDIY' of a coffee maker	research through design	observation of process and results, and interviews	1 to 3	17	
2. 'DfDIY' of a desk lamp	idem	observation of process and results, and interviews	1	7	
3. 'DfDIY' of headphones	idem	observation of process and results	1	8	4
4. 'DfDIY' re-using plastics	idem	observation of process and results	1	2	

Table 1. Design-for-DIY studies

addressed would be feasible. The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Design-for-DIY studies conclusions

The insights and models from the studies serve as valuable and relevant information in search of a suitable, preferably generic, Design-for-DIY framework. They helped to map the development steps taken by the facilitator, which supported the identification of numerous common aspects of the Design-for-DIY process. All four projects included instructional media and a concrete kit that distinguished fixed elements from the free design space available to the layperson concerned. To reach their intended audiences, all the cases included a DIY platform environment to enable laypersons to enrol in the DIY project and obtain the necessary support materials. All four studies had to consider the varying layperson's skills and level of experience, which was done by distinguishing means of facilitation, accommodation and support. In line with conclusions drawn from DIY practices in history (Atkinson, 2006; Bonvoisin et al., 2017; Goldstein, 1998; Hollinetz, 2015), the studies highlighted the importance of collaboration, templates and tools for manipulation, adjusted to the layperson's level. As a general conclusion following the studies, the DIY projects appeared to be possible, feasible and doable, and the Design-for-DIY processes were reasonably similar. A generic step-by-step scenario of a Design-for-DIY process was derived from the studies.

Taxonomies of design models and frameworks

To learn and to serve as a reference for the development of a generic Design-for-DIY framework, this paper explores a relevant selection of existing frameworks and design models.

Schön's reflective practitioner model though approaches designing as a process of solving a unique problem, not as a generic step-by-step process (Schön, 1984). Roozenburg & Eekels' (1998) basic design cycle, similar to Schön's model, emphasizes its circular, thus reflective, intention. Similarly, Evans has long ago proposed a spiral-shape process model to 'highlight the iterative nature of the design process' (Evans, 1959; Vossen, Kleppe, & Randi, 2013; Wynn & Clarkson, 2018). He argues that a design project cannot be run through following a sequential process alone. He suggests a procedure of iteration, reflection, and refining; a spiral shape.

Since 'Design for DIY' specifically and clearly comprises the elements of reflecting and experimenting, as the 'endless' learning cycles of Kolb (Kolb & Kolb, 2008) and Gibbs (Gibbs, 1988) do, a cyclic and 'prescriptive' character would suit best for the Design for DIY framework.

DIY process models

When regarding specific design models or frameworks for DIY or Design for DIY, Fablab (Bo-Kristensen, 2018; Gershenfeld, 2012) has depicted its 'designing the design process' model in their Fablab manual, approaching it from an educational perspective: the model clearly distinguishes the concentric shells of (1) setting learning goals, (2) arranging design materials, and (3) design activities. Although this model does not operationally guide the designer in facilitating DIY, the model is relevant for this study, as it distinguishes the different cycles of preparation, and the design stages inside the most centric design activities shell.

Set up of a Design-for-DIY framework

The knowledge gained in this research serves as input for the construction of the Design-for-DIY framework, a means to help the designer set up DIY projects. Additional to the aforementioned challenges, the Design-for-DIY framework should address both the designer tasks and the steps to be taken by the layperson, each of which forms a design process by itself. The framework, consequently, needs to describe a process model inside a process model. All has led to the insight that 'Design-for-DIY' requires a novel Design-for-DIY process model.

Key elements from that gained knowledge have served as requirements for the shape and structure or the framework (see Table 2). We highlight two of them.

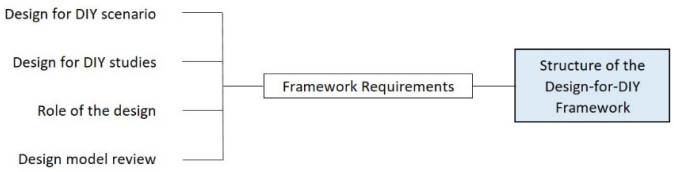

Table 2. Knowledge and requirements for the setup of the Design for DIY framework

(1) The Design-for-DIY scenario and the Design-for-DIY studies have taught us that the entire process is represented by a 'sequential' range of distinctive design cycles, to be executed one cycle after the other, and that each of those tasks can be seen as a process by itself. Additional to the consideration of example frameworks from literature (Bo-Kristensen, 2018; Vossen et al., 2013) and from the Design-for-DIY studies, this pleads for a multi-level approach. (2) Both literature (Peppler & Bender, 2013) and the Design-for-DIY studies indicate the pedagogic character of 'Design-for-DIY' and the importance to support creativity, elements associated with circular and even with spiral shapes and structures that represent designers' cognitive processes.

All the findings together in this study have contributed to the development of the multi-cyclic Design-for-DIY framework depicted in Figure 2, comprising two dimensions: (1) the dimension of concentric design cycles (tasks, functions) to perform, and (2) the analytical and iterative design stages that are part of each cycle.

Design levels represented in the cycles of a Design-for-DIY framework

The proposed Design-for-DIY framework represents the major design tasks to be done, at different decision levels. The model aims to facilitate a dialogue between the designer and the layperson. The concentric shape also reflects the iterative cyclical character of models for teaching and learning documented by various scholars (Gibbs, 1988). The option

of re-running a cycle resonates with the 'learning-by-doing' approach.

Figure 1 shows the proposed spiral shaped Design-for-DIY framework. Each cycle prepares for the next, in centripetal direction. The order in which successive cycles are positioned in the framework is considered fixed, however the designer is free to improvise, and choose his or her preferred path.

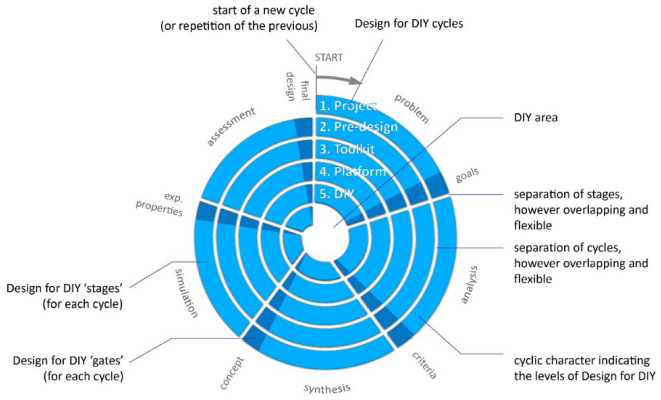

Figure 1. The proposed Design-for-DIY Framework and its elements, visualizing its dimensions: the cycles and the stages.

Referring to Figure 1, cycles 1 to 4 represent preparatory and facilitating tasks by the owner/designer, while the fifth (the DIY cycle) is where the layperson actually undertakes the DIY project, guided by the designer.

Cycle 1: The Project cycle helps to define the goals and contents. The layperson's interests, the product's suitability and accessibility, all need to be considered, as was e.g. the case in study #1. *Cycle 2:* The pre-design serves as a preliminary product design and as a reference for the project, as well as an example for the layperson. Activities in the Pre-design cycle are geared towards anticipating DIY options. The need for such a cycle was observed in all four case studies. *Cycle 3:* The design of the toolkit, a fundamental element of all Design-for-DIY cases run, should include clear task allocation (to what extent is the layperson involved, and for which aspects), specific tools and instructions, and e.g. a specific design-space medium that supports relevant techniques. *Cycle 4:* The Platform cycle considers designer support, tangible and digital materials for inspiration, examples, and e.g. community and network. Related to this, this cycle should cater for a 'post-design' re-interpretation step, in respect of manufacturing, safety, aesthetics and so on. The Design-for-DIY studies #2 and #3 indicated the value of such a 'Post-design' step. The Platform should be inviting, attractive and accessible, and potentially offer multiple projects. *Cycle 5:* The DIY Design cycle is when the layperson is invited to perform their DIY task, guided to a greater or lesser extent by the facilitating designer.

Design process stages represented in each of the framework's cycles

Explained, each of these cycles comprises a full and iterative design process. Either a model as e.g. the Double Diamond model (Design-Council, 2019) or Roozenburg and Eekels' Basic Design cycle could represent the stages within each of the cycles. The latter has served as a reference here.

Validation

An experiment was conducted to evaluate the Design-for-DIY framework as a method, in which twelve designers were asked to develop a DIY project for laypersons to facilitate them in designing and making their own radio receiver. The experiment's research questions, the procedure, the results and conclusions are described below.

Goals and experiment research questions

The goal of the experiments was to evaluate the quality of the Design-for-DIY framework using questionnaires for numerical assessment. The research questions addressed in undertaking the Design-for-DIY experiments centred on the quality and usability of the Design-for-DIY framework as a method and tool to support the designer in establishing a DIY project for the layperson. The specific Experiment Research Questions (ERQ's) were as follows:

ERQ (1). Do designers judge the Design-for-DIY framework as complete?
ERQ (2). Is the Design-for-DIY framework clear?
ERQ (3). Is the Design-for-DIY instructional video clear?
ERQ (4). Do designers perceive the framework as providing sufficient freedom to design?
ERQ (5). Is the Design-for-DIY framework sufficiently accessible?
ERQ (6). Does the Design-for-DIY framework provide new knowledge for building DIY projects?
ERQ (7). Do designers understand the reasoning behind the Design-for-DIY framework?
ERQ (8). How can the Design-for-DIY concept (the vision of Design-for-DIY) and the Design-for-DIY framework be implemented?

Experiment set up and method

The experiments concerned six runs (Table 3), I to VI, each conducted by a different pair of collaborating designers. In doing the experiments, each pair of designers were assigned to the task of running a 'Design-for-DIY' project' by using a set of tools for support: The Design-for-DIY framework (presented as a board game), sketching tools, paper, glue, tape, radio electronics (for indicating the size of the components).

name	method	data	facilitators
experiment I	research through design	observation of process and results, and interviews (Lickert scale)	2
experiment II	idem	idem	2
experiment III	idem	idem	2
experiment IV	idem	idem	2
experiment V	idem	idem	2
experiment VI	idem	idem	2

Table 3. Design-for-DIY experiments: Design-for-DIY of a radio

Detailed spreadsheets and footage showing all the experiment results are available from the corresponding author, upon reasonable request. The experiments concentrated on cycles 2 to 4 of the framework, respectively on the stages from 'problem' to 'concept' within each cycle.

Results and findings

The questionnaires subsequently completed by the twelve participants have generated numerical data on a Lickert scale (graded responses to closed questions). These are presented

below, in turn. The data that support the findings of this study are available from the corresponding author, upon reasonable request. Table 4 shows the results from the questionnaire completed by participants following the experiments. It shows only significant results. The maximum number of responses to each question was 12, since there were 12 participants. As we were interested only in retrieving the positive and negative opinions, since the random results would have been either positive or negative, all neutral scores were omitted from the X^2 analysis.

Research Question (ERQ)	Questionnaire question		N	Positive answers	χ^2
ERQ (1)	Q5	To what extent was the process you ran complete?	10	9	6,40
ERQ (1)	Q20	How would you rate the completeness of the framework?	12	10	5,33
ERQ (1)	Q1	How confident are you that the layman is capable to create his own radio with the kit you designed?	12	12	12,00
ERQ (2)	Q4	To what extent did you specifically address the division between the fixed part by the designer and the design space for the layman?	12	12	12,00
ERQ (2)	Q26	How would you rate the cycle arrangement? (order of cycles)	9	8	5,44
ERQ (2)	Q28	Please rate the clarity of the position of the predesign cycle in relation to the entire DfDIY framework.	11	11	11,00
ERQ (2)	Q29	Please rate the clarity of the position of the toolkit cycle in relation to the entire DfDIY framework.	11	10	7,36
ERQ (2)	Q31	How would you rate the suitability of the followed process steps for other DfDIY cases?	11	9	4,45
ERQ (3)	Q36	How would you rate the clarity of the movie used in this experiment?	11	10	7,36
ERQ (4)	Q9	How would you rate the amount of design freedom you had when creating the kit?	12	11	8,33
ERQ (5)	Q10	To what extent did you feel comfortable to start designing?	9	8	5,44
ERQ (6)	Q32	To what degree did the use of the framework increase your knowledge, considering 'Design for DIY'?	8	7	4,50
ERQ (7)	Q33	How do you rate the clarity of the reasoning behind the framework (why the framework is developed)?	10	10	10,00
Q = questionnaire question					
X2 = Chi square					
ERQ = experiment research question					
N = answers except neutral answers					

Table 4. Numerical results from experiments I - VI: Only significant results are shown (df=1, $p<0.05$). Results are significant if $X^2 > 3,84$ (a result from df=1, $p<0.05$, according to standard X^2 table).

Discussion and conclusions

Reflecting on the quality of the Framework

The framework does address the different design tasks and design abstraction levels, it offers freedom to design your own path as a designer, and it addresses the iterative and pedagogic character that was required. It seems plausible to conclude that the participating designers judged the quality of the proposed framework as positive. The framework provided guidance, appeared to be fairly clear, suitable and complete. The outcomes of the experiment allow us to conclude that the goal of 'creating a Design-for-DIY framework that sufficiently helps the designer to develop and establish a DIY project' has been achieved, which contributes to a sustainable approach to product design and making, through the small-scale and democratised approach of design for DIY. Hence, the outcomes align to the ambition of the paper.

Limitations

Albeit the results of the questionnaire answers in Table 4 are significant, according to the X^2 analysis methodology, which means that the answers are definitely not random, it would be valuable to conduct further experiments in search for potential areas for improvement, and in search for the character of these improvements. Further, the authors advice to carry out studies that include an active role of the layperson to whom the Design-for-DIY framework is addressed, and so learn from the implementation of the Design-for-DIY framework.

Implications and future research

To sketch an optional scenario for what Design-for-DIY could entail, the designer's capacity could be envisioned as serving the supplier of either DIY materials, DIY tools, or the platform (compare Maker Nexus). The designer could also be subsidized by the (local) government to propel people to engage in DIY and making activity. As attitudes and contexts change, the Design-for-DIY approach has the potential to gain ground. Our framework and the accompanying vision could help to increase awareness and so inspire the democratization of design, e.g. through teaching the concept of Design-for-DIY as part of design curricula. In manifesting the Design-for-DIY vision, the framework stresses the importance of the responsibility designers should take.

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