Attachment, Durability and the Environmental Impact of Digital DIY

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ABSTRACT The recent popularization of amateur design practices and digital fabrication tools has been accompanied by a vast discourse announcing the emergence of a new production and consumption paradigm. This new participatory model has been assigned, among other benefits, environmental advantages over more traditional ways of manufacture and trade. However, most of these expectations are based on the possible rather than the actual usage of digital tools. This article questions the assumption that digital DIY is substituting mass production with a more sustainable model and presents a different panorama of the implications of digital DIY based on an ethnographic study of the FabLab Amsterdam users.

KEYWORDS: digital DIY, attachment, durability
Introduction

Design studies scholars are increasingly demanding that the discipline encompass everyday objects and amateur practices. As early as 2000, Judy Attfield (2000: 46) acknowledged the importance of this wider point of view concerning the discipline’s object of study: ‘beyond the group of self-aware designers there is also a contingency of makers who do not see themselves as designers but nevertheless contribute to the physical substance of the material world’. Not to contemplate this vast material production would mean neglecting a whole universe of objects that reflects and transforms our everyday culture.

This study looks at the rising popularity of ‘do it yourself’ (DIY) practices, in particular those aligned with the current emergence of digital fabrication tools, a branch of DIY referred to here as ‘digital DIY’. Although DIY practices have not received much attention from design historians, there have been some attempts to study the variety of meanings and techniques associated with it throughout history. A special issue of the Journal of Design History on the subject offered an important contribution to the field (Atkinson, 2006), with the articles in this publication revealing how DIY has been associated with various social phenomena throughout history.

Researchers portray the attitude of DIY communities today as anti-consumerist, rebellious and creative, with an inclination to produce rather than buy what they need or want (Kuznetsov and Paulos, 2010). In the realm of material objects, the manufacturing possibilities for digitally connected makers have recently been enhanced by the popularization of digital fabrication tools. These tools create material objects from digital designs, the most popular examples being 3D printers (which build objects by adding plastics or other materials layer by layer), laser cutters (which cut or engrave sheet materials) and milling machines (which can subtract matter from similar materials in a mechanical, computer-controlled way). The combination of increasing connectivity and small-scale digital production is enabling makers to create objects in new ways and has led scholars to identify a ‘renaissance of the DIY movement with a high-tech facet’ (Mota, 2011: 283).

The development of the digital DIY movement has been accompanied by a vast ideological discourse, mainly visible in popular media but also influencing academic production.

The possibility of replacing the traditional model of mass production with a complex and organic system in which users create their own designs, share the blueprints online and can manufacture objects on the domestic scale has led some to announce a ‘new industrial revolution’ (Anderson, 2010). While the model of digital DIY certainly enhances the agency of users and gives them autonomy from manufacturers – presumably resulting in an overall material production much more focused on users’ individual preferences and needs – there are many other expectations that emerge from this...
Attachment, Durability and the Environmental Impact of Digital DIY

This study discusses one of these expectations: the notion that digital DIY can replace mass-produced objects with more durable ones, reducing the resources needed (and waste produced) to meet consumers’ desires and needs.

The hypothesis of the longevity of DIY objects is based on the idea that the involvement of consumers in the phases of design and manufacture may increase their attachment to the resulting pieces (Laitio, 2011). To understand the extent to which these expectations are met in digital DIY practice, this study used an ethnographic approach, studying individuals who have used digital fabrication tools to make objects for their own use in the last five years. The findings suggest that: (1) digital DIY objects are not substitutes for mass-produced ones; rather, they generate a new kind of product, increasing the precision and relevance of DIY; (2) participants place a high value on their projects, to which they are particularly attached; and (3) this strong attachment to the project, however, does not imply that the material results are irreplaceable (and therefore more durable); on the contrary, the technology employed has its own agency and makers consider their objects easily replaceable, reducing the possibility of a long lifespan.

Environmental Value of Digital DIY

As pointed out in the previous section, the widespread practice of digital DIY is expected to have a considerable influence on the use of resources and the production of waste in the manufacture of goods. The majority of actors involved in the discussion argue that this model has environmental advantages over traditional mass production. Their main points are that: (1) production becomes local and the distribution of blueprints employs less energy than the transport of goods (Birchennel and Urry, 2013; Easton, 2009); (2) this mode of consumption is based on ‘pulling’ rather than ‘pushing’ goods, meaning that manufacture is made by users on demand, avoiding unnecessary production (Avital, 2011; Muren, 2010); and (3) the involvement of users in the design and manufacture of objects contributes to a particular attachment, which discourages early replacements, extending the lifespan of objects (e.g. Laitio, 2011).

Some scholars, however, take a more nuanced stance and question the assumption that participatory design or digital self-manufacture are unquestionably associated with a positive environmental shift. Catarina Mota (2011), a scholar in digital fabrication, has acknowledged that:

Digital fabrication tools can turn out to be either a much more sustainable form of production or the generators of an enormous amount of additional refuse ... The ability to have something manufactured only when and where it’s needed would also considerably decrease fuel consumption, pollu-
tion and surplus waste. On the other hand, precisely the fact that products can be made at the push of a button may lead us to regard them as disposable and easily replaceable, thus decreasing the product’s life cycle and greatly increasing the amount of waste. (285)

Several studies on consumer participation support the hypothesis of more valuable (and presumably more durable) objects resulting from the involvement of users. In 2004, Franke and Piller (2004) studied the responses of individuals designing their own watches based on an online system of toolkits provided by a firm. This firm would later produce the personalized watch following the principles of mass customization. The researchers found that users are willing to spend, on average, 100 per cent more on their personal design than on standard watches produced by the same firm. In the same line, Norton et al (2012) carried out four studies in which they compared the value given by research participants to cardboard boxes. They identified that participants assembling their own boxes were willing to pay 63 per cent more than those who were offered an identical ready-made box. The authors acknowledge, however, that this counted only for ‘successful’ labour, thus for those who completely assembled the boxes according to the instructions.

Professor of Consumer Research, Ruth Mugge (2008), has studied the phenomena of attachment and durability in detail, with one of her studies concerning the personalization of products. After comparing a group of bicycle owners that had personalized their bicycles to a group that had not, the author concluded that personalization had a positive effect on durability. Mugge (2008: 111) explained this phenomenon as due to the irreplaceable nature of the personalized object: ‘only this specific object resulted from the person’s involvement and it is difficult or in some cases even impossible to create an identical product again’. These studies point to a high attachment to digital DIY objects when they involve personal design, self-manufacture and other forms of personalization. However, the monetary value attributed to an object at a specific moment does not necessarily lead to durability; moreover, the process of design and manufacture in digital DIY is very specific and has its own implications for attachment to objects.

Attachment, Durability and Consumption from a Design Perspective

Attachment to objects has been studied from various perspectives, from psychology to consumer studies (e.g. Belk, 1988; Ball and Tasaki, 1992; Csikszentmihalyi and Rochberg-Halton, 1981). Kleine and Baker (2004) have provided a detailed overview of academic production on the subject. The authors define attachment as a multifaceted property of the relationship between individuals and objects.
that have been psychologically appropriated, de-commodified and singularized through person-object interaction. Many of the studies on the subject have focused on ‘cherished possessions’, such as heirlooms (e.g. Csikszentmihalyi and Rochberg-Halton, 1981); however, design academics have pointed out that these are not particularly relevant to the field: the interest in an attachment to objects from a design perspective is related to the durability of consumer products and ‘it cannot be expected that every product will become irreplaceable thanks to the memories that will grow up around it, or to its family references’ (Verbeek, 2005: 224).

Design scholars’ considerations of attachment have been significantly motivated by its association with the environmental benefits of durable products (Mugge, 2008; Odom et al., 2009; Schifferstein and Zwartkruis-Pelgrim, 2008; Verbeek, 2005). The premature replacement of products is identified as a major contribution to the magnitude of resources used and waste produced to feed our model of consumption. Hence, it is argued that a strong emotional bond with objects could prevent these early replacements, leading to less consumption and consequently to the reduction of its adverse outcomes (e.g. Mugge, 2008: 10). In fact, people tend to keep products to which they are attached and they often exhibit protective behaviours towards them (Ball and Tasaki, 1992: 156; Mugge, 2008: 117). Nevertheless, scholars have acknowledged that strong emotional bonds do not necessarily lead to durability, since attachment changes over time (Ball and Tasaki, 1992; Mugge, 2008; Richins and Bloch, 1986; Schifferstein and Zwartkruis-Pelgrim, 2008). Mugge (2008: 53) has pointed out that ‘from a sustainability perspective, it is essential that the attachment to a product is long-term. Only then, the experience of attachment can postpone replacement’. The author has performed several studies concerning attachment and durability, concluding that:

If the product is replaceable, the strength of the person-product relationship strongly depends on the characteristics of competitive products. As long as the product and its meaning can be separated, other products can convey similar meaning and may thus take over the product’s special meaning to the owner … To stimulate long-term product attachment, products should thus convey a special meaning that is irreplaceable’. (Mugge, 2008: 81–82)

Therefore, only a long-lasting emotional bond to objects considered to be irreplaceable can reduce consumption.

Peter Paul Verbeek (2005), Professor of Philosophy of Technology, has acknowledged the agency of the object itself for the development of a long-lasting relationship with its owner. Based on a post-phenomenological perspective, the author claims that this agency is related to the primary function or materiality of artefacts,
not to secondary or sociocultural functions. The implications for this discussion are that only a strong bond with a concrete object can influence durability, because its symbolic value could be equalled by another object with similar meaning. According to Verbeek, the post-phenomenological perspective accords with the notion of the ambivalence of technology, since technological artefacts mediate experience by closing off some possibilities and opening up new ones. He makes clear that ‘in fulfilling their functions, artefacts do more than function – they shape a relation between human beings and their world’ (2005: 208). From this point of view, this study questions the assumption that digital fabrication tools shape these relationships in a way that diminishes consumption; on the contrary, it is pointed out how this technology increases the quantity of goods produced, arguably leading to a growing use of resources and waste production.

Measuring Attachment

Given the discussion on the expected effects of digital DIY mentioned above, this study is based on the way these tools are actually used, rather than on their possible applications. Accordingly, this research uses an ethnographic approach, studying individuals who have employed digital fabrication tools to make objects for their own use in the last five years. The investigation was carried out in the Netherlands, within the community of the FabLab Amsterdam and in collaboration with Waag Society – Institute for Art, Science and Technology – which is the institution in charge of the lab. FabLabs are laboratories where individuals can walk in and use digital fabrication tools free of charge, with the only condition being that their projects are shared online, so that the entire community can benefit from each member’s experiments.

Observation of the activity in the lab revealed that users of the FabLab Amsterdam develop projects of various natures, only some of them relevant to this study; therefore, an online survey was used to identify the appropriate participants. From the 190 users of the FabLab Amsterdam who completed the survey, 11 had designed and manufactured objects for their own use and were willing to be interviewed. Interviews were carried out by the author, at the location where participants actually used or kept their objects if possible. As the aim of the study was to provide a general overview of digital fabrication and the participants selected had only used the laser cutter and milling machine, two users of 3D printers in the FabLab Utrecht (Protospace) were included in the group (see Table 1, column 5). They were recruited through an email sent to all of the members of the lab who had used 3D printing. Table 1 presents an overview of all of the respondents interviewed for this study and their FabLab projects.

The interviews were based on a semi-structured questionnaire and attachment was assessed qualitatively. Previous surveys of con-
| Maker | Object | Date of fabrication | Quantity produced | Materials | Manufacture process | State in February–March 2013 | Alternative to digital fabrication |
|-------|--------|---------------------|-------------------|-----------|---------------------|-----------------------------|----------------------------------|
| Frank | Mould for stencils | Sept 2012 | 2 | Cardboard | Laser | Thrown away | Traditional DIY |
| Jeroen | Spice rack | 2008 | 2 | Plexiglas | Laser + assembly | In use | None or traditional DIY |
| Mickael | Stamp | Oct 2011 | 2 prototypes1 final | Rubber | Laser | Two thrown away One in use | Traditional DIY |
| Alex | Part of a suitcase | Jan 2012 | 2 prototypes1 final | Foam | Milling | In use | None or traditional DIY |
| Michele | Magazine stand | July 2011 | 1 | Plywood | Laser + assembly | Thrown away | None |
| Rob | Key rings | May 2012 | 20 prototypes | Leather | Laser | Some in use Some stored | None |
| Suzanne | Jewellery | Oct 2012 | Several prototypes 4 final | Plexiglas, wood | Laser | Some in use Some thrown away Some stored | Traditional DIY |
| Floortje | Animation machine | Sept 2010 | 25 prototypes 200 final | Paper | Laser | Some in use Some given away Some thrown away | Traditional DIY (less quantity) |
| Jorn | Lamp | 2010–2012 | 1 prototype 1 final for himself 11 for others | Laminated wood, Plywood | Laser + carpentry | One in use Some sold Some stored | None |
| Rogier | Door | Dec 2011 | 3 | Plywood | Milling + carpentry | In use | Second-hand purchase |
| Barbara | Bag | Beginning 2011 | 1 | Leather | Leather craft + laser | Sold | Traditional DIY |
| Boy | Tap washers | Mar 2012 | 30 | PLA | 3D printing | Some in use Some stored | None |
| Ed | Lamp base | April 2012 | 1 prototype 1 final | PLA | 3D printing | In use | Traditional DIY |
sumer attachment have measured the strength of people’s bonds with their objects through, for example, irreplaceability (e.g. the extent to which the meaning of a clock could be replaced by an identical one; Schifferstein and Zwartkruis-Pelgrim, 2008), product care (e.g. frequency of car washing; Richins and Bloch, 1986) and self-extension (e.g. extent to which a car reminds respondents of who they are; Ball and Tasaki, 1992).

The interview outline for this study included issues such as the use of the objects, the place where they were kept and how they were cleaned or maintained. Moreover, respondents were asked about their willingness to lend or sell the objects, or buy them back if they were no longer in their possession. To widen the discussion of the environmental implications of digital DIY to include other considerations (as introduced in the literature review), participants were also asked about their use of resources and the amount of waste produced. The answers to some of these questions are summarized in Table 1, an analysis of the implications of digital DIY based on the participants’ responses is presented in the following section.

Digital DIY: Less Consumption?

As shown in Table 1, the objects produced by the group interviewed are of a varied nature. Overall, they respond to very specific needs or desires, some of these being long-term (as Rogier’s doors, in Figure 1) and others short-term (as in Floortje’s machines, to be used only once during animation workshops: Figure 2). The specific and personal character of these objects is not surprising, since DIY was for the great majority the only possible way to obtain what they wanted. To understand the extent to which digital DIY functioned as a substitute for mass production or other forms of manufacture, respondents were asked what they would have done if digital fabrication tools had not been available (see Table 1, column 7). Based on their responses, we can conclude that digital DIY is not a substitute for mass production, but tends to be a substitute for traditional DIY (Table 1, column 7: Traditional DIY) or creates a new category of objects that otherwise would not exist (Table 1, column 7: None). This first finding is remarkable, since it reveals that comparisons of the environmental implications of digital DIY with those of mass production are irrelevant, and that this technology increases the amount of goods actually being produced and consumed.

To start uncovering the question of attachment in digital DIY it is relevant to point out the feelings of participants regarding their experience. Most of the interviewees were excited to talk about their projects, they were proud of them and felt that what they got from the process was worth the effort invested. Being involved in DIY had various benefits according to their comments. Boy, who 3D-printed parts for water taps, acknowledged the gratification in solving functional problems in an autonomous way: “every time I open the valve
is a victory, it makes me happy’. Other interviewees, such as Floortje, highlighted the satisfaction of overcoming challenges as well as the emotional results of the experience: ‘it was really, really nice … I worked really hard to create the right design … I really wanted to have it … it was a good feeling’; yet others emphasized the value of the process itself. Jorn, who decided to design and manufacture a lamp with his friends as a replacement for a lost heirloom, saw it as an enjoyable experience: ‘when looking at it I see more the fun in making it, and enjoying the time with my friends. And all these technical things, to work on it, that was quite fun for me’.

In fact, the process of making and its outcomes can inscribe the objects with a special meaning, Suzanne’s opinion was that ‘it’s extra cool if you have made it yourself’, especially in her case, as her jewellery ‘was quite successful’. Mickael has a similar evaluation:
‘It has a special value because we were happy with the result’. The testimonies of Boy, Floortje, Jorn, Suzanne and Mickael show that respondents developed a strong emotional bond with their projects. As the second finding of this study, this particular attachment supports the findings of some of the studies presented above in the literature review.

However, valuable projects do not necessarily lead to durable objects. Those who were not satisfied by the resultant pieces decided not to keep them, even if the ideas behind them were still important; examples of this phenomenon are Michele’s magazine stand (used during one month and destroyed later because ‘it was ugly’) and many of the objects considered ‘prototypes’ by other interviewees (see Table 1, column 3). The association of digital DIY with durability is further restricted by the fact that users of digital fabrication tools can create accurate objects with little investment in time or effort. As a result, this form of production becomes suitable for disposable objects. Frank’s mould for stencils, intended to be used ‘two or three times’, is just one example.

To better understand the implications of digital DIY in terms of attachment and durability, it is worth analysing the particular process of creation involved. Unlike traditional DIY projects, digital technologies entail a long ‘virtual’ design process, during which makers create objects using software, and a comparatively short process of ‘material’ production or fabrication. Each stage has its own results: blueprints and material objects respectively. This strict method of design is the price makers pay for the precision of the results. Alex recalls that ‘to make this I have to go through the linear process of doing everything mathematically, in millimetres, it’s not like playing...
with clay … with digital manufacturing you really need to have a clear idea and give clear instructions to the machines’.

The complex process of virtual creation, which leads to a simpler material production, is one of the distinctive characteristics of digital manufacture. This technology has, in Verbeek’s terms, its own agency – it not only influences the type of objects produced (as seen in the previous sections) but also how they are produced. Alex acknowledges that ‘the machines impose rules on you, on how you think and what you think … You use the rules of thinking of these machines’. The process described above influences makers’ attachment to objects, because digital fabrication tools require little effort to produce each of their easily replicable objects. The third finding of this study indicates that objects are considered replaceable by their makers, and therefore are not likely to diminish consumption.
During her interview, Barbara seemed particularly aware of this phenomenon. When talking about selling or giving away her leather-craft bags, she acknowledged how difficult it was to let them go: ‘that’s with everything I make: I really find it hard to sell them or to give them away … they are my little babies’. However, when asked about a laser-engraved decorative plaque, also self-made, she had a different feeling: ‘then it’s OK, because I know that I can make another one really quickly. It’s the effort that it takes to make another one … if it’s just a matter of placing the material and uploading the drawing, that’s OK’. In fact, the interviews revealed a strong link between the effort invested in each piece and the level of attachment; those manufacturing ‘at the push of a button’ were, in general, willing to give away their objects, even when they had a strong emotional bond with the overall project. This was the case in Floortje’s animation machine (Figure 2), Boy’s tap washers (Figure 3) and Ed’s lamp base (Figure 4).

The participants’ attachment to the project (the process) rather than the object (result) has further implications for consumption. Those interviewees who had created their objects some years ago (see Table 1, column 2) had already considered or made improved versions (e.g. Jorn’s lamp with an enhanced base, Jeroen’s idea of a...
new rotating system for his spice rack and a more recent plastic version of Floortje’s animation machine), suggesting that these ongoing projects can continue to produce material objects.

The findings of this study imply further qualifications regarding the notion of the ‘green’ value of digital DIY. Respondents used considerable amounts of resources and waste, as the materials employed were not local (they required transportation: see Table 1, column 4) and were not available in the exact quantities or sizes needed for fabrication, forcing makers to acquire unnecessary amounts. An exception to this general picture of increasing production and consumption in digital DIY is the fact that it enables users to repair objects. Figures 3 and 4 show that Boy and Ed used the 3D printer to reproduce parts of mass-produced objects that were otherwise not available or very difficult to make; in these cases, digital fabrication tools overcame the need to replace standard products, extending the lifespan of the original objects. In fact, digital DIY improves the ‘transparency’ of objects: users engaging in design and manufacture understand how things work and can repair or upgrade them (Verbeek, 2005: 226–228). This category of flexible material production might adapt more readily to the changing needs or desires of users, while its repercussions for the use of resources will depend on a willingness to re-use parts rather than produce new products.

Discussion and Recommendations

The previous section revealed how digital DIY does not diminish production or consumption but increases both by creating a new category of personal objects previously very difficult to make. Moreover, the associated technology separates the phases of virtual design and material production, simplifying the manufacture of each object, which becomes easily replaceable. As digital fabrication tools unify the infrastructure needed for the process of production (they are particularly versatile compared with traditional tools) and improve the accuracy of the results, this form of DIY may become increasingly applicable to more people in a greater variety of circumstances. My conclusion is that this technology enables increasing consumption. This is based on an analysis of actual digital DIY practices and challenges the arguments of others with respect to the possible implications of digital fabrication tools. Overall, this method of production extends the reach of DIY, since blueprints can be freely shared and distributed, and objects effortlessly reproduced. Far from being negative, these observations lead to a very promising panorama in which consumers are not restricted by the will of companies to meet their material needs; rather, they are empowered to solve their own problems and to share their solutions with peers (Kuznetsov and Paulos, 2010).

Makers enjoy the process of design and manufacture, even when it is challenging; they learn and often feel proud of the results
The feelings described by participants regarding their experience seem closely related to the feeling of ‘flow’, as described by Mihaly Csikszentmihalyi (1991), who has acknowledged that by making things happen, rather than being commanded by outside agencies, people feel in control of their lives and perceive its sense. The enjoyment felt in the rare moments in which the ‘body or mind is stretched to its limits in a voluntary effort to accomplish something difficult or worthwhile … becomes a landmark in memory for what life should be like’ (1991: 2–3). This is the real value of digital DIY, it empowers users to fulfil their needs in an autonomous way, resulting in a more diverse, ‘human-scale’ material culture and feelings of enjoyment and achievement resulting from taking action.

Nevertheless, even considering the positive impact of this technology, we should be concerned about the implications of its popularity for the environment, since it implies easily accessible and distributable material production. Recommendations that may diminish this negative impact include:

- Educating makers to consider the environmental implications of their design decisions: promoting the use of local and recycled materials, highlighting the value of repair and re-use, and considering the efficiency of production beyond the individual level.
- Promoting fabrication centres such as FabLabs rather than digital tools on a domestic scale. These centres may result in a more efficient use of resources, since they might create a supply base of popular materials that can be used by several makers, reducing the energy used for transportation, as well as waste. In the same line, the shared space and experience may lead to more effective practices, with the use of fewer resources throughout the process (e.g. producing fewer prototypes).

**Suggestions for further research**

This study focused on the environmental expectations attached to digital DIY, in particular on the notion that this form of production replaces mass-produced goods with more durable products, diminishing consumption. The subject was approached through an analysis of actual digital DIY practices and qualitative research among users of FabLabs in Amsterdam and Utrecht in the Netherlands. Further insight into the same phenomenon might be gained from studying other cases in which this practice actually replaces mass production. A comparative life-cycle analysis of both categories of objects would allow us to better understand the environmental implications of digital DIY.
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Disclosure statement
No potential conflict of interest was reported by the author.

Notes
1. For the results of the survey see Who is working in the FabLab Amsterdam. [online]. Available at:http://waag.org/en/blog/who-working-fablab-amsterdam [accessed 6 May 2013].
2. The positive feelings of interviewees towards their projects may have led this particular group to participate in the study in the first place; therefore, these findings cannot be considered representative.
3. Interviewees were asked: ‘What if digital fabrication was not available?’, responses like Jorn’s: ‘I don’t think there would be a lamp’, were classified as ‘None’ while others such as Frank’s: ‘before using the FabLab I was making them by hand’ were categorized as ‘Traditional DIY’.

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Biography

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