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Making and unfinishedness: designing toolkits for negotiation

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Abstract: The diffusion and democratisation of computing technologies and physical prototyping systems has supported the rise of Do-It-Yourself culture. In the context of design innovation, this shift has undoubtedly blurred the lines between the roles of amateur and professional. Crowdsourcing platforms providing easily accessible, lightweight services to promote and fund ideas for new products can potentially radically compress the timescale from new concept generation to market. However, questions are emerging around these adjustments in the roles of amateur and professional, and to what extent individual makers and their communities can participate in, and benefit from, this new landscape. This paper will examine this situation using the framing of a “toolkit design and development” approach. We discuss the toolkit approach by drawing on the work of a current cross-European, interdisciplinary, collaborative project that is developing a technology toolkit to enable creation of locally based DIY networking systems.

Keywords: Toolkits, Maker culture, Do-it-yourself, Networking, Pleasure

1. Introduction: Changing Design Landscapes

We are now in the midst of a new Do-It-Yourself paradigm (Fox, 2013, Kuznetsov & Paulos, 2010) as the shift of attention moves from user-generated content in the form of intangible or virtual media such as music, opinion and news, to tangible, physical innovations and products. Due to the rise of open and small-scale production systems, the existing manufacturing paradigm - where there is an inherent trade-off between originality and economical production - is being broken. It is now possible to create highly personalised and individual items in a reasonably economical and efficient way. This opens up a new world of Do-It-Yourself making practice, and it also places a greater importance on the design of effective enabling technologies, services and knowledge infrastructures to support these activities. Of high importance in these underpinning services is the challenge of understanding the full cycle of the design process, from scoping and defining requirements, through prototyping, iterative design and evaluation phases, to deployment and end use. A further key challenge concerns ensuring that products are not simply short-term novelties, but instead are sustainable and relevant in the longer term.

The practice of designing digital products and services is changing, and the demarcation between producer and user is becoming blurred. This is evidenced by the expansion of Maker Faires, Fab Labs (fabrication laboratories) and online maker communities such as Thingiverse.com (n.d.) and Makerspace.com (n.d.). Due to the increasing proliferation of low cost manufacturing processes such as 3D printing, and accessible computing platforms such as Arduino (n.d.) and the Raspberry Pi (n.d.), the conception and creation of both hardware and software is increasingly migrating to the end user away from the commercial manufacturer and distributor.

In the context of design innovation, this shift has undoubtedly blurred the lines between the roles of amateur and professional. Machinery enabling smaller production runs, along with accessible digital design tools enabling novel personalisation and customisation options, allow the end user to share in the design and innovation of small scale products and systems. Alongside these technological developments there is a discernible change in attitudes towards control of intellectual property, evidenced in the growth of the “open” movement which is expanding from software to hardware, including platforms for sharing source files and design techniques, further supporting an enthusiastic DIY culture. Online crowdfunding services including Kickstarter (n.d.) and Indiegogo (n.d.) have further popularised and promoted participation in the product development process, enabling a wider range of people to engage in innovation and entrepreneurship. This expansion in production and design methods promises to lead to a more democratic and inclusive landscape, where individuals and small groups can produce technical solutions for their own particular problems and needs. The reality, however, is always more complex than any utopian technology vision implies, and there continue to be barriers to full involvement in the design process, and uneven access for many people.

The enthusiastic vision of impact on the wider design world as expressed in, for example, Hsu (2015) masks tensions around expectations from the perspective of professional design disciplines. In the words of Jenkins and Bogost (2015), “People risk aspiring to be ‘makers’ instead of makers of things.” Another challenge addresses concepts of “level of finishedness”, completeness, project closure and delivery to the end customer. As Landwehr, Sydow & Jonsson (2015) put it, there can be a tendency amongst some makers of “just adding one more thing”.

The sense of ownership and empowerment created through the act of making is central to the amateur maker, while the benefit of learning through creating physical artefacts and prototypes is something that spans both the amateur and professional. Where differences arise is in the motivation for this learning through creation. The motivations underpinning DIY making are complex, ranging from the desire to address specific identified needs, to the singular pleasure derived from the act of making and personal engagement with materiality. The amateur may be driven by personal needs, interests and curiosity, whereas the professional is driven by pressures to deliver solutions within specific resource boundaries. Where both are united is in the desire to create artefacts that act as a focus for both internal and external dialogues to occur over and through the affordances of materiality.

A challenge that this paper aims to address is how to both acknowledge the differences between the approaches of the amateur and professional, while attempting to build on the strengths and commonalities of each. We examine ways of retaining the attributes of ownership, empowerment and learning and to subsequently integrate these into the design of products and services, while acknowledging that the degree to which people want to be makers will vary depending on the context and expectation. We suggest that methods and approaches to the design of toolkits is currently an under explored area of technology and design research. This research and design topic is currently beginning to interest researchers, for example in the human-computer interaction (HCI)

community, as evidenced by the call for participation in a workshop at ACM CHI 2017 (Marquardt et al, 2017).

2. The joy of making and the importance of learning

The pleasure and joy that is experienced through the acts of making and creation have been described in the influential work of psychologist Mihaly Csikszentmihalyi (1990, p46). He differentiates between pleasure, an experience that is essentially passive, and enjoyment, a more active experience that involves effort and accomplishment. The distinction between these two modes of engagement, according to Csikszentmihalyi, is that pleasure as an important component in the quality of life of each individual, helping to maintain equilibrium. Enjoyment on the other hand is a transformative condition that augments a person's sense of self, changing the consciousness. Csikszentmihalyi (1990, p71) describes this condition of optimal experience in engagement with some kind of activity as "flow", and identifies its characteristics. He lists; a sense of adequate mastery of skill for the task, intense concentration, lack of self-consciousness, and distortion of sense of time as features of the flow experience. As Overbeeke et al (2003) point out, *"a user may choose to work with a product despite it being difficult to use, because it is challenging, seductive, playful, surprising, memorable or even moody, resulting in enjoyment of that experience."*

Sanders and Stappers (2014) also discuss the importance of the creative act of making as a way not just of bringing new objects into being, but as an act of exploration, of meaning making, and description. This is relevant both to designers and non-designers. In this situation, making is not restricted to the production of a prototype, described as the embodiment of a developed concept, it becomes an exploratory and reflective process that is valid in itself. Making is a visible and social process, it is external and therefore can be shared and discussed.

Our position in this paper is that this enjoyment found through acts of creation can be offered to a wider range of people, and opened out beyond those who are already dedicated makers. This can be addressed by considering the toolkit itself as a site for design attention. By taking a design-oriented approach to the development of toolkits, comprising both physical components and the supporting guidance, this flow experience can be supported. One of the challenges is to design the toolkit in such a way that it enables an enjoyable "flow" experience, while also supporting appropriate entry level access for interested novices.

3. The toolkit as a site for design research

Davis, in his presentation of the Technology Acceptance Model (Davis, 1993), emphasised the importance of perceived usefulness and perceived ease of use in the acceptance of technological systems. A key concept here is the belief held by the users, when confronted with a novel system, that they will benefit from it (usefulness), and that it will not be too difficult for them to manage (ease of use). This has implications for the design and presentation of "do-it-yourself" systems – if a system looks like it might be too difficult, or is without benefit, a barrier has been put up. Ecosystems such as the Raspberry Pi, provide us with a model of this understanding. The RaspberryPi.org website provides tangible examples of projects that might be appealing to a user, along with a visual aesthetic and graphic style that conveys simplicity and accessibility to young and non-technical users. Other factors that support or hinder adoption of technology are the rising influence of social media and user recommendation systems. If others, who are like ourselves, consider a system to be easy to

use, this enhances our own belief and trust in the system. Platforms such as the Raspberry Pi make good use of such features to invite engagement from novice users.

Approaches to participatory design and co-creation are becoming more important in order to develop products that are relevant and accepted by their target user groups. Von Hippel (2001), considering the perspective of industrial manufacturers, argued that passing some of the responsibility for innovation tasks and product design over to the user could help to create a more appropriate and successful end product. Addressing the stages of the innovation and design process, von Hippel described the challenge of keeping the sense of pleasure and enjoyment in the process for the user/designer, and he presented a toolkit model, supported by five important objectives. These can be briefly summarised as: enabling trial and error learning, offering design solutions that users want to create, building on user's existing skills, offering modular elements, and ensuring feasible manufacture.

Revisiting the work of von Hippel, Hermans (2014) outlines the implications for the product development cycle including both the design and development side, and the distribution and use side. He describes the shift from finished products as the site of design activity to toolkits as the objects of design. Hermans uses the term "static artifacts" to describe products fully defined by the professional designer, without any anticipation that the user should modify them. Hermans proposes the unexplored possibilities of the digital-physical toolkit enabling the consumer to design their own product. We can see there is a continuum here between the professional and the amateur, each with their own motivations and characteristics.

3.1 Inclusivity in the making process: amateur and professional approaches.

In order to further develop our understanding of the design of toolkits, we need to understand both the characteristics of the intended users as well as the potential attributes of the toolkits themselves.

Beginning with the users we can start by comparing the motivation of the amateur makers, who are working for the pleasure of the activity, and for themselves or for their close community, with that of the career professional who is working in the service of others, under external direction. Professional designers may tend to have explicit, articulated and agreed visions and goals, relatively high levels of skill and knowledge distributed across teams, and adequate material and technical resources for project completion. By contrast, amateur makers may have more unbalanced or partial skills and knowledge, lower material and technical resources, and goals and visions that are fluid and implicit. It should be stressed that this is a very rough and relative differentiation, with much variation and overlap, but there are some fundamental differences between the extremes of these two approaches.

Adding detail to the amateur maker category, Hermans (2014) describes four types and stages of "lay design": adapter, maker, explorer and creator. These are progressive stages, and it is suggested that makers can be supported to advance through these stages by developing their skills, knowledge, imagination and responsibility. Not all amateur makers will want to progress fully or rapidly through these stages, and so research questions are emerging around how to design toolkits that enable appropriate progression through these stages in a manner that suits the maker.

3.2 Toolkit categories: Kits and Tools

Having discussed the attributes of the maker, we now move on to a discussion of what we mean by a toolkit. There are many types of toolkits, comprising of varied resources including tangible materials and hardware, as well as intangible knowledge, guidance, software and so on. However, in our quest

to understand toolkit categories, we can begin by considering whether the emphasis in each toolkit is mainly on the “tool” or on the “kit” aspects. In this framing, a kit-oriented toolkit can be described as having a hard boundary – it is self-contained, complete and leads to a fixed outcome. By contrast, a tool-oriented toolkit has a soft boundary - it provides resources and guidance for the maker to obtain elements and components according to the desires of the maker, and the final outcome is less clearly defined, and open to adjustment. A key difference between these two extremes is that the kit-oriented version of the toolkit primarily promotes the realisation of the original designer’s vision, constructed by the maker, whereas the tool-oriented version gives more autonomy to the maker in the construction process, enabling adaptation, appropriation and customisation. In this version the maker is required to take on more responsibility for making design choices according to their own vision. This discussion of toolkit attributes aligns with Hermans’ (2014) discussion of lay design models, where practices are mapped according to their levels of provided guidance (from step-by-step to no guidance) and outcomes (determined or undetermined). In this paper, we suggest that this tool-oriented view of toolkits retains the positive elements of “unfinishedness” that can be satisfying and empowering to the user, while also supporting and enabling negotiation around the end result of the process.

The way these categories are presented here does not, of course, capture the full diversity and range of types of toolkits. For example, associated with the growth in the making of low cost computational systems, there a trend for instructions to fabricate cases and other types of physical units to house the digital kit components. These could be described as toolkits to make toolkits, and they illustrate the layered and varied possibilities inherent in toolkit design. However our rather binary description provides us with a useful, simple framing in order to understand how to approach the design of toolkits that are appropriate for their intended maker groups. Here we provide some examples in order to illustrate and expand on these categories.

3.3 Kit-oriented toolkits

The two following toolkits can be described as residing on the kit-oriented end of the spectrum, as the outcome of each of the designs is strongly defined by the original designers. Although each of these toolkits is not fully self-contained, in that the maker has to supply some or all of the materials for the construction, there is limited scope for the user to modify the intended functionality. These examples are aimed at both the individual maker working alone as well as at makers working in small groups or embedded in a wider community setting.

WIKIBLOCK

This website provides a set of open-source designs for outdoor furniture and street installations that can be downloaded and fabricated from sheet plywood using a CNC (Computer Numerical Control) router. These computer controlled cutting machines are commonly available at makerspaces. The resulting items are designed to be simple to assemble by slotting together without glue or nails (Figure 1).

www.betterblock.org/wikiblock



Figure 1. The Wikiblocks kit. Image © Better Block Foundation (<http://betterblock.org>, n. d.).

SMART CITIZEN KIT

This is hardware unit built with Arduino, including sensors and data processing functions to measure environmental conditions including air composition, temperature, humidity, light and sound. This data is gathered and visualised through mobile and desktop applications. The system is customisable in various ways, the design files for the case are open-source, and the kit is intended to enable citizens to participate in environmental data gathering activities (Figure 2).

www.smartcitizen.me



Figure 2. The Smart Citizen urban monitoring kit. Image from <https://smartcitizen.me> (n. d.).

3.4 Tool-oriented toolkits

In these next two examples, the emphasis is on the tool aspect of the toolkit. These collections of suggestions and instructions are more open-ended, enabling the maker to try different ideas and configurations. The maker has more autonomy to decide on the form and the materials of the end product, and there are active online communities discussing modifications and adaptations.

IKEA HACKERS

This website provides knowledge resources for modifying and repurposing basic flat-pack furniture and home accessories. The site supports sharing of instructions for maker projects, and there are few restrictions on what kind of outcomes can be made. Users are encouraged to take ownership of their projects to suit their own individual situations and needs.

www.ikeahackers.net

RASPBERRY PI

The Raspberry Pi is an ecosystem of low-cost computer components, along with operating system software, developed with the aim of supporting learning about coding and computational problem solving. Aimed at both children and adults, the Raspberry Pi website presents a growing collection of suggestions, guidelines and other resources along with active and open community facilities for sharing projects, ideas and events.

www.raspberrypi.org

4. The Mazi Toolkit

Mazi is a cross-European, interdisciplinary collaborative project that is developing a toolkit for location based, Do-It-Yourself (DIY) networking. The long term aim of the Mazi project is to develop a toolkit that meets the needs of a range of communities and situations, enabling citizens to build their own local networks for facilitating hybrid, virtual and physical, interactions, in ways that are respectful to their rights to privacy, freedom of expression and self-determination.

While we propose that a toolkit approach can embed the shared goal of “learning by doing”, we also acknowledge that the purpose of “doing” will undoubtedly vary between makers and their communities. For example, the act of doing for makers could range from the pleasure derived from the act of making to the creation of a solution for a specific need and the learning implicit in that process. The act of doing can also be integral in the cycle of gaining insight into a particular design setting.

5. The initial toolkit framework

The work of the Mazi project includes consideration of methods for open and productive dialogue between, and among, designers and makers, in order to negotiate shared understandings of desirable and relevant technological outcomes. The makers in this context are represented by four pilot studies, each located in a different European country, situated within particular communities each with their own distinct motivations, strengths and characteristics. In this study, the design of toolkits for the creation of DIY networks will be one of the topics that will frame dialogue, taking place among the community makers and designers during research and development phases. It is for this reason that we present an early framing for the design of technology toolkits, based on the discussion in this paper. It is proposed that the development of technology toolkits enables the

deliberate designing of “soft boundaries” into products and services, as a way of balancing the need for completion, with the importance of retaining the “joy of making” for the non-professional creator.

Building upon and adapting the literature discussed in this paper, it is proposed that a toolkit for DIY networking should:

Social - community

1. Offer a “solution space” that encompasses the configurations that are desired and appropriate for the local context.
2. Contain libraries of commonly used elements that can be incorporated into the configuration, allowing the users to focus efforts on the elements that are unique to their situation.
3. Develop knowledge and skills in service design, networking technology and community collaboration.

Personal - individual

1. Build on the skills and competences already possessed. Enable entry at the “adapter” level.
2. Support progression through the maker, explorer, and creator levels. Provide learning paths to gain increasing levels of autonomy.
3. Offer safety. Enable recovery through trial and error, and improvement through iteration.

6. Conclusion and discussion

This paper has presented a discussion of an emerging paradigm of Do-It-Yourself making, arguing that toolkit design approaches, framings and methodologies merit further examination from a design research perspective. The paper looks at the pleasure and joy that can be part of the making process, and it is argued that this experiential aspect is crucial for the adoption and success of a toolkit, particularly where the toolkit is “tool-oriented”. This type of toolkit offers soft boundaries and “unfinishedness”, promoting maker autonomy, and enabling negotiation around the realisation of the end result. In an attempt to contribute to this research topic, an early framing is presented that places priority on supporting makers to build on their existing competencies and motivations, while offering possibilities for progression and learning.

The early toolkit framing that is presented here has been developed as part of a project on Do-It-Yourself networking, and the authors intend to further develop the framework within the context of this particular project. However, it is suggested that the framework is applicable to other contexts of making, and we welcome further theoretical viewpoints and examples of practice that would contribute to the refinement, expansion or indeed, alternative versions of this framing.

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