I Would DiYSE For It! A Manifesto For DiY Internet-Of-Things Creation

Abstract
This paper presents a manifesto directed at developers and designers of internet of things (IoT) creation platforms. Currently, most existing creation platforms are tailored to specific types of end-users, mostly people with a substantial background in or affinity with technology. The thirteen items presented in the manifesto result from several user studies including non-technical users, and highlight aspects that should be taken into account in order to open up IoT creation to a wider audience. To reach out and involve more people in IoT creation, a relation is made to the social phenomenon of do-it-yourself, which provides valuable insights into how society can be encouraged to get involved in creation activities. Most importantly, the manifesto aims at providing a framework for do-it-yourself systems enabling non-technical users to create IoT applications.

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IoT, do-it-yourself, manifesto, guidelines

ACM Classification Keywords
D.2.2 Design Tools and Techniques.

General Terms
Design, Documentation
Introduction
The term Do-it-Yourself (DIY) culture refers to a societal movement of doing and making things oneself. Although DIY culture originated from a non-digital world it is again gaining momentum due to the rise of social media and other ‘online’ platforms. One of the key factors in DIY culture is the feeling of belonging to a community. Therefore, the internet has had a drastic influence over the last years as Web 2.0 applications allow end-users to create their own digital content. With the developments related to the internet-of-things (IoT), the digital DIY culture might be taken one step further, resulting in a situation in which end-users themselves can create applications for smart environments. However, for the IoT to really take off, end-users need to participate in the creation process on a larger scale than is the case at the moment. They need to have power and control over the creation and use of applications for smart environments.

The potential of combining the DIY phenomenon with IoT-related research has been made explicit within HCI related research. Furthermore, Kuznetsov and Paulos [19] explicitly call for more interaction between DIY and HCI communities. Moving further along this line of reasoning, this paper presents a manifesto for moving towards a more human-centered IoT world.

Why a manifesto?
In the last decades, a number of manifestos specifically related to DIY have been published. The first of these manifestos was probably The Hacker Manifesto [32], published in 1986. It is a set of guidelines aiming at providing an ethical framework for novice hackers. Another example is Mau’s Incomplete Manifesto for Growth [23] a list of 43 ideas aiming at getting people to do things differently when designing or making things. MAKE magazine has in 2005 published a Crafter’s Manifesto [8] and an Owner’s Manifesto [24], the latter also referred to as The Maker’s Bill of Rights. In 2008, Brett Gaylor presented a Remixers’ Manifesto in an open source documentary film about the world of mash-up media [28]. It deals with the future, freedom and control of remixing digital media. In 2009, Platform 21 launched a Repair Manifesto, to “make repair cool again” [27], encouraging people to repair instead of throwing away, and to motivate designers to create more repairable products. Finally, in 2010, iFixit published the Self-Repair Manifesto [15]. This manifesto was inspired by both the Owner’s Manifesto and the Repair Manifesto and aims at being able to repair devices to reduce throwaway rates.

Although the existing DIY-related manifestos described above do offer links and starting points, many issues related to DIY IoT creation have not yet been touched upon. Therefore, the aim of this paper is to present a manifesto that aims at systems for DIY IoT creation.

Why a manifesto for do-it-yourself IoT creation?
The need of end-user development or DIY creation of IoT applications has been recognized in different domains, such as end-user programming theories and practices [4],[17]. In addition, the IoT as it exists until now has not yet been adopted by the mass [13]. Furthermore, the focus of IoT has been fading away from the ‘things’ towards real-life understandable data streams, as can be seen in applications such as Pachube (www.pachube.com) and Noisetube (www.noisetube.net) and in the growth of personal informatics [21]. These trends are in accordance with
the idea that the goal of HCI will evolve from just making systems easy to use, to making systems that are easy to develop [33].

Origin of the manifesto
The manifesto for DiY IoT creation originated in a European research project called DiYSE: Do-it-Yourself Smart Experiences, which aims to enable ordinary people to create, setup and control smart applications [16]. Within this project, research was conducted to understand how and why users would create their own smart experiences. It included four subgroups of users (30 in total): social crafters (5 persons engaging in craft activities and promoting their crafts via internet platforms such as Etsy, Facebook or Twitter), families (2 families consisting of a father, a mother and two teenage children), IT enthusiasts, (2 IT enthusiasts and three tech savvy friends each) and social (h)activists (7 persons engaged in reclaiming city streets for people).

The research period (September 2010 - April 2011) involved three subsequent phases. First, a contextual diary and interview study was done to collect information about the participants’ current behavior related to electronics, media and DiY. In the second phase, the individual participants received a low-fidelity creation kit that stimulated them to generate ideas for smart objects and applications in their own environment and related to their own activities [6]. This phase resulted in insights into how people envision the idea of being able to create smart objects. Finally, a co-creation session was organized for each of the groups to explore the use of a mock-up sensor kit. These sessions showed how the participants in each group approached the creation of IoT applications.

The analysis of the rich, qualitative dataset resulted in a model for an ideal creation platform for DiY IoT applications (Figure 1). This model visualizes the train of thought behind the manifesto and introduces some specific vocabulary. The smallest entity in the system is called a ‘useful component’ (e.g. a hardware light sensor that can transmit values to a system). Useful components can be combined together to form ‘sets of useful components’ (e.g. a light sensor connected to a buzzer making noise when a lighting threshold is reached). By using such sets, users can create projects (e.g. an application that makes a tune play when one opens a jewelry box). Three ways to ‘enter’ the creation process were identified, allowing a wide variety of people to engage in an IoT creation system; leftovers, materials and ideas.

MANIFESTO ELEMENTS EXPLAINED
In the next section each statement made in the manifesto (presented in Figure 2) will be discussed, referring both to literature and to our own research findings to clarify each aspect’s value in the manifesto.

A Do-it-Yourself IoT creation system should:

1. Inspire to be creative
The system should be a platform that inspires and supports people to be creative, to self-actualize in their projects. It should motivate them to think out of the box, to generate innovative ideas, solutions or content, constrained as little as possible by existing technology or conventions. The project process should be fulfilling.

As Bannon [2] argues, forgetting about how technology works and what boundaries there are to it is essential for opening the design space for ubiquitous technology.
There should be a way to put common conventions aside in order to come up with fresh ways to interact and talk about the world around us.

According to the participants in our own research, ideas for DIY projects come from close by. Summarized by Risa (social (h)activists group): “in the end, inspiration is a fusion of everything you know and see; it brings together all those things you have seen and experienced and translates it to something new.” A more concrete example was observed during the co-creation session in the family groups where a mother repurposed a specific prototype made by her daughter.

2. Support a spectrum of expertise in computational thinking by offering different layers of computational abstractions

Users have different levels of computational thinking. The system should support at least three user types: amateurs, professional-amateurs and professionals.

In his work on professional amateurs, Leadbeater [20] argues that the population can be divided in three categories: amateurs, professional-amateurs (pro-am) and professionals. Sanders makes a similar point [1] when she talks about levels of creativity. Both authors state that depending on one’s level of expertise, one’s way of doing things in a certain area is different. For instance, when you first start cooking, you are capable of sorting your spices but you are not capable of making highly creative combinations of recipes.

The differences in the computational levels of thinking of our own participants became apparent during the co-creation exercises. Carrying out a fairly simple measurement of a variable in the environment was
approached in very different ways. Even for the technically advanced participants, their skills did not result in similar solutions, as their personal preferences, opinions and viewpoints differed. What comes naturally to one, may be foreign to another.

3. Help people to create useful components
The system should guide users to reformulate or organize ideas, solutions or content into useful components. These useful components, that are essentially small applications with fractal characteristics, can be compared to a LEGO brick in terms. Users do not make their own LEGO bricks, but they can combine bricks into a LEGO construction, which can be shared and reused.

A DoY project does not have to be a significant undertaking every time. Sometimes, it is enough to add something small or tweak existing components to make it look like the creation is yours. It comes down to expressing yourself, making the world your own [11].

Often, a small piece of work can make a big difference. By customizing it just a bit, you can make it uniquely yours. Risa (social (h)activist group) often feels that she has no time to make anything, but in the end, she notices that things do get made, although these are small things, made with little effort.

4. Not teach how to program, but should provide an ecosystem to support people in creating ideas, solutions or content
Instead of requiring programming skills from every user, the system enables users to start from (sets of) useful components made by others with more computational skills. The ecosystem should present the (sets of) useful components in such a way that their purpose is evident and combining (sets of) useful components is easy, e.g. by offering templates. The system facilitates incentives for creators, which are not necessarily monetary.

The idea of an ecosystem that allows users to create their own solutions or content without requiring specific technical skills is similar to the notion of open design. In open design, designers do not design objects anymore, but are ‘meta-designers’, creating design environments for unskilled users, or creating design blueprints [5],[1]. An increasingly popular example of open design can be found in 3D printing, where downloadable designs are shared, allowing users to adapt the design and print their design via 3D printers (cf. democratizing manufacturing [26]).

Except for the IT-enthusiasts, most of our research had no affinity with technology at all. In the low fidelity mock up exercise, it became clear that they were able to come up with valuable ideas but saw it as an impossible task to make their ideas into working prototypes. Hilde (from the social crafters group): “if I need something done with electronics, I call an expert”.

5. Equally support starting from ideas, material (new and scrap) or other projects
The system takes into account different purposes, from clear purpose to a vague idea, and different personalities of users. Therefore the system should equally support idea generation, material-inspired projects and projects based on other lingering projects.

Allowing various ways to contribute to a system is an underlying concept illustrated by Gauntlett [12] and
Fischer [9]. Gauntlett argues that a variety of people need different ways to get motivated to participate in a form of creation. Fisher argues that in order to get input and feedback from stakeholders, they need a way to communicate, using systems designed for them.

Some DiYers are driven to start their DiY projects with a very clear idea of the end result. They plan and they sketch: “I am always the kind of thinker, ‘how can I make it the way I want it?’ and then I start with it.” (Dana, social crafter group). Some have a vague idea, no plan nor sketch but by starting the process, the end-result becomes clear to them. To many, material plays an important role. For Dieter (IT-enthusiasts group), a pro-am in the field of LEGO, it is important to keep working with the material, making things, just to try it out as it leads to making something new.

6. Be a cradle-to-cradle system offering playgrounds and recycling belts
The system offers a playground providing leftovers from other projects and collectables. It allows both finished and unfinished projects to linger and users to tinker with these projects.

Taylor [31] illustrates how ‘pottering’ as an activity can be a source of inspiration for designing. Playing or tinkering with things lying about sometimes leads to new creations.

Freedom to begin how and when one wishes, and freedom to end without finishing is important in DiY. Evenly important, and often a consequence of pottering, is the process of making and learning new ways of working, new techniques and taking on challenges [1]. Inge (social crafters group): “I’m always open for learning and for new things, and if I come across something that makes me think ‘oh, I am not familiar with that technique’, I’ll try it and what comes out of it is not that important.”

7. Support sharing of unfinished or evolving projects
Users can share their projects in the seeding phase, the flourishing phase or the finished phase, allowing collaboration, stimulation and support. As sharing is facilitated at several levels, users can passively ‘read’ projects or actively contribute to a project. According to a mixed reality support model, projects can be shown in personal digital galleries and in physical events, allowing users to show off their identity.

Sharing creations and talking about them with other people is a key characteristic of DiY culture [29]. It creates a breeding ground for social contact and improved results.

Before starting a project, it is useful to look around to see if the components or even your ideas have already been thought of by somebody else: “You have a 9/10 chance that somebody already made it and that it’s posted somewhere on the site. You would be dumb not to use it.” (Ilias, IT enthusiasts group). When DiY projects turn out well, most DiYers are happy to share them. If a project turns out for the worst, the process can be shared to be able to find a solution after all, or to hand it over to somebody else to finish.

8. Support & facilitate collaboration between users with various roles
Collaboration is supported and facilitated between users with various roles: creators, debuggers, cleaners,
collectors, spectators, etc. Everyone can collaborate with other users from their own preferred role.

The reflections of Gauntlett on the work of philosopher Ivan Illich [11] indicate that when people have access to open systems (such as Wikipedia or YouTube), joy and playful experiences emerge.

Especially participants with higher levels of knowledge in their DIY domain, mentioned that helping others is a motivator, at least to some degree: "I like to teach things to other people" (Inge, social crafters group). These participants are driven by the chance to learn something new and by being able to showcase their own high level of knowledge to less advanced users.

9. Help users to finish projects by subtle coaching without harassment
To be self-sustainable, the system should reduce barriers withholding users to finish their projects, by means of subtle, non-harassing coaching. Motivation is provided by software actors or by human actors offering immediate feedback.

In his discussion on the role of creativity in research, the ecologist researcher Loehle [22] refers to the Medawar Zone concept: "There is a parabolic relationship between the difficulty of a problem and its likely payoff. Solving an easy problem has a low payoff [...]. Solving a difficult problem may have a high payoff, but frequently will not pay at all." Within the scope of DIY IoT creation systems, the challenge is to help users understand which projects are likely to produce fruitful results and encourage them to finish those projects.

Sometimes, what the DiYer needs, is an extra push. As Dieter, (pro-am, IT enthusiasts group) explains, sometimes, having the right materials, the time and the opportunity does not result in making something: “So it’s not only the time. It’s the combination of time, desire, enthusiasm and finding the right moment”.

10. Allow users to use their own terminology
Users, with knowledge of any domain can use their own terminology. The system learns to adapt to this terminology, resulting in a common terminology.

De Smedt [7] proposes a semantic network of commonsense in order to allow a wide variety of users with various backgrounds to use one common computational creativity system. Such a system provides the capability of linking computational concepts to, for instance, natural language or a variety of graphical representations.

The language of the system should be carefully tailored to the user group it is targeting: being too cute can be seen as condescending even by the least technical users, while even the most commonly used technical terms could be unclear to these users.

11. Allow the use of multimodal system input, using body and objects.
The system should provide multimodal interfaces to create (sets of) useful components and projects. Users are not restricted to PC-based applications only. Instead, they are stimulated to make use of their everyday interaction patterns with their body or with objects to provide input.
Physical interactions play a central part in the way humans experience the world, and are obviously a central element of IoT creation as such. [18] The importance of this element is also shown by several hardware prototyping toolkits, such as d.tools [14].

12. Express and clarify ambiguous situations with the user
By enabling users to create projects and sets of useful components, using their own terminology and interaction patterns, ambiguous situations will rise. In such situations the system should always express the ambiguity to the user, in order to clarify.

This item could be seen as an IoT re-interpretation of Nielsen’s system status heuristics [25] such as ‘Visibility of the system status’ and ‘Help users to recognize, diagnose and recover from errors’. The major difference is, however, that the item in this manifesto is a consequence of allowing end users to freely use a provided platform, which is not necessarily linked to user interface design on its own.

13. Provide added value for all
Besides the main added value of the system, (the ability to create meaningful experiences by connecting everyday objects), the system should provide added value to all stakeholders. Hence it is necessary to understand the different goals and expectations of all stakeholders in each step of the system. Apart from monetary value, the system may benefit a larger group or ideal.

As Franke and von Hippel [10] suggest, addressing the average needs of users in major market segments may lead to many users being seriously dissatisfied. In case of DiY IoT creation systems, user needs will be very heterogeneous. To start with, there will be a variety of different types of users in terms of computational levels. In addition, there will be many more types of users in terms of DiY domain.

Discussion & conclusion
Currently, the notion of IoT runs the risk of developing into a world where people are not in control. To safeguard this, we envision a system enabling every user to create their own meaningful experiences by connecting everyday objects via a network. This paper was written with programmers, engineers, and experts in sensors and actuators in mind. Especially those who would like to contribute to the development of a human-centered IoT world, where people with no to relatively little programming skills are able to create their own smart applications. Thirteen guidelines were formulated in the format of a manifesto to support the development of IoT creation systems for all. With this manifesto, we invite system creators to make the IoT a place where all users are in control and able to create meaningful applications by themselves.

Next to the inspiration and guidance the manifesto has to offer to designers and developers of DiY IoT creation systems, the manifesto has an added value for the research related to such systems as well. As the manifesto targets any type of IoT creation system, its individual guidelines are rather high level. Therefore, it is strongly recommended to perform thorough research into the needs and expectations of the potential users of specific future DiY IoT creation systems, as was also stated in the thirteenth statement. In this respect, the manifesto may serve as a framework for doing such research. Within the context of the DiYSE project, a
prototype has been developed (www.sensetale.com), based on the user research described in this paper. Further research on this prototype will be carried out, including evaluations with users and experts.

A few questions related to the practical use of the manifesto presented here still remain. Most importantly, it is not clear yet whether it will be feasible to design a system that will match all of the manifesto’s statements. It will be a major challenge to create a system that is accessible for non-technical users wishing to create their own smart environment. However, the manifesto provides a good starting point and a solid framework for this. In addition, evaluation of the manifesto’s usefulness outside of the DIYSE project should be further researched. Related to this issue, additional research is needed to validate the manifesto statements on the level of user experience. Although these statements resulted directly from user research, it is not possible yet to evaluate an IoT creation system that applies these statements with users. For example, as was mentioned in the introduction, a core concept of DIY culture is the feeling of belonging to a community. We don’t know yet whether a DIY IoT creation system, which was developed in accordance to the manifesto, actually results in such a feeling of connectedness.

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