Domestic Widgets: Leveraging Household Creativity in Co-Creating Data Physicalisations

Abstract: The home environment is a complex design space, especially when it has multiple inhabitants. As such, the home presents challenges for the design of smart products. Householders may be different ages and have differing interests, needs, and attitudes towards technology. We pursued a research-through-design study with family households to envision and ‘co-create’ the future of data-enabled artefacts for their homes. We have iteratively developed domestic research artefacts for these households that are open, data-enabled, physical visualisations. These artefacts - called Domestic Widgets - are customisable in their design and functionality throughout their lifespan. The development process highlights design challenges for sustained co-creation and the leveraging of household creativity in (co-creation) research toolkits. These include the need to allow and inspire iterative customization, the need to accommodate changing roles within the home ecology, and the aim that such design should be inclusive for all family members (irrespective of age and technical proficiency), whilst maintaining a role and purpose in the home. We invite the RTD community to critically discuss our, and other, open and iterative end-user designs for sustained co-creation. By presenting unbuilt and interactive pre-built Domestic Widgets, we interactively foster engagement with practices of sustained co-creation.
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Many consumer market toolkits also aim to address these perceived obstacles by making hardware and software more accessible. Such toolkits are often used in educational settings targeting new users. Modular toolkits allow quick and easy tinkering with pre-made modules, either through physically connected modules such as littleBits (https://littlebits.com, last visited September 27, 2018), or wirelessly connected modules with flow- or block-based programming software such as Scratch (https://scratch.mit.edu, last visited September 27, 2018). Both of these toolkits lower the barriers to the creative exploration of electronics and coding, compared to platforms such as Arduino (https://www.arduino.cc, last visited September 27, 2018) or Raspberry Pi (https://www.raspberrypi.org, last visited September 27, 2018). Platforms such as these often increase the difficulty in coding and using hardware, yet generally have a lower price point. This introduces a conflict between modularity and cost, as the cost of pre-made modules is often higher than the typical costs for DIY projects (Kuznetsov and Paulos, 2010), with more affordable hardware platforms that require better programming and electronic skills. This remains a challenge for future consumer DIY hardware and software toolkits to lower both barriers.

A number of specially designed toolkits and systems have been developed by researchers in the participatory tradition, to co-creation and end-user development (EUD). Research-through-Design (RdD) approaches to co-creation, such as workshop formats, provide a collaborative context for engaging and supporting participants in creative practices with tangible technologies (e.g. sensors and actuators), enabling them to address potential obstacles in technology literacy or perceived creativity.

Empowering people to be creative is also a common goal in participatory research, including participatory design, co-creation and end-user development (EUD). Research-through-Design (RdD) approaches to co-creation, such as workshop formats, provide a collaborative context for engaging and supporting participants in creative practices with tangible technologies (e.g. sensors and actuators), enabling them to address potential obstacles in technology literacy or perceived creativity.

The growth in supply and demand of these (commercially available) programming and hardware kits further incentivised the rise of the ‘expert amateur’ (Kuznetsov and Paulos, 2010), for whom participating in Do-It-Yourself (DIY) practises is not solely motivated by utility. An expanding demographic of users are being empowered to use electronics for amongst other things - pleasure, utility and expressiveness (Tatenbaum et al., 2013). Here, the responsibilities of implementation that have traditionally been held by designers, programmers and developers increasingly shifts towards the user. In return, more design effort is focused on supportive infrastructure and standardised tools, materials and manufacturing processes. These should provide the user with a high flexibility in customisation and allow for user-led appropriation.

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Figure 4. An environmentally friendly cardboard flat-pack toolkit design requires minimal tools and steps to assemble. Protruding triangular supports stick such that the assembly can be proceeded slowly and one step at a time. Solely the servo-arm assembly requires an adhesive, everything else remains detachable. All materials and components (top) can be acquired for less than $11. - for a single Widget.

Photo by authors

Figure 5. Examples of appropriation (by the authors) to demonstrate different possibilities of positioning and orientation. Whilst the circular cardboard servo-assembly flexibly allows for manipulation and attachment, further exploration should increase adaptability to increase the amount of possible uses.

Photo by authors
The seemingly aimless servo-motor attachment provides means for extension through adhesives and fasteners, yet does so without a clear intended end-result. Similarly, the non-decorated 'dull' cardboard prevents being suggestive about its positioning, which is why no printed cardboard (boxes) were recycled as construction material. In sum, the toolkit provides easy and accessible means to start making structurally sound personal physicalisations. It does so whilst being provided with minimal information about its intended use, so that this can be purposefully left open to interpretation by its users (Gaver et al., 2003). The toolkit thereby empowers families to tinker, craft and explore data-enabled artefacts with accessible materials and tools. This allows us, researchers, to investigate family's experiences of designing and developing equivalent connected systems.

Data Physicalisations

In the era of increasingly connected everyday things, technology can promise people more control over how the things they own work together at home. But equally, these things are gaining more agency. In addition, more sources of data and intelligence are becoming available for everyday use - but, what benefits does this offer? The Domestic Widget design focuses on how we would integrate these developments in our family households, and how they would influence our routines and utility of these sources. To probe collaboration and discussion, we opted for our toolkit to focus on physicalisations, i.e. physical data visualisations (Jansen et al., 2015). Amongst a breadth of output modalities, movement’s expressiveness affects multiple senses and is noticeable for multiple inhabitants at the same time. In light of crafting and DIY practices, physicality through movement further interacts with materials and objects in a way that visuals, temperature or sounds cannot. As such, we argue that creating physicalisations is an extremely useful DIY activity for engaging people in the discussion of digital connectivity in multi-person households - and we suggest similar projects could benefit equally from such an approach.

Speech Interaction at Home

The audibility of speech-based interaction lowers the technical threshold for programming connected objects. It offers a high level of discoverability for inhabitants in the near vicinity, supporting legitimate peripheral participation and over the shoulder learning (Lave and Wenger, 1991). It furthermore democratises interaction (Porcheron et al., 2017), such that anyone is able and allowed to set a Widget’s functionality. On the technical side, using a speech conversation agent enables the utilisation of smart speech recognition algorithms and appropriate prompts based on the users’ inputs, even when the user input is not understood by the system. This provides an accessible way of programming (for designers and developers alike), whilst its output is compatible in further software. We chose speech-based interaction to be accessible and swift in making/crafting data-enabled artefacts - and argue similar work can further benefit from exploring voice-based interaction in the home.

Towards Household Creativity

Our design process was inspired by Google’s Paper Signals (https://papersignals.withgoogle.com/, last visited September 27, 2018), tiny paper-based data physicalisations for everyone to build themselves. We saw potential in the functionality and design of this product, which has a certain aesthetic that, even though it is self-built, remains an aesthetically pleasing (living) object. Furthermore, we build upon their speech-based interaction implementation, though completely revisited the physical and task design. In our own attempts to build these Signals, we quickly realised that the required coding, online authentication and time-consuming complex paper mechanics introduced a substantial threshold for ourselves and various user groups. These Signals are intended as a step-by-step instruction to achieve a pre-defined result. We wished to transfer the abilities and aesthetics of this project onto an open-ended design, with nearly no step-by-step instructions required. Whilst it is not uncommon to prepare or install designs on a participant-by-participant basis in RTD research, we additionally aimed to increase scalability and minimise researcher contact to further leave (more) participants in control.

To avoid influencing the materials or tools that users might be using in conjunction with our Toolkit, we focused our exploration on less-specialised tools and materials. These include printer paper, thick cardboard from boxes, or thinner cardboard from food supplies such as cereal boxes. Standard white paper (80 g/m2) did not offer enough structural support in creating simple self-supporting shapes (which was also the case for the Paper Signals project), whilst thicker paper is less likely to be present in many households. Thick cardboard is commonly available in almost every household, but proved difficult to manipulate. We settled on thinner cardboard (~1.5 mm), which can be manipulated, and is commonly found in homes. Experiments with this material looked aesthetically pleasing and retained its affordance that it may be cut, folded and engaged in movement further interacts with materials and objects in a way that visuals, temperature or sounds cannot. As such, we argue that creating physicalisations is an extremely useful DIY activity for engaging people in the discussion of digital connectivity in multi-person households - and we suggest similar projects could benefit equally from such an approach.

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or ripped. With this material, we explored whether it was possible to make something from scratch. We found designing a structural base with simple tools extremely difficult. Additionally, the designs that could stand and hold the components (Figure 7) required detailed instructions to be easily replicated. This struggle resulted in abandoning the 'making from scratch' approach. Templates for end-users to cut out cardboard were deemed unfit, as they require the end-user to use specialised tools, such as craft knives or even digital fabrication methods. Our proposition was to design a foldable kit that can be prepared with specialised tools by us, but does not require these to be built at home. The resulting design (see Fig. 9) was presented, discussed and evaluated at the national Maker Faire.

**Maker Faire**

In order to engage with our target group, we presented 20 working Domestic Widgets to a steady stream of DIY or technology savvy visitors (see Fig. 8). Using a tablet, visitors were able to configure each Widget through conversation. A children’s activity (see Fig. 10 and 11b) aimed to encourage younger visitors at our stand to engage with the idea of connected artefacts. We provoked visitors to discuss the potential use of these Widgets, to evaluate their perceived usefulness, to imagine valuable data sources these Widgets could physicalise, and to gauge which aspects of such a toolkit would be interesting to families.
The popularity of the children’s activity (Fig. 10 and 11b) further whilst others engaged in the configuration of one or multiple widgets. Visitors were eager to learn the inner-workings of a Domestic Widget, Our stand piqued visitor interest in different ways (Fig. 8). Some included, but were not limited to, Widget functionality such that it represents things like the current wind direction, or when the next train will pass by, or the current room temperature, or the bandwidth used on the local network or a countdown timer. Suggestions that are more personally related data sources included, but were not limited to; a reminder to take some medicine, the emotional state of the cat in the house, where a family member currently is, or when a certain fashion item is on sale. In response to ‘where’ the visitors would place the house, where a family member currently is, or when a certain positioning a Widget straight up, or on its side, effectively reducing utility (see Fig 12 and 13). The resulting design (see Fig. 1) includes a further exploration of form and affordance. Here, we evaluated the reflection upon our interim Widget design (see Fig. 9) led to the physicalization of (manual) data. The use of faceplates was explored in response to Maker Faire visitors’ By using human names (a), references (or instructions) to specific Widgets could be made. An additional children’s activity (b) consisted out of folding and decorating a ‘mini’ Widget (see also Figure 10). This further motivated family engagement and proved to be of much interest to the younger visitors to the younger visitors. The value of our crafting and tinkering approach to inclusively engage all family members of all ages in a discussion on data enabled artefacts, and led us to further pursue our conceptual Domestic Widget design. Similarly, the servo-arm assembly in the interim version (see Fig. 9) was not symmetrical. Changing this to a circle inspired in its use, further supporting our aim to increase the open-endedness of the design. Reflection upon our interim Widget design (see Fig. 9) led to the further exploration of form and affordance. Here, we evaluated the aesthetics of possible form factors, and assessed their practicality/utility (see Fig 12 and 13). The resulting design (see Fig. 1) includes a backwards tilt that ensures stability when weighted objects are attached - something a rectangular box would not. A wider shape would assist in this stability, but this removes the difference between positioning a Widget straight up, or on its side, effectively reducing the possible uses and possibility for appropriation. The use of faceplates was explored in response to Maker Faire visitors’ questions (i.e. “How would you know what it means?”) and suggestions (see Fig. 13). The interim design implemented arrows, yet their meaning without a visible mapping was not understood. As the faceplates allow users to swiftly draw or write a mapping behind the arrows, this accessory would increase its ease of use. However, the faceplates equally strongly suggest this particular use case. As we would like to see the data being externalised in more and different ways by its users, we removed this accessory from the final version. Further Form Explorations

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Permanent goals throughout the development of the Domestic Widgets were to keep the number of components low, and to minimise the specialist tools required to build the toolkit. Contrasting the required laser-cutter for preparing the cardboard, the
current electrical components are readily available, and require minimal labour to assemble them into functional Widgets. In addition, with a total cost of less than €seven per Domestic Widget (excluding the USB power adapter), we believe this design is highly applicable and transferable to other practitioners and researchers.

Through the presentation of Domestic Widgets in this paper, we may argue that DIY and crafting offers a valuable, co-creative method for engaging discussions with end-users on future technology and its role in their lives. The participatory nature of our design might empower participating families as end-users to work through possible alternative (re-)configurations of data physicalisations at home. Yet, we seek broader and further explorations of various aspects that support this endeavour. For example, we still ponder about the balance between using generic accessible data sources or personal data sources that require additional (authentication) methods. Further, we wish to discuss the design in form and aesthetics such that it might motivate creative solutions more effectively. This includes the technical and mechanical elements (such as the attachments to the servo motor), but quite importantly it includes a design that sparks interest and motivates modification at first sight. With this, we will further improve participants ability to act upon their own creations (and reflections thereof). In turn, we can observe and study their reflective practises which can reveal needs and values for future smart domestic artefacts that might normally be too profound.

As is, our design elicits challenges and improvable design aspects. Even more so, we invite the RTD community to engage with us in discussion utilising craft, craft materials and speech-based interaction to establish sustained co-creation. Our IoT simplification into data physicalisations opens up re-configurations of their materiality, and thereby their appropriation and purpose in everyday scenarios.

To critically consider this approach, we engage the RTD community in hands-on building and tinkering with our Domestic Widgets, so that we might explore, evaluate and raise the next steps in these goals collaboratively. We additionally aim to do so through disseminating our work digitally: providing blueprints, tutorials (Desjardins et al., 2017), and potentially even by distributing our toolkits to like-minded researchers. At this stage of development, we are particularly interested in how the Domestic Widgets toolkit can leverage its material qualities, such that its material experience (Giaccardi and Karana, 2015) benefits families competences and values on a performative level to explore connected artefacts through making.
References


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