Sticking Together:

Handcrafting Personalized Communication Interfaces

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ABSTRACT

We present I/O Stickers, adhesive sensors and actuators that children can use to create personalized remote communication interfaces. By attaching I/O Stickers to special greeting cards, children can invent ways to communicate with long-distance loved ones with personalized, connected messages. Children decorate these cards with their choice of craft materials, creatively expressing themselves while making a functioning interface. The low-bandwidth connections leave room for children to design not only the look and function, but also the signification of the connections. We describe the design of the I/O Stickers, a variety of artifacts children have created, and future directions for the toolkit. Preliminary results indicate that I/O Stickers are beginning to make a space for creative learning about communication and to make keeping in touch playful and meaningful.

Categories and Subject Descriptors

H.5 Information interfaces and presentation H.5.2 User interfaces: Theory and Methods

General Terms

Design, Experimentation, Human Factors

Keywords

remote communication, toolkits, paper computing

1. INTRODUCTION

Designers and technologists are actively developing new types of devices for people to connect to each other at a distance, with particular interest in the changing needs of young consumers. We wanted to open up this rich design space to the end users: what if children could invent their own communication interfaces? This work presents the design and development of a "remote communication construction kit," with the following motivations:

- enable personalized communication between loved ones
- promote reflection and discussion about keeping in touch
- support creative expression with technology as a medium
- teach computational ideas about transmitting information

In support of these goals, we propose a construction kit of remotely connected sensors and actuators embedded into stickers - the I/O Stickers - that enable children to create unique functioning communicating interfaces.

The simple sensor-actuator connections also allow them to take ownership of the meaning of the communication through discussion and reflection prompted by inherently ambiguous messages. We hope that the ambiguous nature of the simple communication and the customizability of the medium will encourage children to creatively reflect and share in their area of interest - ranging from making interactive stories to designing secret communication protocols. An example of a possible *I/O Sticker* creation (a custom telegraph) is shown in Figure 1.

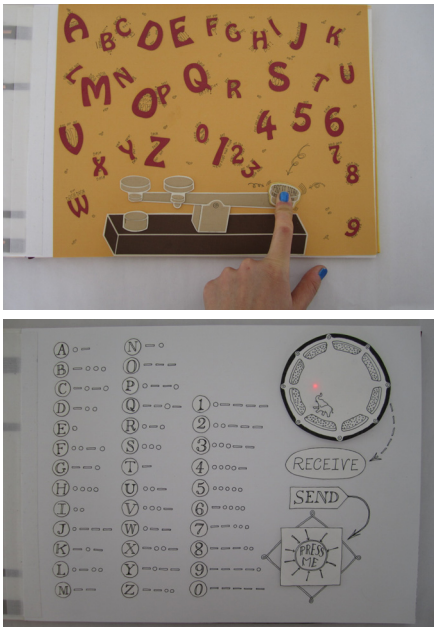

Figure 1. Example of two remotely connected I/O Sticker interfaces. As the user presses a sensor in one book, an LED lights up and a speaker buzzes in the remote book.

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2. BACKGROUND

We situate the *I/O Stickers* toolkit between low-bandwidth remotely connected objects (or "phatic communication interfaces" [6]) and electronics construction kits.

There is a long history of research into communication interfaces that mediate intimacy and recreate the sense of presence that exists when people share the same physical space [8][1]. We argue that the most emotionally compelling interfaces in this genre are not those that most accurately replicate physical/spatial interactions, but those that fit specific users' communication needs the best. How then does one design an artifact for others to experience a sense of connectedness? A design paradigm that fits this goal is that of designing for ambiguity: creating interfaces that leave room for interpretation [4]. This is the motivation for using low-bandwidth connections: simple analog sensors connected to analog outputs with no built-in explanation or meaning. When the interface leaves space for interpretation, reflection and discussion about the meaning of messages becomes possible, as in a study on the meanings people invented for a simple connected button on a computer desktop [6]. In this spirit, our toolkit is centered on the idea of letting kids invent their own connections and imbue them with meaning together.

In addition to supporting users in making the meaning of the messages their own, we also want to also enable them to completely design the interface itself. Papert's theory of constructionism posits that learning happens most effectively as children are active participants in creating artifacts that they are personally invested in. Specifically, with LOGO he aimed to introduce "powerful ideas" of computing to children through hands-on creation. [7] Our toolkit supports that process by allowing children to create and customize their own functioning communication interfaces using their choice of craft materials. While our toolkit in its current stage is simple, the powerful ideas that might be explored with a remote communication construction kit range from the basics of electronics to concepts of networking and information transmission.

The *I/O Stickers* kit builds upon a number of construction kits for novice users, which assemble electronic components into a ready-to-use kit so that users can focus on creating functioning electronic projects with minimal technical knowledge. Two examples are Lego Mindstorms and littleBits, both of which break down electronics into the most basic functions and encapsulate these functions into small, easy-to-connect blocks. However, both of these kits suffer from rigid form factors that make them difficult to integrate with materials outside of the kit. Also, projects made from these kits are impermanent because the materials are scarce and thus often taken apart and reused.

Toolkits that help its users create permanent craft objects are the LilyPad Arduino and Teardrop [2]. This kit places electronics in a novel, creative context where users can make personalized electronic objects using traditional crafting techniques and materials. Studies of projects built using these toolkits show that the affordances of the medium result in very different types of creations than with traditional electronics, expanding the design space. However, both LilyPad and Teardrop require the user to build the circuit fully, which may still be too high a barrier to entry.

3. THE I/O STICKERS TOOLKIT

The basic idea of the *I/O Stickers* is that users can place special electronic stickers onto contact points in pre-wired and preprogrammed pages, and the pages will transmit the state of the input (sensor) sticker to the corresponding remote output (actuator) sticker. For instance, a pressure sensor sticker varies the brightness of a light sticker at a distance as it is pressed.

3.1 I/O Stickers

Six types of stickers were constructed in this iteration of the project: switch, pressure sensor, light sensor, vibration motor, piezo speaker, and light-emitting diode. We relied on shape to differentiate input stickers from output stickers: inputs have a round body and three tabs while actuator stickers have a square body and only two tabs (see Figure 2). The I/O Stickers were also designed so that they would blend in with the blank page, so as to influence resulting designs as little as possible and encourage customization, as shown in figures 2 and 3.

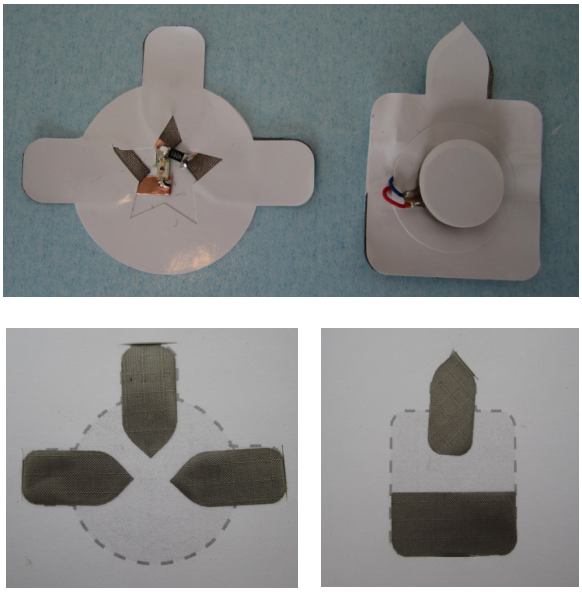


Figure 2: Input (left) and output (right) *I/O Stickers* and corresponding connection points

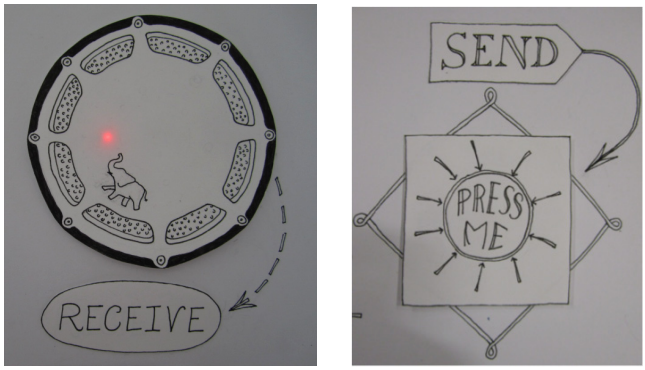


Figure 3: Decorated *I/O Stickers*

3.2 Pages

The pages with contact points for *I/O Stickers* come in form of connected greeting cards: the *Tele-Postcards*. To make the construction process feel as much as possible like crafting traditional greeting cards, we placed all of the rigid circuitry onto separate base boards that the cards snap onto with small magnets. Only the sticker footprints and flexible circuitry need to be on the card, maintaining the look and feel of a paper greeting card.

3.3 Design Principles

*I/*O stickers as a medium has all the affordances of traditional paper crafts in addition to electronic interactivity and long-distance communication. We chose to put one sensor and one actuator on each page to keep interactions clear and simple as well as to leave enough blank space for personalizing the scene. The flatness of the stickers makes them easy to incorporate other paper craft materials. The toolkit is designed to leverage skills that the users already have. Creating I/O stickers involves craft techniques that are familiar to most children, such as cutting, pasting and drawing.

4. PILOT STUDY: TELE-POSTCARDS

4.1 Research Questions

The goal of our pilot study was to discover whether kids could understand and use *I/O Stickers* to produce personalized remote-communication interfaces, gauge their level of engagement, and discover what kinds of use cases they would come up with. With respect to the electronics, we wanted to ensure that the stickers clearly conveyed their functionality and mode of use. From a practical standpoint, getting the kit into the hands of children allowed us to test whether each sticker was robust enough to withstand multiple uses. Finally, we wanted to see if the kit supported a wide range of creative styles, or whether anything in the design of the *I/O Stickers* constrained kids to produce similar projects.

4.2 Study Design

We designed our study to be as simple as possible, choosing to use uni-directional communication where one card is an input and the other is an output. Our pilot study group consisted of three girls and one boy, ages 10 to 12 years old - an age range we chose as an initial audience.

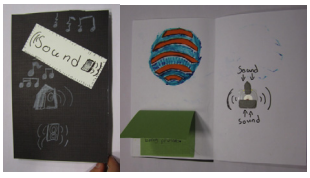
Each child was given the task of constructing two wirelessly-linked greeting cards, one to keep and the other card as a gift for someone they care about who is far away. The goal of this activity was to encourage kids to imagine how someone would react to the card when physically not present, and thus be thoughtful about the interaction and able to explain how the cards communicate.

We began the workshop by introducing the toolkit, demonstrating the functionality of the sensors and actuators. We then demonstrated how the stickers could be peeled off and replaced, to show that they could experiment until the right interaction was made. After the kids were comfortable with how each sticker worked, they were free to make their own cards. The session lasted approximately two and a half hours.

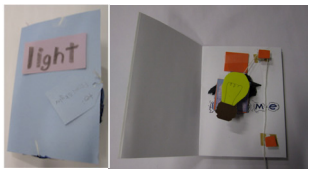
4.3 Results of the I/O Stickers Workshop

Figure 5 shows the complete collection of cards that were created during the workshop, showcasing a wide variety of visual styles, communication ideas, and modes of interaction. We describe the cards and the building process in more detail below.

(a)



(b)



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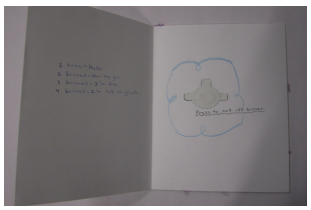

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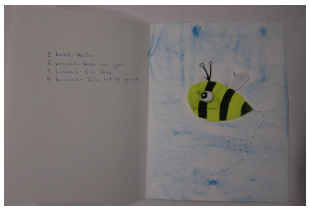

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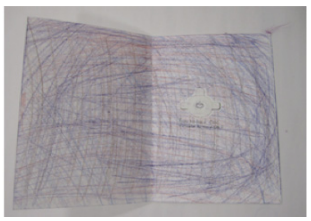
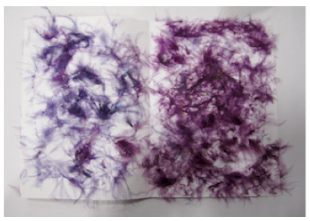


(g)



(h)

4.4 Analysis

4.4.1 What Worked Well

We found that overall the form factor was easy to understand and facilitated a very diverse range of projects. The children felt comfortable covering the stickers completely with their own art. The stickers did not appear to be difficult to manipulate. Several children wanted to change their chosen stickers at some point during the workshop either to change their design or debug, and were able to successfully peel them off and change them. They also appeared to feel comfortable using as many stickers as they needed, going as far as taking one apart to see what was inside. This also met our goal of having the stickers be viewed as "disposable," non-precious craft materials that could be used in permanent creations without any worry of wasting them or using them up. Most importantly, all four children created a very different card and were able to focus on different aspects of communication or craft.

4.4.2 Room for Improvement

To at least one of the children, it was not initially clear that there were two types of stickers (this child tried to stick an actuator on a sensor footprint). It also was not completely clear how to make a good connection between the sticker and the footprint given lack of immediate feedback.

We also found a few technical flaws with the stickers: the pressure sensor values tended to drift over time, and a connection to the vibration motor sticker which had worked during the initial demonstration did not work when the participant tested her card. From a practical standpoint, the all-white stickers were more difficult to debug because the connectors weren't exposed, and also hid the internal components.

5. FUTURE WORK

After incorporating the interface improvements we uncovered in the pilot study, we plan to implement data transmission over the internet so that the cards can be connected at arbitrary distances.

This will enable us to truly study how the crafted objects are used and whether they successfully help long-distance loved ones stay in touch.

One potential future impact of our toolkit is to introduce STEM concepts - in other words, "powerful ideas - in an accessible way and with immediate real-life applications. Towards this goal, we will explore the idea of a programming environment for children to manipulate the streams of data between the books in real time, adding delays, filters, conditions, broadcasts, etc. This will enable both increased control over the custom communication devices and more opportunities for learning high-level concepts.

Another promising STEM learning application for this kit is the electronics themselves. Given our desire to elucidate as much as possible and the study participants' interest in learning more, we plan to evaluate the stickers as a material for teaching more complex electronics and circuitry, explain the construction process and make it possible for users to design their own stickers.

6. CONCLUSION

We designed the I/O Stickers toolkit hoping that children would be able to express themselves by creating their own functioning remote communication interfaces. Participants in our pilot study indeed did so, and surprised us with personal, beautiful, and unexpected creations. We found that the 10-12 year olds in our study were highly engaged, had many ideas, and were even interested in learning more about the construction of the kit itself.

We have not yet tested the I/O Stickers "in the wild." When they had finished inventing and customizing their communication interfaces, the children who helped test the toolkit really wanted to share and use them; this is both a validation of the work so far and an impetus for further research.

7. ACKNOWLEDGMENTS

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