The Story of Things: Awareness through Happenstance Interaction

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Abstract
The *Story of Things* (SoT) system enables children to learn the *story* behind every object they touch in a typical day. Inspired by *Living Media* and the *Internet of Things* (IoT) our goal is to change children's awareness through hands-on interaction with the world they live in. A back-of-the-hand display is activated by stick-on finger sensors when a child touches an object. They can tap the display to select from a number of stories stored in a crowd sourced database about that object: the materials it was made from; the processes used to make it; how it impacts their body; how it will be disposed of; environmental or social rights challenges associated with the object; and how they can take positive action. This information is overlaid on the world through an augmented-reality contact lens. SoT will also enable children to see a *trace* of each day and in doing so help them better understand their environmental footprint and how their actions and choices can change the world for the better or worse.

Introduction
Today's children live at a point in time where nations are reassessing their human rights issues [6]. The United Nations convention on the rights of the Child proposes that children have the right to actively shape their future and the future of the communities they live in. What will enable children to actively participate in shaping their future? To actively participate, children

Figure 1. Spark Fun's Botanicalls Kit [3].

Figure 2. Meet Eater [8].

Figure 3. Infotropism [7].

must understand not only the facts, but how their lifestyle choices impact the world in which they live. They must also feel that they have agency to change the world. Current educational practices may not be adequately preparing our children to participate actively in their future. Teachers are facing a generation of students who often regard their learning as irrelevant to their own lives [1]. This is particularly problematic because researchers in environmental education and policy making have found that teaching people facts or informing them what the right choices are, in terms of social and environmental behaviors, are ineffective ways to support positive behavior change [14].

Imagine if children were able to understand – by simply touching objects in their world – the complex story behind the production, use, and disposal of the materials in that object. Instead of being told to recycle, imagine if as they hold a can of soda (e.g. Coke), they can access a wealth of information addressing questions that they might have: Where did the metal come from? Where did the ingredients of the Coke come from? What were the effects on the environment from creating these materials? Where will the Coke can go once it is disposed of? Who worked in the factories that made the drink? That made the cans? How much jet fuel was used in transporting the Coke? How does Coke affect my body? How can I reduce the impact of this product? Are there other soda choices I can make with lower impact? SoT places a world of information literally at a child's fingertips. It provides children with instantaneous, contextual information about the makeup of the world around them. It allows them to quickly and accurately compare the physical, social, environmental, and/or economic costs/benefits of the foods and products which they use every day, through simple touches and augmented reality. SoT provides a way for children to be informed about the things they use that is novel, interesting, and situated. Through it, they are given the means to discover and choose how they might change the ways they consume, think about, and utilize those everyday objects.

Background

There has been a movement in recent years to think about how technology can be passive while promoting awareness and/or behavior change around various issues. Research has shown that simply accessing information that exists "out there" in the world lacks a personal connection to our real world and rarely results in long term awareness or behavioral change regarding our habits [1]. We propose that a more effective approach is using *happenstance interaction*, in which information retrieval is passively directed by our hands-on interaction with the world. Every object a child touches is logged (creating a *trace* of their day), can be explored on demand, or ignored. SoT also builds on current research in *Living Media* systems that have focused on creating awareness and behavior changes through living organism feedback systems. *Botanicalls* (Figure 1) is a project that communicates plant needs (e.g. water, soil quality) to plant owners [3] . Plant life has been used to communicate information about the stock market (*Spore*, [2]), social and ecological issues (*Babbage Cabbage* [4]), network communication (*PlantDisplay*; [10], *Meet Eater* [8] Figure 2) and promote recycling behavior change (*Infotopism* [7] Figure 3). The motivation underlying these passive and live media systems is that seeing how our actions affect another live organism can promote better awareness, empathy and curiosity. We extend this approach to all things, because all objects – living or not – having

Figure 4. Internet of Things (IoT).
Image source: http://www.dreamstime.com/stock-illustration-internet-things-infographic-flat-design-image51663284

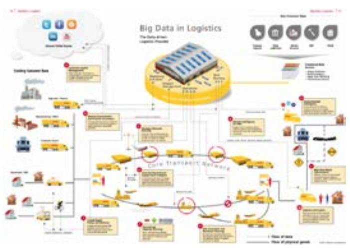

Figure 5. Story of manufactured things.
Image source: http://tarrysingh.com/wp-content/uploads/2014/07/DHL-FOG-2-1024x702.png

stories. Like the IoT (Figures 4,5) our system taps into connections between objects as well as the wealth of crowd sourced information available about how objects are produced, transported, consumed and disposed of. We propose that behavior change can be supported by children's *happenstance interaction* with objects they may not have noticed or thought about before. SoT can enable awareness of what children touch and they can then choose to explore specific information on demand. Touch by touch, object by object, children can come to understand how they impact the world they live in and learn about the positive effects their actions can have.

System and Feasibility

SoT is comprised of five modules: finger-tip sensors; a back-of-the-hand touch display and controller; augmented reality contact lenses; a tablet application; and a crowd-sourced database (see supplementary materials System Overview). Each finger-tip module is approximately 1cm in diameter, and contains a material sensor (microwave ring resonator [17]), which allows the system to determine the composition of real-world materials that it comes into contact with. The back-of-the-hand module incorporates a flexible e-ink touch display, several e-ink touch sensors, next-generation wireless (e.g. 5G), data processing, memory, power storage (graphene supercapacitors), and energy harvesters (e.g. body-heat thermoelectric generators, solar cells [12]); all within an ultra-thin, flexible substrate. The augmented reality contact lens integrates wireless connectivity [13] with a 3D light-field display (e.g. Magic Leap's photonic lightfield chip [16]), which displays 3D images that are practically indistinguishable from real objects. The crowd sourced database is accessed wirelessly, and material data is analyzed through a pre-compiled neural net similar to the Movidius Fathom [18].

SoT is feasible with technologies currently under development [5], however it is likely that future innovations will provide even better ways to implement SoT. The finger-tip and back-of-the-hand modules will be made of a thin (~10μm), self-adhesive elastomeric substrate whose properties, such as flex and stretch, match those of human skin. Adhesion occurs "through van der Waals interactions alone, in a manner that is mechanically invisible to the user" [9], similar to a temporary tattoo. Circuitry will utilize flexible silicon, nanowires, graphene, and carbon nanotubes [15]. Current implementations are ~30-100 microns thick and can support complex circuits such as displays [5], some CMOS circuitry [15], medical sensors and drug delivery [10], and silicon, metallic and graphene conductors [15]. SoT technical development offers multiple avenues for research.

Interaction and Scenarios

Interaction with the system occurs through material sensor input, button presses, information on the hand display and the augmented contact lens display. When SoT is turned on and a child touches an object with fingers that have material sensors, the back-of-the-hand display alerts them (e.g. ping or flash) – taking happenstance interaction and putting it into the child's awareness. The child can tap the back-on-hand-display to select information category(s) of interest such as Materials, Process, Transport, Impact, Disposal, Cool Facts and Action. SoT then analyzes the material(s), interpolates an object if applicable, and displays relevant information through the augmented contact lens. The child can tap through categories to switch between topics or explore more. Information is retrieved wirelessly from the neural net crowd-sourced materials database. The child may scroll through information with simple swipe gestures on the hand display, change categories via tap buttons, or choose a new material/object by simply touching it. At the end of the day their iPad app shows a visual trace of all the objects they touched during the day. They can tap any object to delete, explore or archive for later research.

Usage Scenario: Walking to School
As a child walks to school they carelessly drag their hand along a metal railing, touch a plant, pat a dog, and pull out an apple to eat along the way (see supplementary materials Walking to School Scenario). All of these items are logged in his trace of the day, which he can look at later on his tablet app. As he eats the apple he taps *Impact* on the back-of-the-hand display. SoT connects wirelessly to the database and instantaneously his contact lens displays information about pesticides and the impact on the environment of growing apples with pesticides. Fortunately for him, the display also tells him that his apple is organic.

Usage Scenario: Class fieldtrip
Class field trips offer wealth of opportunities to learn about the world through physical interaction outside of the classroom. By employing a system like SoT, students and teachers could create a contextualized dialogue about living in a globalized society as it relates to various in-class activities. For example, a trip to a local farm could allow children to touch food grown there and compare it to the food in their own lunches. By touching plants, they may learn about fertilizers and pesticides that are invisible to the eye but are recognized by the finger-tip material sensors. They could learn about steel processing by touching a tractor. Each child can explore objects of interest actively as well as through happenstance interaction. Children have different social and cultural practices related to food consumption. SoT can reveal these differences in the group, which opens up space for discussion around empathy and social tolerance. After the trip, the *trace* app can be used by teachers to open up a dialogue with students about the sustainability of their own practices in light of topics they've learned in class and through their deliberate and happenstance physical interactions at the farm.

Research Opportunities

SoT will enable us to investigate questions in learning and interaction design including: How does children's awareness of their patterns of consumption and environmental footprint change over time as they interact with materials in their world? Does a change in awareness correlate to changes in behaviors as children become consumers? In what ways can SoT become a catalyst for discussion or collaboration between children, their peers, caregivers and teachers? How can we design interaction and information to balance peripheral vs. focused attention so that children are made aware of, but not overwhelmed with augmented content? How to visualize complex information in ways that are accessible and suitable for augmented display? Do children using SoT contribute to the crowd sourced database? How can we provide agency so children feel that they create a positive impact? Most importantly, do children learn as they engage with the world in ways that support deliberate reflection, personal growth, and behavior change through happenstance interaction with every day things and the stories of those things?

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