Designing the "Things" of the IoT

Tom Jenkins
Georgia Institute of Technology
Digital Media Program
Atlanta, GA 30332, USA
tom.jenkins@gatech.edu

ABSTRACT
Building objects that question implicit assumptions of common systems can help to reframe technological artifacts. This work builds on an inexpensive prototyping platform that augments everyday objects in minimal ways as an early move towards engaging with the Internet of Things as a site for contestation in interaction design. These intend to account for a broader understanding of design as generating political objects—design things—that draw from the work of Bruno Latour and Studio Atelier. Finally, it introduces the concept of *object ecologies* as a way to both analyze existing ecosystems of design objects and generate new, speculative ones.

Author Keywords
Prototyping; Internet of Things; IoT; design; ecology

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces—prototyping; J.5 [Art and Humanities]—design

BACKGROUND

I'm a PhD student in Digital Media at Georgia Tech's School of Literature, Media, and Communication. My research interests focus on developing systems that explore different kinds of interactions with technology, attempting to create systems that are themselves ideological and that support particular kinds of aesthetic perspectives illustrating alternative values to existing, corporatist technological practices.

My approach to critical technical practice draws from three research contexts. First, Science and Technology Studies offer a historical, textual approach to understanding how meanings and uses of technologies are constructed socially. Broadly speaking, the framework that guides my research can be called *Critical Technical Practice* [1]. A critical technical practice operates simultaneously in two spheres: on the one hand producing technical work, but on the other taking that work and treating it as both a subject for criticism as well as a site for larger cultural critique. Building devices to up-end traditional understandings of device-making engages traditional engineering and art practice to produce real, functional objects: it attempts to transcend what's out there and postulates provocative new ways to get things done. At the same time, the assessment aspect of critical technical practice, where critical theory meets evaluation, hermeneutical implication, and personal experience, can be understood as a period of interpretation that informs later production.

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PROTOTYPING THE INTERNET OF THINGS

"The Internet of Things" describes a trend advocating that all sorts of physical artifacts become connected to and controllable from the Internet. According to this vision, a coffeepot might be controlled alongside a thermostat to have a home warm and the coffee on when a person wakes up; or sensors in the basement might email you if your basement is flooding. While this all seems very sanguine, current IoT technologies rely on centralized servers, well-defined APIs, and black-boxed electronics for the end-user, and are built only to be used in specific, condoned ways.

My project is to develop small, low cost, low-power, prototyping platforms to try to solve problems in everyday life. These systems offer very little: they have four bits of input and output, no analog capability, and must be programmed in assembly. While the assumption might be that these devices are hard to use, the simplicity of the chip and its low capability means that for any number of applications, a solution can be cobbled together quickly: has the mail been delivered? Do I need to cut my lawn? Is there a slot available at that bike rack? Unlike more complicated and expensive platforms like the Raspberry Pi and the Arduino (each approximately 7-10 times more costly than the current system), this prototyping platform is built to explore the possibilities, both aesthetic and prosaic, of ubiquitous minimalist computing.

The Internet of Things without the Internet

I'm using these prototypes begin to sketch out an alternative vision of the Internet of Things. This IoT is bottom-up rather than centrally controlled; it emphasizing material/computational/ human collaboration rather than the parameterization of the everyday world from a central authority, and most notably, does not require the Internet. I intend to construct devices for small-scale, human-

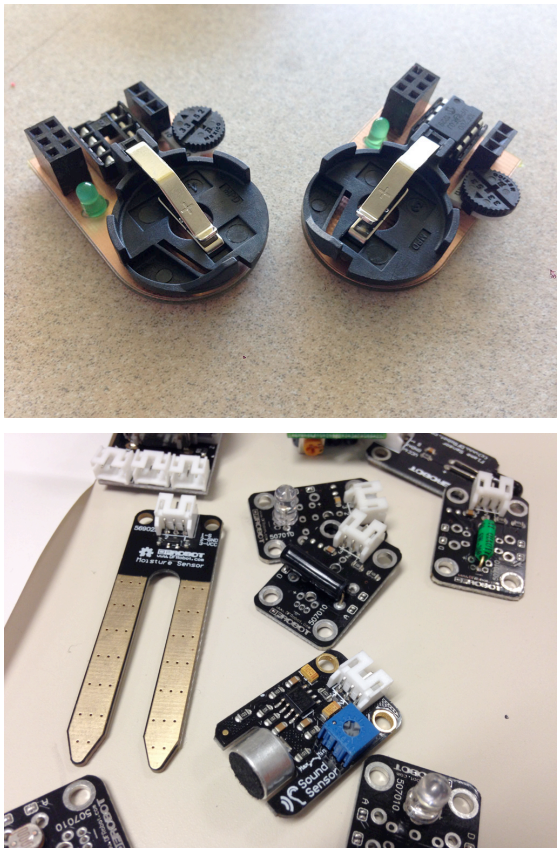

Figure 1. The minimalist prototyping platform with a variety of sensors for prototyping.

evaluated interactions between things; or more complicated, communication-driven emergent interactions that still requires humans for assessment. In these concepts, the system's output stays *in situ*, and people around them draw any relevant conclusions for themselves.

The lower cost that comes with using very simple hardware is a huge benefit. It becomes much more feasible to create many different kinds of smart things, with little regard to whether adding a microcontroller to something makes sense in the short term. It will be possible to build infrastructure-less sensing devices that become cheap, ubiquitous, computational material objects—from a spoon that tells you when your soup is cool enough to consume, to postboxes that make it clear the letter carrier has been by. At that point, we will find ourselves in a situation where the experiences that everyday objects have are translated only partially to the language of the observer.

While prototyping, I've had to take a new look at how people live: what simple, measurable opportunities exist that could become a site for intervention or problem solving. To that end, one unforeseen outcome of developing a platform like this is enforcing a kind of "algorithmic lifestyle" on a prospective user. This has led to a set of research questions around constructing a speculative IoT: What parts of experience can be offloaded into a device? How can we support novelty, play, and other kinds of emergent aesthetic experiences while also supporting effective, useful applications and allowing for satisfying material interactions?

INTERACTION DESIGN AS A PLACE FOR THINGS

Postulating these new kinds of socio-technical "things" has always been a part of design generally, but also of computing specifically. Computational artifacts provide an opportunity to produce objects that also serve as rhetoric, imagining new kinds of participation for both people and artifacts. As an example, Julian Bleeker's concept of *Design Fiction* moves towards postulating entire social spheres of interactive objects that have a point of view: "This is a different genre of design. Not realism, but a genre that is forward looking, beyond incremental and makes an effort to explore new kinds of social interaction rituals. As much as science fact tells you what is and is not possible, design fiction understands constraints differently. Design fiction is about creative provocation, raising questions, innovation, and exploration" [3]. The critical design of Tony Dunne and Fiona Raby offers another example of the design space creating speculative technological futures. In their work, they create devices and systems that emphasize the nature value-laden objects, running the gamut from electronic objects in a home that as a whole seek to protect the residents from the hypothetical dangers of electronic waves [7] to manifests for speculative design objects that interrogate complex, and frequently negative, emotional spaces [5,6].

Bill Gaver has also been producing work that could be called a part of the Internet of Things, even if many of the systems predate common use of the term. The *Home Health Horoscope*, for example, was built to be a "smart home" system, but without representational understandings of its users [9]. Instead of sensing residents and trying to predict their needs, the *Home Health Horoscope* kept a "fuzzy" understanding of what was happening around it. Every morning, residents of the house where it was installed would receive a slip of thermoprinted paper—a horoscope for that day generated from a suite of sensors placed around the house to try to assess emotional valences: whether the medicine cabinet had been opened could indicate that someone was feeling ill, more pressure sensors on the couch being active might represent a homeowner entertaining.

At a larger scale, the *Presence Project* [15] was a project to increase awareness of an elderly population in a housing project called the Bjilmer, in the Netherlands. While perhaps best known in the HCI community as the origin of the popular cultural probes method [8], the *Presence Project* produced a workbook of proposed environmental technologies as well as a set of working prototypes. These include "slogan furniture," such as bus benches that display snippets of emotionally charged text and curated images

from the elderly into the broader public sphere of the Bijlmer.

Finally, the useful qualities of ubiquitous computing as a design discipline have been evident across material boundaries, inviting new kinds of perspectives and collaborations between things and people. Kuznetsov et al, for example, have made an effort to understand the nature of the thing as a means of creating public engagement through their work in urban settings. In *Participatory sensing in public spaces: activating urban surfaces with sensor probes* [13], small, nonfunctioning "sensor objects" are distributed to various publics, including young parents, the homeless, and bicycle enthusiasts enlisting them to place smog sensors, or bio-hazard sensors on objects in their everyday experience. What and how these populations chose to instrument emphasizes particular values that they have, illustrating matters that concern them, and especially the differences between groups, even from the same sensor object. Similarly, in *Ceci n'est pas une pipe bombe: authoring urban landscapes with air quality sensors* [12], these same communities were given real sensor packages outfitted with GPS monitoring to track how and where they were placed, creating a map of social interests as well as serving to create a feeling of public participation in a conversation around air quality.

All of these objects, social interests, plant material, sensors, elderly shut-ins, vague feelings around health practices, guilt, joy of hobbies, and so on are intrinsically parts of their respective systems, but are not usually well accounted for in system design. One way of beginning to take this broad variety of objects and values into account in HCI research in general and interaction design research in particular is to consider these kinds of complex relationships as being *things*.

DESIGN AND AN EMPHASIS ON THE THING

The "thing" is one way that designers and theorists have contemplated the role of objects in sociotechnical systems. At its roots, the "thing" comes from the term *ding*, an ancient Germanic word for particular kinds of gatherings. As described by Heidegger in [11]:

…the Old High German word thing means a gathering, and specifically a gathering to deliberate on a matter under discussion, a contested matter. In consequence, the Old German words 'thing' and 'ding' become the names for an affair or matter of pertinence. They denote anything that in any way hears upon men, concerns them, and that accordingly is a matter for discourse.

This understanding of things as a shift from an object in space to a site for contested political action is expanded by Bruno Latour in *From Realpolitik to Dingpolitik* [16]. This is Latour's proposal of thing-centered or "object oriented" democracy. This "tentative set of experiments" is constructed not to define fully define what an object-oriented view of politics actually is, but rather, to consider the kind of attributes that a politics that takes the perspectives of objects into account would have. In the early 21st century, Latour believes, it has become clear that the enlightenment model of political activity based on some sort of commonly understood mutual goal and founded upon an agreed-upon set of facts is no longer taking place, if it ever was. Instead, he wants to take political actions *as they are*, and rather than some sanitized narrative of consensus-building, examine the messy nature of alliances and allegiances based around particular situated values. "We might be more connected to each other by our worries, our matters of concern, the issues we care for, than by any other set of values, opinions, attitudes, or principles." To Latour, objects become battlegrounds for differing perspectives on matters of concern: "*every one of these objects, you see spewing out of them a different set of passions, indignations, opinions, as well as a different set of interested parties and different ways of carrying out their partial resolution*."

To Latour, the concept of an issue and an object get mixed together in a productive way: objects are issues that have enlisted actants that care about them. Beyond simple, objective statements that can be demonstrably true or demonstrably false, political decision-making is dependent on contested realities, as multiple perspectives on objects can be debated, discussed, and brought to closure. These contested objects are things in themselves, in that they are materialized issues that simultaneously embody multiple political perspectives; but are also the locus of another kind of assembly for those who have a vested interest in that thing. The thing becomes a site for contestation as well as a representation of a perspective on the issue. In the case of the *Home Health Horoscope*, for example, its vagueness as a device that had been designed to create reflection provides tension by subverting expectations around how and what "smart home" devices should do. Refusing to be straightforwardly understandable places the system at the center of an ongoing process of contextual interpretation and shifting reinterpretation.

Latour also emphasizes how the political contestation inherent to things is distinct from governance. Traditional political action takes place exclusively in capitol buildings or parliamentary houses, defining useful political behaviors as being those that lead to resolutions, laws, and other kinds of legal structures. This object-centered political action takes a different tack. "Procedures to authorize and legitimize are important, but it's only half of what is needed to assemble. The other half lies in the issues themselves, the *matters* that matter, in the *res* that creates a public around it. They need to be represented, authorized, legitimated, and brought to bear inside the relevant assembly." This "being brought to bear" is what takes place in *Ceci n'est pas une pipe bombe*, described above. In encouraging different stakeholders to engage with the terrain of the city through installing sensor packages in sanctioned and un-sanctioned ways, the packages themselves become the site of

contestation for thinking about air quality. Authoring the city with devices that make claims about Latour considers the political engagement of things as a primary motivator for objects taking a place in political dialogue. These objects become the "things" that do work'—in some ways implicitly: they operate through organizing and assembling actants into dialogs around contested issues.

Studio Atelier have taken this framing of thing as an assemblage to flesh out the idea of a *design thing*, a designed object that enacts multiple roles in the context of the process of design [2]. Unlike design projects which have well defined boundaries, design things are messy, supporting many different values and viewpoints. Borrowing from Latour the concept of actants working inside a network [14], the design thing "aligns humans and nonhuman resources into to move the object of design forward, to support the emergence, translation, and performance" of the design object through "participation, intervention, and performance in this sociotechnical thing."

As with Latour, Studio Atelier recognises the ability of the object to align various interests. To them, the object of design becomes a point of contention and contestation between many different factions. On the one hand, the design object is part of a lasting record of process: the designers build into the object a history of decisions and compromises. At the same time, the designed object is still an active space for current controversy and consequently, future decision-making.

From this perspective, the Internet of Things changes from suites of consumer products or objects that exist for people to be used exclusively in the here and now into speculative social configurations: they postulate systems to create possible encounters between people, objects, and values. As the role of interaction design has expanded generally—often through nebulous categories of work like "user experience"—the work of interaction design seems more allied with the idea of the design thing than it does making prototypes and wireframes.

OBJECT ECOLOGIES AND THE IOT

Reading the Internet of Things as a complex web of alliances and shadowy political intent casts the work of the designer as being very different at different times. I'm currently writing my dissertation proposal on "object ecologies," taking this wider theoretical framing of things and building out a way to analyze and generate ecologies of objects. I believe that this is a way to generate provocative design systems that are both rooted in the plausible while still offering a rich vein of speculation to mine for producing interesting prototypes. A method for producing speculative design without spectacle.

One example of this can be found as part of Bogost's thing-centered, object-oriented research. He advances what he calls "carpentry", or the production of devices and systems that do philosophical work [4]. Because of the nature of ubiquitous computing as a discipline of technical production, carpentry is inherent to research systems and platforms, whether or not it's acknowledged.

TEI GRADUATE STUDENT CONSORTIUM

The TEI graduate student consortium offers an exciting opportunity to meet, share ideas with, and collaborate with other researchers and practitioners who are operating on different subjects from a similar perspective. I struggle with questions around evaluation and impact. How can we evaluate and create impact from speculative design systems? Can they affect mainstream technological production in worthwhile ways? Interacting with peers undergoing analogous struggles with their own research and production processes will be very helpful in terms of framing my own interests in the Internet of Things and its discontents.

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