Good afternoon. Thanks for having me here. Today I want to give you a bit of my perspective on user experience design for the internet of things. The talk is focused on the consumer internet of things and it will be in two main parts: a general overview of the deep change Internet of Things has on people’s relationships to devices and companies relationships to value, and a review of how I currently go about designing products for the IoT.
Let me begin by telling you a bit about my background. I’m a user experience designer. I was one of the first professional Web designers. This year I am celebrating professionally designing Web sites for 20 years. This is the navigation for a hot sauce shopping site I designed in the spring of 1994.
I’ve also worked on the user experience design of a lot of consumer electronics products from companies you’ve probably heard of.
I’ve written a couple of books based on my experience as a designer. One is a cookbook of user research methods, and the second describes what I think are some of the core concerns when designing networked computational devices.
I also started a couple of companies. The first, Adaptive Path, was primarily focused on the web, and with the second one, ThingM, I got deep into developing hardware.
Today I work for PARC, the famous research lab, as a principal in its Innovation Services group.
+ A DEFINITION OF THE INTERNET OF THINGS
The Internet of Things is a really challenging name to work with, because there are so many definitions. This is Time Magazine’s illustration of the Internet of Things for their “Best Inventions of 2008” edition. I love this illustration is because it makes no sense no matter how you think about it, which is actually quite an accurate representation of how confusing the many definitions of the Internet of Things are right now.
The first thing to note is that there are two definitions of the Internet of Things, which causes a bit of confusion. In the original one Kevin Ashton looked at how RFIDs could affect the logistics industry and saw an analogy to the Internet. RFIDs could be like the packet header in Internet data packets, trucks were like wires, depots like routers, warehouses like caches.

Somewhere around 2010 the definition slipped and rather than being an analogy between shipping and the Internet, it came to mean what Mark Weiser had earlier described as ubiquitous computing, which means that everyday objects as full-fledged citizens of the Internet. Instead of being LIKE packets, the objects now send packets themselves.

What’s especially confusing is that since so many of the new objects are mobile, the first definition ALSO kind of applies. When you’re using Waze to guide you around traffic, it’s treating your car like a data packet because your phone has made your car into a networked computing device.
The implications of this technological change are broad, but today I want to focus on two aspects: how consumers’ relationships to devices change, and how companies value chains change.
The first thing I want to talk about is how people’s relationship to their devices is changing.
The core of this change is a shift from generic devices and software to specialized devices and software. When computing was expensive, you had general purpose devices and general purpose software that had deal with almost every situation. This necessitated design compromises that resulted in devices and software that could do almost everything, but did none of it well.

Now that processing is so cheap, you can have a combination of 10, 20, or 30 computing devices and apps for the price of that one device, and you can acquire new functionality as needed. This means that every device and software package can have a narrower purpose.

Adobe brush
Haiku deck
The second trend is that much of the value of computing is now remote. Today, most people understand that the experience you see on one device is often a part of something that’s distributed throughout the world. There’s no longer a need to pack everything into a single piece of software, and there’s no expectation that everything will be there.

Foursquare as a whole doesn’t live on your phone in any meaningful way, and people know that.
If we chart these two trends, two broad classes of digital products emerge.

If we follow the local to remote axis, we find general-purpose devices that do roughly the same set of things, and differ primarily in size. They exist to provide access to online services, in a form factor that’s appropriate to the context in which they’re used. I call these devices terminals.

If we follow the general to specific axis, we see a shift is to more narrow-function devices that are designed to do a small set of things with specialized hardware. A parking meter can take quarters, which your phone can’t do, and a digital SLR has a giant lens on it, which you probably don’t want on your phone. These devices differ in their specialized hardware. I call these devices appliances.
The most interesting thing, however, to me is that these shifts are part of an even larger transition, one where devices are simultaneously specific AND deeply tied to online services. In this model, the service provides the majority of the value, and can be represented either as a dedicated appliance, an app running on a terminal, or anything in between.

I call these devices service avatars. And this is where much of the Internet of Things currently lies, at least for consumer products.
As value shifts to services, the devices, software applications and websites used to access it—its avatars—become secondary. A camera becomes a really good appliance for taking photos for Flickr, while a TV becomes a nice Flickr display that you don’t have to log into every time, and a phone becomes a convenient way to take your Flickr pictures on the road.

Hardware becomes simultaneously more specialized and devalued as users see “through” each device to the service it represents. The hardware exists to get better value out of the service.
Amazon really gets this. Here’s a telling older ad from Amazon for the Kindle. It’s saying “Look, use whatever device you want. We don’t care, as long you stay loyal to our service. You can buy our specialized devices, but you don’t have to.”
When Fire was released 3 years ago, Jeff Bezos even called it a service.
Amazon’s Echo speaker, which was just announced today is also a service with multiple avatars.
Smart Things clearly states its service offering right up front on their site. The first thing they say about their product line is not what the functionality is, but what effect their service will achieve for their customers. Their hardware products’ functionality, how they will technically satisfy the service promise, is almost an afterthought.
Compare that to X10, their spiritual predecessor that’s been in the business for more than 20 years. All that X10 tells is you is what the devices are, not what the service will accomplish for you. I don’t even know if there IS a service. Why should I care that they have “modules”? I shouldn’t, and I don’t.
A DEFINITION OF USER EXPERIENCE DESIGN
First, I’d like to define user experience design. UX design is not interface design, it’s not industrial design, it’s not product design, but it includes all of those things. UX design is a user-centered problem solving approach that brings together business needs and user needs to create products that are valuable for both groups. The field is about 20 years old and here’s a diagram by Jess McMullin that lays out the basic idea of the goal of the practice.
Here’s a somewhat more elaborate illustration done this year by Corey Stern. I won’t go into the details, but you can see that the pillars are what users want, what businesses need and how the two interact.
Now I would like to talk about how is the Internet of Things changing UX design practice? When I started 20 years ago, interaction design was a combination of graphic design and cognitive psychology. In the IoT UX space, graphic design has been largely replaced by industrial design, which is the design of physical objects, and cognitive psychology has been replaced with service design, where you project specific business models through a range of customer interactions. However, this is not a simple one-to-one tradeoff, since IoT UX design still includes all of those visual design and cognitive psychology questions, plus a whole new set of challenges because the experiences span multiple touchpoints, multiple avatars.
One thing that’s for sure is that the era of a hero design object—that single thing, whether is a device, a poster, or a Web page, that is the primary focus of a design process—that era is over. Every service avatar, whatever it is, is merely one facet of a larger whole, and design as a practice is no longer the creation of objects, but a practice for solving problems that span objects and environments and use contexts.
Because design that focuses only on the experience of a single touchpoint produces gadgets, not solutions to problems, and gadgets are the kind of thing that litter your closet, not things you use every day and that you love and associate with your own happiness.
The design artifacts you make are all over the board. I’m going to go through a handful that I’ve found to be useful, but like I said at the beginning, it’s a new discipline and the way that we approach this changes constantly. When I give this presentation in six months, I’ll probably talk about a different set of deliverables.
To me the key change that the IoT has brought is that now every design problem includes multiple touchpoints simultaneously. That’s often a bit of a challenge for people to wrap their brains around, so after an initial conversations with my clients I put together a high-level description of what pieces the service is going to contain. The diagram separates data sources, analytics, displays, controllers, sensors and actuators and it’s super simple, because one of its goals is to reinforce that all of the pieces are connected and that neither the app, the watch or the thing that’s in your stove is more important. That helps me talk to stakeholders about the scope of what we’re going to build.
Next, someone on the product team needs to create one of these. It’s a Business Model Canvas, from Alex Osterwalder and Yves Pigneur’s Business Model Generation book, which is a single-page checklist that describes what the service is going to do for people, who’s it’s for, and why they’ll pay for it.

The user experience of most multi-touchpoint Internet of Things services is much more closely tied to their business model than in a traditional traditional consumer electronics company. For example, say you’re making a smart lock. How much functionality should you put in the lock mechanism? Well, that depends on what customer problem the service is trying to address. If you primary audience is AirBNB property owners who want to create a unique code for each tenant, that’s a different set of needs than for a security-concerned homeowner who want their lock to be the first line of defense against intruders. Same lock, perhaps even same locking hardware, but a different emphasis based on the key business model.
After the Business Model Canvas, we’re in straightforward UX design for a while. I like to create 4-5 personas, which are characters that describe how the product could be used based on facets of the business model—here’s one we did for a Stanford project. You can see each persona has goals, questions, and frustrations that the service is going to need to address. I prefer to build these based on up-front ethnographic observation, but there are a number of different ways to generate these.
Then you get to use scenarios and storyboards. These help to tell the story of how people interact with various avatars, what role each does and does not play in people’s lives. It’s useful for both communicating a vision among team members and stakeholders, and you often learn important UX lessons just by talking through a couple of stories. This is one we did with Smart Design.

Storyboard by Smart Design
Next, you start bringing things together by putting various touchpoints against important goals your personas’ and your stakeholders’ goals. These touchpoints can be full-fledged service avatars or just interactions with the service. One way to do that is by making a swim lane diagram that puts the touchpoints across the top and then maps interactions across.

This is a chunk of a journey diagram I put together for Sifteo, the game company, a couple of years ago. We developed a set of goals for the UX of the devices, and those goals spanned the documentation, the interface on the devices, and the Web site. Across the top is a set of touchpoints, which range from the text on the box to the instructions that people won’t read, to the firmware and the site. Horizontally I created swim lanes for people’s motivation, what information we gave them, what they can do at that point, etc. And then across this grid I mapped out a strategy for interactions that we hoped would lead people to do things such as downloading the software and buying new games.
Next comes the design for all of the avatars. I divide this process into 2D, which is essentially screen-based interaction design like how you would design an app or a Web page...
...and 3D. Here we take our process cues from industrial design practice and start with sketches then move to models and renderings, with looks-like prototypes...

This is a rendering from a project we did with Smart Design.
...and works-like prototypes.

This part is essentially a traditional iterative product development process, applied to each avatar.

Project: Yoichi Nagashima
And of course in between many of these steps is a lot of user research. Here’s a photo of one of my colleagues doing preliminary ethnography for a shopping product. I’m a firm believer that no idea is worthwhile unless it’s been validated by people who are not your team through the development process, so we do a lot of user research.
In practice this means that the range of things that need to be designed is enormous. One minute you’re debating the business model, the next you’re sitting next to an engineer picking out sensors. There’s a lot of uncertainty.
Broadly speaking, our process is iterative and we try to use agile and lean best practices, but as any of you who have ever done that with a client know, it’s tough to be doctrinaire.
And in practice the process is a lot messier than it looks even in this diagram.
One of the biggest questions that our clients have, and frankly we have, is how to know if a largely new technology or service is going to be successful without actually going through the expense and process of developing a complete product. No one in an interview or a focus group would have said “I want a $250 wifi-connected thermostat with predictive behavior aimed at reducing energy usage.” Nest was able to build one because Tony Faddell had the bankroll and connections of the guy who had created the iPod, but few other projects have those kinds of resources.

Here’s the process I’m currently using to help me push the bounds of existing products and services, and to do it with some idea of what people value and what’s technologically feasible. The top layer describes a highly iterative, highly explorative phase that exists solely to help us understand what experiences provide value to people and what technology our team can reasonably deliver. After this phase is done, we throw everything we did away and start designing the real product from scratch, and that’s where the prototyping process starts.

Probes, are things that resemble finished products—perhaps they’re nonfunctional apps or boxes with lights—but exist to explore hypotheses about what kinds of avatars people will respond well to. We give them to people for a couple of days or a week and then we interview them when they’ve had a chance to live with them. Proofs of concept exist to test core technological ideas. I don’t care if we have to throw a $3000 server at the problem when the end product has to cost $10, is it possible for us to do that thing AT ALL? After we’ve done these two things iteratively, we have a pretty idea of what goes into the prototype, and then we iteratively develop that with additional user feedback until we’re pretty sure it represents a valuable and technologically feasible service. Then we deliver that to our client who uses it as a reference design that they can then tear apart and rebuild using their own in-house technologies or processes or teams.
So, stepping back, why do this? Well, it’s because I think that there’s enormous possibility in the Internet of Things, but it’s not in the things.
Our biggest challenge as innovators, designers, developers and entrepreneurs will not be adding cheap electronics to everyday objects. That’s a solved problem. Our challenge will be to understand how to use those things to create value, and to create sustained and sustainable change, in a world where there is an enormous amount of potential for embedded, networked technology, and an enormous number of paper thin, one note gadgets. I once heard an industrial designer say that everything you design is garbage from the minute it comes off the assembly line, and that it’s your responsibility to keep it out of the trash bin for as long as possible. I think that in the internet of things that is especially true and today I think that our biggest challenge will be to think about why we want to make things at all, and then how we can make them provide the most value, for the least cost, for the most people, for the longest time.

• The wheel is an extension of the foot.
• The book is an extension of the eye.
• Clothing is an extension of the skin.
• Electric circuitry is an extension of the central nervous system.

— Marshall McLuhan,
The Medium is the Massage, 1967
Thank you.

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