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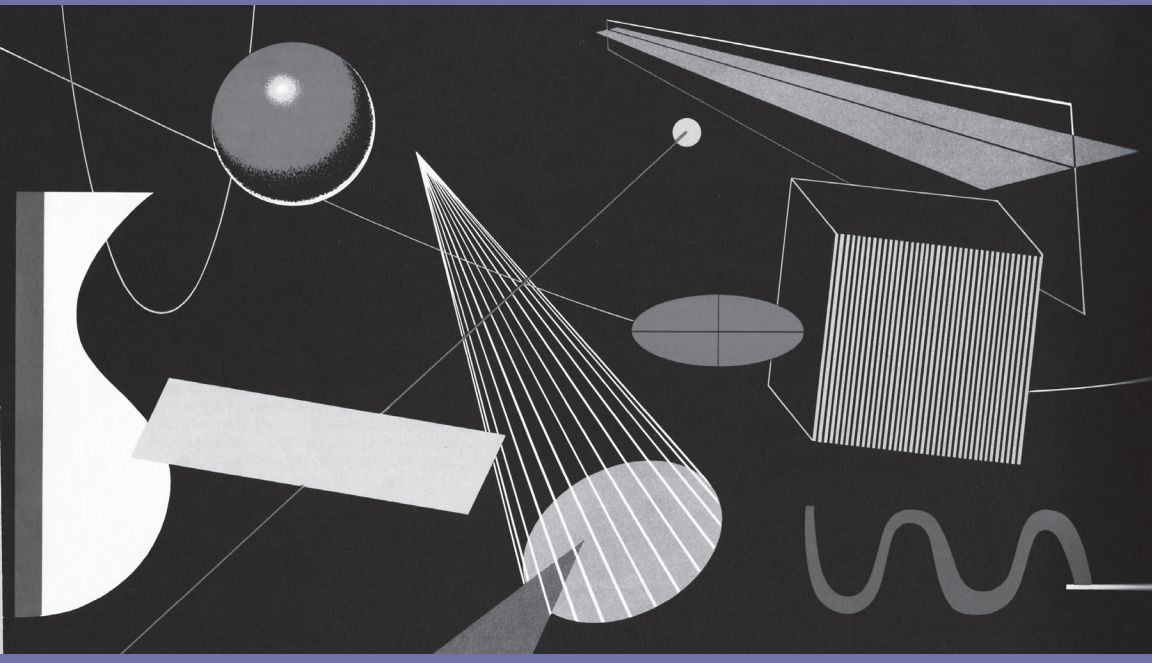
Design for Living with Smart Products

The Intelligent Home



Simone Rebaudengo

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by Simone Rebaudengo

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A Quick Introduction to the "Smart" Problem

The house from which I wrote this report was built around a hundred years ago. It was built by the French in the 1920s to be lent by the Shanghainese municipality to an official of a political party, and then it was given as a sign of respect to a famous opera singer, who decided to consign it to his mistress. It was sold—or more accurately, passed on—in the 1990s and subdivided into smaller apartments to accommodate up to eight families. Now, as a result of Shanghai's housing boom, it's rented out to just three families, at 20 times the price for which it was originally lent. It was built when electricity was a luxury. It was later wired for telephone and then eventually TV cables were installed. I guess that there should also be a satellite cable somewhere, but I cannot recognize which plugs are which anymore. When I moved in, fiber-optic was quickly set up by a cable contractor, thrown out in the courtyard to be bundled up in the mess of wires. My home is connected, and it always was in some way. It's not really owned by anyone and it's a very complex mix of old, new, East, West, rich, poor, and so on.

When I look around my apartment, I see only a few things that I would consider "smart": my laptop; maybe a couple of other things that I managed to coax to work together via Bluetooth; and my dog. The rooms have a complex mix of new things, old things, things I brought with me from previous homes, and things I found here in the neighborhood. There are Italian lamps, Chinese unbranded appliances, and various devices that were manufactured for the

American market (but produced in China). There are a few handmade objects that I acquired for the love of craft as well as a lot of cheaply mass-produced items I bought due to their low prices. There are things I use, things I forgot I had, things that were given to me, and things I bought by mistake (as I recently discovered Taobao Marketplace, which is Alibaba's on-steroids answer to Amazon ecommerce platforms, the latter one boomed).

A home is not a "house"; a home is not only a set of problems that can be solved or tasks that can be automated. A home, as said by Joseph Grima, founder of the architecture and research studio Space Caviar, "is so much more than the sum of the functions it performs,"[1] and it's a very complex mix of people, architecture, history, memories, technology, and generally life. My home—or actually more precisely my apartment—answers as much to my functional needs as it functions as a representation of my own aspirations, or, most likely, actually my laziness. The more I realize looking around, the less I would have imagined that 2017 would look like this.

As a designer working in and with technology daily, I guess my home is the least "smart" that it can be, and it made me wonder, "Why?"

Why am I so excited to design for the near future in which smartness will leak into our daily life, while at the same time not allowing it into my own space? Am I just living the symptoms of my own version of a recurring analog dream? Or, maybe I just don't see the right kind of "smartness" that I want or need?

"Smart" Assumptions

Smartness has been pushed as a term to represent the ongoing aspiration toward a more controlled and more "ecologically viable solution" of today's environments and devices. Smart cities, smart homes, and smart devices are being pushed in our life to help us deal with our own limits and point us in the direction of our personal and common aspiration of financial, ecological, and mental balance. However, when used in relation to home products, "smart" mostly represents the idea of an automated, quantified, efficient,

1 From "Home Is the Answer, but What Is the Question?"" by Joseph Grima in *SQM: The Quantified Home*.

optimized, and potentially also anthropomorphized use of technology. Smart products today are not the highly complicated robots predicted by sci-fi and future visions of the past, nor are they the experimental computers imagined in the ubicomp visions of the 90s; rather, they are mainly mundane objects equipped with sensors, a little bit of processing power, and some sort of connectivity. In a similar scenario of the boom of the *electrified everything* of the late 1800s, we have now a plethora of smart + "thing": from the more advanced smartphones, smart fridges, smart thermostats, smart plugs, and smart toilets all the way to smart bottles and socks.

The ability to embed computing power and connectivity inside almost any product at a viable price opens up completely new services, products, and use cases. "The web getting inside physical things is the twenty-first-century equivalent of electrification, which swept the world in the late 1800s."[2] Beyond connectivity, due to the growing number of tools that allows AI-like functionalities to be accessed by products "in the cloud," a next level of smartness is becoming more and more accessible and setting a need for new paradigms of interaction and relationships with things that listen, adapt, evolve, learn and "dwell" with us. Although this shift will surely affect the experiences of users, it also will require designers, engineers, technologists, and companies to find ways to envision not only new values and use cases, but also to consider the implications of what they are bringing into people's lives. As well put by Scott Smith, founder of the future consulting firm Changeist, "The rush to create new commercial prototypes, products, services, systems and stacks often means culture, custom, needs and desires are overstepped in the reach for profitable new use cases."[3]

Most new smart and intelligent products are promising to turn our homes into more simple and better places to live in, but maybe the biggest issue lies exactly in this exact assumption. There is a long and growing list of people who are *laughing about the usefulness of smart products* or who are concerned about the hidden and dark aspects of privacy and security; however, rather than attacking or defending the "smart that we do not want," what I'm mostly interes-

2 Tim Maly, "The Virtual Haircut That Could Change the World", February 20, 2013.

3 As stated on the website for Thingclash, a lab project of Changeist.

ted in and what I will try to articulate in this report is how we can rethink what smart can mean next.

A fair amount of smart devices are now being designed and developed under the thunder and buzz of smart/AI, but to be successful beyond their goals or investment rounds they will need to be welcomed and accepted into our homes, not necessarily in the same ways as friends or pets that require a lot of attention, but as something closer to new guests that we share space with, that might become useful at times and hopefully don't stink after three days.

Figure 1-1. Uninvited Guest by Superflux, shows a future of "annoying" smartness

To design such products, we will need to break apart some of the assumptions that lie behind the word "smart" and embrace the complex reality of real homes. We also will need to get our hands dirty and understand the basics of processes like learning because they will soon become the main subject and material with which we will design.

In "Learning from the Future" on page 5, we look at some of the technological dreams of the past and how they influenced the present state of the smart home and its products. We also look at some of the present products and experiments that are trying to break the status quo.

In "From Smart Products to Home Guests" on page 20, we break down smartness and some of its main assumptions into a set of new steps and materials that need to be "designed." We explore new challenges that we will face as designers who have to imagine more intel-

ligent and connected products alongside which people actually will want to live.

If you share my views on the conceptual issues I outlined earlier and find yourself having to design something smart for a client or for your own business, I hope this report can help you find new inspiration and ways to think about what smartness can be. If you instead disagree and you love the smartness of today, I hope this report can lead you to see another side of what the future can be. Or, even better, if you've never read anything about smart products, I hope to push you into a new direction from the start.

Learning from the Future

I was born in 1980s Italy; computers and phones were mostly absent from my childhood—they came later on, in my teenage days I also come from a country where past is far more important than the future, where design means furniture, and designers used to be architects rather than engineers or artists. The home for me has always been the first context for design; a place where designers like Joe Colombo (see Figure 1-2) or Achille Castiglioni (Figure 1-3) could embed entire philosophies and historical commentaries in the shape of lamps, chairs, and appliances. When talking about what we should design in the future, it's natural for me to go back to the past, in particular to the future homes of the past.

Figure 1-2. Total Furnishing Unit (1971) by Joe Colombo

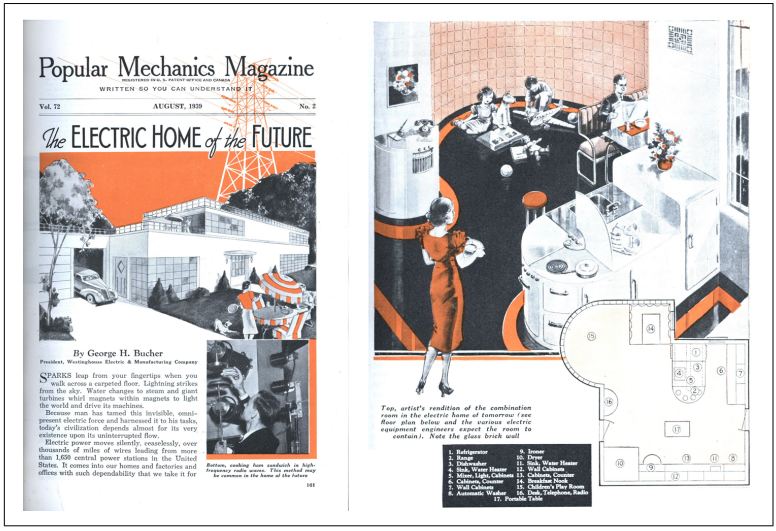
Figure 1-3. Toio Floor Lamp (1962) by Achille Castiglioni

The future home always has been the theater for companies to envision and explain how great technological leaps will be brought to the masses, changing their lives in myriad beneficial ways. In different times, these visions served to dream about a better home life, but also to propose and highlight new products and ways of living in the present. I'd like to present a very brief history of the "future past" and try to highlight the constant patterns and motives that brought us to what we consider "smart" today. I'll also show you different ways of looking at the future in order to introduce a new notion of smartness.

The Future Home of the Past

Homes have always been "connected" to the external world by means of infrastructure and a flow of inputs and outputs. Be it originally in 1700 BC, in the form of water; in the 1700s with gas for light and cooking; in the 1800s, in the form of electricity and telephonic communications; to radio waves and video in the 1920s and 30s; and ultimately data and information in the 1990s. Pipes, cables, lines, satellite dishes, and other infrastructure elements became part of the home to feed faucets, kitchens, washing machines, radios, phones, televisions, and to make the home electrified, automated, or smart.

Looking back at the future electrified home in the 1930s as envisioned by companies like Westinghouse Lighting and publications such as *Popular Mechanics* (see Figure 1-4), we can see how the promise of building an electrified home resonates pretty much with some of the promises of the connected vision of today. Electricity was seen as the solution to simplify complex and labor-intensive daily activities, and ultimately, to enhance our quality of life.


Popular Mechanics Magazine

WRITTEN SO YOU CAN UNDERSTAND IT

Vol. 72 AUGUST, 1939 No. 2

The ELECTRIC HOME of the FUTURE

By George H. Bucher

President, Westinghouse Electric & Manufacturing Company

SPARKS leap from your fingertips when you walk across a carpeted floor. Lightning strikes from the sky. Water changes to steam and giant turbines whirl magnets within magnets to light the world and drive its machines.

Because man has turned this invisible, omnipresent electric force and harnessed it to his tasks, today's civilization depends almost for its very existence upon its uninterrupted flow.

Electric power moves silently, ceaselessly, over thousands of miles of wires leading from more than 1,600 central power stations in the United States. It comes into our homes and factories and offices with such dependability that we take it for

Bottom, cooking bars sandwich in high-frequency radio waves. This method may be common in the home of the future.

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Top, artist's rendition of the combination room in the electric home of tomorrow (see floor plan below) and the various electric equipment engineers expect the room to contain). Note the glass brick wall

1. Refrigerator
2. Range
3. Dishwasher
4. Kitchen Heater
5. Sink, Table, Cabinets
6. Cabinets, Counter
7. Wall Cabinets
8. Automatic Washer
9. Ironer
10. Dryer
11. Sink, Water Heater
12. Cabinets, Counter
13. Cabinets, Counter
14. Breakfast Nook
15. Children's Play Room
16. Desk, Telephone, Radio
17. Portable Table

Figure 1-4. An extract from "The Electric Home of the Future" in Popular Mechanics, August 1939

As a result of a Taylorist approach applied to everyday life, in which every activity can become more efficient, most electrified appliances were promising to free us from the chores of housework to allow more free time for, at the time, the main "user" of the home: the housewife. Cutting cleaning time, saving footsteps, lowering the number of irons pulled up—these all became the promises of a "smarter" or better "electrified" future. Appliances that first required manual and tiresome labor could suddenly work on their own at the press of a button. Driven by the push of the electricity supply industry, electric appliances became the vehicle for the creation of more domestic demand at hours when peaks would be low in the industrial sector, like mornings, lunch, and dinner time. They were sold as new mechanical servants that would help the housewife and potentially relieve the need for actual human servants. Books like *The Servantless Home* (1920) and *First Aid to the Servantless* (1913)

portrayed how with just a few appliances one could live more comfortably and even cheaply, even though in reality most of these new appliances were still targeted at the servants that they should have been replacing.

It also sounded cool and magical at the time: "Because man has tamed this invisible, omnipresent electric force and harnessed it to his tasks, today's civilization depends almost for its very existence upon its uninterrupted flow."[4]

Dreams of Automation

The term *automation* was first introduced in the 1930s by General Motors executive Delmar S. Harder, referring to "the automatic handling of parts between progressive production processes."

Automation or *cybernation* was imagined to become the source of greater good for everyone per the vision of people like Sir Leon Bagrit, the leading pioneer of automation. From being "a process which substitutes programmed machine-controlled operations for human manipulations" mostly in the industrial world, it was brought to the masses in the form of automated appliances, domestic robots, and the home itself. The main home inhabitant of the time, the housewife, would become a sort of operator of a mechanical servant, with the primary task being "waiting for something to happen."[5] Products were marketed in their new, automated incarnation as some new form of intelligence, as in the late 1940's ad copy shown in Figure 1-5: "It's almost as if it were alive!"

4 "The Electric Home of the Future," *Popular Mechanics* (August, 1939).

5 Lev Manovich, *The Engineering of Vision from Constructivism to Virtual Reality*.

Figure 1-5. An advertisement for the Bendix Washer

Computers, robots, and mechanized furniture later became the subjects of the main vision of the automated kitchens and homes of the pre- and post-World War II era, mostly aimed at relieving even more housewives from their chores. They were some sort of "familiar aliens," anthropomorphized to be easy to understand or morphed in various forms to fit the design of the time.

In a fast trip through 30 years, we can see an interesting evolution of robots and computers, from The "Roll-Oh," a "chromium-plated butler" protagonist of a short video from Chrysler and General Motors for New York's world fair in 1940 (see Figure 1-6), through the dreamily scientific and always-moving kitchen of the Monsanto home of the future in 1957, all the way to the Honeywell kitchen computer in 1969, a futuristic new companion aimed at helping housewives to organize menus or balance the family checkbook, with just a two-week programming course and a $10,000 investment.

Figure 1-6. Roll-Oh and its control panel

After just a couple of decades following the rise of media and telecommunication, the focus of most futures shifted into showcasing ways to centralize controls of appliances. With the invention of protocols for communicating between electronic devices in the 1970s, it was now believable to imagine a fully connected home. Later in the mid-80s, to advocate more inclusion of technology and computing in the home, it became the "smart home." Instead of completely replacing people in their tasks, the role of machines became more influenced by the concepts of people like Douglas Engelbart. Rather than replacing people with walking robots, the smart home became a place where information would be displayed and embedded in everyday products to create a stronger "man–computer symbiosis" and "augmenting human intellect."

Dreams of Connectivity

With a growing role of computing and information rather than mechanical engines and electric lines, the new role of future home designers passed to the computing industry, to companies like Microsoft.

The Microsoft Smart Home of the late 1990s (Figure 1-7) imagined an automated and talkative home, with preset lighting settings, music, and cooking processes to answer to new needs and contexts: deal with media, centralize the control of previously automated appliances, and deal with the modern working family.

Figure 1-7. A screenshot from the video "Microsoft Smart Home"

Fast-forwarding to today, with the web leaking into everyday objects and an ever-growing amount of information and smartness that can be embedded in products, most visions of the smart home bounce between two extremes: the calmer version with natural materials and hidden or glass interfaces, on the one hand, to the more sci-fi version of bio-inspired plastic shapes and projected everything, on the other.

Despite the evolving subject technologies depicted in all of these visions, all of the corporate or, as called by Scott Smith, "flat pack" futures seem rather familiar or repetitive, an updated version of the futures that we had 40 or 50 years ago, or, as said by Richard Brandbook, "The future is what it used to be."

One of the primary reasons behind this familiarity lies in the main use cases and motives that seem to be always aimed at solving home life and its shifting loads. It began with the advent of electricity, which relieved housewives of physical work and eased their tasks via automation of processes with new appliances. Next was to simplify some of the cognitive load to control all of these new appliances by

connecting them and controlling them autonomously or remotely. This led ultimately to the goal of relieving the perception of "load" by anticipating our needs with new smart and intelligent assistants.

These myths of labor-saving futures came already with their own consequences, as we can see from some early comments from the 1930s:

> The tendency to use the time freed from labor-saving devices not for more leisure, but for more goods and service of the same general character. The invention of the sewing machine meant more garments...the invention of the washing machine meant more washing...the invention of the vacuum cleaner meant more cleaning.[6]

Just as World's Fairs served as a way to communicate a nation's views and power, the future home visions were used at a smaller scale as a means to disseminate a sponsored and corporate version of what our home should be. Similar to what happened to the electric and the automated home, the future connected and smart home is pushed by the infrastructures and suppliers of the new electricity: connectivity and data. Each scenario and smart appliance serving as a way to push the demand for more bandwidth, usage, and creation of data.

Domesticating the Future

If you look at the videos and the images of the visions and the technologies depicted in the future homes of the past, few products might have made it to the present in the same shape and meaning, and some remain a recurring idea in a different incarnation.

In his thesis "Why Robot? Speculative Design, the Domestication of Technology and the Considered Future," James Auger explains the process of how emerging technology becomes domestic products through the lenses of domestication.[7] Some of them, like computers and appliances, had to evolve in form, function, and interaction to be fully "domesticated" and accepted, whereas some, like robots or the smart fridge, failed or are still failing at this process or just failed to be integrated in the context of the home. At first, computers failed

6 Hazel Kyrk, Economic Problem of the Family (New York: Harper & Brothers, 1933).

7 James Auger, "Why Robot? Speculative Design, the Domestication of Technology and the Considered Future" (PhD thesis, Royal College of Art, 2012).

to be accepted in our homes when sold—for a lot of money—as tools for assisting with tasks like planning a dinner menu or printing invitations. They became welcomed later when their environment changed and due to digitization of media, their main role and function shifted, and they became a central hub of our homes, with a value that was worth the price.

Home robots and smart fridges, such as the fridge shown in Figure 1-8, are great examples of a recurrent "technological dream" living mostly in movies, conferences, and ads—never yet really successful or accepted in homes in its anthropomorphic form and as a caretaker/butler, but quite successful as more animal-like dust hunters.

Figure 1-8. One of the latest LG Smart fridges

Whether electrified, automated, or smart, products in the future homes are living in "stages for performances, rather than spaces for lives. They are also, for the most part, concerned with advancing a particular brand or corporation, without necessarily creating a coherent vision for the future."[8] The smart fridge is one of the primary examples—and a joke for many. These devices were originally sold as a must-have future product, but since 1998 they have been trying in vain to be accepted.

8 Genevieve Bell and Joseph Kaye, "Designing Technology for Domestic Spaces: A Kitchen Manifesto," Gastronomica: The Journal of Critical Food Studies (Vol. 2 No. 2, Spring 2002): 46–62.

In a similar way, when we look at the incarnation of "smart" in today's products market or on kickstarter, we can see a similar pattern of recurring dreams and push-backs from people.

Similar to the early days of the personal computer, what "smart" means today is the incarnation of a specific view of the world, one in which more automated, efficient, and optimized tasks promise a life that maybe not everyone is necessarily looking for.[9]

The Imperfect, Contextual, and Mundane Homes

I was in Italy a few months ago, and as every good Italian does, I spent quite a lot of time in my grandma's kitchen. Observing how she prepares and cooks dishes, I tried to ask her about recipes, steps, and measurements, and most of the time her answer was along the lines of, "Just a touch of this" or "A couple of handfuls of that." When talking about cooking times, she would say, "You taste it, and you'll know it." She prepares certain ingredients months in advance. She takes on multiple recipes, cooking on multiple fires. Her cooking is based on iterations, trial, taste, and a pinch of random mistakes. What she does in her kitchen is far from what some would define as simple and efficient, but in fact it is, just in a very different way. Her emotional approach to the apparent "chore" of cooking made me realize how completely different is the past and the future that most of the mainstream smart visions depict.

She also comes from a past, but different from the one that brought us the dream of the automated kitchen and the smart fridge. She comes from a past in which the kitchen is a central social place; where families meet; where decisions are made; and where food itself is a solution to most family problems.

In "A Kitchen Manifesto," authors Genevieve Bell and Joseph Kaye discuss the cultural biases embedded in the notion of the smart home. From the 1911 publication of Frederick Winslow Taylor's *Principles of Scientific Management* and its influence of Taylorism, efficiency has been considered a primary virtue and a way to "enable women to begin to free themselves from domestic isolation and drudgery."[10] Moreover, most of these visions reinforce the self-

9 For some humorous examples, check out *https://weputachipinit.tumblr.com/*.

10 Bell and Kaye, "A Kitchen Manifesto."

reliability dream of the American urban cul-de-sac lifestyle, wherein the home shelters and mediates with the world around. Whereas "smart" seems to have become a one-size-fits-all solution, most of the world has evolved and lives in a different industrial, cultural, and architectonic evolution of the home. What would be a smart fridge or smart kitchen in a home where problems are based on a different culture? How would you design a smart product for a home in a suburb differently than for a home in a city with a population density of 10,000 people per square kilometer? How would you design for families with divorced parents or remote workers? How could you design something to help my grandma without taking away her love for cooking (Figure 1-9)?

Figure 1-9. Grandma stirring risotto

Scott Smith talks about "culture as the original API," to express how the motives, logics, and basic information that a home or product refer to should be based on the context and the home culture in which they will live and be hosted. Most smart home visions, however, try to sell a future of "generic users" that live in a sort of green-screen context. They also skip over the reality of daily life to show a perfect new home in which everything works smoothly together.

The homes in which most of us live are normally not a white canvas and our lives might be less ideal, but they are full of rituals and inconsistencies that make them livable and real.

To consider these complexities when imagining the future context of a product, Nick Foster of Near Future Laboratory talks about the

need of a "mundane future": a place filled with background stuff; a space where objects from different times live together—they pile up, they break.

Think about all the issues you have today with cables, connectors, chargers, and other odd situations generated by connecting things together—part of that odd present that was not necessarily encompassed by the future vision of the electric home and that we still haven't really solved today. Try to think about the reality of the future context in which your product will live, to think about all the things that work and don't work, the *real* people and things in the background of their lives. To not design always for the hero moment, but as Foster says, "Perhaps we should look past Bruce Willis and design for the 'man at bus stop,' 'girl at bar,' or 'taxi driver.'" As shown in the beautiful documentary *Koolhaas Houselife*—in which an architectural masterpiece, the Maison à Bordeaux, is seen through the lens of its disapproving cleaning lady—even the best design utopias collide with reality and the people inhabiting them in the most unexpected ways.

Alternative Futures of Smart

Recently, a lot of critique began to arise exactly around this point: from the more direct attacks to techno solutionism,[11] to the paternalistic[12] or magical nature of the Internet of Things (IoT), and to questioning of the nature of problems that some of these products seem to solve. More examples of failures involving self-driving cars and thermostats are also pointing at the potential drastic implications of predictive and decision-making systems and the lack of interfaces for people to understand and deal with these issues.

Even though recently there have been critiques around speculative and critical design, there is a great amount of work that is happening to show and tackle the potential issues of the rush to add more things to the IoT, in the form of fictions, toolkits, or completely new spaces to envision alternative scenarios and products.

As Fabien Girardin from Near Future Laboratory states very well:

11 Evgeny Morozov, *To Save Everything, Click Here* (New York: PublicAffairs, 2013).

12 Sara M. Watson, "Dada Data and the Internet of Paternalistic Things," December 16, 2014.

> Translated to the world of data, the introduction of a new service, products, or algorithms requires a responsible design that considers moments when things start to disappoint, embarrass, annoy, or stop working or stop being useful.

In one of its recent projects, Near Future Laboratory looked at some of these problematic situations with automatic decision making and designed a fictional manual for self-driving cars (Figure 1-10).

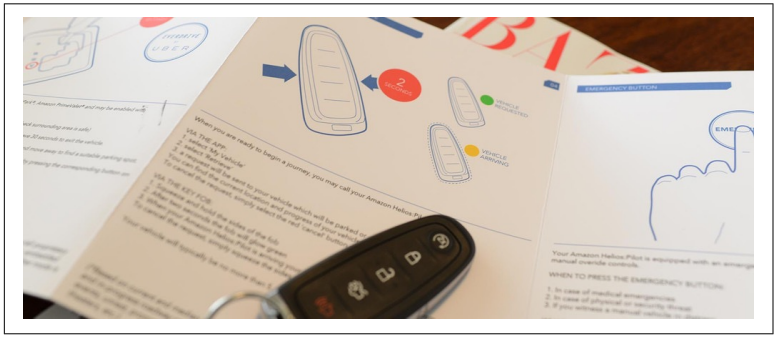

Figure 1-10. Pilot Helios from Near Future Laboratory is a fictional quickstart guide to deal with future self-driving cars and their potential issues

Although it's not a real product, the project illustrates how by beginning to ask questions about the reality of the future, we end up with a lot more situations for which we might need to design. As Girardin asks, "What do you do if you forget a bag of groceries after sending it into Uber mode? Will there be geo-fencing mechanisms to control where the car goes—and how fast it goes—when you give the "keys" to your teenage son to go to football practice? How does the car pick up groceries—and how do you upload the list—when you send it on errands?"[13]

The goal of these types of projects is not to solve existing problems, but rather envision and anticipate the ones that will happen when a future smart product will hit reality, or, as the saying goes, "Clarify today, design tomorrow." In a similar manner, projects like Thingclash from Changeist are looking also at the realistic near-future situation that might arise from clashes between different products or to actually live in a connected home. Thingclash is a toolkit "to find

13 Near Future Laboratory's fictional quickstart guide.

and make legible friction points not only at a technology level, but, more important, at social, economic, and policy levels, as well." Dan Lockton calls for a more open and co-created way of dealing with IoT products and systems. He talks about *knopen* as new tools for people to know about the invisible mechanisms and connections happening inside and between connected products.

To create a platform for discussion of what it will mean to live in a fully connected smart home, Casa Jasmina (Figure 1-11) was opened as an experiment by Bruce Sterling, Massimo Banzi, and Lorenzo Romagnoli. It's an experimental space in which to attempt to build a smart and connected home from bottom up, based on an open source philosophy and "hosting" products and experiments that question how we build and inhabit a smart environment.

Figure 1-11. Casa Jasmina Interiors in Turin

Although I'm not asking you to become a design fiction expert, an angry critic of smartness, or to go back to the analog world, in order to move forward beyond apps-controlled faucets and bottles that count, we need to think about the complexity behind the apparent simplicity of adding the word "smart" to a product and about new possible motives, interactions, and relationships beyond the ones at which the futures of the past pointed.

Rather than thinking about imaginary users and hypothetical issues, we need to ground the smartness of products to the culture and the

context in which they will live. We need to consider the inevitable frictions of daily life, and the rituals and behaviors that—rather than being replaced or made more efficient—could be instead enhanced and expanded.

Let's dive into a new way of thinking about smartness, to design products that could actually become welcome guests in our homes.

From Smart Products to Home Guests

As with every big technological change, connected/smart/intelligent products require a major shift of the role and place of technological artifacts in our lives. From passive tools, objects become tools of action, with more tangible agency and involvement in our lives. As a designer, however, what we should care about is not the technology itself, but how it will relate to people and how we will create ways to interact with one another. In a short article called "Open House from '96," Mark Weiser, chief scientist at Xerox PARC in the 1990s and father of ubiquitous computing, encapsulates the issue perfectly:

> Interacting with something keeps it distant and foreign. If you are only interacting with your spouse, the relationship may be in trouble. We dwell with nature, and roommates, and anything that we let enter us, and we it. Dwelling with computers means that they have their place, and we ours, and we coexist comfortably. Unfortunately, our existing metaphors for computers (and nature, for that matter) are inadequate to describe the "dwelling" relationship. And no metaphor is more misleading than "smart."
>
> "Smart House": Does this mean any more than a house with a computer in it? Does it mean anything like "Better House"? Do we really think that everything in the world would be better if it were smarter? Smart Cappuccino? Smart Park?

For an object to dwell with us means that it might become more like a houseguest that we host for a long or short time. Some of them we will keep at a distance; some might have more of an emotional role in our lives. As with everything and everyone we live with, relationships with smarter products will also lead to potential misunderstandings and adaptations needed on both sides.

As designers of these new products, we need to get deeper into some of the "black boxes," to understand the processes of sensing, computation, and machine learning to be able to create the right interfaces for people to overcome misunderstandings. If we think differently, and we look at products as actual guests in our homes, we might

begin to imagine new metaphors and interactions beyond talkative butlers and look at other ways to interact with a form of intelligence that is foreign to our home.

In this section, we will describe a bit more in depth what we mean by smart products and break down some assumptions to expose a new way of thinking about smart products for the home.

A Quick Anatomy of a Smart Thing

There are probably a thousand definitions, views, and philosophies to describe what a smart/connected/intelligent product is. To capture this new breed of products, Julian Bleecker talked about *blogjects*, Bruce Sterling about *spimes*, Mike Kuniavsky about *service avatars*, and Dutch design agency Booreiland about *meta products* to encapsulate the new nature of products that can "talk," connect, and be physical incarnations of digital services and processes. When a product is connected and smart, it changes not only how it is experienced, but also how it should be designed. Without getting lost in too many theories, I like a very simple scheme, shown in Figure 1-12, and a bulleted list that hints at the main building blocks to design:

- It can *sense* its environment and the people in it (through time and space).
- It can compute that sensory information (with specific goals).
- It can act in some way on the world (through an interface).
- It's part of an ecosystem (of people, products, processes, and companies).

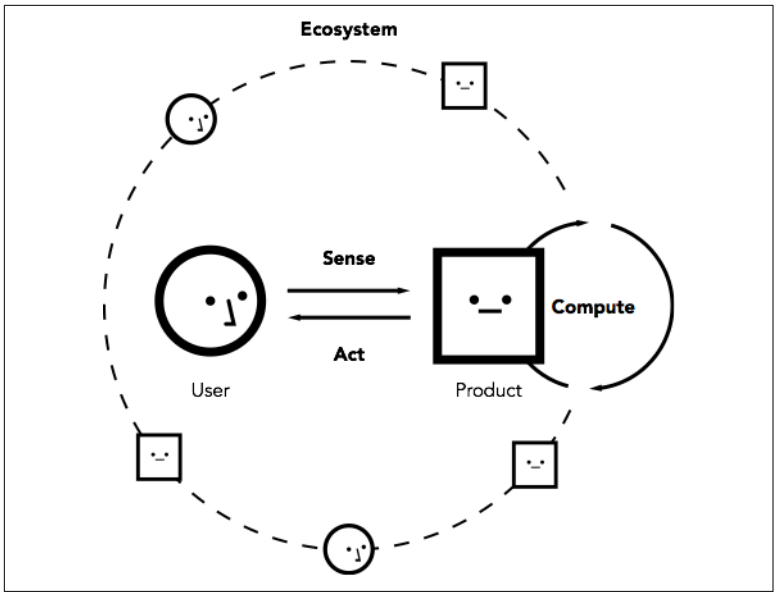

Figure 1-12. Anatomy of a smart thing

With *sensing* the environment, we need to consider not only the local context but also potentially the remote data that can be gathered by being connected to other products, databases, and contexts. The interaction sensed might not be just the one with the single user, but with other people and other objects, too. Moreover, we won't be considering only what is sensed in the now, but potentially both historical and predictive data that will feed and influence what a product will compute. An example of this is the recent Tesla experiments of distributed learning, which allows the entire fleet of self-driving cars to share what they sense and learn to create a bigger pool of information from which each car can draw. We can imagine a similar system for the home, too, in which a network of products might be able to share specific information to determine whether you are actually home, or share preferences and settings.

With *computing*, we mean the act of interpreting the sensed data and translating it into information on which to base the actions of the product. When a product is connected, most of this computing might be outsourced to somewhere other than the device—in the cloud, or in some situation even by remote people (like Amazon's Mechanical Turk that crowdsources human intelligence to support computers). Within this step, there are a lot of the black boxes that

are difficult to comprehend for most users—processes like interpreting, learning, and adapting allowed by machine learning techniques. In these processes, there are also hidden specific goals that influence the action of a product. If we imagine a product like Nest, the self-learning thermostat, learning about your habits and interpreting the context has the main goal of saving time, energy, and money, but what if, instead, comfort would be the ultimate goal? Would it work in the same way?

With *actions*, we mean the ability to perform a physical or digital action in the world. To have agency and influence our lives. This can be in a very simple and direct way to affect our environment, like switching lights on and off, but also can go toward more indirect and subtle ways of influencing our lives and routines with nudges in the form of notifications. Think about all the products out there that are trying to make you drink more, breathe normally, or sleep better and how they become agents of your own will of changing.

With *ecosystem*, we mean the set of connections, relationships, and rules that a product has with other objects, people, and networks. While following user-centered design, we are trained to focus on one-to-one interaction between a user and a product; when dealing with connected products we need to consider and design also the interactions with other actors in this ecosystem. From one-to-one interactions, we need to think of many-to-many. Products also can be part of different ecosystems with completely different rules; although the Amazon Echo (Figure 1-13) might be primarily considered a part of a home ecosystem, with the goal of helping users solve daily chores, it is part of the larger Amazon ecosystem, too, with the goal of selling customers more products.

Figure 1-13. Amazon Echo

Besides the product itself, a few big changes happen in our relationship with these products at different scales, from the shifting concept of control, to the issues around decisions and the implications related to being part of a larger network of products.

The Control Dilemma

It is widely accepted that giving users the sense that they are in control is a classic principle of designing interfaces. In this spirit, objects have been designed to be obedient, responsive, and predictable, and we design interfaces to simplify and provide people the best experience and control over those products. However, when dealing with products that "learn," make decisions, or are considered smart, we change the main notion of the relationship we have with them.

When labeling a product "smart," we charge it with assumptions that change the way we interact with it, and we charge it with expectations that influence the way we experience its flaws. As designers, by relying on a product's smartness, we tend to hide complexity in favor of simple and clean interfaces. By focusing on connectedness, we outsource all controls to remote applications or autonomous decision making, sometimes leaving the user of such products unable to influence the product's behavior. By making new processes, connections, and sensing as seamless as possible, we might blur even more the line of who is actually in control.

In a recent study about the use of the Nest thermostat (Figure 1-14), its most undervalued feature was, surprisingly, its "smartness." Participants in the study couldn't fully rely on the self-setting of certain functionality because the device's sensing was not perfectly accurate (Nest relies on sensing presence to set specific routines such as Away mode). The interviewees didn't fully understand what learning meant, given that the Nest seemed to be repeating what it was set to do. Not everyone understood that the system needs to be trained. They changed the way they interacted with the Nest by intentionally giving limited input for the Nest to memorize intended adjustments, and manually deleted temporary changes they made. Ultimately, what was particularly interesting is that people didn't trust it because "The Nest is doing its own [thing] and doesn't tell you what it is doing."[14]

Figure 1-14. Nest thermostat

A couple of very basic assumptions we have about control might shift.

OFF might no longer exist because products might stay ON and connected all the time. Objects are either asleep or understanding the context and standing by for a signal from a remote application. Recently, Samsung included a warning in its Terms and Conditions

14 Yang, Rayoung, and Mark W. Newman. "Learning from a learning thermostat: lessons for intelligent systems for the home." *Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing*. ACM, 2013.

that people should not speak about private matters in front of their new Smart TV, because their words might be recorded and stored on the company's servers.

Products might not be accessible only by one person, but many, and in remote locations, too. For example: I am not the sole user of the lighting fixtures in my home. How many people have experienced the shock of their partner remotely flickering all of the lights in the house while showing his colleagues his latest home automation experiment?

Ultimately, the experience we have with a product might not only be influenced by the one-to-one interaction with us, but interactions of the many-to-many. Think about the aforementioned Tesla fleet learning technology, in which each car, beyond learning from the specific context in which it operates, can also be influenced by the wisdom of the crowd (of cars).

Embedded Biases

When we give away part of the control of our home environment to objects, be it lights, heating, or food management, we somehow trust products to make good decisions based on the data that they can sense about us and their environment. We trust objects to be objective in some way; however, objects of our everyday lives will have more and more access to a multitude of data. Soon a network of products that can freely share data about our behavior, health, and routines might also know too much to take a neutral stance.

Products are embedded with views and biases that come from the people that design, code, produce, and market them, with rules based on standards, references, and approximations that might become apparent only after the system is in use. As shown recently with respect to automated temperature control systems in buildings, "A new study suggests that the insulation that's supposed to make buildings more energy-efficient doesn't keep them warm enough—that the standards are biased toward the metabolic rates of men, who tend to burn hotter than women."[15]

15 Nick Stockton, "Why Men and Women Battle Over the Office Thermostat," August 3, 2015.

Take as an example an idea of a smart coffee machine that is also able to tap into a few other metrics of my life like health and productivity to better fit the amount of caffeine I consume. Will a coffee machine give me a coffee if it knows that my blood pressure is too high? Will it give me coffee to boost up my productivity if I'm at work, instead? How will these decisions be determined to be right or wrong?

Even with such a banal situation, the level of decision making of a simple product cannot accommodate all parties and all situations. The system will be designed to take into account "certain" inputs, to process a "certain" type of information under a "certain" kind of logic. How are these "certainties" defined, and by whom? How are these autonomous systems going to be able to solve problems without objective answers? And, moreover, as the nature of decision making can be very subjective, how will a smart machine be able to deal with the variety of profiles, needs, situations, beliefs, and cultures?

The Home Is a Complex Jungle

Most visions of the connected life depict perfectly efficient homes wherein all products interact with one another in apparent harmony or are dictated by a centralized automated system that directs them like an orchestra. However, this might not be the reality, given that products of different ages and of different producers will need to dwell together. The speed of change or the pace layer of a home differ greatly when you think of products like a bottle, a TV, or a lock. If we look at the pace layers of building set forth by Stewart Brand,[16] examining in detail what he considers "stuff," we can adapt it to reflect how physical and digital elements of products might change at different speeds, too, as demonstrated in Figure 1-15.

16 Stewart Brand, *How Buildings Learn* (New York: Viking, 1994).

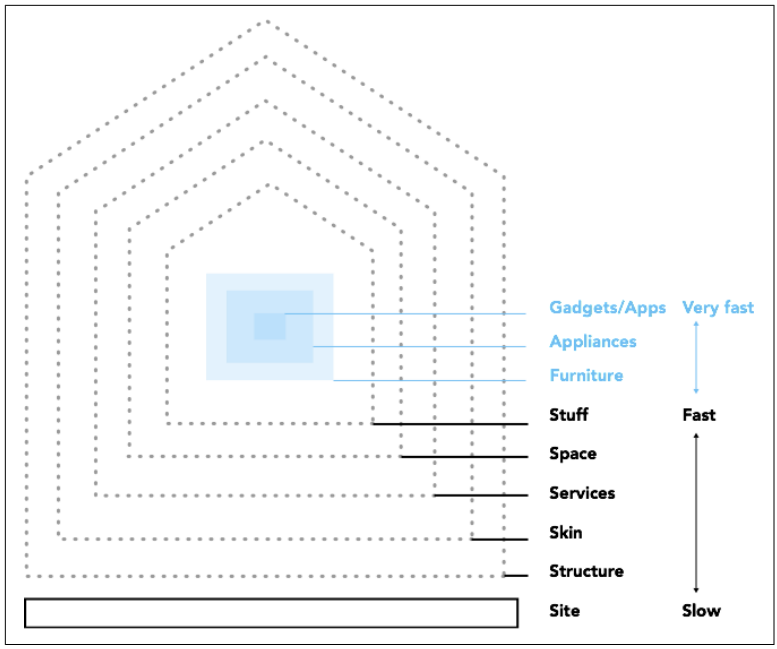

Figure 1-15. An interpretation of Stewart Brand's Pace Layering of building zoomed into "stuff"

So, when designing for a product that might be required to live for a certain amount of time, we need to consider not only how the device itself will continue to work, but how it will keep working in combination with other products that might have a different life pace, too. Although the hardware of a device might be able to last long, its digital counterpart might not. As companies fail or are acquired, platforms, updates, and services might be discontinued. How can we design products that can continue to work anyway? Can we design platforms that somehow adopt products from different families?

It's interesting to look at the complex relationships that emerge between platforms, brands, and protocols. In the absence of a standard or a major winner within the home, it becomes almost a political choice to build products that might work with Nest or that are faithful to Apple home, or that create their own independent ecosystem. In this scenario, certain products might not be able to communicate due to certain barriers, or, if they could, they might not understand one another due to different protocols or languages.

Even if they do understand one another, what would they actually talk about? And would they want to collaborate? Companies have business goals to meet and rivalries with other competitors. Why should a Samsung fridge collaborate with an Apple TV?

Digital Products with Physical and Network Implications

With products that sense and listen, the home is becoming a great source of data. "If data is the new oil, the home is the new Texas," says Joseph Grima.

With the simplicity of sensing and collecting data, more and more "dumb" products have become a great opportunity for small, big, new, and old companies to enter the field of hardware and software. In particular, looking at Kickstarter, a proliferation of IoT products are being unleashed, led by a number of new, young, and intrepid startups. Even though failing fast and selling soon might be a great model for the software world, it has the potential to reveal many more interesting issues when dealing with hardware. Physical products have physical implications, and homes and products might live longer than a couple of rounds of funding. By the same token, business models like in-app purchasing, which works great in the digital world, might become new paradigms for the physical world, too.

What happens when my door lock is discontinued as a service? What happens when I ask people to pay for different light settings for their room?

Additionally, with more complex computational logic (such as machine learning), and with a growing amount of data being stored and processed by products, we add new paradigms and modes of interactions that might not be controllable or even understood.

How do we make a home monitor forget or delete its memory when I move to another home? How do we convince a thermostat that it learned the wrong routines?

Toward a Different Way of Designing Smart Products

As smart products seem to be designed with the philosophy of "invisible by default,"[17] with more complex, physical, and potentially harming situations, we need to change our approach.

These new situations have pretty clear implications for the experiences that we design. More of these examples might become interesting use cases for more people to understand the differences of living with smart things. Showing who is using a product, what processes are happening, and providing the right controls and mental models for people to understand and be partially in control might become new needs that users will ask for or, generally, a new best practice to clarify some of the dilemmas around control. Magic, invisible, seamless experiences with smart products are very attractive points to sell a product, but a trustable, seamful, and partially opaque product might be better to live with.

Evgeny Morozov talked about "good smart" versus "bad smart":

> Devices that are "good smart" leave us in complete control of the situation and seek to enhance our decision making by providing more information...Technologies that are "bad smart," by contrast, make certain choices and behaviors impossible.[18]

Although we think of fully automated or fully controlled as a binary situation, there are more models and relationships that we can investigate and begin designing more relatable and interesting ways of living with smart products. The future of the past pushed us to imagine smart and automated products based on the dream of robotic butlers acting like the human butlers of the time. But if you take a different metaphor and model as a starting point, what would it look like? What if you can build something like a horse,[19] for which control is a gradient that can be given and taken between the man and the machine, feedback is clear even if nonverbal, and controls are visible and tangible?)

In the next section, we go through a series of questions, new metaphors, and new steps to help us imagine and design products

17 Mayo Nissen, "Unseen Sensors: Constantly Sensing but Rarely Seen," design mind, May 2, 2014.

18 Evgeny Morozov, "Is Smart Making Us Dumb?," *Wall Street Journal*, February 23, 2013.

19 NASA, "The H-Metaphor as a Guideline for Vehicle Automation and Interaction."

that go beyond what we think of "smart" now. There will be more questions than clear answers, but it will be a small guide to build a different intelligent home for the future.

A Quick Guide to Designing a Different Intelligent Home

As with *electrified* and *automated* products, soon *connected* and *smart* might cease to be values, per se; although smartphones, smart locks, and smart cars are now terms used to distinguish a new and specific type of product, soon "smart" will be expected and phones, locks, and cars will become again just things. Just as connectivity, remote control, and automation of specific tasks will become as much a part of our mundane reality as light switches or preprogrammed washing machines, so too will voice-activated home shopping and app-controlled thermostats become commonplace.

To differentiate a product from others, the experience it enables and the values it reinforces will be the key differentiator for what makes a product succeed or not. Designing smart products will soon mean taking the new infrastructure, understanding it, and finding what new opportunities it creates beyond "app + thing." It will mean breaking from the perceived value of "smart"—that is, to stop treating it as a determining feature and thinking a bit deeper about what new paradigms and steps we need in our design process.

In this section, we look at the steps needed to design products and experiences for future intelligent homes.

We explore new process steps and examples of how to challenge and discover the new meaning of smart, to think as a product, understand the role of metaphors, and to design relationships rather than single interactions.

Because what we consider smart is not the same in every context or situation, the first step we will explain is to *research and find what is contextually smart*. Then, to flip our perspective, we will explain how and why we should also *design from the perspective of a product* and learn how to map its ecosystem. It's important to think beyond the actual physical sensors that a product might be designed with and begin to map the information that it could reach using external sources or APIs. And, ultimately, to go beyond what we have today, we will need to *explore new metaphors and interactions* to find inter-

esting avenues of collaboration between users and product, *design transparency and controls* to allow people to understand new complex systems, and, because we will need to design products that live with us, we will look at how to *design a relationship through time and embrace frictions and fictions.*

Research and Find the Contextually Smart

The meaning of "smart" in the context of products seems too often to allude to a very particular view of what the problems of our daily routines are and what is considered a good home life. It often implies devices that automate certain complex and problematic tasks to create a more efficient and effortless environment in which to live. As a first step, we need to go beyond this and define what is "smart" in the context and the situation that we are designing for. As Figure 1-16 illustrates, this means looking deeply at the cultural context where the products we design will reside and to define what motives and relationships we can build.

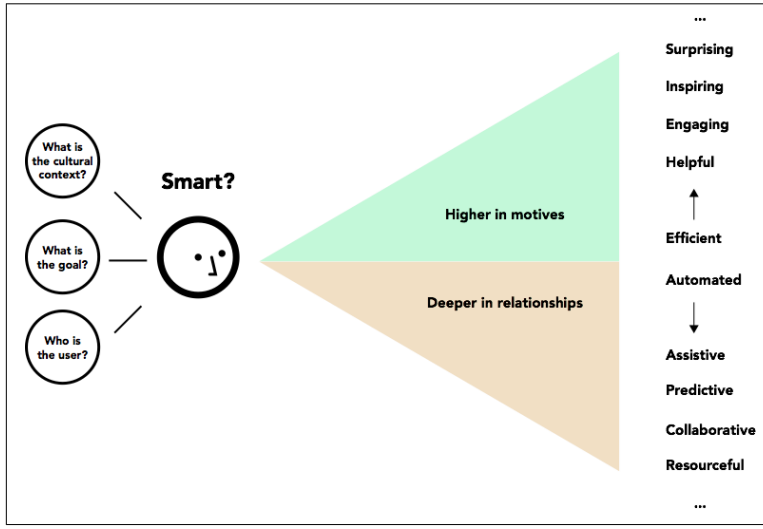

Figure 1-16. What's beyond the notion of smart=efficient+automated?

Think about the home and the context for which you will design:

- Where is this product going to live?
- Who is it going to live with?

- How many people will reside there and from what culture and beliefs?
- What are the rituals and values of that home?
- How will the product fit or change their habits?
- Who is the main user or users of the product?
- What would "smart" mean for those people in this particular context?
- Can we go higher in motives of usage beyond efficiency?
- Can we go deeper in the relationships we create beyond automating a task?

Sometimes, when thinking about a smart object, by default we go straight into thinking about the technological opportunities that connectivity or automation might enable. You might find yourself brainstorming how this new sensor might help you quantify something or how you could automate or remotely control a specific task. Looking at every action as a problem to solve or looking at how many things are not smart yet and putting some chip in it is a very tempting situation but not necessarily the right one. Try to avoid the "irony of automation," wherein "by taking away the easy parts of these tasks, automation can make the difficult parts...more difficult."[20]

Last year, at frog design, we ran a project that centered on environmental sensors and kids. There is a growing amount of technology that is being embedded in toys, furniture, and other products geared toward children. Many sensors or wearables for kids are, yes, used by them, but aimed at the needs of parents to track, quantify, control, and track the behavior, health, or development of their kids.

In the project, called Yibu (Figure 1-17), we tried to flip around the motivation and use of basic environmental sensors. Rather than thinking of sensors as a way to track kids and their environment for the benefit of parents, we focused on rethinking sensors as tools for a child to discover the invisible world that surrounds them.

20 L. Bainbridge, "Ironies of Automation," in *New Technology and Human Error*, eds. J. Rasmussen, K. Duncan, and J. Leplat (Hoboken, NJ: Wiley, 1987), 271–284.

Figure 1-17. Yibu by frog, a digital game played in the real world with sensors

As sensors are normally untouchable objects hidden in a box or overlooking a room (Figure 1-18), we designed a set of environmental sensors (temperature, light, direction, sound, and wind) as an object that children can touch and play with, something that could fit between other toys in a room. Moreover, rather than translating the sensor data into numbers and graphs, we turned it into a digital story that was influenced by the sensors with challenges that are solvable only by playing and understanding the basics of temperature, light, sound, and so on.

Figure 1-18. A typical presence sensor, hidden in the corner of a room

By *changing the motivation of your design and focusing on a different meaning of smart, and by not taking for granted the solutions that are normally used as a recipe for a smart product*, you might end up in very uncharted territories. Challenge the goal and main motive of the product. Not all tasks need to be simple, not all products need an app with some numbers and a graph. *Fast*, *efficient*, and *simple* could be good when dealing with a task that someone wants to avoid or that is considered "a job," whereas *surprising*, *enriching*, *slow*, and *inspiring* might be a far more smarter goal for something related to cooking a dinner for some friends or trying to find a movie to watch. What if being challenging was the main goal of your product? What if a ritual could be enhanced rather than simplified?

Now think about what you want to design and the *people involved*—all of them; the one in the foreground and the one in the background. Who is the main user of your smart product? The actual person using it or someone else reading, controlling, and understanding the data that it records or interprets? How is that influencing the experience you design? How many users does your product have?

Think about *the reality of the home for which you're designing*. Look at the motives, the culture, the good and the bad. Something we consider a smart suggestion in Italy or the United States might be inappropriate or wrong in other countries. Even the banal biases—how much salt to use in a dish or how long a plate of pasta needs to be cooked—require a complex adaptation to culture and context.

Beyond the actual action, what is considered a problem in one situation might not be for all situations. For context, let's again consider my grandma. Surely you could help her to eat healthier or pass less time in front of the stove, but is that something she will accept or that you would even want?

Design from a Product Perspective

Normally, as designers, we might be trained to design by studying people, their motives, needs, and their understanding of the system with which they interface, but as products become more connected and intelligent, and imbued with a higher degree of agency, we might have to start to study and look at their "life" too, as illustrated in Figure 1-19.

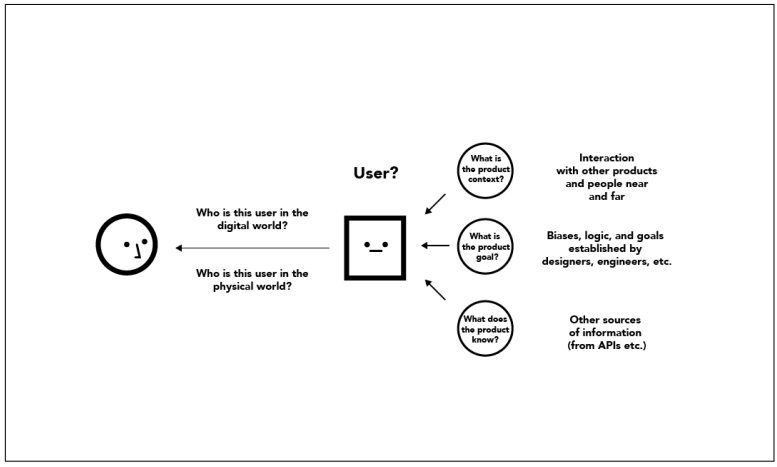

Figure 1-19. What's it like to look at people from the perspective of a thing?

In 1996, Mark Weiser and John Seely Brown were talking about user-centering, or how to design technology that sits at the periphery of a person. Predicting the potential number of smart things that will vie for that person's attention, they were pointing at a new need of a product to stay out of focus or come on stage when needed, avoiding an always on and in-your-face interaction with products in favor of what they defined as *calm technology*. The object becomes the lens to look at an interaction and a relationship, looking at the center—the user—but from the perspective of the object, to understand how and when to take stage.

So, what if we were to design from a product perspective?

There is this great quote from Ian Bogost in his book *Alien Phenomenology* (University of Minnesota Press, 2012): "How does a sensor see a puppy?" Part of the design of a good home guest is to decide what it will know about people and what other information it will be able to reach for and use, taking its perspective to look at the context and the surrounding ecosystem. Understanding the limits and the way that an object might sense and understand the world around itself. The ecosystem to sense and consider would not revolve around one person only; rather, it will be made of other products, near and far.

Figure 1-19 illustrates that there are a few new questions that we might need to ask ourselves when thinking from the perspective of an object rather than a more human perspective:

- What is the context and ecosystem of the product?
- What are other actors in his ecosystem beside the main user?
- What is the goal of the product? Save energy? Make you buy more products?
- What does the product know? What are its channels of knowledge?
- What does it know about the user?

Mapping the perspective of an object

When you are thinking about a new idea, rather than adding random sensors to a random product, *begin by mapping what would be the information available in the context of the product; for example, look at a kitchen or a living room from the perspective of a toaster or a sofa*. Think beyond the actual physical sensors that a product might be designed with and begin to map the information that it could reach using external sources or APIs. What would be the ecosystem of a smart coffee machine, and how would it behave? The experiential journey to define would actually be the one of the object, with its touchpoint with people and other parts of the system, the logic and techniques to get in and out of the focus of the person.

In his short film, *Robot-Readable World*, Timo Arnall shows a mix of footage coming from various machine-vision algorithms. The film shows the new perspective of how the world is seen and interpreted

by an object. In a certain way, to design a good new home guest means to look at the world from the product perspective and understand what information it might know and the limits of that knowledge. Although it seems part of sci-fi or more speculative design, we might find ourselves needing to design more object-friendly home environments targeted at the needs of products to easily read, sense, and communicate.

Clock for Robots (Figure 1-20) from Berg was a product prototype of a clock whose purpose was to give the idea of here and now for both humans and machines. As Matt Jones, former Principal at Berg states:

> It is a sign in a public space displaying dynamic code that is both here and now. Connected devices in this space are looking for this code, so the space can broker authentication and communication more efficiently.[21]

Figure 1-20. Clock for Robots by Berg

The clock functions both for humans and machine, showing the time in numbers as well as displaying a QR code that allows any camera-enabled device to read not only time, but also location. As Arnall says, "I'd like to see more exploration of computer vision that wasn't about looking through a camera, but about our devices interpreting the world and relaying that back to us in simple ways."

21 Matt Jones, "Product Sketch: Clocks for Robots," September 22, 2011.

In a similar way, "With Robots" (Figure 1-21), a project by Diego Trujillo, looks at the reason why we design humanoid robots, which is that as our homes are based around the scale and form of humans, so it is logical that robots should be based on the same form. "With Robots" instead shows this by looking at the issue from another perspective, taking into consideration the limitations and the needs of the robots themselves. The project demonstrates how the objects in the house must be designed thinking on the tasks domestic robots will be performing, such as folding bed sheets, setting the table, washing, cooking, and learning to interact with the world.

Figure 1-21. "With Robots" by Diego Trujillo

These projects show a path to a different way of designing smart objects and the context around them. This methodology takes into consideration the needs and the limits of "smart" and opens different metaphors to define the interaction with a smarter object. Ones that are not necessarily human-like, that require new tools, and that even might need help from us.

Explore New Metaphors of Interaction

Good metaphors should describe similarities in the function, the rules, and the structure of an interaction, not just in the appearance of a product. It should drive the relationship we create with a product and the way an interaction happens. Figure 1-22 demonstrates starting from questions about the goal, and an interaction can help you build better metaphors and mental models about the interaction.

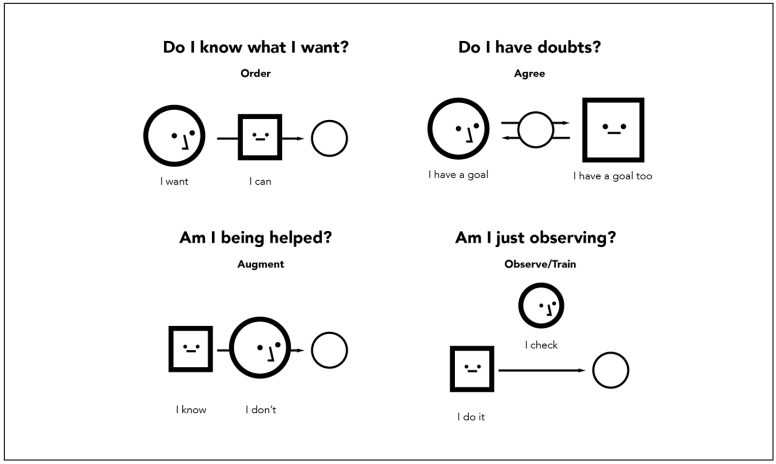

Figure 1-22. What is the scenario of usage of the product?

Do I have a doubt that I need confirmation about? Do I need something to help me complete a task? Do I need suggestions because I don't know what to do? Or am I just observing something doing its own thing? These different scenarios require different metaphors of interaction and a talkative butler might not be the only one.

A good metaphor can lead to a very successful and lasting design, like that of the desktop used in computers. Metaphors also set the roles of the people involved in the interaction and should explain the limits rather than hiding them. Metaphors are very useful to help people transition toward a new product or technology. However, overusing metaphors or following them too literally can lead to quite forced and unclear interactions. Think of how misleading the concept of the "cloud" is: although it lets us imagine this effortless light infrastructure in the sky, the cloud is actually a very heavy block of servers on the ground.

As highlighted by the recent rise in popularity of chatbots and the constant popping up of examples of humanoid robots, when thinking of more advanced intelligent products, to be "more like a human" seems to remain the leading metaphor and model by which to develop interactions. Especially when looking at humanoid robots, developing such prototypes is a great way to advance specific technologies in the laboratory, but it is also a way to drive pretty fast toward very uncanny experiences.

Human conversation and human interactions might be a sort of first skeuomorphic step, a way to explain a more abstract concept into models that people can refer to but hopefully might be only temporary. In a short interview I had with Alexis LLoyd she told me, "Interacting like a human is hard, even for humans." She refers to how even for humans, it's complicated to deal with one another due to differences between cultures, context, and understanding.

For a machine to deal well with all of these changes and variables would require that it openly adapt and learn always from every situation. But, as illustrated by the latest Microsoft bot, Tay (Figure 1-23), completely trying to learn and adapt can lead to weird and unexpected results (as in, becoming racist[22]). Many of the early examples of "intelligence" that we can see now in some of our homes (Nest, Amazon Echo, and Google Home) have abandoned an anthropomorphic shape but are still based on the model of a butler, always ready to respond to delegated tasks and carry out our commands. The information acquired sometimes is also not necessarily used for very smart use cases. As said nicely by Joanne McNeil, "The internet already feels like the Yo app on your birthday,"[23] to underline how by knowing simple information about you can turn into an opportunity for a very shallow brand nudge instead of creating more meaningful understanding of each other.

Figure 1-23. A screenshot of one of the tweets of Tay going quite rogue

22 James Vincent, "Twitter Taught Microsoft's AI Chatbot to Be a Racist Asshole in Less Than a Day," The Verge, March 24, 2016.

23 From "Happy Birthday" by Joanne McNeil in *SQM: The Quantified Home*.

Exploring metaphors

So, what new metaphors can we think about?

An interesting model for defining different metaphors of relationships is also discussed by Alexis Lloyd in terms of how machines are portrayed in sci-fi and their vicinity to the self: from the Iron Man–style augmentation of the human through tools, to a completely separate entity with its own language and life like R2-D2.

Examples like the Here headphones (Figure 1-24), which allow new ways of listening and tuning your sound environment, are interesting new augmentations, whereas Stewart (Figure 1-25), a new self-driving car control concept from a student at Eindhoven University of Technology, explores the concept of a nonhuman-like companion to control and understand the decision making of a self-driving car. The intent here is to make something that is a bridge toward trusting completely an autonomous vehicle, by turning a control into something that shows the autonomous behavior of the car, but that allows you to control it manually, too.

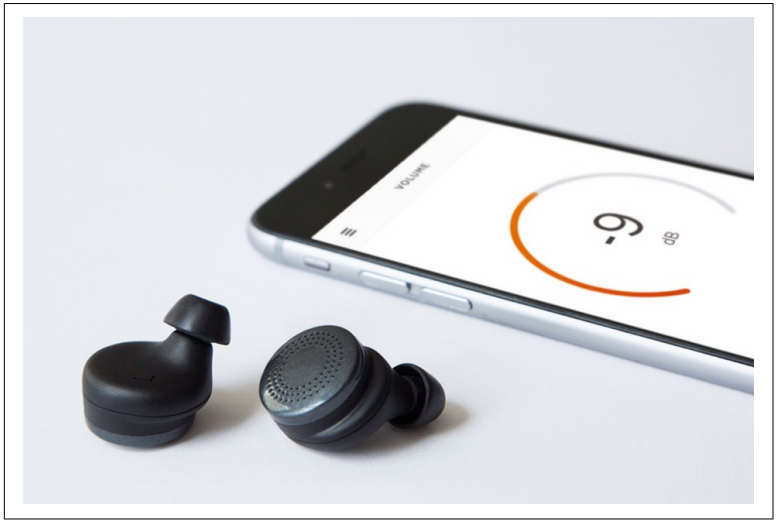

Figure 1-24. Here headphones

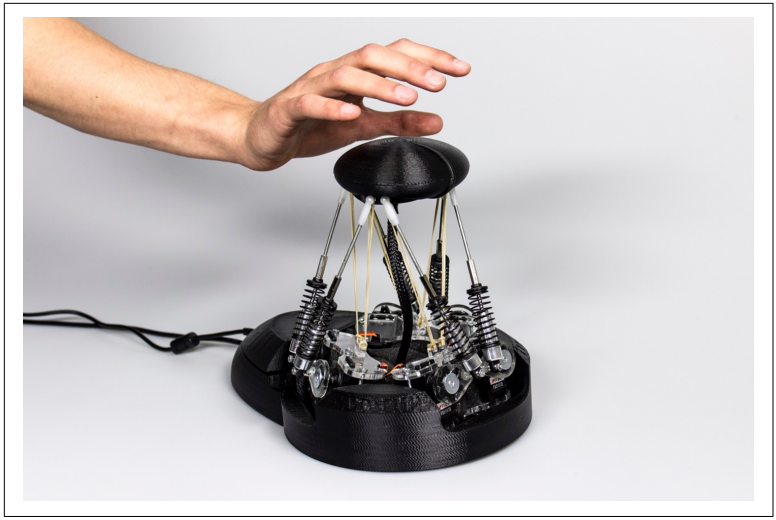

Figure 1-25. Stewart by Felix Ross

When thinking about companions and homes, pets come first to mind but not necessarily as a way to create new artificial dogs like Sony did with Aibo (Figure 1-26), but more about the relationship and communication we have with them.

Figure 1-26. Aibo by Sony in its evolutions

When thinking about "intelligence," its easy to get close to the uncanny valley, or that eerie feeling when a technological artifact too closely resembles real life—both in image and behavior. But as told by Berg a few years ago, It could be avoided by designing with a metaphor in mind rather than a human. When designing smart products for our homes, we should aim at "making smart things that don't try to be too smart and fail, and indeed, by design, make endearing failures in their attempts to learn and improve. Like pup-

pies."[24] As it happens with puppies and with more and more products that turn to machine learning and processes that require a product to learn and evolve in our homes, our role becomes something like a teacher, interacting in ways to encourage good behaviors and correct bad ones within the objects we own. Through the process, pets understand the limit of what that can do and learn how to communicate with us.

But rather than looking at fully automated or fully controlled, the most interesting relationships come when the control is a gradient rather than a binary switch. From either a fully automated system or a fully controlled augmentation, it becomes a *heteromated relationship*, a collaborative situation in which people and objects play at their best strength in a new relationship. Dan Hill expresses this with the shepherd–sheep dog relationship, in which human and product can switch the role when needed. Matt Jones talks about Centaur, referring to the examples of advanced chess games between players helped by computers. A great example of this new approach is Spotify's Discover Weekly feature, which balances the raw power of analysis and correlation of code with human-curated playlists, offering that surprising mix that feels just right. NASA refers to this as the *H-metaphor*, where H stands for Horse, to explain a complex relationship between a person and an automated system. This relationship requires the person to trust the machine and bond with it to set the rules for control. By tightening or relaxing the "grip," the control can fade between the human and the machine. The communication is physical based on the understanding of force feedback, movements, and hierarchy of who is in control—a silent but powerful collaboration.

Finding new metaphors

When talking about the collaboration model, taking from the upcoming field of creative AI, there are a series of new patterns that we can use to imagine what role a product can have to support people in tasks. These roles go beyond pure functionality and delve more into creation. Some of these actions are part of our daily home activities, like cooking, listening to music, or rearranging a space.

24 Matt Jones, "B.A.S.A.A.P.," September 4, 2010.

Taking what machines are good at compared to people and going beyond a butler, an object can be an explorer, recombiner, predictor, optimizer, personalizer, visualizer, parametric creator, recommender, synesthetic observer, and copier.

Think about the interactions you have with other "intelligences" in your home. From the passive messaging of your plants to show that they need to be watered, to the more active messaging of your dog begging for food from you, the home is filled by other models from which we can gain inspiration and learn. Don't fix on automating or controlling tasks; rather, find interesting ways to collaborate.

Think about *the role* that the metaphor you choose will create. Should we teach our thermostats what is considered ambient comfort for us? How would the thermostat behave then? Or perhaps it's the other way around: maybe the thermostat should teach us the best behaviors, given that it has a lot more in-depth knowledge about saving energy.

You might need to take into account how an object might *change roles based on the situation and the context*, or the evolution of its relationship with the user—from a student of your behavior it might evolve into a teacher of better ones. Whereas sometimes it can be independent as a pet, it might need to become more functional and controllable when required. This means choosing the right metaphor of behavior for the right moment.

Think about *the language and signals* involved, because not everything will be mediated by human language and cannot always be articulated as a voice. Complex information can be communicated through lights, levers, force feedback, or even scent—there are plenty of new languages to be found, designed, tested, and interpreted.

A new metaphor also will lead to *rethinking and achieving complete new form factors and design* of the product itself and its "location" in relationship to the user. Is it an observer in a corner? A sidekick collaborator? An empowering tool? Or an invisible ear whisperer?

Think about *new relationships and collaboration models*. Rather than only delegating tasks to an automated kitchen, an intelligent collaborator could help evolve a series of versions for recipes, explore very complex data about taste, recombine ingredients in infinite varia-

tions, predict possible ingredients, visualize invisible components, create synesthetic crossing, and on and on.

Design Transparency and Controls

With more intelligence and complexity of behaviors comes more responsibilities for a product that must dwell in our homes. When a product's behavior might be based on machine learning, whoever designs and codes the system never knows precisely how it might accomplish its tasks. Because neural network's operations are quite opaque and complex, the decision-making process of a thermostat, a door, or a home becomes a black box. Combining this with interfaces that hide this complexity in favor of a simple UI can lead to very complicated experiences. Consider what happened in January 2016, when people in New York had no way to control their smart thermostats. In this case, a code glitch resulted in some dangerously cold homes.[25]

A very opaque, untouchable, sealed system, might be smart for the companies that produce it and the engineers that must maintain it, but it might not be that smart for the person using it. As Jean Baudrillard asked, "How can automatic be smart if it makes us simple spectators?"

When it becomes automatic (on the other hand) its function is fulfilled, certainly, but it is also hermetically sealed. Automatism amounts to a closing-off, to a sort of functional self-sufficiency that exiles man to the irresponsibility of a mere spectator.

Recently, however, there has been a lot of discussion around how the user experience should be designed for intelligent, learning, and connected products. Calling for a more interactive role of people in machine learning processes, Greg Borenstein also calls on designers to get deeper into understanding how logics and algorithms need to be a design choice:

> If we want to build systems that users trust and that we can rapidly improve, we should select algorithms not just for how often they

25 Nick Bilton, "Nest Thermostat Glitch Leaves Users in the Cold," New York Times, January 13, 2016.

> produce the right answer, but for what hooks they provide for explaining their inner workings.[26]

More at the root of the issue are the ideas manifested in *explanatory debugging* from Todd Kulesza, which creates machine learning systems that by default explain their process and allow people to provide feedback and personalize the results.

Moreover, with its latest legislation related to automated decision making that "significantly affects" users, the European Union is pushing for "the right to explanation" for people dealing with autonomous and smart products or processes. People will be able to ask for an explanation of an algorithmic decision that was made about them.

You can imagine the impact this might have on companies, but it could also become a very useful interaction in everyday situations: imagine how a door might have to explain why it let someone else in your home because of similar facial features, or if we could tweak continuously our music library to update based on my aspirations of listening to more classical music rather than my actual behavior.

Designing for the right amount of trust

Being able to see more of what's behind the behavior of a product allows people to understand and become more trusting of a system. Although seamless design seems to be the leading value for products to hide the system and make it more convenient, the idea of a more seamful design would help not only in moments of need but also to create ways for people to explore, discover, and adjust the system that they encounter. *Seamful design* is a term coined by Mark Weiser to clarify how his vision of ubiquitous and calm computing does not mean "hide and make everything invisible;" instead, we should elegantly show seams and controls when needed. Even though this might not appeal to everyone, closing down and making a system completely hermetically sealed might not allow a more personal and trusted experience, and even a more enjoyable one.

Trust in itself is an interesting problem when dealing with autonomous systems. Think for a second of self-driving cars. As nowadays they are not completely autonomous and infallible, they need to be

26 Greg Borenstein, "Power to the People: How One Unknown Group of Researchers Holds the Key to Using AI to Solve Real Human Problems," June 30, 2016.

designed to be trusted enough for us to let them drive, but not enough for us to lose attention for when we need to regain control. *The New Yorker* put it very well: "free drivers from the onus of driving, while burdening them with the worry that, at any moment, they will need to take back control."[27]

This is the paradox facing auto engineers: how to design self-driving cars that feel trustworthy while simultaneously reminding their occupants that, no matter how pristine a given model's safety record, no driver—human or artificial—is perfect. How, in other words, to free drivers from the onus of driving, while burdening them with the worry that, at any moment, they will need to take back control.

In a similar way, we need to think about autonomous systems in our homes that will control light, energy, and every other action. How much should we make them trustable? When should we seek for the people in the house to regain control? And what controls will we give them?

In a running experiment with Casa Jasmina together with my team automato.farm, we worked on exploring what the controls of a smart home would be. We reimagined what a switchboard would be when suddenly not only electricity needs to be switched on and off, but also data and the intelligence of the house itself. We designed what we called a "white box," (Figure 1-27) a transparent and open control for a smart home. Although most of the time the smartness of home is hidden in a "black-boxed" algorithm somewhere in the cloud, we wanted to reveal the smartness, connectivity, and processes of a smart home in the form of a button and levers that people can control. The white box allows a hypothetical host of Casa Jasmina to control what the house knows and how it will act. APIs becomes switches to be turned on and off, allowing users to control whether the house will receive data about you (by tapping into your biometrics and health apps), the location (yours both physically and digitally and the home), the context (weather, people in the house), and the market (trends and pricing of goods and resources). Computational processes are translated into sliders to control how much the house will remember or forget, to what degree it will keep data private or make it public, how much it's going to learn your routines

27 Simon Parkin, "Learning to Trust a Self-Driving Car," The New Yorker, July 15, 2016.

against teaching you better ones, and ultimately, whether its goals will be more related to the single person or to the collective good.

Figure 1-27. White Box by automato.farm for Casa Jasmina

Although the box does not yet offer controls for all of these data sources and to all the appliances, it will be used as a test to see how to control the behavior of multiple connected products, and the first open and transparent smart home.

Think about all the *new processes in a home that might require new controls and a level of transparency for people to understand and be involved in the process*. New data-driven paradigms require new mental models and ways of understanding and controlling these processes:

- How do you reset a house when something goes wrong, how do you make it forget or unlearn something when you don't want that information to be stored?
- How do you delete its memory when you decide to move to a new home?

Think about *what should be seamless and what should seamful*, what should be controllable and what should not, what should be transparent and what opaque:

- Can you configure what APIs to which your kitchen has access?

- What if you want to only follow logics that adhere to specific dietary recipes, such as ones that are vegan or conform to particular religious mandates?
- What if you would like your fridge not to know whether your are home?

Whereas technology companies have the tendency to hoard huge amount of data, think of the home as a place where *private and public start to overlap even more*:

- How can you build tools for people to understand what is public and private in their life?
- How can they choose what to share and with whom?

Build a Relationship Through Time

Designing for a smart product doesn't necessarily mean to become a connectivity or a machine learning expert, but it does require that you know the basics and the limits of the new materials involved in designing such a product. When designing a wooden chair for the first time, we need to see and smell the wood, know how much the wood can bend, and what type of screws will work with it. In a similar way, to design something "smart," we need to play with code to understand its materiality, looking at the limits of the technologies involved, but also imagining beyond that.

As I said earlier, homes that we design for are not the perfect blank page, but a complex mix of other products, issues from the reality of a family, a forgetful user, and so forth. When designing for a product that must handle quite complex tasks like predicting your favorite food or making decisions regarding your health, we need to take into account not only the moments when everything will go smoothly, but also when things will go wrong, when a product might be left behind and abandoned, and when a specific recommendation might be misunderstood. "Translated to the world of data, the introduction of a new service, products, or algorithms requires a responsible design that considers moments when things

begin to disappoint, embarrass, annoy, or stop working or being useful."[28]

A new, more responsible design needs to take time, longevity, and evolution as new parameters to design. It requires thinking not only about the journey of the user, but also that of the product: Understanding and shaping what and how the product is learning and what the role of the user is in teaching it; thinking about how the product can gain trust over time, so that people would not be anxious to let the product do its job (Figure 1-28).

This means really thinking from the first moments when a product is welcomed and the user onboarded in the new experience, to determine the rhythm of interactions with the user, the speed and logic of learning and adapting to a context, all the way to when a product is broken and left behind. As a designer, it's important to embrace the frictions and mistakes that might happen and use them as opportunities for designing new interesting moments of interaction. In some way, a not-so-smart object might become more relatable and accepted. Rather than being an infallible solution that might fail our expectations, something that might require our attention and support and have a more open interaction and collaboration could turn the limits of the technology into a reinforcement of trust.

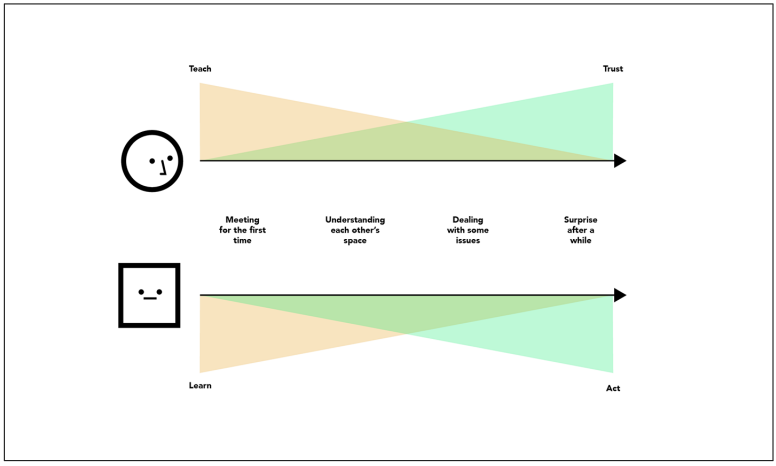

Figure 1-28. Product and user journeys

28 Fabien Girardin, "The Life and Death of Data Products," Design Fictions, July 12, 2016.

However, trust is also a problematic topic, as shown by some of the latest issues with self-driving cars, in which accidents might happen not only because of a technical malfunction, but also because of the complete lack of attention of the chauffeured user. The higher the trust one has in a car to perform its task perfectly, the less one will give attention to its behavior and also its potential errors to correct. Similar to this issue, it will become more and more relevant to think about how to design smart products that feel trustworthy but that at the same time somehow remind their users that no decision-making or automated process is perfect.

Embrace Frictions and Fictions

Although it's difficult to test and prototype situations that might require you to use real technology in a real context and throughout a real timeline, there are ways to conceptualize and explore such scenarios. Borrowing from "design fiction," we need to use design not only as a problem-solving activity, but also as an anticipatory tool to navigate and discuss issues and implications of living with smart products. Imagine and visualize the full journey and evolution of living with a product and look at the good, the bad, and the ugly. It requires a more thoughtful and critical approach, not driven at dismantling the value of the technology or becoming a luddite, but to envision what else of the experience needs to be designed and thought beyond the hero moments. It's a way of testing a possible future without necessarily building it, to look at a series of hypothetical situations that might appear and show the reaction of people and the potential solutions.

When thinking about a new relationship with a product, think how it will start, how the roles will be created from the first interaction. Is it a very sure product that comes through your door with the promise that it will solve all the issues in your life no matter what? Or, is it more of a calmer entry, something that silently enters your home and will find its place? When you think about a product that needs to learn about its user, how long is the "trying to understand you" period? How does the shift to the "now I know you" stage happen and how does the device communicate this?

Embrace the actual reality, the mistakes, the issues, and think about what controls and interfaces that you might need to design because not everything goes the way it's been tested in the laboratory.

In an episode of the TV series *Mr. Robot*, a character's loneliness is underscored by her interaction with Alexa, the voice AI from Amazon. Although the product is aimed at being a useful butler that can tell users information they need on the spot or act on their behalf online, what is portrayed in the scene is Alexa's secondary and unexpected role: a sort of companion to talk to so as to avoid falling into complete loneliness. Even though some of these uses arise from a particular context and are not really designed or anticipated, maybe the most interesting relationship of the product you design is going to be the one you won't be able to anticipate.

Don't Just Add "Smart"

There is no clear recipe for designing a great smart product for the home, but we at least need there to be more understanding of the radical difference between designing a simple kettle, and designing a data-driven kettle with a degree of autonomy and a specific set of responsibilities. There is probably not a better replacement for "smart," but we should call for a more responsible use of the term. *Smart* comes with a set of preset solutions and biases around what life we imagine for people. There is no universal "smart," but there is a series of hidden beliefs, cultures, and ideology embedded and imprinted from the designers, engineers, and companies behind a product.

Figure 1-29. There is no actual "smart"

We need to be clearer on what the home means to others, research it, understand it, and probably go beyond solving issues and turning every home into that one perfect place that will never exist.

When we put a product in a home, we do change the equilibrium of the life of people, we might help them in some way, but we also influence their routines, lives, and beliefs. The more intelligent a product will be, the more it will be impactful.

A lot of similar discussion has already happened around the concept of the smart city, where digital logics applied to physical spaces have questioned the complex and interesting nature of the urban environment. Similarly, the over-efficiency and quantification trend is turning the complex and interesting nature of home into a flatter

environment. Rephrasing what Dan Hill said about the smart city,[29] we should aim more to have smart tenants rather than smart homes:

> The connected world we're building may resemble a computer system, but really, it's just the regular old world from before, with a bunch of microphones and keyboards and flat screens sticking out of it. And it has the same old problems.[30]

Whereas the business focuses on getting a product that can collect data and become the one who will train computers in order to build better products and services, it is still important to think about what we are designing for people. Applying similar logics to physical products in the home as we do with software might have far more issues than we think.

As it happened to learning thermostats and self-driving cars, more examples will show the need of new languages and interfaces for people to deal, trust, and interact with future intelligent objects, but also for a different type of design. We need to move toward a more responsible design, one that takes into account the entire life cycle or relationships that these new guests will create, that is critical and has a point of view of the type of life that it directs, too, and that doesn't hide behind the word "smart."

Designing for these new paradigms requires shifting our mindset as designers to think from different perspectives. We might need to begin thinking about the perspective and the point of view of the objects that we design for—how they understand, misunderstand, and interpret people and context.

This means going beyond what smart means today, turning away from the flat, simple, invisible, and magic, and getting more into the empowering, rich, emotional, and surprising home of the future. Rather than adding "smart" as a feature, we should deeply rethink what products we would like to welcome in our homes, what new abilities we can gain, and what new experiences to show to people. The term we have now, as with other terms before, is mainly an excuse to overstate a value, but under-design products.

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29 Dan Hill, "Essay: On the Smart City; Or, A 'Manifesto' for Smart Citizens Instead," February 1, 2013.

30 Maciej Cegłowski, "The Moral Economy of Tech," June 26, 2016.

About the Author

Simone Rebaudengo is an interaction designer and researcher based in Shanghai, where he consults for international clients like Philips, Nike, and Google Creative Lab on future connected products and experiences, and researches future relationships with emerging technology with his design collective, automato.farm. In his previous career he worked at frog and collaborated with Usman Haque and Pachube trying to install an "addicted toaster" in the office of the British prime minister.

His works focus on exploring the implications of living with networked, smart, and autonomous systems. Sometimes they are real products, and sometimes they are fictional.

Simone is also Visiting Lecturer at Copenhagen Institute of Interaction Design (CIID) and has presented at international conferences like TEDx, IxDA, SolidCon, Thingscon and dConstruct. His works have been published internationally in *Wired*, *Fast Company*, *The Atlantic*, and *Designboom*, and awarded by Core77, the Interaction Awards, and the Internet of Things Awards.