DISTANCE 03

with essays by

Jiashan Wu

Vitorio Miliano

Matt Johnson

http://**distance.cc**

DISTANCE 03

concerns *the future.*

Wherein:

Jiashan Wu travels to Shenzhen, China to learn more about the designers, manufacturers, and distributors of iPhone copycats.

Vitorio Miliano shares the findings of his survey in Distance 01, and proposes better ways to build the future.

Matt Johnson teaches us the role of design thinking in materials science by presenting a new breed of creator.

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DISTANCE's essays don't exist in a vacuum. We encourage you to excerpt and discuss these essays with others. You have free reign to quote as much as you need to get your point across. Good writing begins conversations, and we're listening. Visit *Distance*'s website at http://distance.cc to read and remark on others' responses.

If you have any questions, email us at we@distance.cc and we'll make it right.

Publisher's thoughts

by **Nick Disabato**
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Thanks, as always, for reading *Distance*. We're honored to put every issue together for you, and we hope you get some valuable insights out of this one.

I wonder about the future a lot—probably too much, considering I live in the present, and work to feed and shelter myself *today*. But what will the future look like? Can we predict it? Can we determine who might be well-poised to create it? Do we have the agency and wherewithal to influence it? Or maybe we'll be wrong about what's in store. How do we respond then?

These questions concern all of us; if we're going to remain relevant, not only in our careers but in our beliefs, then we should be concerned about the way things are going to play out in our field, in all of technology, in the world.

We have some great essays in store for you in this issue. Jiashan Wu lived in Shenzhen, China for a year, interviewing the independent designers, manufacturers, and distributors of knockoff cell phones. Matt Johnson profiled three materials scientists who are each helping us build the future. And Vitorio Miliano followed up on his essay from our first issue, sharing some important takeaways about the way we work and the subjects we choose to focus on.

From the moment I first spoke to each of this issue's authors, I knew that this would be one of *Distance*'s finest moments. I'm immensely proud of how this came together, and hope you enjoy it.

Nick Disabato
October 10, 2012

Authors' thanks

Jiashan Wu: Thank you to the phone makers in Shenzhen and phone traders in Hong Kong for opening their world to me; to Professor Gordon Mathews for introducing me to the low-end globalization and his generous help in the Chungking Mansions; to Professor Yi-Chieh Lin for her encouragements and helpful introductions; to Nick Disabato for his awesome work and incredible patience; to the Fulbright Fellowship and in particular Janet Jupton from the IIE Beijing office; to fellow Fulbrighters Peter Sack and Willa Dong for their feedback; and finally to Greg Leuch for his love and support through the hard times in this research.

Vitorio Miliano: I am indebted to my editor and friend, Nick Disabato, for his patient shepherding of an 11,000-word train wreck through two entire other arguments into the hopefully reasonable work you will read here. I am grateful to A List Apart for their yearly research efforts, and to the Austin design community for supporting me with their survey responses. To write this, I stood on the shoulders of such giants as Claude Hopkins, David Ogilvy, Dr. Richard Hamming, Karen McGrane, Bill Moggridge, Matt Webb, and every other researcher, writer and designer I have cited throughout my essay. Thank you all, and thank you, dear reader, for your attention.

Matt Johnson: Thanks to Sarat, you opened my eyes to a new way of seeing the world. You are great critic and a great friend.

Note on citations

Distance exists in quite a few forms: book, PDF, ePub, and Kindle. We know that people read all sorts of ways, and we want the text to fit your reading habits, not the other way around. 1

Most citation methods refer to a work's page number, but only two of *Distance*'s forms have discrete pages. Consistent, understandable citation by page number is impossible, so wayfinding must exist within the actual text. 2

In an attempt to solve this problem, *Distance* doesn't have page numbers. Instead, each essay's paragraph has a little number to the right, as seen here. *These numbers will always be consistent among each format of an issue of Distance.* 3

This is similar to the convention of "purple numbers" in blogging,[1] and it will remove any ambiguity about what's being referenced. As a rule of thumb, where a page number would go, use the **paragraph number** instead. 4

For example, MLA citation should look like Whipple, Jon. "What Designers Know." *Distance* 01: 14–17 for the 14th through 17th paragraphs of Jon Whipple's essay in our first issue. 5

1. See also CIM Community, "Purple Numbers", http://dsn.tc/01x-01 and Simon Willison, "PLinks", http://dsn.tc/01x-02.

I have a hunch that when we invent new things, the first way we test our new technology is with talk. Our ability to communicate is simply one of the most basic use cases in the design problem of our lives. And not only is it essential and important and the rest of it, it's fun. It makes us laugh. Why wouldn't we?

—Hannah Donovan, *Everything in its Right Pace*,
at http://dsn.tc/03x-02

To us, the Web is a sort of shared external memory. We do not have to remember unnecessary details: dates, sums, formulas, clauses, street names, detailed definitions. It is enough for us to have an abstract, the essence that is needed to process the information and relate it to others.

—Piotr Czerski, *We, the Web Kids*,
at http://dsn.tc/03x-03

Shanzhai Phone Makers

The emblem of low-end globalization.

by **Jiashan Wu**
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Mobile phones are the most ubiquitous technology of our time, prevalent even in the most extreme peripheries of the world.[1] How was this made possible? 1

As I write this, I'm sitting in the middle of the answer. Outside my tiny, windowless room, traders from all over South Asia and Africa move in and out of our shared guest house in Chungking Mansions, a building in the center of Hong Kong, known as a hub for traders from the developing world. Ask any of them what they are bringing back home and "mobile phones" is always mentioned first. 2

Gordon Mathews documented the informal mobile phone trade in Chungking Mansions in his book *Ghetto at the Center of the World*, and defined Chungking Mansions as a center of **low-end globalization**—where people from the developing world "carry their goods by suitcase, container, or truck across continents and borders with minimal interference from legalities and copyrights, a world run by cash."[2] Low-end mobile phones are one of the most frequently traded commodities, and they are an emblem of low-end globalization. People often fill their luggage with as many mobile phones as they can, and bring them back home to sell; African traders ship these phones back to their country via large-volume containers. Mathews estimated that over 20% of the mobile phones sold in Sub-sahara Africa passed through the Chungking Mansions. 3

Mobile phones do not only connect underdeveloped regions to the modern world: they are also tools for the accumulation and transfer of wealth. Mobile technology has enabled banking systems to flourish in Africa, where NGOs 4

1. There were over 6 billion mobile subscribers around the world at the end of 2011. About 87% of these subscribers are in the developing world. See also "Global Mobile Statistics", Mobithinking.com, http://dsn.tc/03a-01 .
2. Gordon Mathews, *Ghetto at the Center of the World,* University of Chicago Press, 2011.

can easily transfer funds to remote areas. As a Tanzanian trader told me in Chungking Mansions, "Mobile phones have created an economic revolution in Africa. People are doing business on their phones from the bushes!"

5 People also accumulate wealth through training and entrepreneurship in the mobile phone industry. A Pakistani phone distributor told me that a young person in an undeveloped region back home can be trained for three to four months to start a mobile phone repair business. This distributor had struggled out of poverty by trading low-end phones seven years ago.

6 While the recent victory of Apple in the IP battle with Samsung was big news for the tech industry, this verdict has little direct impact in low-end globalization. Mobile phones traded this way are usually the cheapest phones you can find. Costing as little as 8 US dollars, most of these **Shanzhai phones** are made in mainland China, across the border from Hong Kong. In 2010, these phones counted for more than one out of five mobile phones sold around the world.[3]

7 Through its many forms, the definition of Shanzhai has become muddled. In the ancient Chinese tale *Outlaws of the Marsh*, the term Shanzhai was first used to define the desolate mountain villages that rebels occupied.[4] In 2007, when the mobile phone industry flourished in Shenzhen and won popularity among Chinese consumers, mobile phones made there were coined Shanzhai phones, because they were often made by small, illegal companies. And because Shanzhai phones were often characterized by their likeness with well-known name-brand phones, the term Shanzhai soon became synonymous with any industry's knockoffs.

8 Around 2008, as the media noticed small innovations occurring in the Shanzhai phone industry—such as the creation of the dual SIM card phones or clever twist of brand names (e.g. iOrange)—Shanzhai was glorified as grassroots innovation, maybe even a counter-culture. Depending on who you asked, Shanzhai has been associated with illegitimacy, copies, knockoffs, parodies, amateurs, DIY culture, and grassroots innovation. To lessen the ambiguity and avoid a complicated discussion on what should be defined as a copy

3. Philip Elmer-DeWitt. "Missing: 77 Million Mobile Phones." CNN.com. http://dsn.tc/03a-02.
4. Shi Nai'An, *Outlaws of the Marsh,* Foreign Language Press, 2001.

in design and technology, I define Shanzhai as made by small, independent operations that may be characterized by copied designs.[5]

9 The mobile industry changes quickly. In the developing world, interest in Shanzhai died down as the iPhone redefined the mobile phone industry, with Chinese consumers demanding well-known brands and better quality phones. But the industry continues to evolve. Some of the original Shanzhai phone companies legitimized and expanded their operations, while others turned to the rest of the developing world, where few can afford the latest gadgets.

10 While people have devoted a lot of attention to Shanzhai phones, little seems to be known of their makers. For the most part, the people behind the phones have been described as anonymous figures in a massive industry. Even the South Asian and African phone traders that I spoke with in Chungking Mansions knew little of those who make the products, despite weekly purchases from them. The traders often refer to Shanzhai phone makers as simply "the Chinese", whom they described as a group of people skilled at pursuing profits by selling cheap goods. The hardest thing for many traders is to overcome a certain barrier and build trust with the makers.

11 Ironically, this is also how the makers seem to feel about the traders: that they have to constantly avoid getting cheated. Prior to visiting Chungking Mansions, I lived in Shenzhen for almost a year. Through a chance connection, I met several people who make Shanzhai phones. What had started as research of innovations in the Shanzhai industry turned into an extensive profile of the people in action, as I spent more time with different groups on the front lines: Shanzhai phone makers, factory workers, and a few Chinese distributors.[6]

12 Due to the openness of a few Shanzhai phone makers, I shadowed them throughout my time in Shenzhen, sitting in factory and client meetings, or just hanging out at their offices. I was able to peek into their world; I got to know some of them well. They also introduced me to friends who work in

5. For our purposes, Shanzhai doesn't include large, Chinese government-backed companies such as Huawei and ZTE.

6. All names have been changed.

factories, allowing me to visit the workers in their dorms on their days off—and even crashing at a dorm for a few days.

While spending time with the Shanzhai phone makers, I asked them questions about design, technology, and copying. They told me personal stories, explained how the industry has affected their lives, and ruminated on globalization's relationship to the low-end market. 13

Everyone I met simply called themselves **phone makers** (做手机的). Many people are attached to this identity, especially since their entire social life circulates around this industry, where it's normal to work 12 hours a day, six days a week. At the same time, phone makers are acutely conscious of how their industry is perceived by other Chinese: an industry full of undereducated, rural farmers rushing to Shenzhen to profit from inferior phones.[7] As one phone maker said, "I am always proud to see someone on the street using a phone I made. But I would never tell people outside the industry that I am a phone maker; they will think little of me." 14

As for the industry, it is constantly in flux. (For example, two weeks before the iPhone 5 was announced, a phone maker—who had already decided to leave the industry—was back making Shanzhai iPhone 5's.) One thing is for sure, though: the developing periphery of the world continues to want affordable phones—and as they gain access, modern society is reshaping itself. 15

Technology: How Shanzhai was made possible

In 2004, MediaTek, a Taiwanese semiconductor company, recognized the potential of the Chinese mobile phone market and started to develop its own IC chipsets, technology that has been exclusive to only a handful of mobile companies in the past. They released their product and sold it at half the price of their competitors. Although they initially hoped to work with large, government-backed Chinese mobile companies, MediaTek was turned down by most of them because it was new to the industry.[8] As the company struggled to establish itself, its executive learned that as the mobile industry was just starting in China, their potential clients—private mobile phone 16

7. I consistently heard this from middle-class Chinese and phone makers themselves.
8. 杜欣霏. "山寨机的技术与政治". (Du Xin Fei, "The Technology and Politics of Shanzhaiji".) MA thesis, Tsing Hua University, 2009.

companies—lacked the experience to implement the technology into viable products and had little knowledge of license and patents.

17 Mediatek developed the **system-on-a-chip** solution that addressed these concerns, including chipsets with basic phone functions, handling of patent and technology licensing, and technical support. In doing this, it became substantially easier for someone to make a phone. Soon, swarms of private Chinese companies were purchasing from Mediatek, and mobile technology was made available to anyone with enough capital.

18 Small phone companies proliferated. Some of them profited handsomely; others left the industry empty-handed. Waves of companies continuously opened and closed. Entrepreneurs from all over China rushed to Shenzhen to profit from this technology, and the mobile phone market became saturated in China and the developing world. Now, people from all walks of life participate in making phones—most from rural areas or smaller cities. Some were former factory workers who saved enough money to invest with friends. Most were incapable of making a phone from start to finish, so different types of companies emerged to collaborate with each other:

- **Design houses** modify the IC chipsets to fit the motherboard, which determines the specific functions and features of the phone.
- **ID houses** (Industrial Design houses) figure out how the exterior design will fit the motherboard.
- **Aggregators** match design and ID houses to each other, source the individual hardware components, and find an assembly factory to put it all together.[9]
- **Distributors** buy phones from the aggregators and distribute them to stores in regions where they are well-connected.

19 Some companies grew to employ hundreds of people, eventually acquiring their own design houses and assembly factories. Other companies are one-man operations. They compete with one another, but also collaborate with personal friends and relatives.

9. In this essay, I refer to all engineers in design houses and aggregators as they usually refer to themselves: *phone makers*.

As a result, Mediatek became the largest benefactor of the Shanzhai phone industry. Today it is the fourth-largest chip design company in the world.[10] By opening up the technology and enabling people in the low-end sector to participate, Mediatek created a whole new arena in the mobile phone industry. Even though new chipset manufacturers have emerged in China over the years, Mediatek remains dominant in the realm of low-end phones. As one engineer said to me: "We are all just delivery boys for Mediatek." 20

Shenzhen: A place of manufacturing and making

Shenzhen is a city in the southern end of the Chinese mainland, bordering Hong Kong. Its geographic location and an early implementation of the special economic zone status[11] make it an ideal place for Chinese entrepreneurship and trade. For most electronic enthusiasts and makers, the Hua Qiang Bei area of Shenzhen is the source of all of their goods. Markets line the streets, multiple floors replete with devices and components of all kinds. For the Shanzhai phone makers, Hua Qiang Bei is not only a place to find current market trends and pricing—it is their social and business world as well. Above the markets are twenty to sixty floors of small office and residential spaces. While some companies have recently moved to other areas of Shenzhen, most are still located in Hua Qiang Bei. Business partnerships, friendships, and even romantic relationships are formed here; many of the phone makers I met found their other half in Hua Qiang Bei's crowded markets. 21

For a wide-eyed youth from an underdeveloped part of China, Hua Qiang Bei and inner-city Shenzhen represent modern big-city life in all its glory. Hua Qiang Bei is fast-paced, and crowded with people from all parts of China and the rest of the world, doing business in soaring office buildings and bustling marketplaces. More importantly, this is a place where many Chinese youth feel they can finally make something of themselves. I have heard a phone maker say to his younger cousin, who had just left a small electronics factory 22

10. Lisa Wang, "MediaTek to buy MStar Semiconductor", *Taipei Times,* 13 June 2012. http://dsn.tc/03a-03.

11. As part of China's economic reform in 1976, Shenzhen was developed as a *special economic zone,* with more lax economic laws than in other parts of the country. Shenzhen was the first such zone, and three others now exist as of press time.

and set foot in Hua Qiang Bei to work on repairs for a Shanzhai phone company: "You are now at the source of all opportunities. Work hard and you can maybe make the next successful phone." A successful phone would provide enough money to achieve the Chinese middle-class dream.

23 Electronics factories of all sizes are in the outskirts of Shenzhen and another nearby manufacturing town, Dongguan: from enormous powerhouses like Foxconn which assembles products exclusively for the developed world, to small apartment workshops that assemble copied versions of these products for the developing world. The relationship between these different levels of manufacturing is enabled through experienced workers who often move from one factory to another, informing younger workers of different factory conditions. On a product level, sometimes the Shanzhai phone will use the same components—such as screens—as the name brand phones they're copying.

24 Some workers within the Shanzhai phone industry first started in Shenzhen factories. A successful phone maker told me he started in a large electronics factory that assembled name-brand speakers. He initially made little money as an assembly line worker. But he looked up to a co-owner of the factory, who taught him to "endure hardship and become motivated to achieve success". This co-owner had himself started as an assembly line worker in a Shenzhen factory in the late '80s, back when many factories didn't even have dorm buildings. They built huts out of sheet metal where the workers shared a space. The phone maker described a large bruise his former boss has on his arm: his skin had been burned off when he fell asleep, exhausted from work, on the hut's sheet metal, which was heated by the sun during the day. Compared to this, the phone maker said, he had endured very little hardship.

Low-end design

25 While Shanzhai's core technology depends on Mediatek and other chipset manufacturers, the interface design, feature set, and industrial design are dependent on the phone makers, who are better connected to the low-end market than any name-brand phone maker.

Those who buy Shanzhai phones are still adapting to mobile technology. 26
They live in underdeveloped regions of China, or in African, South Asian, South American, and Eastern European countries. Most will move on to mid-tier or name-brand phones once they are familiar with how mobile phones work and with the differences between models. As a Pakistani phone seller told me, "these China-made phones[12] open the market for name brands, in regions they never paid attention to before."

A prominent feature of many Shanzhai phones is their extremely loud 27
speakers. Many of the older migrant workers work alone until late in the evening. They often use their phones to listen to the radio. The Pakistani phone seller told me that loud speakers and FM radio are popular features amongst African users as well. From my own observation, young factory workers also use loud speakers on their phones to play MP3s. When I hung out with these workers at their dorms, someone often blasted Chinese or Korean pop music from their phone like a boom box.

Initially, phone makers viewed design as a thing of luxury, only reserved 28
for fashionable Chinese living in big cities. But over time, as some phone makers started their own brands, design has gained importance. When I told a phone maker that I am a designer, he immediately congratulated me and encouraged me to stay in design because it has a bright future. Others tried persuading me to open an industrial design house with them.

In learning about design, phone makers became familiar with different 29
product design guidelines and tools. Even the least educated makers—those who never graduated middle school—are quite knowledgeable about the various materials in phone design, as well as their corresponding pricing. While most copy the designs of name brand phones, many modify the designs and add additional features in an attempt to make them more useful and appealing. Some also design according to their own liking, tweaking things like the antenna or speakers, which results in phones shaped like cigarette cases[13] and racing cars. However outrageous these designs may seem, it is an extension of

12. Shanzhai phones are often referred to as simply *China-made* by most international traders.
13. Anonymous, "Shanzhai Mobile Phone Resembles Cigarette Pack", *chinaSMACK*, 7 May 2009. http://dsn.tc/03a-04.

the phone makers' culture. Cigarette smoking has been a large part of Chinese social interaction—a tradition that the phone makers, who often work 12 hours a day, continue to this day.

30 I am often surprised by how open these phone makers are to new ideas—no matter outlandish they may seem. I once told a few phone makers that I wanted to produce a phone out of fragile ceramic, for an art piece. They ruminated on this for a few minutes and said, "There was someone who made ceramic phones a year ago. This type of product does not sell a lot, but people bought it because it is a novelty. Maybe we can consider this…." Knowing that Shanzhai phone makers are quick to act, I cautioned them that these phones could break easily—and they informed me of a chemical coating that can be painted over the ceramic to strengthen it.

31 Here, nobody takes credit for new innovations in design. For instance, I couldn't find a phone maker who knew who first made dual SIM card phones — even though it was a successful micro-innovation in the industry, to the point where name brands employed dual-SIM card slots in their own phones after recognizing the demand. When I asked the owner of a design house if he would patent a new creation, he stared at me in confusion. "If I can come up with a successful new design, I would immediately put it out in the market and make lots of money," he said.

32 Small phone companies cannot afford to patent their own designs. The Shanzhai phone industry moves at such a speed that if a company came up with a novel idea, they would quickly produce it. It could be out in the market within a month or two—after which it is accepted that anyone else can copy the design. As phone makers see it, phone trends change so fast that a design will go out of date quickly. Why not turn it into a quick profit?[14]

33 All of the phone makers I know are aware of the legal implications of copying larger brands, so they work to get around the system. To them, making a phone that says *Nokla* and one that says *Nokia* is a huge difference, and nobody admits that they make exact copies of phones. I heard stories of how

14. However, as China becomes more educated in intellectual property rights, the power of patents, trademarks, and copyright is becoming more widely recognized.

competitors would report a company that makes exact replicas to the police, although I never came across anyone directly involved.

When the Shanzhai phone industry began, there was enough demand for 34
mobile phones that there was no reason to produce exact replicas. But as the market became saturated, demand dropped, and companies competed harshly by cutting prices. Profit margins were cut from a few hundred renminbi (RMB) per phone to only 10–20 RMB per phone—and even less today.[15] At that point, many companies made exact replicas of name-brand phones so they could raise their prices. However, unlike luxury fashion goods, it is easy to spot a "fake" phone, if you're familiar with the original: subtle discrepancies in the material, weight, interface, interaction design, fonts, and packaging can give it away.

While name brands complain that Shanzhai hurts their business, phone 35
makers assume that their customers cannot afford name brand phones anyway. To them, a small company like theirs poses no threat. I have often brought up this issue with them; a maker of iPhone knockoffs remarked, "I can understand that Apple would want to protect their achievements, but they shouldn't make it too hard for everyone else to survive. They can make their big money, while we make our little money."

It's a game of cat and mouse, in which name brands sporadically send **in-** 36
spectors to catch companies making exact copied phones and report them. The punishment is usually confiscation of all phones and an additional fee substantial enough to shut down the operation. Shanzhai makers are wary of the inspectors hired by name brands, whom they view as malicious. Another phone maker said to me, "[brand inspectors] will be struck by lightning one day for the bad deeds they've done. They come in deceivingly, and then stab you in the back to make lots of money from foreign companies like Apple. I know many companies who make copy phones, and I can report them anytime if I want to make easy money. But I would never do a thing like that, because that is not right."

15. At the time of writing, 100 RMB is about equal to 15.69 USD.

Aggregators

Aggregators oversee the whole process of making Shanzhai phones. As explained to me by a friend, Lei, an aggregator is like the director of an independent film, managing all actors and crew members in order to complete a story and handling all of the risks involved. Usually they decide on what kind of phone to make, and they invest in its production. Then they sell the phones to distributors, who disseminate them to stores. As they take the most risk in the process, aggregators stand to gain the most if a phone turns out to be successful. 37

Lei is a one-man aggregator. He and two other aggregator friends, Laoliu and Miao, recently pooled enough money to invest in making an iPhone knockoff. Seeing other successful iPhone knockoffs, they thought they could make some money from one of their own. 38

They are all from Dong Bei, a northern region of China. All have worked in the phone industry, selling phones for many years all over the country. They came to Shenzhen separately between three and five years ago, and quickly became friends. 39

Upon first meeting, the group seemed intimidating. Like many from Dong Bei, Laoliu and Lei are taller and bigger than most Southern Chinese, and they are usually secluded within their own group around other phone makers. As it turned out, though, they were quite open to talking about their industry, life, and views. 40

Lei is the youngest of the group. He grew up on a communal farm, where he said his parents worked more like factory workers than farmers. They earned a monthly wage and were not allowed to do anything outside of their jobs. His father used to go fishing in a nearby lake to make a little extra money—but he had to wait until after dark, when no one would see him. 41

After Lei graduated from high school, he left home to work for a distant older cousin who sold smuggled phones. At the time, the Chinese phone market was mostly closed off to foreign companies in an attempt to develop domestic mobile technology. Many of the first mobile entrepreneurs smuggled foreign phones from Hong Kong or Korea and sold them in the black market. Some got rich from this, including Lei's cousin. 42

Lei and his other seven relatives sold phones for his cousin and lived together in a small apartment. They were paid 800 RMB a month and worked seven days a week. After a year of working for his cousin, whom he described as verbally abusive, Lei left to start a small distribution operation on his own with the clients he accumulated over the year. By the time he moved down to Shenzhen, he had made many friends around the country, to whom he could sell phones directly from the source. At the same time, the Shanzhai phone industry was booming, and because Lei was familiar with the low-end market, he sold mostly Shanzhai phones. Eventually, he was able to buy an apartment and car, a symbol of achieving the Chinese middle class status. 43

Though it's easy to invest in making Shanzhai phones, it's also easy to lose one's money—by getting cheated by other companies, or if the phones don't sell. To lower the risk, Lei's group tries to find the lowest-priced components, and they only work with those they already know or those who have been recommended by friends. 44

Like other aggregators, Lei, Laoliu, and Miao are well-connected in the industry. They know many component suppliers, and recommend them to each other when they are working on individual projects. They often visit Laoliu's home to talk about projects and hang out. Laoliu lives in an old apartment outside the Shenzhen city center with his parents, a relative, and his two young kids. 45

Though only 40, Laoliu looks especially old. After working in Shenzhen for five years, his head was full of grey hair and his face fraught with wrinkles. He said it's from the stress of keeping pace with the phone industry. 46

Engineers & Designers

Lei's group worked with a small design house to realize all the features of their iPhone knockoff. They met Sam, the co-owner of the design house, through mutual friends. Sam was already designing motherboards for another iPhone knockoff. While there are iPhone knockoffs built on the Android platform on the market already, his is a Java phone with basic functions: calling, SMS, MP3, movies, camera, and pre-installed apps like Angry Birds and QQ, a popular Chinese instant messenger. Sam modified the motherboard for Lei's phone and promised to provide repairs in case of malfunctions. 47

Once they confirmed the details with Sam, they went to an ID house to have the phone drawn out in a 3D rendering program. In this case, since they were copying the look of the iPhone 4 and were not adding any ancillary features (e.g., flashlight, TV, etc.), the design house and ID house only had to confirm that everything was in the right place. (When phone makers want to make a new design or modify an old design, the process will be longer, costlier, and riskier.) A small ID house, such as the one Lei's group worked with, charges around 2,000 RMB (350 USD) for their input. 48

The ID house is located inside a residential three-bedroom apartment. Six people work in cubicles in the small living room, and two more people work in two of the bedrooms, with sketches of phone models hanging on the walls. The last bedroom is reserved for meetings. As the work of design houses and ID houses requires extensive training, most owners of these houses have studied engineering or industrial design in college, while their employees may not have college-level degrees. 49

Because design is an emerging field in the Shanzhai industry, industrial designers tend to be young. The owner of this ID house is in his mid-twenties. He studied industrial design in a university back home. Unlike the other phone makers I have met, he has a real iPad, where he keeps sketches of his own designs—as well as a large collection of others' unique phone designs. He told me these are only concept designs that he likes to keep for fun, and claims they have no practical use in his field. He wanted to design cars back in school, but as the automotive design industry in China isn't mature and opportunities are lacking, he now only sketches car designs for fun.[16] 50

While ID houses charge per project, design houses charge for each motherboard they sell. When I first met Sam, 15 people worked in his design house. They had just moved to a new office space, and there were no signs at the front desk. The office looked like their old digs: a group of cubicles in the front, and offices along the side and in the back. The walls were stained gray, exuding a shabby atmosphere. 51

16. Perhaps the manufacturer of the race car phone enjoyed car design, too.

Sam is garrulous, and at our first meeting he talked for hours about his views of Shanzhai culture. He strongly emphasized the value of "micro-innovations", and tried to persuade me that Shanzhai is a form of grassroots innovation—although I suspected that he had read all this in the news. Over time, I got to know him more. I learned that he had grown up in a poor rural area in Anhui, and was the first from his village to attend college. 52

When I asked him if he is proud of this accomplishment, he shrugged. "Many students were just like me, the first to go to college from their villages. Our families had to borrow money from relatives for our tuition. But students who came from the cities complained that while their friends went to better universities, they were stuck here with us." He continued, matter-of-factly. "What I thought was a worthy accomplishment, once compared with others, became very trivial." 53

Sam spends his time pitching sales in Hua Qiang Bei, while his partner is in charge of technical issues and factory-side work. He told me he enjoys his work right now. When he first arrived in Shenzhen, he worked for a small clock company, then left to work as a software engineer at a large phone company. But he didn't want to sit in front of a computer all day, and explained to me that engineer jobs have an age limit here. By the time he is 35, he would be replaced by a younger employee, he claimed. Sensing a lack of growth potential at his old company, he left to open a design house with a former co-worker. 54

Sam always meets over tea. Every company in the industry has a tea set in its meeting room. These tea sets are Cantonese-style, with tiny cups that are only large enough for one gulp of tea. This slows down the conversation, making it a more informal setting. 55

Sometimes, a meeting may involve many different companies simultaneously pitching their components and boards to the same aggregator. They hear what their competitors are doing, and they learn about the latest products and collaborations. This is one way the industry remains collaborative in the midst of extreme competition. 56

Often, Sam would visit these offices with his friend, Shanhe, who also co-owns a design house. Unlike Sam, Shanhe had never graduated from middle school. He moved to Shenzhen when he was only 15 and worked different odd jobs. Though Shanhe's design house also makes an iPhone knockoff model—one with antenna and TV function—Sam and Shanhe are more like partners than competitors, sharing opportunities and updating each other on the latest products. 57

Sometimes aggregators come to Sam's office to ask him for technical suggestions on an upcoming product. Once, someone brought a wireless name-brand phone charger to Sam, and asked him if it would be possible to copy. Though Sam said his design house only makes phone motherboards, he opened up the charger and found the model of the circuit board online. The person informed Sam that the charger currently costs 600RMB (around 100 USD). Sam exclaimed, "That's a rip off! You can easily make this for 200RMB." 58

Factory workers

Lei and I visited a small home workshop where iPhone knockoffs are assembled, in a residential high-rise building outside Shenzhen. After being escorted upstairs, we were greeted by three men in their slippers. Unlike the apartment offices with cubicles, this apartment felt more residential and was furnished with basic necessities. Clothes hung on the balcony; a shabby looking couch set surrounded the tea table. The man who appeared to be in charge seemed hesitant to work with Lei, as he feared that the model might be confiscated during inspections. 59

The apartment had two rooms where phones were being assembled. The larger room contained six young men sitting around a big table preparing phone parts. In the smaller room sat a woman wiping piles of iPhone knockoff screens. Perhaps because we were the only women in the apartment, she immediately started chatting with me—without hampering her speed of work. 60

She was the wife of the man who appeared to be in charge. Their two sons, two and four years old, were living separately with her parents in Guangdong and her husband's parents in Jiang Xi. They'd been living in this apartment for a year and a half, and only started assembling phones a few months ago. 61

All of the workers here had been co-workers in a larger factory, before they quit their jobs and came together to run their own home workshop. She said, "Working on an assembly line was like working as a machine everyday. And you only get paid the set minimum wage (1500 rmb) every month." She continued, "[at our last factory] there were thirty people in each assembly line. Each person only worried about their own station. But here, we work together as a group. Every part of the production is important for everyone, and we help each other out."

62 The boss brings clients in and pays for expenses, while taking a percentage from each phone sold. The rest of the revenues are divided between everyone else. There is no set time frame for work; it's up to them. She told me because of this flexibility, they work more efficiently and are more attentive to quality than at their last factory. They can assemble 500 phones a day, although they rarely have that many orders. The market for these iPhone knockoffs is not huge, and there are many small workshops just like theirs.

63 In the other room, workers were busy putting adhesives on the plastic interior casing of the phones, not unlike their work at their previous jobs. The workshop has someone representing every department of their old factory. She had worked in quality control; her husband worked in engineering. When I asked her if the loss of workers would affect their old factory, she shrugged, "We didn't all leave at the same time. Besides, it's a big place. It makes no difference to them if we are there or not." Meanwhile, in the living room, her husband agreed to work with Lei despite his initial reservations.

64 Many factory workers, upon learning that I came from the United States, asked me the same question: What do Americans think of products made in China? One 19-year-old girl, who had worked in a factory that assembled foreign orders, wondered why the procedures for these orders were much more complicated and time-consuming than the procedures for domestic orders, even though they were the same product. "Are products in America much better than here?" she asked earnestly.

Distributors

Though not part of the manufacturing process themselves, distributors are essential to the Shanzhai phone industry, as they hold the direct connections to the market. Distributors buy phones directly from aggregators, reselling them to stores in regions they are connected to through friends and family. Lei, Laoliu, and Miao have all worked as distributors at different times. They sold their iPhone knockoff model to Laoliu's cousin, who distributed it in Dong Bei. 65

Another distributor I met was Majie. Friendly and humorous, Majie is in her late thirties. She travels between her hometown, and Shenzhen, Dubai, and Indonesia regularly. Maije's husband lives in her hometown with their two children, running a small electronics repair shop. With the money she makes from distributing phones, she supports her life in Shenzhen, as well as her parents, husband, and children back home. 66

I also met with Lei's distant relative, Din, who had recently returned from running a distribution network in Dubai.[17] Din works for Lei's wealthy cousin Chao, who started his own phone brand after making money from a successful Shanzhai phone. 67

Chao has been selling his branded phones to East Africa and South Asia. Even though his phones have their own brand, they are still low-end phones, existing at a much lower price point than the most recognized name brands. But cheaper prices didn't help. After having a warehouse in Dubai for two years, Chao closed it down due to slow business. He still sells phones there, but through independent distributors like Majie instead. 68

Unlike many people I met over the past year, Lei's cousin has a reputation for being exploitative and despised by his employees. But at the same time, Din and Lei admire him as a self-made man. "He has very good business foresight, and there is much to learn from him," they both say. 69

17. Like Chungking Mansions, Dubai is another hub of low-end globalization. If traders from Africa and South Asia cannot afford a flight to Hong Kong, they travel to Dubai to buy phones that they sell back home.

As early as 2007, Lei's cousin had asked Din to help him sell second-hand phones in Dubai. Din refused to go at first, but finally went in 2009, wanting "to see the world". He was initially amazed by Dubai's modernity and the locals' politeness, but soon languished in boredom. Though Din amassed a close-knit group of Chinese friends, he said they couldn't go many places since most of Dubai has a high cost of living, reserved for American and European tourists. Outside of the small areas where most Chinese live, there is only the vast desert surrounding them. Din and his friends usually remained indoors, drinking smuggled Tsingtao and Heineken.[18] 70

Communication with Dubai's locals is rare—aside from being yelled at by the police, or inspected by the largest mobile phone brands. By Din's account, Dubai's locals are quite wealthy and only buy famous name-brand phones. Those from neighboring Middle Eastern and African countries, however, bought the most basic, stripped-down models for as little as 50 RMB (8 USD). 71

None of the merchandise in Dubai's low-end mobile phone market is from the Arabian peninsula; most of it originates in the developing countries surrounding Dubai, such as Afganistan, Pakistan, India, Kenya, and Egypt. Most of the immigrant laborers in Dubai are also from Pakistan, India and Afganistan. 72

Two laborers help Din move shipments from the warehouse to nearby stores. They are paid very little—about 1000 RMB (150 USD) a month—which, according to Din, is standard practice in the region. Since neither Din nor the laborers know much English, Din said there was no pressure to try hard to communicate. Aside from numbers, "no", "ok", "how are you?", and "fine", there is little else they say to each other. 73

Based on his account, it seemed that Din hasn't experienced much of Dubai, even though he lived there for three years. But Din seems to think he's seen it all. 74

This is somewhat true: he has seen the opulent life of the wealthy, as well as some of the poorest people in the world. And he stands in the middle, unable to communicate with either but somehow bridging the modernity gap between them. At the end of our conversation, Din sighed, "I just want to go 75

18. Alcohol is illegal in the United Arab Emirates.

home to Shandong (Northeastern China) now. Though it lacks the opportunities waiting for me here in Shenzhen, or abroad, I can have a good, simple life there."

Conclusion

As I near the end of my research, Lei, Laoliu, and Miao have lost their investment in the iPhone knockoff, due to Sam's motherboards malfunctioning. The phones were returned to them by the distributors and sold to a market that collects unsold phones at two-thirds of cost. 76

Lei is planning to sell real Apple products and accessories to an "Apple Store" his friend is opening. Hoping to continue working together, the three of them are also contemplating opening a low-end business hotel for visitors to Shenzhen. 77

As Sam's motherboards continued having issues, it became increasingly difficult for him to find clients. He is trying to sell his company to a low-end Taiwanese phone brand that manufactures in Shenzhen. 78

Although there is a constant flux of people coming and going in the industry, there remain veterans who are determined to stick with phone making until their dreams of prosperity come true—or until everyone in the world has moved on to brand-name mobile phones. I asked these veterans about the one thing that has not changed in the industry since they started. One guy said, "The only thing that hasn't changed is money. It's still the reason why people get into this industry." His response was echoed by a South Asian trader I met in the Chungking Mansions. "What I like the most about the [Chinese phone makers] is that they are all about making money. It's the same as me." 79

Though phone makers may seem far from ordinary in the West, they are considered *laobaixing* (ordinary people) in China. One phone maker estimated that at Shanzhai's height, over one million people worked in the industry. Phone makers share many characteristics with other entrepreneurs I met in China, but they work with technology that most of them hadn't used until recently. Chungking Mansions' phone traders reveal the inner workings of the Shanzhai phone industry, which is just one way that China has been transformed by low-end globalization. 80

You and Your Designs

Towards a future of significance.

by **Vitorio Miliano**
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> Perhaps the central problem we face in all of [design] is how we are to get to the situation where we build on top of the work of others rather than redoing so much of it in a trivially different way.[1]

We are designers: part of a new breed of interdisciplinary folk, "part sketch artist, part programmer, with a dash of behavioral scientist thrown in", who "are some of the most sought-after employees in technology".[2] If we're web designers, our medium is pixels. If we're user experience or interaction designers, our medium is time itself.[3] Upon the strike of inspiration, we figure out how the rest of the world is to use technology, inventing systems that are innovative and intuitive.

1. R. W. Hamming, "One Man's View of Computer Science", *Journal of the Association for Computing Machinery*, 16(1):3–12, Jan 1969.
   The title of this essay also comes from Dr. Richard W. Hamming. His speech, "You and Your Research," given at Bell Labs in 1986, was a turning point for me as a professional, and portions of this essay are nothing more than a crude, design-tailored paraphrase. The quote is from his 1968 essay on the state of the field of computer science.
2. Gerry Shih, "In Silicon Valley, designers emerge as rock stars", *Reuters*. http://dsn.tc/03b-01.
3. While intended to be hyperbolic here, an unnamed designer argued for this during a Q&A at Interaction11, against keynote speaker Richard Buchanan. Maria Cordell and Dave Malouf have also presented on time as our material over the years. Katie McCurdy, "Interaction 11 recap", *Sensical*. http://dsn.tc/03b-02. Maria Cordell, "Interaction Design for the Fourth Dimension," *IxDA*. http://dsn.tc/03b-03. Dave Malouf, "Foundations of Interaction Design," *Boxes and Arrows*. http://dsn.tc/03b-04. Also related: Paul Ford, "10 Timeframes", *Contents*. http://dsn.tc/03b-05.

We are designers: captains of industry! And captains of laying out these benefits analysis forms for a healthcare services portal—but just for the time being.[4] We read that *Smashing Magazine* article on responsive web design[5] and are proud of Ethan Marcotte for coming up with it,[6] and we understand most of it. But our company is too conservative for that—IT's starting to cave on iPads, but our firewall restrictions still make day-to-day work difficult. 2

We are designers, earning hundreds of millions of dollars for our companies.[7] And while right now we're editing these royalty-free stock photos into some daily deal ads, we also skimmed and bookmarked that article on the future of shopping carts.[8] We don't have a shopping cart, but we'll know what to do if the need arises. 3

We are designers! And by "we" I mean "I," since I'm the only in-house "new media" person in the whole company, and I don't really know any others in town. But I'm sure I get so much freedom compared to those agency or product designers who always have someone telling them what to do. Somebody said design was all about constraints, right? This project is an interesting design constraint: I can pick any royalty-free stock photo I want, as long as both the boss and the client approve it. And as long as it costs only one credit. 4

We are designers, but we feel like we don't do enough design. Even if we have it pretty good, we might not be doing enough research, or we're missing out on mentoring, or we don't get to do enough original work. Perhaps we say we don't have enough time, or our company can't afford it, or our clients won't let us. 5

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4. "There are shop boys, and there are boys who just happen to work in a shop for the time being." —Yvaine from *Stardust* (DVD, directed by Matthew Vaughn, Paramount, 2007).
5. Kayla Knight, "Responsive Web Design: What It Is and How To Use It", *Smashing Magazine,* 12 Jan 2011. http://dsn.tc/03b-06.
6. Ethan Marcotte, "Responsive Web Design", *A List Apart,* 25 May 2010. http://dsn.tc/02a-10.
7. Jared M. Spool, "The $300 Million Button", *User Interface Engineering,* 14 Jan 2009. http://dsn.tc/03b-07.
8. Luke Wroblewski, "Evolving E-commerce Checkout", *LukeW,* 3 Jul 2012. http://dsn.tc/03b-08.

We are designers, and we've noticed the work we've done all year is all pretty much the same, and isn't really worth putting in our portfolios. Perhaps we've been a little slack with our professional grooming. Maybe we have a blog, but we haven't written a professional blog post in six months. We might not even have a portfolio if our work is all under NDA; what would we put in it anyway? 6

We are designers who think maybe the marketplace needs to slow down a little. We only just got all this CSS figured out; what's LESS and SASS? We don't know enough math to make these crazy 3D CSS transforms. We write off WebGL, hoping it will only be important for JavaScript programmers. Sure, we saw multitouch in the movies,[9] and then in that TED talk,[10] but we didn't really expect there to be a phone that used it a year later;[11] certainly this Kinect gesture thing is only for video games. 7

We are designers, making excuses for ourselves. 8

9. *The Island* (DVD), directed by Michael Bay, Dreamworks, 2005.
10. Jeff Han, "Jeff Han demos his breakthrough touchscreen", *TED*. http://dsn.tc/03b-09.
11. The TED talk occurred February 2006. The iPhone was announced January 2007 and released June 2007.

And we're not alone. By every measure,[12] only a quarter to a third of us freelance, meaning most designers are having these experiences *right now*. For every Ethan Marcotte and Jeff Han, there are as many or more unsung, in-house designers toiling away on unnamed enterprise applications.[13] 9

Ethan Marcotte invented an entirely new way of building web sites—and then went independent.[14] Jeff Han invented entirely new hardware technology—and fended off investment offers.[15] We are designers, but we can't *all* build the future, can we? 10

You're not alone in your unease with your professional efforts. You're not alone in what you feel is wrong with our job. And Ethan Marcotte and Jeff Han are not alone in their ability to invent the future. Let's talk about what we're missing, and then discuss how we can improve. 11

12. We talk about other sources in the next footnote, but even the stodgy US Government claims 29% of graphic designers were self-employed in 2010. Bureau of Labor Statistics, U.S. Department of Labor, "Graphic Designers", *Occupational Outlook Handbook*, 2012–2013 Edition. http://dsn.tc/03b-10.

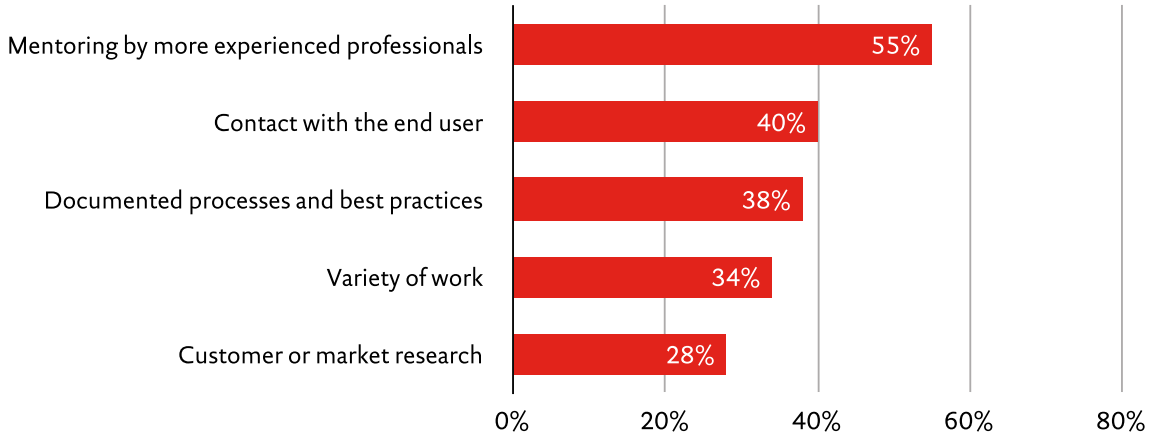
13. How many designers, precisely, is hard to say. AIGA states, "More than half of all professional designers in the United States are employed full-time by corporations and organizations", but cites no sources, and agencies and consultancies may be included in that figure. In 2010, the UK Design Council found 36% of designers worked in-house (against 36% agency and 28% freelance), but only estimated against firms with over 100 employees, suggesting an underestimation. *A List Apart*'s survey that same year found only 27.8% of designers were employees (not partners or owners) of a non-agency/consultancy. However, *ALA*'s 2011 survey found 53% of designers were employees (not partners or owners) of a non-agency/consultancy. AIGA, "AIGA's In-House Initiative", *AIGA*. http://dsn.tc/03b-11. Design Council, "UK Design Industry Overview", *Design Industry Research 2010*. http://dsn.tc/03b-12. *A List Apart*, "Findings from The Survey For People Who Make Websites 2010", calculations by the author. http://dsn.tc/03b-13. *A List Apart*, "Findings from The Survey For People Who Make Websites 2011", calculations by the author. http://dsn.tc/03b-14.

14. Ethan Marcotte, "Oversewing", *Unstoppable Robot Ninja*. http://dsn.tc/03b-15.

15. Kim Zetter, "TED: Jeff Han, A Year Later", *Wired News*. http://dsn.tc/03b-16.

What we're missing

In Austin, TX, for the past two years,[16] we've asked local designers, **"What are you missing in the professional practice in your workplace?"** In 2012, the top five responses look like this:[17]



More than half of us wish we had mentors, meaning we aren't getting the validation, oversight, and training we think we need. Two-fifths of us want more contact with our users, meaning we don't have enough confidence that our design process is appropriately user-centered. Over a third of us don't have reliable best practices or internal processes, and another third wishes we did different work.

The former third isn't able to effectively repeat their strategies or train others: they're winging it. The latter third aspires to something different, and it's not necessarily a grass-is-greener situation. Companies have business needs and hire to solve those specific problems; whether you're a screenwriter[18] or a Java programmer,[19] once you have a track record doing something in particular, it's in an employer's near-term best interest to keep you doing that. An in-house designer who executed a CMS administration interface well is going to

16. Results from the 2011 survey are available at http://dsn.tc/03b-17. Results from the 2012 survey are as-yet unpublished.
17. Designers could pick multiple options.
18. Scott Myers, "The Business of Screenwriting: They will pigeonhole you (and why this can be a good thing", *Go Into The Story* ,18 Aug 2011. http://dsn.tc/03b-18.
19. Sean Landis, "On Avoiding Being Pigeonholed", *Artima Developer,* 29 Mar 2004. http://dsn.tc/03b-19.

get to do more of them; an agency designer might find themselves the reason their company sells a lot more similar projects, too.

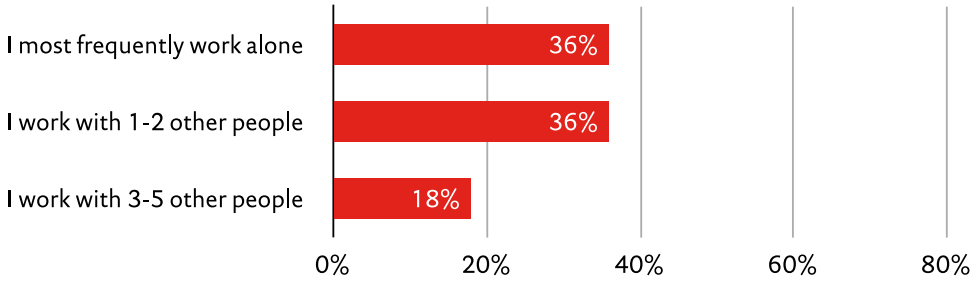
15 Over a quarter of us can't be sure we're designing the right product, because we're being asked to work without any market research. Research is the foundation of user-centered design, and even if you're practicing some other methodology, they all start out the same: "Design activity can't take place without some definition of the problem to be solved and how we might go about solving that problem. These parts of the design process are generally covered by research and analysis."[20]

16 These missing five needs are fundamental to an effective design process. We're not "magical creatives" who "succeed based on instinct, rolling the dice every time, rather than on a methodical process that can be repeated time and time again. […] People get to where they are in life by following a process… Your successful process has also led you to enough good work that people want to keep hiring you to do more work."[21] Because these figures are self-reported, they're also underreported: you have to be self-aware enough to know that you should have a mentor, or that you shouldn't be designing in a vacuum. Many designers don't even realize they're missing these things, and in our survey, nearly 6% said as much. In actuality, everyone should have a mentor, for example: junior people should be mentored by senior people, senior people should be mentored by leads and architects, and leads and architects should be mentored by business development folks and also by the junior folks who are into new technologies so they don't lose their edge. All of these are basic process requirements, and a quarter to half of us are being told, in some manner, shape or form, that our process needs to get stuffed.

20. Jon Whipple, "What Designers Know", *Distance* 01:10–11. Recently available online at http://dsn.tc/03b-20.

21. Mike Monteiro, *Design Is a Job* (epub), A Book Apart, 2012, chapters 1 and 6.

Our survey also asked, **"How many designers do you collaborate with regularly?"** 17



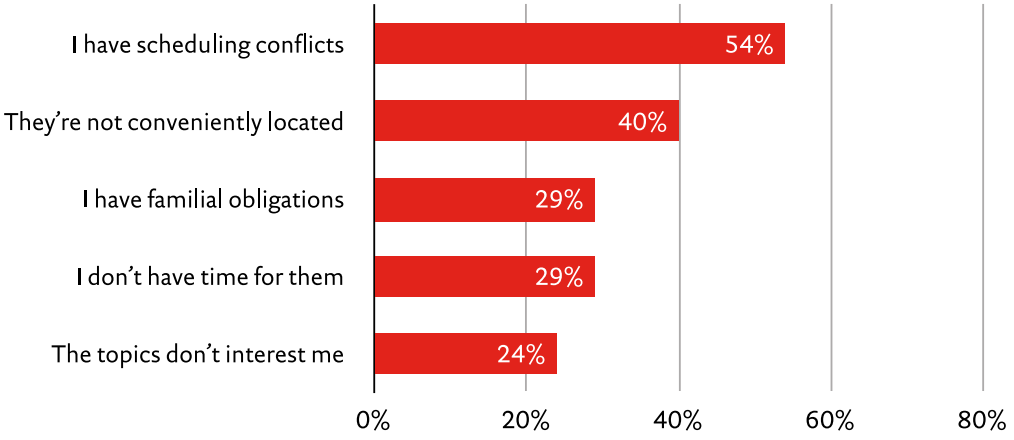
It appears that we usually work alone. A full third of us get no regular interaction with other designers, and another third only interact with one or two people. Working in isolation makes it nearly impossible to bounce ideas off of each other, and working with only one or two people breeds a routine that results in creative ruts. The best work—whether brainstorming or production—comes out of a diversity of personal experience,[22] a diversity of interpersonal interaction,[23, 24] with the oversight of a mentor,[25] and with everyone physically nearby.[26]

Some of us try to fill in these gaps online, but it's hard to explain a UX problem and its context in 140 characters. From the *A List Apart* surveys,[27] we know around 75% of designers have a blog or personal site—but not how often they write about design, nor how often they write about shipped work versus 18

22. Gary Wolf, "Steve Jobs: The Next Insanely Great Thing", *Wired* 4(2), Feb 1996. http://dsn.tc/03b-21.
23. Brian Uzzi and Jarrett Spiro, "Collaboration and Creativity: The Small World Problem", *American Journal of Sociology* 111(2):447–504, Sep 2005. http://dsn.tc/03b-22.
24. Martin Ruef, "Strong Ties, Weak Ties and Islands: Structural and Cultural Predictors of Organizational Innovation", *Industrial and Corporate Change* 11(3):427–449, Jun 2002. http://dsn.tc/03b-23.
25. Bob Sutton, "Why The New Yorker's Claim That Brainstorming Doesn't Work Is An Overstatement And Possibly Wrong", *Work Matters*, 26 Jan 2012. http://dsn.tc/03b-24.
26. Isaac S. Kohane, et al, "Does Collocation Inform the Impact of Collaboration?" *PLoS ONE* 5(12): e14279. http://dsn.tc/03b-25.
27. In 2011, 74.6% of designers had a personal blog or web site. In 2010, 76.5% did. *A List Apart*, "Findings from The Survey For People Who Make Websites 2010", calculations by the author. http://dsn.tc/03b-13. *A List Apart*, "Findings from The Survey For People Who Make Websites 2011", calculations by the author.

casual experiments. We know that when friends get new jobs, significant others,[28] or children, their free time decreases and their writing is often an early casualty.

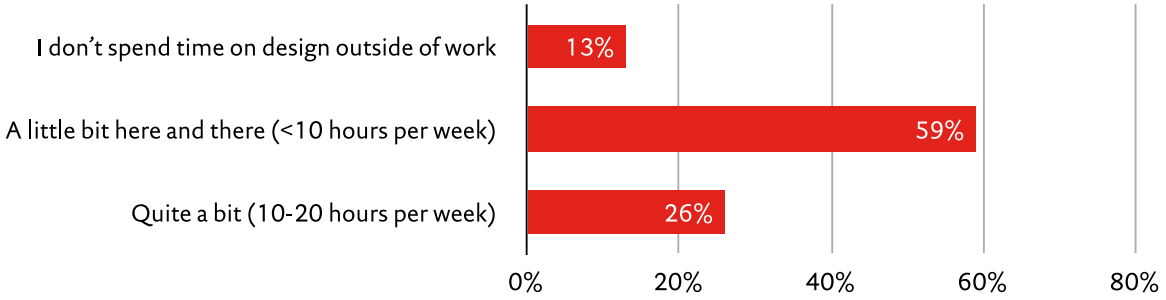
ALA doesn't ask about ongoing writing for blogs, and we didn't ask for that data in our survey, but if we consider blogging to be an extracurricular activity like attending a local design meetup, we can infer those effects from the top five responses to a similar question: **"Maybe you've missed out on local community events. Why is that?"** 19



Over half reported scheduling conflicts: whether from meetups scheduled at the same time or more important or better things to do, we're busy, and we get busier the longer we're in the industry. Two-fifths claim geographic inconvenience: for many, extending the workday an hour or two for a professional meeting nearby isn't unreasonable, but if it's in the opposite direction from home in rush hour traffic, it's a lost cause. Professional support activities, like any application we design, are more usable if they fit into the patterns of things we already know and do. The excuse of being busy surfaces again, as just under a third report family time or no time at all as factors. Finally, a quarter of us report that the topics aren't interesting. If we can't talk (or blog) about work because we're under NDA, and if everyone else is, too, what is there to talk about? Finding professional support in that environment may seem hopeless. 20

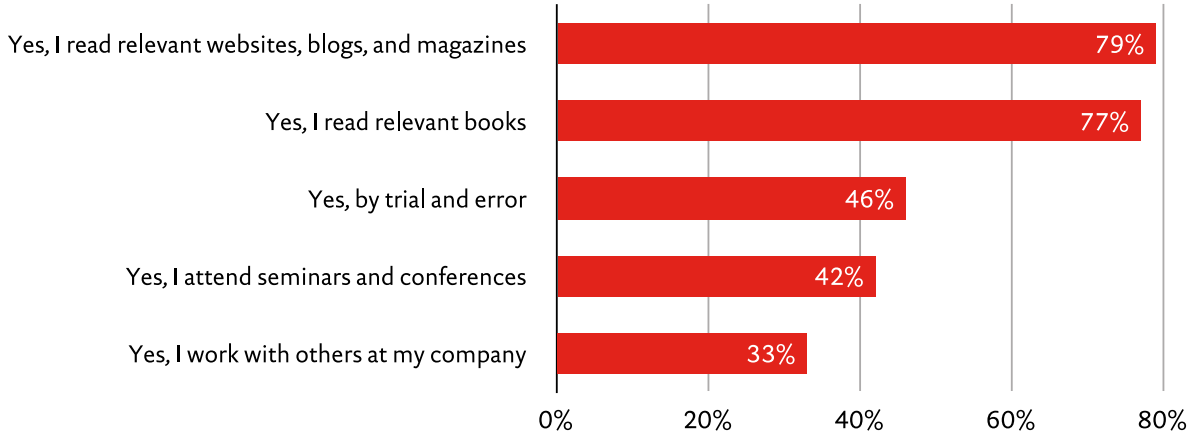
28. Irene S. Levine, "The Friendship Doctor: The Price of Falling in Love: Losing Two Close Friends?", *Psychology Today*, 16 Sep 2010. http://dsn.tc/03b-26.

If we're not getting the professional support we need from our day jobs, we should be making it up outside of work if we expect to improve as designers. Do we? We asked, **"How much time do you spend on design outside of your workday?"** 21



Nearly two-thirds of us spend under ten hours a week on design outside the office, and over ten percent of us spend no time at all. This isn't, by itself, damning. If that time was spent with mentors, or on deliberate or slow practice of design techniques, or on rigorous study of best practices, it could be enough for us to grow.

To find out if we spend our time as best as possible, we also asked, **"Do you study design?"**[29] 22



Investing more time is the number one driver for expert performance, but our top two preferences are overwhelmingly in favor of passive learning. The trouble here is twofold: under ten hours a week doesn't give us enough time to learn new things, and passive learning doesn't give us experience. We don't

29. Apparently, even though two-thirds of us work with at least one other designer, only one-third of us will actually talk with them.

spend enough time doing the right kind of practice to make the difference between understanding a problem and solving it quickly, and only being able to solve it if someone's already written a blog post about it. Knowing CSS's ideal rendering won't teach you about cross-browser subtleties; likewise, being able to dig up an answer through search engines and Stack Overflow isn't the same as comprehending the underlying fundamentals. Nearly half of us report that we also learn by "trial and error", but it's not clear if that means "copy and pasting examples until it kinda does what I want" or "rigorous testing and experimentation to thoroughly understand the material".

These specific examples call out things that we're all bad at to some degree. 23
Whether you're managing a team without a process, or you're a recent graduate who doesn't participate in your local community, a substantial portion of the designer population is just like you. Almost nobody is building the future, because almost nobody has the grounding for it, nor takes the time for it.

But you can take steps to remedy this. All of these examples are rooted in 24
two core issues: *not enough sharing with other designers*, whether in the form of a mentoring relationship or a critiquing process; and *not spending enough time on professional development*, whether following a good process or making the effort to dig into a design subject. These examples call out what holds us back as designers. These are the practices that keep us editing royalty-free stock photos into daily deal ads instead of researching and inventing new interactions for new technologies. We don't need Ethan Marcotte or Jeff Han to tell us how the future should work. We can find it for ourselves, and tell *them* about it the next time around.

What we're finding

We cited responsive web design earlier as a new way of thinking about web 25
design—launched just a couple of months after the iPad. While timely, Ethan Marcotte had been laying the groundwork for responsive web design for at least a year, with articles on fluid grids[30] and fluid images[31] and a book on

30. Ethan Marcotte, "Fluid Grids", *A List Apart,* 3 Mar 2009. http://dsn.tc/03b-27.
31. Ethan Marcotte, "Fluid Images", *Unstoppable Robot Ninja,* 17 Apr 2009. http://dsn.tc/03b-28.

"handcrafted" CSS.[32] But you can't handcraft something without deeply understanding its nuances. The invention of responsive web design is a great example of how "putting in the time" can lead to something bigger. Marcotte shared his work, dove deep into the subject, and was well-poised to make the proposal after the iPad's launch. How you work makes the difference between just working and working significantly.

Scientists and artists have shared quips like "chance favors the prepared mind"[33] for hundreds of years, and research now backs them up. Innovation, creativity, and expert performance do not spring from innate talents. Studies on innovation boil it down to markets, business values, and customer needs, but creativity is more a matter of meaningfully recombining elements from one's experience. Likewise, expert creative performance is not a factor of innate ability, but one's practice regimen. We can study markets to find undiscovered, disruptive innovations. We can share our work early and often. We'll do better work if we practice our craft, try different methods, and learn the precise details of how our work is realized. This provides us with the foundation to make better work. 26

But the best work on enterprise software won't help us invent the future. We have to work on important problems—even if we're not able to work on them all the time. By the numbers, most designers find their work "exciting",[34] but being challenged by unusual constraints, or building for a brand name, are not the same as working on important problems. And to my 27

32. Dan Cederholm and Ethan Marcotte, *Handcrafted CSS: More Bulletproof Web Design,* New Riders Press, 2009.

33. Louis Pasteur, "Discours prononcé à Douai, le 7 décembre 1854, à l'occasion de l'installation solennelle de la Faculté des lettres de Douai et de la Faculté des sciences de Lille" (Speech delivered at Douai on 7 Dec 1854 on the occasion of his formal inauguration to the Faculty of Letters of Douai and the Faculty of Sciences of Lille), reprinted in: Pasteur Vallery-Radot, ed., Oeuvres de Pasteur, Masson and Co., 1939, vol. 7, p. 131. Translated from the original French by the author, also available at http://dsn.tc/03b-53.

34. The question was, "Do you still find your work exciting?" In 2011, 83% of designers answered "A lot" or "Some". In 2010, 74.2% of designers answered "Yes - very frequently" or "Yes - frequently". *A List Apart,* "Findings from The Survey For People Who Make Websites 2010", calculations by the author. http://dsn.tc/03b-13. *A List Apart,* "Findings from The Survey For People Who Make Websites 2011", calculations by the author. http://dsn.tc/03b-14.

knowledge, nobody has surveyed designers to see if they are excited because they're working on anything with long-term importance.

Ask yourself, "What are the most important design problems today?" and "Which of these problems am I working on?" Learn enough to find the answers, and then put yourself in a position to answer them—if not through your day job, then in your off hours. 28

Five important problems

What makes a problem important? It's not the end result: responsive web design provides a new way to build sites, but it's not the only way. Rather, importance is a factor of *solvability*: important problems are answerable, if only you could connect the right dots. Important problems advance understanding. Marcotte figured out how to unify design rhetoric across many devices, but he probably didn't know he was going to get there when he started in 2009: the iPad didn't exist yet, and neither his articles nor his book mention "iPhone" or "mobile" or even just "phone" in a relevant context.[35] 29

You can't know exactly what field to work in, but you can stay active in places where something *might* happen. Maybe these places are where the work is diligent rather than sexy—like documenting the history of interaction design, saving rare hardware, or preserving old books. Maybe they are social and cultural, like educating designers on the value of professional practices, designing supportive professional societies, and building tools for study. Or maybe the future will be built on defining best practices for future tools and their interactions. Wherever *you* see important problems, you'll do great work by sharing your explorations with others. 30

Responsive web design

As a response to the onslaught of new screen resolutions and dimensions, "responsive web design" has gained an enormous amount of attention in a very short amount of time. Attendees of An Event Apart 2012 felt it 31

35. Based on Amazon "Search Inside This Book" results for those terms in *Handcrafted CSS,* and inline search of the *A List Apart* and *Unstoppable Robot Ninja* articles.

was heavily dedicated to it.[36] Major newspaper sites, never ones to take technological leaps, have redesigned with responsive layouts.[37] But designers and clients have struggled to find a workable responsive design process. Responsive web design is an important problem, not because it's the be-all, end-all technical solution to the multi-device, multi-screen problem (it isn't and shouldn't be), but because it exposes content and content management as a first-order design constraint. The tools, processes and practices to support content management for a responsive web design—and for whatever will replace it—are where designers now need to focus their attention.

32 Traditional web design processes evolved from two-dimensional print layout. Sketches and wireframes assume fixed proportions. While a site's information architecture makes no such assumptions, a visual layout must take up a certain amount of space by definition. Drawings must necessarily show a fixed moment in time; they cannot demonstrate the breakpoints of a responsive design. A designer could produce storyboards or motion graphics; a designer with development skills could build an interactive prototype. Popular wireframing tool Balsamiq recently wrote about experimental ways to use their software to prototype responsive designs: repeat the work three times.[38] As their software is a drawing tool, it can't support illustrating transitions, meaning that subtle changes between display sizes or resolutions must be conveyed differently. Rather than illustrate every possible state in every way possible, they suggest producing high-level templates.

33 Responsive designs pose challenges for content strategists as well, as they require different content approaches for each breakpoint. Shorter headlines, summarized copy, and different hierarchies pose new challenges. Speaker and designer Karen McGrane illustrated the problems[39] when a print-centric design mindset collides with a new technology, contrasting Condé Nast's re-

36. One example of many: Erick Beck, "An Event Apart Recap", *Texas A&M Webmaster's Blog*, 13 Jul 2012. http://dsn.tc/03b-29.
37. Jeffrey Zeldman, "Boston Globe's Responsive Redesign. Discuss." *The Daily Report*, 15 Sep 2011. http://dsn.tc/03b-30.
38. Balsamiq, "Responsive Design with Mockups", *Balsamiq*. http://dsn.tc/03b-31.
39. Karen McGrane, "Adapting Ourselves to Adaptive Content (video, slides, and transcript, oh my!)", *Karen McGrane*, 4 Sep 2012. http://dsn.tc/03b-32.

peated failures of their iPad apps[40] to the comparative success NPR has seen with their "COPE" approach, which slices content in the CMS to fit multiple formats ahead of time.[41] In McGrane's presentation, "Adapting Ourselves to Adaptive Content," she holds up the venerable TV Guide as one of the most foresighted of media organizations, for each episode description was written three times—short, medium, and long—and they licensed their database to cable and satellite companies, enabling TV Guide listings to be embedded as a person channel surfed. TV Guide-the-magazine became unprofitable, but the database—three formats for every show ever, forever—became successful. NPR redesigned their process from scratch to succeed, putting them ahead of Condé Nast. With responsive design and flexible content, designers need to work deeply with information architects, content strategists, copywriters and engineers to design novel approaches which pay off.

A/B testing

A/B testing was invented by marketer Richard Stanton in the 1930s as **split-run testing,**[42] where a newspaper or magazine would split its press run to print two different versions of an ad, allowing response rates to be tested within a single demographic pool. This sort of test marketing and copy research was pioneered by Claude Hopkins,[43] the first to describe practices around vetting ads and products in small markets before a mass launch, and to iteratively try different headlines, formats, pitches, copy and targeting, in his 1923 book *Scientific Advertising.*[44] So influential was this work that advertising magnate David Ogilvy introduced a new edition, saying:

40. Nitasha Tiku, "Conde Nast Is Experiencing Technical Difficulties", *New York Observer,* 19 Jul 2011. http://dsn.tc/03b-33.
41. Daniel Jacobson, "COPE: Create Once, Publish Everywhere", *ProgrammableWeb,* 13 Oct 2009. http://dsn.tc/03b-34.
42. David Ogilvy, *Ogilvy on Advertising,* Random House, 1985, p.160. Ogilvy doesn't cite sources, but Richard (Dick) Stanton and "split-run" references can be found in advertising trade magazines dating back to at least 1939.
43. *Ibid.,* pp. 202-204.
44. Claude Hopkins, *Scientific Advertising, 2003 Illustrated PDF by Carl Galletti,* Lord & Thomas, 1923. http://dsn.tc/03b-35. The original edition of this book is now in the public domain.

> Nobody, at any level, should be allowed to have anything to do with advertising until he has read this book seven times.[45]

Today, most A/B testing of web and interactive content still works like a 1930s split-run test: two different designs, pieces of content, or calls to action are produced. Half of your visitors see one, half see the other, and the most successful version wins. Designers often see A/B testing as useful only for settling minor design disputes; marketers use it to optimize copy; non-design savvy organizations use it to make decisions, such as when Google tested 41 shades of blue.[46] 35

For decades, A/B testing has been used to find the most compelling and actionable solution, but few designers pursue it like the best advertising firms do. It's an important problem, not because it's new, but because intentionally and purposefully trying different things goes against how many of us were raised as designers. Steve Jobs quotes Paul Rand as bristling over the idea of trying different things for the NeXT logo design: 36

> I asked him if he would come up with a few options. And he said, "No, I will solve your problem for you, and you will pay me. And you don't have to use the solution—if you want options, go talk to other people. But I'll solve your problem for you the best way I know how, and you use it or not, that's up to you—you're the client—but you pay me."[47]

Our future hinges on our confidence to design entirely toward a goal,[48] including dramatic changes, not only small iterations or aping trends. Marketer Lance Jones calls this out:

> Tweaking an existing design based on 'best practices' or recently-blogged-about split test results may result in a better design, but it won't likely come close to the best design. ...you need to be open to designing bigger, bolder

45. Claude Hopkins, *Scientific Advertising, with an introduction by David Ogilvy,* Crown Publishers, 1966, p.7
46. Douglas Bowman, "Goodbye, Google", *stopdesign,* 20 Mar 2009. http://dsn.tc/03b-36.
47. Steve Jobs, "1993 interview re: Paul Rand and Steve Jobs", *YouTube*. http://dsn.tc/03b-37.
48. Rudy and Jason Fried, comments on "Behind the Scenes: A/B Testing Part 2: How We Test", *Signal vs. Noise,* 2 Aug 2011. http://dsn.tc/03b-38.

> experiments—such as long copy vs. short copy, image heavy vs. text heavy, sales tone vs. academic tone, or process value focus vs. product value focus—before you conduct iterative tests on an existing design.[49]

37 It's an important problem because distrust of A/B testing is widespread. For example, Jamie Dihiansan of 37signals wrote:

> Maybe we don't want to be second-guessed. Maybe we don't want to cater to the lowest common denominator. Designers are taught—explicitly and implicitly—to follow certain visual rules and the final design will work great. The whole A/B testing concept probably came from from "strategy analysts" or "MBAsses".[50]

Jamie Dihiansan had come from Crate and Barrel, a store that puts every corporate team member on a retail store's sales floor for two weeks.[51] Retail stores are experts in the subtle marketing pushes that drive us to buy one thing over another. From the distance between aisles to the specific cents on a price, nothing is arbitrarily determined. Dihiansan continues: "most designers out there design something to sell something else … the best way to communicate something better is to understand what customers need or what they're looking for."[52] What better way to understand than to try different approaches and see what works? That's what all the sales people around him would have been doing.

38 Three years after Dihiansan joined, 37signals decided to A/B test radically different designs for their marketing sites, starting with a long-form, "sales letter-style" approach, a direct marketing standby that many designers criticize as scammy. 37signals' sign-up rate increased by 37.5%.[53]

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49. Lance Jones, "Move Beyond 2% By Avoiding These 5 Testing Obstacles", *Topping Two Percent*. http://dsn.tc/03b-39.
50. Jamie Dihiansan, "Behind the Scenes: A/B Testing Part 3: Finale", *Signal vs. Noise*, 23 Aug 2011. http://dsn.tc/03b-40.
51. Jamie Dihiansan, "On the Front Lines, In the Trenches", *Signal vs. Noise*, 25 Feb 2011. http://dsn.tc/03b-41.
52. *Ibid.*
53. Jamie Dihiansan, "Behind the Scenes: Highrise Marketing Site A/B Testing Part 1", *Signal vs. Noise*, 21 Jul 2011. http://dsn.tc/03b-42.

Another radically different design was tried, and provided a 47% increase in paid sign-ups over the long-form sales letter. This made for a 102.5% improvement over the original site.[54] 37signals doubled their sign-ups, and all they had to do was admit they were eighty-eight years behind the times on marketing. Only by setting aside our classical notions of what it means to design, will we be able to design selflessly,[55] fully in the service of our goals. 39

The Internet of Things

During his seven years with Apple, Tony Fadell led the design and development of the iPod. After leaving in 2008, he launched the Nest:[56] a networked home thermostat that learns your HVAC system's performance and your temperature preferences, adjusting your home's climate accordingly. The Nest is part of a new category of devices in **the Internet of Things**, where common objects gain three additional properties: they know their internal or external state through sensors, they are uniquely addressable, and they are networked to each other. The Nest knows your HVAC system's state and your house's temperature, multiple Nests in a single home work together but can be checked independently, and they all connect over wifi. Through the Nest, your HVAC system is effectively connected to the internet. 40

Internet of Things devices can be classed by their connection type: *smart* or *dumb*. Like the terminals of fifty-year-old mainframe computers, dumb IoT devices require an outside agent to read their sensor data; they can't ping the outside world on their own. For example, a dumb front door couldn't tell you that someone's knocking right now: it can only tell you how many knocks there have been since the last time you checked. Or, a dumb dress shirt could only tell you someone has spilled something on it when you ask. 41

54. Jamie Dihiansan, "Behind the scenes: A/B testing Part 3: Finale".

55. "An artist should create beautiful things, but should put nothing of his own life into them. We live in an age when men treat art as if it were meant to be a form of autobiography. We have lost the abstract sense of beauty." —Basil Hallward from Oscar Wilde, *The Picture of Dorian Gray*, Ward, Lock and Company, 1891.

56. http://www.nest.com.

A smart IoT device, on the other hand, can make connections on its own 42
in response to user or sensor input. For example, the Nest can phone home to check for upgrades, and long-term data usage is reported back to Nest's "Energy History" service. A smart front door could tell you someone is knocking right now; equipped with a camera, it could send you their picture. A smart washing machine could ask a dumb dress shirt how dirty it is, look up each garment manufacturer's recommended washing instructions, tell you how long the wash cycle will take, and text you when it's done.

While this may sound like an old vision of the internet, you can buy the 43
Nest at your hardware store today. Companies, like ex-iPhone engineer Hugo Fiennes' Electric Imp,[57] are building hardware and software platforms to pass data between devices. Other firms are focused on smart or dumb sensors—or, like Toys for Bob,[58] dumb toys that collect data as you progress in a video game. That game, *Skylanders: Spyro's Adventure*, mixes the collectable nature of miniature toy figures with the Internet of Things into a 3D video game. You place a toy on the game console and play as that character. Game progress is saved in the toy itself, making it a dumb sensor that's read by a smart one.

Whether they have smart or dumb network connections, the constants 44
are that you can talk to each object individually (the "uniquely addressable" part), and they know their state (through sensors). Everything else you read about or experiment with the Internet of Things is emergent from these three properties.

By having a sense of their own state, and being able to communicate it, 45
electronic devices can become self-evident. The Nest turns HVAC from an opaque system of furnaces and condensers and ductwork into something that can describe what it is doing. The Skylanders toys aren't pointers to past gameplay; they are their own histories. This is why the Internet of Things is an important problem in design: it means we can do away with metaphors

57. http://electricimp.com.
58. http://www.toysforbob.com.

and have physical objects that contain their own meaning.[59] The Internet of Things is still mostly dominated by electrical and mechanical engineers, and software for their data collection services tend to resemble a spreadsheet, rather than an iPhone app. The focus is on the technology and not on the use cases. We don't yet know all the ways we can remake our tools and appliances given these new properties. And, we still lack a tested, trusted framework for conceptualizing the possibilities for interaction in a world where our household appliances can talk with each other, and with us.

Big data and Computational X[60]

Toys and thermostats aren't the only places for advanced software and big 46
data. Recently, the most famous example of the co-mingling of data and design is the iOS app Dark Sky,[61] which does what most meteorologists never could: it accurately predicts the weather. It constrains itself by predicting only the next hour, answering the question: *will I need an umbrella between now and when I get to my destination?* Dark Sky downloads and processes weather data from NOAA, and renders a next-60-minutes radar map *directly on your phone*. There's no cloud computing or subscription software involved. The math and graphics are so strenuous, only the latest two generations of iOS are supported. As a designer, how does one build a weather app that can predict the future without knowing all of the details?

"Inventing is weird because you have to create for a world which doesn't 47
exist yet," speaks Matt Webb in 2010 to Mobile Monday Amsterdam.[62] He's trying to predict the future in this talk, a Dark Sky for an entire industry. He elaborates on some of the technologies I've named here, and points out: "all of these are just technologies... [they] don't give us any clues for how to design for them, how to design these future media and services, and how we

59. Durrell Bishop argues persuasively for self-evidence in his interview, "Things Should Be Themselves!" Bill Moggridge, *Designing Interactions,* MIT Press, 2007, pp.541–548. Video online at http://dsn.tc/03b-43.
60. Kevin Kelly, "Computational X", *The Technium,* 7 Mar 2011. http://dsn.tc/03b-44.
61. http://darkskyapp.com.
62. Matt Webb, "What comes after mobile", *YouTube*. http://dsn.tc/03b-45.

as humans relate to these things."[63] Webb goes on to provide four clues he's found. The second he listed was *hard math for trivial things*—like Dark Sky, or his favorite example, Sudoku Grab.[64] Sudoku Grab is an iPhone app that uses your camera to recognize a sudoku game on paper, and then it uses neural networks to recognize the printed numbers and overlays the puzzle's answer on your phone's screen. Sudoku Grab is a puzzle solver where all you have to do is point your phone's camera at the puzzle. It's perhaps the simplest, easiest, most efficient interface for a puzzle solver possible—no UI at all, just look — but how can you design that if you don't understand three different kinds of math?

Webb continues, describing a BBC recommendation site that scrapes a hundred million blogs and all of Twitter: 48

> It builds an internal predictive model of how much discussion that programme is going to get, it learns over time, and then it tells you, at the top, which one is getting the most discussion and says you should watch that. We employed a guy who writes fraud prevention algorithms for VISA. What?! This statistical technique was only invented fifteen years ago, it was only possible to make run on a server [instead of a mainframe] five years ago, and now we're running it four times a day? I don't know what's going on in this world, but the fact that we can point the global computing capacity of fifteen years ago at really trivial problems is an interesting clue.[65]

Big data and computational X are important problems for design because they represent the event horizon for designer-as-polymath. Right now, a designer building a basic iPhone application can do it all themselves: design, graphics, programming (albeit slower than having expert coworkers). But, what designer has enough of a background in physics, in neural networks, in computer vision, in GPU programming and in machine learning[66] to build Dark Sky single-handedly? As a profession, as an industry, as a community, 49

63. *Ibid.*
64. Sudoku Grab. http://dsn.tc/03b-46.
65. Matt Webb, "What comes after mobile", *YouTube*. http://dsn.tc/03b-45.
66. Adam Grossman, "How Dark Sky Works", *Dark Sky Journal*. http://dsn.tc/03b-47.

we will never advance beyond the time and ability of a single person unless we stop trying to do everything ourselves and instead share, not just with other designers, but with other professions.

Immersive I/O and natural user interfaces

Frequently, science fiction films are consumers' first look at the future, but the "future's" interfaces are designed by motion graphics artists to look good on the big screen. We saw gestural interfaces in 2002 with *Minority Report*; four years later, we had the Nintendo Wii. The Kinect is now available for PCs, and the Leap motion controller is launching next year.[67] Leap made a splash with its initial advertisement video,[68] demonstrating greater precision than the Kinect in a smaller package, for a lower price. We saw multi-touch in 2005 with *The Island*; a year later, we had Jeff Han's presentation at TED,[69] and a year after that, Apple launched the first iPhone. 50

Immersive, 3D, virtual reality headsets have represented the future for over 20 years. Consumers have seen them in movies from *The Lawnmower Man* and *Hackers* to *Disclosure* and *Runaway Bride*. The new Oculus Rift headset[70] is the first consumer-targeted VR headset in years, and it has the interest and support of every major video game studio. These studios see it as not just a possible future for video games but, from a design and development perspective, a necessary predecessor to augmented reality systems like Google Glass.[71] The Rift, like the Leap, is already shipping hardware to select parties, but those parties are software developers, not designers. New technologies are often first developed by engineers and researchers, with no designers to study users or analyze market fit. 51

The Wii, Kinect, iPhone, and iPad have all been successful, but many of us haven't designed multi-touch UIs or worked with gesture controls, despite their mass market availability for the past five years. Immersive input/ 52

67. https://leapmotion.com.
68. Leap Motion, "Introducing the Leap", *YouTube*. http://dsn.tc/03b-48.
69. Jeff Han, "Jeff Han demos his breakthrough touchscreen", *TED*. http://dsn.tc/03b-09.
70. http://oculusvr.com.
71. Michael Abrash, "Two Possible Paths into the Future of Wearable Computing: Part 1 – VR", *Ramblings in Valve Time,* 7 Sep 2012. http://dsn.tc/03b-49.

output devices and natural user interfaces are important problems in design because they remove our "sensory deprived and physically limited"[72] constraints on interactions with technology. Current visual displays give us a 2D viewport into our digital world at various sizes and resolutions; the Rift offers a 3D space, encompassing our entire field of vision, our view shifting as we move and turn our heads. Keyboards and mice only support an indirect manipulation of intangible representations;[73] the Leap allows for direct manipulation with mimetic gestures, rather than symbolic actions,[74] and the Kinect supports the same for our entire body. Anthropometrics, ergonomics and physiology can no longer be the exclusive realm of industrial designers; to build interactions involving the subtle interplay between a flick of the finger and a nod of the head in a 3D space, interaction designers must understand them, too.

Left as an exercise for the reader

Early drafts of this essay provided explicit recommendations on ways to share work, to be more professional, on prototyping techniques, and how to play with new technologies, but the specifics of these activities don't really matter. All that matters is that you start—and keep doing it. You'll have to fight new battles with yourself, your company, and your coworkers about sharing, professionalism, and what constitute important design problems. Those efforts will be hard enough without worrying about "doing it right." Instead, just start, and you can improve your habits once they actually become habits.[75] 53

These problems touch baby sciences and new moons,[76] and there's a lot of territory over which to get discouraged. You may not be able to understand the problem space until you actively seek out peers in other disciplines. Collaboration will be vitally important; you'll never advance the art if you try 54

72. Nicholas Negroponte quoted by Bill Moggridge, *Designing Interactions*, MIT Press, 2007, p.515.
73. Hiroshi Ishii interviewed by Bill Moggridge, *Designing Interactions*, pp.526–527
74. Stu Card interviewed by Bill Moggridge, *Designing Interactions*, p.637
75. Mark Pilgrim, "Six", *Dive Into Mark*, 9 Oct 2002. http://dsn.tc/03b-50.
76. Matt Webb, *Interconnected*, 17 Mar 2011. http://dsn.tc/03b-51.

to learn everything from scratch. You'll need to find people who understand the internal politics of publishing, or the psychology of consumers, or Arduinos, or algorithms—and who know that things can be better, that more can be done than is currently being done. Otherwise, that's a lot of learning, and you're not going to be able to do it all yourself. We can't improve as a design community, as an industry, if we all start from the same place. We have to trust each other and build upon each others' work. Make friends and play together.[77]

77. On design professionalism, Andy Rutledge's essay of the same name is a strong, opinionated read—as is his follow-up, his code of professional conduct for 2012, which you can read at http://dsn.tc/03b-52. Mike Monteiro's book *Design is a Job* hits many of the same points and some different ones, but in a different manner and from a different perspective. Both are worth your time.

    For the calculations of *A List Apart* survey results, "designers" were considered those who responded either "Web Designer", "Designer", "Interface Designer, UI Designer", or "Information Architect" to the question, "Which of the following most closely matches your job title?" in each year's survey. In 2011, that was 2,977 of 15,707 respondents (18.95%). In 2010, that was 4,637 of 16,904 respondents (27.43%).

    Bill Moggridge's *Designing Interactions* and Bill Buxton's *Sketching User Experiences* go into detail about the sketching exercises, prototyping techniques and user testing activities used from the invention of the GUI through the invention of near-future devices in university labs. The mouse was tested and invented the same way you'd design and test something now. Just start.

Embracing Material Complexity

Building blocks of the future.

by **Matt Johnson**
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> The simple index file of objects upon which modern engineering has constructed its knowledge must now be replaced by more mobile references... technical thought must be capable when necessary of abandoning the strict world of Mars for the fluid world of Venus.[1]

In early August 2012, NASA's Curiosity rover touched down on Mars with a complex descent sequence involving parachutes and sky cranes. Without the sophisticated alloys in the rover's frame, or the high-tech composites shielding it from solar radiation, Curiosity would never have made it to Mars or survived on its surface. 1

Curiosity is the product of contemporary materials science—as are the high-tech materials that dominate the places we live and work in. Though materials science has a long record of innovation, a new path has given us unexpected, valuable results. 2

This essay explores a group of designers who are taking full advantage of contemporary technology while paying attention to materials' tangible aspects. The combination of design thinking, easy access to technical information, and revision through tangible interaction have brought these material concepts to life. 3

In these projects, innovation is emphasized over refinement, material variations are embraced as opportunities, and the internet's wealth of information helps refine ideas. But in order to understand the true significance of this approach, we need to place it in a historical context. 4

1. Ezio Manzini, "The Material of Invention", *Arti Grafiche Varesine,* 1989, p.59.

Embracing Complex Material Behavior

The construction of any object requires an understanding of its material properties. From the Romans' study of arches[2] to Leonardo da Vinci's analysis of steel wire,[3] history is marked with strategies to predict a material's behavior. But it was the developments around the Industrial Revolution that successfully abstracted the craftsman's insights into a set of comprehensive material theories that could aid in industrial manufacture.[4] 5

Materials scientists predict a material's behavior by rigorously investigating it on an atomic scale. They try to eliminate inconsistencies in material samples, so they perform consistently and reliably. This suited the rapid increase in the volume and sophistication of industrial manufacturing, as described by philosopher Manuel de Landa, in *Uniformity and Variability:*[5] 6

> While naturally occurring metals contain all kinds of impurities that change their mechanical behavior in different ways, steel and other industrial metals have undergone in the last two hundred years an intense process of uniformation and homogenization in both their chemical composition and their physical structure…this process was partly based on questions of reliability and quality control, but…both human workers and the materials they used needed to be disciplined and their behavior made predictable. Only then the full efficiencies and economies of scale of mass production techniques could be realized.

This point is reinforced by design strategist Ezio Manzini, who sees this homogeneity as a phase of **controlled complexity**, where we are constantly fine-tuning materials in response to industrial needs:[6] 7

2. Stephen P. Timoshenko, *History of Strength of Materials,* General Publishing Company, 1983, p. 1.
3. *Ibid.,* p. 3.
4. Ezio Manzini, "The Material of Invention", p. 30.
5. Manuel de Landa, *Uniformity and Variability,* p.4. Also available at http://dsn.tc/03c-01.
6. Ezio Manzini, "The Material of Invention", p. 30.

> After science became a factor in production around 1850, the use of in-depth methods of analysis and the developing familiarity […] with the chemical and physical behavior of matter led to the phase of 'controlled' complexity, that is to say the progressive fine tuning of processes capable of producing the homogeneous and isotropic materials endowed with definite and constant properties needed by industry.

Manzini's language is especially important, as it implies our attempts to control complexity, rather than profit from it. This refinement has been crucial in the development of the infrastructure of our contemporary world and is the basis upon which contemporary engineering (and its products) are built—but according to Cyril Smith, there is a "not insignificant loss"[7] in depending on abstracted models alone. At some point, the exact sciences lose the ability to easily quantify and test results, and instinct and empirical observation gain importance.

8 We need a combination of these approaches. The exact sciences are interested in reliable, quantitatively predictive models about material behavior, but designers are more interested in the qualitative and tangible aspects of a material's performance. Manzini claims that we're entering a phase of material development that could be known as **managed complexity**, saying that "impurities can be sought and produced intentionally, with an eye to specific results."[8]

9 Designers are particularly suited to managing such complexities and impurities. For us, predictive models of material behavior are secondary; the ultimate goal is to exploit a material's qualitative potential, and discover the implications of its use. Material inconsistency isn't a fault; rather, it's an opportunity to gain insight. Manzini goes on to describe the designer's role in finding new ideas:

7. Cyril Stanley Smith, *Matter Versus Materials: A Historical View In a Search For Structure,* MIT Press, 1992, p.120
8. Ezio Manzini, "The Material of Invention", p. 30.

> The role of the designer is precisely that of picking up new possibilities. The wave of potential innovations produced by the development of technology and science has prepared the terrain for a new era of inventions...The quality of the final results largely depends on the ability of the designers to overcome the cultural inertia that can prevent them from "seeing" the new, and on their ability to direct design processes that can accommodate the new.[9]

Given that designers seem well-suited to skillfully managing complex behavior, where could they innovate? The sophistication of contemporary materials science might appear to be a high learning curve for non-scientists, but designers' comfort in qualitative revision gives them an advantage in a class of materials where tangibility and unexpected behavior are paramount.

Hybrid Materials

Though we interact with materials every day, their composition is not always obvious. Some materials are of a pure chemical composition, and others are a combination of many chemicals. Let's compare two common materials: concrete and plain-carbon steel (also called *mild steel*). Both materials have properties that we can test, but only mild steel is considered **homogeneous**, with consistent material performance at any scale across any sample. 10

Concrete may appear consistent to the naked eye, but its structure is highly variable. Cement and crushed rock are atomically inconsistent by nature. But because concrete's **macro performance** is relatively consistent, it has material properties which can be tested in the same way as a homogeneous material. Concrete is one example of a **hybrid material**: a combination of multiple materials whose final performance is defined by the interaction of its components. 11

Michael Ashby presents a succinct definition for hybrid materials, saying they are "combinations of two or more materials assembled in a such a way as to have attributes not offered by either one alone."[10] Concrete clearly fits this categorization, as the final mixture displays properties that are reflective of 12

9. *Ibid.*, p. 61.
10. Michael F. Ashby, "Materials Selection in Mechanical Design", *Butterworth-Heinemann,* 2005, p. 340

its components (aggregate, cement, and water), but not achieved by any single one of them. It can be poured like a liquid—but once it's set, it has properties similar to stone.

Like all materials, hybrid materials have testable properties, like breaking strength and melting point. But unlike other types of materials, a hybrid material's properties can be changed by manipulating the ratios of the material's separate components. Most importantly though, the result of the manipulations often occurs at a scale visible to the naked eye and easily felt by the hand. 13

For another example, take a smoothie of strawberries, bananas, yogurt, and ice. Blended, a smoothie is a homogeneous material with a consistent taste and texture. But the smoothie is actually many small pieces of its constituent parts. Zoom in, and a smoothie's components are physically adjacent, rather than bonded chemically. Zoom out, and you'll just see a smoothie. 14

By changing the ingredients' proportions before blending, we can change the smoothie's character. We can add more bananas, and it will taste more like banana. We can add more yogurt, and it will be creamier. We could add alcohol to decrease the freezing point. Manipulating each component changes the whole. 15

Most importantly, a strawberry-banana smoothie doesn't taste like either strawberries *or* bananas: it tastes like something completely new. Similarly, concrete doesn't behave like cement, water, or crushed aggregate: it acts like a pourable stone, and we interpret it as a pourable stone. 16

Though the smoothie example might seem too simplistic, it's the same type of physical material investigation that designers are using to generate new classes of materials. Materials scientist Guido Kickelbick hints at this potential:[11] 17

> The combination of different analytical techniques gives rise to novel insights into hybrid materials and makes it clear that bottom-up strategies from the molecular level towards materials' design will lead to novel properties in this class.

11. Guido Kickelbick, *Hybrid Materials: Synthesis, Characterization, and Applications,* Wiley-VCH, 2007, p.2

This essay proposes that Kickelbick's analytical techniques must also include the design process. The work discussed below proves designers have the capability to produce valuable material innovation. Though Kickelbick refers to molecular-scale strategies, these projects show that qualitative development can also yield important results. All of these projects evolved from student work, and each business spawned further innovations. 18

Sugru: Changing Ownership

Sugru is a sophisticated silicone elastomer material technology that is initially malleable like a putty, self-adhesive and eventually self-cures to the full performance of silicone. Sugru has fundamentally changed the way that its users think about the things that they own. This new class of materials was created by Jane Ní Dhulchaointigh and she best articulates the attitude of the Sugru user: "I don't want to buy new stuff all the time. I want to hack the stuff I already have, so it works better for me."[12] Sugru allows you to repair, re-purpose and customize the objects around you and it has spawned a global community based around a mentality of low waste, and long-term ownership. 19

Sugru's material properties give it a wide range of applications. For example, before curing it can be gently molded around the lip of a baking dish to form a handle. After 24 hours, the handle will be dishwasher-safe and capable of withstanding temperatures up to 356ºF. It can be used to mend cables, to insulate electrical wiring, or even to repair the cooling system in a car. 20

As a hand-moldable air-curing silicone, Sugru represents an entirely new class of materials. But its performance is secondary to the community that supports it. Ní Dhulchaointigh has carefully nurtured a community of users who explore the material's properties and share their insights. Sugru shows us how empirical design research can lead to quantifiable innovations. It is the strongest contemporary example of a non-scientist developing a new material technology. 21

Ní Dhulchaointigh describes her development process as being a physical material investigation in which she began to prolifically combine dissimilar materials while studying for a Masters Degree in Product Design. She was 22

12. "A Partial Visual History of Sugru", *Sugru*. http://dsn.tc/03c-02.

instinctively working with each material's properties, generating a rich palette of samples. Though she may not have called them hybrid materials at the time, they clearly were, and as with all successful hybrid materials, they were demonstrating a range of unexpected properties.

23 Ní Dhulchaointigh did not have a set of preexisting criteria to judge her samples, nor did she have a specific application in mind. The rigorous but subjective evaluation of her work was crucial to identifying which samples were worth pursuing. While highly qualitative, this selection process was effective at identifying which prototypes presented interesting potential. She eventually choose to focus on an interesting sample composed of sawdust and silicone sealant that she first described as *bouncing wood.*[13]

24 But this bouncing wood wasn't intriguing based on its material properties alone; rather the *application* of these properties revealed its significance. This sample was self-adhesive and self-curing, so it could be adhered to an object and left to harden. This would change the form of the object, but more importantly it had the potential to change the relationship between the user and that object. This material concept is what eventually came to be known as Sugru.

25 Take a cup with a broken handle, for example. One can form a new handle with Sugru, fixing the cup. The grip is thermally insulated, more comfortable and unique to its owner too—making it more useful and forging a stronger connection between user and object. This simple addition makes the cup more valuable to its owner and makes it less likely to be discarded.

26 Sugru believes that a material intervention to repair and customize objects can change the relationship between users and those objects, and as a result, reduce waste. Ní Dhulchaointigh describes this concept as a revelation that laid the foundation for eight more years of work. Sugru communicated this idea with one simple phrase: "Hack Things Better."[14]

27 Thanks to an innovative product and continual engagement with users, a strong community has formed around Sugru. Fans of the material prolifically share photos and videos of their applications. Though the stories are often

13. Jane Ní Dhulchaointigh, verbal interview by Matt Johnson at Sugru HQ, 1 Mar 2012.

14. Their current motto is *The Future Needs Fixing.*

personal, the community has proven that no problem is truly unique. Some members add texture to Sugru by pressing it on a screen door; others open new avenues of exploration, such as using Sugru for electrical insulation. By carefully fostering this community, Ní Dhulchaointigh has created an open R&D platform that resonates with the same process she used to create Sugru in the first place.

Sugru's current success is defined by the relationship between scientific rigor and design insight. It's future success will rest on nurturing a process that can easily switch between the two perspectives. As a designer, Ní Dhulchaointigh has laid the groundwork to create a new body of scientific knowledge. Upon this groundwork, thousands of users are creating new ideas, which pushes her to create new materials and technology in turn. 28

Polyfloss: Changing Reuse

Polyfloss allows "any skilled maker to create high-value objects from a free material,"[15] specifically polypropylene, a common household plastic used in the manufacture of textiles, kitchen products and packaging. As a response to plastic waste, Polyfloss proposes a system where polypropylene can be radically transformed into a more versatile material. 29

Polyfloss is made by grinding pieces of polypropylene into small particles, which are then heated and spun into strings in a process similar to the production of cotton candy. Polyfloss can be molded like an industrial plastic, or manipulated like raw wool. The unique properties of this material challenge the attitude, applications, and aesthetics of fossil fuel–based plastics. Polyfloss reforms waste into a valuable new commodity. 30

As Polyfloss is only composed of polypropylene and air, it is structurally simple and can be understood as a hybrid material. Like other hybrids, changes in the components' proportions can produce significant changes in the material's behavior. For example, increasing the fiber density produces a stiffer and heavier material with different textural, acoustic, and insulating performance. Careful manipulation of the input plastic color allows for a wide gradient of output colors. 31

15. Nick Paget, Email interview by Matt Johnson, 8 Jul 2012.

Because Polyfloss is chemically polypropylene, it can be processed like any other thermoplastic: it can be molded, extruded, and heat formed. But Polyfloss opens new application areas for thermoplastics by physically transforming them into a hybrid material. The single most important new property is the ability to cast Polyfloss into an object of variable density. This enables a contiguous material sample to be both soft and hard, flexible and stiff. Its creators refer to this property as "structural diversity".[16] 32

Future applications of Polyfloss will certainly take advantage of the ability to produce and control structural diversity. Three areas have already presented themselves as having interesting potential: textiles, soil-less planting surfaces, and Velcro-compatible objects. 33

By molding Polyfloss carefully it is possible achieve a gradient of density from pure polypropylene to a soft matting, creating a textile whose outer layer is waterproof, but whose inner layer is soft and insulating. This textile could be produced out of a single material in a single process, rather than bonding multiple materials together, reducing the complexity of production dramatically. Polypropylene and other similar plastics are common in contemporary textile manufacture and Polyfloss offers the opportunity to rethink both the form and production of synthetic textiles. 34

As Polyfloss is rugged and waterproof, it reveals itself as a perfect material for a soil-less planting bed (hydroponics). There are other projects which also use recycled plastic in hydroponic plant culturing, the most successful of which is Window Farms.[17] Since 2009 Window Farms has developed the idea of using waste plastic to construct window-mounted vertical hydroponic growing platforms. Polyfloss could work directly in the Window Farms system, enabling a significant design change by reducing the complexity of the system required or lowering the cost of production. 35

Finally, thanks to its wide range of material properties, Polyfloss can effectively mimic Velcro (or other hook and loop fastener systems) and as such makes it possible to create Velcro-compatible objects. Velcro is widely used for temporary fastening of garments and objects, but is rarely integral to the 36

16. Nick Paget, Email interview by Matt Johnson, 8 Jul 2012.

17. http://www.windowfarms.org.

object's structure. Polyfloss could be produced to incorporate a Velcro surface into the object itself, presenting an interesting design opportunity.

37 Though still a nascent technology, Polyfloss clearly has potential to become a disruptive material platform. Most importantly though, it changes the relationship between the user and ubiquitous industrial plastics: [18]

> Production using plastic has little human technique, manufacturing plastics almost always requires huge machines controlled by computers. All this makes it a material for mass-production… unlike wood, metal or textiles, the knowledge of transforming plastic is exclusive to industry.

38 Polypropylene and other industrial plastics have important and useful properties but their production is inherently inaccessible to the individual craftsperson. Polyfloss enables craftspeople to tangibly engage with these abundant materials outside of industrial constraints by openly distributing the instructions to construct a Polyfloss machine. The company's ultimate goal is to see local manufacture enabled by encouraging craftspeople all over the world to create their own Polyfloss micro-factories. Thanks to an abundance of waste plastic and open-source machine instructions, Polyfloss can be produced almost anywhere.

39 Polyfloss calls into question the nature of industrial material homogeneity: because of how Polyfloss is made, it's impossible for any two samples to be perfectly alike. It forces us to examine our understanding of a material's value: through a consistent process, discarded plastics become valuable raw material. The creators of Polyfloss want to reduce global waste by enabling local production of versatile, high-quality plastic. In order to support this, they need to work on outreach, empowering others with this new material, and with the knowledge that in an age of material abundance, what we want can be built from what already exists.

18. "Context", *Polyfloss*. http://dsn.tc/03c-03.

Bare Conductive: Changing Interactivity[19]

Bare Conductive ("Bare") is a London-based startup that produces a unique range of electrically conductive materials centered around Bare Paint, a nontoxic electrically conductive paint that can be applied to most surfaces to form an electrical circuit. More than just a "paintable wire," Bare Paint acts as a way to apply electrical interactivity to almost any object. 40

Bare presents a radically tangible way of interacting with electronics. Whether through painting a circuit onto a piece of paper, printing interactive posters, or hacking the material itself to make liquid switches, Bare proposes an entirely new way to materialize electronics. 41

Bare started as a Master's project focused on applying circuitry to skin, in order to find a middle ground between wearable computing and electronic implants. The dream of applying circuitry to one's skin with a brush has evolved into the reality of writing circuitry with a pen onto almost any surface. Bare's development process is another strong example of how playful and analytical prototyping can lead to scientific innovation. 42

Bare's core technology took almost two years of consistent development, combining commonly available ingredients. After three months of mixing cosmetics and a selection of electrically conductive particulates, a proof of concept was presented at the Royal College of Art's 2009 Work In Progress Show. Bare's creators then presented the project in a series of major venues including the ARS Electronica Festival and a high profile collaboration with Sony Music UK. The popularity of these projects prompted thousands of email requests to purchase Bare's electrically conductive paint, providing the impetus to start a company. 43

Electrically conductive paint is a novel idea for most people, but it is actually an old technology—having been used to make high-precision, low-cost electronics for over thirty years. If the concept of the material already existed, then Bare's innovation can only rely in part on its specific formula. Bare's major innovation is the way in which the concept of the technology is presented. 44

19. The author of this essay is a cofounder of Bare Conductive.

Bare's creators see their paint as a way to explore the fundamentals of electronics, to apply interactivity to almost any surface and then to dematerialize electronics. They have always presented Bare as a design project with the application—rather than the technology—at the forefront of the conversation. What the user does with the material is more important than how it works. 45

As a hybrid material, there are two stages in which Bare Paint can be manipulated. The first is during production where it is possible to manipulate the final material performance through careful control of the manufacturing process and material components. The key properties are viscosity, conductivity, flexibility, and drying time. Each change creates a new set of properties that make the final material more or less appropriate for different applications. 46

Bare Paint's properties can also be changed by the nature of the application. For example, a circuit's electrical resistance is inversely proportional to the material's width.[20] Using Bare Paint, then, a thick line of paint will have less resistance than a thin one. Analyzing a series of identical circuits with varying thickness, the relationship between resistance and thickness becomes intuitive and accessible. Bare supports the idea that in a world filled with technology, it's essential to make electronics education more accessible and intuitive—a view shared by a growing community of users. 47

Bare nurtures an online community through its website and social media, sponsoring projects, donating free material, and providing technical assistance. This community acts as a large open R&D platform for the company and is an essential part of Bare's future success. Though there are many passionate Bare Paint users, they would all probably also classify themselves as part of a larger movement known as **the maker community**. 48

Thanks in part to the development of open-source computing platforms, online forums, and a few print publications,[21] there has been a huge increase[22] in the popularity of hobbyist electronics over the past five years. The maker 49

20. This is given the same depth of a line.

21. Open source computing platforms include the *Arduino microcontroller,* a programmable computer: http://www.arduino.cc. Online forums include http://www.instructables.com and http://www.makezine.com. Print publications include *Make Magazine*.

22. "Home Invention", *The Economist,* 1 May 2008. Also available at http://dsn.tc/03c-04.

community approaches their work with cross-disciplinary openness, making it a perfect platform for Bare's unique materials—for instance, an electrical engineer can use Bare Paint to make a dynamic sensor, while a child can build a doll house with working lights.

While Bare Paint was created by designers through a nontraditional process, it can only continue to be realized through methodical development and industrial collaboration. For Bare's creators, this has been a difficult process: they continually confront an industry that is uncomfortable with materials development by non-scientists. Finding development and manufacturing partners has proven challenging, as do the everyday barriers of language and industry-specific procedure. 50

The transition from a purely design-focused company to a design-led manufacturing company has been challenging but fruitful. This conflict has allowed Bare to build a strong scientific foundation for its design thinking. Careful nurturing of users, maintenance of their design process and continual scientific refinement will ensure that Bare can operate at a scale where it can make an impact. 51

Bare is only beginning to explore the truly revolutionary potential of its materials by placing itself on the cusp of a revolutionary new field known as Paper Electronics. Bare's materials and its design-led approach give it a unique insight into this new area. They believe that Paper Electronics will become increasingly important in the next 10 years as it changes our relationship to, and perception of electronic devices. As we move towards a distributed model of computing and detach ourselves from PCs we will see Paper Electronics replace/augment the ubiquitous PC/LCD/Terminal making our points of interaction less discrete and more elegant. Spaces won't be dominated by monolithic pieces of technology demanding interaction, rather it may not be clear which objects have an electronic component to their interaction, but it also won't matter. What these new objects will do for us will matter much more than how they work. 52

Materials' present and future

A relationship between design thinking and the hard sciences presents an opportunity for novel, useful materials—but more importantly, it proves the value of a flexible approach. Manuel de Landa best articulates the value: 53

> It is precisely those abilities to deal with complex, continuously variable behaviour that are now needed … Hence, we may need to nurture again our ability to deal with variation as a creative force, and to think of structures that incorporate heterogeneous elements as a challenge to be met by innovative design.[23]

The futures of Sugru, Polyfloss, and Bare all rest on their ability to embrace complex behavior while nurturing the interplay between science and design, between quantitative and qualitative exploration. As these companies grow, they will be challenged to maintain the ethic upon which they were founded. If successful, they will prove the cross-disciplinary necessity of modern material development. 54

23. Manuel de Landa, *Uniformity and Variability,* p.5. Also available at http://dsn.tc/03c-01.

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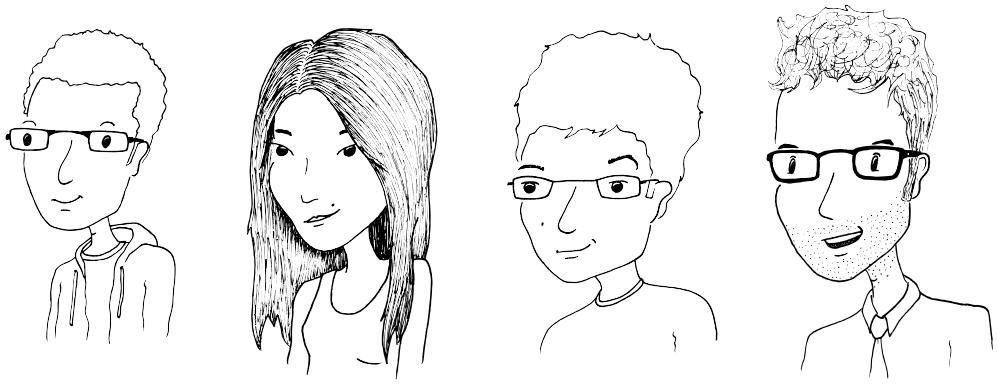

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She grew up commuting between families and schools in Beijing and New Jersey, and lost much sleep over the fear that her friends were having fun on the other side of the world while she was sleeping.

She is passionate about design and technology, and curious to learn about the lives of people who also call this planet their home—she is particularly interested in the lives of individuals in the developing world, and how they are affected by design and technology. This led to a volunteer trip in Uganda in 2009–2010 and a research project in South China in 2011–2012.

She is currently back in her favorite city, New York City, and is enjoying a lot of the food she missed in China—tacos!

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Matt Johnson is based in London, UK and is one of four founders of Bare Conductive Ltd. Matt's current work is focused on prototyping and exploring applications for Bare's unique electrically conductive materials. His interest in exploring the connections between design, material science and technology comes from a lifetime of making and from his time spent earning a dual masters at the Royal College of Art and Imperial College London. Matt is deeply passionate about collaborative work, prone to fits of intense joy over successful experiments, and sometimes doesn't wear shoes in the workshop.

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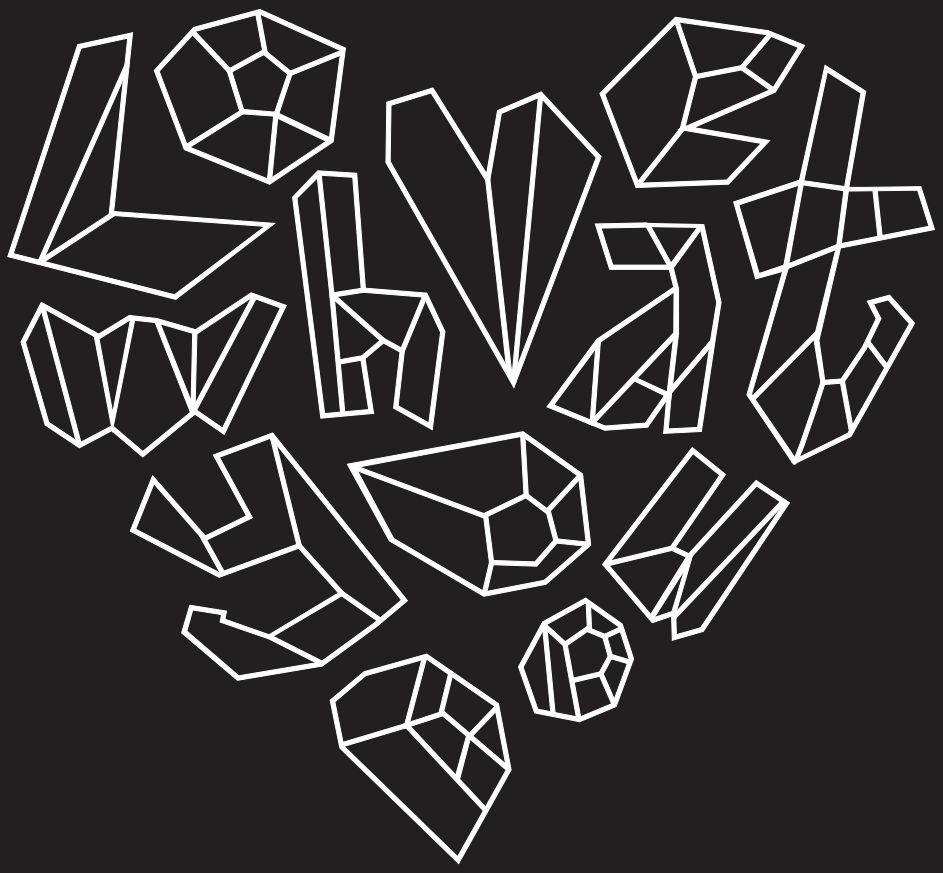

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