Make:

Getting Started with littleBits

Learning and Inventing with Modular Electronics

Ayah Bdeir and Matt Richardson

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by Ayah Bdeir and Matt Richardson

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Foreword by the Founder

You've already bought this book, so I'm not going to spend any time trying to convince you of the merits of the Maker Movement—my assumption is that you're sold. I assume you're sold on the idea that the gratification that one gets from making something—whether in robotics, 3D printing, or food—is very powerful. I assume you're sold on the promise of social, economic, and educational change that can come from spreading the ethos of STEM/STEAM and "learning by making." I assume that you believe that promoting a society where people make, remix and share online or in social settings—as opposed to a silo culture—is a good thing.

But I'm writing today to talk about an even bigger idea: the idea that we don't just need to be makers, we need to be inventors. I believe that inventors are an evolved breed of makers. Inventors are sometimes problem-solvers that are inventing a solution to a particular problem, and other times they are creative thinkers that are inventing a future that has never been imagined. To elevate making to inventing, we need to equip ourselves with a new language to understand the world around us, and a platform to reinvent it.

We spend more than 11 hours with electronic devices every single day, but most of us don't know how they work, or how to make our own. When I first started working on littleBits in 2008, this number was 7.5. Technology has moved from being an integral part of our lives, to helping define who we are. It's the cars we drive, the phones we own, the alarm systems that keep us safe, the iPads that two year old kids tap and swipe. Yet engineering is mysticized, electronic objects are black-boxed, and if we are honest with ourselves, we have ceased to understand the technological world we live in. And in the meantime, the world is moving at a very fast pace, from the Internet of Things to Artifi-

cial Intelligence, each with their own promises and challenges. How can we solve the challenges we face today if we don't understand the world we live in? I believe that to solve 21st century challenges—economic, environmental, medical—we don't need more, we need smarter. Tomorrow's sense of pride will come from inventing the future.

As Matt and I were writing this book, I reviewed some of the very early images, sketches, and writings from the first days of littleBits as a project. I am incredibly humbled and surpassingly excited about what lies ahead. I hope you enjoy this book and all the love and care that has gone into it, and into littleBits as a product and a company. I would like to deeply thank our team of bitsters who work tirelessly to make this vision come to life. They are some of the most talented and dedicated people I have ever had a chance to collaborate with, and they keep it EPIC. But most of all, I would like to thank the littleBits community, an incredibly diverse community of artists, designers, kids, engineers, hackers, educators, librarians, from all ages, all languages, and interests. You never cease to amaze me with all the stunning, shocking, and delightful inventions you come up with every day.

Now enough of me talking, go ahead and start inventing!

— Ayah Bdeir, Founder and CEO, littleBits

Preface

I started working on littleBits in early 2008. I had graduated from the MIT Media Lab and had a prior background in Electrical Engineering. I grew up in Beirut, Lebanon, and to be honest, I never wanted to be an engineer. I am one of four girls and my parents tell me I was always a tinkerer, a maker and very often, a breaker. When it was time for me to decide what I wanted to do in university, my parents and teachers said I owed it to myself to be an engineer because I was good at Math and Science. But I had always found that engineering was dry and not creative. It wasn't until I went to the Media lab that I discovered the power of engineering when combined with creativity. I started to create my own artwork using electronics: wearable electronic fashion, interactive installations, lighting art. A little while after, I realized I was more interested in the tool than the outcome of what I was creating. I had been working with the design agency Smart Design with a colleague Jeff Hoefs, and we wrote a paper called "Electronics as Material." Together we designed some of the earliest prototypes of littleBits and this was the beginning of a long research to try to put the power of electronics in the hands of everyone.

My two biggest inspirations were Lego and Object-Oriented programming, two of the most successful modular systems of our time.

Modular Electronics

To understand complex ideas, I believe in the power of modular systems. Modularity allows us to understand complex notions that we may have previously found intimidating, by allowing us to break them down, and build an even more complex idea back up, one building block at a time.

The first inspiration was a big one. In 1947, Lego had managed to take the cement brick, the most important construction unit in

the world, and make it an imagination tool, accessible to everyday people. With Lego you didn't have to be an expert to make a complex structure, you learnt intuitively, and could build more and more sophisticated structures one brick at a time. In a few short years, Lego bricks took place in every household. It is estimated that over 400 billion bricks have been produced, or 70 bricks for every person on the planet. We didn't have to be engineers to make walls, houses, buildings, bridges. Lego had taken the building block of our time and made it into the building block of our imagination. Suddenly we gained an understanding of the world around us. Structures that we saw on the streets of city centers that previously appeared huge and complicated were not so unattainable, not so intimidating anymore: you could clearly imagine yourself building them up, one brick at a time.

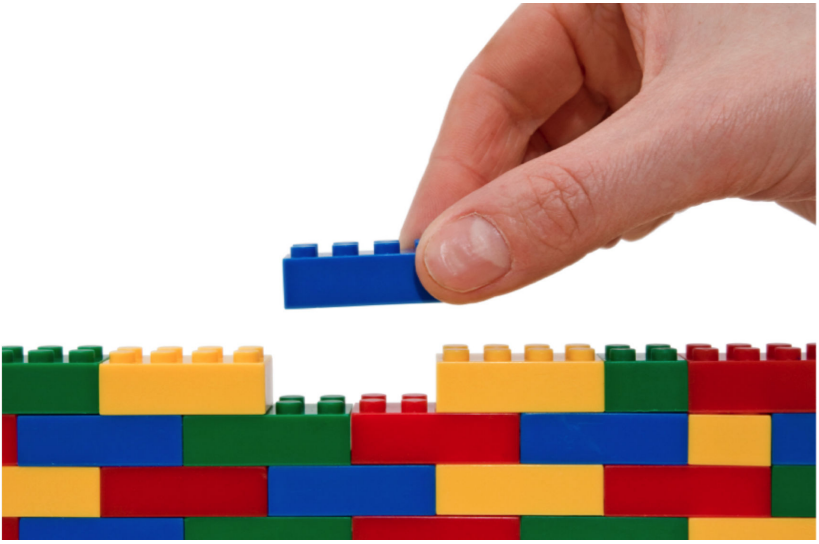


Figure P-1. *One brick at a time (graja/Shutterstock)*

Figure P-2. *Croatian National Theater building made of Lego blocks (Gordana Sermek/Shutterstock)*

The second inspiration was Object-Oriented Programming. Software used to be linear, obscure, and thus only reserved for experts. Then Object-Oriented Programming came along. It introduced the concept of modular blocks, allowing people to reuse pieces of code written by them and other people, and build more and more sophisticated code, one brick at a time. Now anyone with two weeks and a computer can learn to make the most successful game in the world.

But in hardware, this is still not possible. The hardware industry is a very top-down industry where prototyping times are long, expertise is required, and the field in large part still belongs to engineers. So how do we put the power of electronics in hands of everyone? We make electronics modular.

I built the first littleBits prototypes using cardboard, devising a technique using copper tape from Home Depot. It was the best way to touch, and feel the modules. To imagine how a person who had never touched electronics before would interact with them, how they would be inspired by them.

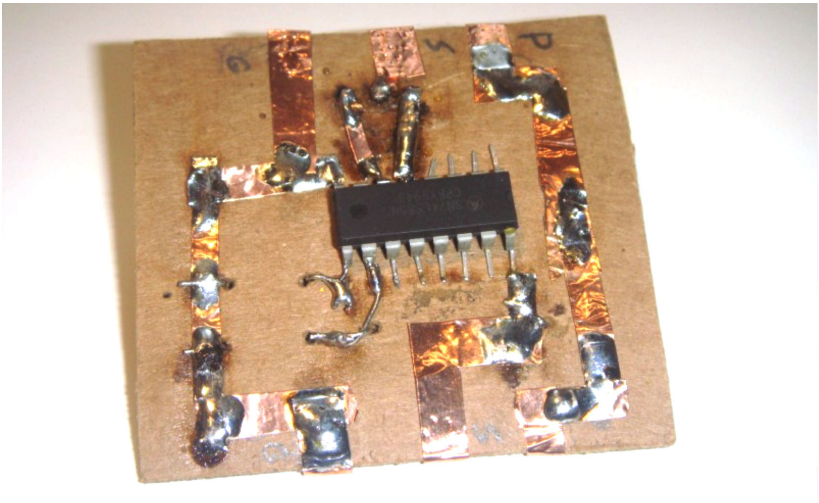


Figure P-3. *One of the first prototypes of littleBits from 2008, using copper tape from Home Depot*

Figure P-4. *Another prototype. Note the ring magnets held together with metal pins*

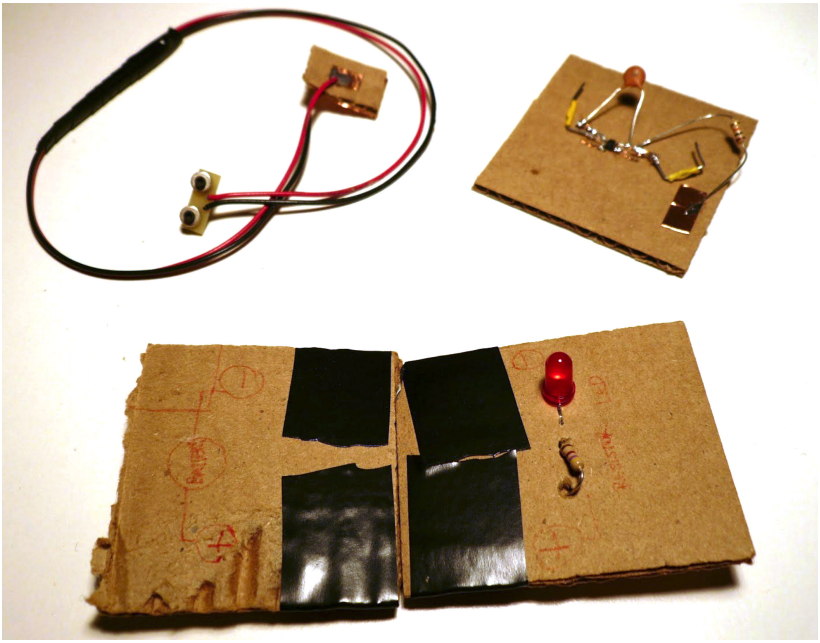


Figure P-5. *Various prototypes ready to be snapped together!*

Every single aspect of littleBits was up for design, nothing was taken for granted. Over 3.5 years there were hundreds if not thousands of experiments and decisions that led to littleBits as it is today. First and foremost of course, electronics design, so that the system of circuits could be genuinely modular: any Bit has to work with any other Bit in the system, and the library should be infinitely extendable. It was also extremely important to figure out the right level of abstraction for each module. littleBits are not component-level modules, they are block-diagram level modules. Nailing how high-level the block diagram had to be, in order to make sure it is understandable, but also how low-level so that it can be versatile, was crucial.

But beyond electronics design: interface design, mechanical design, cost, branding, aesthetics, naming convention, color code—every single aspect was a process, and a decision. For example: I searched for connectors that were easy to attach and detach for weeks, it was very important to take any fear or uncertainty out of making electronics. The connectors needed

to be small, iterative, but most importantly, polarized so that you couldn't make any mistakes and do something dangerous. After hundreds of connectors, I settled on something that I had never yet seen put into electronic circuits before: magnets. And they had the added benefit of making anything feel magical.

The size of the circuits needed to be designed in multiples so that larger circuits could work in any configuration and allow for 2 and 3D rotation, even if that meant sometimes modules would be a little bigger or smaller than they ideally wanted to be. I wanted the circuits to appear inviting, not intimidating as green and black PCBs often are, so I tried different circuit board colors to look crisp and clean—white was the way to do that. The circuits needed to feel human and gender-neutral, hence the handwritten font to denote the name of the module, and they needed to be a building block for creativity, not a finished product, so the circuitry is exposed. There are lots of rules to communicate when it comes to rules of electronics, so we made a color-code that abstracted the rules of electricity into a manageable code: you always need a blue and a green, and pink and orange are optional, in between. I needed to make sure you could understand immediately what each module was and how to interact with it, so the user interface puts any interaction point at the top, and all other circuitry at the bottom, even though it's not always the most sound way to design a circuit.

Figure P-6. *After thousands of experiments and decisions, the littleBits module and design language is born*

I can go through every single aspect of the modules and the system, but it would be a whole other book. Trust me when I say that no aspect of the engineering, design, mechanics, manufacturing or interaction of littleBits is arbitrary; every single aspect

is deliberate. But the good news is, all it takes is to see someone pick them up, whatever their age, gender, background or country of origin, snap the first Bits together with no instructions and see a light come on. Right then and there, you see their face lights up, and you know you've created something truly universal.

Fast forward 3.5 years and 27 prototypes later, the littleBits library was born. A first-of-its-kind modular electronics platform for learning and inventing.

Every Interaction is a Ready-to-Use Brick

Our mission is to put the power of electronics in the hands of everyone.

littleBits is a library of electronic modules for learning and inventing. Each module is a pre-engineered, pre-assembled circuit ranging from the very simple (lights, sounds, sensors, motors) to the very complex (wireless radio frequency, programmability, cloud connectivity). Modules snap with magnets so you can't put them the wrong way, with no soldering, wiring or programming, unless you want to. The modules are color-coded: blue is power, pink is input, green is output, and orange is wire. All you need is a blue and a green; pink and orange are optional in between. There are billions of combinations of circuits possible, and the library is infinitely extendable. The littleBits library is open source, and fosters a community of contributors that can redesign, share online, and learn from each other's ingenuity.

Through looking at the world through the lens of the littleBits modular platform, you can break down any complex electronic device and understand how it works. Now you have a language to understand the world around you, from simple dimmer lights, to automatic elevator doors to internet-connected thermostats.

Figure P-7. *A lightbulb deconstructed: power, bright led*

Figure P-8. *A nightlight: power, slide switch, light sensor, bright led*

Figure P-9. *A digital thermostat: power, slide switch, temperature sensor, number*

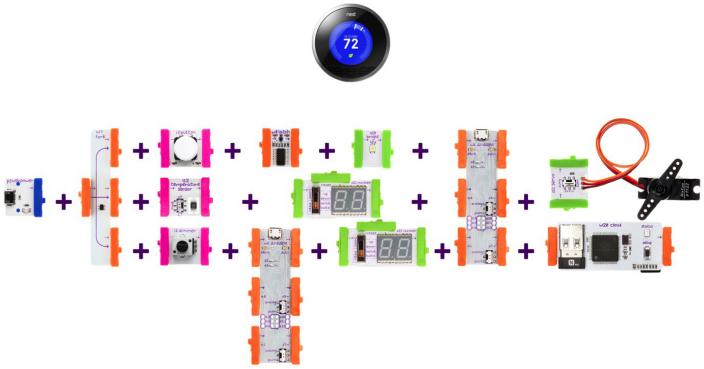
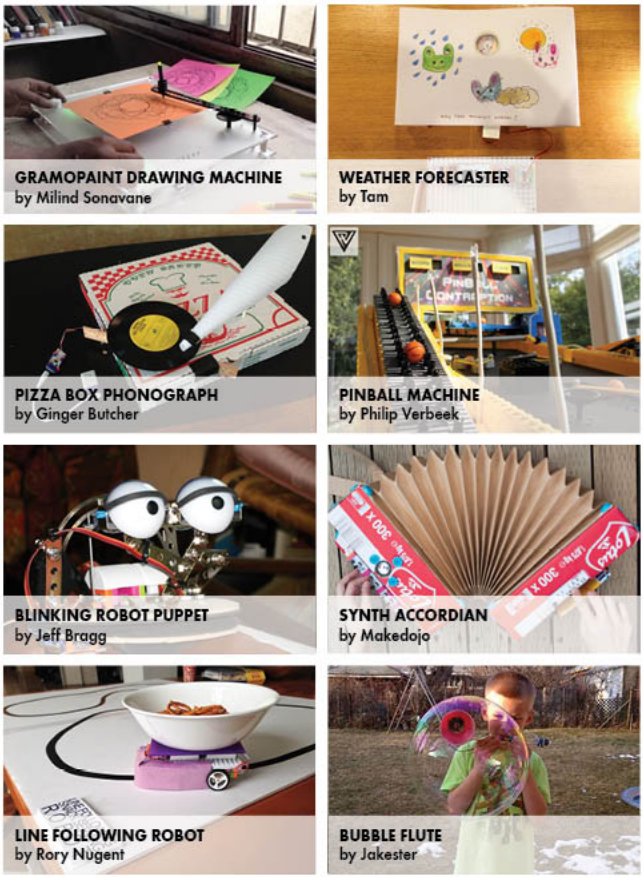


Figure P-10. *A DIY Nest: power, fork, button, temperature sensor, dimmer, Arduino, latch, bright led, number, servo, cloud*

DIY electronic kits are a dime a dozen, but what we are most interested in is a language to allow you understand the world we live in, and to reinvent it. That way we can encourage people to look around them, question the devices and phenomena they take for granted, and get inspired for their next invention.

Today, littleBits is a library of over 70 Bits modules and hundreds of billions of possible combinations. We've designed the system carefully to make it gender-neutral, age-agnostic and independent of discipline or technical experience. With these Bits modules you can make things that would otherwise require programming, soldering, and complex microcontrollers. You can make circuits with timing functions and logic that rival the most complex robotics tools. Over the past 3 years we reached outside the choir and enabled people who never thought of themselves as "makers" to jump in and create their own inventions with electronics. No matter if you were a 30-year-old designer from New York, an eight-year-old boy from Singapore or an educator from NASA, we set out to enable you to learn and invent with electronics within seconds: from a connected doorbell to a fully responsive robotic installation.



Today littleBits are used in over 3,000 schools, afterschool programs and libraries in over 70 countries, and have enabled educators teaching across all grade levels and topics, from grammar, to music to 21st century product design.