

“Business” Chapter of the Book:

“Building Open Source Hardware”

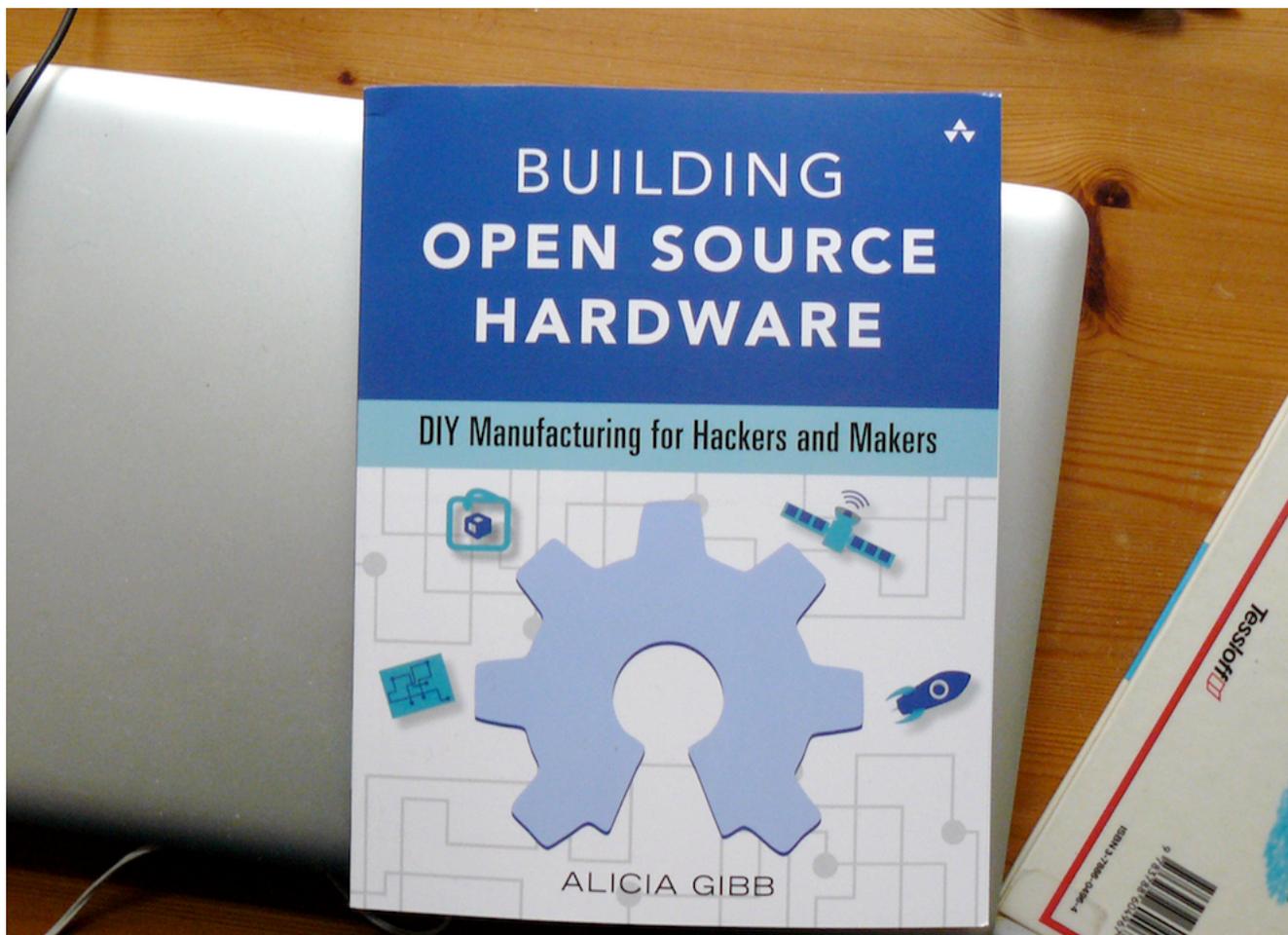
(Addison-Wesley)

Chapter text by Lars Zimmermann <http://larszimmermann.de>

Quotes collected by Alicia Gibb <http://aliciagibb.com/>

Anecdotes by Marcus Schappi <http://littlebirdelectronics.com.au/> & Brandon Stafford
<http://rascalmicro.com/index/>

LICENSE: Attribution-ShareAlike-International 4.0 Creative Commons
<https://creativecommons.org/licenses/by-sa/4.0/>



Lars Zimmermann

The business model of open source hardware? You won't believe how boring it is. We sell products for more than they cost.

Chris Anderson; in his OHSummit Talk 2012 "Microeconomics for Makers: Business Models for the new Industrial Revolution"

This chapter guides you through a variety of business models fit for open source hardware and open design. We start with some remarks about the obvious natural business model that comes with hardware and the importance of the brand. The chapter then presents and explains the Open Source Hardware Business Model Matrix, a tool that aims to help people ask the right questions and research answers while figuring out their business model for open source hardware. Company quotes embedded within this chapter were collected by Alicia Gibb in an open source hardware business survey.

"You can't make money being open" is a common criticism of open source development, although history shows many opportunities work better and more effectively when explored through an open approach. Several businesses were studied for this chapter that debunk the myth that you can't make money by being open source. Open source is often an ideal strategy for developing a more innovative, financially successful, and sustainable business, where money can be made not in spite of being open, but *because* you are open. Of course, this isn't a case of just changing a license and carrying on with business as usual. Open strategies require certain adjustments to a company's business model—sometimes minor alterations, but sometimes transformative change.

A Natural Business Model

The main answer to the business model question for open source hardware could not be simpler: you sell products. Hardware is any physical object—atoms, things, minerals that take work to extract from the Earth. In software, there is little difference between one copy of an MP3, a JPEG, or an ODT file and 1 million copies of it. In contrast, there is a huge difference between one and 1 million copies of a piece of hardware. Every new copy is a new physical object requiring materials, time, work, and energy for production and distribution. It is not hard to understand why you should pay for a physical object. An economics rule is that scarcer things can sell for more: having 1 million copies doesn't create scarcity, but having a few handmade boards you are willing to part with does!

The core of an open source hardware business is the same as for any other hardware business: you produce and sell physical objects at a greater price than the cost of parts and labor. Traditional business strategies are the same as open hardware business strategies: marketing, pricing, efficiency, quality, and distribution. All of the open source hardware companies interviewed for this chapter reported that their problems are overwhelmingly business problems, not open source problems. With openness, you can do some of these things a little different. There are possible collaborative advantages to gain from having open design files, money to be made by innovating faster, and efficiencies to be achieved by persuading a greater number of participants to work on your project. You can download design files very easily but you cannot (yet) download physical objects or a community around a project. Physical objects still need to be produced from design files with skilled people, infrastructure, and care.

The Brand

Here is where the brand comes in. Assume your hardware is open sourced and out into the world for others to reproduce. It makes a difference who produces the products you buy! Brands in open source hardware are as important as they are for businesses with closed source, or patented, hardware. Open source hardware businesses protect their brands just like any other business—that is, with a trademark. Brands are about trust and protecting the consumer rather than intellectual property. The reputation for trust and quality a brand carries with it is something that cannot be copied or downloaded, but must be earned

over time. People prefer to deal with people whom they trust. For example, many clones of the Arduino microcontroller are available in the market, but many people prefer to buy the original. They recognize the original by the Arduino brand.

Under an OSHW license, we release a design so that anyone can make an exact copy of the machine and sell it, so long as they respect our trademarks. However, we've had cases where (sometimes awesome) derivatives were made, but kept our name and/or our product name on it. Or worse, cases where complete derivatives were made where nothing *except* our trademark was kept onboard. As a business based around OSHW, we don't want to play the "bad guys" telling off these people, but derivatives like this are very bad for us and the rest of the OSHW community. (Evil Mad Scientist Laboratories)

A brand is a communication asset, and open source is all about communication. If you share design files and emit resources of great quality, you will gain attention and build up your brand. Deliver good quality and engage in reliable and valuable connections with others, and many people will prefer to buy from you and collaborate with you.

Find some way to make your offering unique. Sometimes it feels that this industry is a race to the bottom; many manufacturers are essentially making different versions of the same thing—the massive success of Chinese companies on eBay and their free shipping is one example. In this day and age oshw companies have got to concentrate on the "value add"—why should people purchase products from you over someone else? (Parallax, profitable, revenue of \$9 million in 2013)

Trademarks create a brand, the brand is how you produce value. Trademarks are not covered by Open Source licenses so they remain your property. It is a rather easy process to file a trademark. Generally speaking, they are inexpensive compared to patents registration, and you can file one for about \$300 in the US, 800Euro in Europe. (Lasersaur, profitable)

"Basically, what we have is the brand," says Tom Igoe, an associate professor at the Interactive Telecommunications Program at New York University, who joined Arduino in 2005. "And brand matters." (quoted in Wired Magazine 16.11 October 20, 2008, "Build It, Share It Profit" by Clive Thompson on the first three years of Arduino.)

The Open Source Hardware and Open Design Business Model Matrix

The Open Source Hardware and Open Design Business Model Matrix was developed by the Open It Agency, an open source business development and communication agency based in Berlin, Germany. The matrix is a collection of open source benefits and advantages and possible income sources. The tool helps users map out complex and fitting business models and strategies for an individual case. It is appropriate for all sorts of physical products, not just for electronic hardware. Some items in the matrix reflect theoretical, yet promising notions for the future; others have been tried and tested by successful open source hardware businesses. The field of open source hardware is very young and has a long way to go, so the matrix is intended to remain flexible. There are more things to find that will be developed by you and others in the future, but the matrix should suffice to get you started.

Should Your Product Be Open?

The matrix (Figure 15.1) is part of a toolkit that is made to answer the question, "Should your business be open?" The top two rows of the matrix should help you decide if your business should be open. Open sourcing products is not for every business, but it does offer many advantages to developers.

***Insert Figure 15.1 15Fig01 S

Why? Advantages & Possibilities to win with Open Source →		Less Costs for R&D <i>Open Innovation, faster Bug Fixes</i>	Better Products <i>interactive, long-lasting, more Features, Freedom, Sustainability, Connectivity</i>	Less legal Fees <i>Less legal Expenses, Less Time to Market</i>
Collaboration & Synergies <i>Material Cycles, Open Standards, Product-as-a-Platform, In-house Communication</i>	Ethical Bonus for the Brand <i>Transparency through Community, Sustainability, Education</i>	Less Costs for Support, Ads, PR etc	Better Employees	
			Donations, Grants, Sponsoring, Public Research	Funding & Crowdfunding
Your Channels <i>Advertisement, Product-Partnerships, Rent, Fees</i>	Education & Training <i>Workshops, Certificates, Consulting, Events</i>	SUPPORT <i>Install, Operate, Maintain, Upgrade, Repair</i>	On Request <i>Individual Development, Customization, Adaptation</i>	Closed Parts <i>Open Core, closed Add-ons, new Version closed, some Parts closed etc.</i>
Foundation/ Consortium Model <i>Members Fees</i>	Selling the Service <i>(e.g. Prints, Energy, Waste-Disposal, Food-growing, Data) using OSHW</i>	Produce & sell Products <i>Quality, Warranted, Shipped</i>	← How to make Money €/ Where does the Money come from?	

OSHW Business Model Matrix, vs. 0.6

by Lars Zimmermann, www.larszimmermann.de, CC-BY

Figure 15.1 Open Source Hardware and Open Design Business Model Matrix vs. 0.6

CC-BY Lars Zimmermann

Another model includes a partially open product, in which both open and closed source parts are combined to create the whole product. Having a combination is fine as long as the company clearly states which parts are open source and which are closed source.

No matter which course you decide to follow, these are questions your company should decide first, because it is nearly impossible to pull your product back into a proprietary model once it has been put in the community as open source. Any individual or company producing open source hardware should be prepared to have their hardware copied, changed in unintended ways, used in various fields, and sold for profit as the open source hardware definition allows.

The matrix is divided in two parts, as shown in Figure 15.1. The top part addresses advantages and possibilities you can benefit from after making your hardware open source. The bottom part considers possible money income sources. Most business models or cases will be a combination of several squares of the matrix. In this section, you will find some information on every square, although the matrix will undoubtedly continue to grow as more benefits are discovered in open innovation. You are encouraged to add your experiences and findings to the matrix: it is also open source! Use the matrix as a set of questions to inspire your own queries and research. The visual element will help you to organize your thoughts, knowledge, and ideas. You can download a picture of the matrix for comparison while reading here: <http://bloglz.de/business-models-for-open-source-hardware-open-design/>

Advantages and Possibilities to Win with Open Source Hardware

The upper part of the matrix lists advantages and possibilities to gain from being open. The advantages mentioned here are somewhat unique to open source hardware. Here you will find your possible reasons for being open. If you want to leverage these benefits, you should choose to open source your hardware. Ask yourself, “Can I design my business model and strategy around this?”

Lower R&D Costs

You can clone us but you can't innovate as quickly as our community can. And that is better than patents. (3D Robotics)

Reducing the cost of research and development through open innovation is one of the most important advantages for many open source businesses. If your design files are open, people have the chance to study them and play with them. If there is a channel for community interaction, users can submit feedback, ask interesting questions, suggest bug fixes, contribute ideas and so on. This communication can help you avoid mistakes and dead ends. Sometimes surprising things and perspectives can emerge. In an open community, you have access to the expertise and skills of people you might never be able to hire because you could not pay them what they are worth or because they have no interest in working for you full time, are retired, work for someone else, or live in another place.

The most helpful aspect of open source hardware at Aleph Objects, Inc. is the ease and speed with which we research and develop our products to get them into the hands of our customers around the world. This applies beyond initial product release, including our ability to rapidly iterate and incorporate feedback from our community to make products better over time. (Aleph Objects [Lulzbot], very close to being profitable, revenue of \$1.7 million in 2013)

With the right context, the right product, and a strong community you can innovate very quickly. People might clone your hardware but they cannot clone your community and the pace of innovation you achieve with them. In some fields, having a faster pace of innovation and being ahead of others is the most important competitive advantage.

There are a lot of different examples of open innovation, and a lot of literature about this development pathway. How do you design your platform and product in a way to trigger rich derivatives with open innovation? Which channels are you using or providing for it (e.g., forums, workshops, labs)? Do you incentivize contributions, or present tasks and challenges? Different products need different solutions. If everything is designed with transparency and respects the rights of open source hardware, however, it is very likely that your open innovation processes will produce faster, cheaper and better outcomes.

If people are going to hack your products anyway, then you may as well get ahead of the game. It's better than suing the people who love your product most. Make your products modular, reconfigurable, and editable. Set the context for open innovation and collaboration; provide venues. Build user-friendly toolkits. Supply the raw materials that collaborators need to add value to your product make it easy to remix and share. (Ahmad Sufian Bayram [author], promoting the state of collaborative economy in the Arab world)

We shared our schematics and firmware to our products because when SparkFun started, we didn't have tech support staff, we didn't have a phone number, we didn't even have a “we.” Open source hardware means you can learn as a group and support each other. (SparkFun Electronics, profitable, revenue of \$30 million in 2013)

For most people it is very important to provide a channel or place where your open innovation can happen. But open innovation does not necessarily mean that the innovation appears in the channels you provide for the process. For example, a forum might be set up with the intention of an innovation platform, but it can appear someplace else on the web. People may also create new use cases you never thought of before. Sometimes entire new markets get created, look at the example of Open Knit growing out of RepRap in Chapter 10. Have an eye on this and learn. You are invited to explore these markets as well. Enable the process. One of the reasons Tesla Motors opened their patents in 2014¹ was to provide the possibility for others to work on spreading electromobility and innovating to bring it places where Tesla would not be able to go as quickly. The benefit to Tesla is a larger electromobility market.

Better Products

There are a lot of reasons why open products can be better than closed ones. There is the chance that the pressure to become open will grow on some markets. This subsection highlights some reasons why an open product can be a better choice for the customer.

An open product can provide more possibilities to interact with it—that is, more ways to use it or adapt it. An open product is easier to hack. MacGyverize the world! This aspect of the product can be very interesting for customers. Make your product easy to hack and rearrange. This will also allow third parties to develop more features, invent and provide add-ons, or create new use-cases and connect the product to other items through the internet of things. The value for the consumer of the product rises with this extension of the product's capabilities. You provide freedom for people to control their technology and shape their lives as they wish instead of being controlled by their technology.

What is the most helpful aspect of open source hardware at your company? Increased customer knowledge. By giving users access to design files, they can better understand and use our products. In the case of open sourcing the Propeller microcontroller, we expect it to allow customers to get closer to the architecture and truly understand its inner workings. (Parallax)

Openness can make it easier to repair things or reuse or repurpose individual parts. This makes products a longer-lasting and better investment for the consumer. For many companies, open source solutions are the better choice to buy for their infrastructure because open source gives them independence from certain producers, suppliers, or support-contractors and freedom to develop their business as they wish to. All of these considerations lead to a more efficient use of resources.

Product as a Platform

The product as a platform approach is something very interesting for open source hardware developers. An open source product is much more likely to become a platform than a closed one, two great examples of this being the 3D printing industry and the Arduino microcontroller with its many derivatives. Open design files give people many more possibilities to interact with your product. Such interactions are especially likely to occur when others can find interesting ways to make a living with your product by developing and providing add-ons or services, or by adapting your product to local circumstances. In this fashion, your product will grow as a platform. For example, many professionals are using Arduino products for consulting or professional prototyping. The more stakeholders there are, the more powerful and useful the product can become, and the more stable the platform will be. For this reason, having your product copied by others is not necessarily a bad thing. Just design your business model to accommodate this possibility. You can see here why a noncommercial license is not open source. Not giving others the possibility to make a living out of your product would reduce the number of stakeholders and limit the potential growth of your platform. Of course, not every product is fit for the “product as a platform” approach.

Lower Legal Fees and Quicker Time to Market

Closing things is expensive. Patents, lawyers, lawsuits, secrecy agreements, and safety measures like prohibitively expensive insurance, to name a few, take a lot of time and money. In the United States, the patent application fee is \$17,000 plus legal fees and engineering fees. Usually patents cost a company upward of \$50,000. But the real cost of a patent comes from fighting the battle if someone infringes on that patent; resolving such a dispute can take millions or billions of dollars depending on how big your wallet is. Going open source could mean lower legal fees. Big companies often spend more money on the legal side than they devote to research and development. Being open source can save you a lot of money, which you can then invest in other things. Of the companies interviewed for this chapter, five reported that they bootstrapped. For those five bootstrapped companies, the annual legal fees combined was \$110,000, which includes a frivolous trademark battle from an outside company for having a similar (but different) name. Most companies noted that the money spent on legal fees was earmarked for obtaining trademarks.

How much money do you spend each year on legal fees? “Approximately \$5000 a year, but the bulk of this is for contract review and is not tied to IP [intellectual property]. Our IP legal fees are nominally \$0.” (SparkFun Electronics)

“Publish early, publish often” is a common mantra of the open source software community. Publishing early and often establishes prior art, which is a legal hook that open source hardware depends on. When a physical object has prior art, it means another company should not be able to patent it.

Have you had any products that have failed due to openness? “Never. Our products are rapidly developed and gaining traction in the market precisely because they are open, not in spite of it.” (Aleph Objects)

As of 2014, no open source hardware company had reported to us that they failed due to failure to protect its IP. In other words, the fact that it has open source IP has not been why a company shut down. Companies shut down because of other business problems that occur in closed source businesses as well, such as marketing, pricing, or hiring failures.

Collaboration and Synergies

Open source is about collaboration—about new decentralized collaboration patterns that are possible with the Internet. Published plans can reduce the collaboration costs for some things, synergies can be found more easily through transparency, and some things become possible that weren’t before. There are obvious ways that outside collaboration has helped each and every open source hardware company. Look at how the RepRap has grown, or how many products at SparkFun are labeled “This project is in collaboration with . . .” and lists a collaborator.

However, one of the most promising synergies that comes with open source hardware development as a result of its transparency is the possibility to collaborate, develop, and organize complete recycling of a product or material. This is sometimes called closed material cycles, regenerative design, Cradle to Cradle design, or zero-waste economy. There are not yet examples in the world of successful closed material cycles that are using the term “open source: to describe how they work. Instead, most of these projects use the term “transparency” to express the fact that open communication made it possible to develop and maintain closed loops and save resources.

Open source often means using or allowing use of open standards (for more on standardization, see Chapter 4). In fact, open sourcing a technology is a common approach to establish it as an open standard. Standards are helpful for collaboration between different companies and work focusing on shared and complex goals (e.g., an ecological zero-waste or circular economy). Open source is also about transparency and adds a whole new layer on top that makes global material cycles even more likely. This is a very strong and interesting potential on a worldwide scope for open source hardware, yet almost an entirely unexplored potential for the future of open source hardware and open design. We will likely see more of this trend in the future. Having transparency to the outside world also means that you have transparency within your company. This can make in-house communication and collaboration much easier. Ensuring that all information is accessible to all people prevents hierarchy and secrecy problems from hindering collaboration.

Most of these considerations have a connection to sustainability. Openness can make it easier and possible to organize an ecological economy with closed material cycles. Open innovation processes might be essential for the future development and spreading of ecological or sustainable products. Sustainability is perceived as valuable; in fact, many customers are asking for such products or companies that support sustainability. Being on the road to sustainability provides many businesses with more opportunities to do better business—for example, to meet governmental regulations or recycling standards.

Ethical Bonus for the Brand

It is not difficult to understand that producing open source hardware might deliver an ecological bonus. However, this aspect of open source development has nothing to do with intellectual property, but rather is a side effect of open source transparency. Open source hardware and open design are still very young and unknown to many people, so there are some good prospects for growth. The more popular narratives today—“Open source is for free” and “Open source means do it yourself”—will clearly be outgrown. “Open source means lower quality/usability” will lose ground, too. Whatever the successful new narratives will be—perhaps “Open source is for sustainability,” “Open source is for freedom,” or “Open is a smart choice”—chances are high that they will have positive spins. “I think open source could be the next organic or fair trade,” the journalist Christoph Gurk said in a conversation with me. Almost everything you can say about open source is valued by people and considered a good thing. The bigger and better the movement grows, the more attractive the brand strategy will be with open source hardware.

Strongly tied to open source development are inputs from the community view. Open source products address and include people as intelligent, creative, caring and responsible co-creators of the world. They educate and enable people rather than looking at them as mindless consumers. Open source provides a lot of new and unique strategies for achieving a sustainable world and economy.

To get serious on another level for a second, closed things are progressively suspected to be unsustainable and work against the consumer. Open source is about giving you the freedom to understand and control your technology at a fundamental level. Closed devices may not give you the option to repair them. Closed devices may collect information about you and send it to anyone for whatever reason. They might also receive orders from someone else with the goal of manipulating you with wrong information. If they are closed, you will never have the chance to determine whether they are or are not doing this. Such a statement might sound like a conspiracy theory today, but the more complex and networked our world becomes (think about the internet of things), the more serious these issues will be. Having the design files of things open for inspection will be key for sustaining our personal freedom and democracy. The more time that goes by, the larger the number of people who understand this point and will be guided by it—especially while making purchasing decisions.

[A]nd because everything we do today involves the Internet and everything we do tomorrow will require the Internet, that means that copyright policy becomes the organizing principle for everything we do in the world. And that’s silly!

There is no way to fight oppression without free devices and free networks. (Cory Doctorow [author], in his talk “it’s not a fax machine connect to a waffle iron” at re:publica Berlin 2013)

Lower Costs for Support and Marketing

If you have an active community and a place where community members can discuss things and exchange knowledge online, their interaction can make a lot of support work obsolete. People can share questions and help each other in forums and other venues. Nevertheless, support does not necessarily have to come only from the online community. If your product is open, it is easier for third parties to offer support, compete in the marketplace, and make support faster, more accessible and cheaper for the consumers, thereby increasing the value of your product.

What is the most helpful aspect of open source hardware at your company? “Free PR from those same engineers who tell lots of others about my products. Free PR from people who make my products from my well documented online plans. (Cornfield Electronics, profitable, revenue of \$178,500 in 2013)

An active community with volunteers and stakeholders means a customer base interested in the success of your product. They will do some marketing for free. They will talk about your product, share it online and offline, and get something viral going.

People are searching the web for good resources. Putting your design files online can attract even more attention than purchasing ads could.

Being open is the most effective form of marketing, so publish early and often. (Open Source Ecology, nonprofit, revenue of \$300,000 from grants in 2013)

Publishing early and often is a development approach that can help reduce marketing costs and allow you to spend less time on marketing in general. Having open design files and an open development process means that people will already know about your product before it hits the market. If they love it and are active contributors, they will also spread the word and will be happy to help its success.

What is the most helpful aspect of open source hardware at your company? Reduced transaction cost in business. I don't have money for marketing or business development, so I just hang it all out there and let the informed buyer choose. (Andrew (Bunnie) Huang [Sutajio Ko-Usagi], profitable in 2013)

"If you build it, they will come" is a saying that does not automatically hold true with open source hardware. It takes a tremendous amount of work to create a community that will help support your products. Community building requires cultivation, encouragement, and appreciation of those members who do outstanding work. There are numerous examples of open source companies that have created positive communities that in turn have helped grow their brands. Notably, Lasersaur, RepRap, Open Source Ecology, and DIYdrones have all been intentional in fostering very positive communities whose support has led to explosive growth of these companies.

This is always the first thing I hear when I talked to people about open source: "If I open source my schematics, code, designs, I can't sell a product and make money!"

First, your project is not really about the nuts and bolts. The value of any project, open or otherwise, is much more about the service, community, and support that come with it. Great real-life examples are companies like Adafruit and SparkFun. Their products are entirely open source and transparent, and people buy from them because their support, community, and documentation are top-notch. People can still clone their products, but it's unlikely that people would buy others because they do not come with the same support, quality, and compatibility guarantees.

(Lasersaur)

Better Employees

Some companies are using forms of openness to attract and recruit highly motivated and qualified employees. Most people are good at what they do professionally because they learned a lot from others. Learning happens while sharing knowledge. Being allowed to share and interact with others enables people to improve their knowledge base. Having your name appear next to great resources makes you visible in your community, and allows you to burnish your reputation and grow your cultural capital. Public design files allow people to find a product online, study it, learn something about it and the company behind it, and take an interest in their fate.

Remarks on Dual Licensing & Closed Parts

While licensing is discussed in depth in Chapter 3, this section briefly considers what **dual licensing** means as a business model. Dual licensing is a mixture of both open and closed hardware models. Having a combination of some open source hardware and some patented parts on the same project is considered dual licensing. Having some source files that are open source and covered by a Creative Commons (CC) license and some that are closed and covered by a noncommercial (NC) license is considered dual licensing. This strategy can provide certain advantages, as it enables you to publish some of your design files without making them open source. It means that you add licenses to the design files or hardware that forbid certain uses, such as commercial use, production of derivatives, or military use. With an NC license, the design files are public and open to be studied by everyone and to be worked with by hobbyists and academics; if people want to make commercial use of the design, however, they must obtain a license from the project originator. This is not open source hardware: the Open Source Hardware Definition states that an open source license cannot discriminate against fields of endeavor or specific business uses. Thus, if you apply an NC clause to your work, you cannot call your hardware open source.

Perhaps most importantly, NC clauses produce a legal minefield because it is not entirely sure where commercial use starts. If I help a friend produce an NC-licensed device and beer is exchanged, are we violating the license? In the field of education, it is unclear whether educators can freely use and make copies of files that are under NC license if they teach at a for-profit university. Given the many gray areas associated with NC and dual licensing, why should someone choose your NC-covered hardware over fully open source hardware that gives the user ultimate freedom and a future full of yet unknown possibilities?

Publishing your design files without making them fully open source can help you realize some of the advantages mentioned earlier: with open design files your hardware could be used for education; it might be easier to hack, repair, and recycle; it can help people understand their technology and sustain their freedom; you would be transparent; and you could even get some bug fixes or improvements submitted. Nevertheless, this strategy quickly encounters some limitations.

The world is complex and cases are infinite. There may be instances where dual licensing is the right thing to do and would allow for some important things to happen (such as sustaining freedom or allowing recycling). Especially when you are thinking about venture capital, it is very likely that you will be asked to close some of your things. Maybe dual licensing is in some cases a good first step towards open sourcing something fully. Study carefully what you lose and what you win with closing some parts.

Numerous combinations of closed and open parts are possible. You could close the newest version and open up the older ones. You could create an open core with closed add-ons—for example, a printer that is open, but uses cartridges that are closed. You could open source the inner functionality of your hardware but protect your three-dimensional brand or shape; in other words, you could ensure that the inner workings of a mechanical puppet are open, but its outside appearance is protected. You could open source the design files of your products but keep the organizational structure of your production-chain or your backend software closed. Is it really possible or necessary to open source your packaging? Find your own individual combination.

Pick the flavor that is right for your business. There isn't a "one size fits all" business model or license. I recommend a balanced approach between open and protected, especially if you want external funding. (LittleBits, partly VC funded)

If you are closing things, you probably won't be able to take advantage of open source hardware for the closed parts. Taking away the ability of others to study, adapt, co-develop, and make commercial use of your hardware reduces the number of roles and motivations you offer to people. Your chances of growing your product into a strong platform (see the earlier discussion of the "product as a platform" approach) will probably decrease as well.

Of course, every case is different. Perhaps having something closed is the smartest and best option for your business and for the community around it.

Where Does the Money Come From?

Where will you find the money needed to start your business? There are a lot of possible income sources for a company. None of them are specific or unique to open source hardware, but working in the open source world can suggest unique ways to combine the advantages and possibilities that come with open source development and turn them into cash. Think about which assets you have or need to make an income. Usually monetizing a venture is connected to growing its assets. Build up your assets in the right way so you are likely to create a profitable business.

Produce and Sell Products

Hardware comes with a natural business model, regardless of whether those products are open source or closed source: you sell physical objects. It might be easy to argue about who the owner of an MP3 file is, but buying and selling a physical chair is a very straightforward process. This is the classic business proposition: I have this thing for sale for \$19.95. You may be able to raise the sheep to create the wool yourself, or hammer the fork into the correct shape, or solder the resistors together, but is it really worth your time? Can you produce the thing with the same quality or with the tools you currently own? It doesn't matter if your product is open or closed: people are willing to spend money so they can save time and focus on larger projects. If you design an open source product that people need, they will pay real money for it. People are always searching for reliable, warrantied and high-quality products and are willing to pay for them.

The secret to open source is innovation. If your company cannot innovate quickly, it will lose to the competition. This is the essence of a capitalistic marketplace. Behind every open source company, you will find people innovating quickly and freely. Open source entrepreneurs make money quite simply because they are innovating faster. Surprising to many people outside the open source community, these companies are making more money than their closed source competitors. (SparkFun Electronics)

Make your open source product easy to purchase, keep it in stock, and describe it clearly. Focus on business basics, and customers will choose to shop with you simply because you run a good business; open source will be the surprise filling in your pastry that they didn't know they would enjoy.

How much should you sell a product for? In his keynote speeches and his book *Makers*,¹ Chris Anderson of 3D Robotics talks about the 2.6 multiplier used at 3D Robotics. According to Anderson, he learned this concept from others: set the price for your product by taking its production costs and multiplying them by 2.6, and you will be able to sustain your business by selling the product. This markup also incorporates a margin for all people in the distribution chain; they are part of the community as well.

Don't give up if your business is not the cheapest source in the marketplace. Many factors cross a customer's mind when deciding which company to purchase from. Price is important, but so are quality, availability, sustainability, support, and ease of use (just to name a few!).

¹<http://www.makers-revolution.com/#about-makers>

Foundation/Consortium Model

The foundation model is something we know from the open source software world. With this approach, the administration of the product is handled by a (nonprofit) foundation. Members of this foundation are different companies, public institutions, and private persons who have an interest in using the product and the advantages that come from its being open source. Different models for foundations exist, but in most cases each member pays fees for the common infrastructure and contributes to the development process. Companies hire and pay developers to work full time on the project. Foundations may also generate standards, and charge members to use the standard. Finally, some foundations are nonprofit organizations that receive grant funding for their projects, such as Open Source Ecology.

The consortium model is a lot like the foundation model, except that the consortium can be a for-profit entity. There may be fewer members; indeed, the consortium may potentially serve only large companies. To use this approach, you need to have the right product and a lot of potential stakeholders. You also need a good development model, a governance model, a suitable license and IP model, and a maintenance and support model. If you are thinking about pursuing a consortium model, a good starting point for research could be open source software foundations such as the Eclipse Foundation and the Document Foundation.

Selling the Service Using OSHW

Making money from open source hardware does not necessarily mean selling the hardware itself. You can also sell what you are producing with that hardware. For example, you might sell 3D prints rather than your open source printer. You might sell energy, rather than the open source power plant you use to create it. You might sell transportation, rather than the technology you use to provide that service. You might sell a data service, rather than the hardware you use to collect the data. You might repair open source garbage disposals as your revenue stream, rather than manufacturing or selling those products.

If your infrastructure and your machines are open source, you can make the advantages of open source work for you to create a better and cheaper service with them. Marcin Jakubowski, for example, started Open Source Ecology because his tractor broke and he needed a new one for his farming operation but could not afford to buy one.

It is likely that we will have more discussions in the future about open source hardware for public service infrastructure. Think of the democratic value the community and society will attach to it. It should become more difficult to justify why our police cars, power plants, street lightning, and water treatment plants are not open source if there are open source solutions available to meet these needs.

This is precisely how the Arduino team works. It makes little off the sale of each board—only a few dollars of the \$35 price, which gets rolled into the next production cycle. But the serious income comes from clients who want to build devices based on the board and who hire the founders as consultants.

What's more, the growing Arduino community performs free labor for the consultants. Clients of Banzi's design firm often want him to create Arduino-powered products. For example, one client wanted to control LED arrays. Poking around online, Banzi found that someone in France had already published Arduino code that did the job. Banzi took the code and was done. (Wired Magazine 16.11 October 20, 2008, "Build It, Share It Profit" by Clive Thompson on the first three years of Arduino.)

Hardware on Request

If your products are not made for an assembly line, you might be able to make your money from individual development, customizations, or adaptations addressing individual needs, cases, or scenarios. An example is the installation of a sophisticated irrigation system. Make things special for individual customers, such as "aspirin tailored to your DNA" (Kevin Kelly²), an example of a truly enabling product. Can you imagine selling unique prototypes like art or making the first copies worth more than later ones? This model produces hardware on request, although it might also seem close to "selling the service." Using or creating open source hardware for individual solutions allows you to make the advantages of open source work for your product or service and your customer. Imagine a marketing campaign based on this capability: customers buy your expertise for the product created.

Support

There are two ways to make money from support. First, the business model may focus on selling support to install, repair, or be on call for hardware. This support model has been successful in the open source software business world; a notable example is RedHat. For some software, you need professional help to install it and run it. Some open source hardware might potentially use the same model; that is, you need professionals to operate, maintain, upgrade, or sometimes repair the hardware. "The copy of code, being mere bits, is free—and becomes valuable to you only through the support and guidance" (Kevin Kelly³). Consider

²<http://kk.org/thetechnium/2008/01/better-than-fre/>

³<http://kk.org/thetechnium/2008/01/better-than-fre/>

offering a support or service deal. If you're a small start-up, the fact that you're a co-developer of the hardware might make it easier for clients to trust you owing to your expertise.

Education and Training

Selling education and training is also a possibility derived from the open source software world. You can download design files everywhere, but hand-holding or trained skills may be more difficult to obtain. Some people will be happy to book a workshop to learn how to make something or hack on your product. Perhaps you can sell physical copies of books. Working with open source hardware, providing it, or developing it can make you a visible and proven expert in a field. You can monetize that expertise by holding workshops or consulting. SparkFun's education department bought an RV and drove it around the United States while teaching workshops to teachers. A school would pay for SparkFun to make a stop in its town to train its teachers. If special training is needed to operate or maintain the hardware, you can offer courses and tests or a certificate program to become a proven administrator for the hardware. If you are the main developer of the hardware, it might be easier for *you* to be the trusted institution.

All sorts of events focusing on or celebrating open source hardware are an excellent place to gain leverage, such as hackathons. Physical objects to touch, test, or play with also attract attention. You can sell tickets for such events, and then display your hardware there. Open things are often easier to celebrate because all layers are visible to celebrate. Which sounds like more fun: a hackathon exploring an Arduino-driven washing machine, or a trade fair with closed source washing machines to look at and hear numbers about?

Your Channels

In open source hardware ventures and any other businesses, things get exchanged. Products and parts are sold; building plans and knowledge are communicated, viewed, shared, and downloaded. These exchanges need channels. Webpages and webshops, forums, stores, workshops, and other venues focused on communication are all examples for channels. Channels offer special ways to generate revenues for those people running them. Do you have your own successful and trusted webshop? Use it to sell not only your own products but also the products of others and gain a profit margin. There are several ways to monetize the customers you already have. Can you find some elegant possibilities for advertisement?

Product partnerships could be another possibility. If you build your hardware with supplies from certain companies or shops, get them on board and cross-advertise your products. Ask for a discount on their hardware or ask for a public relations (PR) fee when mentioning their product in your tutorials and design files. If your webpage is a trusted place for certain information, use it to sell workshops or certificates. Can you rent out your hackerspace or some of your machines—offer a full library of things to play with, test, or experiment with, while collecting fees from visitors.

Channels are important for everything else mentioned in this chapter as well. When you create your business, ask yourself, Which things get exchanged and which channels are needed for this industry? Which of these channels do you want to create and maintain yourself? Which channels could be used by others, and how could they pay for it? Channels are assets you can make money from.

Funding and Crowd Funding

Funding and crowd funding are options that you can pursue to get some early money into your pockets. Most of the open source hardware businesses are bootstrapped, but some are backed by venture capital funding. When businesses obtain VC funding, they are often asked to close some designs down. VC funding, however, is not as big or important as people tend to think. As Diane Mulcahy pointed out in her *Harvard Business Review* piece “Six Myths about Venture Capitalists,”⁴ fewer than 1% of U.S. companies have raised capital from VCs and the VC industry is shrinking.

If you can, bootstrap it. If you own 100%, then every dollar you earn is a dollar you can keep. Once you get VCs involved, you're diluted out; also, your gains are illiquid until a so-called “liquidity event” when you get VCs involved—it can take years before you see a dime, if anything. The VC wants to shoot the moon, and will encourage you to squander every dime building the company up to be huge, even if you don't want that. Remember, the VC is paid out of management fees and performance of a composite fund, but you're paid out of just one horse in the race. However, if you own 100%, you can take a dividend or a payment out of your company anytime you think is appropriate.” (Bunnie [Sutajio Ko-Usagi])

An alternative to VC funding is crowd funding. Crowd funding is very popular with open source hardware projects. Most crowd-funding platforms require a working prototype, so such campaigns are often used for gaining attention and growing a community for an existing or advancing product. Crowd funding leverages viral videos of campaigns. It is also used to test the water and collect feedback for the product, in the form of open innovation, or to collect pre-orders and collect some money

⁴<http://hbr.org/2013/05/six-myths-about-venture-capitalists/ar/1>

before getting in touch with producers. Click through literature about crowd funding before you jump into these waters, as crowd-funding sites have different stipulations.

The following text should be gray-shaded and boxed

Anecdote: Crowd Funding

Marcus Schappi

The process of crowd funding a project can lead to better OSHW projects, and vice versa. The necessity of having to pitch your project to would-be backers forces you to distill the project down to its most crucial elements. The platform provided by crowd funding means that there are many like-minded individuals checking out your project. In our latest Kickstarter project, we made the schematics to the MicroView immediately available for download. Soon after, one of our backers identified an issue with the circuit and provided a fix that we were able to incorporate into the shipping product. As they say, starting is easy and finishing is hard. Having backers is a great motivator, as they'll be sure to tell you off if you don't post regular updates, and really let you know about it if you don't ship!

End gray-shaded and boxed

Sponsoring, Grants, Donations, Public Research

In keeping with the rationale for the “ethical bonus” of open source hardware, it may be possible to fund some kinds of initiatives through donations or grants. There is often a public interest or promise to “make the world a better place” that is considered worthy of funding. Large companies may sponsor such efforts by partnering with smaller open source hardware projects. Jobs in public research could be dedicated to developing open source hardware. The more that the advantages and values of open source hardware for our communities are realized, the better democracy and the environment will become, and the harder it will be to justify enormous public research funds being devoted to closed source innovations. The more we work on developing examples that show and explain how open source is good for the public, the easier it will be to support open source hardware projects with public funding, grants, and donations in the future. For more information about the benefits of open source hardware projects in research, refer to Chapter 16.

The following text should be gray-shaded and boxed

Anecdote: Open Source Hardware in Public Art

Brandon Stafford

The realm of electronics, like the Arduino and its ecosystem, has dominated the open source hardware efforts of the last decade. Despite the success of the Arduino, most electronic hardware is still proprietary. Large hardware companies are reluctant to open source their designs because they see the blueprints for their designs as a source of advantage over their competition. If their competitors knew exactly how to fabricate their designs, they could replicate everything, without having to pay any engineers to come up with the designs. Additionally, virtually the entire electronics industry is funded by private investment. Occasionally, we see public investments like Small Business Innovation Research (SBIR) grants in the United States, but they are rare. We could summarize the situation in the electronics world as follows: “private money pays for originals; payback comes from replication.”

In the world of art, the situation is reversed, and in public art, even more so. The summary for public art is this: “public money pays for the original; the original is the payback.” Open sourcing public art can add an even greater payback, as future artists can build on the work of their predecessors.

Today, reproducing art is no longer a serious challenge. Paintings can be forged well enough that ordinary people are fooled, and any kid with a computer can duplicate music or movies. If the only thing that makes a Monet a Monet is that the guy holding the paintbrush was named Monet, then the argument of whether the methods of creation need to be secret is over. The greatest forger can paint all day long, and she'll never make a Monet. Like Marcel Duchamp submitting a urinal to a gallery in 1917, the art lies in the act of creating the art, not the physical object itself.

Public art, where an artist is paid to create art that is installed in a public setting, like a park or city plaza, has the same characteristic: the identity of the artist makes the art. The funding for public art usually comes from public sources, such as municipal governments or neighborhood advocacy groups, or occasionally private philanthropists for the benefit of the public. Public art tends to be site specific and unique; we don't want replicas of Anish Kapoor's giant shiny bean (“Cloud Gate”) in Chicago duplicated in every city around the world. Leo Villareal's LED installation on the Bay Bridge in San Francisco needs the bridge to hold it up; it wouldn't work in Phoenix, Arizona, where there is no water, never mind bridges.

Some public art is already being open sourced. For the last few years, I have worked as part of New American Public Art, a group of five artists in Boston and Philadelphia, that open sources all the art we create. We've found that open

sourcing public art is harder than it seems. Open sourcing our code and electronics designs is easy, but most of our art has large mechanical elements that are largely undocumented. As we're building, we make a few pencil sketches, but they're often inaccurate by the time the design is finished, due to design changes made along the way. As we start to use more digital fabrication tools, such as 3D printers, CNC routers, and laser cutters, we're finding that open sourcing our mechanical designs is easier, but we often can't afford to spend the time to detail assembly and finishing procedures. Of course, that's where the open source hardware community can come in!

End gray-shaded and boxed

Summary

When you are selecting a model for an open source hardware business, you have a variety of options to choose from. Concentrate on making the advantages of open source hardware work for you, and combine them with means to generate income. Figure out the best mix and strategy for your individual case. Keep an eye on other projects, and learn about the business models followed by other open source hardware companies. Open source hardware and open design are still in their early stages, so there is a lot of room for improvement and a lot of things worth trying.

Many of the points made in this chapter are easily said, but not easy to do. Building a hardware business—open or not—is hard. All of the open source hardware companies interviewed for this chapter reported that their problems were overwhelmingly business problems, not open source problems. While making your hardware open source will give you some possible advantages, it will also add some challenges to your workload. Creating and providing useful information, maintaining up-to-date design files, and managing a community take a lot of time and skill. Nevertheless, this is where the collaborative advantages of the open source world come into play. Currently, a lot of the tools used to collaborate on complex hardware projects are lacking or are not as effective as software collaboration tools, but you can help make those better. The more people start working on open source hardware, the more development will gain speed and get more powerful, modular, and distributed. The better the tools, the better the open source hardware, the easier it will be to build a business on top of it, and the more important it will become for our economy.