Comprehensible Open Hardware

on building the Open Book and friends

Joey Castillo, FOSDEM 2024
About Me

- Technologist in Residence at Cornell Tech in NYC
- I make things under the banner of Oddly Specific Objects
- Background: Journalism, not tech
- Learned by doing and making (and cribbing notes from open source designs)

- **True believer in Open Source Hardware**
FRAMEBUFFER SRAM

SPI SRAM can be used to store the screen data if the NCU doesn't have 6KB free SRAM.

VOLTAGE REGULATOR

3/5V -> 3V LEVEL SHIFTING

HEADER PINS

SD CARD

SD & MMC

1.54in RedBlack eInk rev E
7/15/2018 11:41 PM Sheet: 1/1
Drawings: AUTHOR Adafruit Industries
The Open Book

Goals

• Function as an open hardware ebook reader
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• Support reading texts in all the languages of the world
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• Be affordable, accessible and DIY’able
Много Ли Человеку Земли Нужно
ألد ليلة وليلة
孙子兵法

Οδύσσεια
The Weary Blues
Little Women
The Sun Also Rises
Paul's Case
The Gun
The Picture of Dorian Gray
The Great Gatsby
The Machine Stops
Frankenstein
The Open Book
Goals

• Function as an open hardware ebook reader

• Support reading texts in all the languages of the world

• Be affordable, accessible and DIY’able

• Be understandable by the person who builds and uses it
But, why?
The Problem
Closed tech fails users

- Who does the technology empower?
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- Who does the technology empower?
- Who does the technology diminish and disempower?
- Why does the technology get to do this?
- What can we do about it?
One Solution
Make it comprehensible

- Design well documented open hardware...
- ...that people can build on their own and understand, at least in broad strokes...
- ...to teach them that they don’t have to accept technology that wasn’t made with their best interests at heart.
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“The point of open source is not to ritualistically compile our stuff from source. It’s the awareness that technology is not magic: that there is a trail of breadcrumbs any of us could follow to liberate our digital lives.”

- Bunnie Huang, “On Liberating My Smartwatch From Cloud Services”
  https://www.bunniestudios.com/blog/?p=5863
So, what are those breadcrumbs?
Three Sets of Breadcrumbs
Different trails for different contexts

• Explaining how it works.
• Explaining how to build it.
• Explaining how to use it and hack it.
This trail leads to... Understanding how it works?

- Use the silkscreen to narrate what each component is for
- Pros:
  - It could demystify the tech?
- Cons:
  - Hard to really explain it in the space available
- Is this the most useful info?
Maybe.
Optimizing for DIY builds
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- Larger passives and exposed pins for easier soldering
Open Book Abridged

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- Using a friendly module like the Pi Pico make it easier for folks
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- Have a fine pitched part? Put it on your own castellated module and PCBA that!
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- Have a fine pitched part? Put it on your own castellated module and PCBA that!
- Use the silkscreen for assembly instructions!
This trail leads to...

Building the device yourself?

- Use the silkscreen for directions to the person building it

1. The On/Off switch

Melt a blob of solder onto one of the pads, then melt it again as you place the switch on the footprint. The pin should bond to the board. Then solder the other two pins. Note that UP is the ON position.
This trail leads to...
Building the device yourself?

- Use the silkscreen for directions to the person building it
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This trail leads to…
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What about self-documenting boards that come preassembled?
Moving to PCBA
AKA: not building it yourself

- Arrange components in functional blocks...
- …that match what’s in the schematic
- This still gives an overview of "how it works"
- Still: what to do with the rest of the silkscreen?
This trail leads to... Making use of the device!

- Pin assignments and notes on how to develop for the device!
- True facts: I use this a ton when writing my firmware!
- It’s an affordance both for me and for users of the device.
This trail leads to…
Making use of the device!

• Pin assignments and notes on how to develop for the device!

• True facts: I use this a ton when writing my firmware!

• It’s an affordance both for me and for users of the device.

• Works on boards of (many?) shapes and sizes.
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Making use of the device!

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Self-documenting circuit boards...

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- Add immediate context to the hardware you have in hand
- Create a self-contained artifact
- Are user-hackable by default
- Pairs nicely with code that makes use of the same names

```c
// Buttons
HAL_GPIO_PIN(BTN_LIGHT, A, 22)
HAL_GPIO_PIN(BTN_MODE, A, 23)
HAL_GPIO_PIN(BTN_ALARM, A, 2)
```
Questions to Ask
How can we do even better?

- How do I imagine other people making use of the device?
- What affordances am I offering in the service of those use cases?
- What information would I want to give to a novice user of the device? An advanced user?
- Can I tell the story of the device in a way that makes sense?
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Oddly Specific Objects: oddlyspecificobjects.com
The Open Book: theopenbook.is
Sensor Watch: sensorwatch.net
Fediverse: mastodon.social/@joeycastillo