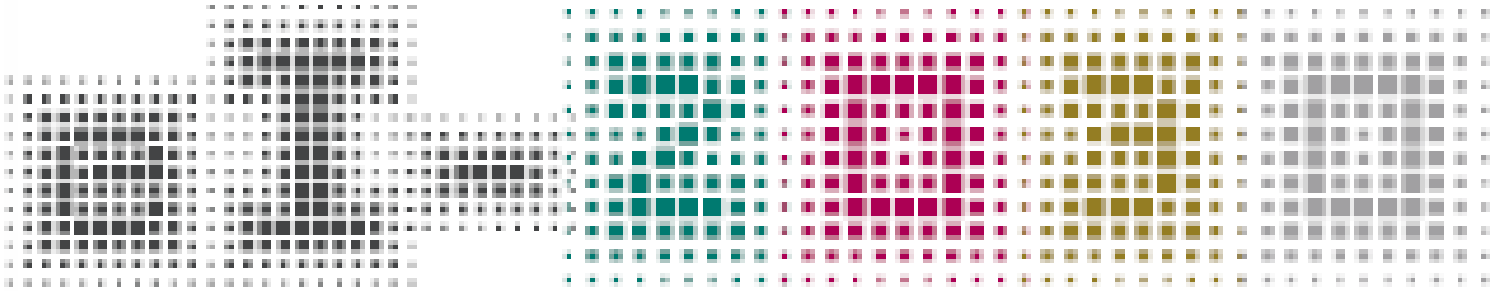


Building an Open-Source E-ink Laptop

Tuesday, 1st June 2021, at 14:00 UTC+2

Speaker notes

Thank you to foss-north for organizing this event and for the invitation.

Alexander Soto
(he/him/his)
Project Lead
@EI2030

I’m a community organizer, educator and software engineer.

My interests are in exploring community-building, social justice, education, and leveraging technology to address social problems.

I’m currently an Expert In Residence at Resilient Coders and I'm the project lead at EI2030.

@alexsotodev

alexsoto.dev/slides

contact@alexsoto.dev

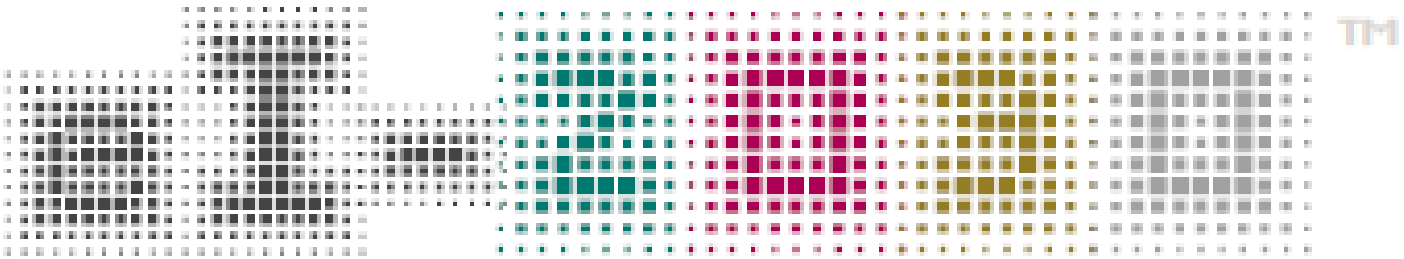
ei2030.zulipchat.com

Speaker notes

Summary

My name is Alexander Soto, my pronouns are (he/him/his). I'm currently an Expert-In-Residence at Resilient Coders and I'm the project lead at EI2030.

Below you can find my Twitter handle @alexsotodev, email, our Zulip Server, and website where you'll find the slides posted for this talk.



The goal of EI2030 is to promote healthier computing practices, connecting people who are interested in **learning**, **discussion**, and facilitating the exchange of **ideas** and **collaboration**.

Speaker notes

A little history, EI2030 started about a year ago amidst the COVID-19 pandemic, the transition to remote-working, and the increasing amount of time we spend on our digital devices. The goal of EI2030 is to promote healthier computing practices, connecting people who are interested in learning, discussion, and facilitating the exchange of ideas and collaboration.

Wenting

Brodie

Tom

Anjan

Matt

Manuel

Giovanni

Speaker notes

Summary: We are a broad mix of hardware/productivity hackers, health-tech enthusiasts, and gadget lovers. Our community is open to everyone and we are steadily growing. I want to say thank you to...

Wenting: DSP Product Application Engineer, member of #Driving E Ink Displays and #Non-emissive Displays working groups, and leads the development of our Archer/Caster laptop prototypes.

Brodie: An electrical engineer focuses mainly on product design, member of #Laptop Chassis working group and leads the development it's development.

Tom: Studies psychology at the University College London, member of the #Psychology & UX working group, focuses on the psychological benefits of e-ink and the UX/UI of creating e-ink applications

Anjan: Supports day-to-day activities at EI2030, experience in industry and displays, member of #Non-emissive displays and #Psychology & UX working groups.

Matt: Software developer of 15+ years, leading the development of our website using Gatsby

Manuel: One of the original founders of responsible for marketing and community activities.

Giovanni: Supports with day-to-day activities at EI2030 and is a member of #Low Power and #PaperTerm working groups.

Community Built E-Ink Laptop Project

- Build a proof of concept of an **open-source** and **open-hardware** e-ink laptop.
- Pool our resources, knowledge, and expertise in working groups.

KiCad

FreeCAD

Speaker notes

We've recently have launched: The Community Built E-ink Laptop Project. We are building a proof of concept of an open-source and open-hardware e-ink laptop. As a community, we pool our resources, knowledge, and expertise in working groups.

Structure

- A working group focuses on a **specific objective.**
- **Timeboxed**.
- Documents their **process**.
- Shares **resources** and **knowledge**.

Speaker notes

- Zulip - Topic threading
- Github
- Gatsby aggregates from different repositories using git-source-plugin.

Working Groups 🛠️

- Drivers for E-ink Displays
- Laptop Chassis
- Non-emissive Displays
- Psychology & UX
- Low Power MCU's
- PaperTerm

Speaker notes

Summary: mention working groups on left directly related to eink laptop, low-power mcu's and paperterm exploring the possible use cases of an eink laptop

Driving E-Ink displays:
Explore the different ways to drive an eink display
- Near: Using the i.MX7/8 and RK3566 family of microcontrollers.
- Long: Building an open-source external electrophoretic display controller.

Laptop Chassis:
- Using open-source software, i.e. FreeCAD/OpenSCAD create a laptop chassis that can be used for building an eink laptop.

Non-emissive Displays:
- Discuss non-emissive displays such as e-ink, RLCD, DES, and alternatives.
- Create prototypes and learning more about display physics.
- Research on non-emissive displays' developments will be distilled and shared for current/future working groups.

Psychology & UX:
- Investigate the psychological benefits of e-ink.
- Ideate and investigate ways to design the UX of e-ink devices to improve productivity and well-being through psychology.

Low Power MCU's:
- Explore the available Real-time operating systems and develop a Linux port from scratch for the Ambiq Apollo 3 & 4 series processors or similar ultra low power microcontroller.

PaperTerm:
- A microcontroller-based project used solely to connect to and run/interact with programs installed on remote computers through SSH/telnet, remote desktop, VNC. etc

Meet Archer 👋

Speaker notes

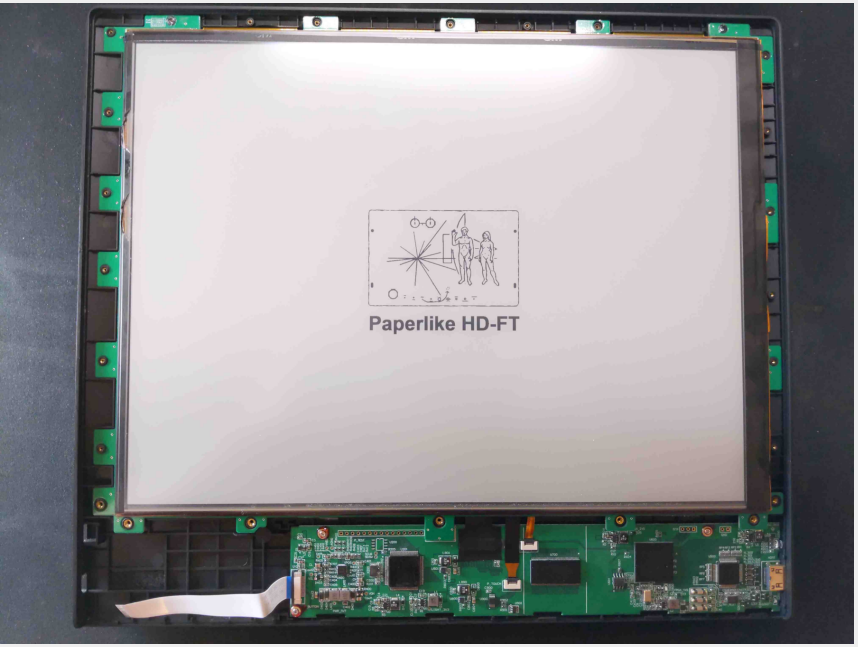
Goals of Archer

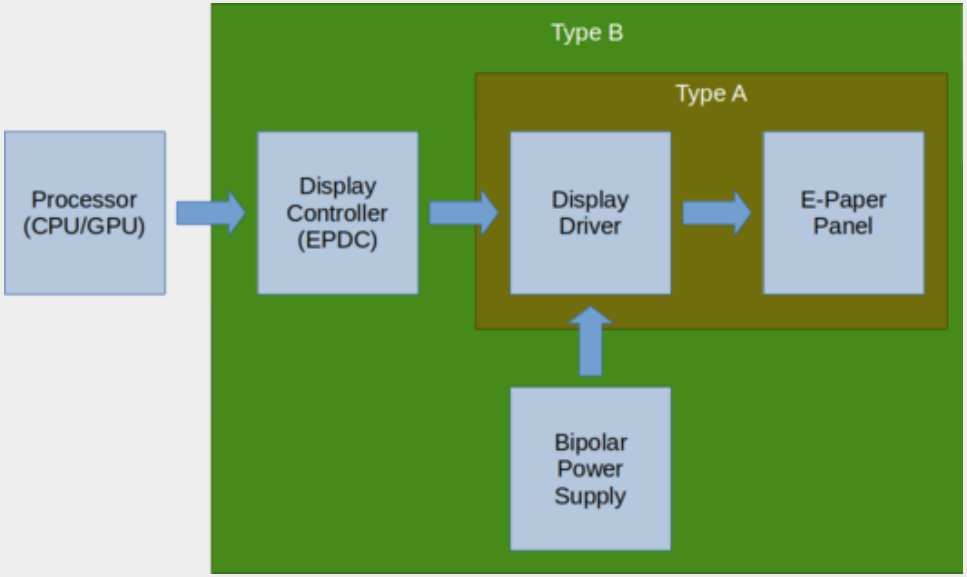
- Proof of Concept of an eink laptop.
- Enable early development of EC firmware and the user software.
- Test chassis design ideas.
- Verify peripheral circuit design.
- Enable future prototypes

Challenges Building an E-Ink Laptop 🎯

#1 Driving an E-Ink Display

- Proprietary electrophoretic display controller (EPDC).
- Proprietary vendor waveforms.





Speaker notes

- EPDC, specifically designed to drive e-ink panels.
- Waveforms control the transition of state changes on the screen, text, graphics, etc.
- Dasung, Onyx

Progress: #Driving E-Ink Displays

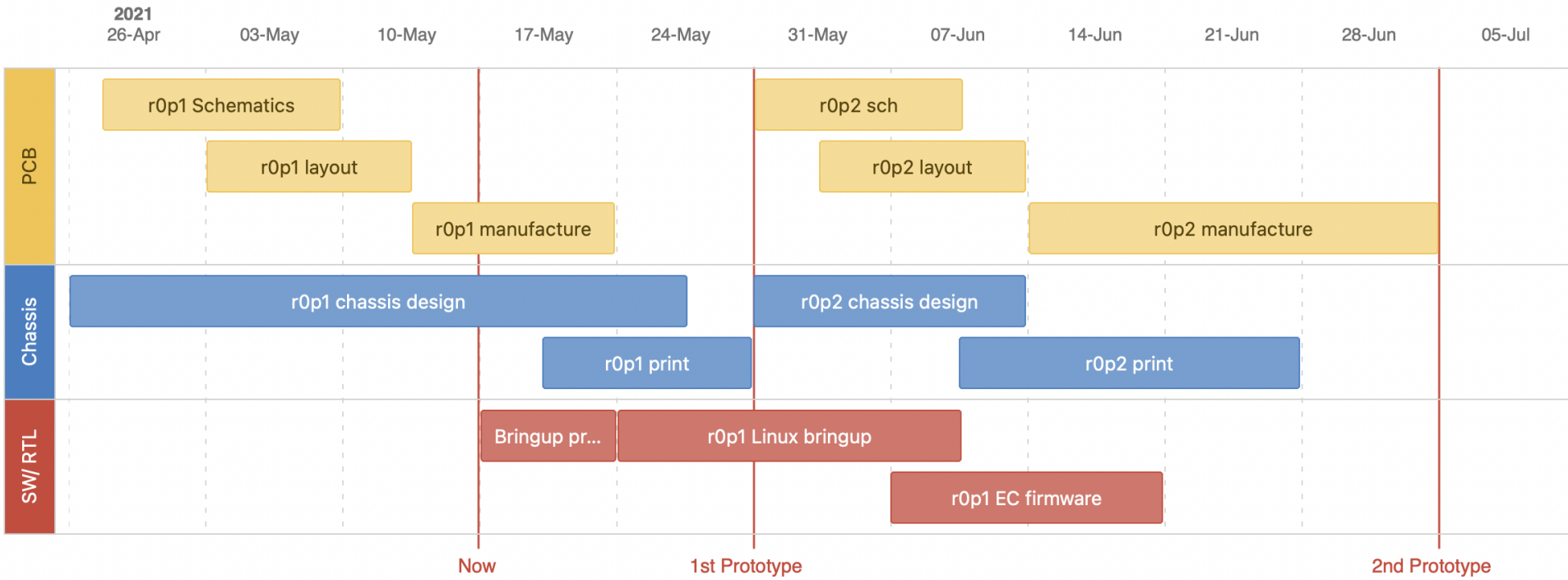
To build our **open-hardware** and **open-source** e-ink laptop we are creating:

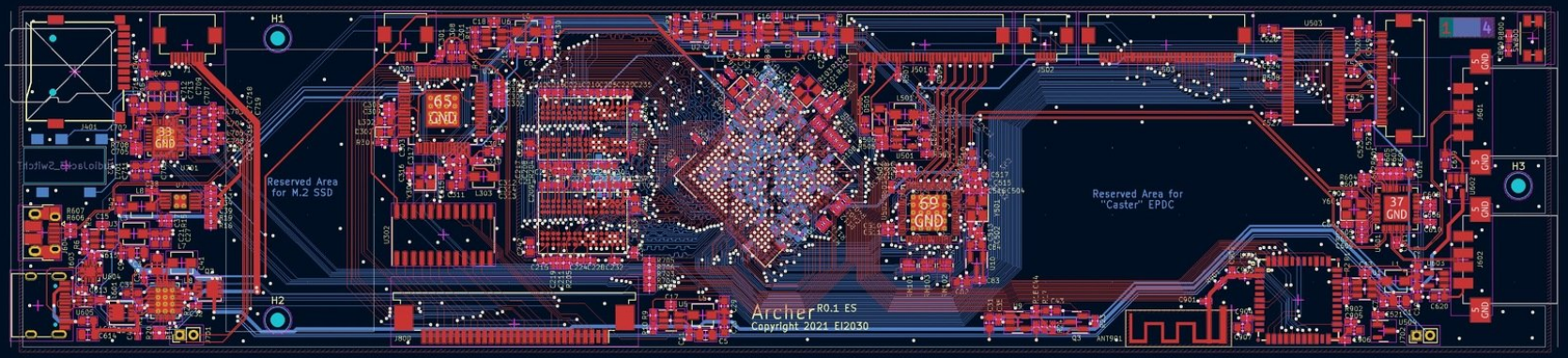
- **Open-hardware** electrophoretic display controller to drive e-ink panels.
- **Open-source** waveforms for different e-ink panels.
- Design files available on our **EI2030 Github account.**

In time, we hope to create a database of open-source waveforms compatible with a range of eink displays to be used in different projects and devices.

Speaker notes

- Creating an open EPDC enables the creation of open-source waveforms as an alternative to the vendor waveforms.
- The creation of open EPDC and waveforms enables the re-use of eink displays and opens up space for others to contribute.


2021
26-Apr
03-May
10-May
17-May
24-May
31-May
07-Jun
14-Jun
21-Jun
28-Jun
05-Jul
PCB
Chassis
SW/ RTL
r0p1 Schematics
r0p1 layout
r0p1 manufacture
r0p2 sch
r0p2 layout
r0p2 manufacture
r0p1 chassis design
r0p1 print
r0p2 chassis design
r0p2 print
Bringup pr...
r0p1 Linux bringup
r0p1 EC firmware
Now
1st Prototype
2nd Prototype



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This source is distributed WITHOUT ANY EXPRESS OR IMPLIED WARRANTY, INCLUDING OF MERCHANTABILITY, SATISFACTORY QUALITY AND FITNESS FOR A PARTICULAR PURPOSE.

Copyright EI-2030 2021. / Engineer: Wenting Zhang

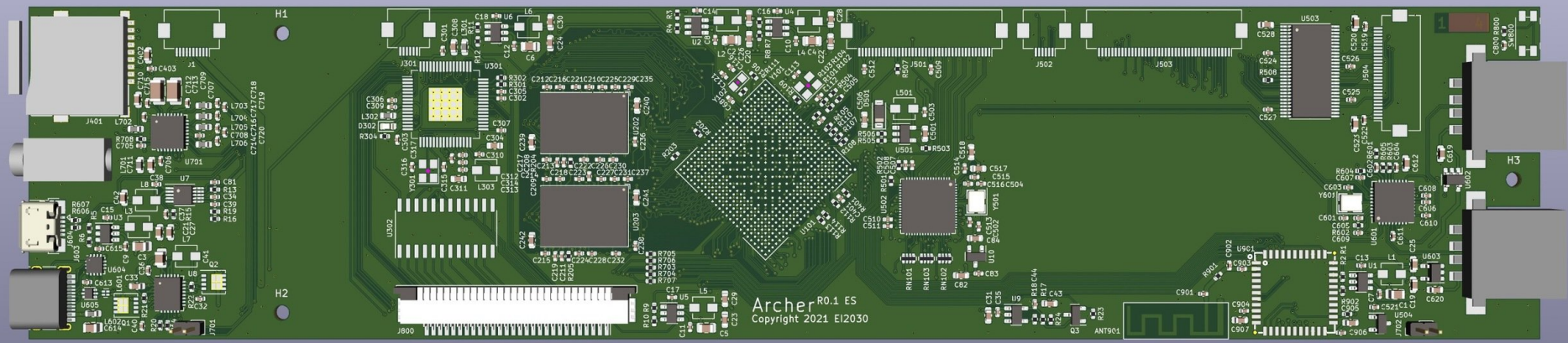
Sheet:
File: pcb.kicad_pcb

Title: Archer mainboard

Size: A4	Date: 2021-05-05	**Rev: R0.1 draft**
KiCad E.D.A. kicad (5.99.0-10539-g7356f9568d)		Id: 1/1

Speaker notes

We've started working on the mainboard for our prototype Archer. The mainboard has been fabricated, experienced some delays in shipping.


Archer R0.1 ES
Copyright 2021 EI2030

Specifications 📋

- **SoC**: NXP i.MX 7Dual (2x ARM Cortex-A7 @ 1.2GHz)
- **RAM**: 2x Micron MT41K256M16 (1GB in total, DDR3)
- **Flash**: None (prototype designed to always boots from TF card)
- **HDD**: None
- **Network**: RTL8273BS (802.11n + BT)
- **Main Screen**: E Ink ED103TC2 (10.3" 1872x1404) with capacitive touch screen
- **Sub Screen**: ER-TFT0784-1 (7.84" 1280x400) with capacitive touch screen
- **Screen Controller**: i.MX7 integrated EPDC
- **Battery**: 2x User-replaceable LiFePO4 18650 battery
- **EC**: LPC55S28
- **Ports**:
  - USB 2.0 Type-A Host x1
  - USB 2.0 Type C UFP with Power Delivery x1
  - USB 2.0 Micro B Serial Debug Console x1
  - TF card slot

Speaker notes

Non-goals:
- Archer will not represent the performance level of the final product
- Archer is not optimized for low power consumption

Caster

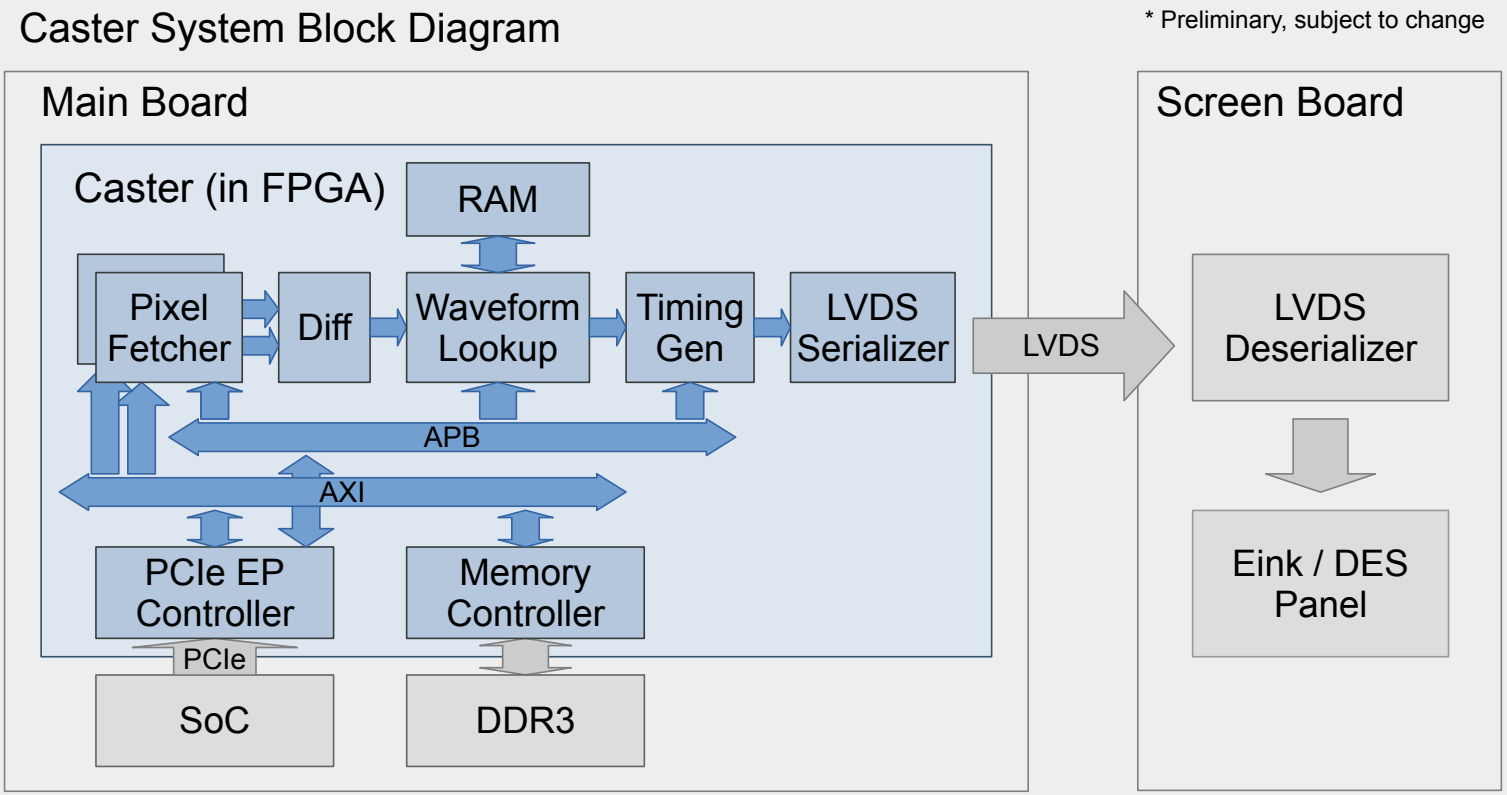
- Caster is the codename for our open-hardware EPDC using an FPGA development board.
- 2230 M.2 E-key or A-key slot and provide one LVDS connector to connect to EPD panels.

Speaker notes

Specification 📋

- **FPGA**: XC7A15T or XC7A35T-1CSG325C
- **RAM**: Micron MT41K64M16 (128MB, DDR3)
- **Form Factor**: M.2 NGFF A key or E key
- **Host Interface**: PCIe Gen2 x1 (500 MB/s)
- **Port**: 1x 30pin LVDS connector (4ch 7:1 LVDS + 1ch I2C) to connect to Eink panels

Caster System Block Diagram



#2 Laptop Chassis

- 10.3 - 13.3 e-ink screen use an aspect ratio of 4:3.
- Difficult to find an original design manufacturer(ODM) that has a laptop chassis with a 4:3 display aspect ratio.
- There are not many laptop chassis that are completely open and made with FOSS.

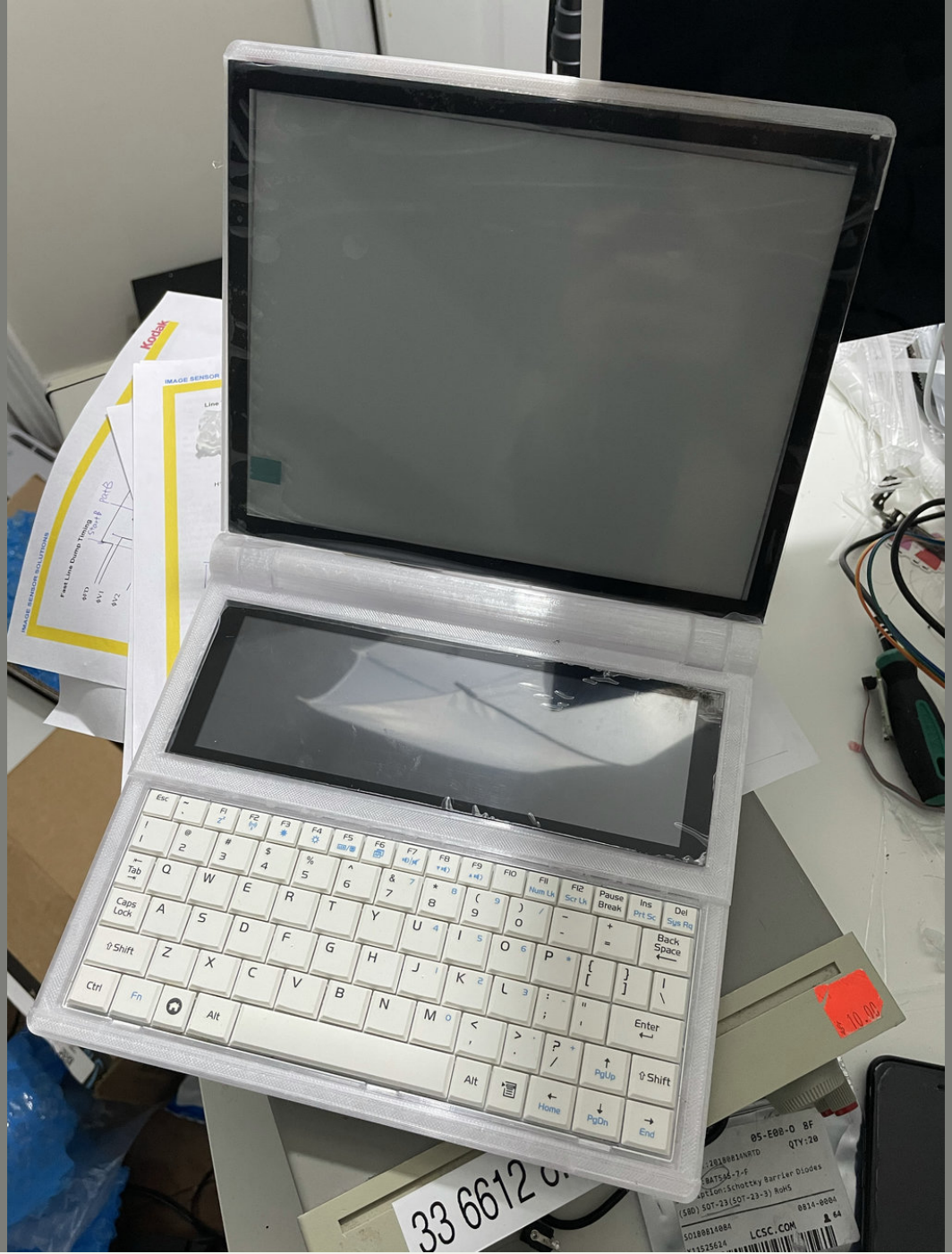
Speaker notes

- STEP, STL
- Made with proprietary software

Progress

Archer

Prototype For The Community Built E-Ink Laptop Project


Kodak
IMAGE SENSOR
IMAGE SENSOR SOLUTIONS
Fast Line Dump Timing
Caps Lock
Shift
Ctrl
Fn
Alt
Home
PgUp
PgDn
End
Enter
Back Space
Pause Break
Ins
Del
Sys Rq
Prt Sc
Scr Lk
Num Lk
$ 10.00
LCSC.COM

Esc
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
Num Lk
F12
Scr Lk
Pause
Break
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K
L
Enter
Shift
Z
X
C
V
B
N
M
PgUp
Shift
Ctrl
Fn
Alt
Alt
Home
PgDn
End

Progress: #Laptop Chassis

To build our **open-hardware** and **open-source** e-ink laptop we are creating an:

- **Open-source** design of a parametric laptop chassis using **FreeCAD**.
- We've started looking at different possible laptop designs.
- Design files available on our **EI2030 Github account.**

By using **FreeCAD** to design the laptop chassis, we hope to enable others to remix and adapt our design to their needs.

Speaker notes

Brodie is in the early stages of designing a parametric laptop chassis using FreeCAD.

#3 Operating System and Applications

- There isn't an open-source e-ink first operating system.
- There are few e-ink optimized applications.

Speaker notes

MuditaOS

mudita

PRODUCTS ABOUT COMMUNITY STORE

Mudita Pure

OVERVIEW DESIGN EINK SAR MUDITAOS SPECS FAQ PRE-ORDER

MuditaOS

Minimalistic, yet powerful

Developing our mobile operating system has been a big challenge in the process of creating Mudita Pure. We came up with a beautifully designed E Ink mobile OS and open-sourced it to fully meet our users' desire for quality and transparency.

MuditaOS is Open Source

Sign up for the Developer Preview

SIGN UP

Speaker notes

- MuditaOS: Based on FreeRTOS(Real-time operating system), open-source e-ink mobile operating system. Developer Preview to sign-up

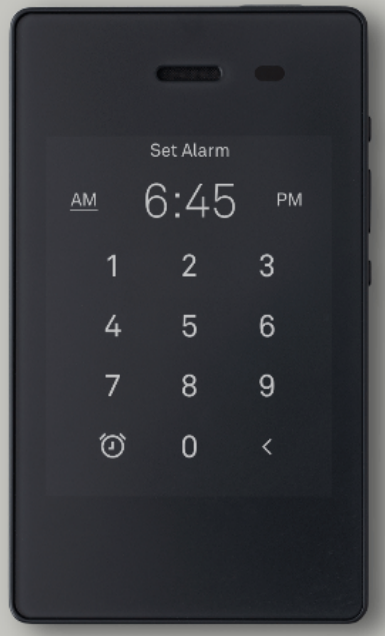
LightOS

tools not feeds

The Light Phone II is built around a user-customizable menu of tools. All of the tools are custom-designed for our LightOS to ensure a thoughtful, and private user experience.

Available tools currently include an alarm, a calculator, a simple music player, and a podcasts tool. The phone also supports hotspot tethering.

The Directions tool is in development and is expected in late Spring 2021. We'll continue to release other utility-oriented tools, which will be available with software updates.

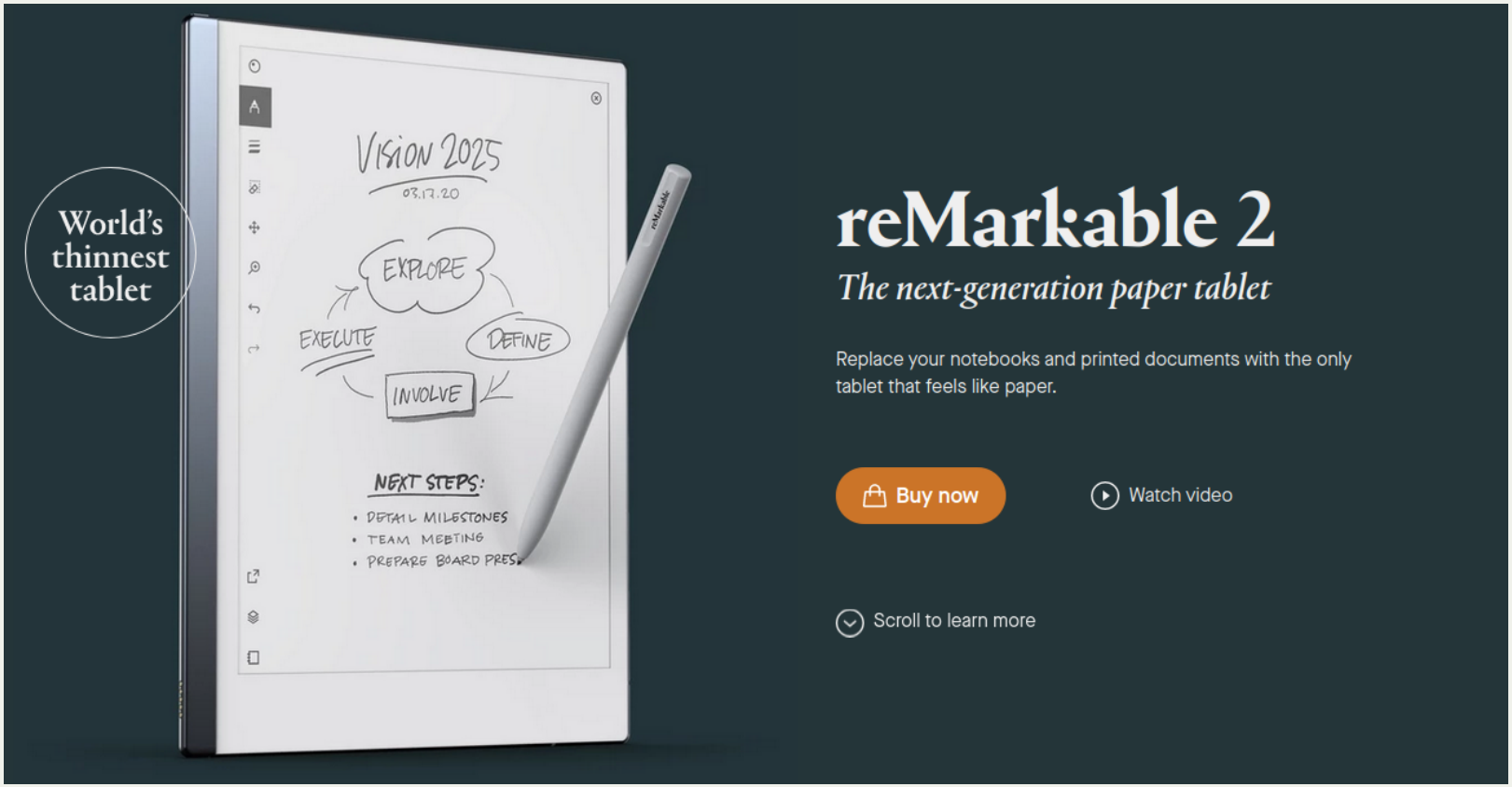


Alarm

Speaker notes

Light Phone II / Light OS: Based on Android Operating System Project (AOSP) and uses a React Native app as the default launcher.

Codex


World's thinnest tablet
VISION 2025
03.17.20
EXPLORE
DEFINE
INVOLVE
EXECUTE
NEXT STEPS:
• DETAIL MILESTONES
• TEAM MEETING
• PREPARE BOARD PRES
reMarkable 2
The next-generation paper tablet
Replace your notebooks and printed documents with the only tablet that feels like paper.
Buy now
Watch video
Scroll to learn more

Speaker notes

Remarkable / Codex: A custom Linux-based OS optimized for low-latency for their tablet. Parts are available: boot-loader, kernel, SDK | UI is not publicly available.

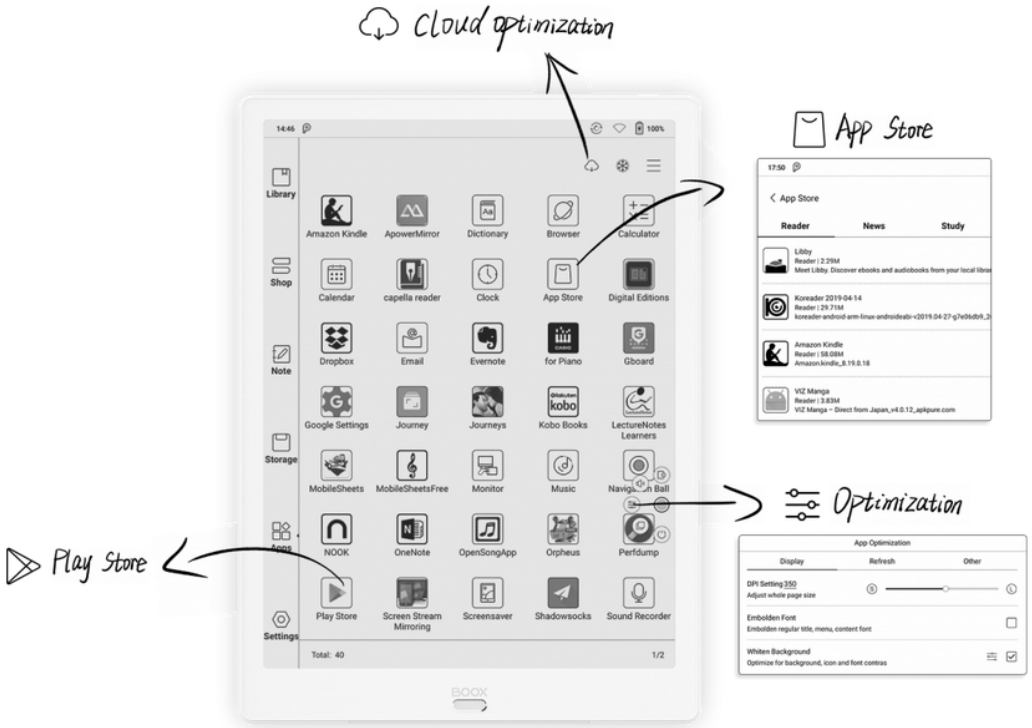
Onyx Boox

BOOX PRODUCTS ACCESSORIES BUY SUPPORT TECHNOLOGY BUSINESS ABOUT ENGLISH

Tools for Apps on E Ink

Get Everything Done Fast with Apps

There are various apps can be downloaded from the built-in App Store to improve your work efficiency. Find more interesting third-party apps such as office, news, magazine apps from Google Play. And easily optimize them for the best performance on E Ink display.



Speaker notes

Onyx and Dasung devices: Best to my knowledge uses AOSP with a UI not publicly available.

Dasung

NoteReader 103
Unprecedented E-ink Tablet
Display Like Real Paper
Powerful, Portable & Versatile
10.3 E-ink Tablet 227 ppi
Qualcomm 660 Chip
DASUNG Turbo High-speed Refresh Technology
Open Android 9.0 4G+64G TF Card
Cool & Warm Front-light
5 Points Touch
6400mAh QC 3.0
Bluetooth 5.0 WiFi / 5G
Speaker & Microphone
Compatible with Most Devices

Open Android 9.0, 4+64G Mass Storage
Open Android system,smart, you can install various Apps such as Facebook / YouTube / Ted, 4+64GB memory large-capacity storage, supports TF expansion card.

What would a digital device look like that respects our attention, time and health?

Progress: #Psychology & UX

To build our **open-hardware** and **open-source** e-ink laptop we are making:

- Researching how to create e-ink optimized applications.
- Coming up with design principles.
- Performing case studies on the possible psychological benefits of eink.
- Exploring Android, Fuchsia, minimal Linux distribution

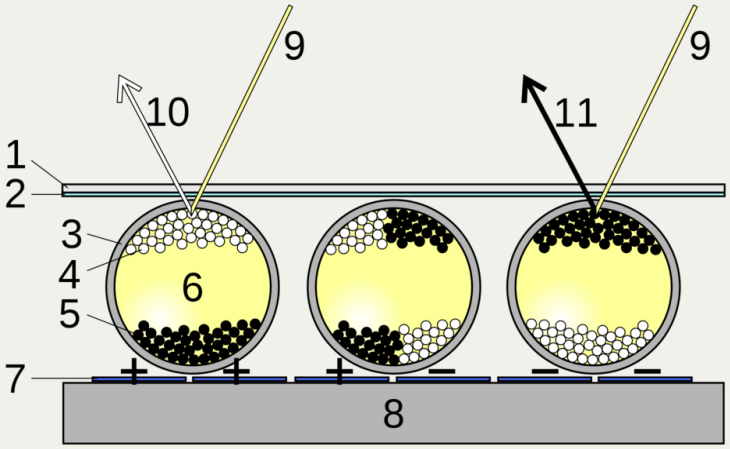
🔎 We are looking for software developers and UX/UI designers interested in building e-ink applications.

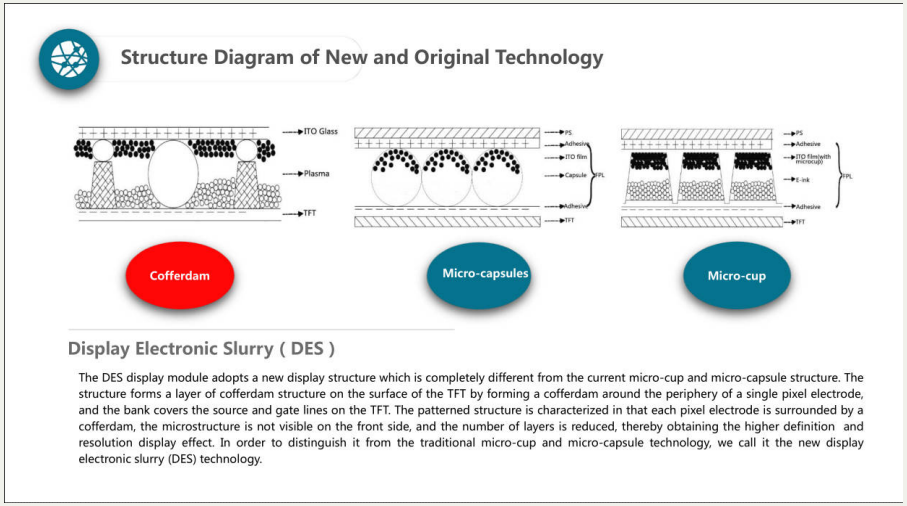
Speaker notes

#Psychology & UX working group

#4 Sourcing the E-ink Display

- How to satisfy E-Ink's minimum order quantity(MOQ) (10,000?)
- The "chicken & egg problem"
  - Perceived lack of application & demand and thus lack of suppliers producing e-ink displays.
- DES, RLCD, E-ink, Electrowetting...





Progress: #Non-emissive Displays

To build our **open-hardware** and **open-source** e-ink laptop we are:

- For our prototypes, we are using the 10.3" e-ink panel from Waveshare.
- We are looking to source e-ink panels from other distributers, Good Display. (no MOQ)
- We are exploring using alternative epaper technologies such as display electronic slurry (DES).

Progress

GDEW0154M10
1.54" EPD DES
152 x 152
R=45% CR=35
GDEH0213B72
2.13" EPD
Microcapsule
250 x 122
R=35% CR=10

#5 Manufacturing Process

- Costs and prices (injection moulding!)
- Sourcing of parts (keyboard, hinges, etc.)
- Minimum order quantities
- Domain specfic knowledge
- Mistakes happen
- Time

Speaker notes

- The cost of Injection moulding anywhere between 10-15 thousandth.
- Sourcing of parts: keyboard, hinges among others.
- Minimum order quantities that need to be fulfilled
- Mistakes happen in the manufacturing process
- Time consuming
- Domain-specfic knowledge

Progress

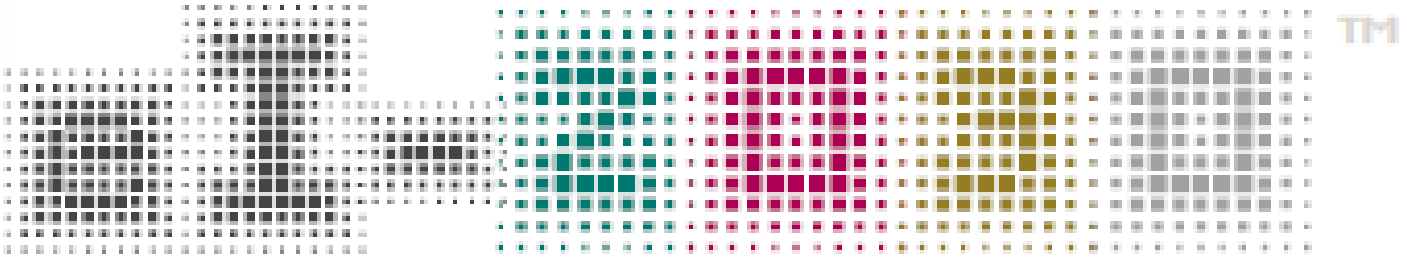
To build our **open-hardware** and **open-source** e-ink laptop:

- We are 3D printing our initial prototypes, i.e., laptop chassis.
- Producing laptops at scale requires injection moulding.
- Exploring crowdfunding options.

🔎 We are looking for more people with experience in the manufacturing process.

Next Steps

- Learn from Archer and work on our second prototype that includes Caster, our open EPDC.
- Iterate on the open design of our laptop chassis and test.
- Build e-ink optimized applications and identify people who are interested in contributing.
- Learn more about the manufacturing process.
- 2021 Hackaday Prize
- Crowdsourcing Campaign in 2022.



If any of these challenges or a part of the project interests you let's talk

@alexsotodev

ei2030.zulipchat.com

contact@alexsoto.dev

alexsoto.dev/slides

Wenting

Brodie

Tom

Matt

Manuel

Giovanni

Thank you! 🎉🙂