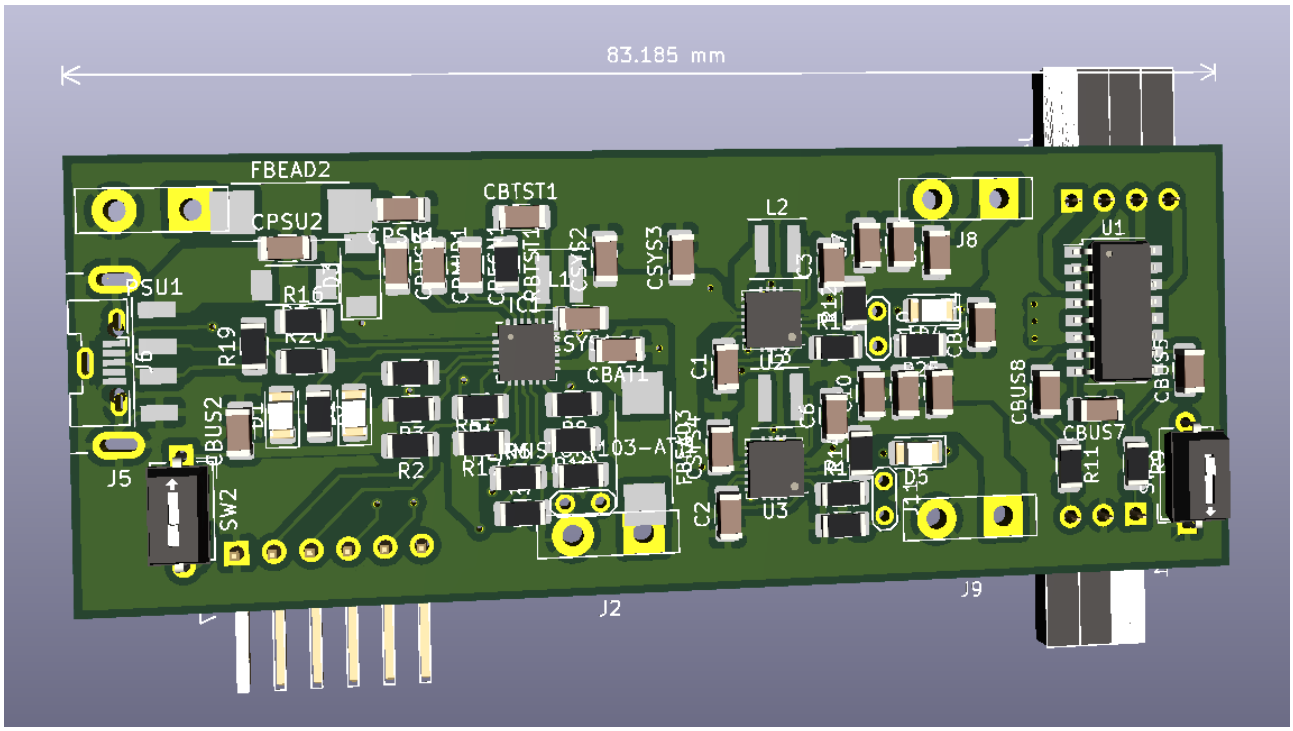
Balthazar system continues...

So, we defined Balthazar as open-source open-hardware project of an affordable laptop computer. The basic hardware idea crystalized in a skeleton principle: to upgrade one buys a new raspberry pi-like, orange pi- like, ... mini-computer. These small computers are the result of current miniaturization processes that are derived directly from mobile phone industries. Sometimes called the "singapore" computers – since many of the startups are located there. They are cheap and moving fast. Balthazar project will probaly have a specific CPU/GPU hardware result too.

However, my specific job is to prepare the skeleton for the brain to be plugged in. To reach the goal of soon-to-be prototype of an open-source laptop, some basic parts of the system were pushed to the degree of functional blocks. Two pcb's were developed:

1. Power supply unit based on battery charger (Texas Instruments) chip from any available source (12V / 4A mains adapter or USB power bank) and two separate buck/ boost converters for 3.3V or 5V for the necessary computer blocks (the LCD and the processor board). The board also has a stereo D-class audio power amplifier powered directly from battery (and/or adapter) 3.6 to 4.2V - so as not to dwel on the two much more important stabilized sources.

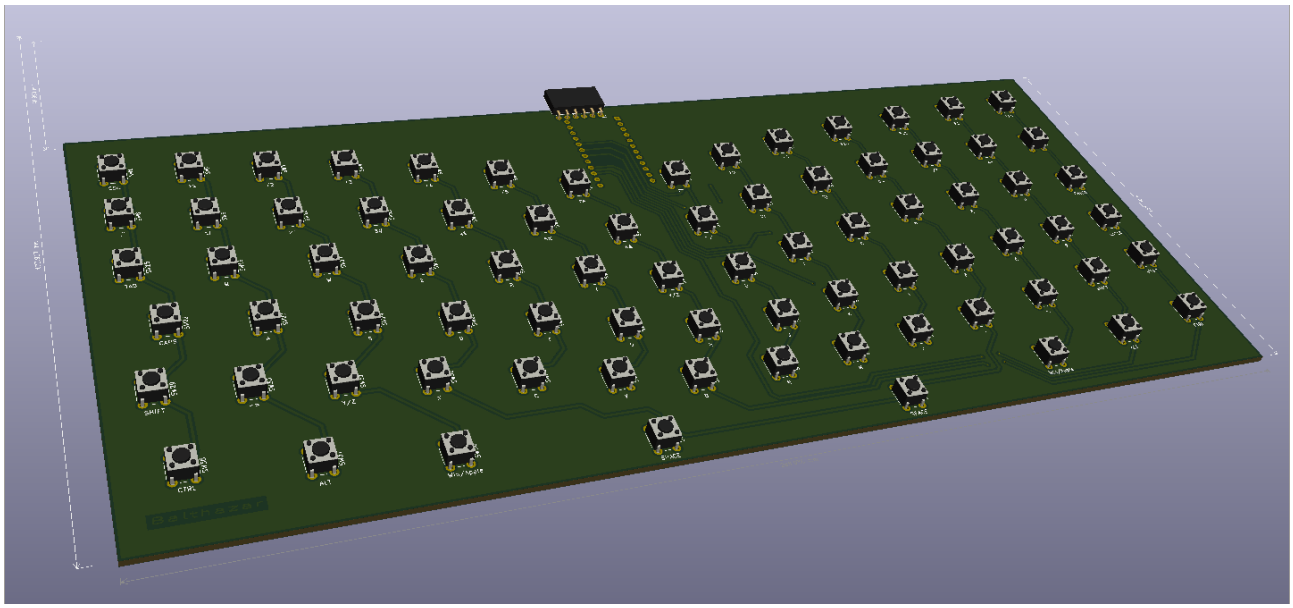


From left to right / top to down:
- Terminals for adapter
- USB-A power bank connector
- option for USB-micro on-the-go periphery
- toggle switch for manual charge disable
- connector for I2C and additional data control
- TI BQ battery charger chip
- optional charger I2C control lines
- LiIo or LiPo battery terminal with thermistor protection terminals for approx. 10Ah 1s (paralleled single cell) battery pack
- two separate buck/ boost dc-dc converters with separate options for 3.3V/4A or 5V/2-3A
- approx. 3 to 5W class-D stereo audio power amplifier (bridge mode) with line audio input
- toggled switch for manual audio mute

2. The computer keyboard system with microcontroller (*for now an 8-bit Atmel built into a small Sparkfun ProMicro board)*
A normal ISO keyboard layout is used. An option is given to test the ability of the microcontroller to handle also the control for PSU board and the touchpad module data transfer to USB. Keypad and touchpad user activities are usually mutually exclusive – so this seems ok. Charger control is active a couple of seconds on startup of the system, so this is also ok. In case of some charger error there is a mechanical switch on PSU board to stop charging. In this way three functions would be fulfilled in a single microcontroller – connected to the system with one USB.

Keyboard pcb has some dimensions already defined by the LCD's dimensions of 13.3 inch in diagonal: 290mm x 180mm. The width is the most determining factor for the keys raster which is about 17mm – instead of the regular 19mm. The keys have some ergonomic solution that gives some additional design touch.

The keyboard switches are important but are for now very typical low cost membrane switches. A little better solution are the softer (silicone) – but still membrane – switches (not much love for the higher quality Cherry buttons). The idea is to have a waterproof (silicone) layer over the whole board. The board can then already act as a top cover. The feel of silicone rubber is preferred to that of natural rubber.



If the keyboard pcb is meant to act as the complete top cover then it's height is also defined by the LCD -> 180mm. The touchpad module would fit above the keys (as was envisioned in the broad design considerations recently) – not as usual below the keys.

The two loudspeakers go to the usual positions left and right – at the two top edges of the full-size keyboard pcb. In this way the acoustic horn effect will be at its best with LCD screen up.

The mechanical skeleton built in this manner needs additionally an USB hub board on the top right which also takes in all the necessary inner periphery (camera, keyboard). There are some of these hubs on the market, but could be made here additionally. On to four hub is prefectly ok - two externally accessed USB-connectors and two internally used for camera, keyboard.

The keyboard in this rudimentary fashion acting as the top is also very thin – maybe defining the triangle-like side cross-section – since there must be enough space at the top/ back/ bottom of the lower segment. The battery pack consisting of LiIo batteries are standardized in diameter – so this

defines the height. About the same size are the vertically positioned USB-A female plugs.
The loudpeaker sound greatly benefits from this volume behind.

Let's repeat: the interchangeable CPU/ GPU upgrade module would basically be the mini-computer mainboard itself. To upgrade – one buys a new board and inserts it in the place of the old board. If the software and file system could be kept on some SSD version of mass storage – this would be an advantage (or maybe a necessity...).

Just a thought:

If this laptop skeleton could be made compatible with existing modules like Raspberry Pi, Orange Pi, etc... - then it would already enter the market...

This idea defines the following:
- Raspberry Pi dimensions: 55 x 85 x 20mm
- Orange Pi dimensions: 60 x 95 x 20mm
- above meaning that the inner depth of the computer should be 20mm – creating a bulge
- so-far 5V/3A seems to be the power supply standard
- HDMI video output on existing boards means that Balthazar laptop might need HDMI-LVDS converter included internally.
- some internal mass storage and converter.

While not the basic aim, the two PCB modules can be used independently and already have their expanded functionality (computer keyboard on its own via USB, keyboard with touchpad via USB, battery charger on its own via adapter or USB with audio power amplifier...).

Mechanical shell construction:

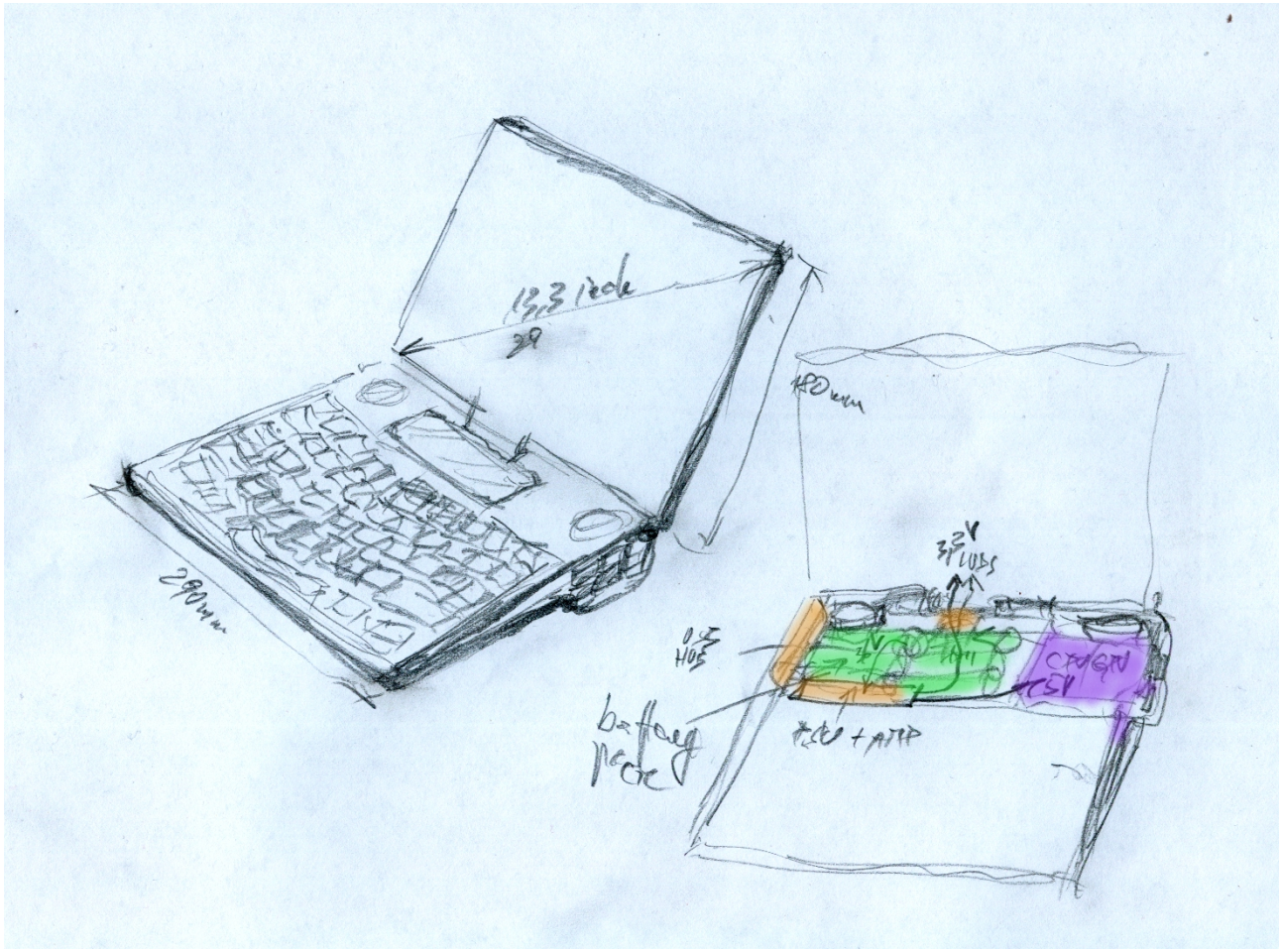
The top cover seems to be solved with larger keybard PCB, the LCD display front solves itself. The bottom of Balthazar and the LCD back will have to act as efficient thermally conductive surfaces, electromagnetic shields and be mechanically rugged enough. Aluminium is the best. One piece formed for the bottom, another for the screen back. Some simple hinge between the two – at the middle. A bit more thicker aluminium sheet – much stronger the case.

Aluminium sheets would be pressure formed into relatively rounded form with some hatched crossections/ corrugations to add to torsion stability. Underneath the keyboard PCB a couple of screws would create a firm sandwich stucture. However, we should not bother too much with the durability and indestructabilty – it should be simple and cheap. And a bit special.

The back of the LCD screen may be glued to LCD. The computer top with keyboard, touchpad and loudspeakers is attached to the bottom aluminium formed plate with screws. PSU pcb should be attached to bottom plate – for the cooling reasons and the heavy duty PSU wire connections.

The battery pack is situated centrally to the left, while the (preferably) L-shaped mini-computer seats at the top right. In some way the heat from the SoC or processor, etc. should be transferred directly to bottom aluminium shell to allow for the passive heat dissipation – if possible. With the existing -pi solutions the board would be turned top to bottom and some form of additional aluminium stand/ heatsink added. Yes, it can be done.

There was a wish that maybe adapter could be inserted from the left side, but this doesn't look very realistic. The priority is the battery pack. Or maybe this priority may be left to the user? Half of the battery pack and an mains adaptor side by side?



Here is a fast sketch and a brief look at the outer looks – on the left - and inner guts (on the right). Notice the bulge at the bottom end of lower part - to acommodate the voluminous parts. If the front part below the keyboard is kept thin we get much more air flow below. We also get the sloped trapezoidal form for the front – meaning that the hands are more relaxed. They are also not seating on the computer (which is a good thing).

Half of the green stuff (LiIo battery pack) could be exchanged for mains adapter. The violet block is a -pi computer. The HDMI goes to LVDS converter chip (orange block near the hinge) where it is also joined with 3.3V LCD power supply from the PSU – AMP module (orange). On the leftside the USB HUB orange block.

Camera can be situated somewhere – depending on how adventurous we feel – not much use to set it up above the display! Maybe on the hinge itself. The microphone also needs some amplification – not usually provided on -pi computers by default. The camera and microphone must have options for mechanical cover/ disable.

The lower part of computer has main weight very near the the hinge to the display part. This might prove a bit too close – the balance of weight might not be good enough. On the other hand – the thin modern lcd screens are very lightweight and the back aluminium cover can be much thiner than the bottom aluminium shell. A prototype would allow to check on this.

Details on PSU module

Features:

- **LiIo / LiPo battery charger 3A with wide range of input options**
- **mains adapter 4.9-17V/3A, USB power bank 5V power sources**
- **two independent dc-dc buck/ boost converters (each 3.3V/4A or 5V/3A)**
- **options for USB on-the-go power supply for external devices**
- **options for logic control of charger**
- **manual charge enable/ disable switch**
- **class D stereo audio power amplifier 2 x 3W**
- **manual audio mute switch**

Bathazar PSU schematic version 0.2
Bill of materials
PCB ready for prototype

Details on Keyboard module
Features:

- **ISO standard keyboard layout**
- **a bit ergonomic design**
- **minimally (1/10th) reduced keyboard size**
- **silicone rubber waterproof overall keys blanket**
- **microcontroller shared between keyboard, charger safety control and touchpad PS2 to USB**

Bathazar keyboard schematic version 0.2
Bill of materials
PCB ready for prototype