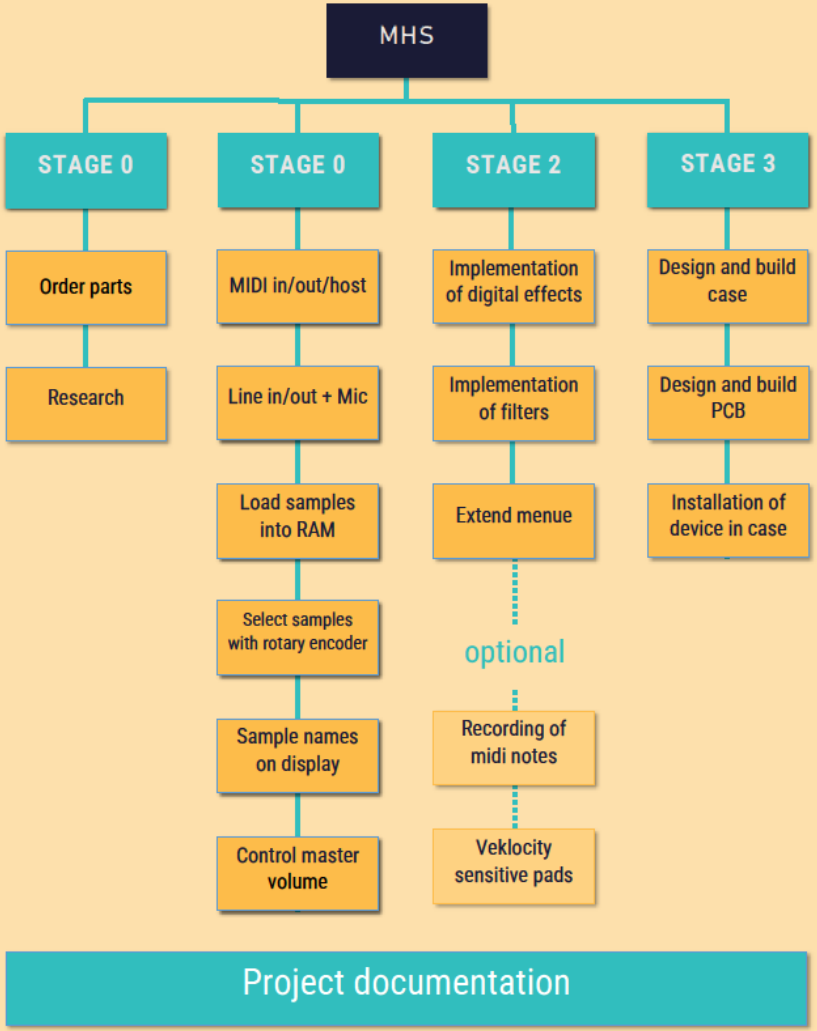
# MHS

MOBILE HARDWARE SAMPLER


MHS
STAGE 0
STAGE 0
STAGE 2
STAGE 3
Order parts
Research
MIDI in/out/host
Line in/out + Mic
Load samples into RAM
Select samples with rotary encoder
Sample names on display
Control master volume
Implementation of digital effects
Implementation of filters
Extend menue
optional
Recording of midi notes
Veklocity sensitive pads
Design and build case
Design and build PCB
Installation of device in case
Project documentation

| AP number | Work package | Project part | Duration (days) | Predecessor |
|---|---|---|---|---|
| 1 | audio playback and storage | Audio | 10 | 0 |
| 2 | sample selection with rotary encoder | Display | 10 | 3 |
| 3 | displaying selected sample names | Display | 10 | 0 |
| 4 | menu design (structure and visuals) | Display | 5 | 3 |
| 5 | line out playback | Audio/Midi | 5 | 1 |
| 6 | recording with line in and mic | Audio/Midi | 10 | 1 |
| 7 | master volume control | Audio/Midi | 5 | 5 |
| 8 | Midi connection over DIN 5 connecto | Midi | 10 | 0 |
| 9 | digital effects and filters (at least 2) | Audio | 15 | 1, 5, 7 |
| 10 | menu extension: controlling effects | Display | 10 | 2, 3, 4, 9 |
| 11 | Adding 4 velocity sensitive pads | Audio/Midi | 10 | 1, (12) |
| 12 | recording midi | Audio/Midi | 10 | 8 |
| 13 | 2-8 voice polyphony | Audio | 5 | 1, (9) |
| 14 | case design and crafting | Display | 10 | 2, 5, 6, 8 |
| 15 | pcb assembly | Audio/Midi | 10 | 2, 5, 6, 8 |
| 16 | device assembly (case + pcb) | All | 10 | 15, 14 |
| 17 | testing performance stability | All | 10 | 1 – 13 |
| 18 | testing mobility | All | 5 | 16, (17) |
| 19 | testing usability | All | 5 | 2, 3, 4, 10 – 13, (18) |

STAGE 1

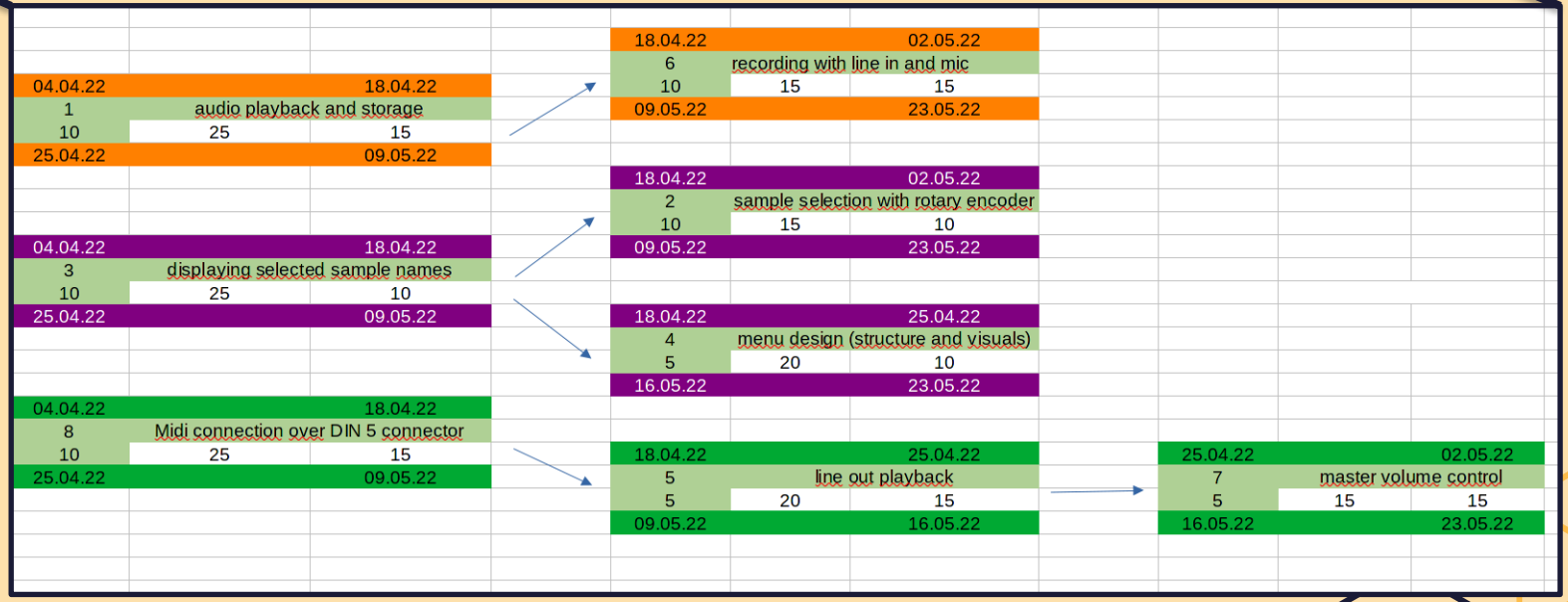
Stage 2

Stage 3

Testing and troubleshooting

| Nr. | Work package | Duration | CW 14 (04.04.) | | | | | CW 15 (11.04) | | | | | CW 16 (18.04.) | | | | | CW 17 (25.04.) | | | | | CW 18 (02.05.) | | | | | CW 19 (09.05.) | | | | | CW 20 (16.05.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F |
| 1 | **Stage 1** | **7 weeks** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | audio playback and storage | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | sample selection with rotary encoder | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | displaying selected sample names | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | menu design (structure and visuals) | 5 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | line out playback | 5 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | recording with line in and mic | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | master volume control | 5 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | Midi connection over DIN 5 connector | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**buffer**



| Nr. | Work package | Duration | CW 21 (23.05.) | | | | | CW 22 (30.05.) | | | | | CW 23 (06.06.) | | | | | CW 24 (13.06.) | | | | | CW 25 (20.06.) | | | | | CW 26 (27.06.) | | | | | CW 27 (04.07.) | | | | | CW 28 (11.07.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F | M | D | M | D | F |
| 10 | **Stage 2** | **8 weeks** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | digital effects and filters (at least 2) | 15 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | menu extension: controlling effects | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Adding 4 velocity sensitive pads | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | recording midi | 10 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | 2-8 voice polyphony | 5 days | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**buffer**

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| 23.05.22 | | | | | | | | | | | | | 13.06.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | digital effects and filters (at least 2) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | 25 | | | | | | | | | | 20 | | | | | | | | | | | | | | | | | | | | | | | | |
| 20.06.22 | | | | | | | | | | | | | 11.07.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23.05.22 | | | | | | | | | | | | | 06.06.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | menu extension: controlling effects | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | 30 | | | | | | | | | | 30 | | | | | | | | | | | | | | | | | | | | | | | | |
| 04.07.22 | | | | | | | | | | | | | 18.07.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23.05.22 | | | | | | | | | | | | | 06.06.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | Adding 4 velocity sensitive pads | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | 30 | | | | | | | | | | 20 | | | | | | | | | | | | | | | | | | | | | | | | |
| 20.06.22 | | | | | | | | | | | | | 04.07.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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| 13.06.22 | | | | | | | | | | | | | 20.06.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | 2-8 voice polyphony | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | 20 | | | | | | | | | | 20 | | | | | | | | | | | | | | | | | | | | | | | | |
| 11.07.22 | | | | | | | | | | | | | 18.07.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 06.06.22 | | | | | | | | | | | | | 20.06.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | recording midi | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | 20 | | | | | | | | | | 20 | | | | | | | | | | | | | | | | | | | | | | | | |
| 04.07.22 | | | | | | | | | | | | | 18.07.22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Nr. | Work package | Duration | CW 21 (23.05.) | CW 22 (30.05.) | CW 23 (06.06.) | CW 24 (13.06.) | CW 25 (20.06.) | CW 26 (27.06.) | CW 27 (04.07.) | CW 28 (11.07.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | M D M D F | M D M D F | M D M D F | M D M D F | M D M D F | M D M D F | M D M D F | M D M D F |
| 16 | **Stage 3** | **4 weeks** | | | | | | | | |
| 17 | case design and crafting | 10 days | | | | | | | | |
| 18 | pcb assembly | 5 days | | | | | | | | |
| 19 | device assembly (case + pcb) | 5 days | | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 23.05.22 | | 13.06.22 | | 13.06.22 | 20.06.22 |
| 9 | digital effects and filters (at least 2) | | | 13 | 2-8 voice polyphony |
| 15 | 25 | 20 | → | 5 | 20 | 20 |
| 20.06.22 | | 11.07.22 | | 11.07.22 | 18.07.22 |
| | | | | | |
| 23.05.22 | | 06.06.22 | | | |
| 10 | menu extension: controlling effects | | | | |
| 10 | 30 | 30 | | | |
| 04.07.22 | | 18.07.22 | | | |
| | | | | | |
| 23.05.22 | | 06.06.22 | | 06.06.22 | 20.06.22 |
| 11 | Adding 4 velocity sensitive pads | | | 12 | recording midi |
| 10 | 30 | 20 | → | 10 | 20 | 20 |
| 20.06.22 | | 04.07.22 | | 04.07.22 | 18.07.22 |

# Quality Control

1. Real Time DSP
2. Clear User Control
3. Sample Polyphony
4. Modern looking
5. Connectivity

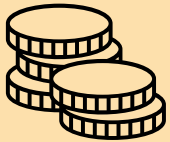
# Quality Control

1
2
3
4
5

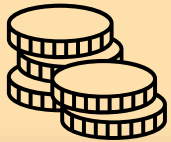
| Quality Goals | Quality Criteria | Achieve Quality Goals | Quality Control |
|---|---|---|---|
| Real Time DSP | 20ms Latency | Separated Audio and Display/Input Threads. | Often called Functions in the “hot” part as efficient as possible. |
| Clear User Control | Intuitive usability of the product | Always show the current state of the Device! Naming the Controls on the Device. | Tests with unfamiliar Persons to use the Device |
| Sample Polyphony | 2 - 8 Samples Concurrent | Good Structure of the 128M-Bit Ram. Fast Communication with the Teensy 4.0 | Include a Playback Test with the specified Polyphony |
| Modern looking | Smooth Feeling and modern Design | Inform about how to achieve good quality with 3D-Printers. | Tests with unfamiliar Persons |
| Connectivity | Easy connection between other musical Devices | Using Midi In - Out and Midi Host as well the Line In and Out Jack | Connect different Midi Devices and use various Software to check the Host Functionality. Good sound Quality with Line In & Out |

# Hardware Cost

| Partname | Function | Quantity | Price/Pc |
|---|---|---|---|
| Teensy 4.0 Development Board | Microcontroller | 1 | 18.64 |
| Audio Adaptor Board Rev. D | Audio Shield | 1 | 13.23 |
| 14-Pin Header Double Insulator | | 2 | 0.084 |
| | **Exp-Tech** | | **32.038** |
| EA OLEDM204 | Display | 1 | 24.22 |
| 6N138 | Optocoupler 100kBaud | 1 | 0.56 |
| | **Reichelt** | | **24.22** |
| AOM-6738P-R | Electret Condenser Mic | 1 | 1.07 |
| W25Q128JVSIM | 128M-Bit Flash Memory | 1 | 1.71 |
| | | | |
| | **Midi** | | |
| Adafruit 1134 | Midi In/Out | 2 | 1.59 |
| Resistors | 1x220, 1x470, 2x47 | 1 | 0.56 |
| | | | |
| | **Extra Parts** | | |
| NMJ4HCD2 | TS 1/4" Jack | 4 | 1.5 |
| P160KN-0FD18C10K | 10k Poti linear | 4 | 0.81 |
| PEC11H-4220F-S0024 | Rotary Encoder, 24 ppr, Button | 1 | 2.33 |
| 74HC4051 | 8:1 Analog Multiplexer | 1 | 0.63 |
| | | | |
| | **Mouser:** | | **18.72** |
| | **Essentials:** | | **74.978** |



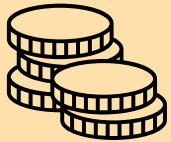
# Time Expense



| Phase | Time | Buffer |
|---|---|---|
| Preparation and Information | 85h | ± 5h |
| Hardware | 100h | ± 5h |
| Team Meetings | 115h | ± 7h |
| Software Development | 450h | ± 30h |
| Testing | 100h | ± 5h |
| Documentation | 50h | ± 3h |
| **SUM** | 900h | ± 55h |

| | | | |
|---|---|---|---|
| Working Hours | 900h ± 55h | 50€ / h | 45000 € - 47750€ |

# Profit margin



| Parts Price | Consumer Price | Profit | Devices until profit |
|---|---|---|---|
| 75€ | 200 € | 125 € | 382 |

# Capacity

| What do we need? | Restrictions? |
| --- | --- |
| 6x Teensy 4.0 microcontroller<br>6x Teensy audio shields<br>6x Displays<br>12x Midi Ports<br>6x Electret Condenser Microphones<br>6x 128M-Bit Flash Memories<br>24 x TS ¼" Jacks<br>24 x 10k linear Potis<br>6 x Rotary Encoders<br>6x 8:1 Analog Multiplexer | We are planning to order the parts this week (29.03- 03.04.) |
| 5x Media technology students/ engineers | One Student is missing for two weeks (31.3 -16.4) |
| Tools for communication and data exchange | Tools are implementet and ready to use |