

---

---

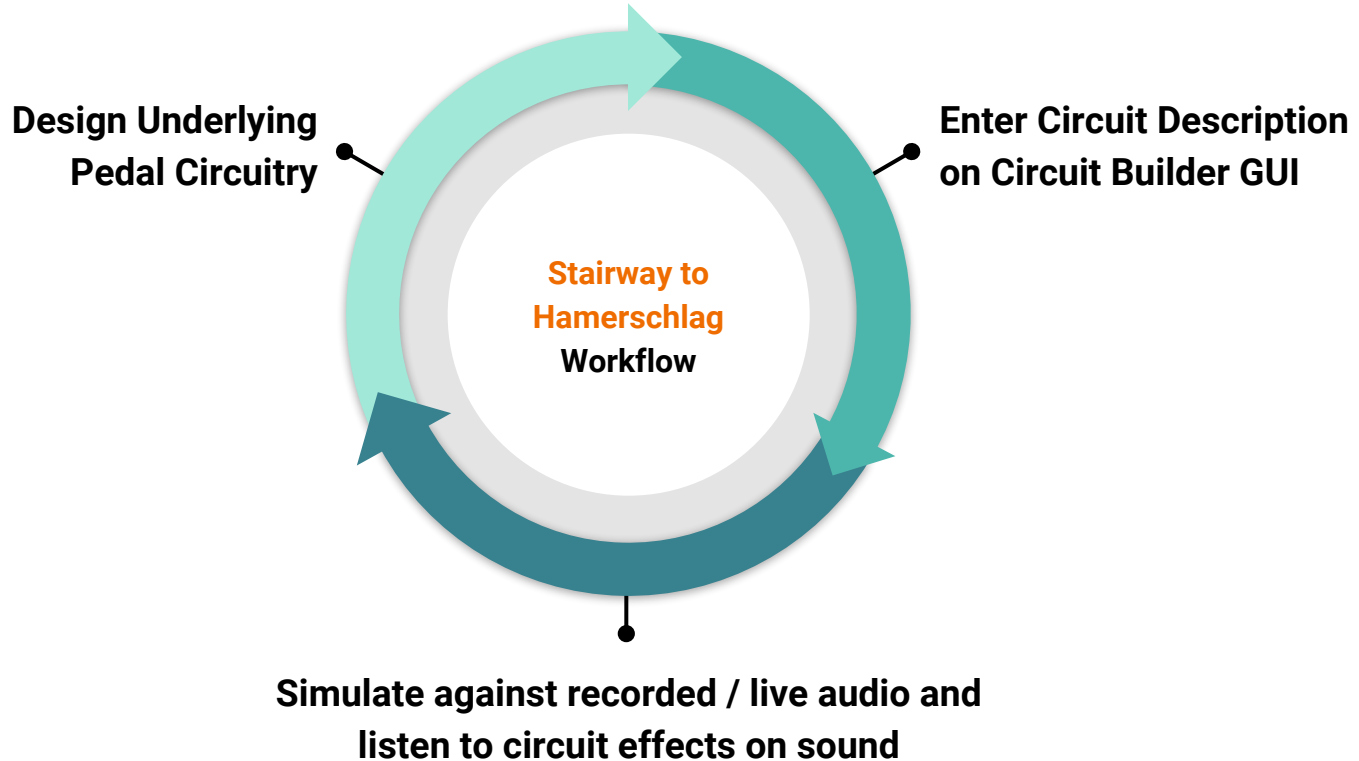
# Stairway to Hamerschlag Design Review

— Stephen He, Matt Kasper, and —  
Joseph Kim (Team D8)

---

---

# Improved Guitar Pedal Design Workflow



# Project Breakdown

## Front End / UI

- Capture user circuit designs
- Allows users to select audio sources
- Lets users simulate their designs

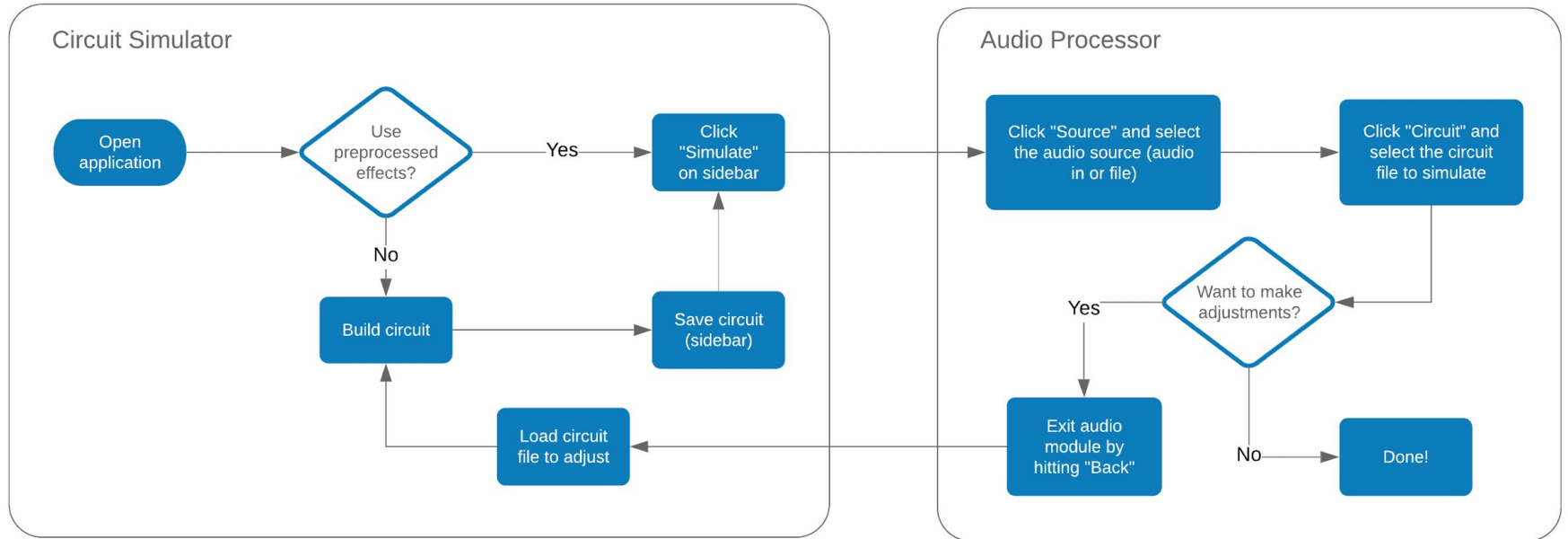
## Circuit Simulator

- Preprocess custom user circuits
- Perform live simulation and signal transformations
- Provide output signal to Audio Processor

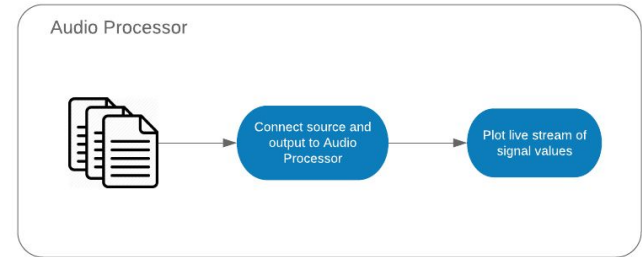
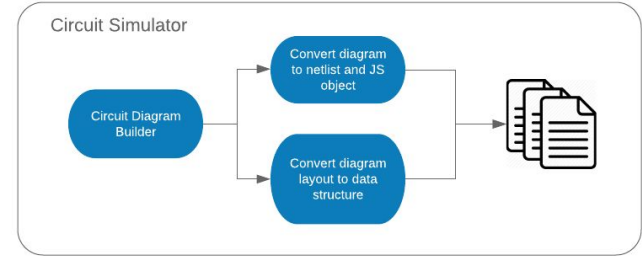
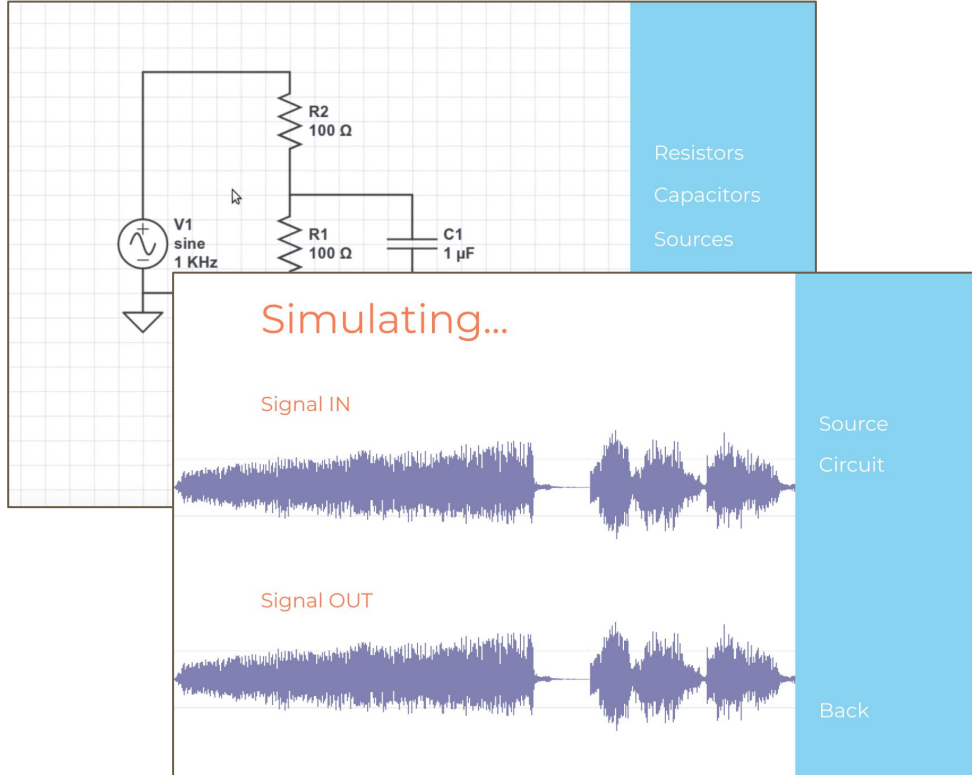
## Audio Processor

- Routes audio input and output
- Selects between audio hardware and filesystem
- Communicates with the circuit simulator and UI

# User Journey Flow

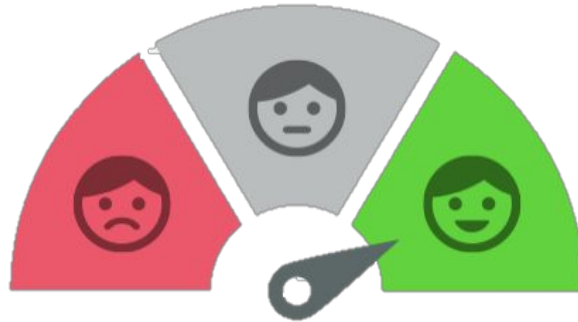


# Frontend - Design / User Interface

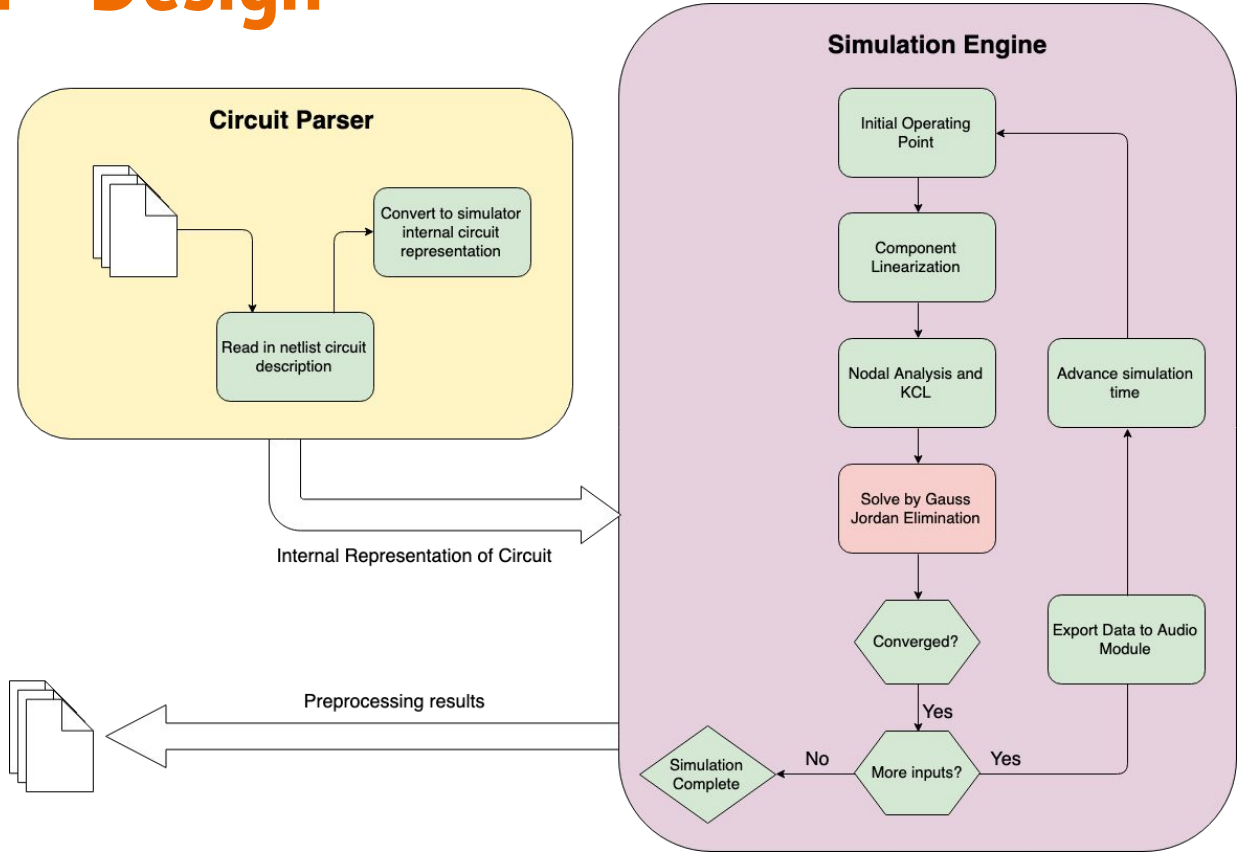
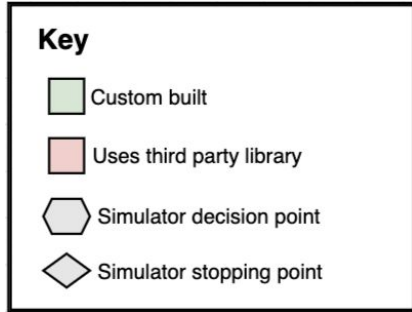


# Frontend - Testing

- ***Unit Tests on circuit transformations:*** Testing for correctness, not performance
- ***User Survey / Observations:*** Overall average user satisfaction  $\geq 75\%$



# Circuit Simulator - Design



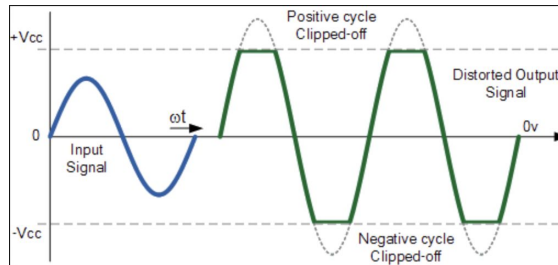
# Circuit Simulator - Testing

- **Euclidean distance** from known solution (SPICE), normalized to account for length/amplitude of sample

- Perfect Accuracy:  $E = 0$
- Target Accuracy:  $E \leq 0.2$

$$E = \frac{1}{n} \sqrt{\sum_{i=1}^n (d_{ours} - d_{spice})^2}$$

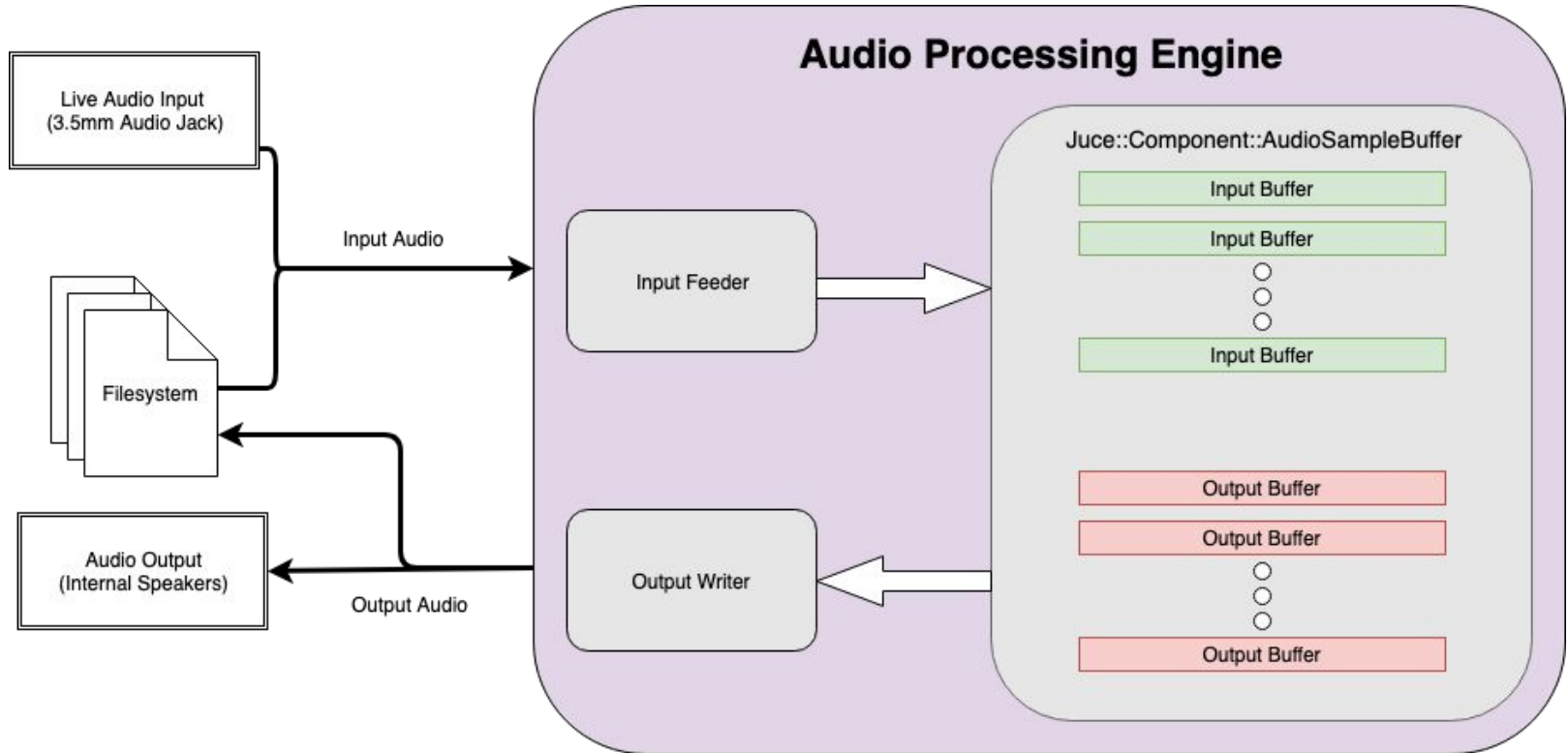
- **Manual waveform inspection** for LPF, HPF, BPF, Overdrive, and Fuzz



*Expected clipping effect for basic fuzz pedal.*



# Audio Processor - Design



# Audio Processor - Testing

- **Direct playback:** Play songs and pre-recorded audio tracks to built in computer microphones to test audio output capability
- **End-to-end playback:** Read in audio signal from instrument connected to 3.5mm audio jack and play it back through internal microphone



## User Plays Instrument

Audio processor reads in the audio signal into the input buffer to test input path.



## Forward Input Data to Output Buffer

Audio processor passes input directly to output buffer without modification.



## Play Audio from Output Buffer

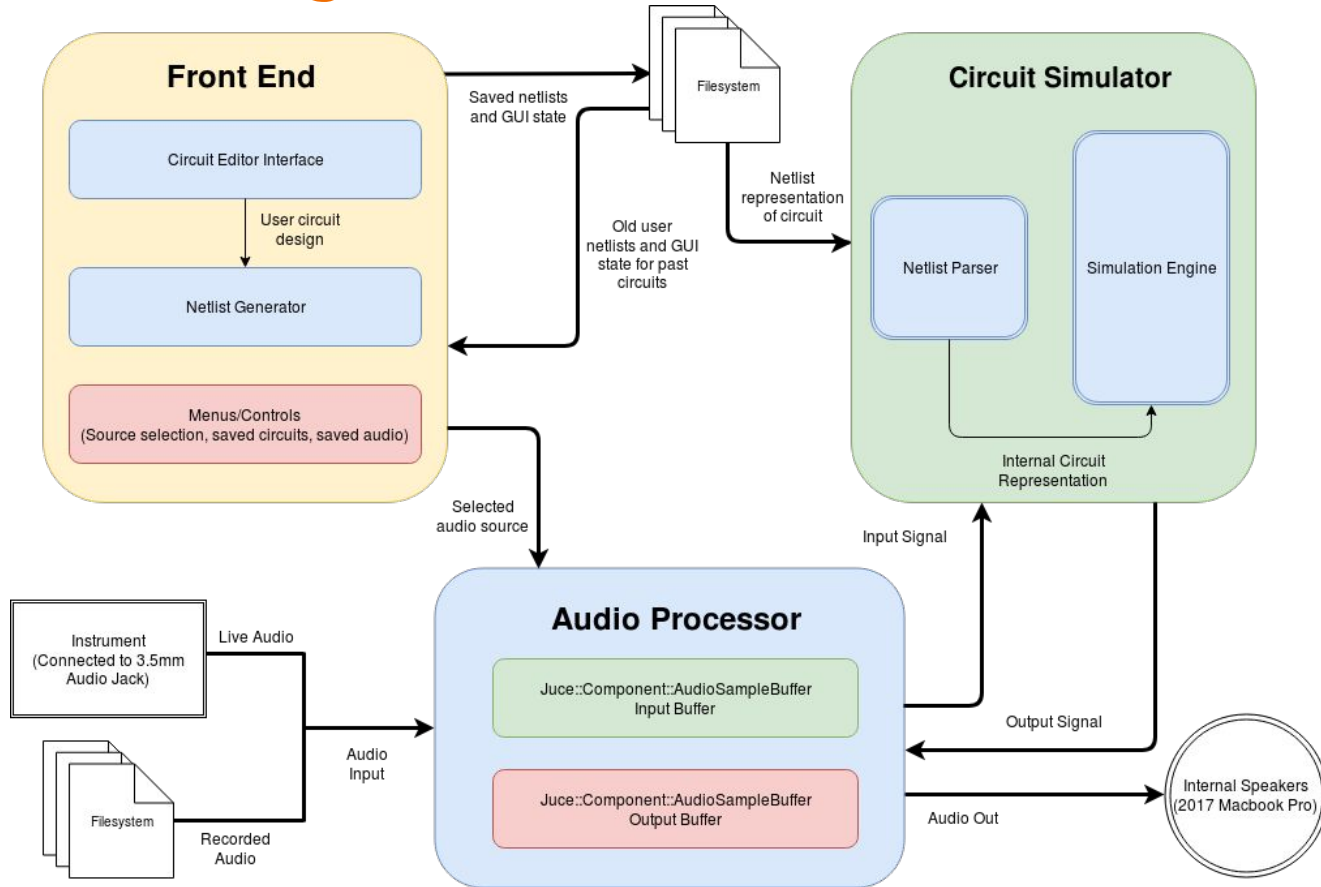
Audio processor plays back sound from built-in microphones.



## Listen for Correctness

Human listener observes output sound to determine if it sounds correct.

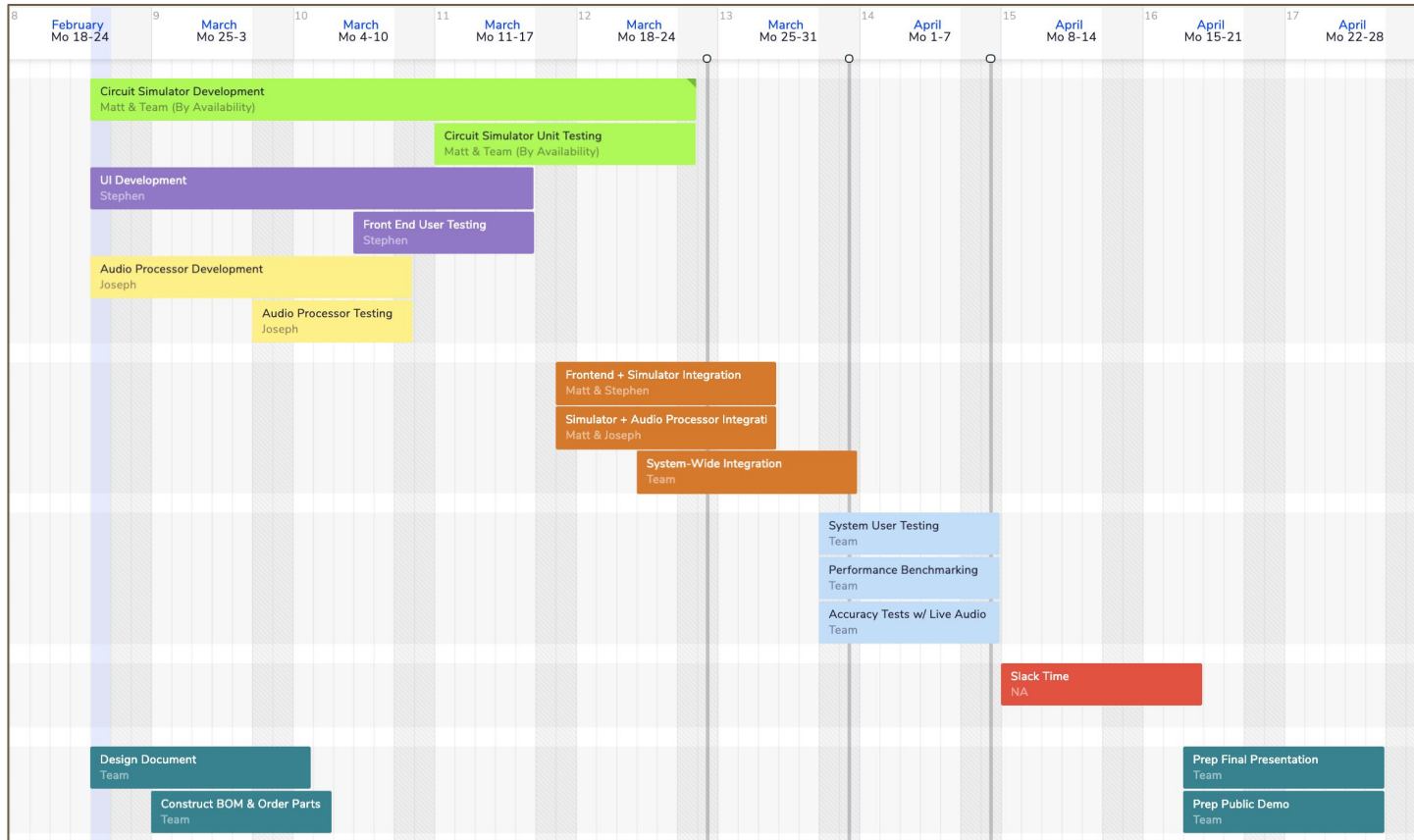
# Putting it All Together



# System-Wide Testing Plan

- **Requirement:** Simulation accuracy
  - **Test:** Normalized cross correlation on basic pedals (fuzz, overdrive), LP/HP/BP filters
  - **Success Criteria:** Score of 0.8 or greater
- **Requirement:** Intuitive, user-friendly interface
  - **Test:** User study of other students
  - **Success Criteria:** Average sentiment of 4/5 in ease of use and overall experience
- **Requirement:** Low average “round-trip” latency
  - **Test:** Measure time taken to produce output for each input point in fixed set of recorded input signals.
  - **Success Criteria:** Average latency (per datapoint)  $\leq 50$  ms

# Schedule



- Circuit simulator development
- Front end development
- Audio processor development
- Integration
- Testing
- Slack time
- Team deliverables