CIRMMT / Columbia Exchange 2023

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***Exchange Supervisors**: Philippe Depalle (CIRMMT, McGill), Seth Cluett (Columbia University)*

During the summer of 2023 I travelled to New York as a visiting researcher at Columbia University's Computer Music Center (CMC). The purpose of the visit was to perform research on the RCA Mark II, a synthesizer developed in the 1950s under the auspices of what was then the Columbia-Princeton Electronic Music Center (CPEMC). Currently the Mark II sits dormant, a sort of fossil of American electronic music history silently occupying one of the offices at the CMC on 125th Street in Harlem. While the synthesizer and its corresponding schematics remain mostly intact, very little attention has been given to the task of its digital preservation.

The research I performed follows important work done by Kurt Werner, Ezra Teboul, Seth Cluett, and Emma Azelborn in the previous summer of 2022. In their paper titled *Modeling and Extending The RCA Mark II Sound Effects Filter*, Wave-Digital Filter (WDF) methods were used to model the Mark II's Sound Effects Filter unit, resulting in a digital model of the filter that was implemented in the FAUST programming language. Ezra and I saw this project as the beginning of a larger-scale archival project in not only modeling this one unit but perhaps one day modeling the entire Mark II synth. With guidance from Seth Cluett—director of the CMC—as well as my thesis advisor and CIRMMT sponsor Philippe Depalle, I decided to continue the effort in modelling the Mark II by focusing on the Tone Generator unit.

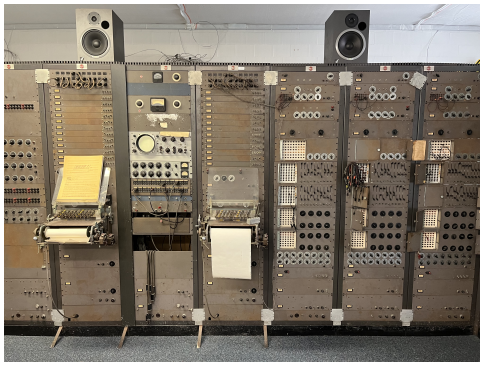

Figure 1: *The RCA Mark II Synthesizer*

Considered somewhat of an anomaly, the Mark II uses a rare and unorthodox method for tone generation. Unlike other analog synthesizers from the latter half of the 20th century, the oscillator on the Mark II generates tones from twelve in-unit tuning forks tuned to the equal tempered scale. Once powered on, the unit keeps the forks constantly resonating using magnetic inductance. The output of the constantly resonating tuning forks in the Tone Generator

unit is subsequently patched to an Oscillator unit that contains potentiometers on the face plate, allowing the user to shift the frequencies of the twelve tones.

My approach to modeling the Tone Generator deviated a bit from the methods used last summer in modeling the Sound Effects Filter. This is mainly due to the fact that while looking through inventory in the CPEMC stock storage closet, I was able to find extra stock of practically every component used on the original Tone Generator unit. Thus instead of modeling the unit's individual components digitally, my plan was instead to recreate the original circuit, record the output of the each of the twelve tuning forks, and make a probabilistic model of their frequency domain representations. The output of the model would then pass through a separate model of the Oscillator unit simulated in LTspice. Furthermore, since each of the tuning forks are removable from the original unit, they can easily be inserted into a socket on the recreated circuit and powered on just as they would be on the original unit.

(a) (b)

Figure 2: *The top (a) and bottom (b) of the Tone Generator unit removed from the Mark II's rack. The tuning forks are housed in the twelve capsules along the center of (a).*

Much of my time at Columbia was spent in the rare books archive, in which librarian Nick Patterson helped me in retreiving the original circuit schematics and documents pertaining to the unit. To double check the accuracy of these schematics, Seth and I removed the original unit from the Mark II's rack mount in order to examine and take photos of the components. Finally, I was able to spend time in the CPEMC stock storage closet to source the various vacuum tubes, inductors, and sockets that I would later use in the replica circuit that I was going to design.

Although I came away with all of the information and material I needed, the acquisition of materials and parts took longer than expected. In this case it was mainly due to a delay in retreiving circuit schematics from the rare books archive because of construction in the library. Despite this delay, I was able to come away with an implementation of the Oscillator unit in LTspice, a PCB layout of the recreated circuit of the Tone Generator, and practically all of the stock components needed to model input from the tuning forks. This semester at CIRMMT, I'll slowly be assembling this duplicate version of the Tone Generator and if all goes well I'll be able to go back to Columbia to record the output of each of the original tuning forks from the unit.

I'd like to give many thanks and acknowledgement to Seth Cluett, Ezra Teboul, Nick Dunston, and Philippe Depalle for their guidance on this project, and a special thanks to David Karp and David Vallencourt for their help with analog electronics and circuit design. I'm very excited to continue this project at CIRMMT and conclude with a final digital model of the unit very soon!