# The Mobile Device Marching Band

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## ABSTRACT
In this paper, we present the "Mobile Device Marching Band" (MDMB) as a new mode of musical performance with mobile computing devices. We define an MDMB to be, at its most general, any ensemble utilizing mobile computation that can travel as it performs, with the performance being independent of its location. We will discuss the affordances and limitations of mobile-based instrument design and performance, specifically within the context of a "moving" ensemble. We will also discuss the use of a Mobile Device Marching Band as an educational tool. Finally, we will explore our implementation of an MDMB, an electronic Brazilian percussion ensemble.

## Keywords
Mobile, iOS, percussion, marching, parade, street, collaborative, laptop orchestra, physical modeling, contact microphones, education, electronic, ensemble


**Figure 1. the Princeton Laptop Orchestra rehearsing as a Mobile Device Marching Band.**

## 1. INTRODUCTION
In the past decade, laptop orchestras have been a steadily growing trend in academic institutions. As an ensemble in an educational context, they provide an excellent platform for teaching electronic music techniques, and combining engineering skill development with artistic enrichment. However, the nature of electronic music traditionally requires a static, concert or club style performance environment. In the last few years, as mobile devices have become ubiquitous, several of these electronic ensembles have explored options for incorporating mobile computing into their musical practices. We present one approach to this possibility, a marching electronic percussion parade, and discuss some logistical and pedagogical issues related to this idea.



## 2. RELATED WORK
The primary framework from which this research springs is the work of Dan Trueman and Perry Cook, with their development of PLOrk, the Princeton Laptop Orchestra in 2005 [5]. Since then, the idea has spread and many different approaches have been explored. There has also been an explosion of research on making audio with mobile devices [4], and the work most directly related to our project is Ge Wang's development of MoPho, the Stanford Mobile Phone Orchestra [3] [6]. Wang's group has very similar goals, and is also both a performance ensemble and an educational platform for teaching electronic music. Much of this work involves performers using mobile phones as instruments, but the actual mobility of performers tends to be limited to moving around a standard performance space. We consider our work to be an extension of Wang's mobile phone orchestra idea, reaching into the even more mobile territory of an ensemble that travels while playing.
The closest musical work to our project that we are aware of is the band Itchyo [7], from Colorado, most known for their performances with David Byrne of the Talking Heads. This group is a marching band using traditional acoustic instruments for the brass and percussion, but they have some portable electronic instruments mixed in to give a more modern flavor to their sound.

## 3. CHALLENGES AND SOLUTIONS
The stage-less, roaming nature of a Mobile Device Marching Band places some restrictions on the types of devices and interactions that can be incorporated into a performance. A minimal MDMB set-up could involve equipping each performer with a mobile device, a controller for audio, and a personal amplification device. We will discuss the limitations of the "minimal" set up, as well as ways to tackle these limits.

In general, performers in an MDMB will have much less screen-based feedback than performers working in a stationary setting. A mobile device screen will be significantly smaller than a laptop screen, and the constant motion of the ensemble would make concentration on the screen more difficult. Additionally, if the performer is dedicating both hands to using their instrument, the mobile device may not even be visible. These problems could potentially be solved by creating wearable supports for the mobile devices, and multiple devices could be used if extra screen space is needed. Hands-free displays like Google Glass could also be used.

MDMB performers will also generally have a relatively limited "working space." A stationary performer can create a zone around them where they can access different pieces of equipment in turn, and as a result, could utilize a vast array of different physical objects in a performance. MDMB performers would, for the most part, have to carry much of their available gear with them. For performers hoping to switch between multiple physical tools, this could present quite the challenge. To use multiple pieces of equipment during performance, performers could use a utility belt or vest to carry the equipment on their person. Alternatively, extra equipment could be moved on a cart that is moved along with the performers, who could simply switch devices and store them on the cart throughout a performance. For larger performances, performers could even set up a work area on a moving platform.

Mobile devices themselves may also present computational limits. The limited processing power available on phones could limit the number of live-synthesis instruments being run on a single device. Also, networking between mobile devices on the move could provide challenges; LAN networks can be unwieldy to set up in a portable manner (although battery-powered routers exist), and 3G connections may not provide the low latency necessary for some applications. Another challenge of working with mobile devices is the limited number of ports for external hardware. Battery powered routers or bluetooth connectivity could be used to create movable networks, and microcontroller platforms such as Arduino could be used to build custom solutions for providing multiple hardware ports.

# 4. ADVANTAGES

However, the movable nature of such an ensemble also presents some unique performance opportunities.

A movable ensemble can interact with the concert hall in novel ways, and can also interact with a wider range of environments than the typical concert hall. When the performers, and thus, the sound sources, are free to move around, they can freely explore the acoustics of their performance space. Interaction with the reverberant characteristics of the performance space could be pre-planned, or even improvised. The portability of the instruments would also allow for much more flexibility in what constitutes a performance space. Rather than stay in a single room, performers could move throughout an entire building, or even move through an outdoor area. This freedom of movement would allow performers to make on-the-fly decisions as to how they would select their performance space and improvise based on their surroundings. Performers could even move through a never-before-seen environment and react to their novel surroundings.

Movable ensembles also allow for a high degree of performer autonomy, and inter-performer spatial relations could be used in a variety of ways. The data of the relative location between performers could be used to control the auditory or visual elements of a performance. Also, the visual organization of the players could be utilized either artistically or as a way to give the audience greater insight into the inner workings of the ensemble. For example, during a particular piece, performers playing related parts could stand close to each other, so the spatial movement of the performers would reflect the thematic organization of voices in a piece. Furthermore, performers' ability to move around would allow them to adjust their position to hear others better during a performance.

Individual mobility on the part of the performers would greatly increase the potential for audience interaction and participation. Rather than separating the performers and the audience, the two could intermingle, and performers could change their positions in predetermined or improvisatory ways. Most importantly, performers could actively seek out audience members and engage them, facilitating a two-way interaction that is almost impossible with a non-moving ensemble. Two-way communication and the intermingling of performers and audience members could allow for many new types of highly interactive performance.

# 5. CASE STUDY: MOBILE ELECTRONIC PERCUSSION MARACATU AND SAMBA BAND

## 5.1 Goals

There were four main goals in creating the Mobile Electronic Percussion Maracatu and Samba Band. First, it was imagined as an educational tool for introducing students to digital musical instrument design, signal processing and basic electronics. Second, it was an experiment in the basic feasibility of a simple mobile device marching band. Third, it was an opportunity to focus on musicianship with electronics, where rhythmic feel and skill would be developed through rehearsal. Lastly, it seemed like an especially enjoyable musical experience for both the student participants and the audiences.

## 5.2 Implementation

Once the decision was made to focus on percussion-style electronic instruments, we evaluated the possible methods of controlling the synthesis. We wanted to take advantage of mobile devices such as iPhones for the audio processing, but the obvious option of using the touchscreen as a controller seemed less than ideal. The idea of simply sending pulses over a network and having the performers adjusting parameters seemed to lack musicianship and left the performers with too little to do. It would also produce a sound that was too clean and precise for the style of music we intended to make. The fun part of percussion is that you get to hit things! Therefore, we decided to build external triggers that we could use to control synthesis on the mobile devices. Since getting wired data into an iPhone is not quite as simple as a USB connection, we decided to take advantage of the microphone/line input on the device as our input port.

### *5.2.1 Trigger Instruments*

Each student in the group built an input trigger instrument, to which a contact microphone was affixed. The students had free reign over the design of their instruments, and the variation in design ideas was inspiring. Some were meant to be struck with sticks, some tapped with the fingers, some scraped with a sandpaper block. The contact microphone had to be fed into a simple transistor buffer circuit to protect the phone input from voltage spikes and to match the impedance of the source to the phone audio input. The students soldered together these buffers from components and attached them to their instruments. Another option would have been to purchase inexpensive pre-built contact microphone amplifiers, but building them from scratch was an interesting educational opportunity to learn about simple transistor circuits.

**Figure 2. Avneesh Sarwate's sheet metal "trigger instrument", with different grits of sandpaper to allow for scraping activation.**

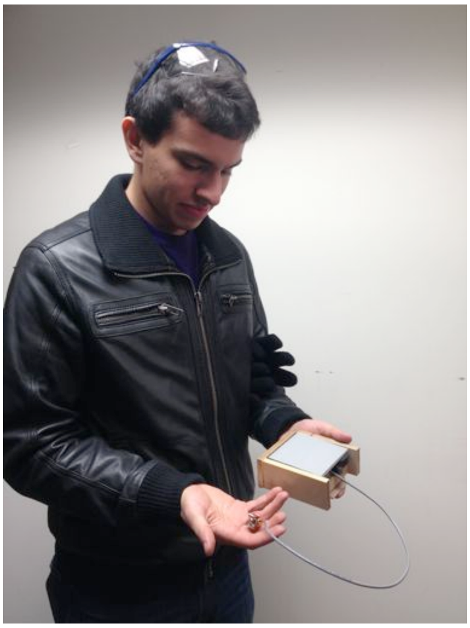

**Figure 3. Noah Fishman's "trigger instrument", a compact design made from wood and foam rubber and tapped with the fingers.**

#### *5.2.2 Synthesis*

Next, we had to find some synthesis solutions to convert the contact microphone signals into useful percussive audio sounds. We used a combination of tools, including Daniel Igleisa's MobMuPlat [8] to wrap synthesis patches written using libPD [9], Brad Garton and Damon Holzborn's iRTCMix [10] to access the physical models in the STK package [1], and an excellent commercial iOS app by Jarosław Jacek called Impaktor [11] that is designed to create synthesized percussion sounds based on microphone input. An interesting addition to this arsenal would be Bruno Zamborlin's Mogees software [12], which is actually intended as a way to convert contact microphone input on an iPhone into synthesis, but it isn't yet available for use as of the present writing. Another approach we used to complement this mobile computing solution was to connect a digital delay guitar pedal to the contact microphone and use an audio rate delay as a comb filter to produce a simple, yet distinctive electronic drum sound.

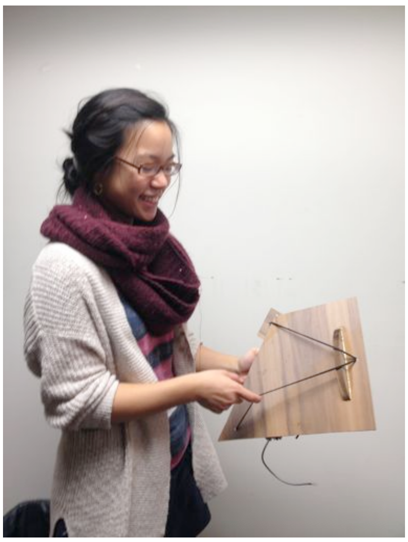

**Figure 4. Carolyn Chen's "trigger instrument", with rubber band strings for plucked activation.**

**Figure 5. Cenk Ergün's "trigger instrument", nicknamed the "burrito" and designed to be struck with a drum stick.**

#### *5.2.3 Amplification*

For amplification, we initially used Behringer EPA-40 portable amplifiers, which can be worn over a performer's shoulder. These are sufficiently loud for the purpose, and have a reasonable tone despite the expected lack of bass frequencies. Due to a high failure rate of the non-standard proprietary batteries they use, we eventually switched to using Fender Passport Mini amplifiers, which use standard C-cell batteries. The Passport Mini amplifiers did not come with a shoulder strap, so we installed strap-lock strap buttons onto them, and attached guitar straps. They turned out to be an excellent solution. One issue we discovered is that the directionality of the speakers is a bit of a problem. When the amplifier is worn over the shoulder, the speaker points away from the musician, so that it is hard to tell how loud you are. An ideal portable amplifier for this purpose would include a monitor speaker pointed at the player as well. For bass frequencies, we used a Roland MiniCube portable bass amplifier, which can be worn with a strap, but is rather heavy and costly.

#### *5.2.4 Musical Material*

Part of the goal of this project was to teach musicianship through the learning of a repertoire of existing music. We learned drum patterns from Scott Kettner's book on Maracatu [2] and listened to samba recordings to parse out the rhythms. We chose to create synthesized percussion instruments that mimicked the features of the percussion instruments used in these traditional genres, while still sounding identifiably "electronic" and taking the sound of the music into unusual territory. We were not interested in producing a faithful representation, but rather a unique electronic arrangement of the musical style.

## 6. RESULTS

The Mobile Marching Band has proved to be a successful teaching experience and an enjoyable musical experience for the students. They felt that they had learned a lot about percussive synthesis techniques, as well as many of the tools that can be used to program audio. The mobile platform opens up many opportunities for the ensemble to be involved in events for which a standard performance situation would not be appropriate. We presented a concert by the

Princeton Laptop Orchestra at Princeton University in April of 2014 that utilized the Mobile Electronic Percussion Maracatu and Samba Band as a way to lead the audience from one concert location to another. The first half of the concert was in a standard concert hall, and the last piece was staged in another location, since we would be performing with a giant industrial robot that could not be moved into the concert hall. We bridged these two locations by leading the audience out of the concert hall, and over to the robot, playing our electronic percussion music, and were also joined by two acoustic musicians on a samba snare drum and an *alfaia* (Maracatu bass drum). We complemented the percussion instruments in this particular performance with a vocoded voice part, using a small iRig MIDI keyboard for control, a headset microphone, a vocoder patch created in MobMuPlat, and the same Fender Passport Mini amplifier that was used for the electronic percussion instruments.

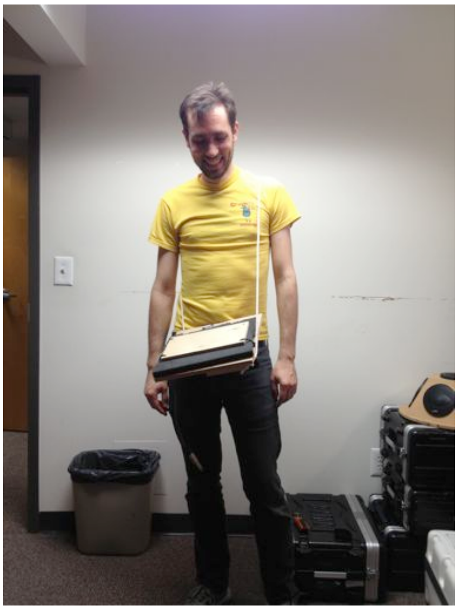

**Figure 6. Jeff Snyder's "trigger instrument", a marching snare-style wooden surface with a wearable support.**

**Figure 7. Quinn Collins's "trigger instrument", meant to be struck with a drum stick.**

## 7. FUTURE WORKs

While the current version of the group focuses entirely on percussion, we would like to add many more instrument types, such as bass instruments and portable electronic wind instruments. Other genres of music, such as Balkan brass bands or New Orleans brass bands, would be very interesting to approach electronically. While we chose to perform existing repertoire to make the initial development of the group simpler, we would like to work up original compositions, preferably from within the group itself. We intend to continue exploring this idea for the foreseeable future.

## 8. ADDITIONAL AUTHORS

Molly Bolten, Carolyn Chen, Cenk Ergün, Noah Fishman, Mike Mulshine, and A.K. Williams, Quinn Collins.

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