

---

# MAES:TRO: A Practice System to Track, Record, and Observe for Novice Orchestral Conductors

**Ekaterina Ivanova**

Indiana University  
901 E 10th Street  
Bloomington, IN 47405 USA  
ebivanov@indiana.edu

**Lulu Wang**

Indiana University  
901 E 10th Street  
Bloomington, IN 47405 USA  
luluwang@indiana.edu

**Yihe Fu**

Indiana University  
901 E 10th Street  
Bloomington, IN 47405 USA  
fuyihe@indiana.edu

**Jeffrey Gadzala**

Indiana University  
901 E 10th Street  
Bloomington, IN 47405 USA  
jagadzal@indiana.edu

**Abstract**

Conductors use their entire bodies to communicate with an orchestra to guide musicians through a piece of music. Currently, novice conductors learn basic conducting techniques through solo practice, which lacks factors that exist in a live orchestra rehearsal. We propose MAES:TRO: a conducting practice room that provides an immersive rehearsal experience and utilizes hand gestures, body orientation, and eye-gaze directions to directly alter a musical score. With the use of auditory/visual feedback and a report of incorrect beat, tempo, and instrument emphasis, conductors are able to self-reflect and improve basic techniques. Our user testing of a low-fidelity prototype showed the system's potential to improve the effectiveness of novice conductor's solo practice.

**Author Keywords**

Gestures; conducting; music interfaces; music education

**ACM Classification Keywords**

H.5.2. [Information Interfaces and Presentation]: User Interfaces, user-centered design; H.5.m. [Information Interfaces and Presentation (e.g., HCI)]: Miscellaneous.

Copyright is held by the author/owner(s).

CHI 2014 Extended Abstracts, April 26 – May 1, 2014, Toronto, Canada.  
ACM xxxxxx.

*When conducting your body is the instrument to create sounds and music."*

*- Christian*

*"For beginner conductors, practicing skills and techniques is essential."*

*- Danko*

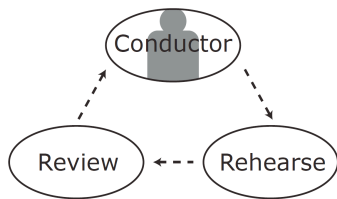


Figure 1. Framework.

## Introduction

A conductor's goal is to bring a written score to life through body motion [1]. Conducting is defined by the Oxford Dictionary of Music as, "the art or method of controlling a choir, a band, an orchestra, or an operatic performance by means of gestures, which involve the beating of time, ensuring correct entries, and the 'shaping' of individual phrasing" [2,3].

Conductors must be precise in their body movements and facial expressions to convey their interpretation of a piece of music. Compared to advanced conductors who focus on the development of personal style and relationships with musicians, novice conductors, "focused attention on surface aspects, especially rhythm and cuing. They experienced difficulty performing multiple tasks" [4]. By "novice conductors," we refer to those in their first four years of practice. Currently, conductors practice either with a live orchestra or alone with a mirror. However, organizing a live orchestra on demand is expensive and unrealistic for most novice conductors. Further, solo practice does not optimally recreate a rehearsal experience that is necessary for self-reflection.

In searching for ways to interpret Bodydata to raise self-awareness, we explored current conducting practices and propose a novel approach for novice conductors to improve their physical skills and self-awareness in their solo practice. Our goal is to make solo practice more effective for novice conductors.

## Design Process

Through affinity diagrams and semi-structured interviews, we identified an opportunity space to design for conductors. Adopting a user-centered design

approach, we first conceptualized a holistic three part system for orchestral conductors to practice, perform, and review before, during, and after a performance (Figure 1). Following interviews with two expert conductors who emphasized the importance of maintaining the attention of the musicians during a performance, we focused our design on the practice and review phases, as they pose the most significant educational benefits for conductors, especially novice conductors, without distracting from the live performance experience.

From our research on the praxis of novice conductors, we learned that in order to practice the physical techniques that use movements of the body, face, and hands, conductors best learn by doing and receiving direct and immediate auditory feedback from an orchestra. A generalized conceptual learning process framework guided us through our design decision-making process (Figure 1). The framework contains two interdependent elements, practice and review. Practice entails learning by physically doing, while review entails watching videos of previous practices. Repeating the process as needed consolidates the knowledge necessary for understanding the use of one's body as a means for communication.

## User Research and Insights

We conducted contextual interviews [5] with four student conductors (Figure 2) with conducting experience ranging from one to fifteen years. Our goal was to discover the details of their solo practice, the use of visual aids during practice, the use of mirrors, the goals the conductors want to achieve from practice, and the ways they want to be perceived by musicians. We also observed an orchestral conducting class and



Figure 2. Interviewing a student conductor.



Figure 3. Conducting class observation.

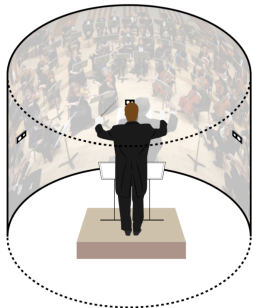


Figure 4. MAES:TRO system in use.

interviewed the professor to understand the setting and experience of an orchestral rehearsal (Figure 3).

Through this research, we gained three valuable insights of the needs of novice conductors during solo practice.

*Insight 1: Visual aids help conductors allocate their attention to different sections of an orchestra.* One interviewee mentioned mentally visualizing sections of an orchestra during practice. Another told us that when he first began conducting, he would arrange his childhood teddy bears and practice with them so that he could “see” the orchestra.

*Insight 2: Conductors want to see themselves from different angles.* Conductors use mirrors to see themselves during solo practice to be aware of how their body movements look in the eyes of the musicians. Furthermore, conductors record videos of their practices for the purpose of review and reflection on their body movements. However, it is not easy for them to arrange mirrors or cameras in ways that allow for review during every solo practice.

*Insight 3: Conductors want to be in control of the music.* All of the conductors interviewed said that they often practice in silence to hear the music in their heads as they do not want to follow another conductor’s interpretation of a piece.

Using the insights gained from the user research, we defined “effective conducting practice” as: (1) easy access to a rehearsal experience; (2) review of body movements from musicians’ angles and perspectives;

and (3) adjustment of physical errors based on recommendations and self-critique.

We further explored the currently available technologies that are capable of gesture recognition in order to determine the feasibility of an orchestral conducting system. We interviewed Professor Christopher Raphael to learn about “The informatics philharmonic”, a computer-driven orchestra follows and learns from a soloist in real time [6]. A literature search returned other technologies including “The Conductor’s Jacket”, a musical software system that utilizes a wearable device to measure and interpret physiological and gestural signals [7]; “Follow-Me!”, a real-time continuous gesture recognition system [8]; and iSymphony, an interactive orchestral conducting system for digital audio and video that adaptively adjusts to the user’s conducting style [9]. The literature search along with the interview confirmed the feasibility of a responsive virtual orchestra.

Following primary and secondary research, we generated concepts that could help conductors increase the effectiveness of solo practice such as a portable conducting station to be used within the home, a mirror with a camera display screen and timer, and a peer review online system. In order to best mimic a rehearsal experience, we narrowed our focus to a practice room with a virtual orchestra.

### The System

The MAES:TRO system (Figure 4) is contained inside of a circular room that consists of the following elements:

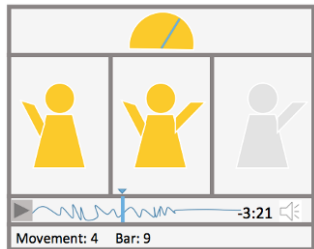


Figure 5. Selecting front view, left view, and orientation indicator on control panel.

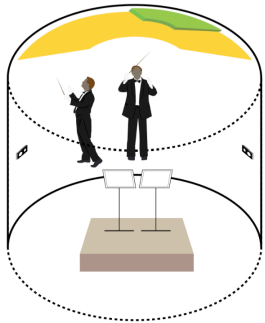


Figure 6. Videos in front and left view are projected on the screen with animated graphics.

### *Tracking System and Responsive Orchestra*

Three Kinect cameras [10] are installed to the front, left, and right side of the podium at hip level to capture full body movements from the musicians' perspectives. An Intel® 3D perceptual camera capable of close range facial tracking and attribution detection [11], is installed on the podium to detect the conductor's eye-gaze direction. We envision a back-end system that interprets the bodydata to adjust the beat, tempo, and volume of the music in real time.

### *Podium, Electronic Music Stand and Control Panel*

A podium with an electronic music stand and a control panel is installed in the center of the room. The electronic music stand allows for the user to read directly from and make annotations to an electronic version of the score at any time. Understanding that not all users may be comfortable using electronic scores, the user is free to use a paper version. A touch screen control panel is located to the left of the electronic music stand. Prior to rehearsal, the control panel functions as a way for the user to select a score from a digital library, preview the audio of the selected piece, and navigate to a particular section within the score to practice. After rehearsal, the conductor can use the control panel to review the video and audio by turning on/off specific camera views (front, left and right side) and an animated graphic indicating body orientation and eye-gaze direction (Figure 5).

### *Visualization*

During rehearsal, an orchestra is projected onto a semi-circular screen in front of the podium and serves as a visual aid. During review, life-size videos of the conductor from all three angles (front, left and right

side) are projected onto the screen. Additionally, an animated graphic of the orchestral map with a line indicating body orientation and a highlighted orchestra section indicating eye-gaze direction is projected. The graphic adjusts as the video progresses to show how these factors change throughout the practice session (Figure 6).

### *Audio System*

A surround stereo sound system plays the audio of the score. The audio adjusts to the conductor's motions as previously described by the tracking system and responsive orchestra.

### *Correction System*

After rehearsal, the audio generated from rehearsal is compared to the original score. A report detailing incorrect beat, tempo, or instrument emphasis is generated for further review.

### *User Information Database*

A user profile system is embedded and the practice history is archived to encourage continued use.

### **Design Evaluation**

We created a low-fidelity prototype and invited three student conductors with less than three years of conducting experience to test our design. Our goal was to determine whether the interface is transparent and easy to use and whether the functionality meets user needs. The prototype contained an interactive PowerPoint file showing the control panel and a printed banner with an image of an orchestra. We created three scenarios to lead the users through the system. We prompted them with questions such as "How would you rehearse Beethoven's 9th Symphony?" and "So you



Figure 7. User testing.

are ready to rehearse but you want to start from the 4th movement, what do you do?" We showed the banner in front of them when they started to rehearse (Figure 7).

Our results showed the ease of use of the system and garnered an overall positive and enthusiastic response from the users. Some concerns that were brought up included: whether the technology to support a responsive orchestra is available, whether to include an electronic score, and whether a video commenting system is needed. The testing led us to remove certain distracting elements such as visual cues that point out errors while the user is rehearsing and a commenting system for users to tag comments to specific moments in the video. In place of the video commenting system, we maintained a method that is more commonly practiced: directly annotating the scores either on paper or electronically (Figure 8).

The results led us to emphasize the simplicity of the system by maintaining certain elements that are currently practiced in a live orchestra rehearsal setting. Furthermore, MAES:TRO's ability to provide a virtual responsive orchestra was key to the experience.

### Discussion

Technologies that produce audio and visual information following the interpretation of gestures exist currently; however, they are only able to capture basic gestures [7,8,9] and none incorporate eye-gaze direction. In order to have a fully responsive virtual orchestra with similar responses to that of a live orchestra, precision in technology and algorithms are required. Though currently not available for use, we believe that the MAES:TRO system will be feasible in near future.

Another limitation is that by recreating an immersive rehearsal experience, it does not supplement other important aspects of the practice such as building relationships with musicians, learning basic musicianship skills, and developing organizational skills [12]. MAES:TRO's purpose is to focus on addressing body awareness and provide a space for novice conductors to improve self-control. Future iterations could further incorporate the aspects outlined above.

From our interviews, we are also aware that the traditional education and practice of conducting may have challenges incorporating technological changes. As Siegel and Beck mentioned in their paper, "capturing and representing qualitative data such that it encourages attitudinal or behavioral shifts" is "especially important for slow change" [13]. We believe that our system can encourage the adoption of technology in the conducting field, as it provides valuable qualitative feedback to inform novice conductors about their body movements.

Due to the educational nature of the system, the installation of MAES:TRO within a university setting would be ideal as universities already provide shared practice spaces for musicians. It would be possible to incorporate the feedback of professors and other student conductors in the establishment of a collaborative learning environment such as an online forum to share notes and videos.

### Conclusion

Our iterative design process, driven by research of our user group and existing technologies, led to the development of valuable insights and possibilities that can transform a novel conductor's solo practice. Unlike

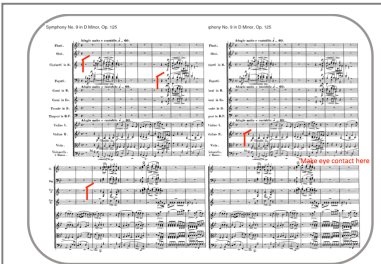


Figure 8. Conductors can mark cues (in red) on the electronic score.

the preexisting conducting technologies [7,8,9], the MAES:TRO system provides the conductor with valuable qualitative information to assist in learning and self-reflection. Feedback that is generated from bodydata both during the rehearsal and the review process, allows for the user to better identify areas for improvement and align a piece of music with their personal interpretation.

### Acknowledgements

We would like to extend our sincere gratitude to: Dr. Martin Siegel, Dr. Erik Stolterman, Dr. Christopher Raphael, Dr. Arthur Fagen, Matt Jennex, Tony Kennedy, Sijie Yang, and all conductors who participated in our research.

### References

- [1] Wakin, D. The maestro's mojo. *The New York Times*. (2012) <http://tinyurl.com/77a335n>
- [2] Kennedy, M. (Ed.) In *Oxford Dictionary of Music*. <http://tinyurl.com/lfkm6p7>
- [3] Brandão, J. *Learning and Teaching Conducting through Musical and Non-Musical Skills: An Evaluation of Orchestral Conducting Teaching Methods*. Doctoral dissertation. Louisiana State University, Baton Rouge, LA, USA, 2011 (etd-06082011-160513).
- [4] Bergee, M.J. An exploratory comparison of novice, intermediate, and expert orchestral conductors. *International Journal of Music Education* 23, April (2005), 23-36.
- [5] Holtzblatt, K. and Jones, S. Contextual inquiry: A participatory technique for system design. In *Participatory Design: Principles and Practice*. Hillsdale, NJ, USA, 1993.
- [6] Raphael, C. The informatics philharmonic. *Communications of the ACM* 54, 3(2011), 87-93.

[7] Nakra, T.M. *Inside The Conductor's Jacket: Analysis, Interpretation and Musical Synthesis of Expressive Gesture*. Doctoral dissertation. MIT: Cambridge, MA, USA, 2000.

[8] Han S., Kim J.B. and Kim, J. Follow-Me!: Conducting a virtual concert. In *UIST Adjunct Proc. '12*, ACM Press (2012), 65-66.

[9] Lee, E., Karrer, T., Kiel, H., Wolf, M., Dedenbach, S., Borchers, J., and Gröll, I. iSymphony: An adaptive interactive orchestral conducting system for digital audio and video streams. In *Proc. CHI 2006*, ACM Press (2006), 259-262.

[10] Kinect. <http://www.xbox.com/en-US/kinect>

[11] Intel® Perceptual Computing SDK 2013. <http://software.intel.com/en-us/vcsources/tools/perceptual-computing-sdk>

[12] Battisti, F. *On Becoming A Conductor: Lessons and Meditations on the Art of Conducting*. Meredith Music Publications: Galesville, MD, USA, 2007.

[13] Siegel, M. and Beck, J. Slow change interaction design: A theoretical sketch exploring the mindsets required for creating interactive technologies that facilitate attitudinal and behavioral change over time. *Interactions* January-February (2014), 28-35.