Challenges in the Development of an Easy-Access Mobile Phone Orchestra Platform

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ABSTRACT

How can an easy-access Mobile Phone Orchestra (MPO) platform be developed to facilitate high-end, flexible artistic expressions suitable for concert hall performances? Moreover, what challenges and possibilities arise in the development process of a novel MPO platform embracing school children as performers? In this paper, we discuss potential answers to these questions, which were integrated in the development process of mobilephoneorchestra.com. In particular, we highlight the main challenge of developing a performance platform that is both mobile and artistically rewarding, but still easily accessed by schoolchildren. Mobilephoneorchestra.com was developed as a Web Audio API to enable large-scale concert hall performances of fixed polyphonic contemporary art music. It is a kind of philharmonic orchestra for electronic sounds that embraces school children as performers and uses smart phones as instruments. Through an autoethnographic approach, our research was carried out in multiple iterations, inspired by action research. In this paper, we present findings from three iterations that include performances of music involving MPO. Schoolchildren/youths between 10 and 17 years old were addressed as MPO performers. The findings reveal both the artistic challenges of the platform and the possibilities. We specifically highlight the use of mobile music interfaces in combination with animated notation as a novel approach for an MPO concept.

1. INTRODUCTION

In this paper, we present an approach on how to perform polyphonic electronic contemporary art music. In general, this is a participatory approach with the ambition of generating flexible and high-end artistic expressions. In particular, this paper focuses on a Mobile Phone Orchestra (MPO) approach, which has similarities with a traditional philharmonic orchestra, but utilizes electronic sounds and embraces novices as performers. In recent years, several composers and researchers have explored MPO as a new performance concept [e.g. 22; 1]. Smart phones and other mobile devices have been used as both participation interfaces embracing novices [e.g. 12; 5;] and as sound generating music instrument interfaces in ambitious artistic performances [e.g. 17]. However, there are very few MPO examples (to the best of our knowledge) aiming for high-end and flexible MPO-generated artistic expression that still allow novices to be performers. Embracing novices as performers has two purposes in our approach: firstly, it simplifies the staging of large-scale MPO concert hall performances, since almost anyone could be a performer. Secondly, it would make way for new experiences of contemporary art music for musical novices. In this paper, we present the content and the challenges of the development process of mobilephoneorchestra.com. Two overall research questions have guided the process: How can an easy-access MPO platform be developed to facilitate high-end, flexible artistic expressions suitable for concert hall performances? Moreover, what challenges and possibilities arise in the development process of a novel MPO platform embracing schoolchildren as performers? The development process of the platform evolves in multiple iterations inspired by action research. Using an autoethnographic approach, the first author has engaged in this process as both a composer/artist and as a researcher. In this paper, we report from three iterations of the development process of mobilephoneorchestra.com. Schoolchildren/youths between 10 and 17 years old were addressed as MPO performers. The three iterations included performances of fixed compositions for stand-alone MPO, MPO and chamber ensemble, and finally MPO and sinfonietta. MPO-generated artistic expressions evaluated included: polyphonic melodies, soundscape textures in various densities, dynamics, frequency/pitch registers and rhythmical patterns/accents. The findings reveal challenges of performing rhythmic-related musical material using the platform. Moreover, the paper provides a new example of an easy-access, mobile and artistically rewarding platform within the concept of MPO. In particular, we highlight the novelty in this platform of combining easy-access mobile phone instruments with multipart animated notation for use in large-scale concert hall performances.

2. PREVIOUS RESEARCH

2.1 Mobile Phone Orchestra (MPO)

The development of smart phone technology has increased the possibility of using mobile devices as powerful tools in music performance. Gale et al. describes *Mobile music* as a new field dealing with musical interaction in mobile settings using portable technology [8]. In various research projects, there are different approaches to how smart phones are used. In massMobile, a participatory approach is used that enables the audience to affect performances in real time via their smart phones [23]. TweetDreams is another example of a participatory approach, where the audience use their phones to interact and co-create music during a performance [5]. However, in these two examples of novices being embraced as performers, the sounds are not generated by the phones of the participators. DialTones is an early example were the sounds from mobile phones of a large audience are used as musical output [13]. During a concert, the audience´s phones are dialed up by live performers on stage, to create large-scale polyphonic musical structures. Another early example where sounds from mobile phones were used in a performance was Phony from 1995 by Mossenmark [16]. The music in Phony was based on the sounds that emerge when one presses the digits on a phone. However, the performers in this scenario

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needed to have a certain amount of musical background since a conductor was used. The Stanford Mobile Phone Orchestra (MoPhO) certainly influenced the development of MPO as a concept [17]. As part of the Stanford Mobile Phone Orchestra, an open-source mobile music software toolkit (MoMu) was developed [3] as an easy- access programming toolkit for programmers, composers and others to easily develop interactive audio application for mobile music performances. Consequently, several compositions and applications have been developed within the MoPhO concept, exploring, for example, structured improvisation (Drone In/Drone Out), free-form improvisation (The MoPhive Quintet) and audience participation (Orkestra) [22]. In previous compositions where the MPO performers played the sounds with their phones as instruments, a specific musical background was required. Moreover, when such performances have been suitable for novices, the role of the participators has often been to affect the music, the actual sound output of which was generated by professional musicians. Indeed, examples could also be found where attempts have been made to involve large crowds of novices playing on their phones as if they are instruments in a performance. In Echobo, the audience use their phones as instruments and tap different sounds, which are controlled by a master musician on stage [12]. Another example can be found in Composition for Conductor and Audience by Charles Roberts, where the audience use his IOS and Android application: Control [18]. Indeed, these examples of Echobo and Control could facilitate audience participation with large crowds as MPO. However, the challenge is to also provide a flexible artistic expression, which could be rich in terms of possibilities for variation of such musical parameters as dynamics, density and pitch.

2.2 Animated notation

Within the field of contemporary art music, animated notation can be seen as a natural development of the work on graphic scores made famous by composers like Earl Brown and John Cage in the middle of the 20th century. Researcher Cat Hope defines animated notation as "a predominately graphic music notation that engages the dynamic characteristics of screen media" [10]. In particular, animated notation has been argued by researchers to conduct and to illustrate electronic sound in a live performance. Its intuitive approach and the opportunity it provides for notating any type of sound source or non-traditional instrument are other advantages of animated music notation [7]. Ryan Ross Smith gives a detailed overview of the field of animated notation in his thesis and on his website, animatednotation.com [20]. Researchers and composers such as Lindsay Vickery, Georg Hajdu, Guðmundur Steinn Gunnarsson and David Kim-Boyle, in addition to previously mentioned researchers, have contributed their work to the development of the field. Within contemporary art music, animated notation is mainly used by professional musicians as an extended notation for developing new musical expressions. However, there are examples of composers instructing novices as performers by adopting animated graphic scores. Áki Ásgeirsson, a member of the Icelandic artist collective S.L.A.T.U.R., along with Guðmundur Steinn Gunnarsson, involved more than a thousand nine-year-olds performing animated notation [2] in his composition 268°. Moreover, researcher and music educator Shane McKenna highlights the intuitive manner of animated notation in his platform Dabbledoomusic.com [4]. He argues that his animated notation is accessible, engaging and fun for both teachers and students. However, the intuitive nature of animated notation is probably best demonstrated in such music videogames as Singstar and GuitarHero [21; 9]. The popularity of these videogames has illustrated the ability of animated graphics to engage and provide music performance instructions to people regardless of their musical background. Inspired by the notation approach in previously mentioned videogames, the first author developed an animated notation system for non-professional performers in a previous research project [15]. In particular, the animated notation was developed to provide performance instructions for large crowds of people divided into multiple parts using the human voice as musical sound source. Evaluations of performances within his artistic research have illustrated the intuitive manner of his animated notation and have also presented it as a tool to provide flexible artistic expression. On one hand, atmospherical textures, pitch and noise clusters in various densities have been evaluated as being suited as concert hall material. On the other hand, more synchronised percussive hits, patterns and defined collective rhythms have been evaluated as being very challenging and not yet ready for concert hall performances [15].

3. RESEARCH APPROACH

The research approach applied here was carried out in multiple iterations, inspired by action research [14]. Each iteration included three key steps: planning, action, and analysis. Consequently, in a project with multiple iterations, the conclusions drawn from one iteration informed the next. The study presented here is based on data collected from three iterations, which all had an important impact on the development process of the platform. In addition, an autoethnographic approach was used, since the first author participated both as composer and researcher within the iterations [6]. An autoethnographic approach draws a blurry line between external objective knowledge and personal, internal subjective knowledge [19]. Reflexive notes and video-audio recordings of the action steps were the primary data to analyse within each iteration. At the third iteration, a survey was also used as data to gain an understanding of the experiences made by MPO performers. All participants within the three iterations had gotten relevant information about the project including signing a document, according to good research practice.

4. MOBILEPHONEORCHESTRA.COM

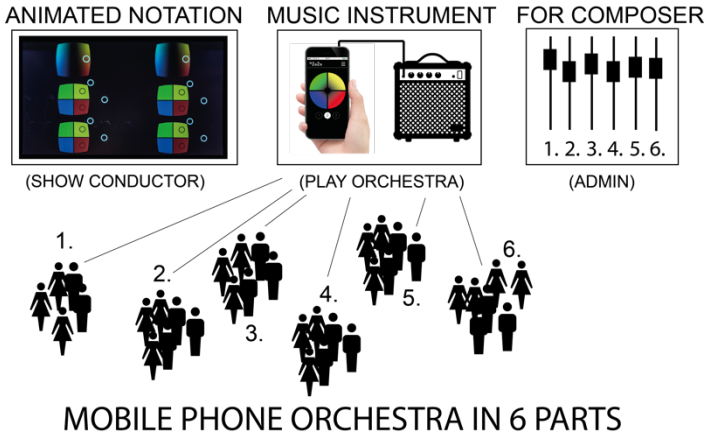

Figure 1. Mobilephoneorchestra.com structure

We developed mobilephoneorchestra.com as a team consisting of a composer, programmer and graphic designer. The idea was to develop a MPO performance platform embracing schoolchildren as performers for fixed electronic music suited for concert halls. Furthermore, similar to a philharmonic orchestra, we wanted to enable dividing the MPO in multiple instrument parts to facilitate artistic output with several layers. Moreover, we wanted the sounds to come out of individual phones to

achieve an electronic orchestra sound when the whole MPO performed together. Three main criteria for the platform were established to fulfil the ambitions of the platform: easy access, mobile and artistically rewarding. Easy access referred both to the availability of the platform as well as being user-friendly to people, regardless of their musical background. The mobile criteria refers to mobility and its availability for use in a wide range of areas and spaces. However, the main challenge was developing a platform that could both facilitate flexible artistically rewarding output and be easy-access and mobile, embracing novices as performers. By artistically rewarding, we meant that it would provide both a high-end and flexible artistic expression for the audience as well as a rewarding experience for the participators of a mobile phone orchestra. As for flexible artistic expression, we wanted the MPO to generate: polyphonic melodies, granular textures, soundscape textures in definite pitches, cluster and noise textures in various densities, dynamics, frequency/pitch registers and, finally, rhythmical patterns/accents. The previously mentioned artistic research on animated notation by the first author was used as the initial foundation of the platform [15]. Consequently, the idea was to develop an MPO platform, which included both musical instruments as well as an easy access animated notation for conducting an MPO performance.

4.1 Overall Structure

To meet the criterias of the platform, the setup for the platform was divided into three main sections: Play Orchestra (music instruments), Show Conductor (animated notation) and Admin (for composers).

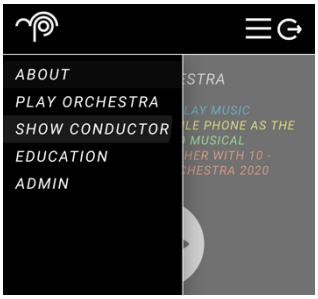

Figure 2. Main Menu

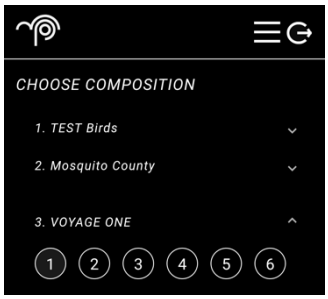

Figure 3. Play Orchestra menu

4.2 Play Orchestra (Music Instruments)

The Play Orchestra section is for the MPO performers and contains all music instruments. The performers choose which composition to perform and then which individual part they should play during a performance (see figure 3.). When the MPO performers have chosen their part, all their instruments for that specific composition are available for a performance. The platform offers three different instrument interfaces to perform on (see figure 4.). All instruments are designed as sample players, to have limited control options, but to still provide for a constrained but specific artistic expression. During a performance, each participant in an MPO has the ability to switch between and use all three instruments, to facilitate a diverse artistic expression. The instruments are built using a modified howler.js webaudio library, Angular on the front-end, and Express with NEdB to store compositions. Hosted on a digitalocean droplet running Ubunto 18.04 and websockets for real-time master volume. Nginx is used to serve the static resources, handle the ssl encryption and to serve as a reverse proxy for api calls and websocket connections to the Node back-end. The graphic interfaces of the three instruments are designed to be intuitive, functional and inspiring.

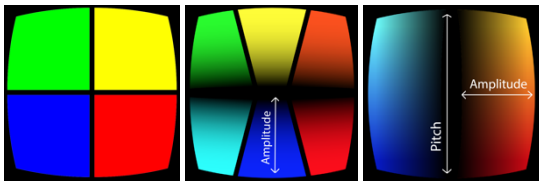

Figure 4. Instrument graphic interfaces 1,2,3

4.2.1 Instrument 1

The graphic interface of Instrument 1 consists of four coloured fields holding four individual sound samples (figure 4). By tapping a field a sound is triggered. Within the admin section, sounds are uploaded for the instrument, and there is an ability to add an amplitude and pitch randomizer and min – max range for the randomizers. Instrument 1 is used to perform rhythmic patterns/accents and granular textures in various densities.

4.2.2 Instrument 2

The graphic interface of Instrument 2 consists of six coloured fields holding six individual sustained sound samples (figure 4). By pressing and holding onto specific positions on the interface, sound is triggered. On page load, all of the samples are set to play and loop indefinitely, with a gain of zero. When interacting with the instrument, gain is set for the triggered sound inversely proportional to the distance from the cross axis. If the interaction is lost or triggers a different area of the instrument, the currently playing sound will fade out over a short time period to achieve a crossfade effect. The sound samples for the six fields are set in the admin section. Instrument 2 is used to perform polyphonic melodies, soundscape textures in definite pitches, cluster and noise textures in various densities, dynamics.

4.2.3 Instrument 3

The graphic interface of Instrument 3 consists of two graded coloured fields holding two individual sustained samples (figure 4). The behaviour of Instrument 3 is similar to Instrument 2, but pitch here could also be modulated when interacting on the vertical axis. Within the admin section, the samples are uploaded, and the min-max range of the pitch modulation can be adjusted. Instrument 3 is used to perform granular textures, cluster and noise textures in various densities, dynamics and frequency/pitch registers.

4.3 Show Conductor (Animated Notation)

The Show Conductor section is for the organisers of an MPO-performance and contains video files of the animated notation for the compositions. The animated notation is designed to show performance instructions for six individual parts and conduct the MPO through a performance (see figure 5). The performance instructions includes both which instruments are to be used at certain times and how and when they are to be performed. The animated notation interface was designed in the visual programming language MaxMSP and is controlled by midi. The animated notation is then rendered into a single video file to be uploaded within the Show Conductor section. During a performance, the animated notation is to be displayed on a large television monitor or projected onto a canvas that is clearly visible to the MPO performers. The animated notation is recommended to be limited to show instructions for six individual parts depending on what can fit within the dimensions of a screen. However, if

multiple screens are used the number of individual parts could be increased.

The white circles show when and where to perform on the instruments. For Instrument 1 (see parts 3 and 5 in figure 5), white circles move towards a grey circle on a coloured field. The performer is expected to tap on that field when the white circle reaches the grey circle, and a white dot appears inside the circle (see red field on part 5 in figure 5). For Instruments 2 (see part 6) and 3 (see part 1,2), the performer should start playing on a coloured field when a white circle appears on a field. A grey circle and a countdown in white from 4 to 0 prepares the performer for playing (see part 1). The performer then follows the movement of the white circle on the instrument and stops when the white circle disappears. When a big letter anywhere from A-Z (dependent on how many instruments are included in the part) appears on the part (see part 4) the performer should switch instrument to that letter.

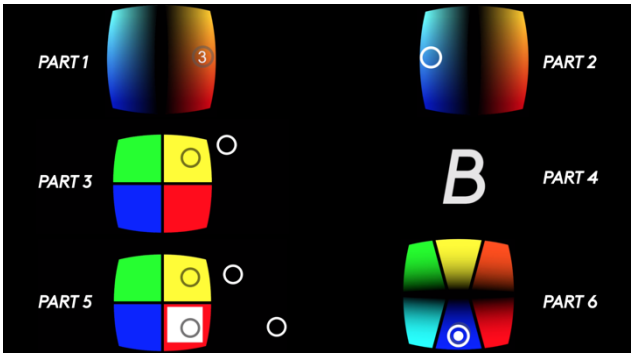

Figure 5. Animated Notation

4.4 Admin (For composer)

How many individual parts available for a composition is determined within the admin section and could vary from one to infinity. However, a maximum of six individual parts is recommended since it would be hard to show performance instructions for more due to screen size (see: animated notation). How many instruments are to be included for one part in a composition is determined within the admin section. There is no upper limit for the number of instruments to be included within a part in a composition. However, a maximum of 12 instruments is recommended, due to the average phone screen size. Furthermore, a master volume mixer and volume mixers for each individual parts of a composition are included within the admin section, which makes it possible to mix a performance in real time.

5. CHALLENGES IN THE PROCESS

The development process of mobilephoneorchestra.com has undergone several iterations and is still in progress. In this paper we report from three different iterations, which all had a significant role revealing the challenges in the process.

5.1 First Iteration: MPO + Chamber ensemble

The first iteration for the development of the platform included a performance of Twenty Twenty - a new composition for MPO and chamber ensemble. The MPO consisted of approximately one hundred schoolchildren between 10 and 12 years old. The performance of Twenty Twenty took place in February 2017 in a small movie theatre in Piteå, Sweden. Prior the performance 2 x 60-minute rehearsals with the MPO had been executed. The performance of Twenty Twenty had a duration of 17 minutes. The MPO performers shared 14 speakers for amplification. Two research questions permeated this first iteration: 1. To what extent can the target group perform the musical material of Twenty Twenty as an MPO? and 2. What conclusions could be drawn based on the results and related to the three criteria: easy access, mobile and artistically rewarding? The graphic interfaces of the instrument were slightly different in this first cycle, with the number of fields one could interact with being the major difference. The experience of participating in the performance in addition to the reflexive notes of the first author and the audio/video recording had provided a great deal of data to reflect on. In terms of easy access, the platform proved to be easy to understand. The schoolchildren could after only a few minutes during the first rehearsal already perform sounds on the three different instruments. The performance instructions, illustrated by the animated notation, was also shown to be easy to understand for the target group. The availability of the platform was seen as good, since the smart phones used were different brands and models, and we did not spot any major technical problems. The use of monitor speakers to amplify the mobile phones was evaluated as a less successful strategy considering the mobility criteria. All speakers needed a power cord, and a great deal of time and effort was needed for the speaker setup. The main challenge was related to the criteria of artistically rewarding, where several issues were revealed. At several times during the performance, the MPO performers lost their focus, which resulted in a non-satisfactory artistic expression. Since the data indicated the platform to be easy access, the analysis pointed towards issues for the platform to maintain the level of engagement of the participants during the performance. Looking at the data, a pattern emerged that after longer pauses for the performers they lost a bit of their engagement and focus for the performance. Other factors we considered as having an effect on motivation were the large number of participants and their young age, or perhaps a combination of the two. In terms of the musical material, the rhythmic patterns were shown to have low precision, resulting in a non-satisfactory artistic expression. Looking at the data, one factor was likely that the MPO performers needed to look down at their instruments to hit the right field, which often made them miss the accurate triggering time indicated by the animated notation. The data also showed that the wrong sounds were quite often triggered when using Instrument 1. Furthermore, the dynamics of the sounds of the MPO in relation to the acoustical sounds of the chamber ensemble were not satisfactory. However, the data also indicated that some music material could be performed successfully by the MPO. Especially the performance of some sustained atmospheric textures and granular textures using Instruments 2 and 3 in multiple parts were seen as interesting. Moreover, some granular textures in various densities performed by Instrument 1 were also for seen as interesting artistic expressions.

5.2 Second Iteration: Stand-alone MPO

The target group in the second iteration consisted of 13 schoolchildren at the age of 13 years old. The musical material being tested focused on Instrument 2. The iteration focused on a six-minute performance of Voyage One - a slow tempo minimalistic polyphonic piece for stand-alone MPO based on six individual melody lines. Since Instrument 2 could hold only four fundamental sounds, each melody line was limited to four notes. Thirty minutes of instructions/rehearsal proceeded the

performance, which took place in a small auditorium.[1] The MPO performers were instructed to avoid looking down at their instruments to maintain focus on the animated notation. The animated notation was projected on a large canvas in front of the performers. No amplification was used for the sounds of the phones. The research question was: To what extent can the target group perform polyphonic melody lines in six individual parts as an MPO? Going through the collected data from the performance, the results showed that the target group could perform polyphonic melody lines at a slow tempo. The key to the result was analysed due to the MPO performers being able to perform following the animated notation without the need to look down at the instrument interfaces. The data also indicated that the musical material affected the motivation of the performers. When the polyphonic melody lines were the focus of the expression, the MPO performers seemed to get more motivated and focused on the performance. However, the sound quality of the phones was thin. Amplification is preferable. Still, the absence of external speakers made the platform mobile and easy access. The number of participants and the age of the target group made the platform more artistically rewarding than in the first cycle. However, the number of participants would preferably be more than two to three on each part to accomplish an orchestral sound as the artistic output.

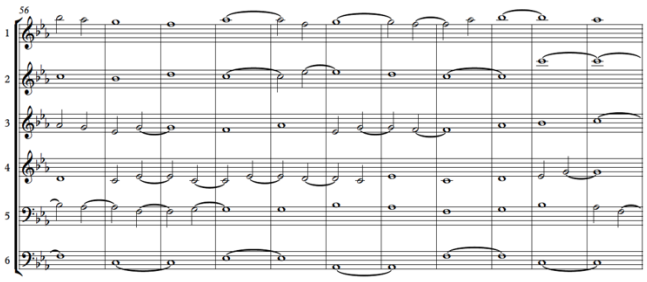

Figure 6. Transcribed polyphonic melodies in Voyage One

5.3 Third Iteration: MPO + Sinfonietta

The overall layout was changed to make better use of the limited space a touchscreen offers. In addition, the platform now had an unlimited number of instruments that each participant could use during a performance. New features were added to the admin section. The main thing was a master volume /dynamics controller, which could control both the volume for each part (1-6) of an MPO and the master volume in real time during a performance. Other features included an amplitude and pitch randomizer for instrument 1 and the ability to change the range of the pitch control in instrument 3. The animated notation had also been adjusted according to results of previous iterations. For Instrument 1, the moving circles was now indicating the tempo of the beat before the triggering point. Instead of just moving in a straight line, they now also moved up and down, with the bounces indicating the tempo. In the animated notation for Instrument 2, a new function was added. A grey circle now appeared to prepare the performer for which field to play on for the next beat. This cycle included a concert performance of Uphonia – a composition for MPO and Sinfonietta. The target group for the MPO was 26 non-music students at the age of 17. Music material to be tested for the MPO consisted of polyphonic melody lines performed in sync with the sinfonietta, sustained atmospheric textures - granular textures in various densities and rhythm accents. The performance of Uphonia took place in January 2019 in a concert hall at a gymnasium in Riga. The MPO performers used their personal smart phones as instruments. Each MPO performer had a small external mobile speaker as amplification. An hour of rehearsal with MPO and an hour of grand rehearsal with MPO together with Sinfonietta Riga preceded the concert.[2] After the concert, the MPO performers answered an evaluation survey. Answers were graded from 1-5 with 1 = does not agree at all! And 5 = Totally agree! Two research questions permeated this cycle: 1. What is the experience of the participating MPO performers? and 2. What conclusions could be drawn based on the results and by focusing on the criteria of artistically rewarding?

1	It was easy to play on the phone instruments?	4,64
2	It was easy to understand the animated notation?	4,73
3	It was fun to play with the MPO platform?	4,46
4	It was a challenge to play without errors?	3,92
5	I would have like to play a more difficult part?	3,88
6	I was inspired to do my best in the concert?	4,57
7	I never played wrong in the concert?	2,68
8	I felt like being part of the music in concert?	4,54
9	It never became boring during the concert?	3,3
10	It was exciting to play with Sinfonietta Riga?	4,88
11	I would like to play in a MPO again?	4,61

Figure 7. Results of survey in third iteration

According to the results of the survey, the target group experienced it as being easy to play and understood the animated notation as an MPO. Furthermore, the target group thought it was fun and exciting to perform as an MPO and together with Riga sinfonietta. In addition, the MPO was motivated and felt like being part of the music during the concert. Indeed, the survey also indicated that some of the participants were bored at some point during the performance. However, the motivation was still high to try their best. From a composer perspective, the audio recording of the performance of MPO was evaluated as artistically rewarding in many respects. Looking at the data, we argue that the high motivation level was a key factor of the high-level artistic output of the MPO. All music material tested with the MPO except for the rhythmic accents was evaluated as being artistically rewarding and as suited for professional concert hall performances. The use of mobile external speakers for each MPO performer made it possible to output sound textures in a wide frequency range. However, as seen in previous iterations, rhythmic patterns and accents were still an issue. Moreover, there were minor issues related to dynamics and balance between the MPO and the sinfonietta. Still, the ability to control the MPO master volume now made it possible to adjust the balance according to the sinfonietta.

6. CONCLUSIONS

This study was based on three iterations, all of which were important to the development process of the performance platform mobilephoneorchestra.com. The results of the findings have shown that the platform could be easily accessed, and was both mobile and artistically rewarding. Furthermore, the findings indicate that a

[1] Video from second iteration: https://youtu.be/z5LGOqmsZGA

[2] Video from rehearsal: https://youtu.be/lsX27q9MyqE

target group for the platform in a professional concert hall performance should be people over 14 years old. The number of participants should be at least 24 people to achieve an orchestral artistic expression. However, more research is needed to completely draw conclusions about appropriate target groups and the number of participants. The findings show that components in the musical material to perform as: number and length of pauses, and types of artistic expression, have an impact on affecting the MPO performers motivation. Moreover, the findings show that the motivation level of the MPO performers deeply affects the quality of the artistic expression in a performance. The musical material that in these findings has been evaluated to be suited for the MPO platform are: slow six-part polyphonic melody lines, sustained and granular atmospheric and noise textures in various densities and dynamics. However, rhythmic accents and patterns are still an issue, at least for performances within professional concert hall settings. Furthermore, the findings show that the platform could enable performance synchronization between an MPO and a traditional ensemble or sinfonietta. We argue that the key to this platform is the animated notation, which can give performance instructions for multiple parts. In addition, instrument interfaces that could be performed on without the need to look down was another key factor of the platform. As a conclusion, this study contributes knowledge with a new example of an MPO platform for concert hall performances. The findings show the ability of the platform to involve novices as performers, but still provides for a high-end flexible artistic expression. We especially highlight the novelty of using an approach combining novel mobile phone instruments and dedicated multipart animated notation, for performances of fixed polyphonic electronic contemporary art music.

Figure 8. MPO in third iteration

7. ACKNOWLEDGMENTS

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